FOCUSED FEASIBILITY STUDY FOR SOURCE CONTROL

Former Deknatel Facility
Queens Village, New York

Prepared for:

Pfizer Inc

Prepared by:

Golder Associates

OJECT No. 923-6103

MAY 1993

Golder Associates Inc.

305 Fellowship Road, Suite 200
Mt. Laurel, NJ USA 08054
Tel: (609) 273-1110
Fax (609) 273-0778

FOCUSED FEASIBILITY STUDY
FOR SOURCE CONTROL
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NEW YORK

Prepared for:

Pfizer Inc
235 East 42nd Street
New York, New York 10017

Prepared by:

Golder Associates Inc.
305 Fellowship Road, Suite 200
Mt. Laurel, New Jersey 08054

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May 28, 1993

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Project No.: 923-6103

New York State Department of Environmental Conservation
Region 2 - Hazardous Waste Remediation
47-40 21st Street
Long Island City, NY 11101

Attention: Mr. Shaminder Singh

RE: FOCUSED FEASIBILITY STUDY FOR SOURCE CONTROL
FORMER DEKNATEL FACILITY, QUEENS VILLAGE, NEW YORK

Gentlemen:

On behalf of Pfizer Inc (Pfizer), Golder Associates Inc. (Golder) is pleased to present eight copies of a Focused Feasibility Study (FFS) for the former Deknatel facility located at 96-20 222nd Street in Queens Village, New York (Site). The FFS is being submitted in compliance with the Order on Consent effective March 4, 1992. It is our understanding that the New York Department of Environmental Conservation will distribute copies of this FFS to the appropriate parties.

This FFS follows a Remedial Investigation Report (RI) prepared by Recra Environmental, Inc. (Recra) in conjunction with Roux Associates, Inc. (Roux). The draft RI was issued in October 1992 and finalized in May 1993. This FFS has been prepared in accordance with the NYSDEC Technical and Administrative Guidance Memorandum for the Selection of Remedial Actions at Inactive Hazardous Waste Sites (TAGM). This FFS is being submitted concurrently with an Off-Site Ground-Water Investigation and Additional Source Investigation Report (OGI/ASI), which was prepared by Roux.

In summary, the previous investigations indicated that areas in the southern portion of the Site have been impacted primarily by hexavalent chromium as a result of previous disposal practices. This FFS evaluated two alternatives for source control of the impacted soil specifically: excavation and replacement (Alternative 1); and, in-place (in-situ) stabilization (Alternative 2). Both alternatives satisfy criteria discussed in the TAGM and would be protective of human health, the environment and future off-Site groundwater. However, as described in the attached FFS, there are distinct factors and circumstances that favor the use of Alternative 1 at this Site. Pfizer, therefore, recommends the implementation of excavation and replacement (Alternative 1) as the source control remedy.

If you have any questions or require additional information, please contact us.

Very truly yours,

GOLDER ASSOCIATES INC.

Walter W. Burke, P.E.
Senior Project Manager

Randolph S. White, P.E.
Senior Project Manager

cc: Mr. Steven Kemp/Pfizer Inc

WWB/RSW:drs
Z:FSFMAYCL

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1.0 INTRODUCTION

Pfizer Inc (Pfizer) presently owns (through one of its wholly owned subsidiaries) property located at 96-20 222nd Street in Queens Village, New York (the Site). The Site was previously owned and manufacturing operations were conducted by Deknatel, Inc., a business formerly owned by Pfizer. This report presents a focused Feasibility Study (FFS) to remediate impacted soils resulting from the Deknatel operations conducted at the Site.

It is the intention of Pfizer to begin implementation of a remedial action, as quickly as possible, which is protective of human health and the environment and also permits unrestricted, post-remediation site use. Based on the work completed to date, it is Pfizer's opinion that source control, consisting of removal and replacement of the impacted soils, would best achieve these objectives.

This document follows a Remedial Investigation Report (RI) which was prepared by Recra Environmental, Inc. (Recra) in conjunction with Roux Associates, Inc. (Roux). The RI was issued in October 1992 and finalized in May 1993. This FFS is being submitted concurrently with a May 1993 report prepared by Roux entitled: Off-Site Ground-Water Investigation and Additional Source Investigation (OGI/ASI).

1.1 Site Description

The Site is located in the eastern portion of Queens County, New York near the Queens County-Nassau County border as shown on Figure 1. The Site is bounded by 222nd Street to the east, the Long Island Railroad (Railroad) to the south, and private properties to the north and west. The property measures approximately 200 feet along 222nd Street, by 100 feet along the Railroad right-of-way. An existing three story reinforced concrete main building, which measures 190 feet by 45 feet, in plan, is approximately 10 feet from the property line along 222nd Street and abuts the property line with the Railroad. Former laboratory and pump house structures are connected to the southwestern portion of the main building. Directly west of the main building, portions of the property are paved or covered with packed gravel. East of the building, along 222nd Street, the site is grass covered. Figure 2 provides a schematic site plan showing the predominant physical features.

Land use in the surrounding area is primarily mixed commercial/light industrial and residential. Urban residential areas are located to the southwest across the Railroad, and to the north and northeast of the Site. A single unit residence is located directly north of the Site.

1.2 Site History

1.2.1 Source Investigation Study and Remedial Investigation

The following paragraphs present a summary of historical events, as presented in the RI, and which were pertinent to the preparation of this FFS report.

An internal environmental audit of the Site conducted by Pfizer revealed the existence of two (2) inactive former disposal points. The disposal points reportedly received spent acid waste resulting primarily from the former costume jewelry and surgical needle manufacturing processes.

The first of the disposal points, identified on Figure 2 as DP-1, is a cistern located at the southwestern corner of the Site. DP-1 received wastes (spent nitric-sulfuric acid containing copper salts), from approximately 1925 through 1956, which were reportedly washed down a sink using large volumes of water and discharged to DP-1 where they percolated into the ground. From 1956 to 1960, wastes (spent chromic-sulfuric acid containing copper salts) were reportedly disposed of in the same manner.

As illustrated on Figure 2, a second disposal point, DP-2, is located at the south central portion of the Site. Wastes (spent chromic-sulfuric and phosphoric acids both containing metal salts and possibly lead from the liner of an electropolishing bath) were reportedly emptied directly into a cistern consisting of two wooden barrels embedded in the ground from which the wastes would then percolate into the ground. These wastes were reportedly discharged at DP-2 for an approximate 20 year period beginning in 1956. Manufacturing operations ceased at the Site in 1990 from which time the Site has remained inactive.

As a response to the audit identification of the two disposal points (DP-1 and DP-2), a Source Investigation Study (SIS) was performed in 1988 to determine if the waste material remained on-Site and if groundwater beneath the Site was impacted. The results of the SIS indicated that soils surrounding DP-2 have varying levels of chromium and to a lesser extent other metals. The RI report indicated that at DP-1, the concentrations of chromium were lower than at DP-2 and were more localized in their extent. The SIS identified chromium as the principal waste constituent present in soils. Groundwater levels of chromium, yielded by one of three sampling events, exceeded the New York Department of Environmental Conservation (NYSDEC) groundwater standard of 50 μg/L.

After the SIS report was submitted to the New York State Department of Environmental Conservation (NYSDEC), the Site was listed on the NYSDEC list of Inactive Hazardous Waste Sites. Subsequently, a NYSDEC Phase I investigation was performed in 1989. Following the completion of the Phase I investigation, the Site was classified by NYSDEC as a Class 2 facility. Subsequently, Pfizer submitted a Workplan for a Remedial Investigation/Feasibility Study (RI/FS) to NYSDEC in August 1989.

In accordance with an Order On Consent (effective March 4, 1992) issued to Pfizer by NYSDEC, the RI was implemented at the Site. Sampling and analysis of soils during the RI confirmed that chromium (Cr), specifically hexavalent chromium (Cr^{+6}), is the primary soil constituent of concern resulting from past disposal activities. To a much lesser extent, other inorganic constituents including lead were also detected within some of the areas identified as being impacted by Cr^{+6}.

The RI assessed the extent of on-Site Cr^{+6} impacts and indicated that the majority of the Cr^{+6} disposed of at the Site is in the subsurface soils adjacent to DP-2. The RI report identified these impacted soils as a potential source of Cr^{+6} impacts to groundwater quality. The maximum concentration of Cr^{+6} detected in groundwater on-Site during the RI was 300 $\mu g/l$ at a monitoring well (Well MW-5) located approximately 35 feet west of DP-2.

Regarding the potential for off-Site impacts, the RI determined that Cr^{+6} was not impacting Jamaica Water Supply Company (JWSC) wells identified within one mile or at greater distances from the Site based on the data reviewed in the SIS. In addition, Cr^{+6} was also not detected in the JWSC wells (within one mile of the Site) during 1992. The RI concluded that these data continue to suggest that levels of Cr^{+6} detected on-Site were not impacting utilized JWSC public groundwater wells. The RI also concluded that Cr^{+6} is the constituent representing a degree of groundwater impairment from past Site disposal activities and that feasible Cr^{+6} source control measures would be an appropriate remedial strategy.

The RI report was submitted to NYSDEC in October, 1992. The NYSDEC provided written comments to the RI on January 6, 1993 and the RI report was finalized in May 1993. That report should be consulted for additional details regarding the SIS and RI. A summary of the RI results pertinent to this FFS is presented in Section 2.0 of this report.

1.2.2 Off-Site Groundwater Investigation and Additional Source Investigation

Concurrent with the preparation of this FFS, and in accordance with a meeting held with NYSDEC on December 17, 1993, Pfizer implemented additional groundwater studies to assess potential impacts on groundwater quality at the southwest corner of the Site and at selected off-Site areas. The following paragraphs summarize portions of a May 1993 report prepared by Roux entitled Off-Site Ground-Water Investigation and Additional Source Investigation (OGI/ASI). That report is being submitted concurrent with this FFS and should be consulted for further details regarding the OGI/ASI.

The off-Site groundwater investigation (OGI), which was performed in two phases, included the installation of seven off-Site monitoring wells and one on-Site monitoring well (Well MW-7). The additional source investigation (ASI) included the installation of two on-Site monitoring wells (Wells MW-10 and MW-11) and eight test borings (Borings TB-9 through TB-16). During the OGI/ASI a pit, with concrete walls and an earthen base, was discovered in the southeastern corner of the main building. The pit is about five feet deep and three feet long and extends approximately two feet on either side of the eastern building line. The pit is suspected to be related to the building sewer system which traverses the southern portion of the main building and the laboratory. There is no historical evidence to indicate that the pit was utilized as a disposal point. In addition, a former floor drain, in the vicinity of the sewer line, was noted in the laboratory building. Figure 3 illustrates the locations of all on-Site monitoring wells and test borings, the pit and the previously discussed disposal points (DP-1 and DP-2).

The OGI/ASI report indicated that, except for off-Site monitoring wells MW-8, MW-12 and MW-13, none of the other off-Site monitoring wells contained detectable concentrations of Cr^{+6}. Cr^{+6} was detected in Well MW-8 at concentrations of 15 μg/L in January 1993 and 10 μg/L during February 1993. Cr^{+6}

was detected in groundwater samples collected on April 13, 1993 from Wells MW-12 and MW-13 at concentrations of 262 µg/L and 1,770 µg/L, respectively. Confirmatory samples collected from Wells MW-12 and MW-13 on April 21, 1993 yielded concentrations of 236 µg/L and 602 µg/L, respectively.

The OGI/ASI report indicated that concentrations of Cr^{+6} in groundwater in the on-Site monitoring wells ranged from not detectable at Wells MW-1, MW-3 and MW-4 to a maximum concentration of 2,020 µg/L at Well MW-7, located at the southwestern corner of the Site. The OGI/ASI report indicates that the highest concentrations of Cr^{+6} (and in turn total Cr) were detected along the southwestern portion of the Site in Wells MW-5 (1,730 µg/L), MW-7 (2,020 µg/L), MW-10 (1,410 µg/L) and MW-11 (298 µg/L). The report indicated that Cr^{+6} concentrations in groundwater generally comprise between 80 and 100 percent of the total Cr concentrations.

The OGI/ASI concluded that the majority of Cr^{+6} in soil is distributed radially around DP-2, consistent with the findings of the RI. In the southwestern corner of the Site, Cr^{+6} impacted soil is believed to extend radially from DP-1. In this area of the Site, the existing data shows soil quality impacts are confined to within a 13 foot radius around DP-1 based on the absence of Cr^{+6} at Borings TB-9 and DP-1A. However, shallow soil in the southwestern Site corner (Boring TB-15) appears to have been impacted by surface spills.

The existing data shows Cr^{+6} impacts attributable to the building sewer system were found to be limited to soil immediately beneath and adjacent to the pit and the former floor drain. In each of these areas, the extent of soil impacts attributable to the sewer system is primarily to soil less than 17 feet in depth. The highest Cr^{+6} impacts in this area were observed at Boring TB-11 from a surface material sample collected at the base of the pit, i.e., 5 feet. In Boring TB-16, located approximately 10 feet west of the pit, the highest Cr^{+6} impacts in that boring, were detected in the 10 to 12 foot sample. The impacts measured at TB-16 are believed to be caused by the sewer line. Further discussion of the results of the OGI/ASI are provided in Section 2.0.

1.3 Objective of the Focused Feasibility Study

Consistent with the conclusions of the RI report, the primary objective of this FFS was to determine the most appropriate alternative for the remediation of Cr^{+6} impacted soil at the Site (source control) in order to minimize potential future impacts to groundwater quality. Identification and analyses of remedial alternatives have been prepared in accordance with the NYSDEC Technical and Administrative Guidance Memorandum for the Selection of Remedial Actions at Inactive Hazardous Waste Sites (TAGM); September 13, 1989 as revised May 15, 1990. This guidance allows for a focused identification and evaluation of remedial alternatives at a site if these alternatives are readily apparent and well proven. Therefore, this FFS was conducted using a focused approach and considered a limited number of applicable and well proven remedies. This focused approach was further agreed to during a meeting held with NYSDEC on December 17, 1992.

This FFS is being submitted in accordance with the Order On Consent effective March 4, 1992 and was performed in a manner consistent with the procedures for the detailed evaluation of remedial alternatives described by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the National Contingency Plan (NCP) and the U.S. Environmental Protection Agency (USEPA) guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," dated October 1988. In addition, the detailed analysis of remedial alternatives considered in this FFS was also performed in a manner consistent with the procedures described in the "Workplan For A Supplemental Remedial Investigation/Feasibility Study At The Deknatel Facility, Queens Village, Long Island, New York", (Recra, 1989).

2.0 NATURE AND EXTENT OF SOURCE AREA

The data, interpretations and evaluations presented in the RI and OGI/ASI reports were used in the preparation of this FFS. The RI report was prepared by Recra Environmental, Inc. (Recra) in conjunction with Roux Associates, Inc. (Roux), submitted to NYSDEC in October 1992 and finalized in May 1993. The OGI/ASI report was prepared by Roux in May 1993.

The investigation of the chromium source area at the Site was conducted in three Phases: SIS (1988), RI (1992) and OGI/ASI (1993). A total of over 330 soil samples were collected from 29 on-Site soil testing and monitoring well borings and seven off-Site monitoring well borings. Soil samples were collected in discrete intervals from the ground surface to depths of over 70 feet which extended below the groundwater table (approximately 54 feet below grade based upon 1993 data). Initially, the locations of the on-Site borings were generally centered around DP-2 and extended radially outward as the investigation progressed. During the OGI/ASI, borings were advanced in the southeastern corner of the main building to investigate the pit and the suspected building sewer line. In addition, test borings and monitoring wells were also located in the southwestern corner of the Site to further investigate the area in the vicinity of DP-1. Figure 3 presents the locations of the on-Site soil testing and monitoring well borings. Locations of the off-Site monitoring wells are presented in the OGI/ASI report. During the advancement of the borings, blow counts and geologic descriptions of the soil samples were recorded. All field work and sample collection were performed by Roux.

Selected soil samples were analyzed for parameters which included metals (including Cr^{+6}), other inorganic constituents (nitrate, sulfate and phosphate), TCLP, TCL organic compounds and geotechnical parameters (grain size distribution). Analytical testing of soil samples were performed by Recra

Laboratories, Inc. Laboratory analyses for the RI and OGI/ASI were performed in accordance with the 1991 NYSDEC Analytical Services Protocol. Copies of the soil sample laboratory data analyses summary tables from the SIS, RI and OGI/ASI reports are presented in Appendix A. The results of a limited geotechnical laboratory testing program by Golder Associates Inc. are presented in Appendix B.

2.1 Conclusions of Previous Investigations

The major conclusions reached during the previous investigations are presented below. These conclusions have been summarized, to the extent necessary, to provide a technical basis for the identification and evaluation of remedial source control alternatives.

2.1.1 Disposal Point DP-1

It was estimated in the RI, that given the historical use of DP-1, approximately 670 pounds of chromium were disposed of at this location. The soil data available at the time of the RI indicated that only a small portion of this material remained at DP-1. The RI report also indicated that the majority of the waste material has reportedly been flushed from the soil by the large volumes of water historically used in the process. The RI report concluded that DP-1 was not considered to be a significant source area.

The OGI/ASI report, prepared subsequent to the RI, reported that Boring TB-15 encountered concentrations of Cr^{+6} greater than those previously disclosed in Boring DP-1. Samples recovered from the 0 - 2 foot and 5 - 7 foot depth intervals contained Cr^{+6} concentrations of 46.7 mg/kg and 1.1 mg/kg, respectively. The Cr^{+6} concentration was 37.4 mg/kg in the 10 - 12 foot sample interval and decreased to 0.23 mg/kg in the 35 - 37 foot sample interval.

The OGI/ASI report indicated that the Cr^{+6} contained in the upper samples (0 - 2 foot and 5 - 7 foot depth intervals) in Boring TB-15 appear to be attributable to a surface source (possibly a localized surface spill). However, below a depth of about eight feet (the base of DP-1), the Cr^{+6} and total Cr present in the soil samples has been attributed to subsurface migration from DP-1.

2.1.2 Disposal Point DP-2

The area immediately adjacent to DP-2 is historically considered to be the major chromium source area. A large fraction of the chromium present within the soil at the site exists in the vicinity of DP-2 within a radial distance of 20 feet and within the upper 30 feet of soil.

2.1.3 Hexavalent Chromium - Primary Source Constituent

As presented in the RI, chromium impact is the major concern resulting from past disposal activities at the Site. Based on the analytical test results reported in the RI report and subsequent OGI/ASI report, detected (soil) levels of total Cr, consisting of Cr^{+6} as well as trivalent chromium (Cr^{+3}), ranged from 3.5 mg/kg to 25,800 mg/kg and Cr^{+6} ranged from not detectable to 4,610 mg/kg. As presented in the RI report, Cr^{+3} is relatively insoluble and exhibits little or no toxicity. The data indicate that the areal and vertical extent of Cr^{+3} is, in general, similar to the extent of Cr^{+6}. Cr^{+6} is the primary constituent of concern in the source area because of its higher solubility and resulting mobility in an aqueous environment, and its toxicity.

This FFS, therefore, addresses the remediation of the source area as defined by the distribution of Cr^{+6} which will in effect also address the large majority of Cr^{+3}. The distribution of Cr^{+6} is discussed in Section 2.2.

2.1.4 Fate and Transport of Cr^{+6}

The RI report concluded that based on the measured values of pH, oxidation-reduction potential (Eh) and the presence of ferrous iron (Fe^{+2}), conditions exist at the Site which are conducive for the in-situ reduction of Cr^{+6} to the less mobile and less toxic Cr^{+3}. The RI report further stated that the kinetics of the Cr^{+6} reduction will occur at a quicker rate in saturated soil due to the additional presence of soluble iron (Fe^{+2}). This geochemical environment may explain why there is such a low proportion of Cr^{+6} to the total chromium detected in soil.

2.1.5 Other Inorganic Constituents

Certain other metals which were detected above background levels during the SIS and RI included aluminum, antimony, cadmium, copper, iron, lead, manganese, nickel, vanadium and zinc. Except for lead, the measured concentrations of these metals are close to the background levels or are less than their respective NYSDEC draft cleanup guidance level based on ingestion as the route of exposure. Lead exceeded the NYSDEC draft cleanup guidance level (250 mg/kg) at five locations within twenty feet of DP-2. At DP-1, lead concentrations exceeding the guidance level were limited to depths of between eight and 12 feet below the ground surface.

2.1.6 Organic Constituents

Several soil samples exhibiting elevated levels of chromium were analyzed for TCL organic compounds. The volatile and non-volatile organic compounds detected, were estimated at low levels (parts per billion), suspected of being laboratory artifacts and were otherwise not considered by the RI report to be a significant concern as a source to groundwater impacts at the Site.

2.1.7 Non-Hazardous Classification

Two soil samples were collected in the immediate vicinity of DP-2 and were analyzed for Toxicity Characteristic Leaching Procedure (TCLP) metals. The leachable concentrations of total Cr were one order of magnitude below the RCRA criterion of 5 mg/L. Specifically, Sample DP-2N (4 - 6 feet) contained 2.0 mg/kg of Cr^{+6} and 450 mg/kg of total Cr. The results of the TCLP testing for this sample was 0.038 mg/L of Cr^{+6} and 0.209 mg/L of total Cr. In addition, Sample DP-2S (6.5 - 7.5 feet) contained 1,870 mg/kg of Cr^{+6} and 11,000 mg/kg of total Cr. The results of the TCLP testing for this sample was 0.082 mg/L of Cr^{+6} and 0.369 mg/L of total Cr.

Further, the wastes discharged at DP-1 and DP-2 from the former processes conducted at the Site as described in Section 1.2 do not meet any of the F or K listed process waste codes in 6NYCRR Part 371 (i.e., electropolishing is not a metal finishing or electroplating process). Because the process wastes are not discarded commercial chemical products, they are not P or U listed wastes. As indicated by the RI report, the wastes consist of spent acids resulting from electropolishing operations.

Therefore, given the above, the chromium impacted soils tested at the Site are not characteristic hazardous wastes nor are the former process wastes discharged at the Site listed hazardous wastes in accordance with RCRA or 6NYCRR Part 371. While the impacted soils are expected to yield similar results, further TCLP testing will be performed to verify the non-hazardous characteristics of the soil prior to any off-Site disposal.

2.1.8 Geologic Materials Encountered

The RI indicates that the Site soils, overlying crystalline bedrock, consist of the following, in order of increasing depth: glacial deposits; Magothy Formation; and, Raritan Formation. The subsurface explorations were limited to the surficial glacial deposits which regionally consist of till, moraine and glacial-fluvial outwash deposits. The RI indicates that in the vicinity of the Site, the glacial deposits consist of glacio-fluvial outwash deposits consisting of sands and gravels with minor fractions of silt and clay. An unconfined groundwater table exists within these deposits which are referred to as the Upper Glacial Aquifer. In the borings performed for the RI, water was generally encountered at depths of 51 to 54 feet below ground surface; however, based on more recent explorations, this FFS estimates groundwater to be at a depth of 54 feet. The RI report should be consulted for the boring logs included in that study. The OGI/ASI report should be consulted for subsurface explorations performed subsequent to the RI.

Subsequent to the SIS and RI, soil samples were collected by Roux from three depth intervals (15 - 17 feet, 30 - 32 feet and 45 - 47 feet) in Borings TB-9 and TB-10 and Wells MW-10 and MW-11. From these explorations, samples from common depth ranges were combined together to form three separate composite soil samples. The composite samples were analyzed by Golder Associates for geotechnical classification parameters. In general, the test results indicated that the composite samples submitted to Golder consisted of fine to coarse and fine to medium sands with less than about 5 percent fines and up to 20 percent gravel. The soils tested had a specific gravity of 2.6 with an organic carbon content of 0.5 percent; moisture contents ranged from 4.1 percent to 5.5 percent. The results of these analyses are provided in Appendix B.

As indicated above, the Site surficial soils are predominantly granular glacial outwash materials. Based on a review of the available boring logs and the accompanying standard penetration test blow counts, it is inferred that oversize (gravel to cobble-size) material was encountered in many of the borings as evidenced by sample descriptions and high sampling resistance (SPT blow counts). Based on the results of the borings, it is inferred that gravel or cobbles are present in the Site soils, at various depths. However, as a generalization, it appears that a near-surface gravel/cobble zone was encountered at a depth of about eight to 12 feet and another zone was disclosed at about 25 to 30 feet in depth. Other similar zones may exist at other depths between the sample intervals or at locations not explored by the borings.

2.1.9 Groundwater Quality/Hydrogeology

The following general conclusions are based on the results of the RI and subsequent OGI/ASI reports.

1. Groundwater flow beneath the Site is toward the west and southwest at an average horizontal gradient of 0.0014 ft/ft and at a rate of approximately 1 foot per day. However, because of the flat hydraulic gradient, changes in precipitation recharge or local use may temporarily alter the local direction of flow.

2. The water table elevation has risen approximately eight feet over the last four years (1988 through 1992).

3. Groundwater sample analyses have shown that chromium is the primary constituent resulting, from historical practices, that has impacted groundwater quality.

4. In on-Site groundwater, Cr^{+6} was at non-detectable to low (10 μg/L) concentrations at side gradient (MW-1 and MW-3) and upgradient (MW-4) wells, respectively. Beneath the southwestern corner of the Site, at Wells MW-5 and MW-7, maximum Cr^{+6} concentrations were 1,730 and 2,020 μg/L, respectively, which exceed NYS Class GA Groundwater Quality Standards (50 μg/L). In the south central portion of the Site, at Well MW-11, the maximum concentration of Cr^{+6} in groundwater was 298 μg/L. In addition, copper and lead were also detected above NYS Class GA Groundwater Quality Standards on-Site.

5. To the west and downgradient of the Site, Cr^{+6} concentrations in the wells located closest to the Site ranged from 236, in Well MW-12 to 1,770 μg/L, in Well MW-13. Also, copper and lead concentrations exceeded NYS Class GA Groundwater Quality Standards. However, in wells located 120 feet west or 160 feet southwest of the Site, copper, Cr^{+6} and lead concentrations were within permissible limits.

Both the RI and OGI/ASI reports should be consulted for a more comprehensive description of groundwater quality and hydrogeology.

2.2 Distribution of Hexavalent Chromium In Soil

Based on the results of the RI, supplemented with the results of the OGI/ASI, the majority of Cr^{+6} impacted soil at the Site extends radially from DP-2. Inspection of the data indicates that the large majority of Cr^{+6}, at concentrations greater than 0.5 mg/kg, are situated within a radius of about 20 feet from DP-2 and to a depth of approximately 30 feet below the ground surface. A smaller amount of Cr^{+6} impacted soils, at concentrations less than 0.5 kg/mg, extend to Boring TB-9, located about 32 feet southwest of DP-2.

At Well MW-10, Cr^{+6} was detected in the 0 - 2 foot depth sample at a concentration of 202 mg/kg. This location is adjacent to a former floor drain in the approximate center of the laboratory building. It is worth noting that, at Well MW-10, Cr^{+6} levels quickly decreased with depth and, below seven feet, were found at concentrations equal to or less than 1.6 mg/kg.

During the OGI/ASI, Boring TB-15 was performed in the southwestern corner of the Site, approximately 8 feet to the west of DP-1. As previously noted, Cr^{+6} concentrations in Boring TB-15 were significantly higher than those previously indicated in the RI report for samples obtained from Boring DP-1 at similar depth intervals. In Boring TB-15, the Cr^{+6} concentration in the 10 - 12 foot sample (the approximate base of the DP-1 cistern) was 37.4 mg/kg and decreased to 0.23 mg/kg in the 35 - 37 foot sample. It should also be noted that in Boring TB-9, located about 12.5 east of DP-1, Cr^{+6} did not exceed 0.33 mg/kg.

Lacking other data, it is inferred that the Cr^{+6} impacted soil, attributable to DP-1, extends radially from DP-1 to a maximum concentration at a radius equal to the distance from DP-1 to TB-15 and decreases to relatively low concentrations at a radius equal to the distance from DP-1 to TB-9. It is inferred that the Cr^{+6} impacted soil configurations, resulting from DP-1 and DP-2, essentially abut at or near Boring TB-9. The lower concentrations of Cr^{+6} in the DP-1 samples (relative to those in the Boring TB-15 samples) are attributed to the flushing action of water which was discharged into the DP-1 cistern from a sink.

In the near-surface samples from boring TB-15 (recovered from the 0 - 2 foot and 5 - 7 foot depth intervals) Cr^{+6} concentrations were 46.7 mg/kg and 1.1 mg/kg, respectively. This Cr^{+6} impacted soil is believed to have been caused by a relatively localized surface spillage, since these samples are above the reported base of the DP-1 cistern.

During the OGI/ASI, Borings TB-11, TB-14 and TB-16 were performed in the southeastern corner of the main building to investigate the sewer system. Soil samples were collected from a boring (TB-16) located adjacent to the suspected sewer line. Soil samples were also collected from explorations through the pit (Boring TB-11) and adjacent to the pit (Boring TB-14) which is suspected to have been impacted by the sewer system.

In this area of the Site, Cr^{+6} concentrations were significantly lower, relative to those identified in DP-1 and DP-2. The maximum Cr^{+6} concentrations in the area of the pit were contained in the samples obtained from Boring TB-11 which was located in the northwestern corner of the pit. In Boring TB-11, the Cr^{+6} concentration was at a maximum of 4.1 mg/kg in the 5 - 7 foot sample (the base of the pit) and decreased to 0.16 mg/kg in the 20 - 22 foot sample. Elsewhere in this area of the Site, Cr^{+6} concentrations ranged, between non-detectable and 0.82 mg/kg. Lacking other data, it is inferred that Cr^{+6} impacted soils extend five feet radially beyond the eastern limits of the pit, which is the distance from the center of the pit to Boring TB-14. Furthermore, samples in this area of the Site, below a depth of 22 feet, contained Cr^{+6} at concentrations less than 0.5 mg/kg.

3.0 LIMITS OF REMEDIATION

3.1 Development

Consistent with the recommendations and conclusions presented in the RI, conceptual limits of remediation (CLR) were formulated to provide source control of Cr^{+6} impacted soil at the Site. The CLRs are presented on Figure 4. Development of the CLR involved the inspection of the Cr^{+6} concentration data obtained during the SIS, RI and OGI/ASI, trial estimations of the CLR and subsequent contaminant transport modeling to demonstrate long-term effectiveness.

From inspection of the Cr^{+6} concentration data, inferred concentration contours of 0.5 mg/kg were developed for selected depth intervals. The selection of 0.5 mg/kg, as the data evaluation reference, was supported by initial review of the data which indicated a significant majority of the Cr^{+6} impacted soil was contained within this concentration contour. It was further observed that, in general, Cr^{+6} concentrations rapidly decreased to minimal or non-detectable levels outside of the 0.5 mg/kg contours.

After development of the concentration contours, trial CLRs were formulated for DP-1, DP-2 and the pit structure. As a minimum, the trial CLRs were selected to encompass all of the concentration contours at each of the three areas.

It was also recognized that the minimal amount of Cr^{+6} impacted soil remaining outside of the trial CLRs needed to be estimated. From inspection of the Cr^{+6} concentration data, inferred contours representing non-detectable limits were developed for selected depth intervals. It was conservatively assumed that the non-detectable limits represent the possible extent of Cr^{+6} impacted soil. Further, the non-detectable limits were conservatively assigned a Cr^{+6} concentration of 0.1 mg/kg (laboratory detection limit) which then yielded an average Cr^{+6}

concentration of 0.3 mg/kg ([0.5 mg/kg + 0.1 mg/kg] ÷ 2 = 0.3 mg/kg) bounded by the inferred limits of Cr^{+6} impacted soil (0.1 mg/kg contours) and the CLR. From these assumptions, the amount of Cr^{+6} which may remain outside of the CLR above the water table after remediation was estimated. The inferred limits of Cr^{+6} impacted soil and calculations supporting the estimation of post-remediation residual Cr^{+6} weight are included in Appendix C. Figures C.1 and C.2, which illustrate the CLRs and inferred limits of Cr^{+6} impacted soil, respectively, are also included in Appendix C.

Utilizing the estimated residual Cr^{+6} weight, Roux performed an analytical contaminant transport model to verify that the CLRs selected would be protective of future groundwater quality immediately downgradient of the Site. The results of Roux's model are presented in their report entitled "Evaluation of Potential Impacts of Residual Hexavalent Chromium on Ground Water", dated May 28, 1993 which is included in Appendix D. Roux's evaluation concluded that source control utilizing the CLRs formulated as described above would be protective of future groundwater quality in that the estimated residual Cr^{+6} above the present groundwater table would not cause Cr^{+6} concentrations in groundwater immediately downgradient of the Site to exceed 50 μg/L.

3.2 Conceptual Limits of Remediation

The CLRs verified by Roux's report are illustrated on Figure 4. Accordingly, source control of Cr^{+6} impacted soil will consist of the following:

- At DP-1, a 25 foot diameter cylinder, centered about DP-1, would extend to a depth of 15 feet. It should be noted that the conceptual configuration is based on an inferred radial distribution of Cr^{+6} impacted soil. Subsequent to this FFS, additional explorations will be performed to refine the distribution of Cr^{+6} impacted soil in the vicinity of DP-1. As a result of these activities, the actual remediation configuration may differ from that shown on Figure 4. Also specific soil horizons within the CLR may be selectively excavated.

- At DP-2, the configuration shown on Figure 4 would extend as close as practical to the groundwater table, estimated to be at a depth of 54 feet. In consideration of engineering designs or practical construction limitations, the actual footprint may be modified somewhat. However, as a minimum the remediation configuration would encompass the conceptual limits illustrated.

- At the pit structure, an approximately 13 foot diameter cylinder, centered about the pit, and extending to a depth of 22 feet will be remediated. The actual excavation configuration may vary.

The remedial configuration described above for DP-1 and to be discussed in this FFS extends off-Site to the south and west. It is assumed that appropriate permission and approvals to access off-Site properties will be granted so that the remedial action discussed herein can be implemented.

While the objective of the remediation at the Site is to perform source control of Cr^{+6} impacted soil, the CLR discussed above and shown on Figure 4 will also address other constituents present at the Site. As previously discussed, the areal and vertical extent of Cr^{+6} typically also approximates the extent of total Cr. Therefore, effective source control of Cr^{+6} impacted soil will also address total Cr impacted soil. Based on the data presented in the RI and OGI/ASI reports, concentrations of total Cr, at locations outside of the CLRs, are generally within the range of 5 to 15 mg/kg which is similar to those concentrations detected at background Wells MW-1 and MW-4. Based on the data collected, the CLRs will also encompass the Site lead impacted soils.

4.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

4.1 Overview

After several candidate remedial technologies were initially identified, they were first evaluated with respect to implementability coupled with their potential to achieve the stated objective of source control. During the initial cursory evaluation, it was determined that a number of the candidate technologies, while technically feasible at other applications, would not be appropriate at the Site or would not provide any additional benefits at a higher cost of implementation. The candidate technologies, which remained after the initial evaluation, were subsequently assembled into remedial alternatives.

The following candidate technologies were initially considered:

- Soil Removal: Soil removal technologies included conventional excavation techniques (e.g., soldier pile/lagging system, reinforced concrete slurry wall, etc.) as well as removal using a caisson (drilled shaft) drill rig.

- Backfilling: Backfilling included the use of imported, environmentally-clean fill material as well as stabilized, on-Site materials.

- On-Site Soil Treatment: The candidate on-Site soil treatment technologies evaluated included:

    - in-situ soil stabilization;
    - ex-situ soil stabilization;
    - in-situ soil washing; and,
    - ex-situ soil washing.

- Off-Site Disposal: The initial evaluation considered:

    - off-Site disposal at an appropriate, licensed disposal facility; and,
    - re-use of the contaminated soils as aggregate for the preparation of construction materials, such as cement or asphalt concrete.

Because the TAGM allows for a focused identification of remedial alternatives that are readily apparent and well proven, the following technologies were retained following the initial evaluation:

- soil removal using a conventional excavation methodologies;
- backfilling using imported, environmentally-clean imported material;
- off-Site disposal at an appropriate, licensed disposal facility;
- re-use of the contaminated soils as aggregate for the preparation of construction materials, such as cement or asphalt concrete; and
- on-Site soil treatment by in-situ soil stabilization.

4.2 Assembly of Alternatives

4.2.1 General

The retained technologies were assembled into the following remedial alternatives:

Alternative 1 -

Excavation and Replacement: Soil would be removed using conventional deep excavation techniques and the resultant excavation would be backfilled using imported environmentally clean fill. It is envisioned that excavation stability would be maintained using a properly engineered bracing system. However, other excavation support alternatives may also be considered. The soils would be transported to an appropriate off-Site licensed disposal facility and/or used as aggregate for the preparation of construction materials.

Alternative 2 -

In-Situ Stabilization: The soils would be stabilized in-place (in-situ) using soil mixing techniques. Prior to in-situ stabilization, a limited amount of the most impacted soil would be excavated and disposed of off-Site. The volume of the removed soil would be equal to the estimated swelling of the volume within the CLR due to the introduction of the stabilization additives.

For both alternatives, the conceptual limits of remediation (CLR) would be as shown on Figure 4. The CLR at DP-1 would be 25 feet in diameter and would be extended to a depth of about 15 feet below ground surface. This remediation configuration, which is based on an inferred radial distribution of Cr^{+6} impacted soil, would be verified by additional explorations which will be performed subsequent to this FFS. The CLR for DP-2 would extend to the groundwater table, approximately 54 feet in depth below ground surface. The remediation configuration for the pit structure would be approximately 13 feet in diameter extending to a depth of about 22 feet. A further discussion of the recommended remedial alternatives, addressing methodologies, effectiveness and implementability, is presented below.

The development of the CLRs was conservatively considered, such that post-remedial residual Cr^{+6} would have minimal impacts on groundwater quality. The limits of remediation are not based on concentration levels. Therefore, post-remediation sampling, beyond the CLRs, is not required. As discussed previously, the inferred extent of Cr^{+6} will be verified by additional explorations at DP-1 prior to implementing the selected source control remedy.

The remedial source control alternatives evaluated will all share certain common aspects such as mobilization, building demolition, removal of below grade structures, temporary facilities and field engineering controls. The following discussions do not address such common items, in detail.

4.2.2 Alternative 1 - Excavation and Replacement

4.2.2.1 Methodology

This alternative consists of removal of the source soil using excavation techniques. At this time it is envisioned that Alternative 1 would utilize conventional, braced excavation methods. To depths of 20 to 25 feet, the Cr^{+6} impacted soils from the remediation configurations may be removed using a large backhoe. However, depending upon Site constraints, excavation of materials deeper than about 25 feet from the DP-2 source configuration may involve the use of small powered equipment which could be lowered into the excavation. The materials would then be removed using a crane-mounted bucket or a material conveyor system. As indicated above, excavation of the DP-1 and pit configurations may extend to depths of approximately 15 feet and 22 feet, respectively. Excavation of the DP-2 configuration will proceed as close as practical to the water table (approximately 54 feet in depth below the ground surface).

The excavations would be performed in accordance with requirements of the Occupational Safety and Health Administration (OSHA). Due to the Site space constraints and excavation depths, it will not be possible to cut the side slopes to a safe working angle. A number of techniques are available to maintain sidewall stability. The actual method of excavation will be determined following NYSDEC approval of this FFS during Remedial Design. However, at this time, it is anticipated that stability of all excavations would be maintained using a properly engineered structural bracing system as conceptually shown on Figure 5. Due to the granular nature of the Site soils, it is likely that a solider pile/lagging system would be utilized. Because of the potential for encountering gravel or cobbles, the soldier piles may need to be pre-drilled or driven using a large pile hammer. Depending upon practical and structural considerations regarding design of the bracing system, the shape of the DP-2 remediation configuration may change from that depicted on Figure 5. The actual shape of the DP-2 excavation, which will be finalized during the Remedial Design, will, as a minimum, encompass the CLRs shown on Figure 4. During remedial activities, the existing monitoring wells within and near to the excavation footprints would be decommissioned and the remaining monitoring wells would be protected from damage.

The excavated impacted soils would be transported off-Site for disposal at an appropriate, properly licensed facility and/or used off-Site as construction material should regulatory approvals be granted. In addition, below-grade existing structures, such as building footings, the pit structure and the DP-1 and DP-2 cisterns, would be removed and transported off-Site for disposal at an appropriate facility.

Upon completion of the excavation, backfilling would be accomplished using environmentally-clean, imported fill material. To minimize the potential for post-construction settlements and to provide a usable and marketable property, the fill would be placed and mechanically compacted in layers, or lifts. Typically, each lift would be eight to 12 inches thick. In-place density testing would verify that the proper compaction is attained. It would be necessary for the soldier pile/lagging to remain permanently in-place to provide excavation stability during backfilling operations. However, to avoid causing obstructions to potential future development and Site use, the upper portion of the bracing system (typically 10 feet) may be removed as the excavation is backfilled.

During excavation and backfilling activities, proper surface water management measures would be implemented. Such measures may include:

- proper management and handling of direct precipitation and inflow into the excavations using temporary ditches and berms to minimize run-on;
- diversion of collected surface water to off-Site disposal points consistent with current surface water flow patterns (e.g., storm sewers);
- covering the interior of the excavations with temporary tarps, to the extent practical, during rainfall events; and
- management of excavation and filling activities such that a localized low area or sump can be maintained as needed.

4.2.2.2 Effectiveness

Alternative 1 represents a remedial technology which satisfies a NYSDEC criterion of reducing the mobility of the contaminant. While the volume of contaminated material will not be reduced, after removal it will be contained in a controlled and permanent manner (to the extent possible by current technology). Permanent removal of the contaminated materials will result in a remedial action at the Site that will be protective of human health and the environment and will provide unrestricted future site use. The effectiveness of this alternative will be verified by a groundwater monitoring program. Short-term effectiveness with regard to worker exposure and exposure to the surrounding community will be provided by the implementation of appropriate construction/health and safety protocols coupled with proper material handling, surface water management and transportation precautions.

4.2.2.3 Implementability

Alternative 1 represents a well proven and conventional remedial technology which is adapted, in part, from the construction industry and is well suited to this Site. The soil removal procedures described herein are considered routine for similar, or even deeper/larger excavations. Furthermore, in the New York City area, there are several qualified excavation contractors. Because all of the source work will be performed "in the open", quality control and verification procedures can be easily implemented. In the waste disposal industry, proper transportation and disposal practices, including spill control, manifesting and documentation, are well established and accepted.

4.2.3 Alternative 2 - In-Situ Stabilization

4.2.3.1 Methodology

Alternative 2 combines in-situ stabilization with limited initial excavation. In-situ stabilization is a process which introduces additives to the in-place (in-situ) soil. The mixing is accomplished using large specially designed augers, or mixing blades. As the apparatus is advanced into the soil, an additive(s) is injected, typically under pressure, and combined with the soil by the rotating action of the augers/mixing blades. Stabilization is performed by establishing a pattern consisting of overlapping cylinders as illustrated on Figure 6.

Prior to stabilization, existing below-grade structures would be removed. These include building foundations, the pit, and the DP-1 and DP-2 cisterns. Conversations with specialty contractors that perform in-situ stabilization indicate that the introduction of additives during the stabilization process can result in a volume increase (swell) of up to 25 percent depending upon the materials to be treated. For this FFS, it has been conservatively assumed that in-situ stabilization will result in an approximately a 25 percent volume increase within the CLRs. To compensate for this swelling, a limited initial excavation, at each area to be remediated, will be performed prior to in-situ stabilization. The actual swell estimate would be refined during the Remedial Design. To the extent possible, the initial excavation would attempt to remove the most impacted soils, such as at DP-2 and around the DP-1 cistern. The excavated materials would be transported off-Site to an appropriate disposal area similar to Alternative 1.

Following initial excavation, in-situ stabilization of the CLRs would be performed. In-situ stabilization of the DP-2 remedial configuration would extend, as practical, to the groundwater table (approximately 54 feet below ground surface). In-situ stabilization within the DP-1 and pit CLRs would extend to depths of approximately 15 feet and 22 feet, respectively. As needed during the remedial activities, proper material handling protocols, control of surface run-on (at the ground surface) and direct precipitation (into the excavations) would be implemented as discussed for Alternative 1.

For this Site, additives would be used to improve the chemical and physical characteristics of the impacted soils. As a chemical-treatment step, a reducing agent would be introduced to maximize the potential for reducing Cr^{+6} to Cr^{+3} which is less mobile in water and less toxic. While the reducing agent will help immobilize the Cr^{+6}, this procedure will not improve the physical/strength characteristics of the treated soils or decrease the permeability to further immobilize the Cr^{+6}. Without another additive, the mixing action would most likely result in a loosened permeable and settlement-prone treated soil mass. Therefore, concurrent with the chemical reduction step, in-situ stabilization would also mix a cementing additive, such as portland cement, (possibly with bentonite) into the soil. The purposes of the cementing additive would be to produce a stabilized soil mass with an in-place strength equal to or greater than that of the existing soils and a permeability considerably less than that of the existing soils.

A small on-Site batch plant, or pug mill, would be established to prepare the additives for injection. Selection of the appropriate type and amounts of the reducing agent and cementing additive would be based on treatability studies to be performed during Remedial Design utilizing TCLP testing as one performance standard.

4.2.3.2 Effectiveness

Alternative 2 represents a remedial technology which satisfied the NYSDEC criteria of treatment by reducing the toxicity and mobility of the contaminant by solidification/chemical reduction. In-situ stabilization of the contaminated materials will result in a permanent remedial action that will be protective of human health and the environment. However, because this method is in-situ, complete mixing and effectiveness cannot be visually verified during construction. As indicated in the RI report, the geochemical environment at the Site should be conducive to methods which reduce Cr^{+6} and Cr^{+3}. As with Alternative 1, the permanence of this alternative will be verified by the implementation of a groundwater monitoring program. It should be noted that in-situ reduction of Cr^{+6} to Cr^{+3}, as yet, does not have a proven long-term track record. Therefore, the groundwater monitoring program for Alternative 2 would be maintained somewhat longer than for Alternative 1. With regard to the limited soil removal phase, short-term effectiveness will be promoted by the implementation of proper construction, transportation and material handling procedures as indicated for Alternative 1. With regard to the in-situ stabilization phase, short-term effectiveness would be further promoted since the soil mixing action occurs primarily below the ground surface which reduces exposure of the contaminants to the ambient environment. During all phases of this alternative, proper health and safety protocols would be implemented to minimize the exposure of workers to the contaminants.

4.2.3.3 Implementability

Alternative 2 also represents a proven remedial technology which may be suited to this Site. The initial limited excavation phase shares all of the aspects previously indicated for Alternative 1. As discussed above, a pattern of overlapping cylinders coupled with a multi-phased stabilization process should promote treatment during the in-situ stabilization phase. However, there are several factors which should also be considered. While there are several specialty contractors able to perform in-situ stabilization it appears that only one is located in the vicinity of the Site and he expressed concern regarding the anticipated subsurface conditions as disclosed by the explorations. As discussed previously, the logs for the on-Site test borings and monitoring wells indicated the likely presence of gravel or cobbles. The presence of gravel/cobble layers may cause delays to the stabilization process, cause the loss of additives or even preclude the use of certain equipment depending upon the size, type or power of stabilization equipment intended for use.

5.0 DETAILED EVALUATION OF ALTERNATIVES

In Section 5.0, the alternatives which have been compiled in Section 4.2, are evaluated in accordance with the criteria outlined in the TAGM. The information presented in Section 3.0 was used as the technical basis for the alternative evaluations. Additionally, potentially applicable Standards, Criteria and Guidance requirements are identified.

5.1 Identification of Standards, Criteria and Guidelines (SCGs)

The remedial alternatives being considered in this FFS were evaluated for compliance with applicable Standards, Criteria and Guidelines (SGCs). The SGCs presented below provide the regulatory requirements and guidance that apply to the remedial alternative being evaluated. Some of the SCGs are dependent upon the classification of the material being remediated and the method of remediation. In particular, the classification of the soil containing chromium and lead can determine the number and type of applicable SCGs. Review of 40 CFR 261, entitled "EPA Regulations for Identifying Hazardous Waste", revealed that the material is not a listed hazardous waste with respect to the manufacturing process used (i.e. electropolishing). Additionally, the material is not a D-series waste by characteristic, since the leachable total Cr, as determined by TCLP tests, is significantly lower than the RCRA criteria. For these reasons, the material being remediated is considered a non-hazardous waste. Therefore, "Land ban" (40 CFR 268) which regulates the disposal of hazardous waste listed in 40 CFR 261 is not applicable.

SCG are typically classified as location-specific, chemical-specific, or action-specific as discussed in the following sections. Table 1 presents a summary of the SCGs evaluated for this FFS.

5.1.1 Location Specific

Location-specific SCGs are restrictions on the concentrations of substances or the conduct of activities entirely due to their location. Of the regulations evaluated, 6 NYCRR 360-8 is a location specific SCGs. This regulation outlines the requirements for landfills located on Long Island which may be relevant if material from the Site (either building demolition debris or soil) is disposed at a Long Island facility. Also applicable would be the solid waste transportation and disposal regulations for the remainder of New York State and other states where appropriate disposal facilities may be located.

The individual solid waste permit for each landfill will determine whether a landfill can receive the material from this Site. Therefore, these permits are also location-specific SCGs.

Regardless of the remedy to be selected, construction is likely to generate noise, dust and traffic. Local laws of New York City have requirements specifically addressing and restricting construction activities. All activities relative to the remedial alternatives, including Site preparation and building demolition, must comply with applicable codes and ordinances.

5.1.2 Chemical Specific

Chemical specific SCG are health or environmental risk based numerical values or methodologies. An example of a chemical specific SCG is 6 NYCRR 371 which establishes the methods and maximum concentration levels for classifying a waste as hazardous. The criteria established in this regulation, as well as the federal version of it, have already been used to demonstrate that the soils tested at this Site do not exhibit hazardous characteristics. Based upon this determination, NYSDEC and USEPA regulations promulgated for hazardous waste are not considered SCG applicable to this Site.

The Draft NYSDEC Cleanup Policy and Guidelines (October, 1991) specify cleanup guidance levels for soils based upon incidental human ingestion for a number of constituents. The cleanup levels for Cr^{+3}, Cr^{+6}, and lead are 80,000 mg/kg, 400 mg/kg and 250 mg/kg, respectively. The soil sample results show that at all locations at the Site, concentrations of Chromium (Cr^{+6} and Cr^{+3}) are less than their respective NYSDEC cleanup guidance level except for at two depth intervals at DP-2 where Cr^{+6} was detected at concentrations of 1870 mg/kg and 4610 mg/kg. NYSDEC TAGM Determination of Soil Cleanup Objectives and Cleanup Levels (November 1992) was initially considered as a potential SCG in this FFS. Because this TAGM does not provide groundwater quality protection guidance for metals nor does it provide direct exposure protection levels different from those specified in the 1991 NYSDEC Draft Cleanup Levels, this TAGM was not considered a chemical specific SCG for source control at the Site. However, it should be noted that based on the available data, the residual concentrations of chromium outside of the CLR would generally not exceed the guidance levels indicated in the TAGM for chromium. 6 NYCRR Part 703.5 was also reviewed with regard to potential impacts to groundwater quality.

5.1.3 Action Specific

Action specific SCGs are technology or activity related requirements or limitations. If wastes are removed from the Site, 6 NYCRR Part 364 governs their transportation. Grubbing, construction and renovation debris, as defined in 6NYCRR 364.1(e)(2)(vii), are exempt from this regulation.

Two other action specific SCG exist which are applicable to the alternatives being considered. Regulation 6 NYCRR Part 360-1.15 provides an exemption for the beneficial use of a solid waste after departmental preapproval. If acceptable to NYSDEC, the New York State Department of Transportation (NYSDOT) and the New York State Department of Health (NYDOH), soil removed from the Site could be used as an aggregate in construction materials such as cement or asphalt concrete.

The Building Code of the City of New York (Building Code) establishes requirements and regulations regarding design and construction. Depending on the remedial alternative selected for this Site, all engineering designs for that alternative will be prepared and implemented in accordance with the Building Code.

5.1.4 Other Requirements

Site remedial activities are subject to regulation 29 CFR 1910.120 which is the Occupational Safety and Health Administration's (OSHA) hazardous waste operations and emergency response standard for the environment. In particular, paragraphs (b) through (n) outline requirements which include, but are not limited to, a site specific health and safety program, personal protective equipment for workers, proper worker training, medical surveillance program for workers, air monitoring program, decontamination procedures, and a site specific emergency response plan.

Another OSHA requirement (29 CFR 1926) outlines the health and safety aspects for excavation construction. These requirements apply to all excavation and bracing activities.

5.2 Detailed Evaluation Criteria

The following criteria outlined in the TAGM will be used to evaluate the alternatives compiled in Section 4.2:

- Compliance with SGCs;
- Overall protection of human health and environment;
- Short-term impacts and effectiveness;
- Long-term effectiveness and permanence;

- Reduction in toxicity, mobility, and volume; and
- Implementability;
- Cost.

This section addresses the specific factors included in each criterion.

The first criterion determines the ability of the alternative to satisfy the SCGs previously identified in Section 5.1 of this FFS. The second criterion evaluates the overall protection of human health and the environment by considering the protection the alternative achieves with time and the reduction of Site risks.

The third and fourth criteria are short-term and long-term impacts, respectively. The short-term impacts and effectiveness assess the effects of the alternative during the construction and implementation phase. The factors considered by this criterion are mitigation of any potential risks to the community, environment or workers, and the implementation schedule. Subsequently, the long-term effectiveness and permanence criterion evaluates the performance of the alternatives as well as the extent and effectiveness of any post-remediation controls that may be required.

The fifth criterion considers the reduction of toxicity, mobility and volume that an alternative may provide. The amount of material impacted by the alternative, treatment components of the alternative, the irreversibility of the alternative and the amount of residual impacted soils or constituents are assessed. The sixth criterion evaluates the implementability of the alternative by addressing the technical and administrative feasibility, as well as the availability of the necessary services and materials. Finally, the last criterion considers the capital, and operation and maintenance costs of the alternative. Note that the cost estimates included herein do not address the engineering costs for Remedial Design or any further Site or off-Site subsurface explorations.

The following section assesses each alternative identified in Section 4.2 relative to these criteria.

5.3 Detailed Analysis of Alternatives

5.3.1. General

A detailed analysis of the two remedial alternatives being evaluated for on-Site source control of Cr^{+6} consists of an evaluation with respect to the seven criteria presented in the previous section. Each alternative was ranked quantitatively with respect to the first six criteria in accordance with the ranking tables (identified in the TAGM as Tables 5-2 through 5-7) which are included in Appendix E. The resulting analysis factor subtotals for both alternatives are summarized on Table 2. Relative costs are addressed by the TAGM but are not ranked by the tables in Appendix E. Costs are discussed herein and cost summaries are presented in Appendix F. Table 3 presents a detailed analysis summary and comparative analysis summary is included as Table 4.

For the sole purpose of completing the ranking tables, the soils being remediated were implied as being hazardous. It should be noted that, in fact, the soils tested did not show hazardous characteristics in accordance with 6 NYCRR Part 371 as described in Section 2.1.7. It was necessary to assume that the soils were hazardous due to the format of the tables. The general methodologies, effectiveness and implementability of the two remedial alternatives being evaluated have been discussed in Section 4.2. Detailed analyses of the alternatives are discussed below.

5.3.2 Alternative 1 - Excavation and Replacement

5.3.2.1 Compliance With SCGs

The results of the evaluation of Alternative 1, with respect to compliance with New York State SCG, are discussed below. Table 1 presents a summary of this evaluation.

Location Specific. Alternative 1 would be implemented in compliance with applicable local and New York City Laws and Ordinances as they relate to requirements such as hours of operation, noise and traffic. Disposal of the building demolition debris and/or excavated material would be performed in compliance with 6 NYCRR Part 360 for landfills located in New York and specifically Long Island, if applicable. For disposal at other licensed facilities, implementation would be performed in compliance with the other states' respective applicable waste disposal regulations. Preliminary contact with several non-hazardous waste disposal permitted facilities in Pennsylvania indicated that disposal of the impacted Site soil would be in compliance with Pennsylvania Department of Environmental Resources (PADER) regulations.

Chemical Specific. The New York Draft Cleanup Policy and Guidelines (October 1991) establishes cleanup guidance levels for Cr^{+6} as 400 ppm, Cr^{+3} as 80,000 ppm and Lead as 250 ppm, which are based on incidental ingestion route of exposure. Generally, both Cr^{+3} and Cr^{+6} were detected at the Site at levels less then these guidance levels except at two depths at DP-2 where Cr^{+6} was detected at concentrations of 1,870 mg/kg and 4,610 mg/kg. Based on the analytical testing performed for the RI, lead was detected at concentrations greater than the guidance levels extending to a depth of 12 feet at the DP-1 source configuration and to a depth of seven feet within the DP-2 source configuration. (At DP-2 analysis for lead was not continued below seven feet in depth). This alternative will permanently remove both the detected Cr^{+6} and lead constituents at concentrations exceeding the cleanup guidance levels. As demonstrated by an analytical contaminant transport model ("Random Walk", performed by Roux and previously presented in Appendix D), the minimal residual mass of Cr^{+6} after implementation of Alternative 1 should not cause Cr^{+6} concentrations in groundwater to exceed the NYS Class GA Groundwater Quality Standard of 50 μg/L.

Action Specific. Off-Site transportation of excavated impacted soils would be performed in compliance with 6 NYCRR Part 364 for transportation in New York State. Off-Site transportation would be performed in compliance with the applicable rules and regulations of other states and the U.S. Department of Transportation. Application to NYSDEC, NYDOT and NYDOH would be required to determine whether the beneficial use of the excavated soil is permissible. All engineering designs will be prepared and implemented in accordance with the New York City Building Code (Building Code), as necessary.

Other Requirements. During implementation of Alternative 1, appropriate health and safety protocols would be developed, in compliance with 29 CFR 1910.120, and proper material handling procedures would be implemented as discussed in Section 5.3.2.1. Safe working conditions would be maintained in accordance with 29 CFR 1926, regarding excavations, as well other applicable OSHA and state safety requirements.

In summary, Alternative 1 can comply with all of the SCG identified above except possibly beneficial use of the excavated soil which is a disposal option of this alternative. As stated above, compliance with New York State requirements for this disposal option will be assessed following the submittal of this FFS.

5.3.2.2 Overall Protection of Human Health and the Environment

This alternative provides overall protection of human health and the environment as described below:

- The permanent and irreversible removal of the DP-1, DP-2 and pit area Cr^{+6} impacted soil, in accordance with the CLR discussed in Section 3.2 and shown on Figure 4, will be protective of future groundwater quality downgradient of the Site. Post-remediation residual Cr^{+6} above the groundwater table should not cause Cr^{+6} concentrations in downgradient groundwater to exceed 50 μg/L.
- Well accepted material handling procedures, dust control techniques, surface water management, health and safety protocols and factors of safety in design will be implemented to protect the surrounding community, environment and health and safety of workers.
- This alternative complies with applicable SCGs.
- The use of compacted clean backfill material will improve the marketability of the Site for future use and would not restrict future Site use activities.
- There are no environmentally sensitive areas such as wetlands or streams at or in the immediate vicinity of the site which would be impacted.

5.3.2.3 Short-Term Impacts and Effectiveness

Short-term impacts would consider protection of the community, the environment and workers during implementation of the remedial action and the duration of remedial construction. During excavation, the primary route of potential exposure to the surrounding community would be the inhalation of any airborne dust containing Cr^{+6}.

Protection of the Community. Excavation of the DP-1, DP-2 and pit CLRs shown on Figure 4 and described in Section 3.2 will involve the removal and off-Site disposal of approximately 4,100 cubic yards of impacted soil.

Appropriate material handling protocols would be implemented to control fugitive dust emissions caused primarily when the excavated soil is dry. The existing perimeter security fence will be augmented and maintained as required. If necessary, a minimum eight foot high wood or plastic construction wall will be built around the Site to reduce the visibility, sound and attraction of the community to construction activities. Appropriate measures to limit the potential for dust production would be implemented. Such measures may include the use of tarpaulins, temporary covers, limited use of water spray and, to the extent possible, limiting exposed soil surfaces. As previously discussed in Section 4.2.2.1, proper control of surface water and direct precipitation into the excavations would be implemented. Soil handling activities would be restricted to a secured area that would include the CLR plus a construction buffer zone, soil transfer equipment area, truck loading area and a decontamination area. A schematic of one such layout is illustrated on Figure 7. Dust control measures will be focused on exposed soil surfaces and equipment as necessary, within this secured area. To the extent practical, it is anticipated that soil will be loaded directly from the excavation into the haul trucks.

To mitigate against the off-Site migration of impacted soils, proper material handling protocols would be implemented. For example, the beds of the haul truck can be lined with oversized plastic sheeting which would extend down the truck sides. After the haul trucks are loaded with excavated materials, the sheeting can then be wrapped over the soil and a load cover secured for over-the-road transportation. Haul trucks can be loaded in a designated location within the secured area on disposable plastic sheeting to contain any soil spillage which could then be incorporated into the loads. If appropriate, the haul trucks and any other equipment in direct contact with impacted soil could be spray washed in a decontamination area prior to leaving the Site.

During off-Site transportation, proper documentation and non-hazardous waste manifesting would be maintained. Other mitigation measures, which are routinely used for the waste-hauling industry, could easily be implemented such as covering haul loads. It is anticipated that the excavated material could be taken to an appropriate disposal facility expected to be within a day's drive (or less) from the Site.

Properly implemented, the example mitigative measures described above would protect the surrounding community from any adverse impacts during remediation. The effectiveness of the dust control measures would be continually evaluated. Appropriate evaluation methods would be developed as part of the Remedial Design.

Construction activities would comply with applicable local ordinances with respect to aspects such as hours of operation and noise. Impacts to local traffic would be reduced to the extent practical. As illustrated on Figure 7 one-way (haul truck) traffic flow would be established through the Site; another curb cut would be obtained. Curb-side parking for trucks waiting to be loaded will be avoided if possible. To the extent possible, all pertinent preparation activities would be performed on-Site. For example, it may be appropriate to utilize portable on-Site truck scales to reduce the need for using other off-Site scale facilities. To the extent practical, efforts will be made to alleviate potential vibration and noise concerns due to installation of the soldier piles.

Protection of the Environment. There are not anticipated to be any environmental receptors which could be impacted by remedial construction activities. Any potential environmental impacts will be minimized by the implementation of appropriate dust mitigation, surface water management and material handling procedures, such as those described above for the protection of the surrounding community.

Protection of Workers. In addition to airborne dust, for which the control and monitoring was described above, other potential worker exposures would include incidental ingestion of impacted soil and physical hazards. A comprehensive health and safety plan will be developed during the Remedial Design for use at the Site during remedial construction. These procedures will incorporate measures to minimize ingestion exposures and will include the use of appropriate personnel protection measures, such as protective clothing, wash stations, separate eating areas and restrictions to eating and smoking within the secured area. Appropriate respiratory protection and appropriate measures to evaluate worker dust exposure may also be used to address the airborne dust hazard.

The excavation bracing will be designed with the necessary factors of safety to ensure the stability of the excavation walls. As appropriate, air monitoring may also include evaluation of organic vapors (as a check, none are expected), oxygen, and hydrogen sulfide (if necessary). The health and safety plan will address potential physical hazards during remedial construction including confined entry protocols and will present contingency procedures to be implemented, as necessary.

Duration of Remedial Construction. It is anticipated that the implementation of this source control alternative would be on the order of six months.

The short-term effectiveness protective measures are both proven effective and reliable.

5.3.2.4 Long-Term Effectiveness and Permanence

This alternative will provide a permanent and irreversible reduction of contaminants within the DP-1, DP-2 and pit area source configurations. Removal of the Cr^{+6} impacted soil will be protective of groundwater quality immediately downgradient of the Site. As demonstrated by the analytical contaminant transport model used, after proper implementation of this alternative, the minimal Cr^{+6} mass remaining above the water table will not cause Cr+6 concentrations in groundwater, immediately downgradient of the Site, to exceed the NYS Class GA Groundwater Quality Standard of 50 μg/L.

While further controls are not necessary, groundwater monitoring will be performed to confirm the effectiveness of this alternative. The actual monitoring program will be developed during the Remedial Design (a five year period is assumed for cost estimating purposes).

5.3.2.5 Reduction of Toxicity, Mobility and Volume

As discussed in Sections 3.0, the CLRs illustrated on Figure 4 will permanently and irreversibly remove nearly all of the Cr^{+6} impacted soils on the Site. Based on the available data, this alternative will also remove the lead impacted soils. Disposal at a properly licensed off-Site disposal facility will assure positive containment of the Cr^{+6} (and Cr^{+3} and lead) impacted soils. A properly engineered disposal facility will incorporate the following controls:

- liner and cover systems;
- leachate collection, management and, as appropriate, treatment; and
- a network of groundwater monitoring wells.

This alternative complies with the TAGM criterion of off-Site land disposal.

5.3.2.6 Implementability

Technical Feasibility. As indicated in Section 2.1.7, gravel and cobbles within the Site soils are anticipated. At a minimum, zones of such coarse materials are expected at depth intervals of about 8 to 12 feet and 25 to 30 feet. Proper penetration of the solider piles through these zones would be facilitated using conventional construction techniques such as removal of the obstructions with a backhoe, pre-drilling or the use of a large pile hammer. Removal of the impacted soil from the excavation would be readily implemented using conventional mechanized equipment suited for such operations. Excavation at the water table may require the use of conventional excavation techniques, such as dewatering, remote clamshell excavation, platform excavation, sheet piling or other methods. Backfill and compaction operations to replace the excavated materials would be routine. Because all of the work will be performed in the open, verification, that all of the soil within the defined source is removed, can be readily performed by visual inspection. Quality control of proper backfilling operations would be routine. Therefore, the reliability of the soil excavation and replacement technologies will be high.

For qualified contractors with experience in environmental operations and the local soil conditions, scheduling should be straight forward. Again, the greatest potential for technical difficulties would be in the installation of the soldier piles. While a common method, the completion of a braced excavation requires the coordination and scheduling of a number of interrelated work items.

Administrative Feasibility. Assuming operations are performed in compliance with applicable local codes and ordinances, administration efforts should be normal for projects in the New York City area. Because the work is performed in the open, it may be possible to excavate and segregate the less impacted soils for beneficial off-Site use should the appropriate regulatory approvals be obtained.

Availability of Services and Materials. Alternative 1 would employ currently available methods, equipment and materials which are routinely utilized in the construction industry. There are a number of qualified contractors in the vicinity of New York City who have experience with similar excavations which may be larger or deeper than those needed for the CLRs. The presence of local qualified and experienced contractors will promote competitive bidding. Preliminary contacts with potential off-Site disposal facilities, licensed to handle the Cr^{+6} impacted soil, have indicated that ample disposal capacity is available.

5.3.2.7 Cost

The estimated present worth cost of this alternative was evaluated for direct and indirect capital costs, operation and maintenance costs, potential future remedial action costs. Costs were based on a number of sources. These included published construction estimating guides (e.g., Means Guide) and discussions with various vendors and specialty contractors. The cost estimate also includes selected use of unit costs or line item costs contained in two separate estimates prepared for this project in April 1993 by a New York City based construction management consultant and a specialty environmental remediation contractor. The cost estimate is included as Table F-1 in Appendix F and the findings are discussed as follows:

Direct Costs: Direct costs include the equipment, labor and materials specifically required to design and implement source control Alternative 1. Certain activities such as site preparation, building demolition and security fencing, will be common to each remedial alternative. Because this alternative utilizes conventional construction techniques, the estimated direct cost includes a contingency allowance of about five percent ($140,000). The estimated subtotal for direct costs is $2,850,000. Since remediation will be implemented, if possible, in 1993, the estimated subtotal is assumed to be a present worth cost.

Indirect Costs: Indirect costs include additional and appurtenant labor and materials, for such items as general and site engineering and coordination and implementation of appropriate health and safety protocols, for an estimated six month construction schedule. The estimated subtotal for indirect costs is $1,310,000, which would also be a present worth cost.

Operation and Maintenance Costs: O&M costs would consist of a quarterly groundwater monitoring program which would be maintained for an estimated period of five years. Moreover, it is anticipated that the two closest off-Site, downgradient monitoring wells (Wells MW-12 and MW-13) would be adequate and that additional wells would not be required. For the purpose of this FFS, the assumed monitoring program would consist of quarterly sampling for the first two years and semi-annual sampling for the remaining three years, with occasional background well sampling. Based on a five percent discount rate, the present worth to maintain the monitoring program would be $60,000. However, to accommodate minor changes or unanticipated conditions, the estimated O&M cost also includes a 15 percent ($10,000) contingency allowance which yields a present worth subtotal of $70,000.

Potential Future Remedial Action: Properly implemented, future remedial action regarding the source volume is not expected.

Total Estimated Cost: Based on the subtotals discussed above, the total estimated cost for Alternative 1 is $4,230,000.

Sensitivity Analysis: The factor which would most significantly affect the estimated cost of Alternative 1 is the soil removal volume because the respective line item costs for excavation and bracing, disposal and backfilling are all influenced. For Alternative 1, the costs associated with these work items represent about 74 percent of the direct capital costs and approximately 50 percent of the total estimated cost. Other indirect costs, which would also be somewhat affected, would be those related to the construction duration. Based on the distribution of on-Site subsurface explorations, it is anticipated that there would be less uncertainty with respect to the size of the DP-2 CLR than the DP-1 or pit CLR. The cost sensitivity evaluation presented in Table F-2 in Appendix F is based on an assumed 25 percent increase in excavation volume with the following distribution:

- a 100 percent increase in the pit CLR;
- a 100 percent increase in the DP-1 CLR; and
- a 17 percent increase in the DP-2 CLR.

the new total estimated cost for Alternative 1 would be $4,900,000.

5.3.3 Alternative 2 - In-Situ Stabilization

A general description of this alternative is provided in Section 4.2.3. The detailed analysis of this alternative is presented below.

5.3.3.1 Compliance with SCGs

The results of the evaluation of Alternative 2, with respect to compliance with New York State SCG, are discussed below.

Location Specific. Alternative 2 would be implemented in compliance with applicable local and New York City Laws and Ordinances as they would relate to aspects such as hours of operation, noise and traffic. Disposal of the building demolition debris and/or impacted material to be removed as a result of the initial, pre-treatment excavation would be performed in compliance with 6 NYCRR Part 360 for landfills located in New York State and in particular on Long Island, if applicable. For disposal at other out of state licensed facilities, implementation would be performed in compliance with other applicable state waste disposal regulations. Preliminary contact with several permitted non-hazardous waste disposal facilities in Pennsylvania indicated that disposal of the impacted Site soil would be in compliance with Pennsylvania Department of Environmental Resources (PADER) regulations.

Chemical Specific. Based on an incidental ingestion route of exposure, the October 1991 New York Draft Cleanup Policy and Guidelines establishes cleanup guidance levels for Cr^{+6} as 400 mg/kg, Cr^{+3} as 80,000 mg/kg and Lead as 250 mg/kg. Generally, both Cr^{+6} and Cr^{+3} were detected at the Site at levels less then these guidance levels except at two depth intervals at DP-2 where Cr^{+6} was detected at concentrations of 1,870 mg/kg and 4,610 mg/kg. Lead was detected at both DP-1 and DP-2 at concentrations greater than the guidance levels. During the initial pre-treatment excavation, which is required to accommodate the expected swell volume and remove the existing structures, the impacted soils containing the greatest concentrations of lead and Cr^{+6} can also be removed. The subsequent in-situ treatment and stabilization will reduce Cr^{+6} to Cr^{+3} which is significantly less soluble and less toxic than Cr^{+6}. Furthermore, the residual concentrations of Cr^{+3} will be below cleanup levels. The residual lead will be stabilized within a soil-cement mass. Therefore, while post-remediation lead concentrations within the DP-2 CLRs may exceed 250 mg/kg, the amount of lead available for direct exposure would be limited. The intent of the guideline for reducing direct contact would be met.

Action Specific. Transportation of material excavated from the CLRs would be performed in compliance with 6 NYCRR Part 364 for transportation in New York State and in accordance with applicable rules and regulations of other states and the U.S. DOT. In addition, all engineering designs would be formulated in accordance with the Building Code.

Other. During implementation of Alternative 2, appropriate health and safety protocols would be developed, in compliance with 29 CFR 1910.120, and proper material handling procedures would be implemented such as those discussed in Section 5.3.3.1. Safe working conditions would be maintained in accordance with 29 CFR 1926, regarding excavations, as well other applicable OSHA and state safety requirements.

In summary, Alternative 2 can comply with all of the SCGs except possibly with the cleanup guidance level for lead. However, direct ingestion exposures from future contact with the stabilized mass are expected to be minimal because the lead will be stabilized within the solidified soil mass.

5.3.3.2 Overall Protection of Human Health and the Environment

This alternative provides for the overall protection of human health and the environment because of the following:

- During the pre-stabilization excavation, this alternative will permanently remove the DP-1, DP-2 and pit CLRs to a secure off-Site disposal facility.
- The remaining contaminated materials within the DP-2 source volume would be stabilized in a substantially irreversible manner.

However, since lead, at concentrations exceeding cleanup levels, based on incidental ingestion, may remain in-place, it may be appropriate to establish selected institutional controls such as restrictions on future below-ground development (e.g., basements).

- Stabilization of the CLRs will provide reduction of Cr^{+6} to less mobile and less toxic Cr^{+3} in a geochemical environment naturally conducive to this reduction. The reduction of Cr^{+6} to Cr^{+3} is expected to achieve the remedial action objective of minimizing potential future impacts to groundwater quality.

- With the possible exception of the lead impacted soils, Alternative 2 complies with SCGs.

5.3.3.3 Short-Term Impacts and Effectiveness

Protection of Community. Measures, which would be implemented to mitigate against potential adverse effects to the surrounding community, would be the same as those discussed in Sections 4.2.2.1 and 5.3.2.1 for Alternative 1 and as further discussed in Section 4.2.3.1. However, there are significant differences particularly because this alternative exposes and handles less soil above ground after the initial excavations have been performed.

Prior to in-situ stabilization, this alternative will require the removal of the existing below grade structures (i.e., cisterns and pit) and approximately 935 cubic yards of impacted soil from the DP-1, DP-2 and pit CLRs in anticipation of the estimated 25 percent volume increase expected to occur as a result of the in-situ stabilization process. Appropriate material handling procedures, surface water management and dust control measures such as those described for Alternative 1, will be used during the initial excavation. However, the reduced soil removal volume which will be transported off-Site will correspondingly reduce aspects such as truck traffic, noise and potential dust generation. In addition, in-place soil stabilization will further reduce the amount of contaminated material potentially generating dust. Some in-situ stabilization equipment uses a hood or shroud to seal the ground surface above the mixing tool.

Duration of Remedial Construction. If properly scheduled, the time required for implementation of this source control alternative is anticipated to be five months following the site preparation phase.

Protection of the Environment. Similar to Alternative 1, there are not anticipated to be environmental receptors which would be impacted by this alternative's remedial construction activities. Any potential environmental impacts will be minimized by the implementation of appropriate dust mitigation, surface water management and material handling procedures such as those described for the protection of the surrounding community.

Protection of Workers. Because of the relatively shallow excavation depths, required for the removal of the expected swell volume (two to eight feet), of the DP-2 concentrated core, it is anticipated that the necessary earthwork would be accomplished by open cutting to safe sideslope angles. Also, because the area of exposed impacted soil would be incrementally reduced as in-situ stabilization proceeds, the duration of worker exposure (to ingestion and inhalation routes of exposure) due to excavated material handling will also be correspondingly reduced.

5.3.3.4 Long-Term Effectiveness and Permanence

In-situ stabilization satisfies the TAGM criteria for permanence as defined by TAGM Item 2.1(c) Solidification/Chemical Fixation. The technology of in-situ soil mixing has been successfully demonstrated by the USEPA within the Superfund Innovative Technology Evaluation (SITE) Program (EPA/540/A5-89/004). As described in Section 4.2.3.1, in-situ stabilization injects/mixes an additive(s) with the contaminated material. During the Site program cement and other additives (e.g., fly ash) were used.

The RI report concluded that based on the Eh and pH of the soils disclosed at the Site and the presence of ferrous iron (Fe^{+2}), it appears that conditions conducive to the in-situ reduction of Cr^{+6} to Cr^{+3} exist. For this Site, it is anticipated that a reducing agent, such as ferrous sulfate, sodium bisulfate or sodium sulfite would be added to reduce the Cr^{+6} to Cr^{+3}, which is less mobile in water and less toxic.

With the reducing agent, a cementing additive, such as portland cement (possibly with bentonite), would also be added to further stabilize and decrease the permeability of the treated material. The effectiveness of the treatment process is highly dependent upon the proper selection of the stabilization and treatment additives as well as the contractor's expertise. Treatability and other bench or pilot-scale testing would be performed during the remedial design to determine the proper selection proportions and mutual compatibility of the additives. For example, the application of sulfate or sulfite reducing agents may require the use of a sulfate resistant cementing additive. Provided the proper additives are utilized and the in-place mixing is thorough and uniform, the resulting stabilized mass will provide a long term remedy which will satisfy the remedial action objective of minimizing future impacts to groundwater since the result Cr^{+3} is significantly less soluble and therefore less mobile in water.

With regard to remediation of the Cr^{+6} impacted soils, long-term controls would not be not required following implementation of this alternative. A groundwater monitoring program will be used to verify that this alternative is protective of groundwater. The actual monitoring program will be developed during the Remedial Design (a ten year period for this alternative is assumed for cost estimating purposes).

It should be noted that the reduction of Cr^{+6} to Cr^{+3}, while technically feasible, is currently at the bench or pilot-scale stage without a long-term proven track record. In addition, since in-situ stabilization does not lend itself to direct visual inspection, as does Alternative 1, there is not the ability to verify that all impacted soil within the CLRs has been remediated. Therefore, a ten year groundwater program is assumed for Alternative 2. Residual lead, at concentrations exceeding cleanup guidance levels, may still be present after remediation. It may be appropriate to implement institutional controls, such as deed restrictions that limit below ground development (e.g., basements).

5.3.3.5 Reduction of Toxicity, Mobility and Volume

The initial excavation will result in remediation of the Cr^{+6} and lead impacted soils having the greatest concentrations of these constituents by removal to an off-Site landfill, similar to Alternative 1. As illustrated conceptually by Figure 6, the CLRs to be stabilized by Alternative 2 would be the same as for Alternative 1. As discussed above, previous bench scale testing has demonstrated that the introduction of reducing agents can effectively reduce Cr^{+6} to the less mobile and less toxic Cr^{+3}. Based on the conclusions of the RI report that the natural geochemical environment is conducive to such a reaction, it is anticipated that the treatment, if properly performed, would be substantially irreversible.

As previously discussed, the introduction of the additives will not reduce the volume within the CLRs; rather, there would be a volume increase. However, as previously indicated, limited initial excavation and off-Site disposal of the upper materials at each CLR will reduce the amounts of Cr^{+6} to be reduced and lead to be stabilized. As indicated in Section 5.3.2.3, disposal of the initial excavated material at a properly licensed off-Site facility will result in permanent containment of the untreated impacted soils.

5.3.3.6 Implementability

Technical Feasibility. The large mechanized equipment utilized for this technology is adapted from the heavy construction/foundation industry. The technical procedures necessary to implement in-situ stabilization are relatively straightforward. However, the presence of gravel or cobbles within the Site soils is anticipated to be problematic. One of the remedial contractors contacted during the preparation of the FFS, declined to present budgetary unit costs after a review of the boring logs. Delays in the construction schedule are likely due to the probable presence of gravel and cobbles. In addition, the presence of possible silt/clay interbeds, as cited in the RI, may impede the effectiveness of the soil mixing process. The proper implementation of in-situ stabilization is highly dependent upon the skill and expertise of the contractor. It should also be noted that the alternative does not provide the ability for direct visual inspection to verify that all of the source volume within the CLRs has been thoroughly and uniformly stabilized.

Administrative Feasibility. Assuming operations are performed in compliance with applicable local codes and ordinances, administrative efforts should be normal for projects in the New York City area. Because Alternative 2 is expected to require only the limited excavation, the number of labor trades and the scheduling/coordination requirements associated with this aspect would be reduced.

Availability of Services and Materials. There are only a limited number of specialty contractors who are experienced and qualified to perform this technique. During the preparation of this FFS only two contractors were found in the eastern U.S. who have demonstrated experience regarding in-situ stabilization and one of these claimed his equipment was not capable of working in the Site soil conditions. Since the equipment used is highly specialized, especially for stabilization within the gravel and cobble zones, mobilization of additional equipment or replacement, if required, may delay the project schedule.

5.3.3.7 Cost

The estimated cost for this alternative was evaluated for direct and indirect capital costs, operation and maintenance costs, potential future remedial action costs and present worth. Costs were based on similar references as cited for Alternative 1. The cost estimate is included as Table F-1 in Appendix F and the findings are discussed as follows:

Direct Costs: Direct costs include the equipment, labor and materials specifically required to implement source control Alternative 2. Certain activities such as site preparation, building demolition and security fencing, will be common to each remedial alternative. Because this alternative utilizes specialty equipment which may be adversely impacted by the presence of gravel and cobbles, the estimated direct costs include a contingency allowance of 25 percent ($520,000). The estimated subtotal for direct costs is $2,590,000. Since remediation will be implemented, if possible, in 1993, the estimate subtotal is assumed to be a present worth cost.

Indirect Costs: Indirect costs include additional and appurtenant labor and materials related to general and site engineering and coordination and implementation of appropriate health and safety protocols for an estimated five month construction schedule. The estimated subtotal for indirect costs is $1,180,000, which would also be a present worth cost.

Operation and Maintenance Costs: O&M costs would consist of a groundwater monitoring program which would be maintained for an estimated period of up to ten years due to the somewhat greater uncertainty associated with Alternative 2. It is assumed that the program would consist of quarterly sampling for the first two years and semi-annual sampling thereafter. Assuming the monitoring program would be initiated in 1994 and based on a 5 percent discount rate, the present worth for a period of ten years, would be $110,000. Including a 15 percent ($17,000) contingency allowance, the estimated O&M subtotal would be $127,000.

Potential Future Remedial Action: Properly implemented, it is anticipated that there would be no future remedial action regarding the source volume.

Total Estimated Cost: Based on the subtotals discussed above, the total estimated cost for Alternative 2 is $3,897,000.

Sensitivity Analysis: Similar to Alternative 1 the factor which would most significantly affect the estimated cost of Alternative 2 is the soil volume to be stabilized. The cost associated with this work item represents about 57 percent of the direct capital costs and approximately 38 percent of the total estimated cost. Other indirect costs, which would also be somewhat affected, would be those related to the construction duration. As shown by Table F-2, in Appendix F, if the total volume to be stabilized are increased by an assumed 25 percent (with the same incremental distribution as Alternative 1 between the CLRs), the revised total estimated cost for Alternative 2 would be $4,477,000 based on a revised construction duration of six months.

6.0 COMPARATIVE EVALUATION OF ALTERNATIVES

6.1 General

The following provides a brief summary of both alternatives relative to the TAGM evaluation criteria discussed in detail in previous sections. The comparative evaluation also presents each alternative scoring relative to the ranking tables (Tables 5-2 through 5-7 in the TAGM) which are included in Appendix E. Further, the ranking table subtotals are summarized comparatively in Table 2. Table 3 summarizes the discussions of each alternative as presented in Section 5.3 while Table 4 provides a comparative analysis.

It should be noted that the TAGM gives more preference to treatment technologies than to landfill disposal alternatives. The quantitative ranking tables included in the TAGM, and in Appendix E of this FFS, reflect this preference. However, while treatment technologies are appropriate for many applications, at this Site there would be some significant difficulties due to the presence of lead impacted soils and the likely presence of resistant zones of gravel and cobbles. Relative the Alternative 2, Alternative 1 (Excavation and Replacement) offers the advantages that:

- the proven and conventional techniques which would be used are more adaptable to the anticipated Site subsurface conditions;
- Alternative 1 will result in the permanent removal of impacted soil from the Site; and
- future use of the Site will be unrestricted.

Quantitative ranking tables, taken from the TAGM, are included in Appendix E. Subtotals for each of the selection criteria indicated in the TAGM are presented in Sections 6.1 through 6.6 below and also in Table 2. As Table 2 indicates, the quantitative ranking scores are 70 for Alternative 1 and 61 for Alternative 2.

6.2 Compliance with SCGs

For Alternative 1:

- the remedial action would be in compliance with the SCGs identified; and,
- the quantitative ranking subtotal is 10.

For Alternative 2:

- the remedial action would be in substantial compliance with the SCGs identified; however, lead levels within the stabilized mass may remain at concentrations greater than the cleanup guidance levels; and
- the quantitative ranking subtotal is 6.

6.3 Protection of Human Health and the Environment

As described in the FFS, Alternatives 1 and 2 will both provide overall protection of human health and the environment with respect to remediation of Cr^{+6} impacted soil.

For Alternative 1:

- removal and off-Site disposal of the Cr^{+6} impacted soil would be protective of future downgradient groundwater quality;
- based on the current Site data, implementation of this alternative will also remediate the lead impacted soil;
- there would be an improved future marketability for unrestricted use of the Site by the use of properly compacted clean backfill material; and
- the quantitative ranking subtotal is 20.

For Alternative 2:

- with proper implementation, Cr^{+6} will be reduced to significantly less soluble and less toxic Cr^{+3} and will be stabilized in a low permeability mass which would be protective of groundwater quality; and
- lead impacted soil, remaining in the stabilized mass, may result in the requirement for institutional controls.
- the quantitative ranking subtotal is 17.

6.4 Short-Term Impacts and Effectiveness

As discussed in Section 5.3, proper engineering designs, effective and reliable health and safety protocols, surface water management, appropriate material handling procedures and construction scheduling would be implemented, for both alternatives, to mitigate against adverse short-term impacts to the community, environment and workers.

For Alternative 1:

- the potential for more time-related, short-term impacts is somewhat higher due to its longer estimated six month schedule;
- the potential for greater dust generation is higher due to more exposed soil and soil handling above ground;
- there would exist the normal working hazards associated with any similar braced excavation; and,
- the quantitative ranking subtotal is 9.

For Alternative 2:

- time-related, short-term impacts are slightly lower due to its estimated five month construction schedule;

- after the initial, pre-treatment excavations are performed, the potential for dust generation is decreased due to less above ground exposed soil handling;

- the excavations can be performed by open cutting to safe sideslope angles without the need for bracing; and,

- the quantitative ranking subtotal is 9.

6.5 Long-Term Effectiveness and Permanence

Both remedial alternatives will provide a long term source control remedy of Cr^{+6} impacted soil in a manner that will satisfy the remedial action objective of minimizing future impacts to groundwater quality. In addition, long-term controls regarding remediation of Cr^{+6} would not be required. A groundwater monitoring program will provide verification of proper performance with respect to protection of groundwater quality.

For Alternative 1:

- there will be a permanent and irreversible elimination of the Cr^{+6} impacted soils at the Site;

- the residual Cr^{+6} left in soil will not cause downgradient groundwater to exceed NYS Class GA Groundwater Quality Standards;

- excavation will have the added benefit of also removing the lead impacted soil;

- direct visual inspection provides simple and effective quality control; and

- the quantitative ranking subtotal is 12.

For Alternative 2:

- in-situ stabilization satisfies the NYSDEC criteria for permanence as defined by TAGM Item 2.1 (c);

- except for the initial excavation, stabilization techniques which are intended to remediate the Cr^{+6} impacted soils may not remediate the lead impacted soils;
- in-situ stabilization does not have the same degree of control of effectiveness that is associated with excavation and replacement, the likely presence of gravel and cobbles will be problematic and there is a risk that some material within the CLRs may not be treated or stabilized; and,
- the quantitative ranking subtotal is 12.

6.6 Reduction of Toxicity, Mobility and Volume

Both alternatives will provide an effective and permanent remedial action in regard to Cr^{+6} impacted soils.

For Alternative 1:

- there would be a reduction to the mobility of the contaminants through permanent containment at a properly licensed and designed off-Site disposal facility;
- while excavation and off-Site disposal would not provide a treatment technology for the reduction of toxicity or volume, it is a remedial technology accepted in the TAGM; and,
- the quantitative ranking subtotal is 5.

For Alternative 2:

- while there would not be a reduction in volume, in-situ stabilization of the Cr^{+6} impacted soil satisfies the TAGM criteria of reduction in toxicity and mobility as defined in Item 2.1 (c);
- after treatment, the residual Cr^{+3} will be significantly less soluble and, therefore, less mobile than Cr^{+6};
- the addition of cement will conceal residual lead within a stabilized mass;

- there would be the same permanent off-Site disposal, for the pretreatment excavated materials, as Alternative 1; and,

- the quantitative ranking subtotal is 10.

6.7 Implementability

Both Alternative 1 and Alternative 2 use procedures and methodologies which are adapted from the heavy construction/foundation industry. For Alternative 1, competitive bidding would be promoted since there are qualified excavation contractors available. There are only a number of contractors experience with in-situ stabilization. It should be noted that the presence of gravel and possibly cobbles will impact both alternatives to some extent but is expected to have significant impacts on in-situ stabilization procedures. Coordination efforts should be normal, for a project in the New York City area, in consideration of the different work tasks to be performed.

For Alternative 1:

- the relatively conventional methods, equipment and materials required would be available from a number of qualified contractors in the New York City area;

- the potential problem associated with obstructions due to gravel/cobbles could be reduced using readily available methods and equipment;

- careful scheduling and planning, which is common to any excavation project, would be required; and,

- the quantitative ranking subtotal is 14.

For Alternative 2:

- there are only a limited number of qualified in-situ stabilization specialty contractors and the effectiveness of the in-place soil mixing technique is almost entirely due to the skill and expertise of the contractors;

- the potential for obstructions due to gravel/cobbles adversely impacting in-situ stabilization is expected to be problematic and the possible presence of silt/clay interbeds or layers may also impact the effectiveness of in-situ stabilization; and

- the quantitative ranking subtotal is 7.

6.8 Cost

The cost estimates discussed in Section 5.3 and presented in Appendix F were developed for the purposes of comparing Alternatives 1 and 2. A number of pertinent aspects, such as site preparation activities, would be common to both remedial alternatives.

For Alternative 1:

- the total estimated cost for a six month construction schedule and an estimated five year post-remediation groundwater monitoring program, is $4,230,000; and,

- the cost is most sensitive to soil removal volume.

For Alternative 2:

- the total estimated cost, for a five month construction schedule and an estimated ten year post-remediation groundwater monitoring program, is $3,897,000;

- potential doubts on the effectiveness of this alternative may lead to increased costs in order to ensure a successful outcome; and

- the cost is most sensitive to soil volume which must be stabilized.

6.9 Recommended Alternative

In summary, both alternatives could provide an effective source control remedy which would be protective of human health and the environment at the Site. However, while it is recognized that the TAGM favors treatment alternatives, the higher numerical ranking of Alternative 1 versus Alternative 2 shows a technical preference for utilizing Alternative 1 as the source control remedy. Pfizer recommends the implementation of Alternative 1 because:

- It utilizes well-proven and straight-forward methods, procedures and equipment available from a number of contractors in the New York City area;
- It lends itself to direct visual inspection and simple quality control;
- It will permanently and irreversibly remove the Cr^{+3}, Cr^{+6} and lead impacted soils from the CLRs;
- The potential for adverse impacts due to the likely presence of gravel and cobbles would be far less as compared to Alternative 2; and
- It will be protective of future off-Site groundwater quality and will result in a marketable property having unrestricted future beneficial use.

GOLDER ASSOCIATES INC.

Walter W. Burke, P.E.
Senior Project Manager

Randolph S. White, P.E.
Senior Project Manager
State of New York, Professional Engineer No. 062926

ASSESSMENT OF STANDARDS, CRITERIA AND GUIDELINES
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NEW YORK

ANDARD, CRITERIA OR GUIDELINE (SCG)	ALTERNATIVE 1: EXCAVATE & REPLACE	ALTERNATIVE 2: IN-SITU STABILIZATION
LOCATION SPECIFIC		
6 NYCRR Part 360-8 (requirements for landfills on Long Island)	Would be applicable if building demolition debris or soil is disposed at Long Island facility Could be met.	Same as Alternative 1 Could be met.
Solid Waste Disposal Regulations of Other States [e.g. Pennsylvania (PADER)]	Off-site disposal would need to to comply with other state solid waste disposal regulations. Preliminary contact with four permitted non-hazardous disposal facilities in PA indicate soil disposal would be in compliance with PADER regulations. Could be met.	Same as Alternative 1 Could be met.
New York City Local Laws and Ordinances (requirements for hours of operation, noise, traffic, etc.)	The hours and scale of operation will be designed to be in compliance with these requirements. Could be met.	Same as Alternative 1 Could be met.
CHEMICAL SPECIFIC		
New York DRAFT Cleanup Policy and Guidelines (October 1991) (establishes policies and guidelines for the selection of cleanup levels, establishes cleanup guidance levels for Cr+6 as 400 ppm, Cr+3 as 80,000 ppm and lead as 250 ppm, based upon human ingestion.	The alternative removes the Cr+6 impacted soil from the pit, DP-1 and DP-2 source volumes and, therefore, meets these guidelines. Based on available data the alternative also removes all lead at concentrations exceeding cleanup levels. Could be met.	The initial excavation necessary to compensate for the volume increase will be performed as selectively as practical so as to remove the soils containing the highest concentrations of Cr+3 and lead. The stabilization treatment will reduce the Cr+6 to Cr+3. Post treatment concentrations of Cr+3 will be less than cleanup levels. Stabilization will reduce amounts of residual lead available for direct contact and conceal residual lead in a cement stabilized mass. The intent of this SCG could be met.
6 NYCRR Part 703.5 (water quality criteria)	Alternative 1 will be protective of off-Site groundwater. The minor amounts of Cr+6 remaining at the Site following remedial action will not cause Cr+6 concentrations in groundwater to exceed NYS Class GA Groundwater Quality Standard of 50 μg/L. Could be met.	In-situ stabilization will reduce Cr+6 to less soluble and less toxic Cr+3. Furthermore, stabilization with a cement additive will result in a relatively impermeable mass as compared to the surrounding natural soils. The intent of this SCG could be met.

TABLE 1
ASSESSMENT OF STANDARDS, CRITERIA AND GUIDELINES
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NEW YORK

STANDARD, CRITERIA OR GUIDELINE (SCG)	ALTERNATIVE 1: EXCAVATE & REPLACE	ALTERNATIVE 2: IN-SITU STABILIZATION
ACTION SPECIFIC		
6 NYCRR Part 364 (governs transport of waste)	Applies to the off-site transport of demolition debris and soil. Materials can be transported off-site in a manner such that this requirement will be satisfied.	Same as Alternative 1 Could be met.
6 NYCRR Part 360 (provides an exemption for the beneficial use of solid wastes and would apply if soil is intended to be reused as a construction material.)	Pfizer would need to apply for NYSDEC, NYDOT and NYDOH approval of reusing the soil as construction material.	Reuse of excavated soil would most likely not be considered for this Alternative. They would have highest concentrations of Cr+6 and lead. Not Applicable.
Building Code of the City of New York (establishes requirements and regulations regarding engineering designs)	All engineering designs will be formulated and implemented in in accordance with the Building Code. Could be met.	Same as Alternative 1 Could be met.
OTHER REQUIREMENTS		
29 CFR 1910.120 (establishes OSHA's hazardous waste operations and emergency response standard for the environment)	Outlines health and safety preparations for Site at which closure of wastes is being performed. Health and safety protocols will be established to insure compliance with this requirement. Could be met.	Same as Alternative 1 Could be met.
29 CFR 1926 (establishes OSHAs requirements for excavation.)	Outlines health and safety requirements for excavation and shoring/bracing systems. These operations will be performed in accordance with these requirements as well as other OSHA and state regulations regarding safe working conditions. Could be met.	Same as Alternative 1 Could be met.

TABLE 2
QUANTITATIVE RANKING OF ALTERNATIVES
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NY

ANALYSIS FACTOR	A-1	A-2
COMPLIANCE WITH SCGs		
* Compliance with Chemical Specific SCGs	4	0
* Compliance with Action Specific SCGs	3	3
* Compliance with Location Specific SCGs	3	3
Subtotal:	10	6
PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT		
* Use of the site after remediation	20	0
* Human health and the environment exposure after the remediation	NA	7
* Magnitude of residual public health risks after the remediation	NA	5
* Magnitude of residual environment risks after the remediation	NA	5
Subtotal:	20	17
SHORT-TERM EFFECTIVENESS		
* Protect community during remedial actions	3	3
* Environmental impacts	4	4
* Time to implement the remedy	2	2
Subtotal:	9	9
LONG-TERM EFFECTIVENESS AND PERMANENCE		
* On-site or off-site treatment or land disposal	0	3
* Permanence of the remedial alternative	0	3
* Lifetime of remedial alternative	3	NA
* Quantity and nature of waste or residual left at the site after remediation	5	4
* Adequacy and reliability of controls	4	2
Subtotal:	12	12
REDUCTION OF TOXICITY, MOBILITY OR VOLUME		
* Volume of hazardous waste reduced	2	6
* Reduction in mobility of hazardous waste	0	4
* Irreversibility of destruction or treatment or immobilization of hazardous waste	3	NA
Subtotal:	5	10
IMPLEMENTABILITY		
* Technical Feasibility	10	6
* Administrative Feasibility	1	1
* Availabilty of services and materials	3	0
Subtotal:	14	7
TOTAL RANKING	70	61
Note: NA indicates question or item was not relevant or applicable.		

TABLE 3
DETAILED ANALYSIS SUMMARY
FOCUSED FEASIBILITY STUDY
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NY

ANALYSIS FACTOR	ALTERNATIVE 1: Excavation & Replacement	ALTERNATIVE 2: In-Situ Stabilization
Compliance with SCGs	• Could be performed in compliance with the SCGs identified. • Excavation will remove nearly all Cr^{+6} impacted soil plus all of the detected lead impacted soil.	• Could be performed in substantial compliance with the SCGs identified. • Lead levels within the stabilized mass may exceed the NYSDEC cleanup guidance level; however, the amount of lead available for direct exposure would be limited.
Protection of Human Health and the Environment	• Permanently and irreversibly removes the Cr^{+6} source from the Site. • Results in unrestricted use of the Site. • Is protective of groundwater quality and the environment.	• In-situ stabilization reduces Cr^{+6} to Cr^{+3} which is significantly less mobile and less toxic and will produce a low permeability and structurally stable mass. • In-situ reduction of Cr^{+6} to Cr^{+3} does not have a proven track record. • Stabilized mass may contain lead exceeding cleanup guidance levels; the amount of lead available for direct exposure would be limited.
Short-term Impacts and Effectiveness	• Appropriate and well proven measures are readily available to mitigate against any detrimental short-term effects to the community or the environment. • Effective and readily available health and safety protocols, surface water management and material handling procedures will be implemented. • Estimated duration is 6 months. • Can be coordinated so that impacts to community are reduced. • Potential impacts to the environment will be minimized.	• Appropriate and well proven measures are readily available to mitigate against any detrimental short-term effects to the community or the environment. • Limited excavation and below-ground nature of stabilization procedures will reduce dust generation. • Effective and readily available health and safety protocols, surface water management and material handling procedures will be implemented. • Estimated duration is 5 months. • Can be coordinated so that impacts to the community are reduced. • Potential impacts to the environment will be minimized.

DETAILED ANALYSIS SUMMARY
FOCUSED FEASIBILITY STUDY
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NY

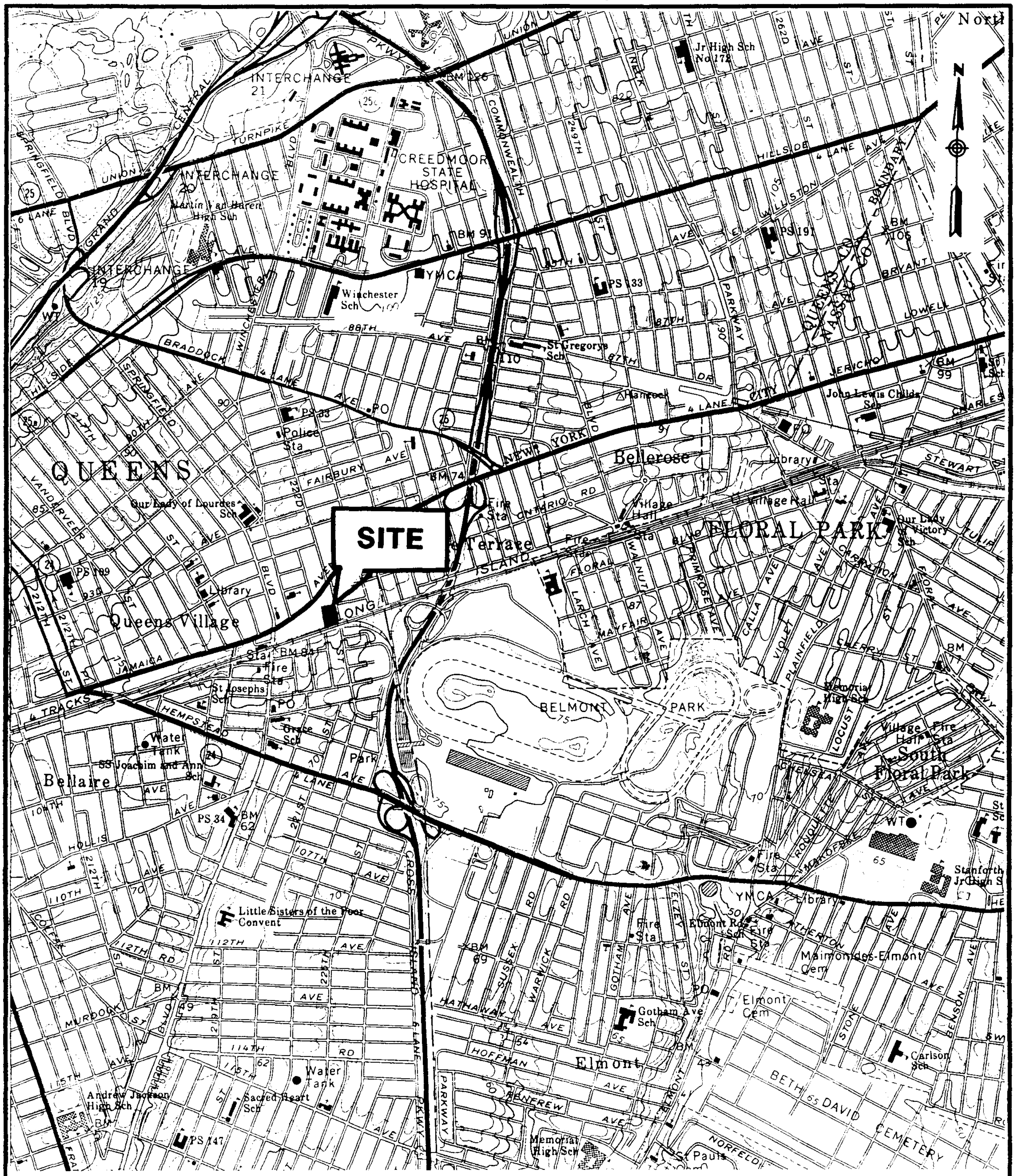
ANALYSIS FACTOR	ALTERNATIVE 1: Excavation & Replacement	ALTERNATIVE 2: In-Situ Stabilization
Long-term Impacts and Permanence	• Provides for permanent and irreversible removal of Cr^{+6} (and lead) source volume. • Is protective of downgradient groundwater quality. • Disposal of excavated materials at a licensed facility will provide permanent containment of these materials. • No further environmental controls are required.	• Geochemical environment is conducive to reduction of Cr^{+6} to Cr^{+3} which is significantly less mobile and less toxic. • Effectiveness of in-situ stabilization is nearly entirely dependent upon contractor's expertise and is anticipated to be impacted by presence of gravel/cobbles and possible presence of silt/clay interbeds. • Reduction of Cr^{+6} to Cr^{+3} is currently at the bench or pilot scale study stage with limited published case studies regarding full scale applications. • In-situ reduction of Cr^{+6} to Cr^{+3} does not have a proven track record.
Reduction of Toxicity, Mobility or Volume	• Permanently removes CR^{+6} (and lead) source from the Site for off-Site disposal and containment.	• In-situ stabilization reduces toxicity and mobility by the reduction of Cr^{+6} to Cr^{+3} and the introduction of a cementing additive intended to result in a solidified mass of limited permeability. • Residual lead may be contained in the stabilized mass.
Implementability	• Utilizes conventional excavation/hauling/disposal sequencing. Qualified contractors are located in the vicinity of New York City. • Permits direct visual inspection and straightforward quality control. • Potential for obstructions due to gravel and cobbles would be reduced using readily available methods and equipment. • Scheduling and coordination will be routine for New York City work. • Estimated duration of construction will be 6 months.	• There are only a limited number of qualified specialty contractors. • Effectiveness is primarily dependent upon contractor expertise. • Presence of gravel/cobbles and possible presence of silt/clay interbeds are expected to impact implementation and possibly effectiveness. • Visual inspection to verify complete treatment is not possible. • Scheduling and coordination will be similar for New York City work. • Estimated duration of construction will be 5 months.

TABLE 3
DETAILED ANALYSIS SUMMARY
FOCUSED FEASIBILITY STUDY
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NY

ANALYSIS FACTOR	ALTERNATIVE 1: Excavation & Replacement	ALTERNATIVE 2: In-Situ Stabilization
Cost	• Estimated direct construction costs (labor and materials) are $2,850,000. • Estimated indirect construction costs are $1,310,000. • Estimated post-remediation operations and maintenance costs for 5 years of groundwater monitoring (present worth based on a 5% discount rate with contingency) is $70,000. • Total estimated cost is $4,230,000. • Cost is most sensitive to an increase in excavation volumes due to the combination of excavation, bracing, disposal and backfill.	• Estimated direct construction costs (labor and materials) will be $2,590,000. • Estimated indirect costs will be $1,180,000. • Estimated post-remediation operations and maintenance costs for 10 years of groundwater monitoring (present worth based on a 5% discount rate) is $127,000. • Total estimated cost is $3,897,000. • Cost is most sensitive to in-situ stabilization volumes.

TABLE 4
SUMMARY OF COMPARATIVE ANALYSIS
FOCUSED FEASIBILITY STUDY FOR SOURCE CONTROL
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NY

EVALUATION CRITERIA	ALTERNATIVE EVALUATION SUMMARY
Compliance with SCGs	Both alternatives could be performed in substantial compliance with the identified SCGs. Alternative 1: removal of Cr^{+6} and lead impacted soils; no deed restrictions. Alternative 2: levels of lead remaining in the stabilized mass may exceed the NYSDEC guidance levels for human ingestion; the amount available for direct exposures would be reduced; deed restrictions may be appropriate.
Protection of Human Health and the Environment	Both alternatives will provide overall protection of human health and the environment and will be protective of groundwater quality with respect to the Cr^{+6} impacted soil. Alternative 1: will also remediate lead impacted soils. Alternative 2: will not remediate lead impacted soils.
Short-Term Impacts and Effectiveness	Short-term impacts resulting from either alternative can be mitigated with conventional measures. Alternative 1: greater potential short term impacts due to dust exposure and deep excavation methods. Alternative 2: potential for less short-term impacts during in-situ stabilization.
Long-Term Effectiveness and Permanence	Both alternatives will provide a long-term and effective source control remedy for Cr^{+} impacted soil. Alternative 1: remediates Cr^{+6} and lead impacted soil by removal and containment. Direct visual inspection provides simple and effective quality control. Alternative 2: reduces Cr^{+6} to Cr^{+3} in a conducive geochemical environment; does not remediate lead except by concealment within stabilized mass; has a lower degree of quality control.
Reduction of Toxicity, Mobility and Volume	Alternative 1: reduces the mobility of Cr^{+6} and lead through containment; does not reduce toxicity or volume. Alternative 2: provides a treatment technology which reduces the toxicity and mobility of Cr^{+6}; after stabilization residual lead may remain at concentrations exceeding cleanup levels; increases soil volume.
Implementability	Alternative 1: conventional and well proven construction techniques; adverse impacts due to gravel and cobbles relatively low; several qualified contractors. Alternative 2: highly specialized equipment; may be adversely impacted by gravel and cobbles; few qualified contractors.
Cost	Alternative 1: estimated cost is $4,230,000. Alternative 2: estimated cost is $3,897,000.
Quantitative Ranking	Alternative 1 (70) scored higher than Alternative 2 (61).



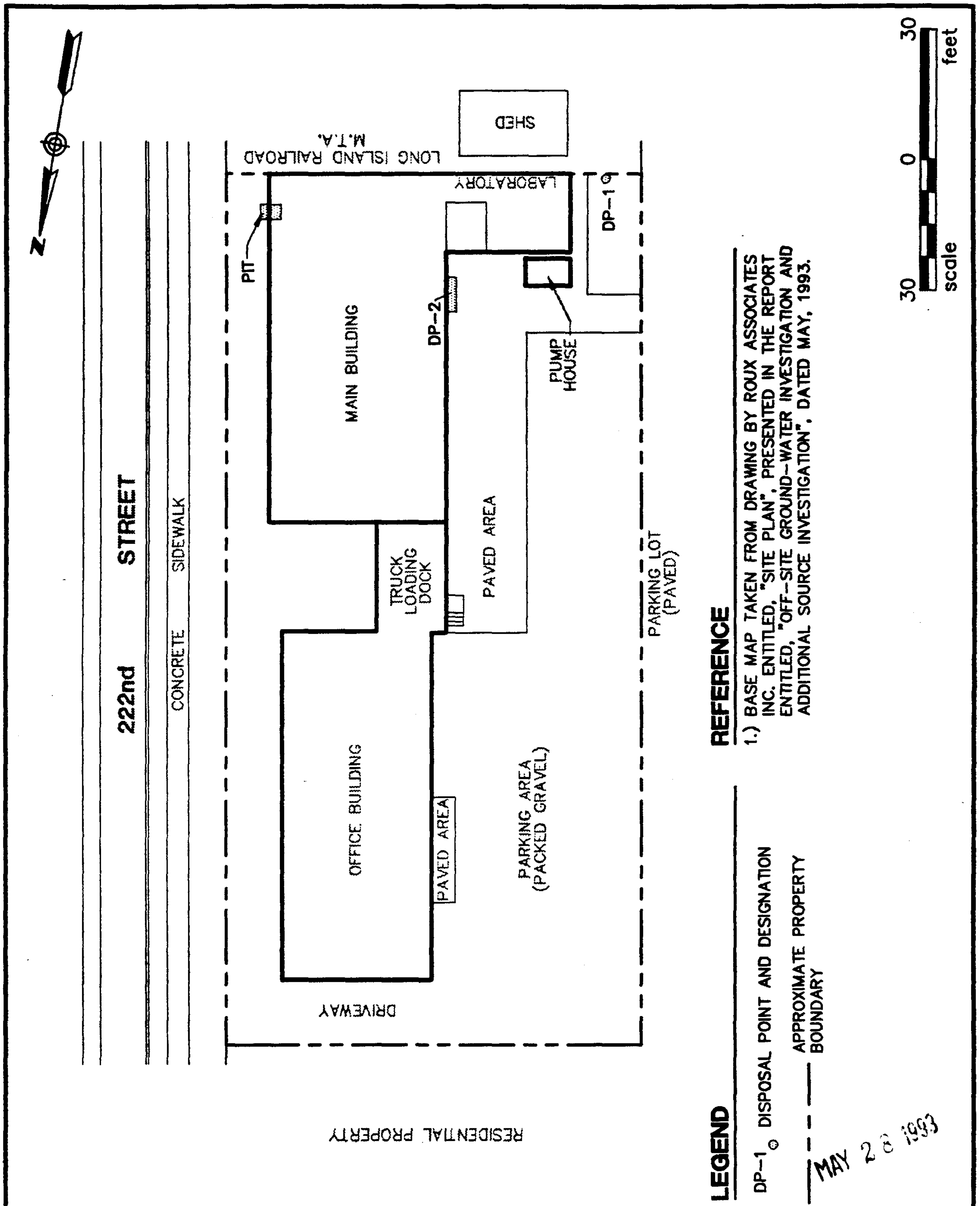
REFERENCE: BASE MAP TAKEN FROM U.S.G.S. 7.5 MINUTE QUADRANGLE LYNBROOK, NY, DATED 1969.

MAY 28 1993

2000 0 2000

scale feet

JOB No.: 923-6103	SCALE: AS SHOWN	GENERAL VICINITY MAP	
DR BY: LAS	DATE: 01/18/93		
CHK BY: VEJ	FILE No.: NY02-055		
REV BY: WWB	DR SUBTITLE: 01		
Golder Associates		PFIZER/FOCUSED FS/NY	FIGURE 1



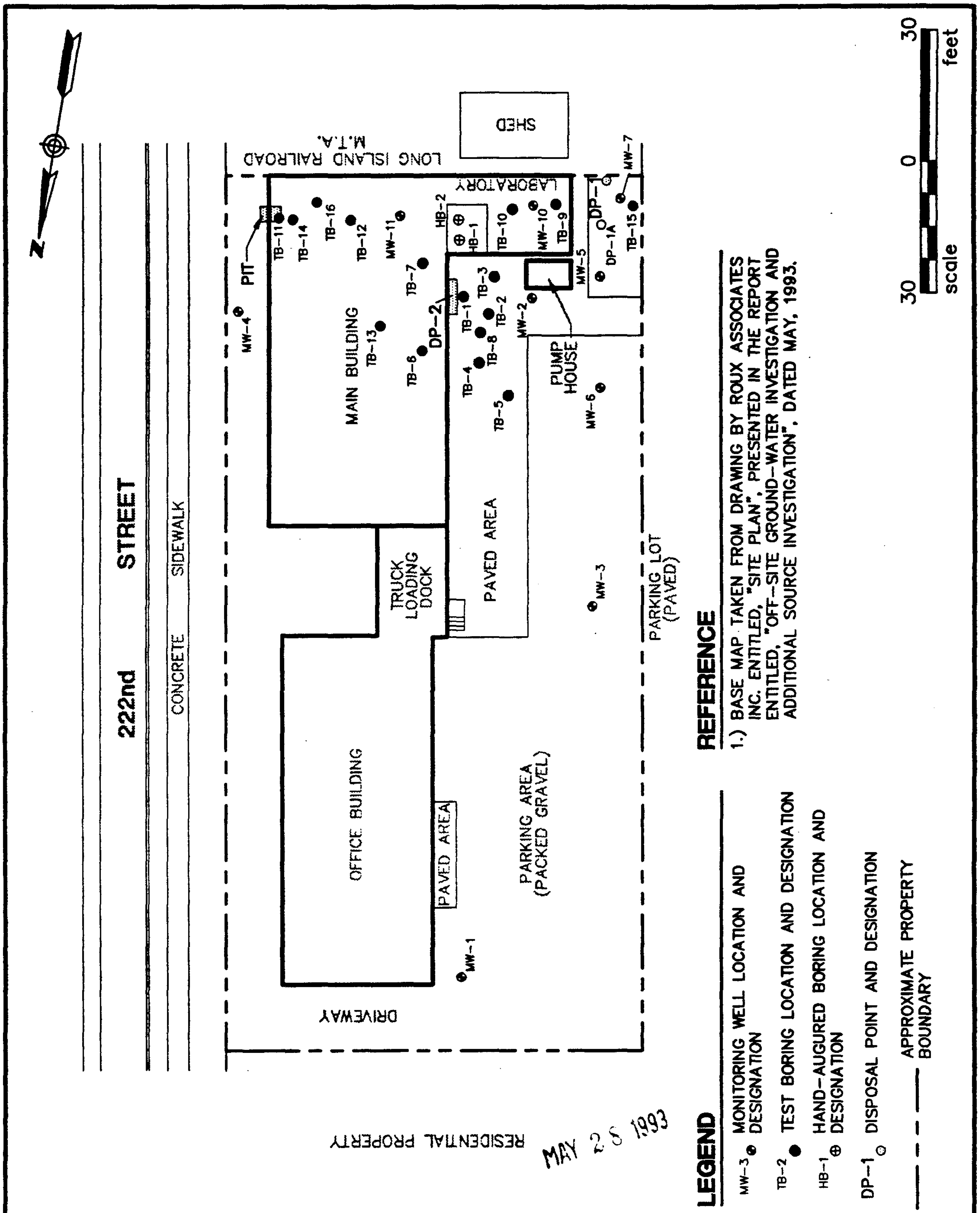
JOB No.:	923-6103	SCALE:	AS SHOWN
DR BY:	LAS	DATE:	05/20/93
CHK BY:	MDL	FILE No.:	NY02-085
REV BY:	WMB	DR SUBTITLE:	01

SITE PLAN

Golder Associates

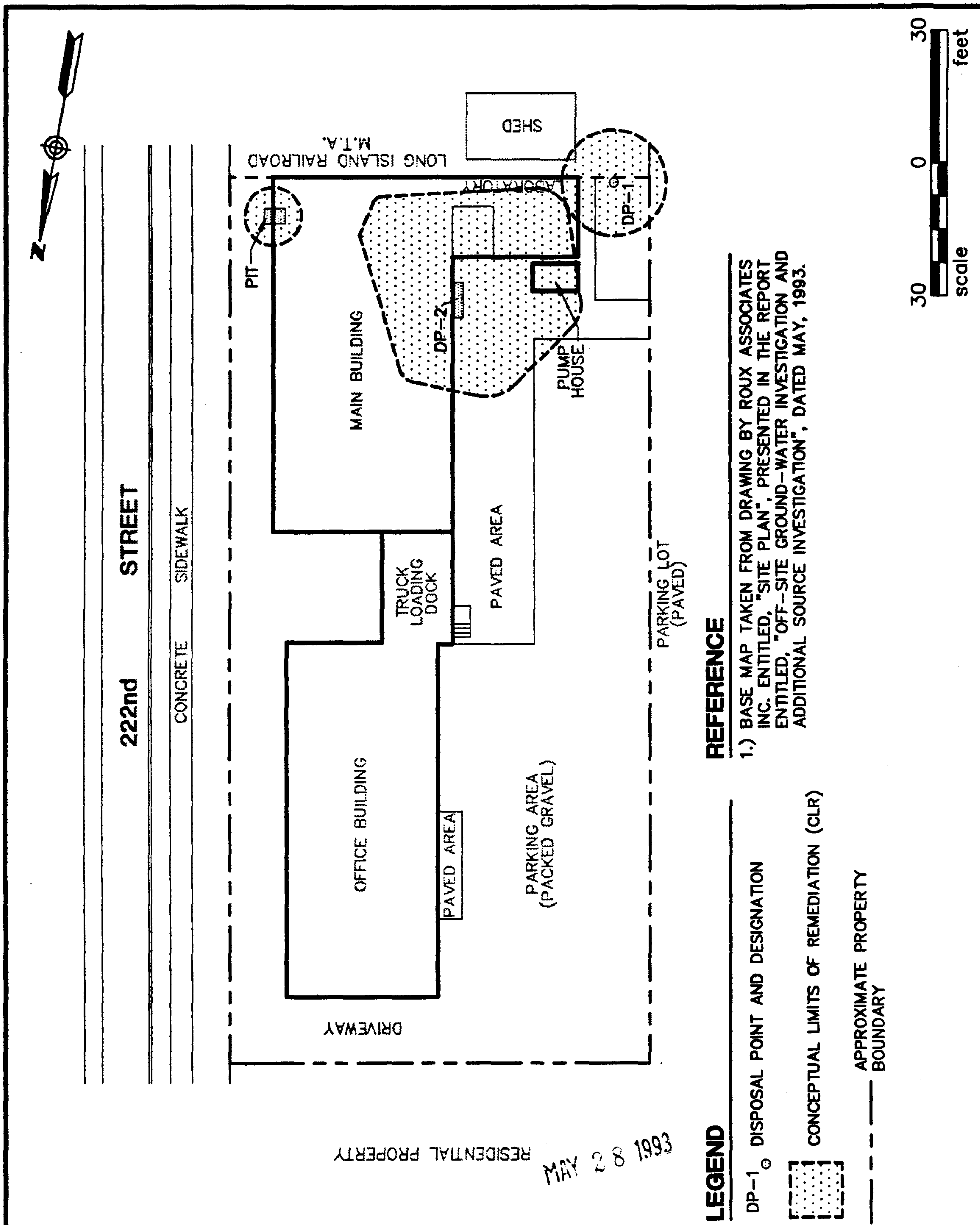
PFIZER/FOCUSED FS/NY

FIGURE 2



JOB No.:	923-6103	SCALE:	AS SHOWN	**TEST BORING AND MONITORING WELL LOCATION PLAN**
DR BY:	LAS	DATE:	05/18/93	
CHK BY:	MDL	FILE No.:	NY02-079	
REV BY:	WWB	DR SUBTITLE:	01	

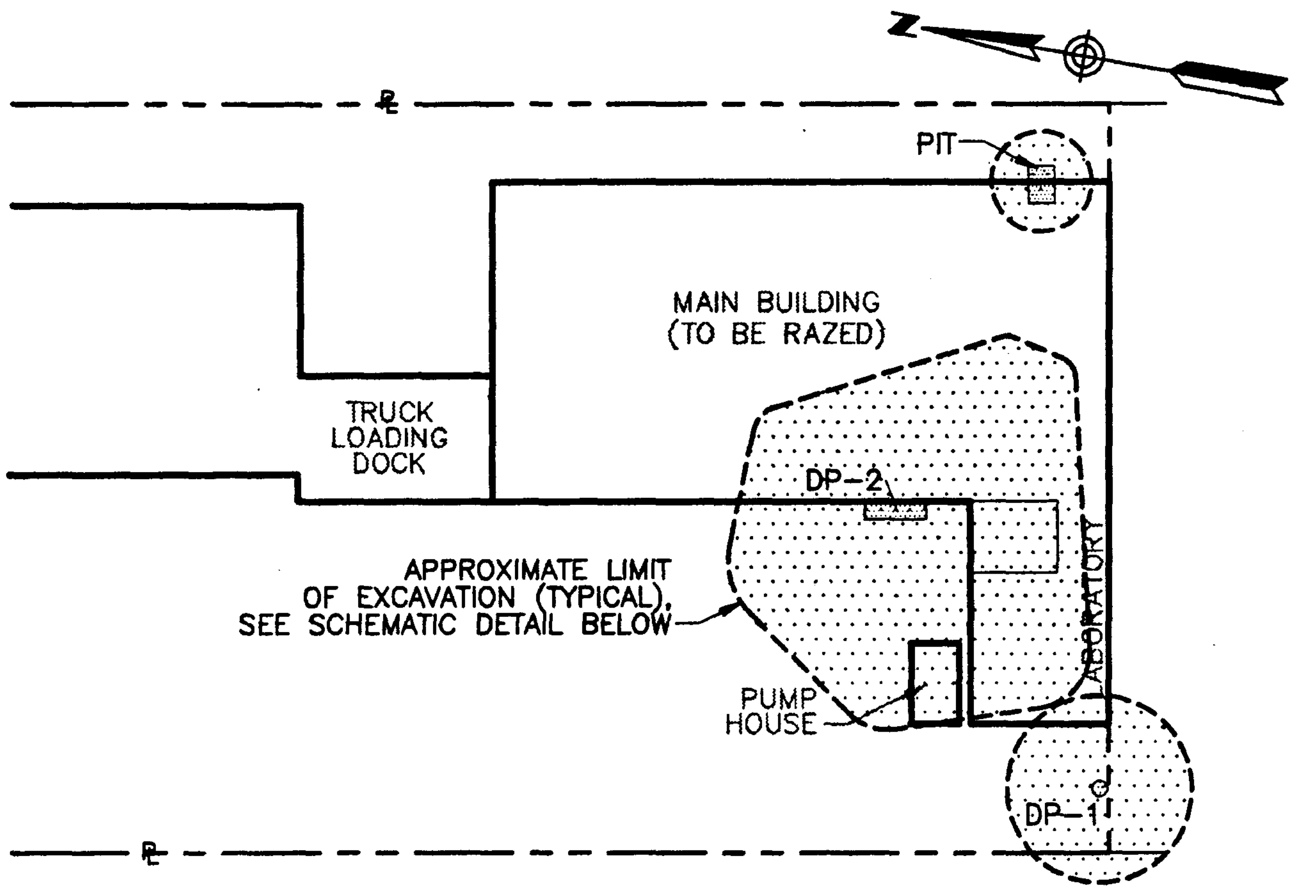
Golder Associates | PFIZER/FOCUSED FS/NY | FIGURE **3**

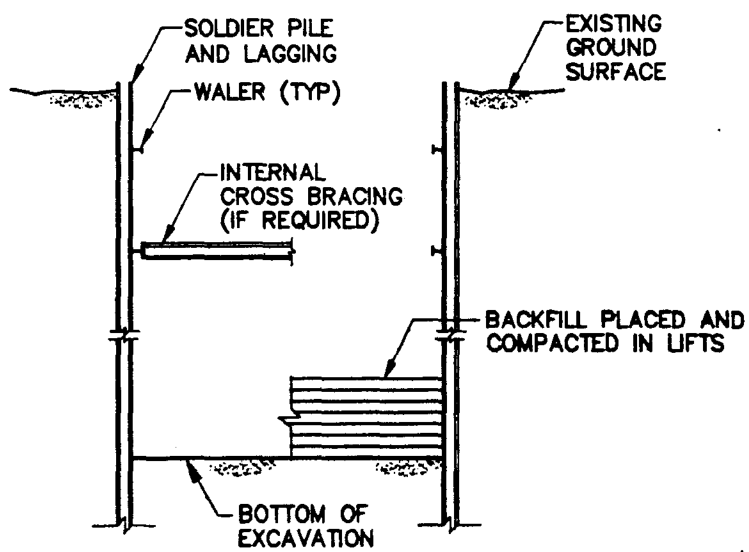


JOB No.:	923-6103	SCALE:	AS SHOWN	**CONCEPTUAL LIMITS OF REMEDIATION (CLR)**
DR BY:	JSG	DATE:	05/18/93	
CHK BY:	MDL	FILE No.:	NY02-084	
REV BY:	WWB	DR SUBTITLE:	01	

Golder Associates | PFIZER/FOCUSED FS/NY | FIGURE 4

DWG\9236103\ny02084.DWG I 05-28-93 10: 12AI 1=30

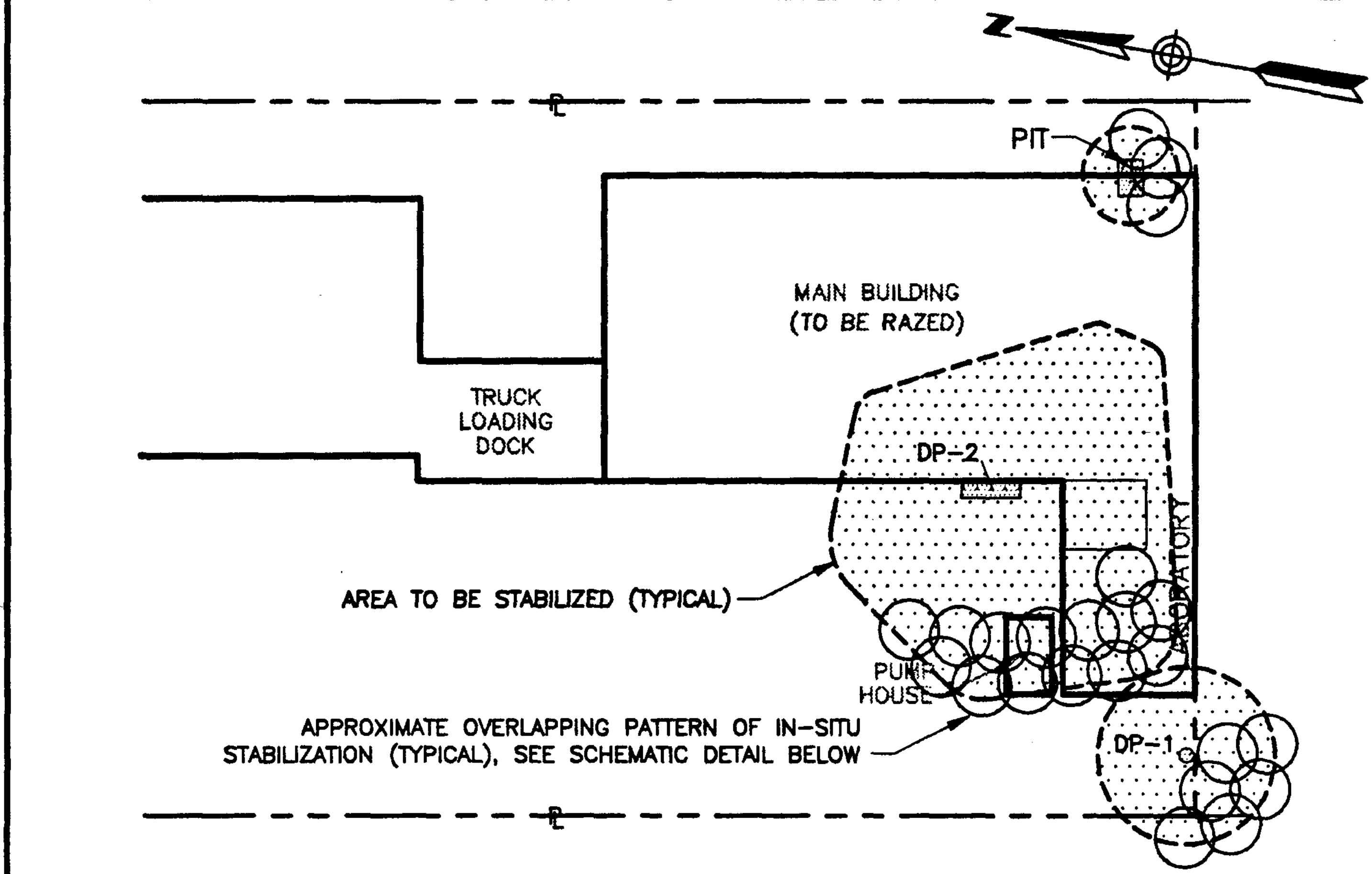


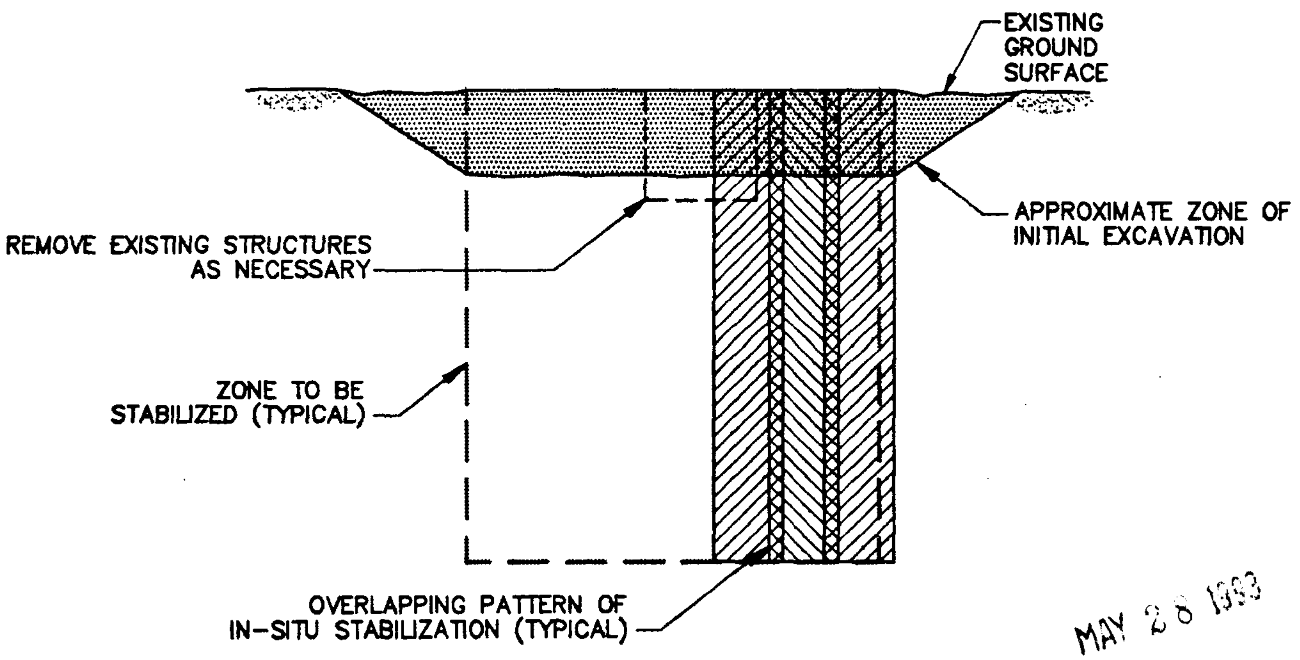


SCHEMATIC DETAIL (TYPICAL)

MAY 28 1993

JOB No.: 923-6103	SCALE: NOT TO SCALE	ALTERNATIVE 1 EXCAVATION AND REPLACEMENT CONCEPTUAL SKETCH		
DR BY: JSG	DATE: 05/20/93			
CHK BY: MDL	FILE No.: NY02-086			
REV BY: WWB	DR SUBTITLE: 01			
Golder Associates		PFIZER/FOCUSED FS/NY	FIGURE	5



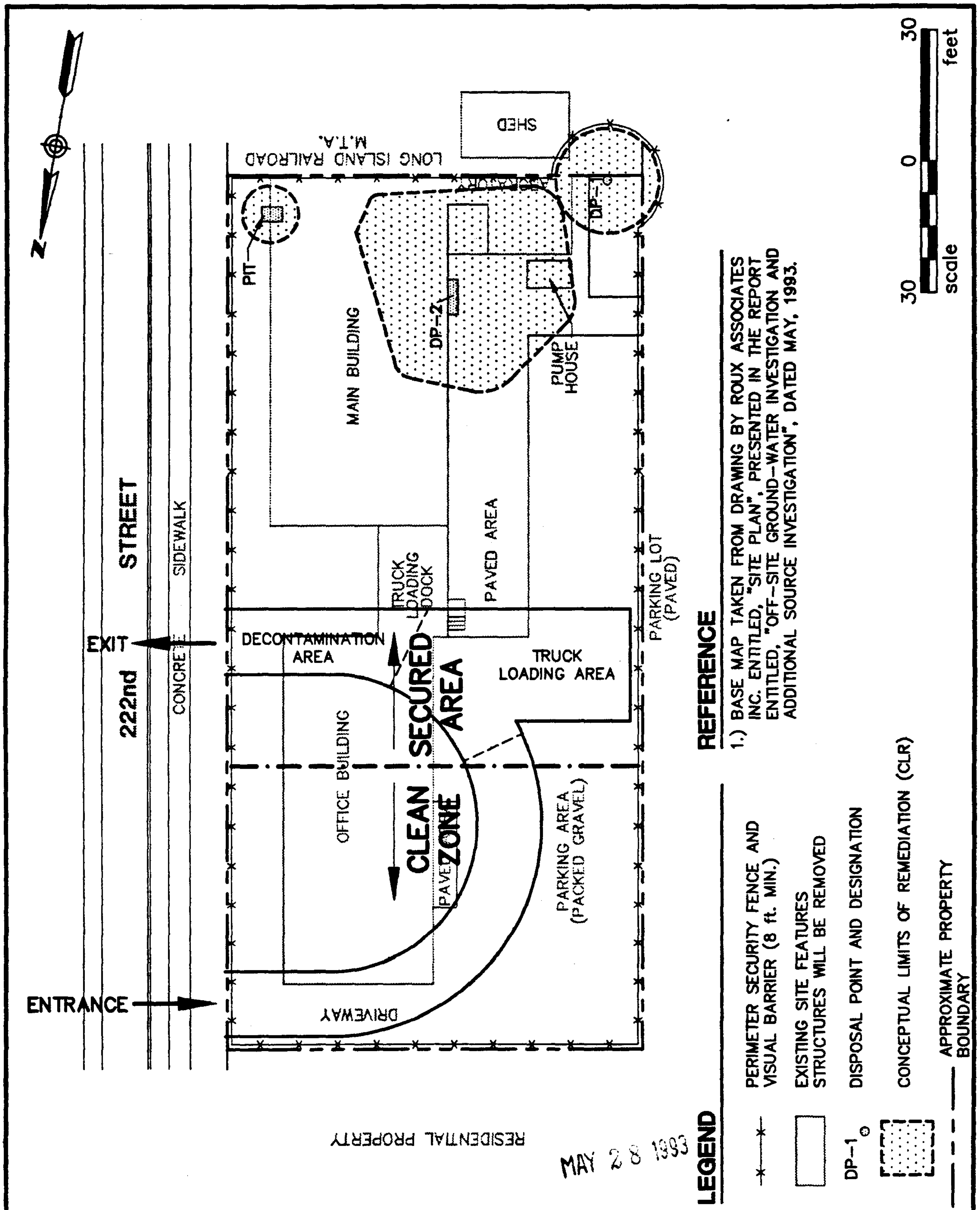


MAY 28 1993

SCHEMATIC DETAIL (TYPICAL)

JOB No.:	923-6103	SCALE:	NOT TO SCALE	**ALTERNATIVE 2 IN-SITU STABILIZATION CONCEPTUAL SKETCH**
DR BY:	JSG	DATE:	05/21/93	
CHK BY:	MDL	FILE No.:	NY02-087	
REV BY:	WMB	DR SUBTITLE:	01	

Golder Associates	PFIZER/FOCUSED FS/NY	FIGURE 6



JOB No.:	923-6103	SCALE:	AS SHOWN	**CONSTRUCTION LAYOUT SCHEMATIC**
DR BY:	JSG	DATE:	05/20/93	
CHK BY:	MDL	FILE No.:	NY02-082	
REV BY:	[illegible]	DR SUBTITLE:	01	
Golder Associates				PFIZER/FOCUSED FS/NY — FIGURE 7

Appendix A

APPENDIX A

COMPILATION OF ANALYTICAL LABORATORY DATA

APPENDIX A-1

"REMEDIAL INVESTIGATION REPORT,"
OCTOBER 1992, BY RECRA ENVIRONMENTAL, INC.

TABLE 1-3

TOTAL CADMIUM
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	<0.6	1.4	1.0	0.76
4-6	<0.5	<0.6	<0.5	<0.6
10-12	<0.5	<0.6	<0.5	<0.5
14-16	<0.5	<0.6	<0.5	<0.6
20-22	<0.5	<0.6	<0.5	<0.6
24-26	<0.5	<0.5	<0.5	<0.5
30-32	<0.5	<0.5	<0.5	<0.5
34-36	<0.5	<0.6	<0.5	<0.5
40-42	<0.5	<0.5	<0.5	<0.6
44-46	<0.5	<0.5	<0.5	<0.5
50-52	<0.5	<0.6	<0.5	<0.6
54-56	<0.5	<0.5	<0.6	<0.5
60-62	<0.6	<0.6	<0.6	<0.5
64-66	<0.6	<0.6	<0.6	<0.6
70-72	<0.6	<0.6	<0.6	<0.6

TABLE 1-4

TOTAL CHROMIUM
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	900	260	790	17
2-4	2,010			
4-6	1,220	3,580	200	11
6-8	1,770			
8-10	1,440			
10-12	1,760	340	86	7.0
12-14	3,050			
14-16	1,680	210	71	5.5
16-18	1,240			
18-20	710			
20-22	500	410	36	6.9
24-26	440	380	30	6.5
30-32	370	200	21	6.2
34-36	380	130	28	4.8
40-42	380	100	21	8.6
44-46	300	100	17	9.2
50-52	98	51	6.5	8.2
54-56	110	18	12	5.4
60-62	59	28	7.8	7.8
64-66	26	27	5.6	9.2
70-72	15	13	7.3	5.4

RECRA
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TABLE 1-5

HEXAVALENT CHROMIUM
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	8.2	4.3	11	<0.09
4-6	16	29	0.46	<0.09
10-12	19	2.0	0.095	<0.09
14-16	18	2.3	0.14	<0.09
20-22	7.9	2.4	0.31	<0.09
24-26	9.2	0.53	0.22	<0.09
30-32	7.0	4.7	0.15	<0.09
34-36	13	6.2	0.10	<0.09
40-42	9.6	6.8	0.17	<0.09
44-46	7.3	3.0	0.10	<0.09
50-52	3.1	1.7	<0.09	<0.09
54-56	3.2	0.32	0.12	<0.09
60-62	2.8	0.19	<0.09	0.32
64-66	0.26	0.19	<0.09	0.44
70-72	0.32	0.17	0.17	0.28

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TABLE 1-6

TOTAL COPPER
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	12	120	120	97
4-6	7.2	14	8.3	9.6
10-12	8.8	5.4	5.5	7.0
14-16	7.1	5.9	14	7.4
20-22	5.8	7.6	21	5.9
24-26	5.2	5.9	17	9.6
30-32	12	10	7.9	9.1
34-36	10	18	11	6.9
40-42	6.7	8.8	10	6.8
44-46	7.6	12	12	8.6
50-52	4.9	5.9	4.0	7.9
54-56	6.2	4.3	5.1	3.8
60-62	5.7	6.3	4.5	5.9
64-66	4.4	7.1	3.6	4.5
70-72	4.2	6.7	4.2	3.3

TABLE 1-7

TOTAL IRON
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	6,140	12,700	13,400	8,710
4-6	6,600	18,900	8,420	7,840
10-12	12,600	5,560	4,470	4,350
14-16	9,050	4,080	7,510	5,960
20-22	5,860	6,810	7,610	3,890
24-26	4,720	5,360	5,110	6,360
30-32	8,790	8,110	6,560	7,180
34-36	9,140	8,650	7,910	6,380
40-42	10,400	10,700	9,000	7,410
44-46	9,090	10,800	12,200	7,440
50-52	4,340	5,540	4,940	6,320
54-56	6,380	4,410	5,850	5,530
60-62	3,930	4,940	5,220	8,000
64-66	3,090	5,210	4,440	4,960
70-72	2,810	3,580	3,930	3,460

TABLE 1-8

TOTAL LEAD
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	380	480	590	130
4-6	110	71	4.0	15
10-12	11	5.1	<4	<5
14-16	31	<6	<4	6.2
20-22	5.0	<6	<4	<6
24-26	<3	6.0	<4	<5
30-32	<3	6.6	<4	5.9
34-36	<4	<6	<4	<5
40-42	<3	<5	<4	<6
44-46	<3	<5	<4	<5
50-52	<3	<6	<4	<6
54-56	<3	<5	<4	<5
60-62	<4	<6	<4	<5
64-66	<6	<6	<4	<6
70-72	<4	<6	<4	<6

TABLE 1-9

TOTAL NICKEL
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	5.1	21	15	12
4-6	<4	11	10	15
10-12	14	6.1	10	12
14-16	4.9	10	13	10
20-22	5.0	9.4	11	17
24-26	4.8	<4	8.0	8.0
30-32	7.0	<4	8.8	7.9
34-36	6.0	17	7.9	6.9
40-42	5.8	8.8	14	8.1
44-46	7.8	8.9	11	5.8
50-52	5.9	4.0	<4	12
54-56	5.0	4.8	7.0	5.0
60-62	5.3	<5	6.9	5.8
64-66	5.5	4.1	7.7	<5
70-72	5.5	<6	6.8	7.1

TABLE 1-10

TOTAL SELENIUM
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL			
	TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2			
	3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	<0.6	<0.6	<0.6	<0.6
4-6	<0.5	<0.6	<0.5	<0.6
10-12	<0.5	<0.6	<0.5	<0.5
14-16	<0.5	<0.6	<0.5	<0.6
20-22	<0.5	<0.6	<0.5	<0.6
24-26	<0.5	<0.5	<0.5	<0.5
30-32	<0.5	<0.5	<0.5	<0.5
34-36	<0.5	<0.6	<0.5	<0.5
40-42	<0.5	<0.5	<0.5	<0.6
44-46	<0.5	<0.5	<0.5	<0.5
50-52	<0.5	<0.6	<0.5	<0.6
54-56	<0.5	<0.5	<0.6	<0.5
60-62	<0.6	<0.6	<0.6	<0.5
64-66	<0.6	<0.6	<0.6	<0.6
70-72	<0.6	<0.6	<0.6	<0.6

TABLE 1-11

TOTAL ZINC
(ug/g Dry Weight)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	32	360	150	130
4-6	8.9	35	18	20
10-12	19	21	13	30
14-16	8.1	17	30	11
20-22	7.0	22	19	11
24-26	7.2	17	14	29
30-32	12	21	18	34
34-36	13	17	20	14
40-42	12	29	18	30
44-46	11	24	34	26
50-52	8.8	17	9.4	34
54-56	9.9	12	11	8.4
60-62	7.8	11	9.4	22
64-66	7.1	18	18	16
70-72	6.9	17	7.6	8.5

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TABLE 1-12

LEACHABLE NITRATE
(ug/g Dry Wt.)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	54	<3	9.6	3.7
10-12	16	<3	<3	2.0
20-22	<3	<3	5.3	<3
30-32	<3	<3	2.2	<3
40-42	2.3	<3	5.5	3.1
50-52	<3	2.4	3.3	3.5
60-62	2.7	5.4	4.3	2.8
70-76	3.1	3.4	3.3	5.6

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TABLE 1-13

LEACHABLE PHOSPHORUS
(ug/g Dry Wt.)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	79	61	66	<0.9
10-12	400	39	41	<0.9
20-22	48	30	43	<0.9
30-32	22	18	11	<0.9
40-42	32	29	28	<0.9
50-52	17	16	13	<0.9
60-62	17	17	7.5	<0.9
70-72	2.1	6.1	15	<0.9

TABLE 1-14

LEACHABLE SULFATE
(ug/g Dry Wt.)

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft	BACKGROUND
0-2	69	120	78	58
10-12	<42	<42	<42	<41
20-22	<42	<42	<42	<41
30-32	<43	<42	<42	<42
40-42	<42	<42	110	<42
50-52	<42	<42	73	64
60-62	<45	<43	<46	<42
70-72	<46	<45	<48	<48

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TABLE 1-15

PERCENT DRY WEIGHT

(SOURCE INVESTIGATION STUDY)

SAMPLE DEPTH (ft)	BORING/MONITORING WELL TB-1	TB-2	MW-2	MW-1
	DISTANCE FROM CENTER OF DP-2 3 ft.	10 ft.	18.5 ft.	BACKGROUND
0-2	93.10	80.16	81.82	88.20
2-4	94.63			
4-6	96.50	89.63	95.67	95.30
6-8	89.06			
8-10	95.83			
10-12	96.00	96.75	97.01	97.51
12-14	96.30			
14-16	96.58	96.67	95.68	95.63
16-18	97.00			
18-20	96.57			
20-22	96.87	95.80	96.09	97.35
24-26	97.03	96.54	95.20	96.79
30-32	92.92	95.64	94.89	96.44
34-36	95.86	95.52	96.08	96.61
40-42	95.83	95.18	95.21	97.06
44-46	95.94	95.01	95.31	96.64
50-52	96.06	95.39	95.54	96.00
54-56	94.94	96.07	95.71	95.90
60-62	89.20	91.30	86.13	93.82
64-66	89.84	88.76	89.01	88.25
70-72	87.66	88.02	82.49	83.58

.ABLE 1-16

SUMMARY OF ANALYTICAL RESULTS FOR SOIL SAMPLES
COLLECTED AT DISPOSAL AREAS 1 & 2
(SOURCE INVESTIGATION STUDY)

Sample I.D.	Depth of Sample (feet)	Total Metals (ug/g) Cd (BGR MAX 0.76)	Cr (BGR MAX 17)	Cr+6 (BGR MAX 0.44)	Cu (BGR MAX 97)	Fe (BGR MAX 8,710)	Pb (BGR MAX 130)	Ni (BGR MAX 17)	Se (BGR MAX <0.6)	Zn (BGR MAX 130)	Leachable Inorganics (ug/g) NO_3 (BGR MAX 5.6)	PO_4 (BGR MAX <0.9)	SO_4 (BGR MAX 64)
DP-1	8-10*	-	4,100	9.5	540	17,000	10,000	-	-	840	9.8	8.0	150
	10-12**	-	1,700	0.28	120	14,000	2,800	-	-	230	1.8	<0.6	47
	13-15	-	69	1.3	31	6,510	150	-	-	30	1.3	9.1	28
	15-17	-	62	0.59	21	6,710	150	-	-	15	1.7	7.7	<20
	17-19	-	34	0.81	21	7,810	110	-	-	17	6.2	6.1	<20
	19-21	-	13	0.13	12	4,020	55	-	-	9.2	3.7	5.7	<20
	21-23	-	35	0.29	25	13,600	73	-	-	23	3.2	3.6	<20
	23-25	-	8.1	<0.08	7.1	2,920	28	-	-	8.7	1.7	3.7	<20
	25-27	-	8.7	0.10	9.6	5,080	37	-	-	10	1.9	3.9	37
	27-29	-	12	<0.08	19	20,900	97	-	-	12	1.4	5.4	58
	33-35	-	18	0.11	14	4,570	39	-	-	10	1.6	4.7	<20
DP-2	0.0-0.5	1.1	25,800	4,610	220	19,000	53,200	29	<0.6	200	-	-	-
	2.0-2.5	<0.6	4,570	150	17	9,220	570	4.6	<0.6	20	-	-	-
	4.0-4.5	<0.6	4,740	220	18	6,820	1,600	5.1	<0.6	19	-	-	-
	4.5-5.0	<0.6	3,650	400	15	7,050	7,050	<2	<0.6	15	-	-	-
	5.0-5.5	<0.6	3,350	110	10	6,230	830	<2	<0.6	11	-	-	-
	6.0-6.5	<0.6	3,050	69	11	9,510	750	<2	<0.6	9.9	-	-	-
	6.5-7.0	<0.6	3,200	130	11	4,350	5,690	2.8	<0.6	10	-	-	-
	7.0-7.5	<0.6	3,110	87	11	4,010	800	3.7	<0.6	10	-	-	-

Note: BGR MAX is the maximum background value found for each element in the soils from MW-1, all values are in ug/g.

* Composite sample was taken from the 8-9' and 9-10' sampling interval, listed on analytical results as Comp-1.

**Composite sample was taken from the 10-11', 11-11.5' and 11.5-12' sampling interval, listed on analytical results as Comp-2

\- Not analyzed.

TABLE 4-1
PFIZER HOSPITAL PRODUCTS GROUP, INC.
96-20 222nd Street
Queens Village, NY

LABORATORY DATA SUMMARY
For Chromium and Iron Analysis of Soils

Boring No.	Depth Below Surface (ft)	Hexavalent Chromium (ppm)	Total Chromium	Total Iron (ppm)
TB-3	1-3	0.47	62.2	
	3-5	0.19	29.8	
	5-7	<0.10	33.7	
	7-9	0.35	57	
	9-11	0.15	48.3	
	11-13	0.17	52.5	
	13-15	<0.10	80.5	
	15-17	0.35	116	5920
	17-19	1.1	78.0	5340
	19-21	1.3	117	
	24-26	1.4	102	
	29-31	2.4	129	
	34-36	3.6	155	
	39-41	1.8	131	
	44-46	2.2	91.1	
	49-51	1.8	70.7	7330
	54-56	2.0	114	
	59-61	0.46	72	
	64-66	<0.12	47.2	
TB-4	1-3	4.9	302	
	5-7	0.73	121	
	13-15	0.83	88.4	5790
	15-17	0.71	75.2	
	19-21	1.5	81.6	7180
	27-29	1.8	79.7	
	35-37	1.7	60.2	8020
	40-42	0.49	36.1	
	45-47	0.68	46.5	
	50-52	0.33	31.9	7230
	55-57	0.14	10.5	
	63-65	<0.12	17.8	

TABLE 4-1 (Continued)
PFIZER HOSPITAL PRODUCTS GROUP, INC.
96-20 222nd Street
Queens Village, NY

LABORATORY DATA SUMMARY
For Chromium and Iron Analysis of Soils

Boring No.	Depth Below Surface (ft)	Hexavalent Chromium (ppm)	Total Chromium	Total Iron (ppm)
DP-1A	35-37	<0.10	16.8	
	40-42	<0.11	23.9	
	50-52	<0.10	9.6	
	57-59	<0.11	33.3	
MW-4	0-2	<0.12	19	
	9-11	<0.10	10.8	
	19-21	<0.10	7.3	5640
	29-31	<0.10	6.5	
	39-41	<0.10	11.9	
	49-51	<0.10	5.5	5820
	59-61	<0.11	10.6	
MW-5	0-2	<0.11	6.4	
	9-11	<0.10	12.2	
	19-21	<0.11	11.0	
	29-31	<0.10	12.6	
	39-41	<0.10	11.4	
	49-51	<0.08	15.3	
	59-61	<0.09	11.0	
MW-6	1-3	<0.10	8.8	
	9-11	<0.11	18.6	
	19-21	<0.10	6.2	4820
	29-31	<0.10	10.7	
	39-41	<0.10	11.7	
	49-51	<0.10	46.8	8230
	59-61	<0.11	6.9	

TABLE 4-1 (Continued)
PFIZER HOSPITAL PRODUCTS GROUP, INC.
96-20 222nd Street
Queens Village, NY

LABORATORY DATA SUMMARY
For Chromium and Iron Analysis of Soils

Boring No.	Depth Below Surface (ft)	Hexavalent Chromium (ppm)	Total Chromium	Total Iron (ppm)
TB-6	0.5-1	<0.11	15.3	
	2-5	3.2	327	
	5-7	0.13	43	
	10-12	1.3	81.2	
	15-17	1.4	71.5	
	20-20.3	0.47	86.4	
	25-26.5	1.3	47.6	36.1
TB-5	1-3	<0.12	17.0	
	5-7			
	13-15	<0.10	9.4	
	15-17	<0.10	19.3	
	19-21	<0.10	9.5	
	25-27	<0.10	7.9	
	29-31	<0.10	12.6	
	35-37	<0.11	13.7	
	40-42	<0.11	18.0	13,500
	45-47	<0.10	10.6	
	50-52	<0.10	49.1	5770
	55-57	<0.12	6.8	
	60-62	<0.13	8.1	7190
	65-67	<0.12	5.4	
HB-1	0.5-1.0	<0.11	20.7	
	2.5-3.0	.82	3510	
	4.5-5.0	4.4	900	
HB-2	2-3	0.13	36.9	
HB-2	3-4	1.5	183	
HB-2	4-5	0.21	60	
HB-2	5-6	0.18	42.6	

TABLE 4-1 (Continued)
PFIZER HOSPITAL PRODUCTS GROUP, INC.
96-20 222nd Street
Queens Village, NY

LABORATORY DATA SUMMARY
For Chromium and Iron Analysis of Soils

Boring No.	Depth Below Surface (ft)	Hexavalent Chromium (ppm)	Total Chromium	Total Iron (ppm)
TB-8	3-5	72.4		
	5-7	34.1	5290	
	9-11	3.8	497	
	13-15	1.7	373	
	15-17	4.1	737	
	17-19	6.8	618	
	19-21	4.5	554	7260
	21-23	4.4	727	5430
	23-25	3.8	580	
	25-27	4.6	383	6270
	28-30	3.9	384	
	30-32	1.4	269	
	36-38	2.1	258	
	39-41	1.0	203	
	44-46	0.72	145	10,600
	49-51	1.5	123	
	54-56	0.26	64.3	
	59-61	0.32	40.2	
	64-65	0.27	29.4	
TB-7	0.5-2.5	<0.11	15.5	
	2.5-4.0	<0.11	18.3	
	4-5	1.2	100	
	5-7	0.29	88.5	
	7-10	0.38	113	
	10-12	0.28	174	
	15-17	4.1	337	
	20-22	4.0	509	
	25-27	4.5	448	
	30-32	3.9	109	
	35-37	2.2	49.5	
	40-42	0.41	43.5	
	45-47	0.2	36.6	

TABLE 4-2
PHPG, INC. - Queens Village, NY
Chromium and TCLP Metals Testing at DP-2

Parameter	DP-2N (4-6) (mg/kg)	DP-2N (4-6) TCLP (ug/l)	DP-2S (6.5-7.5) (mg/kg)	DP-2S (6.5-7.5) TCLP (ug/l)
Hexavalent Chromium	2.0	38	1870	82
Total Chromium	450	209	11,100	369
Total Arsenic		<5		20
Total Barium		601		39.2
Total Cadmium		4.5		2.1
Total Lead		800		200
Total Mercury		<0.2		0.24
Total Selenium		<5		<5
Total Silver		<10		11.1

<=Indicates the compound was analyzed for, but not detected above the sample quantitation limit.

TABLE 4-3
PHPG, INC. - QUEENS VILLAGE, NY
TOTAL METAL CONCENTRATIONS
OF SOILS (in ppm)

PARAMETER	TB-8 (5-7')	TB-3 (34-36)	MW-5 (49-51)	DP-1A (40-42)	BACKGROUND MW-4 (29-31)	NYSDEC DRAFT CLEANUP GUIDANCE LEVELS
Aluminum	4460	2760	2370	3340	1570	
Antimony	28.8	<10.2	<10.6	<10.3	<10.3	30
Arsenic	<2.4	<1.1	<1.1	<1.0	<1.1	80
Barium	31.8B	17.5B	18.7B	22B	12.4B	4000
Beryllium	<1.2	<1.0	<1.1	<1.0	<1.0	0.16
Cadmium	<0.07	<0.06	<0.06	<0.06	<0.04	80
Calcium	<468	<406	<426	485B	<412	
Chromium	5290	155	10.4	20	9.7	80,000
Cobalt	<4.7	<4.1	<4.3	<4.1	<4.1	
Copper	<2.3	8.5	<2.1	3.5B	<2.1	
Iron	16,400	10,000	5480	13,200	8330	
Lead	493	4.7	4.6	12.5	2.8	250
Magnesium	518B	963B	1010B	1340	584B	
Manganese	96.5	180	79.8	69.8	122	20,000
Mercury	<0.11	<0.09	<0.09	<0.10	<0.08	20
Nickel	<4.7	9.5	7.1B	16.5	9.4	2,000
Potassium	<1170	<1020	<1060	1280	<1030	
Selenium	<1.2	<1.1	<1.1	<1.0	<1.1	
Silver	<2.4	<2.0	<2.1	<2.1	<2.1	200
Sodium	269B	<203	231B	<206	<206	
Thallium	<1.7	<1.5	<1.5	<1.5	<1.5	6
Vanadium	15.2	9.4B	9.0B	15	6.5B	600
Zinc	14.4	18.7	13.3	17.3	13.0	20,000
Cyanide	<1.5	<1.3	<1.3	<1.3	<1.2	2,000

< - Parameter not detected above the indicated detection limit.
B - Parameter detected in the associated blank as well as in the sample.

RECRA ENVIRONMENTAL, INC.

TABLE 4-4
PHPG, INC. - Queens Village, NY
Summary of Organic Analyses of Soil Samples
(Results in ppb)

	Sample Identification				
Volatile Organics	**DP-1A (40-42)**	**TB-3 (34-36)**	**TB-8 (3-5)**	**MW-5 (49-51)**	**MW-4 (29-31)**
Bromomethane	0.2 BJ	0.2 J	<11	<10	<10
Acetone	21	12B	27B	4J	4J
Toluene	2BJ	<10	<11	<10	<10
Semi-Volatile Organics					
Butylbenzylphthalate	<360	<360	<360	<360	1800
Di-n-butylphthalate	850B	1800B	1700B	25BJ	<330
Bis (2-ethylhexyl) phthalate	44BJ	<340	65 BJ	430B	290J
Di-n-octylphthalate	<360	<360	<360	<360	55J
Naphthalene	<330	330J	<330	<330	<330
2-Methylnaphthalene	<330	110J	<330	<330	<330
Acenaphthene	<330	84J	<330	<330	<330
Phenanthrene	<330	130J	<330	<330	<330
Benzo (b) fluoranthene	<330	<330	9[illegible]J	<330	<330
Benzo (k) fluoranthene	<330	<330	45J	<330	<330
Indeno (1,2,3-cd) pyrene	<330	<330	95J	<330	<330
Dibenzo (a,h) anthracene	<330	<330	17J	<330	<330
Benzo (g,h,i,) perylene	<330	<330	89J	<330	<330
Pesticides					
4,4'-DDT	<17	<17	1.6J	<17	<17

J=Indicates an estimated value. The result is less than the sample quantitation limit, but greater than zero.
<=Indicates the compound was analyzed for, but not detected above the sample quantitation limit.
B=Indicates the analyte was found in the associated blank as well as in the sample.

RECRA ENVIRONMENTAL, INC.

APPENDIX A-2

"OFF-SITE GROUND-WATER INVESTIGATION AND ADDITIONAL SOURCE INVESTIGATION," MAY 1993, BY ROUX ASSOCIATES, INC.

Table 2. Summary of Analytical Results for Soil Samples Collected by Roux Associates, Inc. from On-Site Sampling Locations During February and April 1993, 96-20 222nd Street, Queens Village, New York.

Concentrations in mg/kg

Sample Depth	MW-10		MW-11		TB-9		TB-10		TB-11	
	Cr	Cr+6	Cr	Cr+6	Cr	Cr+6	Cr	Cr+6	Cr	Cr+6
0 - 2	16600	202	17.1	0.22	12.9	0.15	3.5	0.11 U	NS	NS
5 - 7	10.1	0.35	12.0	0.17	40.0	0.11 U	4.9	0.10 U	1010	4.1
10 - 12	13.4	0.58	4.0	0.21	4.5	0.22	18.2	0.10 U	97.0	1.6
15 - 17	18.2	1.0	11.6	0.58	12.2	0.16	11.3	0.10 U	69.9	0.70
20 - 22	4.5	0.11 U	15.7	0.66	6.2	0.11 U	29.8	0.10 U	22.1	0.16
25 - 27	4.9	0.18	18.2	0.56	6.7	0.20	50.9	0.55	9.7	0.10 U
30 - 32	38.4	0.47	21.7	0.32	14.7	0.22	48.1	0.44	7.6	0.10 U
35 - 37	27.0	1.5	30.4	0.90	17.2	0.22	33.8	0.55	8.7	0.10 U
40 - 42	44.1	1.6	35.3	1.1	30.6	0.33	32.6	0.22	8.6	0.10 U
45 - 47	35.8	0.79	26.2	0.62	20.6	0.33	37.1	0.80	10.2	0.10 U
50 - 52	14.6	0.59	17.6	0.17	8.0	0.24	25.2	0.55	8.7	0.10 U
55 - 57	13.9	0.46	16.9	0.31	12.4	0.12 U	24.7	0.37	6.4	0.12 U
60 - 62	19.0	0.52	9.9	0.17	NS	NS	NS	NS	NS	NS

Concentrations in mg/kg

Sample Depth	TB-12		TB-13		TB-14		TB-15		TB-16	
	Cr	Cr+6	Cr	Cr+6	Cr	Cr+6	Cr	Cr+6	Cr	Cr+6
0 - 2	15.9	0.11	16.9	0.17	16.9	0.11 U	3240	46.7	12.9	0.11 U
5 - 7	10.2	0.10 U	19.1	0.19	21.7	0.25	171	1.1	17.3	0.22
10 - 12	10.5	0.16	12.2	0.14	30.0	0.61	1130	37.4	30.8	0.59
15 - 17	14.1	0.19	16.4	0.21	47.2	0.82	287	5.1	28.0	0.29
20 - 22	22.1	0.43	6.4	0.12	12.7	0.50	273	7.0	17.8	0.26
25 - 27	9.2	0.11 U	6.1	0.13	13.2	0.26	14.3	0.26	12.1	0.17
30 - 32	10.7	0.10 U	11.5	0.12	8.5	0.31	81.0	1.0	26.4	0.30
35 - 37	10.9	0.24	11.8	0.27	10.3	0.24	17.3	0.23	11.3	0.21
40 - 42	14.0	0.20	9.8	0.17	9.5	0.14	14.2	0.21	11.1	0.23
45 - 47	11.5	0.12	8.1	0.14	7.3	0.25	11.5	0.10 U	11.2	0.10 U
50 - 52	7.1	0.18	6.7	0.10 U	6.5	0.16	10	0.10 U	7.9	0.10 U
55 - 57	5.0	0.14	6.2	0.12 U	8.0	0.17	7.9	0.11 U	9.2	0.11 U

NS - No sample collected
U - Not detected
mg/kg - Milligrams per kilogram
Cr - Total Chromium
Cr+6 - Hexavalent Chromium

Table 3. Summary of Eh and pH for Soil Samples Collected by Roux Associates, Inc. from January through April 1993, 96-20 222nd Street, Queens Village, New York.

Sample Location	Depth (ft bls)	Date	Eh (mV)	pH
MW-7	54 - 56	1/5/93	181.8	6.06
MW-8	54 - 56	1/8/93	136.9	5.74
MW-8D	79 - 81	1/11/93	170.8	6.48
MW-9	54 - 56	1/6/93	137.5	6.17
MW-9D	80 - 82	1/7/93	158.1	6.31
MW-10	0 - 2	2/16/93	174.6	4.35
	5 - 7	2/16/93	152.5	5.20
	10 - 12	2/16/93	150.8	5.64
	15 - 17	2/16/93	131.3	4.98
	20 - 22	2/16/93	125.8	5.36
	25 - 27	2/16/93	128.6	4.84
	30 - 32	2/17/93	148.6	5.28
	35 - 37	2/17/93	146.7	5.49
	40 - 42	2/17/93	152.6	5.89
	45 - 47	2/17/93	163.6	6.12
	50 - 52	2/17/93	168.6	6.23
	55 - 57	2/17/93	153.1	6.35
	60 - 62	2/17/93	148.9	6.30
MW-11	0 - 2	2/18/93	196.1	6.28
	5 - 7	2/18/93	168.2	6.26
	10 - 12	2/18/93	168.7	6.10
	15 - 17	2/18/93	146.5	6.12
	20 - 22	2/18/93	153.7	6.05
	25 - 27	2/18/93	124.9	5.98
	30 - 32	2/18/93	131.0	5.96
	35 - 37	2/18/93	140.2	5.86
	40 - 42	2/19/93	136.8	5.86
	45 - 47	2/19/93	146.6	5.88
	50 - 52	2/19/93	142.3	5.81
	55 - 57	2/19/93	136.6	5.91
	60 - 62	2/19/93	139.2	5.87
MW-12	55 - 57	3/22/93	118.6	5.81
MW-13	55 - 57	3/23/93	126.6	5.89
MW-14	60 - 62	4/2/93	146.8	6.02

mV - Millivolts
ft bls - Feet below land surface

Table 3. Summary of Eh and pH for Soil Samples Collected by Roux Associates, Inc. from January through April 1993, 96-20 222nd Street, Queens Village, New York.

Sample Location	Depth (ft bls)	Date	Eh (mV)	pH
TB-9	0 - 2	2/22/93	153.8	6.13
	5 - 7	2/22/93	163.6	6.02
	10 - 12	2/22/93	156.3	5.86
	15 - 17	2/22/93	159.6	5.79
	20 - 22	2/22/93	146.6	5.86
	25 - 27	2/22/93	163.6	6.02
	30 - 32	2/22/93	166.3	6.12
	35 - 37	2/22/93	159.6	6.23
	40 - 42	2/22/93	171.6	6.13
	45 - 47	2/22/93	146.6	5.89
	50 - 52	2/22/93	154.2	6.12
	55 - 57	2/22/93	157.3	6.31
TB-10	0 - 2	2/23/93	167.7	6.47
	5 - 7	2/23/93	212.8	3.71
	10 - 12	2/23/93	198.6	4.69
	15 - 17	2/23/93	175.5	4.98
	20 - 22	2/23/93	129.2	6.14
	25 - 27	2/23/93	136.2	6.23
	30 - 32	2/23/93	142.6	6.32
	35 - 37	2/23/93	168.6	6.26
	40 - 42	2/23/93	154.5	6.13
	45 - 47	2/23/93	165.0	5.49
	50 - 52	2/23/93	153.5	5.63
	55 - 57	2/23/93	151.3	5.88
TB-11	5 - 7	4/12/93	149.2	6.24
	10 - 12	4/12/93	142.6	6.18
	15 - 17	4/12/93	123.6	6.09
	20 - 22	4/12/93	118.6	6.19
	25 - 27	4/12/93	126.3	6.21
	30 - 32	4/12/93	132.6	6.18
	35 - 37	4/12/93	136.6	6.16
	40 - 42	4/12/93	132.3	6.03
	45 - 47	4/12/93	126.3	6.28
	50 - 52	4/12/93	118.6	6.33
	55 - 57	4/12/93	112.8	6.36

mV - Millivolts
ft bls - Feet below land surface

Table 3. Summary of Eh and pH for Soil Samples Collected by Roux Associates. Inc. from January through April 1993, 96-20 222nd Street, Queens Village, New York.

Sample Location	Depth (ft bls)	Date	Eh (mV)	pH
TB-12	0 - 2	4/13/93	136.4	6.36
	5 - 7	4/13/93	126.3	6.42
	10 - 12	4/13/93	104.8	4.79
	15 - 17	4/13/93	112.6	5.68
	20 - 22	4/13/93	132.8	5.32
	25 - 27	4/13/93	144.2	6.12
	30 - 32	4/13/93	113.0	6.73
	35 - 37	4/13/93	120.2	6.68
	40 - 42	4/14/93	80.5	6.85
	45 - 47	4/14/93	85.6	6.88
	50 - 52	4/14/93	92.6	6.68
	55 - 57	4/14/93	116.3	6.72
TB-13	0 - 2	4/14/93	116.3	5.96
	5 - 7	4/14/93	98.6	6.23
	10 - 12	4/14/93	89.6	6.42
	15 - 17	4/14/93	112.6	6.56
	20 - 22	4/14/93	113.2	6.61
	25 - 27	4/14/93	96.2	6.72
	30 - 32	4/14/93	86.8	6.82
	35 - 37	4/15/93	102.6	6.52
	40 - 42	4/15/93	106.6	6.49
	45 - 47	4/15/93	92.2	6.76
	50 - 52	4/15/93	86.6	6.81
	55 - 57	4/15/93	76.2	6.84
TB-14	0 - 2	4/16/93	148.3	6.86
	5 - 7	4/16/93	126.3	6.76
	10 - 12	4/16/93	116.8	6.72
	15 - 17	4/16/93	120.6	6.81
	20 - 22	4/16/93	119.2	6.73
	25 - 27	4/16/93	103.2	6.91
	30 - 32	4/16/93	106.5	6.88
	35 - 37	4/16/93	96.9	6.79
	40 - 42	4/16/93	102.2	6.92
	45 - 47	4/16/93	112.6	6.81
	50 - 52	4/16/93	103.6	6.62
	55 - 57	4/16/93	118.6	6.49

mV - Millivolts
ft bls - Feet below land surface

Table 3. Summary of Eh and pH for Soil Samples Collected by Roux Associates, Inc. from January through April 1993, 96-20 222nd Street, Queens Village, New York.

Sample Location	Depth (ft bls)	Date	Eh (mV)	pH
TB-15	0 - 2	4/19/93	192.4	5.86
	5 - 7	4/19/93	146.8	6.14
	10 - 12	4/19/93	162.6	6.23
	15 - 17	4/19/93	146.6	6.11
	20 - 22	4/19/93	138.2	6.36
	25 - 27	4/19/93	122.6	6.24
	30 - 32	4/19/93	136.6	6.33
	35 - 37	4/19/93	138.2	6.06
	40 - 42	4/19/93	143.6	6.12
	45 - 47	4/20/93	148.1	6.23
	50 - 52	4/20/93	152.2	6.43
	55 - 57	4/20/93	162.6	6.59
TB-16	0 - 2	4/20/93	176.6	5.91
	5 - 7	4/20/93	151.6	6.01
	10 - 12	4/20/93	146.3	6.22
	15 - 17	4/20/93	151.6	6.29
	20 - 22	4/20/93	142.2	6.49
	25 - 27	4/20/93	166.6	6.72
	30 - 32	4/20/93	161.2	6.43
	35 - 37	4/21/93	160.6	6.29
	40 - 42	4/21/93	150.9	6.42
	45 - 47	4/21/93	171.1	6.28
	50 - 52	4/21/93	158.4	6.39
	55 - 57	4/21/93	172.4	6.24

mV - Millivolts
ft bls - Feet below land surface

Appendix B

APPENDIX B

RESULTS OF GEOTECHNICAL LABORATORY TESTING PERFORMED BY GOLDER ASSOCIATES INC.

ASTM GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2216 and D2217

PROJECT TITLE:	PFIZER, INC.	Sample No.:	15'- 17'
PROJECT NUMBER:	923-6103.007	Sample ID.:	JAR

WATER CONTENT (Delivered Moisture)		% PASSING #10 SIEVE	
Tare no.	M-10	Total Wt	377.21
Wt soil & tare,moist	585.87	Wt Split #10	323.61
Wt soil & tare,dry	565.03	% PASSING #10	85.8%
Wt tare	187.82		
Wt moisture	20.84		
Wt dry soil	377.21		
% WATER	5.52%		

USCS	SIEVE	wt ret	% ret	% PASS	SIEVE	
coarse gravel	3.000		0.00%	100.00%	3.000	coarse gravel
	1.500		0.00%	100.00%	1.500	
	1.000		0.00%	100.00%	1.000	
fine gravel	0.750		0.00%	100.00%	0.750	fine gravel
	0.375	8.64	2.29%	97.71%	0.375	
coarse sand	#4	23.89	6.33%	93.67%	#4	coarse sand
medium sand	#10	53.74	14.25%	85.75%	#10	medium sand

SAMPLE PREPARATION FOR HYDROMETER ANALYSIS

% Pass #10 Sieve	85.75	Initial Moist Wt.	76.42
Specific Gravity	2.60	Calculated Dry Wt	76.38
ml Dispering Agent Used	125	(40ml Na(PO4)n per 1000ml H2O)	

WATER CONTENT (Hygroscopic #10)		% PASSING 200 SIEVE	
Tare no.	CH-17	Tare no.	CH-011
Wt soil and tare,moist	60.58	Wt soil and tare,dry (wt,dry)	128.43
Wt soil&tare,dry	60.56	Wt soil&tare,wash (wt,wash)	125.49
Wt tare	21.66	Wt tare	52.05
Wt moisture lost	0.02	Wt fines lost (wt,dry-wt,wash)	2.94
Wt dry soil,final	38.90	Wt dry soil, (wt,dry-wt,tare)	76.38
% HYGROSCOPIC MOISTURE	0.1%	% FINES LOST	3.8%

PERCENT BETWEEN #10 AND #200 SIEVE CALCULATION

SIEVE	CUMUL WT. RETAINED	CUMUL WT. RET. CORR	PERCENT PASSING		
#10	0.00	12.69	85.75%	LL	
#20	9.28	21.97	75.33%	PL	
#40	34.02	46.71	47.56%	PI	
#60	58.38	71.07	20.21%	Gs	2.60
#100	70.49	83.18	6.61%		
#200	73.45	86.14	3.29%		

DATE	TIME	ET (min)	RDNG R	TEMP T	TEMP.COR K	HYD.RDNG. H
03/09/93	09:00	2.00	6.0	25.00	0.013	4.00
	09:02	4.00	6.0	25.00	0.013	4.00
	09:06	8.00	6.0	25.00	0.013	4.00
	09:13	15.00	6.0	25.00	0.013	4.00
	09:28	30.00	5.5	25.00	0.013	4.00
	09:58	60.00	5.0	25.00	0.013	4.00
	10:58	120.00	4.5	25.00	0.013	3.50
	12:58	240.00	4.0	25.00	0.013	3.50
	17:02	484.00	4.0	24.50	0.013	3.50
03/10/93	08:58	1440.0	4.0	24.00	0.013	3.50

Grain Size Percentages

% C GRVL	0.0%
% F GRVL	6.3%
% C SAND	7.9%
% M SAND	38.2%
% F SAND	44.3%
% FINES	3.3%
% TOTAL	100.00%

ET (min)	RDNG,C	EFF LTH	K	A	PAR DIA	%FINER
2.00	2.00	16.0	0.013	1.01	0.037	2.3
4.00	2.00	16.0	0.013	1.01	0.026	2.3
8.00	2.00	16.0	0.013	1.01	0.018	2.3
15.00	2.00	16.0	0.013	1.01	0.013	2.3
30.00	1.50	16.1	0.013	1.01	0.010	1.7
60.00	1.00	16.1	0.013	1.01	0.007	1.1
120.00	1.00	16.1	0.013	1.01	0.005	1.1
240.00	0.50	16.3	0.013	1.01	0.003	0.6
400.00	0.50	16.3	0.013	1.01	0.002	0.6
1440.00	0.50	16.3	0.013	1.01	0.001	0.6

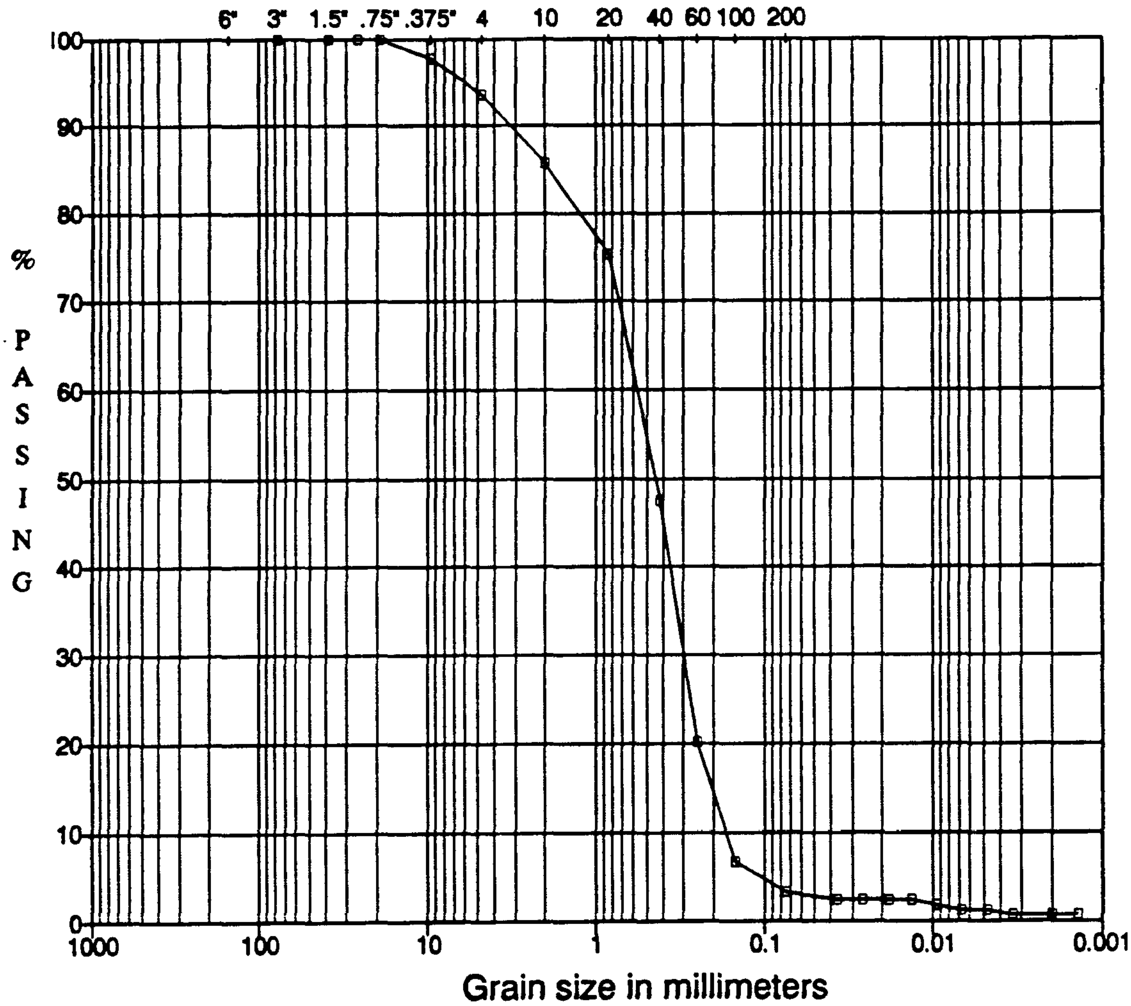
WET COLOR: Yellowish brown
DESCRIPTION: [illegible]

USCS:

GOLDER ASSOCIATES INC
MT. LAUREL, NJ

TECH: TK
DATE: 3/10/93
CHECKED: [signature]
REVIEWED:

PARTICLE SIZE DISTRIBUTION ASTM D-421 AND 422
US STANDARD SIEVE OPENING SIZES



COBBLES	GRAVEL		SAND			FINES (Silt and Clay)
	Coarse	Fine	Cor	Med	Fine	

SAMPLE ID	W%	LL	PL	PI	Gs	DESCRIPTION
15'- 17'	5.5				2.60	Yellowish brown f-m SAND, little gravel, trace fines
	Date Tested: TK					
TECHNICIAN: TK	DATE: 3/11/93				CHECKED: [illegible]	REVIEWED:

PFIZER, INC.
923-6103.007

GOLDER ASSOCIATES INC.
MT. LAUREL, NJ

ASTM GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2216 and D2217

PROJECT TITLE:	PFIZER, INC.	Sample No.:	30'- 32'
PROJECT NUMBER:	923-6103.007	Sample ID.:	JAR

WATER CONTENT (Delivered Moisture)			% PASSING #10 SIEVE	
Tare no.		BL-14	Total Wt	249.16
Wt soil & tare,moist		450.63	Wt Split #10	189.19
Wt soil & tare,dry		439.38	% PASSING #10	75.9%
Wt tare		190.22		
Wt moisture		11.25		
Wt dry soil		249.16		
% WATER		4.52%		

USCS	SIEVE	wt ret	% ret	% PASS	SIEVE	
coarse gravel	3.000		0.00%	100.00%	3.000	coarse gravel
	1.500		0.00%	100.00%	1.500	
	1.000		0.00%	100.00%	1.000	
fine gravel	0.750		0.00%	100.00%	0.750	fine gravel
	0.375	16.90	6.78%	93.22%	0.375	
coarse sand	#4	32.47	13.03%	86.97%	#4	coarse sand
medium sand	#10	60.02	24.09%	75.91%	#10	medium sand

SAMPLE PREPARATION FOR HYDROMETER ANALYSIS

% Pass #10 Sieve	75.91	Initial Moist Wt.	77.10
Specific Gravity	2.62	Calculated Dry Wt	77.02
ml Dispering Agent Used	125	(40ml Na(PO4)n per 1000ml H2O)	

WATER CONTENT (Hygroscopic #10)		% PASSING 200 SIEVE	
Tare no.	30C	Tare no.	CH-035
Wt soil and tare,moist	48.33	Wt soil and tare,dry (wt,dry)	127.84
Wt soil&tare,dry	48.30	Wt soil&tare,wash (wt,wash)	123.60
Wt tare	20.46	Wt tare	50.82
Wt moisture lost	0.03	Wt fines lost (wt,dry-wt,wash)	4.24
Wt dry soil,final	27.84	Wt dry soil, (wt,dry-wt,tare)	77.02
% HYGROSCOPIC MOISTURE	0.1%	% FINES LOST	5.5%

PERCENT BETWEEN #10 AND #200 SIEVE CALCULATION

SIEVE	CUMUL WT. RETAINED	CUMUL WT. RET. CORR	PERCENT PASSING
#10	0.00	24.44	75.91%
#20	13.12	37.56	62.98%
#40	37.62	62.06	38.83%
#60	59.63	84.07	17.14%
#100	69.72	94.16	7.19%
#200	72.67	97.11	4.28%

LL	
PL	
PI	
Gs	2.62

DATE	TIME	ET (min)	RDNG R	TEMP T	TEMP.COR K	HYD.RDNG. H
03/09/93	09:07	2.00	7.5	25.00	0.013	4.00
	09:09	4.00	7.0	25.00	0.013	4.00
	09:13	8.00	6.0	25.00	0.013	4.00
	09:20	15.00	6.0	25.00	0.013	4.00
	09:35	30.00	5.5	25.00	0.013	4.00
	10:05	60.00	5.0	25.00	0.013	4.00
	11:05	120.00	4.5	25.00	0.013	3.50
	13:05	240.00	4.0	25.00	0.013	3.50
	17:05	480.00	4.0	24.50	0.013	3.50
03/10/93	09:05	1440.0	4.0	24.00	0.013	3.50

Grain Size Percentages

% C GRVL	0.0%
% F GRVL	13.0%
% C SAND	11.1%
% M SAND	37.1%
% F SAND	34.5%
% FINES	4.3%
% TOTAL	100.00%

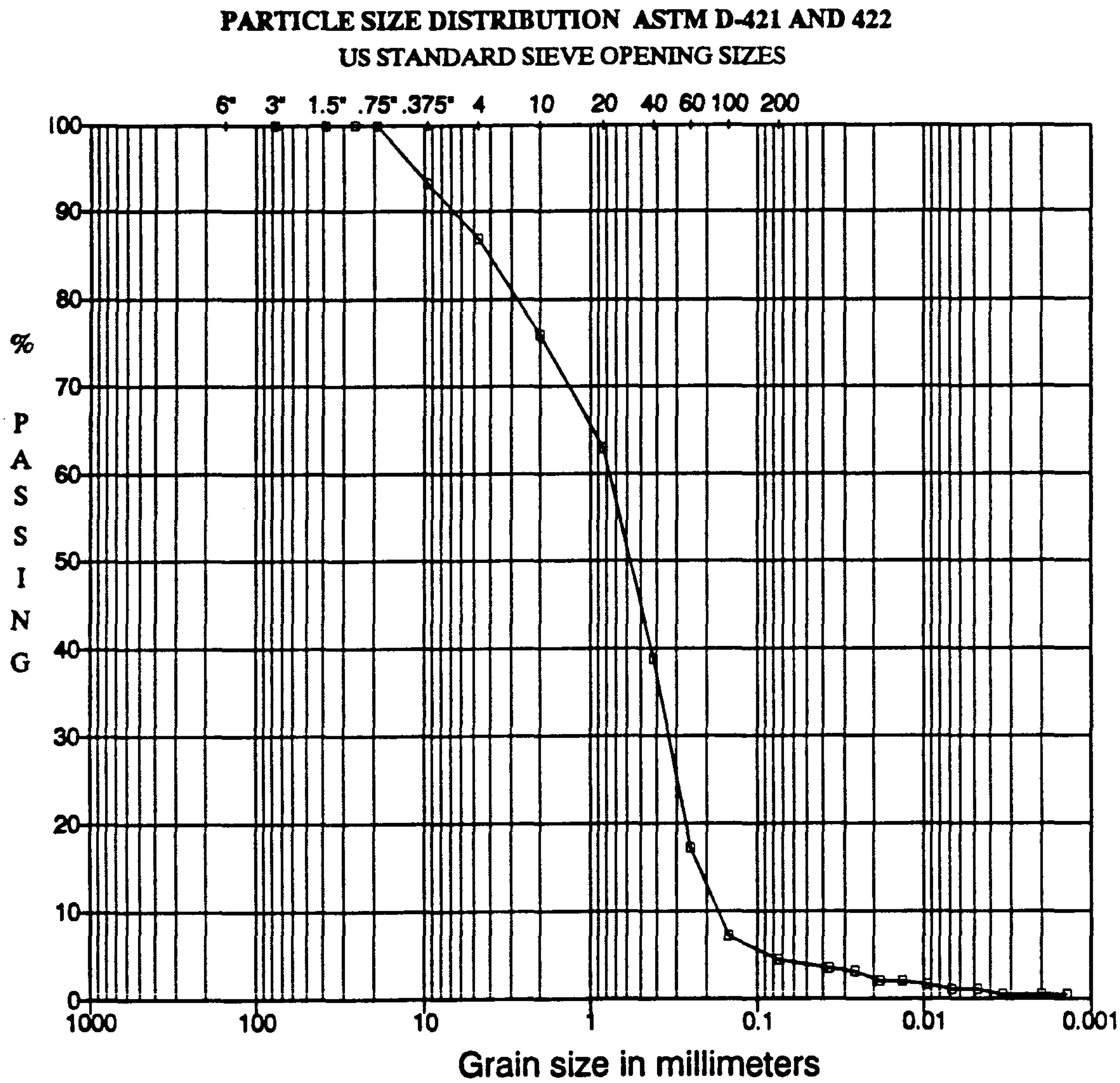
ET (min)	RDNG,C	EFF LTH	K	A	PAR DIA	%FINER
2.00	3.50	15.8	0.013	1.01	0.037	3.5
4.00	3.00	15.8	0.013	1.01	0.026	3.0
8.00	2.00	16.0	0.013	1.01	0.018	2.0
15.00	2.00	16.0	0.013	1.01	0.013	2.0
30.00	1.50	16.1	0.013	1.01	0.010	1.5
60.00	1.00	16.1	0.013	1.01	0.007	1.0
120.00	1.00	16.1	0.013	1.01	0.005	1.0
240.00	0.50	16.3	0.013	1.01	0.003	0.5
480.00	0.50	16.3	0.013	1.01	0.002	0.5
1440.00	0.50	16.3	0.013	1.01	0.001	0.5

WET COLOR: Yellowish brown
DESCRIPTION: [illegible]

USCS:

GOLDER ASSOCIATES INC
MT. LAUREL, NJ

TECH	TK	CHECKED	[signature]
DATE	3/10/93	REVIEWED	



COBBLES	GRAVEL		SAND			FINES (Silt and Clay)
	Coarse	Fine	Cor	Med	Fine	

SAMPLE ID	W%	LL	PL	PI	Gs	DESCRIPTION
30'- 32'	4.5				2.62	Yellowish brown m-f-c SAND, some f gravel, trace fines
	Date Tested: TK					
TECHNICIAN: TK	DATE: 3/11/93		CHECKED: [signature]			REVIEWED:

PFIZER, INC.
923-6103.007

GOLDER ASSOCIATES INC.
MT. LAUREL, NJ

ASTM GRAIN SIZE ANALYSIS
ASTM D421, D422, D1140, D2216 and D2217

PROJECT TITLE:	PFIZER, INC.	Sample No.:	45'- 47'
PROJECT NUMBER:	923-6103.007	Sample ID.:	JAR

WATER CONTENT (Delivered Moisture)

Tare no.	M-12
Wt soil & tare,moist	639.12
Wt soil & tare,dry	621.29
Wt tare	187.75
Wt moisture	17.83
Wt dry soil	433.54
% WATER	4.11%

% PASSING #10 SIEVE

Total Wt	433.54
Wt Split #10	293.24
% PASSING #10	67.6%

USCS	SIEVE	wt ret	% ret	% PASS	SIEVE	
coarse gravel	3.000		0.00%	100.00%	3.000	coarse gravel
	1.500		0.00%	100.00%	1.500	
	1.000		0.00%	100.00%	1.000	
fine gravel	0.750	14.76	3.40%	96.60%	0.750	fine gravel
	0.375	46.62	10.75%	89.25%	0.375	
coarse sand	#4	89.61	20.67%	79.33%	#4	coarse sand
medium sand	#10	140.72	32.46%	67.54%	#10	medium sand

SAMPLE PREPARATION FOR HYDROMETER ANALYSIS

% Pass #10 Sieve	67.54	Initial Moist Wt.	76.43
Specific Gravity	2.62	Calculated Dry Wt	76.34
ml Dispering Agent Used	125	(40ml Na(PO4)n per 1000ml H2O)	

WATER CONTENT (Hygroscopic #10)

Tare no.	12B
Wt soil and tare,moist	61.65
Wt soil&tare,dry	61.60
Wt tare	20.12
Wt moisture lost	0.05
Wt dry soil,final	41.48
% HYGROSCOPIC MOISTURE	0.1%

% PASSING 200 SIEVE

Tare no.	CH-036
Wt soil and tare,dry (wt,dry)	127.45
Wt soil&tare,wash (wt,wash)	124.48
Wt tare	51.11
Wt fines lost (wt,dry-wt,wash)	2.97
Wt dry soil, (wt,dry-wt,tare)	76.34
% FINES LOST	3.9%

PERCENT BETWEEN #10 AND #200 SIEVE CALCULATION

SIEVE	CUMUL WT. RETAINED	CUMUL WT. RET. CORR	PERCENT PASSING
#10	0.00	36.69	67.54%
#20	14.84	51.53	54.41%
#40	42.27	78.96	30.14%
#60	63.72	100.41	11.16%
#100	71.46	108.15	4.32%
#200	73.32	110.01	2.67%

LL	
PL	
PI	
Gs	2.62

DATE	TIME	ET (min)	RDNG R	TEMP T	TEMP.COR K	HYD.RDNG. H
03/09/93	09:15	2.00	7.0	25.00	0.013	4.00
	09:17	4.00	6.5	25.00	0.013	4.00
	09:21	8.00	6.5	25.00	0.013	4.00
	09:28	15.00	6.0	25.00	0.013	4.00
	09:43	30.00	6.0	25.00	0.013	4.00
	10:13	60.00	5.5	25.00	0.013	4.00
	11:13	120.00	5.0	25.00	0.013	3.50
	13:13	240.00	4.5	25.00	0.013	3.50
	17:13	480.00	4.0	24.50	0.013	3.50
03/10/93	09:13	1440.0	4.0	24.00	0.013	3.50

Grain Size Percentages

% C GRVL	3.4%
% F GRVL	17.3%
% C SAND	11.8%
% M SAND	37.4%
% F SAND	27.5%
% FINES	2.7%
% TOTAL	100.00%

ET (min)	RDNG,C	EFF LTH	K	A	PAR DIA	%FINER
2.00	3.00	15.8	0.013	1.01	0.037	2.7
4.00	2.50	16.0	0.013	1.01	0.026	2.2
8.00	2.50	16.0	0.013	1.01	0.018	2.2
15.00	2.00	16.0	0.013	1.01	0.013	1.8
30.00	2.00	16.0	0.013	1.01	0.010	1.8
60.00	1.50	16.1	0.013	1.01	0.007	1.3
120.00	1.50	16.1	0.013	1.01	0.005	1.3
240.00	1.00	16.1	0.013	1.01	0.003	0.9
480.00	0.50	16.3	0.013	1.01	0.002	0.4
1440.00	0.50	16.3	0.013	1.01	0.001	0.4

WET COLOR: Yellowish brown

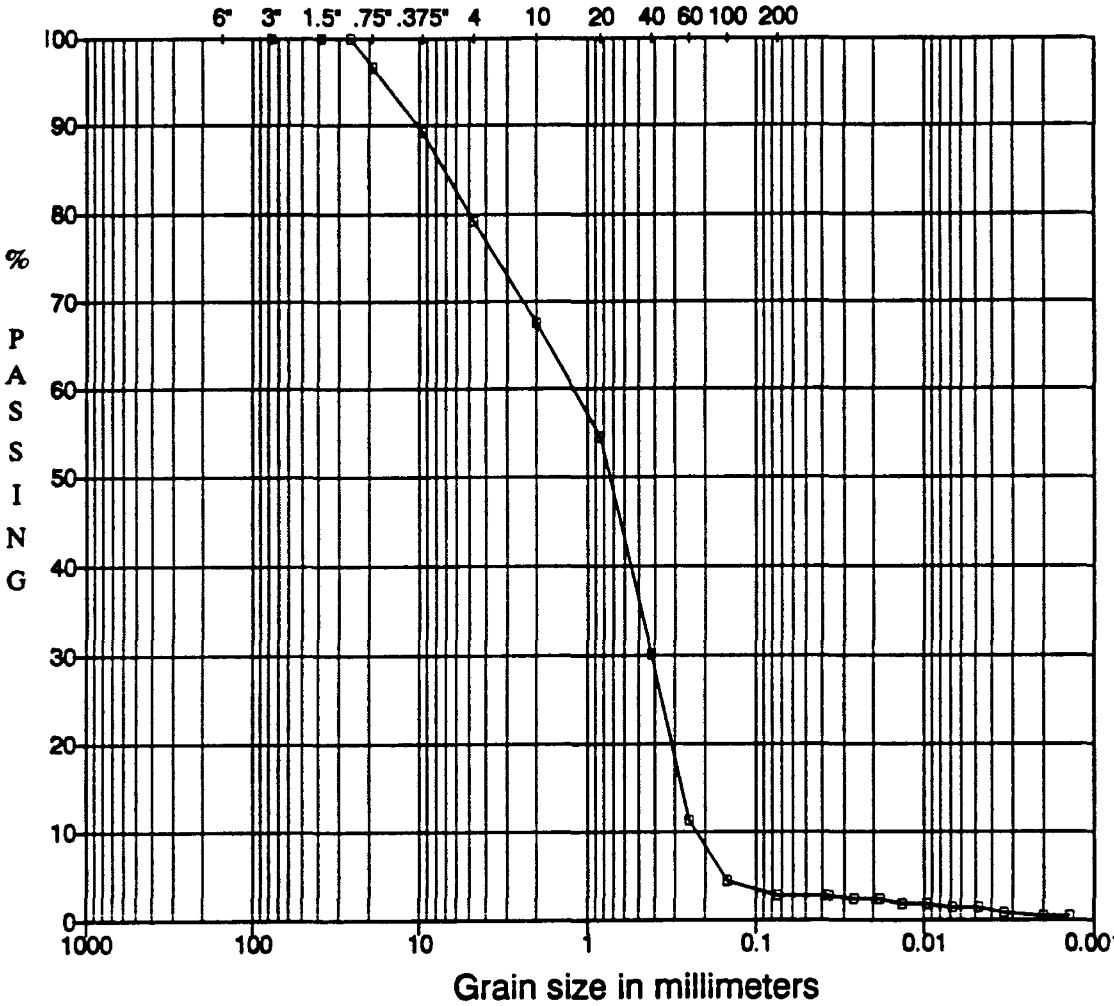
DESCRIPTION: [illegible]

USCS:

GOLDER ASSOCIATES INC	TECH: TK	CHECKED: [illegible]	
MT. LAUREL, NJ	DATE: 3/10/93	REVIEWED:	

PARTICLE SIZE DISTRIBUTION ASTM D-421 AND 422

US STANDARD SIEVE OPENING SIZES



<table>
<tr><td rowspan="2">COBBLES</td><td>Coarse</td><td>Fine</td><td>Cor</td><td>Med</td><td>Fine</td><td rowspan="2">FINES (Silt and Clay)</td></tr>
<tr><td colspan="2">GRAVEL</td><td colspan="3">SAND</td></tr>
</table>

SAMPLE ID	W%	LL	PL	PI	Gs	DESCRIPTION
45'- 47'	4.1				2.62	Yellowish brown m-f-c SAND, some f gravel, trace fines
	Date Tested: TK					
TECHNICIAN: TK	DATE: 3/11/93			CHECKED:		REVIEWED:

PFIZER, INC.
923-6103.007

GOLDER ASSOCIATES INC.
MT. LAUREL, NJ

ORGANIC CONTENT (PERCENT ORGANICS)
ASTM D-2974,Method C

PROJECT TITLE:	PFIZER, INC.
PROJECT NUMBER:	923-6103.007

SAMPLE IDENTIFICATION

Boring No.:				
Sample No.:		15'- 17'	30'-32'	45'- 47'
Depth				
Tare no.				
Wt soil dry & tare, i	(W1)	161.55	169.10	148.87
Wt soil burnt & tare, f	(W2)	161.12	168.66	148.51
Wt tare	(W3)	75.19	76.17	70.99
Wt Ash	(W4=W2-W3)	85.93	92.49	77.52
Wt dry soil	(W5=W1-W3)	86.36	92.93	77.88
% Ash	(%Ash=(W2-W3)/(W1-W3)*100)	99.5%	99.5%	99.5%
% Organics	(100-%Ash)	0.5%	0.5%	0.5%

GOLDER ASSOCIATES
MT. LAUREL, N.J.

TECH:	[signature]	CHECKED:	
DATE:		REVIEWED:	

SPECIFIC GRAVITY OF SOILS
ASTM D-854
PYCNOMETER METHOD

PROJECT TITLE:	PFIZER, INC.	SAMPLE NO.:	15' - 17'
PROJECT NUMBER:	923-6103.007	SAMPLE ID.:	JAR
NOTES:			

HYGROSCOPIC MOISTURE OF MATERIAL PASSING THE #4 SIEVE

Tare Number		CH-20
Wt soil and tare,i	(W1)	49.48
Wt soil and tare,f	(W2)	49.45
Wt Tare	(W3)	21.28
Wt moisture lost	(W4=W1-W2)	0.03
Wt dry soil	(W5=W2-W3)	28.17
% Hygroscopic Moisture	(HM=(W4/W5)*100)	0.1%

TRIAL		1	2	3	
Pycnometer No.		62	102	82	
Wt Pycnometer Empty (g)	(Wf)	169.29	178.02	184.42	
Wt Pycnometer & Water (g)	(Wa)	667.62	676.31	682.88	
Wt of Soil & Pycnometer (g)		199.30	208.03	214.42	
Wt of Soil, Water & Pycnometer (g)	(Wb)	686.36	695.24	701.64	
Temperature of Mixture (C)	(Tx)	22.0	22.0	23.0	
Correction due to Temperature	(K2)	0.9996	0.9996	0.9993	
Wt of Dry Soil (g)	(Wc)	30.01	30.01	30.00	
Correction Wt Dry Soil (g)	(Wo'=Wc/(1+HM/100))	29.98	29.98	29.97	
Wt of Pycnometer & Water (g)	(Wa'=Wa)	667.62	676.31	682.88	
Wt of Soil, Water & Pycnometer (g)	(Wb'=Wb*K2)	686.09	694.96	701.15	
					Gs Average
SPECIFIC GRAVITY	Gs=(Wo'/(Wo'+(Wa'-Wb'))	2.604	2.647	2.562	2.60

Correction Values Due to Temperature

Temp. (C)	Corr. (K)	Temp. (C)	Corr. (K)	Temp. (C)	Corr. (K)
15.00	1.0010	22.00	0.9996	29.00	0.9977
16.00	1.0008	23.00	0.9993	30.00	0.9974
17.00	1.0006	24.00	0.9991	31.00	0.9971
18.00	1.0004	25.00	0.9989	32.00	0.9968
19.00	1.0002	26.00	0.9986	33.00	0.9965
20.00	1.0000	27.00	0.9983	34.00	0.9962
21.00	0.9998	28.00	0.9980	35.00	0.9959

GOLDER ASSOCIATES INC.
MT. LAUREL, NJ.

TECH:	TK	CHECKED:	[signature]
DATE:	3/9/93	REVIEWED:	

SPECIFIC GRAVITY OF SOILS
ASTM D-854
PYCNOMETER METHOD

PROJECT TITLE:	PFIZER, INC.	SAMPLE NO.:	30' - 32'
PROJECT NUMBER:	923-6103.007	SAMPLE ID.:	JAR
NOTES:			

HYGROSCOPIC MOISTURE OF MATERIAL PASSING THE #4 SIEVE

Tare Number		M-9
Wt soil and tare,i	(W1)	57.18
Wt soil and tare,f	(W2)	57.14
Wt Tare	(W3)	21.73
Wt moisture lost	(W4=W1-W2)	0.04
Wt dry soil	(W5=W2-W3)	35.41
% Hygroscopic Moisture	(HM=(W4/W5)*100)	0.1%

TRIAL		1	2	3
Pycnometer No.		65	69	71
Wt Pycnometer Empty (g)	(Wf)	170.89	172.49	174.03
Wt Pycnometer & Water (g)	(Wa)	668.92	670.43	672.23
Wt of Soil & Pycnometer (g)		200.89	202.50	204.03
Wt of Soil, Water & Pycnometer (g)	(Wb)	688.13	689.49	691.01
Temperature of Mixture (C)	(Tx)	23.0	23.0	23.0
Correction due to Temperature	(K2)	0.9993	0.9993	0.9993
Wt of Dry Soil (g)	(Wc)	30.00	30.01	30.00

Correction Wt Dry Soil (g)	(Wo'=Wc/(1+HM/100))	29.97	29.98	29.97	
Wt of Pycnometer & Water (g)	(Wa'=Wa)	668.92	670.43	672.23	
Wt of Soil, Water & Pycnometer (g)	(Wb'=Wb*K2)	687.65	689.01	690.53	
					Gs Average
SPECIFIC GRAVITY	Gs=(Wo'/(Wo'+(Wa'-Wb'))	2.667	2.630	2.568	2.62

Correction Values Due to Temperature

Temp. (C)	Corr. (K)	Temp. (C)	Corr. (K)	Temp. (C)	Corr. (K)
15.00	1.0010	22.00	0.9996	29.00	0.9977
16.00	1.0008	23.00	0.9993	30.00	0.9974
17.00	1.0006	24.00	0.9991	31.00	0.9971
18.00	1.0004	25.00	0.9989	32.00	0.9968
19.00	1.0002	26.00	0.9986	33.00	0.9965
20.00	1.0000	27.00	0.9983	34.00	0.9962
21.00	0.9998	28.00	0.9980	35.00	0.9959

GOLDER ASSOCIATES INC.
MT. LAUREL, NJ.

TECH:	TK	CHECKED:	[signature]
DATE:	3/9/93	REVIEWED:	

SPECIFIC GRAVITY OF SOILS
ASTM D-854
PYCNOMETER METHOD

PROJECT TITLE:	PFIZER, INC.	SAMPLE NO.:	45' - 47'
PROJECT NUMBER:	923-6103.007	SAMPLE ID.:	JAR
NOTES:			

HYGROSCOPIC MOISTURE OF MATERIAL PASSING THE #4 SIEVE

Tare Number		32C
Wt soil and tare,i	(W1)	56.15
Wt soil and tare,f	(W2)	56.10
Wt Tare	(W3)	20.89
Wt moisture lost	(W4=W1-W2)	0.05
Wt dry soil	(W5=W2-W3)	35.21
% Hygroscopic Moisture	(HM=(W4/W5)*100)	0.1%

TRIAL		1	2	3	
Pycnometer No.		104	103	105	
Wt Pycnometer Empty (g)	(Wf)	178.34	179.11	179.10	
Wt Pycnometer & Water (g)	(Wa)	676.54	677.00	677.30	
Wt of Soil & Pycnometer (g)		208.35	209.11	209.10	
Wt of Soil, Water & Pycnometer (g)	(Wb)	695.49	696.10	696.28	
Temperature of Mixture (C)	(Tx)	23.0	23.0	23.0	
Correction due to Temperature	(K2)	0.9993	0.9993	0.9993	
Wt of Dry Soil (g)	(Wc)	30.01	30.00	30.00	
Correction Wt Dry Soil (g)	(Wo'=Wc/(1+HM/100))	29.97	29.96	29.96	
Wt of Pycnometer & Water (g)	(Wa'=Wa)	676.54	677.00	677.30	
Wt of Soil, Water & Pycnometer (g)	(Wb'=Wb*K2)	695.00	695.61	695.79	
					Gs Average
SPECIFIC GRAVITY	Gs=(Wo'/(Wo'+(Wa'-Wb'))	2.605	2.641	2.613	2.62

Correction Values Due to Temperature

Temp. (C)	Corr. (K)	Temp. (C)	Corr. (K)	Temp. (C)	Corr. (K)
15.00	1.0010	22.00	0.9996	29.00	0.9977
16.00	1.0008	23.00	0.9993	30.00	0.9974
17.00	1.0006	24.00	0.9991	31.00	0.9971
18.00	1.0004	25.00	0.9989	32.00	0.9968
19.00	1.0002	26.00	0.9986	33.00	0.9965
20.00	1.0000	27.00	0.9983	34.00	0.9962
21.00	0.9998	28.00	0.9980	35.00	0.9959

GOLDER ASSOCIATES INC.	TECH:	TK	CHECKED:	[signature]
MT. LAUREL, NJ.	DATE:	3/9/93	REVIEWED:	

Appendix C

APPENDIX C

COMPUTATIONS FOR AMOUNT OF RESIDUAL Cr^{+6}

Golder Associates	SUBJECT POST-EXCAVATION RESIDUAL Cr^{+6}		
	Job No.	Made by	Date 5-26-93
	Ref.	Checked	Sheet 1 of 1
		Reviewed	

SUMMARY

Following hereafter are two sets of calculations ("Residual Cr^{+6} After Excavation," dated 5-17-93; and "Residual Cr^{+6} At DP-1," dated 5-19-93) both pertaining to amount of Cr^{+6} left in-situ after excavation associated with the remedial activities of Alternative 1.

Based on the two attached sets of computations a residual (post-excavation remediation) weight of 1.2 pounds distributed over the inferred Cr^{+6} impacted area plus an additional residual weight of 1.2 pounds at DP-1 (25' ∅ CLR) was provide to Roux Assoc., Inc on 5-18-93. The two values of 1.2 pounds were for input into Roux's contaminant fate/transport model to assess potential effects to groundwater quality.

OBJECTIVE

Determine amount of of Cr^{+6} remaining in ground after excavation of soil w/in the defined "Remediation Limits" (CLRs). Keep in mind:

DP-1 Excavated to 32'
DP-2 Excavated to 54' (GWT)
PIT Excavated to 22'

Depths are defined as the estimated vertical extent of Cr^{+6} concentrations greater than 0.5 mg/kg.

METHODS

Superimpose the "Limits of Remediation" over the "Limits of Inferred Cr^{+6}." The area bounded by the "Limits of Inferred Cr^{+6}" & by "Limits of Remediation" is what will be left in-situ after excavation. Use digital planimeter to calculate areas (two trials, area is considered average of two trials). Use average-end method to compute volume of soil. Multiply volume by dry unit wt. of 115 pcf to obtain pounds of soil. Multiply pounds of soil by a Cr^{+6} concentration of 0.30 ppm to determine weight of Cr^{+6} remaining in-situ.

$$V_{OL} = \sum_{n=1}^{\infty} V_n = \sum_{n=1}^{\infty} \Delta Z_{\frac{n}{n+1}} \left[\frac{A_n + A_{n+1}}{2} \right]$$

REFERENCES

- 8½" x 11" Work sheets (attached) used for planimeter tracings. Areas planimetered are cross hatched.

Golder Associates	SUBJECT RESIDUAL Cr^{+6} AFTER EXCAVATION		
	Job No. 9236103.1	Made by MDL	Date 5-17-93
	Ref. PFIZER	Checked / Reviewed WB	Sheet 2 of 13

AREA + VOLUME COMPS.

DEPTH (FT)		TRIALS		AVERAGE (FT^2)	VOL. (FT^3) (AVE. END METHOD)
0	Assume same as @ 1.0'			301.	
1.0'	AREA ①:	100.75,	100.75,	101 ✓	
	AREA ②:	18.6,	18.6,	+ 19 ✓	
	AREA ③:	178.25,	182.9	181 ✓	
				301.	1150
5.0	AREA ①	46.5	46.5	47	
	AREA ②	68.2	68.2	+ 68 ✓	
	AREA ③	43.4	44.95	44	
				159	1635
10.0	—	492.9	497.5	495	2707.5
15.0	AREA ①	575.05	576.6	576	
	AREA ②	13.95	10.85	+ 12.	
				588	2952
20.0	—	587.45	598.3	593	1106
22.0				513	3784
30.0				433*	1169
32.0				736	2664
35.0				1040*	5180
40.0				1032*	8440
50.0				656*	3095
55.0	—	579.7	584.35	582	
					33,882 C.F.

* Planimetered by ALK 5-17-93.

POUNDS OF RESIDUAL Cr^{+6}

ASSUME: (1) 0.1 ppm @ Inferred Limits of Cr^{+6}
0.5 ppm @ Limits of Remediation

Ave concentration Cr^{+6} remaining : $\frac{0.1+0.5}{2} = 0.3$ ppm

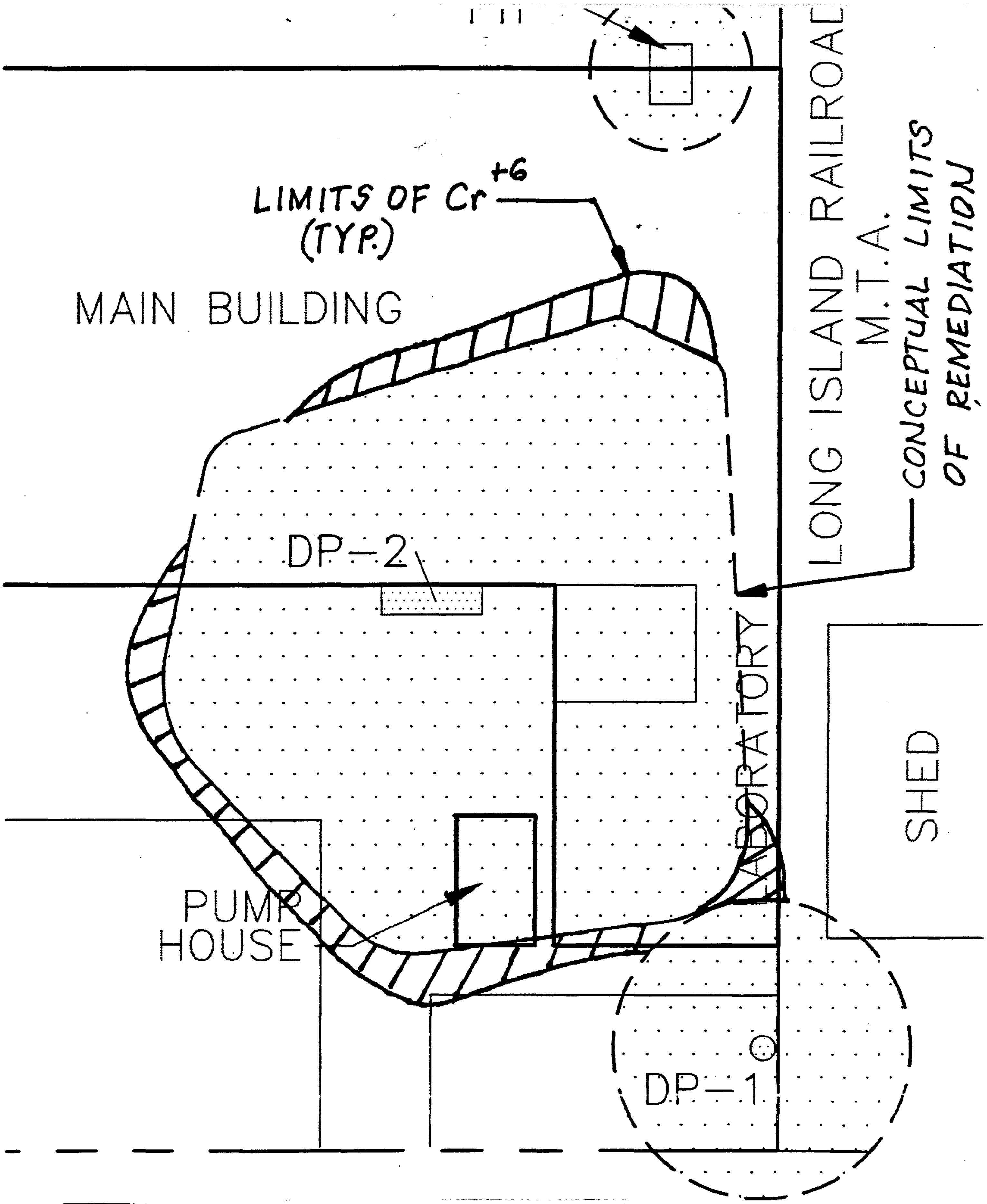
(2) Dry Unit Wt. of Soil = 115 pcf

$$\text{Wt. of } Cr^{+6} = (\text{Vol. Soil Remaining}) * (\gamma_{DRY}) * (\text{Ave. Conc.}) \div 1 \cdot 10^6$$

$$= 33{,}882 \text{ CF} * 115 \frac{lb}{CF} * 0.30 \text{ ppm} \div 1 \cdot 10^6$$

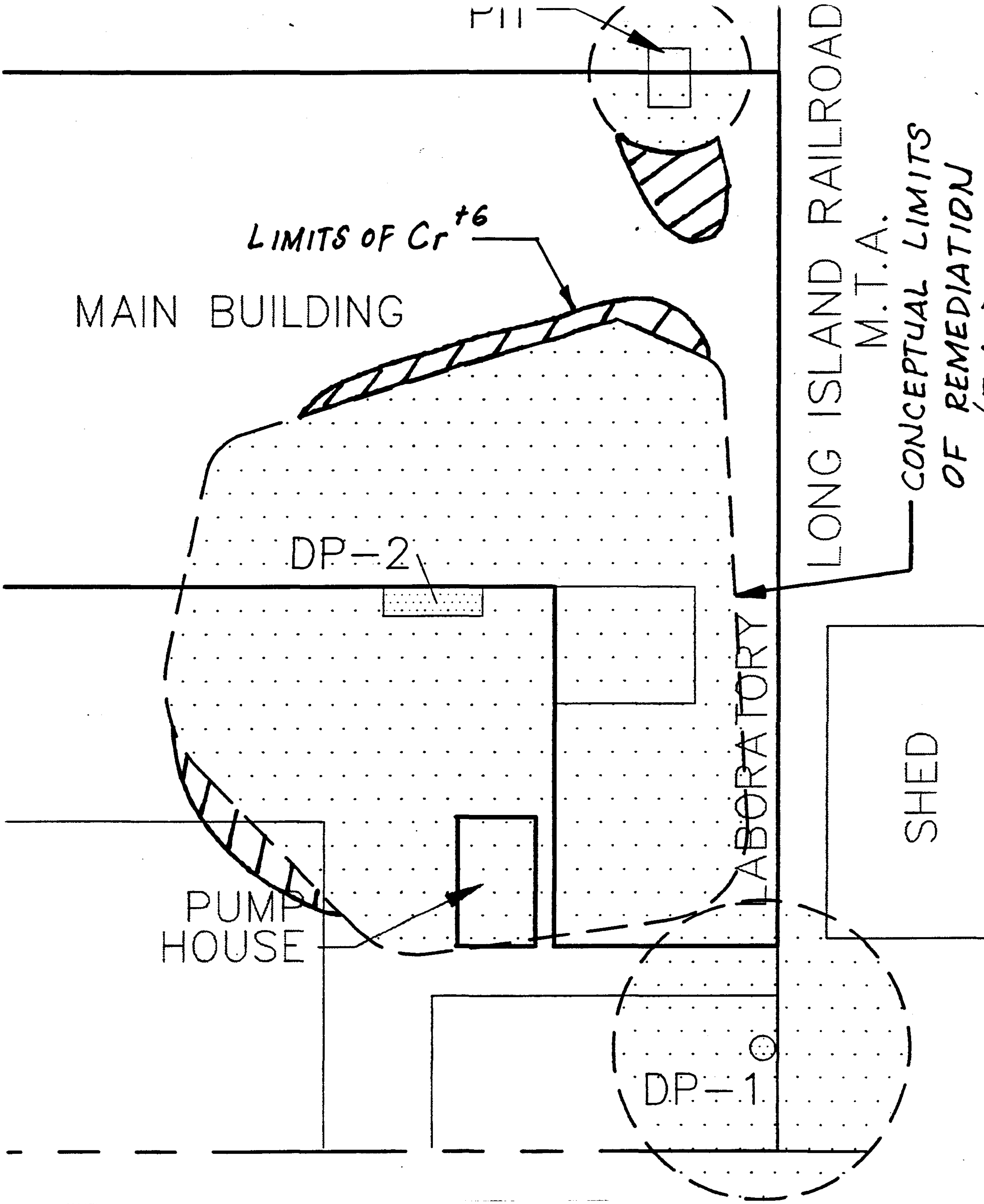
Wt. Cr^{+6} = 1.2 lbs of Cr^{+6}

N.B.: Following above estimation of the residual Cr^{+6} for remediation configurations encompassing Cr^{+6} concentrations < 0.5 mg/kg, determine additional residual Cr^{+6} at DP-1 for remediation depths less than 32 ft. Refer to comps. titled " Residual Cr^{+6} @ DP-1" and dated 5-19-93.

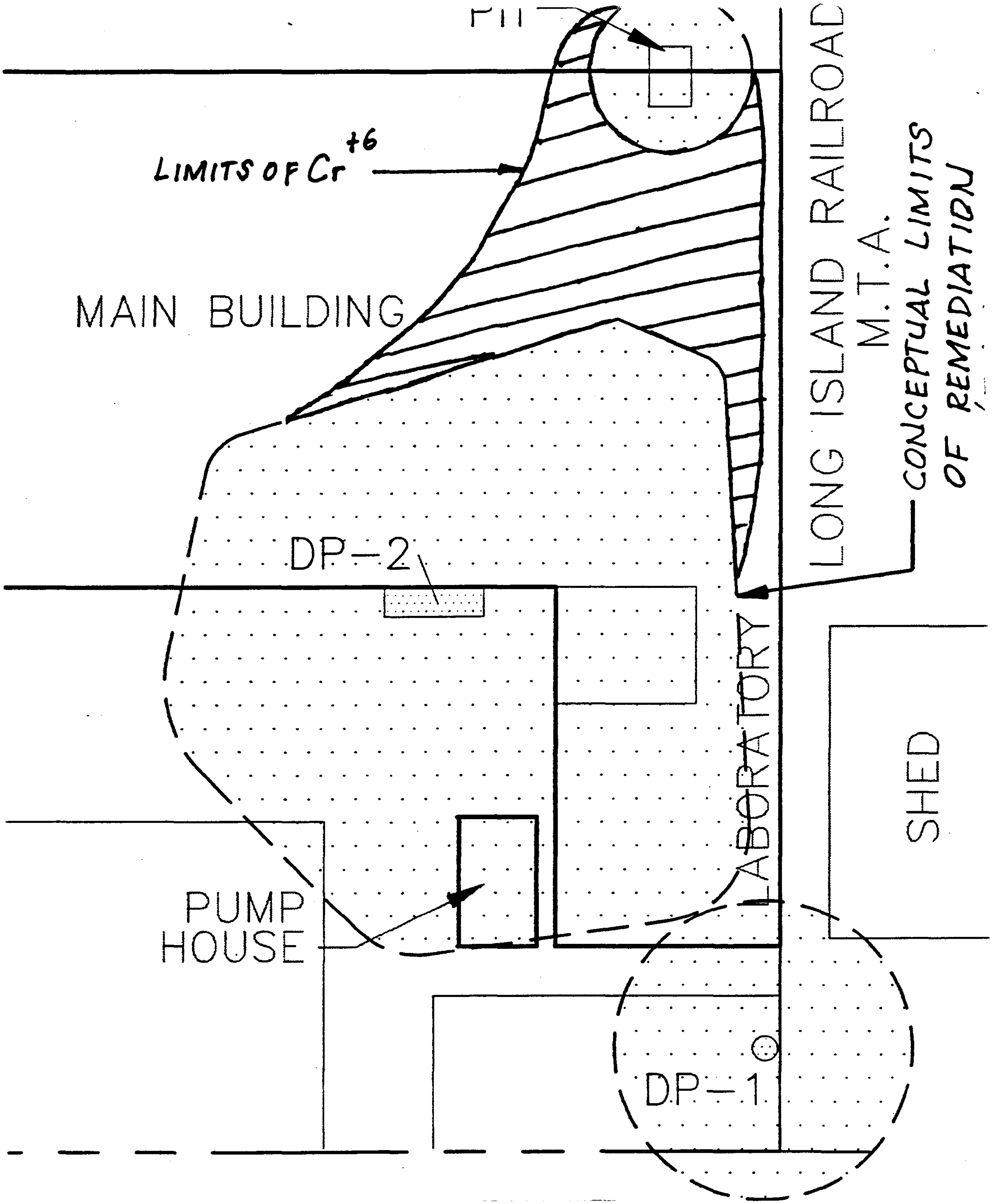


Golder Associates

SCALE: 1"=10' DEPTH: 1.0 FT		
Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked MB	Sheet 4 of 13
	Reviewed	



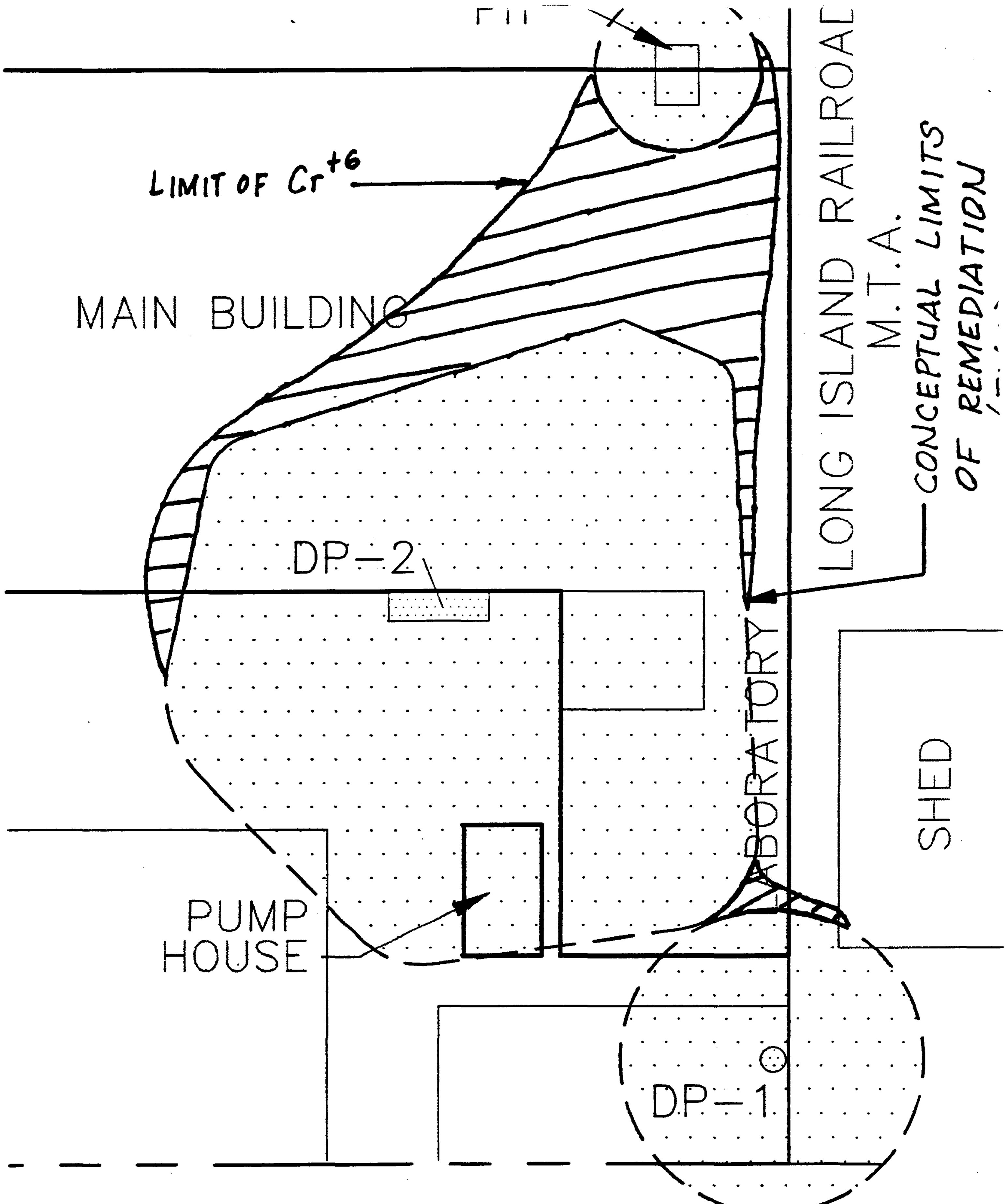
Golder Associates	SCALE: 1" = 10' DEPTH: 5.0 FT		
	Job No. 9236103	Made by MDL	Date 5-19-93
	Ref. PFIZER	Checked WB	Sheet 5 of 13
		Reviewed	



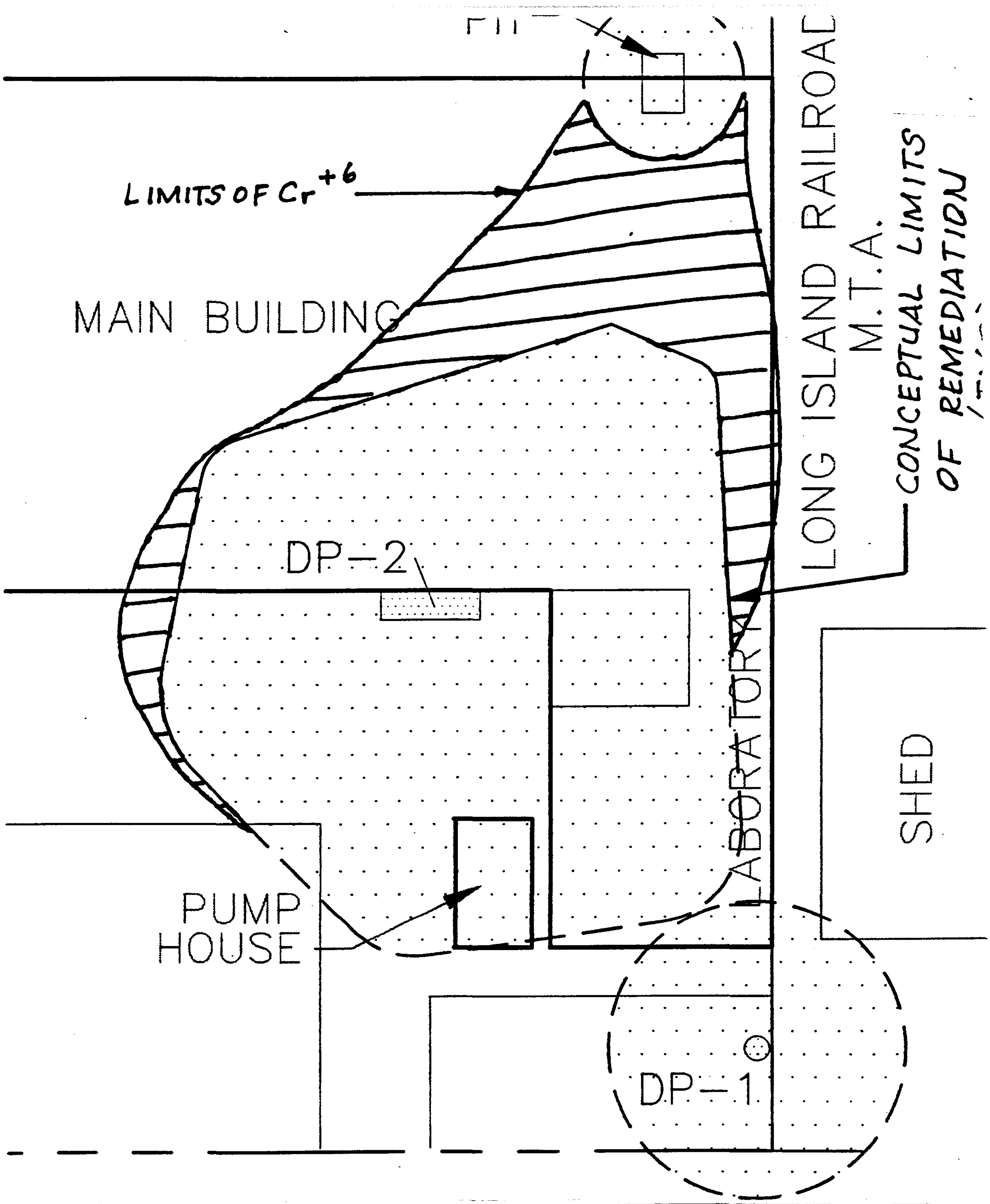
Golder Associates

SCALE: 1" = 10' DEPTH: 10.0 FT

Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked WB	Sheet 6 of 13
	Reviewed	

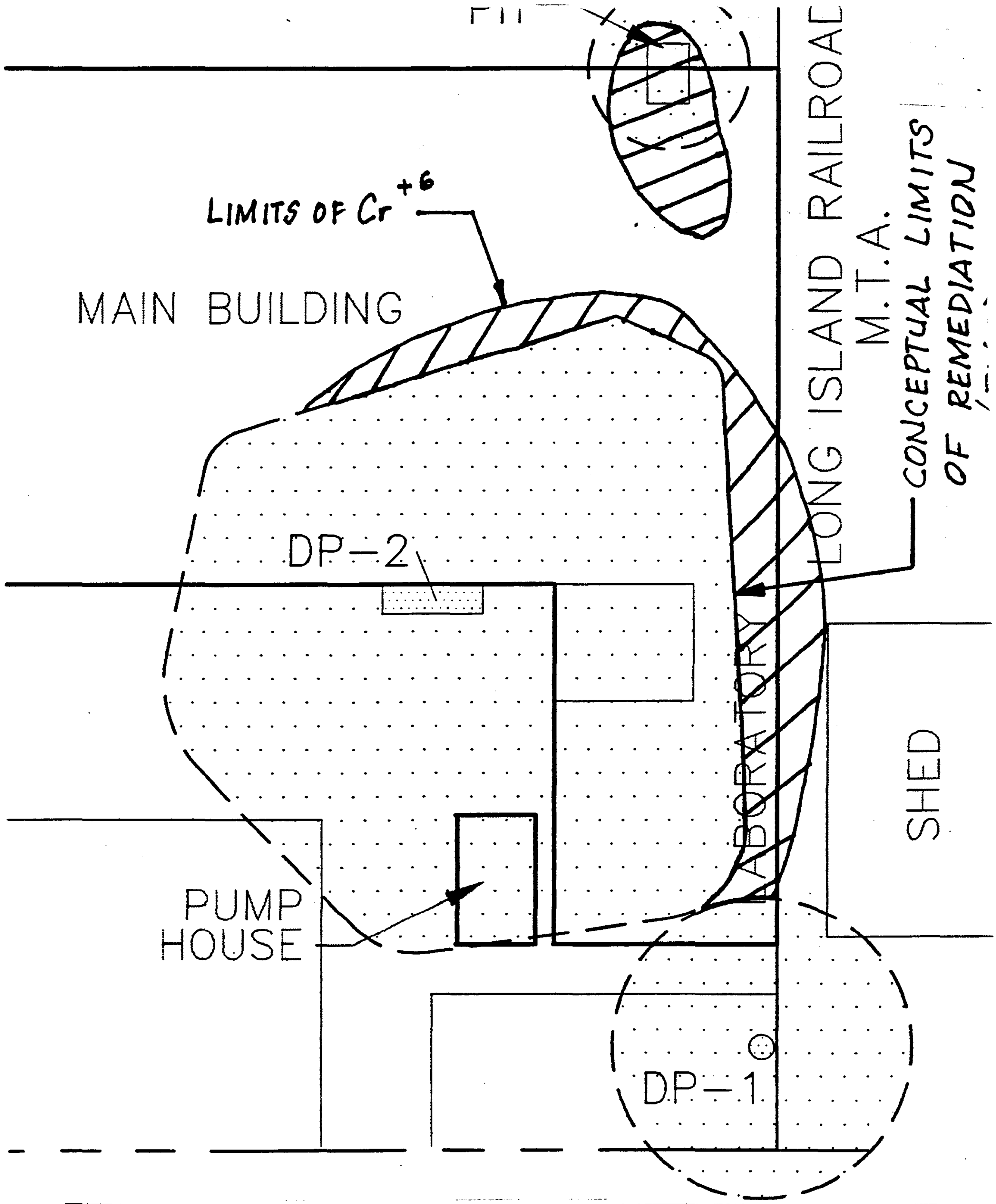


Golder Associates	SCALE: 1" = 10' DEPTH: 15.0 FT		
	Job No. 9236103 Ref. PFIZER	Made by MDL Checked WB Reviewed	Date 5-19-93 Sheet 7 of 13



Golder Associates

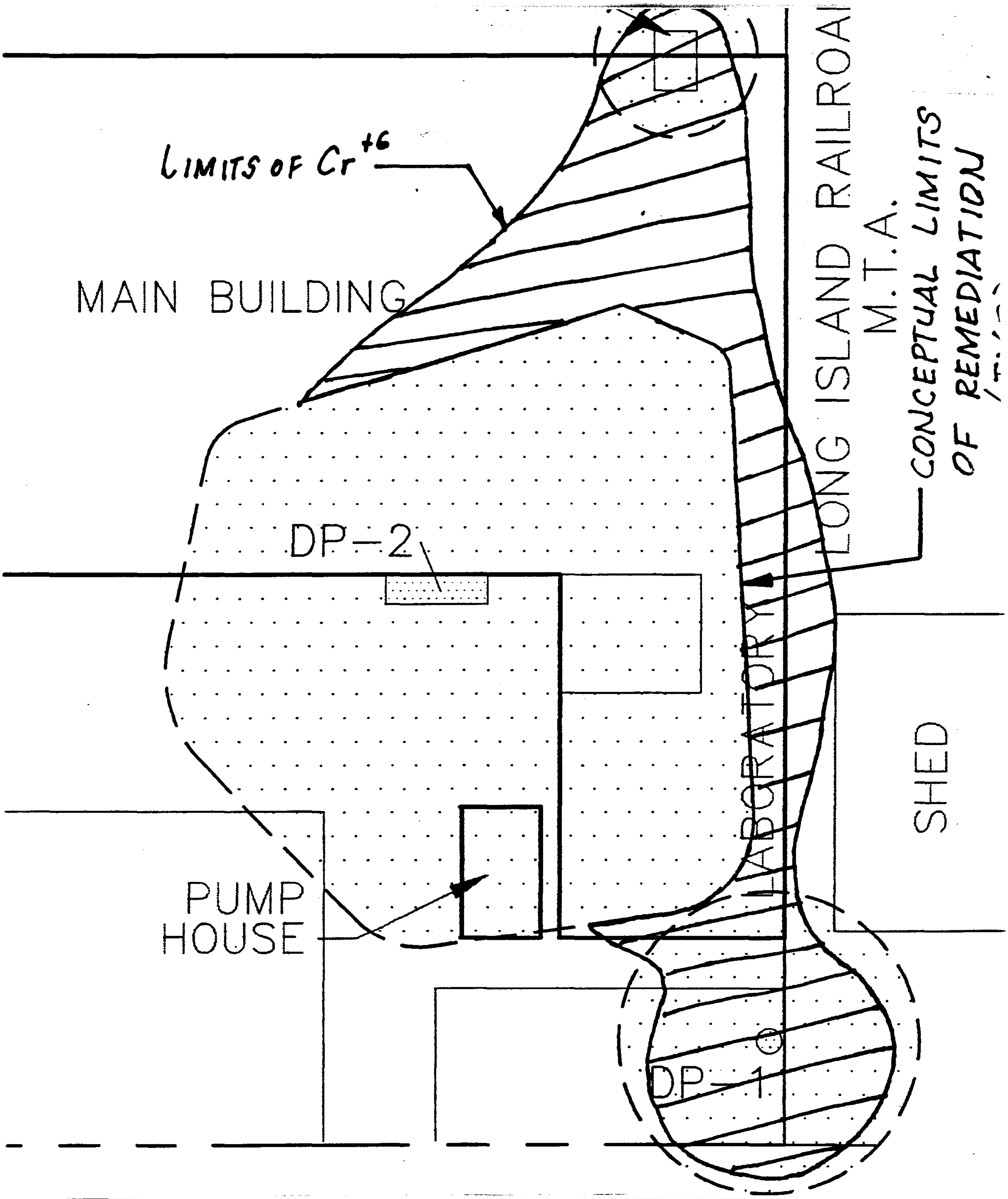
SCALE: 1"=10' DEPTH: 20.0 FT		
Job No. 9236103 Ref. PFIZER	Made by MDL Checked [initials] Reviewed	Date 5-19-93 Sheet 8 of 13



Golder Associates

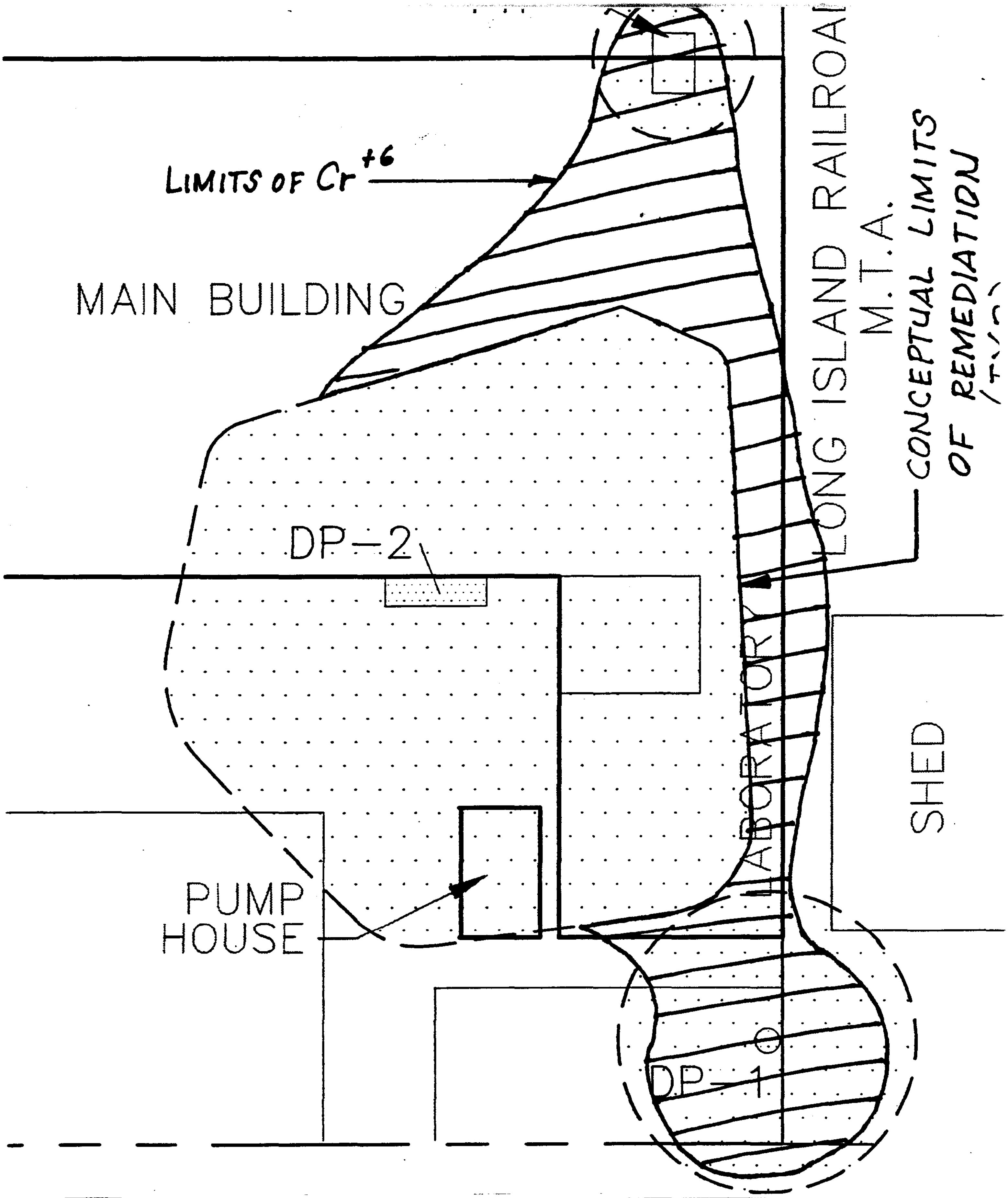
SCALE: 1" = 10'   DEPTH: 30.0 FT

Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked WB	Sheet 9 of 13
	Reviewed	



Golder Associates

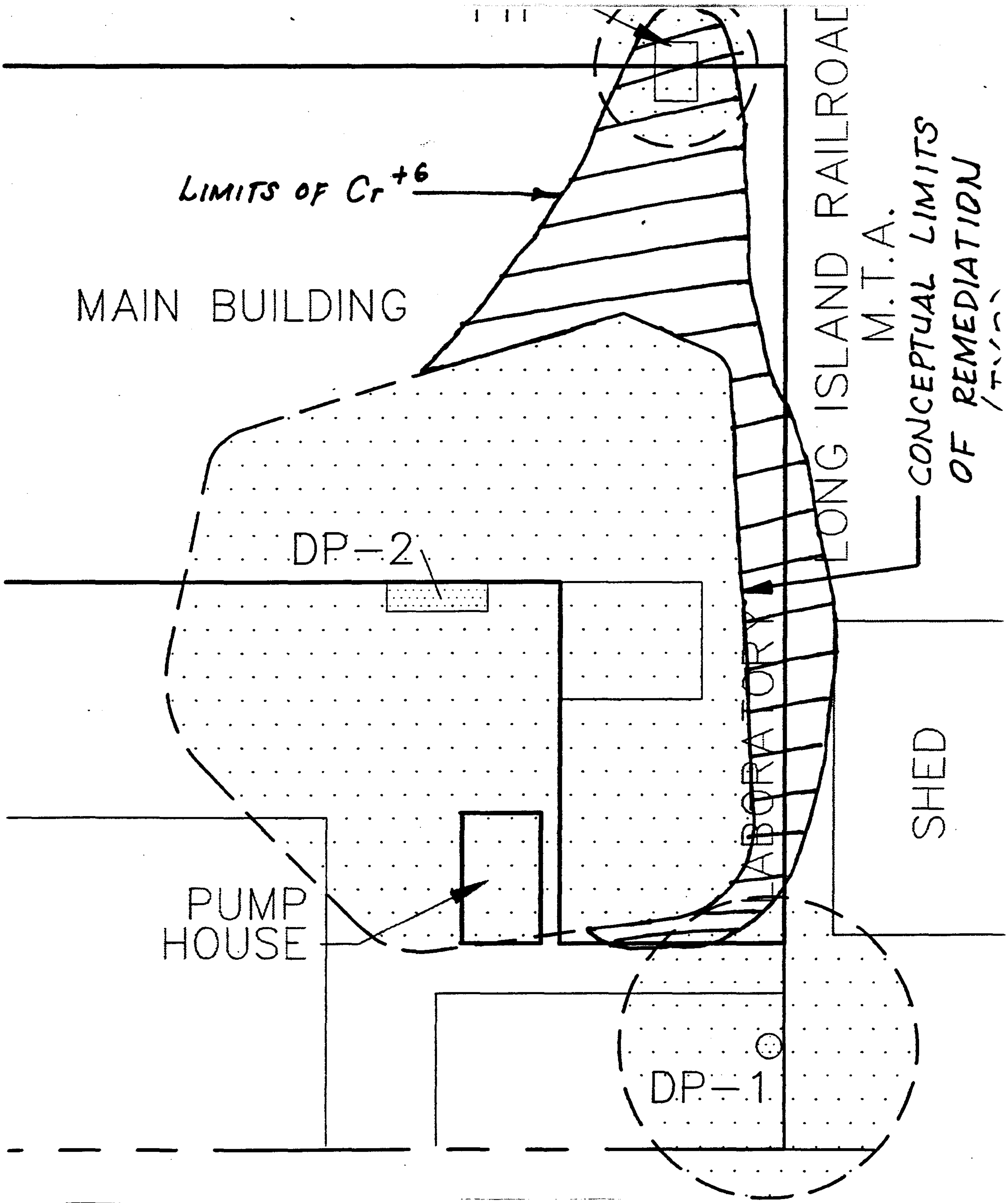
SCALE: 1"=10' DEPTH: 35.0 FT		
Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked WB Reviewed	Sheet 10 of 13



Golder Associates

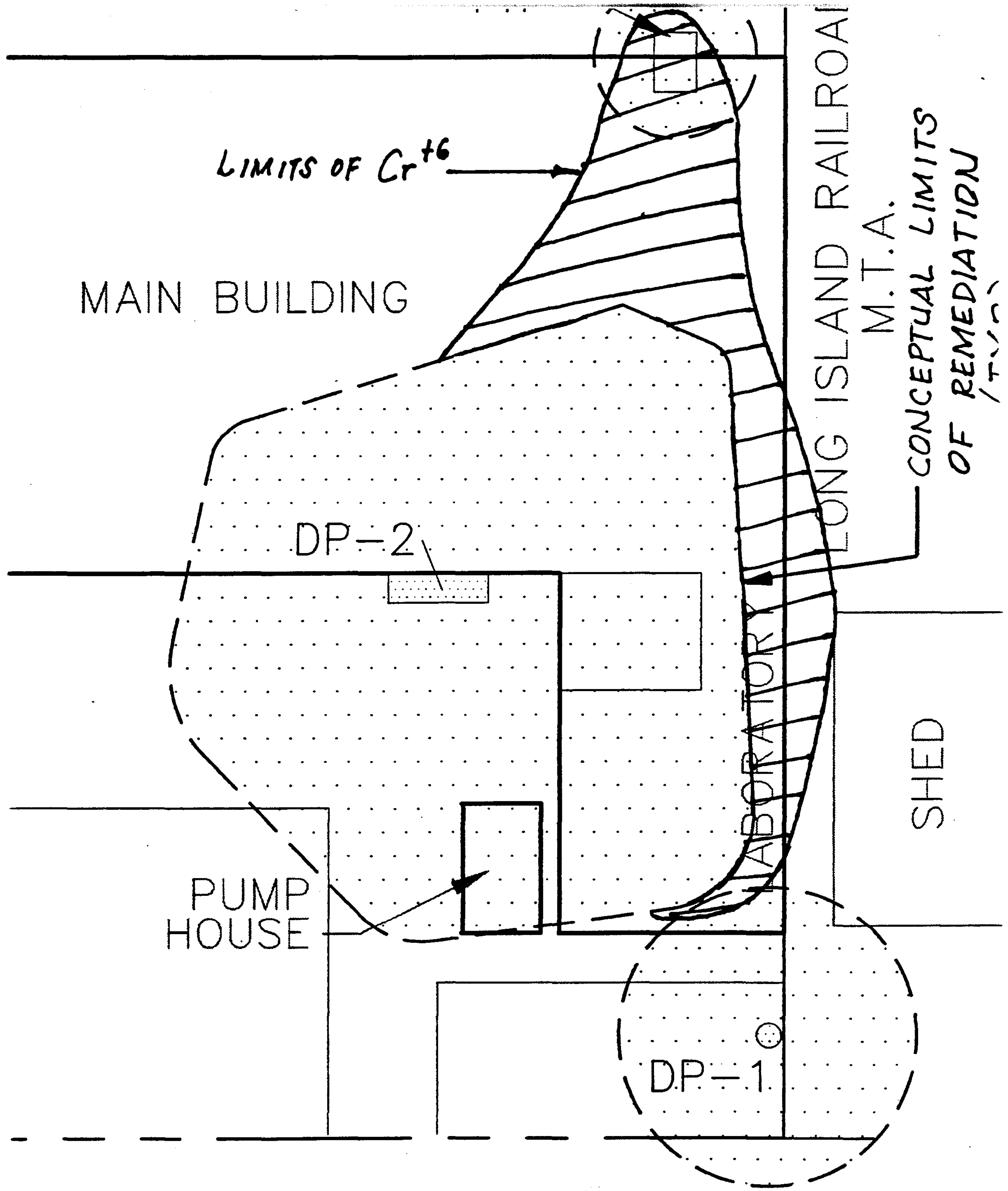
SCALE: 1" = 10' DEPTH: 40.0 FT

Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked MB	Sheet 11 of 13
	Reviewed	



Golder Associates

SCALE: 1" = 10' DEPTH: 50.0 FT		
Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked WB	Sheet 12 of 13
	Reviewed	



Golder Associates

SCALE: 1" = 10' DEPTH: 55.0 FT		
Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked WB	Sheet 13 of 13
	Reviewed	

Golder Associates	SUBJECT RESIDUAL Cr^{+6} AT DP-1		
	Job No. 9236101 Ref. PFIZER	Made by MDL Checked WB Reviewed	Date 5-19-93 Sheet 1 of 3

OBJECTIVE

Determine amount of additional residual Cr^{+6} @ DP-1 if remediation configuration does not extend to initial depth of 32 ft (approx. limits of 0.5 ppm concentration). The dia. of the excavation around DP-1 will be held at 25 ft.

METHODS

Examine analytical lab data on Cr^{+6} concentrations at TB-15 + DP-1. Multiply weight of soil from assumed depth (ϕ is constant @ 25') to 32' by average Cr^{+6} concetration over that interval to obtain pounds of additional residual Cr^{+6}.

REFERENCES

1.) Roux Assoc., Inc. (13 May 93), "Off-Site Ground-Water Investigation and Additional Source Investigation," Table 2.

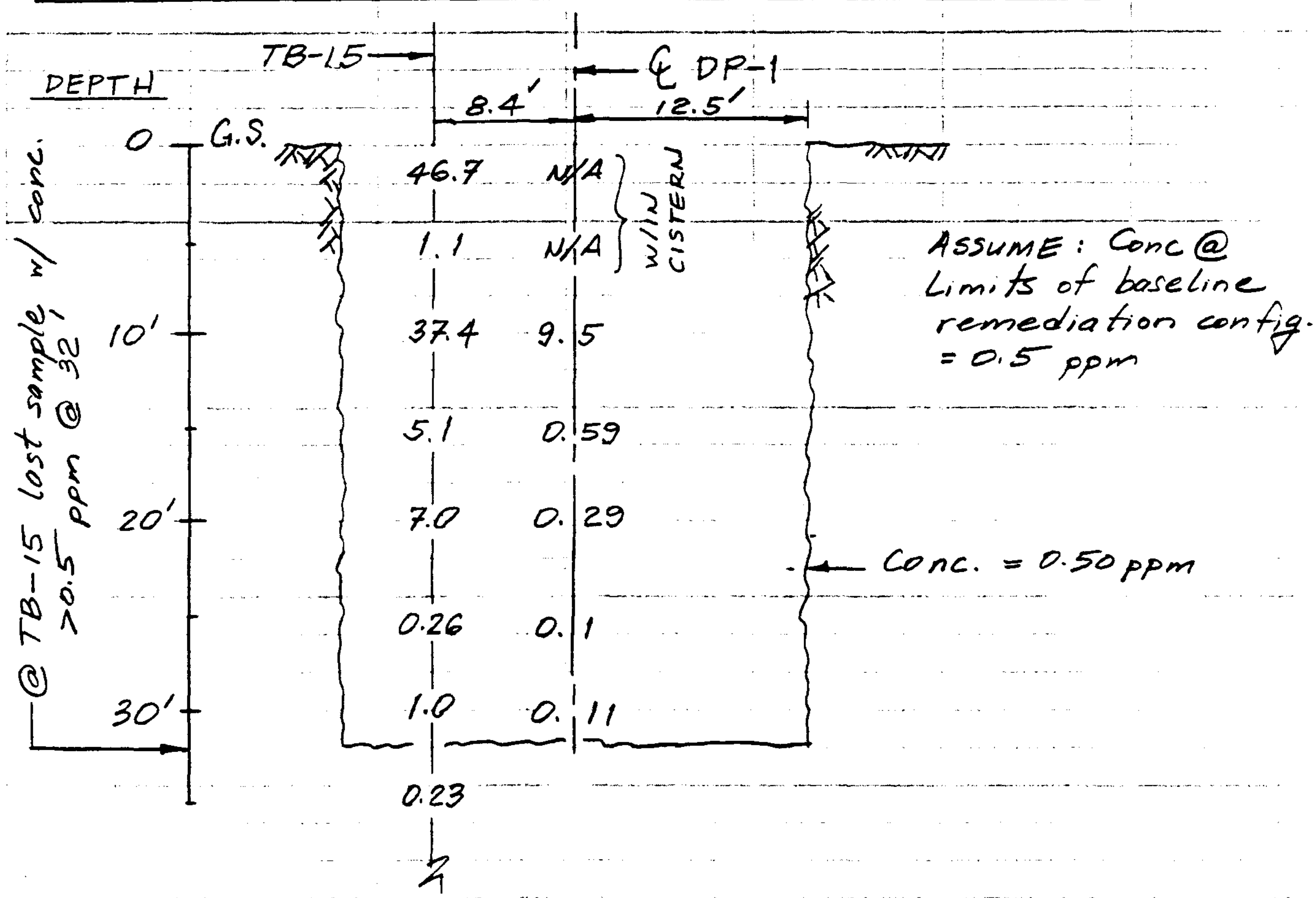
2.) Golder Assoc Inc (Apr 93) "Focused Feasibility Study," Table 1-16.

Golder Associates

SUBJECT RESIDUAL Cr^{+6} @ DP-1		
Job No. 9236103	Made by MDL	Date 5-19-93
Ref. PFIZER	Checked MB	Sheet 2 of 3
	Reviewed	

COMPUTATIONS

Schematic of Concentration Distribution of Cr^{+6}:



TRIALS: 1.) 25'Ø x 10' deep → determine Cr^{+6} remaining 10'–32'

2.) 25'Ø x 15' deep → " " " 15'–32'

Wt. of Soil per ft of depth = $\pi\left(\frac{25}{2}\right)^2 * 115\#/cf$

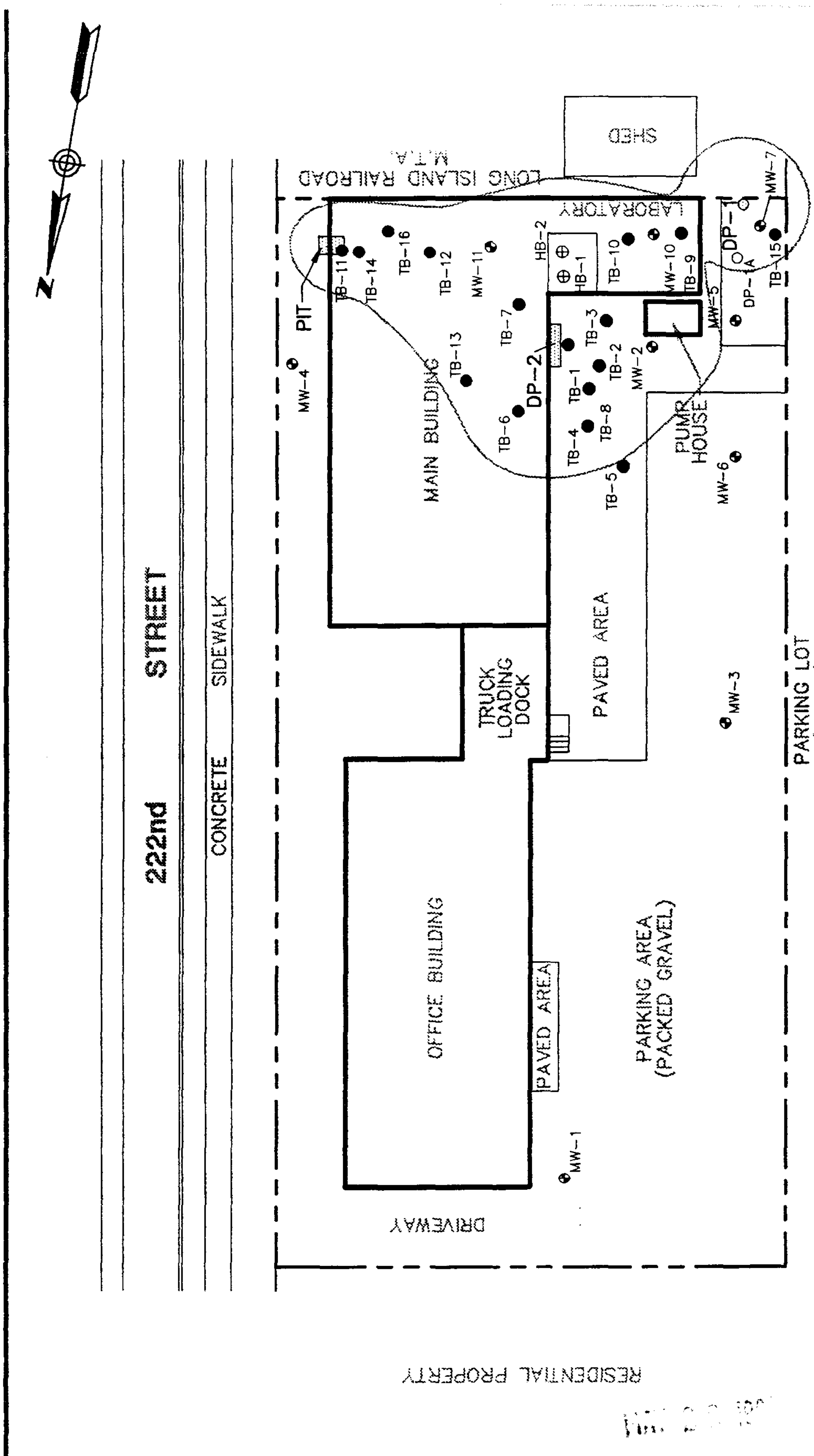
$\frac{\text{Wt. Soil}}{\text{ft depth}}$ = 56,450 lbs.

(Assumed γ_{DRY} = 115 pcf).

$\frac{\text{Wt. Soil}}{\text{5ft depth}}$ = 282,253 lbs.

DEPTH z	Δz	Ave. Conc. Cr^{+6}	Wt. Cr^{+6}/ft = Wt. Soil * conc./$1 \cdot 10^6$	Wt. Cr^{+6} = $\frac{\Delta z}{2}(W_{T_i} + W_{T_{i+1}})$ 1.)	2.)
10'		(37.4 + 9.5 + 0.5)/3 = 15.8	0.892		
	5'			2.52	—
15'		(5.1 + 0.59 + 0.5)/3 = 2.06	0.116		
	5			0.66	0.66
20'		(7.0 + 0.29 + 0.5)/3 = 2.60	0.147		
	5			0.41	0.41
25'		(0.26 + 0.1 + 0.5)/3 = 0.29	0.016		
	7			0.16	0.16
32'		(1.0 + 0.11 + 0.5)/3 = 0.54	0.030		
				3.75#	1.23#
			Call:	3.8#	1.2#

CONCLUSION: Excavation at DP-1 can terminate 15' below ground surface.



NOTE

1.) INFERRED LIMITS OF Cr^{+6} ARE PRESENTED FOR THE SOLE PURPOSE OF CONSERVATIVELY ESTIMATING POST-REMEDIATION AMOUNTS OF Cr^{+6} AS DEFINED BY THE SIS, RI AND OGI/ASI DATA AND DO NOT NECESSARILY REPRESENT ACTUAL EXTENT OF Cr^{+6}.

REFERENCE

1.) BASE MAP TAKEN FROM DRAWING BY ROUX ASSOCIATES INC. ENTITLED, "SITE PLAN", PRESENTED IN THE REPORT ENTITLED, "OFF-SITE GROUND-WATER INVESTIGATION AND ADDITIONAL SOURCE INVESTIGATION", DATED MAY, 1993.

LEGEND

- MW-3 — MONITORING WELL LOCATION AND DESIGNATION
- TB-2 — TEST BORING LOCATION AND DESIGNATION
- HB-1 — HAND-AUGURED BORING LOCATION AND DESIGNATION
- DP-1 — DISPOSAL POINT AND DESIGNATION
- — — APPROXIMATE PROPERTY BOUNDARY
- ······ INFERRED LIMITS OF Cr^{+6} IMPACTED SOIL

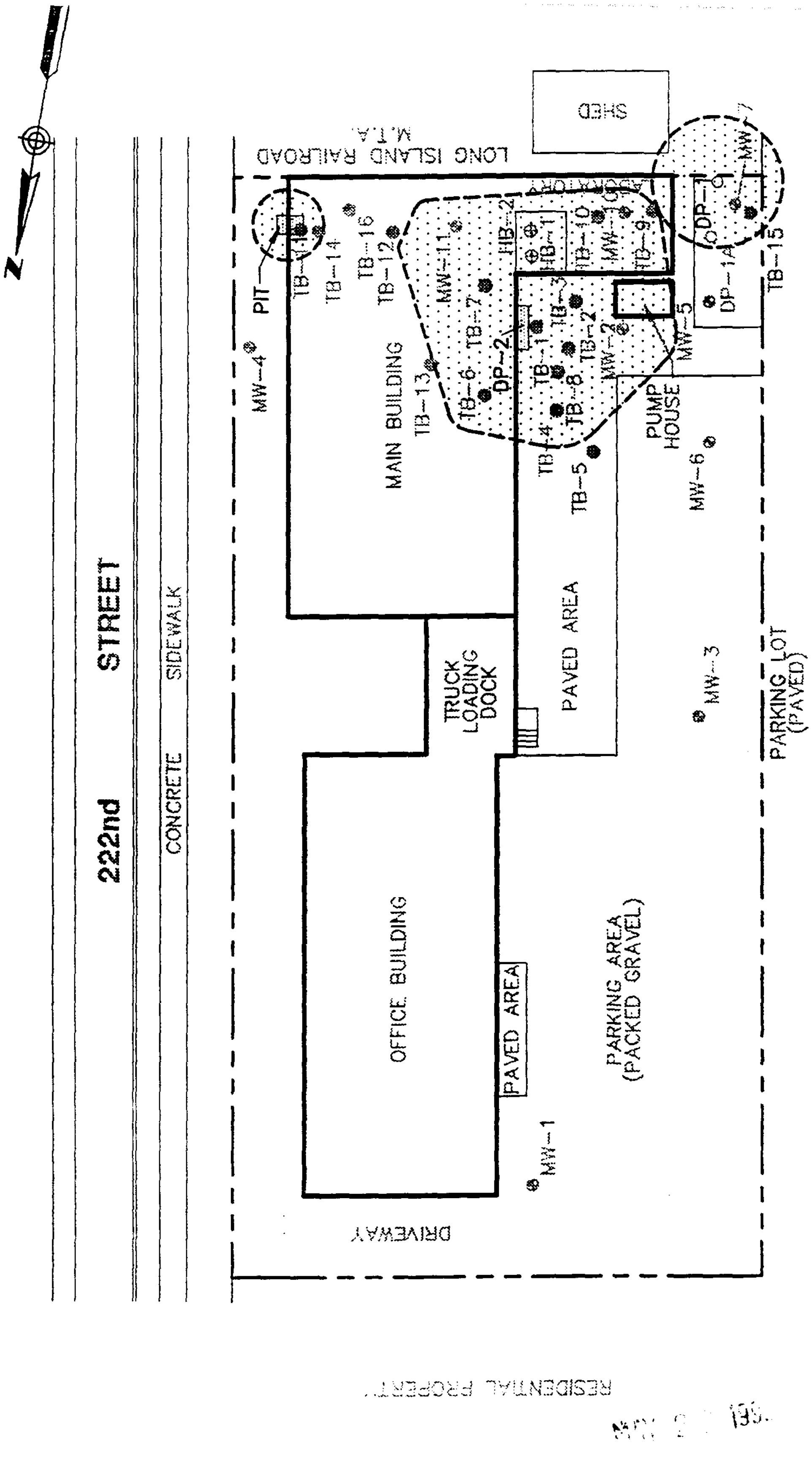
JOB No.:	923-6103	SCALE:	AS SHOWN
DR BY:	LAS	DATE:	04/20/93
CHK BY:	MDL	FILE No.:	NY02-081
REV BY:	WWB	DR SUBTITLE:	01

INFERRED LIMITS OF Cr^{+6} IMPACTED SOIL

Golder Associates

PFIZER/FOCUSED FS/NY

FIGURE **C.2**



0 30 feet
scale

REFERENCE

1.) BASE MAP TAKEN FROM DRAWING BY ROUX ASSOCIATES INC. ENTITLED, "SITE PLAN", PRESENTED IN THE REPORT ENTITLED, "OFF-SITE GROUND-WATER INVESTIGATION AND ADDITIONAL SOURCE INVESTIGATION", DATED MAY, 1993.

LEGEND

- MW-3 — MONITORING WELL LOCATION AND DESIGNATION
- TB-2 — TEST BORING LOCATION AND DESIGNATION
- HB-1 — HAND-AUGURED BORING LOCATION AND DESIGNATION
- DP-1 — DISPOSAL POINT AND DESIGNATION
- CONCEPTUAL LIMITS OF REMEDIATION (CLR)
- APPROXIMATE PROPERTY BOUNDARY

JOB No.:	923-6103	SCALE:	AS SHOWN
DR BY:	JSG	DATE:	05/20/93
CHK BY:	MDL	FILE No.:	NY02-083
REV BY:	WWB	DR SUBTITLE:	01

CONCEPTUAL LIMITS OF REMEDIATION (CLR)

Golder Associates

PFIZER/FOCUSED FS/NY

FIGURE C.1

Appendix D

APPENDIX D

"EVALUATION OF POTENTIAL IMPACTS OF RESIDUAL HEXAVALENT CHROMIUM ON GROUND WATER"; DATED MAY 28, 1993; BY ROUX ASSOCIATES,INC.

Evaluation of Potential Impacts of Residual Hexavalent Chromium on Ground Water

Former Deknatel Facility
96-20 222nd Street
Queens Village, New York

May 28, 1993

Prepared for:

Pfizer Inc
235 East 42nd Street
New York, New York 10017

Prepared by:

ROUX ASSOCIATES, INC.
775 Park Avenue
Huntington, New York 11743

ROUX

PF04784Y.1.25/CV

CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

Roux Associates, Inc. (Roux Associates) was retained by Pfizer Inc (Pfizer) to perform analytical transport modeling of hexavalent chromium in ground water for the former Deknatel facility located at 96-20 222nd Street in Queens Village, New York (Site). The objective of the modeling was to determine the potential post-remediation impact of low-level residual hexavalent chromium (Cr^{+6}) on ground-water quality. A conceptual area of remediation was developed during the Feasibility Study (FS) by Golder Associates, Inc. (Golder Associates). The modeling provided a means of evaluating the potential impact on ground-water quality from the low-level residual Cr^{+6} in soil that may not be included in the area of remediation. Roux Associates and Golder Associates coordinated work efforts to ensure that the modeling assumptions conservatively reflected data and remedial alternatives developed during the FS.

The model was considered conservative due to the following assumptions:

- all of the residual Cr^{+6} would eventually enter ground water;
- the value assumed for dispersivity to model the spreading out of Cr^{+6} in ground water downgradient of the Site is less than typical published values for the Upper Glacial Aquifer on Long Island; and
- reduction of Cr^{+6} to Cr^{+3} with subsequent retardation via precipitation and adsoprtion was not considered in the model.

Each of the above-mentioned assumptions tends to maximize the modeled potential impact of residual Cr^{+6} on ground water. Despite the conservative assumptions, the results of the model suggest that low-level residual Cr^{+6} will not impact ground water immediately downgradient of the Site above New York State (NYS) Class GA Ground-Water Standards for Cr^{+6}.

This report describes in detail the methods and assumptions used to perform the modeling.

2.0 METHODOLOGY

The "Random-Walk" (Prickett et al. 1981) solute transport model, as adapted for use as an analytical model for personal computers (Thomas A. Prickett & Associates 1984), was used to simulate Cr^{+6} transport in the aquifer beneath the Site. Random-Walk is a widely-used, well-documented program. The program simulates solute transport via the use of "particles" and can account for transport mechanisms including dispersion and retardation; however, Cr^{+6} reduction to Cr^{+3} and subsequent removal from solution was not considered in the model.

Random-Walk requires hydrologic and contaminant parameters to be input to govern how particle, or contaminant, transport is treated by the program. The parameters used for the modeling, the assumptions employed, and the justifications for the values are provided below.

2.1 Estimate of Residual Hexavalent Chromium

Previous investigations of the Site delineated the extent of Cr^{+6} in soil associated with two former disposal points (DP-1 and DP-2), and a concrete pit (with an earthen bottom) believed to be associated with the Site sewer system. Golder Associates prepared maps showing Cr^{+6} isoconcentrations in soil at 5-foot depth increments from land surface to the water table. The isoconcentrations were constructed based upon a review of soil boring data obtained during the previous investigations.

Preliminary analytical transport modeling performed by Roux Associates suggested that an average concentration of 0.5 mg/kg of low-level residual Cr^{+6} left in the soil after remediation would not impact ground-water quality downgradient of the Site above NYS Class GA Standards for Cr^{+6}. Therefore, to model the effects of remediation on ground-water quality the FS developed a conceptual areal extent of remediation for the Site that includes the area approximately delineated by 0.5 mg/kg isoconcentration contours. It was assumed that the remediated area will no longer be a source of Cr^{+6} to ground water.

For modeling purposes, it was assumed that there will be a halo of soil that contains low-level concentrations of Cr^{+6} surrounding the conceptual remediated area. The estimated soil volume containing this residual Cr^{+6} was calculated based upon the area between the limits of remediation and the inferred extent of residual Cr^{+6} estimated based upon non-detected soil boring concentrations at each 5-foot depth increment (Figure 1). It was then assumed by Golder Associates that an average of 0.3 mg/kg of residual Cr^{+6} would be left in the halo. Using the assumed average of 0.3 mg/kg residual Cr^{+6}, Golder Associates calculated the mass of Cr^{+6} contained in the halos surrounding the limit of remediation around Disposal Points DP-1 and DP-2. The calculated masses were 1.2 pounds of residual Cr^{+6} in a halo around Disposal Point DP-2, and 1.2 pounds of residual Cr^{+6} in a halo around Disposal Point DP-1. The relatively small amount of residual Cr^{+6} associated with the concrete pit was included in the total for Disposal Point DP-2.

2.2 Particle Mass

Each particle in the model represented a fraction of the total mass, in pounds, of the residual Cr^{+6} left in the soil. Model simulations are run with 5000 particles; therefore, the mass of each particle is equal to the estimated potential total mass of residual Cr^{+6} (2.4 pounds) divided by 5000, for a particle mass of 0.00048 pounds.

2.3 Representation of the Sources

The sources from which the particles are released in the model were represented by two circles to correspond to the roughly circular halos of residual Cr^{+6} surrounding Disposal Points DP-1 and DP-2 (Figure 1). One circle was centered at Disposal Point DP-2 with a radius of 25 feet, and the second at Disposal Point DP-1 with a radius of 12.5 feet. These radii are based upon the approximate radii of the halos of residual Cr^{+6} surrounding the conceptual remediation at Disposal Points DP-1 and DP-2.

During a model simulation, particles were introduced into ground water at a constant loading rate around the perimeters of each circle to simulate continuous input of low-level Cr^{+6} from the halos into ground water. The assumed transport mechanism from soil into ground water was leaching by infiltrating precipitation and/or a rising water table.

2.4 Simulated Model Duration

In the model, all of the particles were simulated to be released from the sources continuously for a modeled time period of 10 years. The justification for this time period is discussed below.

A review performed during the remedial investigation of the history of discharge of chromium to the soil has suggested that discharge commenced in 1956 and ceased in 1976 (Recra Environmental 1992). Since 1976, leaching of Cr^{+6} from soil may have represented a continuous source to ground water, resulting in the high dissolved Cr^{+6} concentrations detected during the off-site investigation (up to 2,020 $\mu g/L$). Despite the potential continuous leaching of Cr^{+6} from soil over at least 17 years, it is estimated that most of the mass of Cr^{+6} discharged remains in the soil (Recra Environmental 1992). This suggests that under current Site conditions leaching of Cr^{+6} from soil occurs slowly, requiring decades for complete removal. The slow leaching rate may be in part due to reduced infiltration rates caused by buildings and pavement over the source areas. Therefore, a conservative estimate of the potential impact on ground-water quality was obtained from the model by assuming that all of the residual Cr^{+6} potentially left in the soil after excavation would leach into ground water at a constant rate over a 10 year period. It is likely, based upon the above observations, that it would take much longer for all of the residual Cr^{+6} to be leached into ground water. A longer release time for the residual Cr^{+6} would result in lower Cr^{+6} concentrations in ground water.

2.5 Dispersion

Constant longitudinal and transverse dispersion coefficients were used in the model. The values used were determined based upon preliminary model calibration to the existing off-site data indicating that the lateral extent of Cr^{+6} in ground water was limited to the approximate distance between Monitoring Wells MW-9 and MW-14. This suggests that the maximum potential lateral extent of Cr^{+6} 160 feet downgradient of the Site is less than 180 feet. The preliminary model calibration suggested that a transverse dispersivity of 1 foot yielded a modeled lateral extent of Cr^{+6} 160 feet downgradient of the Site with a width of approximately 180 feet. By assuming that the ratio of longitudinal to transverse dispersivity is ten to one (Walton 1991), a longitudinal dispersivity of 10 feet was used.

The value for the longitudinal dispersivity is less than the value typically assumed for the Upper Glacial Aquifer on Long Island (approximately 70 feet [Walton 1991]). This assumption yields a more conservative model by minimizing the dilution of Cr^{+6} concentrations via dispersion.

2.6 Retardation

A distribution coefficient (K_d) for Cr^{+6} was calculated based upon a review of soil- and water-quality data for Monitoring Well MW-13 obtained during the off-site investigation. Using 235 micrograms per kilogram ($\mu g/kg$) for adsorbed Cr^{+6} below the water table at

Monitoring Well MW-13 and 1,185 μg/L dissolved Cr^{+6}, a K_d of 0.2 liters per kilogram, or milliliters per gram (ml/g) was calculated. The retardation factor (R_f) was calculated using the following equation (Freeze and Cherry 1979):

$$R_f = 1 + \frac{\rho_b}{n} K_d$$

where,

ρ_b = soil bulk mass density (grams per milliliter)

n = porosity

With an assumed average bulk mass density of 2.0 grams per milliliter (Walton 1991), a porosity of 30 percent (Roux Associates 1992), and a K_d of 0.20, R_f was calculated to be 2.3.

Similar values of K_d and R_f for Cr^{+6} were reported in the literature (Mehran 1991).

2.7 Additional Parameters

The additional parameters that were input into the model are listed below:

- the hydraulic conductivity, as determined during the hydrogeologic investigation of the Site (Roux Associates 1992) is 210 feet per day (ft/d);
- the saturated thickness was assumed to be 20 feet based upon an assumption of dominantly horizontal flow, and assumed monitoring well screen lengths of 20 feet;
- the ground-water flow rate is 1 ft/d (Roux Associates 1992); and
- the porosity is 30 percent.

Regional flow maps (Doriski 1987) and water-level maps generated during previous investigations at the Site suggest that the average direction of ground-water flow is approximately parallel to a line connecting the centers of the two circles representing the sources.

3.0 RESULTS AND DISCUSSION

The results of the Random-Walk model simulation are tabulated in the model output files provided in Appendix A. A review of the output files indicates that the average modeled Cr^{+6} concentration in ground water corresponding to locations downgradient of the Site was approximately 20 μg/L. The model output files indicate a maximum Cr^{+6} concentration of 44 μg/L. These results indicate that under constant loading rate conditions the conceptual soil remediation will be protective of ground-water quality downgradient of the Site even though it was assumed that potentially up to 2.4 pounds of residual Cr^{+6} may be left in the soil after remediation. It should be noted that due to current impacts of the unremediated source on ground-water quality, there will be a time frame following remediation during which the concentration of Cr^{+6} in ground water exceeds the modeled-predicted values.

The simulated Cr^{+6} concentrations represent potential average concentrations of Cr^{+6} in ground water based upon the data (field and assumed, as previously discussed) used to construct the model. It was assumed during model construction that the low-level residual Cr^{+6} will be uniformly distributed in circular halos surrounding the remediated areas. Moreover, a constant loading rate of 10 years for all of the residual Cr^{+6} was assumed. Under these average conditions, the residual Cr^{+6} will not impact ground water above the NYS Class GA Standard for Cr^{+6}. However, there could potentially be localized pockets of Cr^{+6} that are higher in concentration than the modeled residual Cr^{+6} concentrations and other areas where the concentrations are lower than the modeled residual Cr^{+6} concentrations yet still result in the same average concentration of residual Cr^{+6}. If the localized pockets of high Cr^{+6} concentrations are sufficiently dense and close to a monitoring well, Cr^{+6} concentrations in ground water at the monitoring well may exceed those predicted by the model. However, due to dispersion, the concentrations should be consistent with those predicted by the model for locations farther downgradient. Moreover, loading rates may vary based upon varying infiltration rates following precipitation events. This may result in actual short-term loading rates that exceed the modeled rate. Conversely, loading rates may be less than the modeled rates between precipitation events.

The modeling did not take into account reduction of Cr^{+6} to Cr^{+3}, which is a potential removal process downgradient of the Site. Small amounts of ferrous iron (Fe^{+2}) contained in the aquifer can reduce mobile Cr^{+6} in ground water to relatively immobile Cr^{+3} (Palmer and Wittbrodt 1991; Rai et al. 1989). It is expected that reduction will occur downgradient of the Site given the known presence of dissolved iron in ground water in the vicinity of the Site (Recra Environmental, Inc. 1992; Roux Associates 1993). If reduction of Cr^{+6} to Cr^{+3} and subsequent precipitation and adsorption are important processes downgradient of the Site, then the potential impact to ground water from leaching of the residual Cr^{+6} would be even less than the model predicted.

4.0 SUMMARY AND CONCLUSIONS

Roux Associates performed analytical transport modeling to confirm that the conceptual limits of remediation in the FS would be protective of ground-water quality. It was conservatively assumed that halos of low-level residual Cr^{+6} averaging 0.3 mg/kg could potentially be left in the soil completely surrounding the conceptual remediated volumes. The total mass of residual Cr^{+6} was calculated by Golder Associates to be 2.4 pounds. Based upon a review of the results of analytical transport modeling, Roux Associates anticipates that the residual low-level Cr^{+6} would not result in Cr^{+6} concentrations in ground water downgradient of the Site in excess of the NYS Class GA Standard for Cr^{+6}.

Based upon conservative model assumptions of leaching of all residual Cr^{+6} over a 10 year period, limited dispersion and, no reduction of Cr^{+6} to Cr^{+3}; an average Cr^{+6} concentration of 20 μg/L in ground water immediately downgradient of the Site was predicted by the model.

The model could not account for temporal and spatial variability in residual Cr^{+6} input into ground water. If either localized pockets of higher-level residual Cr^{+6} exist, or if leaching rates via infiltrating precipitation events exceed the average assumed input rate, Cr^{+6} concentrations in ground water may temporarily exceed those predicted in the model over limited areas.

Respectfully submitted,

ROUX ASSOCIATES, INC.

Nathan Epler, Ph.D.
Project Hydrogeologist

Andrew Baris
Senior Hydrogeologist

Paul Roux
President

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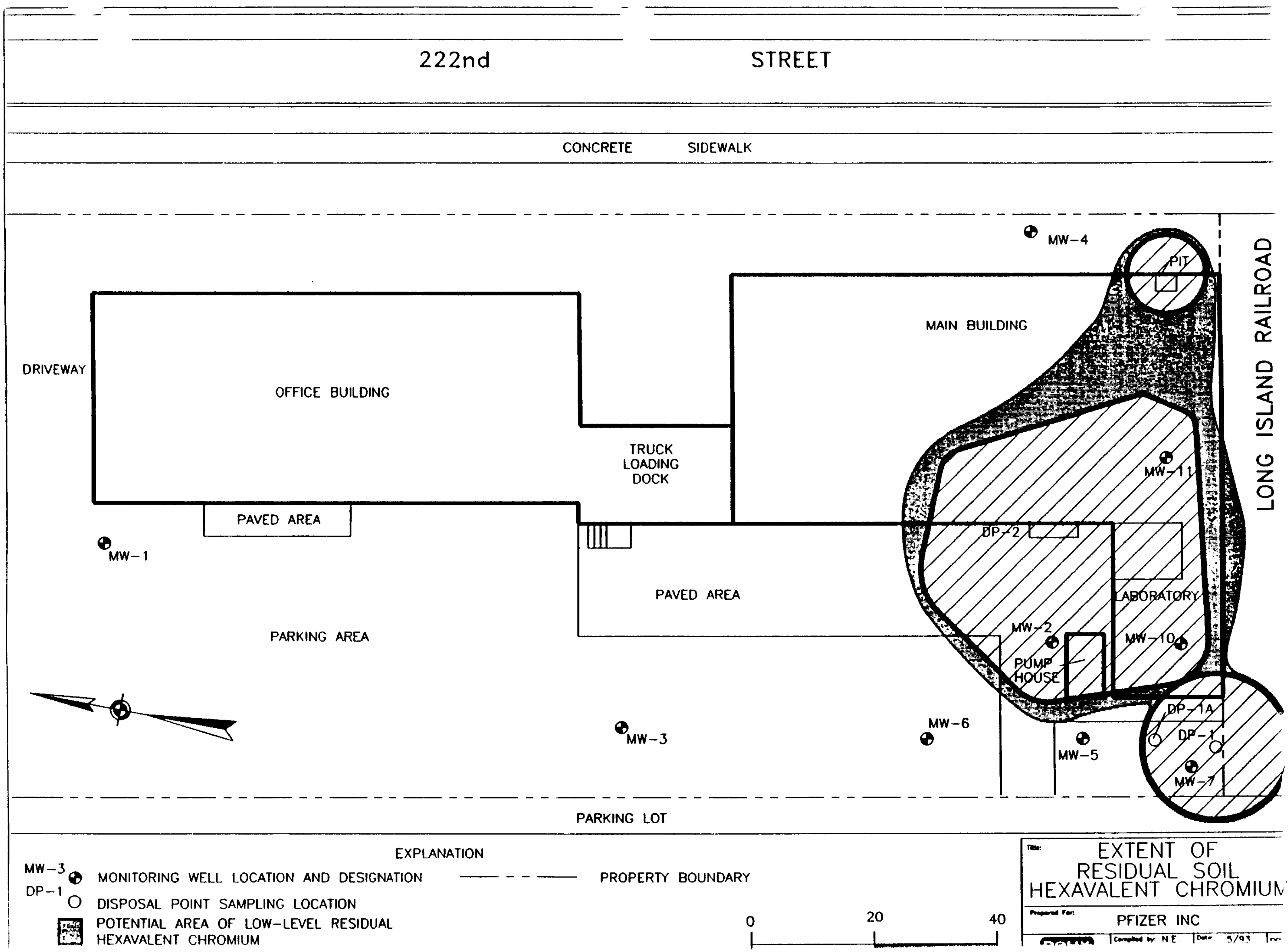
222nd STREET
CONCRETE SIDEWALK
LONG ISLAND RAILROAD
DRIVEWAY
OFFICE BUILDING
PAVED AREA
TRUCK LOADING DOCK
MAIN BUILDING
PIT
MW-4
MW-11
DP-2
LABORATORY
MW-2
PUMP HOUSE
MW-10
DP-1A
DP-1
MW-7
MW-5
MW-6
MW-1
MW-3
PAVED AREA
PARKING AREA
PARKING LOT
EXPLANATION
MW-3 MONITORING WELL LOCATION AND DESIGNATION
DP-1 DISPOSAL POINT SAMPLING LOCATION
POTENTIAL AREA OF LOW-LEVEL RESIDUAL HEXAVALENT CHROMIUM
PROPERTY BOUNDARY
0 20 40
Title: EXTENT OF RESIDUAL SOIL HEXAVALENT CHROMIUM
Prepared For: PFIZER INC
Compiled by: N.E.
Date 5/93

APPENDIX A

Random-Walk Model Output Files

```
////////////Present Mass Transport Coefficients\\\\\\\\\\\\

            Transmissivity =  31420 (Gpd/Ft)
            Storage Coefficient  =  .18
            Hydraulic Conductivity =  1571 (Gpd/Ft^2)
            Effective Aquifer Porosity =  .3
            Retardation Coefficient =  2.33
            X Component of Aquifer Pore Velocity =  1 (Ft/Day)
            Y Component of Aquifer Pore Velocity =  0 (Ft/Day)
            Particle Mass =  .00048 (Lbs/Particle)
            Species Half Life =  1E+20 (Years)
            Dispersivity Model is CONSTANT
            Longitudinal Dispersivity =  10 (Ft)
            Transverse Dispersivity =  1 (Ft)

\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\///////////////////////////////
```

Accumulated Time = 3650 Days Particles = 5000

Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

SOURCES FOR PARTICLES

Y	50	65	80	95	110	125	140	155	170	185	200
275	·	·	·	·	·	·	·	·	·	2	·
260	·	·	·	·	·	·	·	·	·	·	·
245	·	·	·	·	·	·	·	·	5	2	2
230	·	·	2	2	5	12	24	10	5	7	15
215	·	2	2	5	12	22	20	22	10	22	29
200	·	7	5	10	7	15	15	17	29	22	34
185	·	2	10	12	17	17	27	27	15	24	20
170	·	·	2	2	5	7	7	7	12	15	17
155	·	·	·	·	·	·	·	7	·	2	·
140	·	·	·	·	·	2	2	·	·	·	·
125	·	·	·	·	·	·	·	·	·	·	·

X

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000

Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y	200	215	230	245	260	275	290	305	320	335	350
275	·	·	·	·	·	·	·	·	·	·	·
260	·	·	2	5	2	2	·	·	·	2	2
245	2	·	2	5	12	7	·	5	5	5	10
230	15	10	20	17	10	15	24	12	12	5	12
215	29	24	44	34	20	24	15	20	22	29	22
200	34	27	24	34	27	34	34	24	15	32	34
185	20	27	29	42	27	29	20	24	32	24	24
170	17	12	15	10	15	10	7	24	17	17	10
155	·	5	2	5	·	2	5	·	7	5	10
140	·	·	·	·	5	2	·	·	·	·	2
125	·	·	·	·	·	·	2	·	2	·	2

X

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000

Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	·	·	·	·	·	·	·	2	·	2	2
260	2	2	2	5	2	2	5	2	7	5	2
245	10	2	5	15	10	7	10	2	·	10	7
230	12	7	5	12	7	10	17	20	12	24	5
215	22	20	24	24	17	27	12	29	22	22	24
200	34	29	39	15	15	37	20	24	17	7	22
185	24	15	22	10	10	17	27	24	12	27	12
170	10	7	12	10	12	24	22	15	17	12	12
155	10	7	5	5	12	2	10	7	5	15	2
140	2	·	·	2	·	7	·	5	5	2	2

Y											
125	2	·	·	2	·	·	·	·	2	·	2
X	350	365	380	395	410	425	440	455	470	485	500

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	2	·	·	5	2	2	·	·	·	2	2
260	2	7	2	5	·	·	7	10	2	7	7
245	7	10	7	10	2	7	2	17	12	2	7
230	5	12	5	17	12	12	12	24	15	17	12
215	24	20	12	12	17	15	17	10	22	20	10
200	22	39	20	24	24	20	15	22	27	27	20
185	12	22	20	20	20	15	22	24	10	12	10
170	12	10	17	27	24	10	24	22	15	20	7
155	2	7	10	12	17	10	7	2	5	2	5
140	2	2	5	7	2	7	7	7	·	2	·
125	2	2	·	5	2	5	·	2	5	5	5
X	500	515	530	545	560	575	590	605	620	635	650

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	2	2	5	2	2	5	2	·	2	·	7
260	7	5	10	5	7	12	5	·	2	7	·
245	7	2	5	5	5	5	20	7	20	10	10
230	12	7	10	12	15	12	32	24	17	5	24
215	10	22	10	12	20	7	15	10	27	34	24
200	20	17	12	22	17	20	15	17	17	24	24
185	10	15	10	7	24	24	7	5	17	10	24
170	7	10	15	10	12	7	10	15	15	20	5
155	5	5	10	12	15	7	12	10	12	17	17
140	·	5	5	5	5	7	2	5	12	5	5
125	5	·	2	2	2	5	2	2	5	·	·
X	650	665	680	695	710	725	740	755	770	785	800

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	7	7	·	2	7	2	2	5	7	2	2
260	·	5	7	7	5	2	10	7	·	10	15
245	10	7	12	7	20	10	7	15	10	7	12
230	24	10	22	15	12	12	15	12	10	12	7
215	24	12	12	17	12	20	15	5	27	15	17
200	24	22	22	17	24	12	5	12	22	27	15
185	24	5	24	20	5	7	24	10	10	15	20
170	5	12	12	12	12	24	7	7	20	12	10
155	17	22	12	10	17	5	15	7	12	10	10
140	5	5	7	7	5	2	·	2	10	2	12
125	·	2	·	2	7	2	2	·	·	·	5
X	800	815	830	845	860	875	890	905	920	935	950

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	2	5	5	2	2	10	5	10	7	2	2
260	15	5	2	2	10	2	10	5	·	10	10
245	12	12	10	15	·	7	20	7	2	7	7
230	7	12	7	15	12	10	7	34	22	15	12
215	17	7	20	12	24	12	12	15	22	20	20
200	15	12	10	12	15	27	22	17	12	24	22
185	20	20	12	5	12	22	17	17	10	5	17
170	10	10	12	5	24	7	5	7	10	17	17
155	10	17	7	17	20	10	5	10	7	20	24
140	12	2	2	7	·	5	7	7	7	12	10
125	5	·	5	2	5	2	12	2	10	5	2
X	950	965	980	995	1010	1025	1040	1055	1070	1085	1100

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	2	5	·	2	·	7	·	5	7	5	2
260	10	2	5	2	10	7	15	7	7	7	5
245	7	7	20	5	2	5	5	5	12	12	15
230	12	12	17	7	5	15	12	10	10	7	10
215	20	20	17	7	10	24	17	12	5	12	20
200	22	7	17	17	17	5	22	12	22	7	10
185	17	7	24	12	10	15	20	2	20	12	12
170	17	10	15	7	32	2	7	5	12	7	7
155	24	12	10	12	7	10	·	15	2	2	17
140	10	10	·	10	5	10	7	5	10	7	5
125	2	7	5	5	2	·	2	2	2	2	7
X											

	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	2	2	2	2
	0	1	3	4	6	7	9	0	2	3	5
	0	5	0	5	0	5	0	5	0	5	0

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	2	·	·	·	2	5	7	2	7	·	2
260	5	5	5	2	10	10	2	12	7	2	7
245	15	10	10	12	7	2	7	10	12	15	5
230	10	2	15	12	10	10	5	5	7	12	12
215	20	22	12	10	15	10	10	5	15	15	7
200	10	7	20	15	15	22	15	24	5	2	7
185	12	15	10	10	15	17	7	17	24	5	10
170	7	10	7	7	12	10	17	12	15	2	5
155	17	5	10	17	7	12	10	2	12	20	7
140	5	7	2	12	12	7	5	7	5	12	10
125	7	5	2	12	2	2	2	2	·	7	12
X	1	1	1	1	1	1	1	1	1	1	1
	2	2	2	2	3	3	3	3	3	3	4
	5	6	8	9	1	2	4	5	7	8	0
	0	5	0	5	0	5	0	5	0	5	0

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y											
275	2	7	7	15	·	5	·	·	5	7	2
260	7	2	2	12	·	5	2	7	10	10	5
245	5	5	15	10	2	7	10	5	12	7	2
230	12	7	10	12	15	5	2	17	7	5	2
215	7	10	5	2	7	12	5	7	15	12	5
200	7	24	17	17	10	12	7	15	7	10	15
185	10	5	12	10	5	10	15	10	10	12	15
170	5	2	22	7	2	15	5	15	2	10	5
155	7	5	7	15	10	12	7	15	12	15	20
140	10	7	7	20	12	7	2	2	7	2	5
125	12	2	·	7	·	12	5	7	2	5	·
X	1	1	1	1	1	1	1	1	1	1	1
	4	4	4	4	4	4	4	5	5	5	5
	0	1	3	4	6	7	9	0	2	3	5
	0	5	0	5	0	5	0	5	0	5	0

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y

Y	1550	1565	1580	1595	1610	1625	1640	1655	1670	1685	1700
275	2	7	2	15	·	2	2	·	2	·	·
260	5	5	10	·	2	·	2	2	2	2	·
245	2	10	7	15	5	5	10	2	2	5	2
230	2	2	15	7	2	7	5	5	12	2	·
215	5	7	10	5	7	2	7	15	2	7	5
200	15	5	5	10	5	5	7	5	2	12	5
185	15	7	5	·	15	10	2	10	12	10	5
170	5	7	12	5	7	7	2	15	7	7	·
155	20	10	12	2	7	7	2	5	2	2	5
140	5	5	7	5	5	2	10	·	2	5	5
125	·	2	·	12	7	2	2	2	·	2	2

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y	1700	1715	1730	1745	1760	1775	1790	1805	1820	1835	1850
275	·	·	7	·	2	2	·	·	·	·	2
260	·	7	·	2	·	2	2	2	·	·	2
245	2	2	5	7	2	2	2	2	·	2	·
230	·	2	7	2	7	2	·	5	7	2	2
215	5	10	·	5	5	·	2	·	·	·	2
200	5	7	2	2	·	·	2	2	·	·	5
185	5	10	7	2	5	2	·	·	·	2	2
170	·	·	7	2	·	2	·	5	2	5	5
155	5	10	·	·	10	·	·	2	·	2	·
140	5	5	7	5	15	·	·	2	·	2	·
125	2	2	2	2	2	·	·	·	·	·	2

X and Y Coordinates Shown Are in (Ft) From Origin

Accumulated Time = 3650 Days Particles = 5000
Concentration Map in µg/l (P Signifies Pumpage, I Signifies Injection)

Y	1	1	1	1	1	1	1	1	1	1	2
275	2	2	2	·	·	2	·	·	·	·	·
260	2	·	2	2	·	·	·	2	·	·	·
245	·	·	2	5	·	·	·	·	·	·	·
230	2	2	2	2	2	·	·	·	·	·	·
215	2	5	2	2	·	2	·	·	·	·	·
200	5	2	·	·	·	·	·	·	·	2	·
185	2	·	·	2	·	·	·	·	·	·	·
170	5	·	·	·	·	·	·	·	·	·	·
155	·	2	·	·	2	2	·	2	2	·	2
140	·	5	·	·	·	·	2	·	·	·	·
125	2	·	·	·	·	·	2	2	·	·	·

8 8 8 8 9 9 9 9 9 9 0
5 6 8 9 1 2 4 5 7 8 0
0 5 0 5 0 5 0 5 0 5 0

X and Y Coordinates Shown Are in (Ft) From Origin

////////////Present Mass Transport Coefficients\\\\\\\\\\\\

Transmissivity = 31420 (Gpd/Ft)
Storage Coefficient = .18
Hydraulic Conductivity = 1571 (Gpd/Ft^2)
Effective Aquifer Porosity = .3
Retardation Coefficient = 2.33
X Component of Aquifer Pore Velocity = 1 (Ft/Day)
Y Component of Aquifer Pore Velocity = 0 (Ft/Day)
Particle Mass = .00048 (Lbs/Particle)
Species Half Life = 1E+20 (Years)
Dispersivity Model is CONSTANT
Longitudinal Dispersivity = 10 (Ft)
Transverse Dispersivity = 1 (Ft)

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Appendix E

APPENDIX E

ALTERNATIVE RANKING TABLES

Alternative 1

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
1. On-site or off-site treatment or land disposal	° On-site treatment*		3
	° Off-site treatment*		1
	° On-site or off-site land disposal	X	0
Subtotal (maximum = 3)			
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** ___	3
		No X	0
Subtotal (maximum = 3)			
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr. X	3
		20-25yr. ___	2
		15-20yr. ___	1
		< 15yr. ___	0
Subtotal (maximum = 3)			
4. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site (within CLR).	**None** X	3
		≤ 25% ___	2
		25-50% ___	1
		≥ 50% ___	0
	ii) Is there treated residual left at the site? **(If answer is no, go to Factor 5.)**	**Yes** ___	0
		No X	2
	iii) Is the treated residual toxic?	**Yes** ___	0
		No ___	1
	iv) Is the treated residual mobile?	**Yes** ___	0
		No ___	1
Subtotal (maximum = 5)			

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
5. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. X	1
		> 5yr. ___	0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? **(If answer is no, go to "iv")**	**Yes** ___	0
		No X	1
	iii) Degree of confidence that controls can adequately handle potential problems.	**Moderate to very confident** ___	1
		Somewhat to not confident ___	0
	iv) Relative degree of long-term monitoring required **(compare with other remedial alternatives)**	**Minimum** X	2
		Moderate ___	1
		Extensive ___	0

Subtotal (maximum = 4)

TOTAL (maximum = 15)

Alternative 1

REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Volume of hazardous waste reduced (reduction in volume or toxicity). **If Factor 1 is not applicable, go to Factor 2.**	i) Quantity of hazardous waste destroyed or treated. **Immobilization technologies do not score under Factor 1.**	**99-100%**	___	8
		90-99%	___	7
		80-90%	___	6
		60-80%	___	4
		40-60%	___	2
		20-40%	___	1
		< 20%	X	0
	ii) Are there untreated or concentrated hazardous waste produced as a result of (i)? **If answer is no, go to Factor 2**	**Yes**	___	0
		No	X	2
Subtotal (maximum = 10) **If subtotal = 10, go to Factor 3**	iii) After remediation, how is the untreated, residual hazardous waste material disposed?	**Off-site land disposal**	___	0
		On-site land disposal	___	1
		Off-site destruction or treatment	___	2
2. Reduction in mobility of hazardous waste. **If Factor 2 is not applicable, go to Factor 3**	i) <u>Quality of Available Wastes Immobilized After Destruction/ Treatment</u>	**90-100%**	___	2
		60-90%	___	1
		< 60%	X	0
	ii) <u>Method of Immobilization</u>			
	- Reduced mobility by containment		X	0
	- Reduced mobility by alternative treatment technologies		___	3
Subtotal (maximum = 5)				
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste	Completely irreversible		___	5
	Irreversible for most of the hazardous waste constituents.		X	3
	Irreversible for only some of the hazardous waste constituents		___	2
	Reversible for most of the hazardous waste constituents.		___	0
Subtotal (maximum = 5)				
TOTAL (maximum = 15)				

Alternative 1

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
1. <u>Technical Feasibility</u>				
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.		X	3
	ii) Somewhat difficult to construct. No uncertainties in construction.			2
	iii) Very difficult to construct and/or significant uncertainties in construction.			1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.		X	3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.			2
c. Schedule of delays due to technical problems.	i) Unlikely		X	2
	ii) Somewhat likely			1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.		X	2
	ii) Some future remedial actions may be necessary.			1
Subtotal (maximum = 10)	**Minimum Required Score = 7**			
2. <u>Administrative Feasibility</u>				
a. Coordination with other agencies.	i) Minimal coordination is required.			2
	ii) Required coordination is normal.		X	1
	iii) Extensive coordination is required.			0
Subtotal (maximum = 2)				
3. <u>Availability of Services and Materials</u>				
a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	X	1
		No		0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes	X	1
		No		0

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	X	1
		No		0

Subtotal (maximum = 3)

TOTAL (maximum = 15)

Alternative 2

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)

(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	Yes	___	4
		No	X	0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	Yes	X	3
		No	___	0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	Yes	X	3
		No	___	0

TOTAL (Maximum = 10)

Alternative 1

COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE NEW YORK STATE STANDARDS CRITERIA AND GUIDELINES (SCGs)

(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Score
1. Compliance with chemical-specific SCGs	Meets chemical specific SCGs such as groundwater standards	**Yes**	X	4
		No		0
2. Compliance with action-specific SCGs	Meets SCGs such as technology standards for incineration or landfill	**Yes**	X	3
		No		0
3. Compliance with location-specific SCGs	Meets location-specific SCGs such as Freshwater Wetlands Act	**Yes**	X	3
		No		0

TOTAL (Maximum = 10)

Alternative 1

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes	X	20
		No		0
TOTAL (Maximum = 20)				
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes		3
		No		0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes		4
		No		0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes		3
		No		0
Subtotal (maximum = 10)				
3. Magnitude of residual public health risks after the remediation.	i) Health risk	$\leq$ 1 in 1,000,000		5
	ii) Health risk	$\leq$ 1 in 100,000		2
Subtotal (maximum = 5)				
4. Magnitude of residual environmental risks after the remediation.	i) Less than acceptable			5
	ii) Slightly greater than acceptable			3
	iii) Significant risk still exists			0
Subtotal (maximum = 5)				
TOTAL (maximum = 20)				

Alternative 1

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
1. Protection of community during remedial actions.	° Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes	X	0
		No		4
	° Can the risk be easily controlled?	Yes	X	1
		No		0
	° Does the mitigative effort to control risk impact the community life-style?	Yes		0
		No	X	2
Subtotal (maximum = 4)				
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes		0
		No	X	4
	° Are the available mitigative measures reliable to minimize potential impacts?	Yes		3
		No		0
Subtotal (maximum = 4)				
3. Time to implement the remedy.	° What is the required time to implement the remedy?	≤ 2yr.	X	1
		≥ 2yr.		0
	° Required duration of the mitigative effort to control short-term risk.	≤ 2yr.	X	1
		≥ 2yr.		0
Subtotal (maximum = 2)				
TOTAL (maximum = 10)				

Alternative 2

PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT
(Relative Weight = 20)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
1. Use of the site after remediation.	Unrestricted use of the land and water. (If answer is yes, go to the end of the Table.)	Yes	___	20
		No	X	0
TOTAL (Maximum = 20)				
2. Human health and the environment exposure after the remediation.	i) Is the exposure to contaminants via air route acceptable?	Yes	X	3
		No	___	0
	ii) Is the exposure to contaminants via groundwater/surface water acceptable?	Yes	X	4
		No	___	0
	iii) Is the exposure to contaminants via sediments/soils acceptable?	Yes	___	3
		No	X	0
Subtotal (maximum = 10)				
3. Magnitude of residual public health risks after the remediation.	i) Health risk (likely)	≤ 1 in 1,000,000	X	5
	ii) Health risk	≤ 1 in 100,000	___	2
Subtotal (maximum = 5)				
4. Magnitude of residual environmental risks after the remediation.	i) Less than acceptable		X	5
	ii) Slightly greater than acceptable		___	3
	iii) Significant risk still exists		___	0
Subtotal (maximum = 5)				
TOTAL (maximum = 20)				

SHORT-TERM EFFECTIVENESS
(Relative Weight = 10)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
1. Protection of community during remedial actions.	° Are there significant short-term risks to the community that must be addressed? (If answer is no, go to Factor 2.)	Yes	X	0
		No		4
	° Can the risk be easily controlled?	Yes	X	1
		No		0
	° Does the mitigative effort to control risk impact the community life-style?	Yes		0
		No	X	2
Subtotal (maximum = 4)				
2. Environmental Impacts	° Are there significant short-term risks to the environment that must be addressed? (If answer is no, go to Factor 3.)	Yes		0
		No	X	4
	° Are the available mitigative measures reliable to minimize potential impacts?	Yes		3
		No		0
Subtotal (maximum = 4)				
3. Time to implement the remedy.	° What is the required time to implement the remedy?	$\leq$ 2yr.	X	1
		$>$ 2yr.		0
	° Required duration of the mitigative effort to control short-term risk.	$\leq$ 2yr.	X	1
		$>$ 2yr.		0
Subtotal (maximum = 2)				
TOTAL (maximum = 10)				

Alternative 2

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis		Score
1. On-site or off-site treatment or land disposal	° On-site treatment*	X	3
	° Off-site treatment*		1
	° On-site or off-site land disposal		0
Subtotal (maximum = 3)			
*treatment is defined as destruction or separation/ treatment or solidification/ chemical fixation of inorganic wastes			
2. Permanence of the remedial alternative.	° Will the remedy be classified as permanent in accordance with Section 2.1(a), (b), or (c). **(If answer is yes, go to Factor 4.)**	**Yes** X	3
		No ___	0
Subtotal (maximum = 3)			
3. Lifetime of remedial actions.	° Expected lifetime or duration of of effectiveness of the remedy.	25-30yr.___	3
		20-25yr.___	2
		15-20yr.___	1
		< 15yr.___	0
Subtotal (maximum = 3)			
4. Quantity and nature of waste or residual left at the site after remediation.	i) Quantity of untreated hazardous waste left at the site (within CLR).	**None** X	3
		≤ 25% ___	2
		25-50% ___	1
		≥ 50% ___	0
	ii) Is there treated residual left at the site? **(If answer is no, go to Factor 5.)**	**Yes** X	0
		No ___	2
	iii) Is the treated residual toxic?	**Yes** X	0
		No ___	1
	iv) Is the treated residual mobile?	**Yes** ___	0
		No X	1
Subtotal (maximum = 5)			

REDUCTION OF TOXICITY, MOBILITY OR VOLUME
(Relative Weight = 15)

Analysis Factor		Basis for Evaluation During Detailed Analysis			Score
1. Volume of hazardous waste reduced (reduction in volume or toxicity). If Factor 1 is not applicable, go to Factor 2.	i)	Quantity of hazardous waste destroyed or treated. Immobilization technologies do not score under Factor 1.	99-100%	___	8
			90-99%	___	7
			80-90%	___	6
			60-80%	X	4
			40-60%	___	2
			20-40%	___	1
			< 20%	___	0
	ii)	Are there untreated or concentrated hazardous waste produced as a result of (i)? If answer is no, go to Factor 2	Yes	___	0
			No	X	2
Subtotal (maximum = 10) If subtotal = 10, go to Factor 3	iii)	After remediation, how is the untreated, residual hazardous waste material disposed?	Off-site land disposal	___	0
			On-site land disposal	___	1
			Off-site destruction or treatment	___	2
2. Reduction in mobility of hazardous waste. If Factor 2 is not applicable, go to Factor 3	i)	Quality of Available Wastes Immobilized After Destruction/ Treatment	90-100%	___	2
			60-90%	X	1
			< 60%	___	0
	ii)	Method of Immobilization			
		- Reduced mobility by containment		___	0
		- Reduced mobility by alternative treatment technologies		X	3
Subtotal (maximum = 5)					
3. Irreversibility of the destruction or treatment or immobilization of hazardous waste		Completely irreversible		___	5
		Irreversible for most of the hazardous waste constituents.		___	3
		Irreversible for only some of the hazardous waste constituents		___	2
		Reversible for most of the hazardous waste constituents.		___	0
Subtotal (maximum = 5)					
TOTAL (maximum = 15)					

LONG-TERM EFFECTIVENESS AND PERMANENCE
(Relative Weight = 15)

nalysis Factor	Basis for Evaluation During Detailed Analysis		Score
5. Adequacy and reliability of controls.	i) Operation and maintenance required for a period of:	< 5yr. ___	1
		> 5yr. _X_	0
	ii) Are environmental controls required as a part of the remedy to handle potential problems? **(If answer is no, go to "iv")**	Yes ___	0
		No _X_	1
	iii) Degree of confidence that controls can adequately handle potential problems.	Moderate to very confident ___	1
		Somewhat to not confident ___	0
	iv) Relative degree of long-term monitoring required (compare with other remedial alternatives)	Minimum ___	2
		Moderate _X_	1
		Extensive ___	0
Subtotal (maximum = 4)			

TOTAL (maximum = 15)

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
1. Technical Feasibility				
a. Ability to construct technology.	i) Not difficult to construct. No uncertainties in construction.		___	3
	ii) Somewhat difficult to construct. No uncertainties in construction.		___	2
	iii) Very difficult to construct and/or significant uncertainties in construction.		X	1
b. Reliability of technology.	i) Very reliable in meeting the specified process efficiencies or performance goals.		___	3
	ii) Somewhat reliable in meeting the specified process efficiencies or performance goals.		X	2
c. Schedule of delays due to technical problems.	i) Unlikely		___	2
	ii) Somewhat likely		X	1
d. Need of undertaking additional remedial action, if necessary.	i) No future remedial actions may be anticipated.		X	2
	ii) Some future remedial actions may be necessary.		___	1
Subtotal (maximum = 10)	**Minimum Required Score = 7**			
2. Administrative Feasibility				
a. Coordination with other agencies.	i) Minimal coordination is required.		___	2
	ii) Required coordination is normal.		X	1
	iii) Extensive coordination is required.		___	0
Subtotal (maximum = 2)				
3. Availability of Services and Materials				
a. Availability of prospective technologies.	i) Are technologies under consideration generally commercially available for the site-specific application?	Yes	___	1
		No	X	0
	ii) Will more than one vendor be available to provide a competitive bid?	Yes	___	1
		No	X	0

IMPLEMENTABILITY
(Relative Weight = 15)

Analysis Factor	Basis for Evaluation During Detailed Analysis			Weight
b. Availability of necessary equipment and specialists.	i) Additional equipment and specialists may be available without significant delay.	Yes	___	1
		No	X	0

Subtotal (maximum = 3)

TOTAL (maximum = 15)

Appendix F

APPENDIX F

COST ESTIMATE TABLES

TABLE F-1
PRELIMINARY COST ESTIMATE FOR SOURCE CONTROL AT FORMER DEKNATEL FACILITY QUEENS VILLAGE, NEW YORK

ACTIVITY	UNIT COSTS	ALTERNATIVE 1: EXCAVATE & REPLACE	ALTERNATIVE 2: IN-SITU STABILIZATION
ESTIMATED CONSTRUCTION COSTS			
MOB/DEMOB		$250,000	$250,000
DEMOLISH & SITE PREPARATION		$350,000	$350,000
SOLDIER BEAMS WITH LAGGING	$47/SF	$710,000	——
CONVENTIONAL EXCAVATION	$30/CY	$120,000	$80,000
IN-SITU STABILIZATION	$225/CY	——	$920,000
OFF-SITE DISPOSAL (non-RCRA)	$147/T	$1,060,000	$490,000
IMPORTED CLEAN BACKFILL	$20/CY	$80,000	——
PLACE/COMPACT IMPORTED BACKFILL	$35/CY	$140,000	——
PLACE BACKFILL (*without compaction*)	$10/CY	——	——
CONTINGENCY		$140,000	$520,000
SUBTOTAL		$2,850,000	$2,590,000
ESTIMATED INDIRECT COSTS			
GEN ENGINEERING SERVICES & DESIGN	LUMP SUM	$300,000	$250,000
PERMITTING/REGULATORY COORDINATION	LUMP SUM	$80,000	$80,000
LIABILITY INSURANCE	LUMP SUM	$70,000	$70,000
TEMPORARY FACILITIES	LUMP SUM	$150,000	$150,000
IMPLEMENT HEALTH & SAFETY PLAN	LUMP SUM	$200,000	$200,000
FIELD ENGINEERING	LUMP SUM	$460,000	$380,000
AS BUILT DOCUMENTATION			
SURVEYING	LUMP SUM	$10,000	$10,000
PERFORMANCE TESTING	LUMP SUM	$30,000	$30,000
AS-BUILT REPORT	LUMP SUM	$10,000	$10,000
SUBTOTAL		$1,310,000	$1,180,000
ESTIMATED O & M COSTS			
POST-REMEDIATION GW MONITORING (PRESENT WORTH @ 5% DISCOUNT RATE)	LUMP SUM	$60,000	$110,000
CONTINENCY		$10,000	$17,000
SUBTOTAL		$70,000	$127,000
FUTURE REMEDIAL COSTS		N/A	N/A
TOTAL ESTIMATED COST		$4,230,000	$3,897,000

ASSUMPTIONS:

1) Duration of construction operations is 6 mos for Alt. 1 and 5 mos for Alt. 2.
2) Total volume of soil to be remediated within the three conceptual limits of remediation (CLRs) = 4095 cy
3) Volume of soil to be remediated within the CLR for DP-1 and Pit = 273 cy and 108 cy, respectively
4) Continency for Alt. 1 = 5 % of estimated construction costs subtotal
   Continency for Alt. 2 = 25 % of estimated construction costs subtotal
5) Contingency for escalation of post-remediation groundwater monitoring program = 15 %
6) For Alt. 2, initial excavation to compensate for swelling = 25 % of volume within each CLR
7) Duration of post-remediation groundwater monitoring is 5 yrs for Alt. 1 and 10 yrs for Alt. 2
8) Values rounded to nearest $10,000

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TABLE F-2

PRELIMINARY COST ESTIMATE
FOR SOURCE CONTROL AT
FORMER DEKNATEL FACILITY
QUEENS VILLAGE, NEW YORK
WITH 25% INCREASE TO VOLUME OF REMEDIATION

ACTIVITY	UNIT COSTS	ALTERNATIVE 1: EXCAVATE & REPLACE	ALTERNATIVE 2: IN-SITU STABILIZATION
ESTIMATED CONSTRUCTION COSTS			
MOB/DEMOB		$250,000	$250,000
DEMOLISH & SITE PREPARATION		$350,000	$350,000
SOLDIER BEAMS WITH LAGGING	$47/SF	$880,000	—
CONVENTIONAL EXCAVATION	$30/CY	$150,000	$70,000
IN-SITU STABILIZATION	$225/CY	—	$1,150,000
OFF-SITE DISPOSAL (non-RCRA)	$147/T	$1,320,000	$610,000
IMPORTED CLEAN BACKFILL	$20/CY	$100,000	—
PLACE/COMPACT IMPORTED BACKFILL	$35/CY	$180,000	—
PLACE BACKFILL (without compaction)	$10/CY	—	—
CONTINGENCY		$160,000	$610,000
SUBTOTAL		$3,390,000	$3,040,000
ESTIMATED INDIRECT COSTS			
GEN ENGINEERING SERVICES & DESIGN	LUMP SUM	$350,000	$300,000
PERMITTING/REGULATORY COORDINATION	LUMP SUM	$80,000	$80,000
LIABILITY INSURANCE	LUMP SUM	$70,000	$70,000
TEMPORARY FACILITIES	LUMP SUM	$150,000	$150,000
IMPLEMENT HEALTH & SAFETY PLAN	LUMP SUM	$200,000	$200,000
FIELD ENGINEERING	LUMP SUM	$540,000	$460,000
AS BUILT DOCUMENTATION			
SURVEYING	LUMP SUM	$10,000	$10,000
PERFORMANCE TESTING	LUMP SUM	$30,000	$30,000
AS-BUILT REPORT	LUMP SUM	$10,000	$10,000
SUBTOTAL		$1,440,000	$1,310,000
ESTIMATED O & M COSTS			
POST-REMEDIATION GW MONITORING (PRESENT WORTH @ 5% DISCOUNT RATE)	LUMP SUM	$60,000	$110,000
CONTINGENCY		$10,000	$17,000
SUBTOTAL		$70,000	$127,000
FUTURE REMEDIAL COSTS		N/A	N/A
TOTAL ESTIMATED COST		$4,900,000	$4,477,000

ASSUMPTIONS:

1) Duration of construction operations is 7 mos for Alt. 1 and 6 mos. for Alt. 2.
2) Total volume of soil to be remediated within the three conceptual limits of remediation (CLRs) = 5120 cy
3) Volume of soil to be remediated within the CLR for DP-1 and Pit = 540 cy and 219 cy, respectively
4) Continency for Alt. 1 = 5 % of estimated construction costs subtotal
   Continency for Alt. 2 = 25 % of estimated construction costs subtotal
5) Contingency for escalation of post-remediation groundwater monitoring program = 15 %
6) For Alt. 2, initial excavation to compensate for swelling = 25 % of volume within each CLR
7) Duration of post-remediation groundwater monitoring is 5 yrs for Alt. 1 and 10 yrs for Alt. 2
8) Values rounded to nearest $10,000

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