Final RFI Report
General Motors Corporation
Martin Luther King Boulevard Facility
Anderson, Indiana
RCRA Facility Investigation
IND 980 700 801

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August 12, 2005
Revised: September 28, 2007

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1.0 INTRODUCTION

This report addresses the results of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) conducted by General Motors Corporation (GM) at the Dr. Martin Luther King Jr. (MLK) Boulevard Facility, Anderson, Indiana. This report is submitted to the Indiana Department of Environmental Management (IDEM) and the U.S. Environmental Protection Agency (US EPA) in partial fulfillment of the corrective action requirements contained in Section F.2 of the Administrative Agreed Order Cause H-13855 between Commissioner, Indiana Department of Environmental Management (IDEM) and General Motors Corporation.

As appropriate, this report updates findings of a previous Stage I RFI report submitted in July 2001 and includes the results of investigations conducted since that time. This final report provides analyses, interpretations, and conclusions based on data contained in both the Stage I RFI Report and the recent Stage II RFI Data Report. It is not intended to duplicate either of these submittals. The reviewer interested in details of soil borings, well completions, and laboratory reports should consult the previous Stage I RFI Report or the Stage II RFI Data Report, as appropriate.

A summary of the areas of investigation and the types of investigation that were conducted at each area is provided in Table 1.1.

The screening risk evaluation presented in Section 4 of this report and the Baseline Risk Assessment (Section 5) were prepared by ENVIRON International Corporation (ENVIRON).

1.1 Report Organization

This report is organized as follows.

Section 2 provides a general overview of the RFI and includes a general Facility history and description, a description of each investigative area, an RFI history, a description of the types of investigations conducted, and a description of interim corrective measures (IMs) that have been conducted.

Section 3 provides a description of the environmental setting of the Facility, regional and site-specific hydrology, land use, and groundwater use.

Section 4 provides a summary of work conducted at each investigative area, analytical sampling results, and the results of risk screening of the data.

Section 5 presents a baseline risk assessment that evaluates the potentially significant releases of hazardous constituents at areas identified in Section 4 that exceeded screening criteria, to determine whether corrective measures are warranted.

Section 6 provides summary and conclusions regarding the presence or absence of significant releases from each investigative area and the baseline risk assessment results for each area.

Section 7 provides a comprehensive list of references cited within this text.

2.0 RFI OVERVIEW

2.1 Facility Description

The GM MLK Boulevard Facility is located in the northwest quarter of Section 23, T19N, R7E, on the southwest side of Anderson, Madison County, Indiana (Figure 2.1). GM no longer conducts operations on the property, and leases portions of the property to Guide Corporation. Formerly, the Facility comprised approximately 3,000,000 square feet of manufacturing area situated on 234 acres. MLK Boulevard divides the Facility in a north-south direction. Formerly, GM conducted manufacturing operations in plants on both sides of MLK Boulevard. The former east manufacturing areas (Plants 6 and 9) are bounded by MLK Boulevard on the west, by a railroad on the south, by 29th Street on the north, and by Madison Avenue on the east (Figure 2.2). Except for the former Facility wastewater treatment plant (WWTP) and the parking lot along MLK Boulevard, this property is no longer owned by GM.

The manufacturing facilities west of MLK Boulevard, referred to as the Main Plant, are bounded on the west, south and southeast by railroad tracks, and on the north by 25th Street. Facility parking areas are located west of the westernmost railroad, and north of 25th Street. Developed areas of the Facility are largely covered with asphalt or concrete. Small areas near administrative buildings and along Facility borders are maintained in short grass cover. Land use surrounding the Facility varies from residential and commercial on the north and east, to residential and recreational on the south, and to agricultural on the west. A small public-access park is located in the northwest part of the property.

Operations at the MLK Boulevard Facility began in 1929. Manufacturing plants were expanded several times, generally proceeding from the north end of the Main Plant southward and eastward. Construction dates for buildings in the South Court Area range from 1937 to 1973. According to verbal reports from plant personnel and observations from historic aerial photographs dated 1950, a low area formerly existed between the railroad tracks at the south end of the Main Plant. The area is now level, paved with asphalt, and used for outside storage of sand and gravel, wire shipping baskets and construction materials.

East of MLK Boulevard, Plant 9 construction commenced in 1969, and building additions were performed in 1973, 1977, 1981, 1985, 1986 and 1989.

Demolition of the former WWTP at the MLK Boulevard Facility began in late September 2002. The demolition involved removal of all above grade structures and demolition and filling of the former clarifier, blender and mixing tanks. During the demolition, the concrete bottoms of each tank area were broken and the upper portion of the concrete walls of each tank collapsed into the floor area.

GM has divested itself of portions of the MLK Boulevard Facility property. The former Plant 6 and 9 properties have been sold. The Main Plant west of MLK Boulevard is currently leased to Guide Corporation, but remains in GM ownership. Figure 2.2 reflects the current GM property line. The term "Facility", as used throughout this report, refers to the aggregate of current and former GM properties, including former Plants 6 and 9.

2.2 Investigative Areas

Various areas of concern (AOCs), areas of interest (AOIs), solid waste management units (SWMUs) and Areas (aggregate groups of AOCs, SWMUs, etc.) were investigated during the RFI. The locations of investigative areas discussed in this report are shown in Figure 2-2. AOC and SWMU designations used in this report follow the historical usage of the RCRA Facility Assessment (RFA) documents. Detailed descriptions of the history of each of these areas are provided in the RFA and various Work Plan documents listed in Section 2.3.

GM has conducted RFI investigations at two areas not previously designated as SWMUs or AOCs. These areas are AOI 1 – North Parking Lot and AOI 2 – Chromium Recovery Area, located in the Main Plant building.

AOI 1 – North Parking Lot is located north of the Main Plant building, and northwest of the intersection of 25th Street and MLK Boulevard (Figure 2.2). The area consists of approximately 25 acres, bounded on the west by a CSXT rail line, and on the north by 22nd Street. The area north and east of the parking lot fence line is covered for the most part with grass except for an access road connecting the parking lot to 22nd Street. The majority of the parking lot is covered in asphalt. Two areas of AOI 1 are known to have stockpiled high sulfur coal. Previous subsurface soil and groundwater investigations in these areas indicated that arsenic and iron were constituents of potential concern in subsurface soil.

AOI 2 – Chromium Recovery Area is located in the Main Plant Building. The Chromium Recovery Area contained several tanks utilized in chromium recovery from plating solutions. Chromium recovery operations ceased in 1998, and the area was decommissioned in 2002. All tanks, piping and ancillary equipment were removed. The area was never formally designated as a SWMU or AOC.

AOI 3 – Bay R4 Area is located in the northern portion of the Main Plant building. This area contained a sump that was discovered during construction activities undertaken by tenant Guide Cooperation in 2002. The sump was apparently associated with two former, small metal plating operations (Cadmium Plater and Handy Plater) located in this general area of the plant. The sump is believed to have been utilized as a collection point for cadmium plating wastewaters from one or both of the plating operations. This portion of the Main Plant building was constructed in 1964. The sump was installed latter, probably in 1965 or 1966, and was believed to be in operation until about 1975. The area was never formally designated as a SWMU or AOC.

In addition, GM has grouped certain AOCs and SWMUs together based on their proximity and/or common waste management history. These aggregate units, referred to as Areas, are as follows.

Area 1 – South Court and Related Areas
- AOC 1 - South Court
- West Chromium Area
- SWMU 17 - Conrail Ditch Area

Area 2 – 309/352 Platers, Acid/Caustic Strip Areas
- SWMU 2 - 352 Plater
- SWMU 3 - 309 Plater

SWMU 7 – Acid / Caustic Strip Tank

Area 3 – East Storage Area
SWMU 21 - Concrete Pad
SWMU 22 - Site Assessment Area

Area 4 – Nalco Areas
SWMU 25 - Nalco Pit Area
SWMU 26 - Bulk Materials Loading Area

Area 1 – South Court and Related Areas The three investigative areas associated with Area 1 are located west of MLK Boulevard. A volatile organic compound (VOC) groundwater plume associated with AOC 1 – South Court was previously detected and delineated during the Stage II RFI investigations. This plume extends northward beneath several SWMUs in the Main Plant building, eastward beneath MLK Boulevard to the former Plant 9 property, and southward to off-Facility areas. The extent of this plume is included in Area 1.

Area 2 – 309/352 Platers, Acid/Caustic Strip This area consists of three contiguous SWMUs located in the Main Plant building. The 309 Plater predated the 352 Plater and Acid/Caustic Strip Tanks and was located in the same physical area. Detailed description of the history of each of these areas is contained in the Work Plan Amendment Main Plant Plating and Recovery Areas (Earth Tech, July 31, 2002). These areas were investigated during Stage II of the RFI using a common strategy and parameter list.

Area 3 – East Storage Area The East Storage Area is located east of MLK Boulevard behind the former Plant 9. The area is no longer owned by GM, and work on this property is conducted pursuant to an access agreement with the current owner. The area consists of two contiguous SWMUs. SWMU 21 is an outdoor concrete storage pad located immediately east of the former East Container Storage Building (Figure 2.2). SWMU 22 is a storage area to the north that was the location of previous site assessment sampling activities. Investigations were conducted at both SWMUs during Stage I of the RFI, and around a blind sump at SWMU 22 during Stage II.

Area 4 – Nalco Areas This area designation applies to two continuous SWMUs located near the former Nalco emulsion pit behind Plant 9. This area was completely investigated during Stage I of the RFI. No Stage II investigations were conducted here.

2.3 RFI History

General Motors submitted notification to the US EPA as a large quantity hazardous waste generator August 18, 1980, qualifying the Facility for interim status for containerized storage of hazardous wastes. The Facility initially submitted separate RCRA Part A permit applications, and received separate identification numbers, for the Main Plant (west of MLK Boulevard) and Plants 6 and 9 (east of MLK Boulevard). Effective December 1982, at the Facility's request, one identification number was canceled, and the entire contiguous MLK Facility began operating under one identification number (IND 980 700 801).

A RCRA Part B permit application was initially submitted in 1983, and a revised Part B application was submitted January 15, 1992. The Federal Part B permit became effective February 14, 1993 and contained corrective action requirements for several areas. These corrective action requirements largely followed the corrective action recommendations contained in the RFA. The RCRA Part B permit was renewed as necessary by GM through 2003.

GM contested certain RCRA permit conditions in a petition for review filed on February 5, 1993. Submittal of an RFI Work Plan for specific SWMUs targeted for corrective action was stayed during the review period. As noted and stipulated in correspondence from US EPA Region 5 dated September 6, 1994, the Environmental Appeals Board rendered a decision on the petition July 11, 1994, and submittal of an RFI Work Plan for investigations at several SWMUs became due by February 8, 1995.

A final RFI Work Plan for conducting investigations at several areas was submitted on October 14, 1997. This Work Plan was approved by the US EPA and the Indiana Department of Environmental Management (IDEM) on November 20, 1997.

Preliminary RFI investigations were initiated in December 1997 with a soil gas survey of the general AOC 1, SWMU 17 and the West Chromium Areas, using a direct-push probe-type sampling system and on-site gas chromatographic (GC) analysis. The results of these investigations were provided in the RFI Soil Gas Data Report (Earth Tech January 26, 1998). This report was submitted to the IDEM in January 1998. The report contained a plan for soil boring and sampling based on the soil gas data. The soil boring plan was conditionally approved by the IDEM on September 1, 2000. GM clarified remaining sampling and analysis issues with the IDEM in a memo dated October 13, 2000 and provided notification that RFI field work was scheduled to begin. Stage I field investigations were initiated by GM in October 2000

The Stage I RFI investigations were conducted pursuant to the following Work Plan documents:

- RFI Work Plan (Earth Tech, October 14, 1997);
- Soil Gas Data Report (Earth Tech, January 26, 1998);
- GM notification memorandum (October 13, 2000);
- RFI Work Plan Amendment – Walking Track Area (Earth Tech, October 14, 1997); and
- RFI Work Plan Amendment – West Impoundment Area (AOC 5) (Earth Tech, October 1, 1998.

GM conducted a residential well survey of areas adjacent to the MLK Facility in December 2000. Ten private wells were identified and sampled.

A Stage I RFI report was submitted to the IDEM in July 2001 (Earth Tech and ENVIRON, July 31, 2001). The Stage I report addressed investigations conducted from October 2000 through July 2001, including the residential well survey, and was submitted to the IDEM in partial fulfillment of the corrective action requirements contained in Section III.F. of the Federal portion of the RCRA Part B permit. Stage I investigations were conducted at the following investigative areas, as currently defined:

- AOC 2 – Former Fire Training Area;
- AOC 3 – East Chromium Area;
- AOC 4 – Walking Track Area;
- AOC 5 – West Impoundment Area;

- Area 1 − South Court and Related Areas (including AOC 1, SWMU 16, SWMU 17, and West Chromium Area);
- Area 3 – East Storage Areas (SWMUs 21 and 22); and
- Area 4 – Nalco Areas (SWMUs 25 and 26).

Areas evaluated during the Stage I RFI that required no additional investigation included AOC 2, AOC 4, AOC 5, and Area 4. The Stage I RFI report included a plan for further investigations at AOC 3, portions of Area 1, and Area 3. These additional investigations were conducted during the Stage II RFI beginning in October 2003.

Stage II investigations were also conducted in expanded portions of Area 1 and at several additional areas as identified in the following Work Plan documents:

- RFI Stage I Report – Section 5.0 (Earth Tech and ENVIRON, July 31, 2001);
- RFI Work Plan Amendment – North Parking Area / Vacant Parcel (Earth Tech, January 30, 2002);
- RFI Work Plan Amendment – Main Plant Metal Plating and Recovery (Earth Tech, August 16, 2002);
- RFI Work Plan Amendment – Additional Stage II Work (Earth Tech, August 5, 2004); and
- RFI Work Plan Amendment – Soil and Groundwater Delineation (Earth Tech, November 16, 2004.

The expanded portions of Area 1 included areas east of MLK Boulevard (former Plant 9 and the Meadowbrook Golf Course). The new areas included the following:

- AOC 06 – Electroform Room;
- AOC 07 – 400 Plater:
- AOI 01 – North Parking Area;
- AOI 02 – Chromium Recovery Area;
- AOI 03 – Bay R4 Area;
- Area 2 – 309/352 Platers, Acid/Caustic Strip;
- SWMU 04 – 1002 Preplater; and
- SWMU 06 – Nickel Recovery.

Several of the new areas were recently decommissioned metal plating and recovery areas that were, in part, the subject of the 1993 petition for review.

A Stage II data report summarizing data collected from October 2003 to February 2005 was submitted to the IDEM on March 30, 2005. That report was submitted in partial fulfillment of the corrective action requirements contained in Section F.2 of the Administrative Agreed Order Cause H-13855 between the Commissioner, Indiana Department of Environmental Management and General Motors Corporation. The data report included soil boring logs, monitoring well completion diagrams, hydrogeologic cross sections and maps, potentiometric surface maps, laboratory data reports, isoconcentration maps, and various data box plots.

2.4 RFI Objectives

The RFI was conducted as necessary to support the following objectives:

- Determine whether a significant release of hazardous constituents has occurred from various SWMUs and AOCs not fully evaluated during the Stage I RFI;
- Determine the lateral and vertical extent of constituents in soil, groundwater and surface water where a significant release of hazardous constituents that had been confirmed;
- Provide a sufficient set of data to support the RCRA Corrective Action Environmental Indicators (EI) determination;
- Assess potential risks to human health and the environment associated with the potentially significant release of hazardous constituents and determine whether interim or corrective measures are necessary to mitigate current and future unacceptable risks, if any; and
- Collect data necessary to evaluate the necessity of interim or corrective measures for areas where such measures are warranted.

2.5 Field Investigations

This section provides a brief synopsis of the RFI investigative procedures and field investigations undertaken at the Facility.

2.5.1 Soil Sampling

During Stage I of the RFI, soil borings were completed at each investigative area described in the Work Plan during the period of October 30 to November 13, 2000. Soil samples for field examination and laboratory analysis were collected using a direct-push *Geoprobe* Macro-core® soil sampler. This device obtains a 45-inch long x 1.5-inch diameter core utilizing a plastic (PETG) or stainless steel sample tube liner. Samples collected for visual examination of the soil material and/or off-site laboratory analysis of target metals parameters were obtained using the PETG liners. Samples for VOC and semi-volatile organic compound (SVOC) constituents were collected in stainless steel liners.

During Stage I, soil samples were also collected using hollow-stem auger and split spoon sampling techniques at AOC and the Background West sampling areas. Soil samples for visual examination were collected at a minimum rate of one sample per 2 1/2 feet of drilling depth, unless heaving sand conditions were encountered.

Soil samples were also collected using hollow-stem auger and split spoon sampling techniques during Stage II as part of the groundwater hydropunch survey and monitoring well installation. Each sample was completely described and HNu / PID screened by an Earth Tech field geologist, as described in Section 5.2.1 of the Work Plan. Most soil samples for visual examination were collected continuously to total depth. Boring SB 214 was blind drilled to 20 feet, sampled from there continuously to a depth of 60 feet, and then at five foot intervals to total depth. Similarly, borings SB 215 and SB 216 were sampled continuously to a depth of 60 feet and then at five foot intervals to total depth.

During Stage II, soil borings were completed at each investigative area described in Section 5.0 of the Stage I Report and Work Plan Amendments for the North Parking Area / Vacant Parcel and former metal plating and recovery areas during the period of November 3, 2003 to February 20, 2004. Soil boring locations and the corresponding Area / Location designations are shown on the schedule provided in Table 1. Soil samples for field examination and laboratory analysis were collected using a *Geoprobe* 6610 DT track-mounted direct-push rig equipped with Macro-core® soil sampler. In areas where samples were to be analyzed for volatile organic constituents, Stage II samples were collected using Method 5035 and *En-core*™ sampling equipment according to field SOP A-6-3. Each soil boring was examined by the on-site geologist and a soil boring log was completed. Soil boring logs are included in Attachment A of the Stage II Data Report (Earth Tech; March 30, 2005). Boring logs for soil borings completed after March 2005 are included in Attachment B.

Soil borings were described according to Section 5.2.1 of the Work Plan. The description included the sample texture, color (including mottling), structure, moisture content, consistency, carbonate content, and presence of other significant features, including fill sequences. Soil material descriptions were completed following guidelines established by the IDEM using Natural Resources Conservation Service soil descriptive procedures.

Soil samples collected at AOC1, AOC 3, AOC 4, AOC 5, AOI 1, and Area 3 were screened for VOC contamination using a HNu / PID organic vapor detector. A small portion of each sample was sealed in a clean glass jar or plastic bag for several minutes prior to the screening. Field screening results were recorded on soil boring log forms contained in the Stage I RFI, Stage II RFI Data Report, or Attachment B.

All boring and sampling equipment used to obtain samples for laboratory analysis were decontaminated prior to use at each boring. Between samples, sampling equipment was decontaminated utilizing low-phosphate *Alconox* detergent followed by tap water rinse and DI rinse. All drilling equipment was decontaminated between borings by washing with a high-pressure hot water rinse. Any excess soil removed from the boring was collected in containers for appropriate disposal. Borings not completed as monitoring wells were filled with bentonite upon completion, and where applicable the pavement was patched with concrete/asphalt after filling.

Drilling cuttings and decontamination fluids were contained for characterization and proper disposal.

2.5.2 Groundwater Screening

Groundwater screening samples were collected from soil borings SB 217 to SB 221, SB 237B, SB 243 to SB 246, SB 251 to SB 260, SB 262, SB 263, and SB 273 using a *Geoprobe*® stainless steel screen point sampler at the locations shown on Figure 2.2. The sampler allows water to enter laterally into the rods. Once the desired depth was attained, the rod assembly was retracted, exposing the screen. Flexible polyethylene tubing in conjunction with a stainless steel check valve or peristaltic pump was utilized to extract the sample. Samples collected in SWMU 21 (SB 217 and SB 243 to SB 246) were subject to on-site GC field screening for xylenes and ethylbenzene and laboratory analysis. Samples collected in the East Chromium Area (SB 218 to SB 221), Meadowbrook Golf Course (SB 251 to SB 255 and SB 258 to SB 260), west manufacturing building (SB 237B and SB 263) and former Plant 9 (SB 256, SB 257, SB 262 and SB 273) were submitted for off-site laboratory analysis. The *Geoprobe* screening results were used for selecting locations for monitoring well installations MW 56 to MW60, MW 64 to MW 66, and MW 80 on Meadowbrook Golf Course property, former Plant 9, and the west manufacturing building.

Groundwater screening samples were also collected from soil borings SB 201 to SB 212 utilizing a *HydroPunch II®* sampler at the locations shown on Figure 2.2. At least two hydropunch samples were obtained from within the Unit 3 sand aquifer pursuant to Sections 5.3.2 and 5.3.3 of the Stage I Report. Where multiple Unit 3 sand units were encountered, hydropunch samples were obtained from each unit. The samples were submitted to the laboratory with a forty-eight hour turn-around time and analyzed for Target Compound List (TCL) VOCs. A total of 37 screening samples, including duplicates and rinsate blanks were analyzed. Hydropunch screening results were used for selecting locations for monitoring well installations MW 38 to MW 48 on CSXT property and along MLK Boulevard (Figure 2.2).

2.5.3 Monitoring Well Installation

Monitoring wells MW 1 to MW 17 are pre-RFI monitoring wells installed during 1992 and 1993. Stage I monitoring well installation began October 18, 2000 at the locations specified in the Work Plan. A total of 20 new monitoring wells (MW 18 – MW 37) were installed during Stage I. All monitoring wells were installed using a minimum auger size of 4 1/4-inch I.D. to provide annular space for placing well sealing materials consistent with Indiana Department of Natural Resources and IDEM guidelines. The pre-RFI and Stage I monitoring wells were constructed of nominal 2-inch diameter flush joint PVC screen and riser.

Stage II monitoring well installation began November 21, 2003 at the locations specified in Section 5.0 of the Stage I Report and various Work Plan Amendments. A total of 46 new monitoring wells (MW 38 to 84) were installed at the locations shown on Figure 2.2. All Stage II monitoring wells, with the exception of MW 59 and MW 60, were installed using a minimum auger size of 4 1/4-inch I.D. to provide annular space for placing well sealing materials and to meet IDEM guidelines. Monitoring wells MW 59 and MW 60 were installed using *Geoprobe®* 2 1/4-inch OD probe rods, and were constructed of 1-inch diameter flush joint PVC screen and riser. All other Stage II wells were of two-inch construction and utilized stainless steel well screens.

Monitoring wells were usually completed in holes offset a short distance from the sampled soil boring using an auger string fitted with a bottom plug. This procedure was followed to prevent the accumulation of "heaving" sand in the augers, and to facilitate proper placement of the well screen. Well screen lengths were suitable for the thickness of the saturated zone to be monitored, to a maximum length of 10 feet.

All monitoring wells were developed with an electric submersible pump or with a tubing and foot value arrangement using a centrifugal pump to remove drilling fluids and fine-grained formation material from the well screen and casing. Monitoring well development water was containerized for testing and appropriate disposal.

Figure 2.3 presents a cross section of the Facility and illustrates schematically monitoring well completion zones. Each well installation was supervised by an on-site geologist and a well completion diagram form completed. Well completion diagrams for wells installed during the Stage II RFI are included in Attachment B of the Stage II Data Report (Earth Tech, March 30, 2005). The well completion diagram for MW 84 installed after the Stage II Data Report submittal is included in Attachment B.

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2.5.4 Sample Location Survey

Instrument survey of all RFI monitoring well and soil boring locations was performed at various times throughout the RFI investigation period. The survey was performed using global positioning system (GPS), electronic distance measuring (EDM) total station and leveling instruments.

National Geodetic Survey (NGS) monument PID No. LA1286 was found and used as the reference monument to adjust previous 1998 GM property survey plat drawings to the Indiana State Plane (1301 East, NAD 83) coordinate system. Two previous survey plat drawings, provided by GM, of the areas west and east of Pendleton Avenue were transformed and rotated to this datum. The East Chromium Area was not shown on either GM plat drawing so a plan drawing of this area was produced during this investigation and appended to the GM drawings. The final georeferenced GM drawing as well as base map drawings obtained from the City of Anderson were used to prepare the various figures contained in this report.

The ground surface and datum (top of casing) elevation data monitoring wells is based on level survey relative to U.S. Geologic Survey (USGS) monument PID No. LA1429 stamped "F 42 1934". This monument has a second order NAVD 88 elevation of 882.61 feet and was found per NGS data sheet retrieval notes. A level survey was carried from this monument about 0.9 miles south to the Facility.

During Stage II, survey control was carried into the Main Plant Building to tie the metal plating and recovery areas to the pervious outside surveys. Key features such as sumps, curb edges, and trenches around each area were surveyed to georeference the original GM plan drawings of each area.

During October 2002, locations of samples taken from beneath the former WWTP storage tanks at AOC 3 during demolition of the tanks were established by tape measurements from the tank walls or from the control points established along the perimeter of the demolition area. The demolition schedule did not permit access to the sampling locations for later survey. The elevation of the WWTP tank floors and samples were determined using standard leveling techniques. Two temporary benchmarks and control points were established north of the tank area along the south side of the parking lot.

2.5.5 Groundwater Sampling

All monitoring well sampling employed during the RFI utilized a low-flow rate purging and sampling strategy employing a downhole two-inch submersible pump except for one-inch wells MW 59, MW 60 and the AOC 6 wells MW-ER-1, -2, and -3. Each monitoring well sampled utilizing the low-flow rate sampling procedure was assigned a length of dedicated Teflon-lined tubing. This tubing is cleaned and reused during subsequent sampling events. One-inch wells were purged with a disposable bailer or peristaltic pump and dedicated Teflon tubing. When the peristaltic pump was used, samples were obtained with a disposable bailer.

Geochemical parameters were recorded after each successive screen volume was removed. Those parameters include pH, temperature, dissolved oxygen content (DO), conductivity, oxidation-reduction potential (ORP), and turbidity. Samples submitted for dissolved metals and polychlorinated biphenyls (PCBs) were field filtered through a 0.45 micron high capacity in-line filter. All field notes were recorded in a field logbook and on a purging and sampling field data form. Samples were shipped daily to Tri Matrix Laboratories for analytical analysis.

Purge water generated during groundwater sampling was containerized for testing and proper disposal.

2.5.6 Water Level Measurements

Several complete and partial rounds of water level measurements were taken during the RFI. The most recent measurements made during Stage II on January 18, 2005 and March 10, 2005 involve the most well installations and provide the most definitive information on groundwater hydraulic gradients. Groundwater level measurements were made at wells with a direct read electronic water level indicator.

Several surface water bodies were also measured. Surface water level measurements were made at temporary bench mark established in surface water bodies using a folding rule. Measurements were recorded to the nearest 0.01 feet.

2.5.7 Surface Water Sampling

Surface water samples were collected during the Stage II RFI. These samples were collected using a clean polyethylene dipper. Sample containers were directly filled from the polyethylene dipper.

2.5.8 Water Supply Well Sampling

Potable well sampling was conducted in December 2001 and during Stage II of the RFI. Samples from potable wells were obtained by purging the well using the installed well pump for at least 15 minutes. Samples were collected from the closest tap to the pump and prior to any water treatment. Geochemistry parameters were recorded at 5 minute intervals. All field notes were recorded in a field logbook and on a purging and sampling field data form.

A former high-capacity production well on GM property (Well No. 11) was sampled during Stage II. This well had an installed 60 horsepower turbine pump the prevented access to the well. Prior to sampling, the pump motor, drive line, and pump bowl assembly were removed from the well to provide access to the well. With the well pump removed, total depth and screen length was determined. A four-inch submersible pump was set near the top of the screen to purge the well prior to sampling. Approximately 600 gallons were purged from the well. Geochemistry parameters were recorded throughout the purging process. Discharge from the well was containerized on site for proper disposal. The sample was collected using a two-inch submersible pump fitted with dedicated Teflon-lined tubing. Sample containers were filled directly from the discharge end of the tubing. To limit access to the well, the wellhead was secured with a steel plate and locking access port.

2.6 Interim Measures

GM has implemented interim measures (IMs) related to soil and groundwater at the site.

2.6.1 On-Site Soil and Groundwater

General Motors has completed an IM at AOC 1 – South Court. The IM was conducted pursuant to an Interim Measures Work Plan (Conestoga-Rovers & Associates, March 21, 2005). The IM area is shown in Figure 2.4.

The primary objective of this IM was to address trichloroethylene (TCE) concentrations in a small area of AOC 1 that were an order of magnitude greater than the soil concentrations in other portions of the South Court Area.

Removal of these soils has resulted in a substantial risk reduction. A secondary objective of the IM was to treat perched water in fill soil. Perched groundwater in this area is a probable contributing source of elevated TCE and cis-1,2-dichloroethene (cis-1,2-DCE) concentrations to underlying aquifer units.

Delineation of high-TCE in the IM work area was accomplished during Stage II of the RFI (see Section 4.6.1). The area of soil with significantly elevated TCE concentrations is bounded by SB 277 (north), SB 280 (east), SB 275 (south), and SB 274 (west) (Figure 2.4). A 20 x 35 foot excavation bounded by these locations and to the top of the perched water zone was completed. A total of 374 tons of TCE impacted fill and soil material was excavated into 26 rolloff containers on July 5 and 6, 2005. The material was manifested and transported as hazardous waste to EQ Industrial Services, Ypsilanti, MI. The soil from the excavation was treated as D040 (TCE) hazardous waste.

The presence of cis-1,2-DCE in the soil and perched groundwater suggests that significant biological degradation of TCE is occurring via reductive dechlorination mechanisms. The degradation process may be accelerated by mixing Hydrogen Releasing Compound (HRC®) into the top of the perched water zone. This compound releases lactic acid over time, which enhances biological degradation by maintaining reducing conditions in the aquifer.

After the excavation was extended into the top of the water table, excavating equipment was used to mix 390 pounds (13 5-gallon buckets) of HRC® into the saturated material at the bottom of the excavation prior to backfilling.

Monitoring well MW 31, located within the excavation bounds, was removed during the IM. A replacement well MW 31R was installed at the former well location within the excavated area on July 25, 2005. MW 31R is screened within Unit 1 at a depth of 12.7 feet. Groundwater monitoring of selected wells the area, including MW 31R, will be conducted to evaluate the IM. GM will present an assessment of the IM as part of the Final Corrective Measures Proposal due March 2008 following completion of the two-year groundwater monitoring plan.

2.6.2 Off-Site Groundwater

GM has identified two potable water wells used for water supply located on the Meadowbrook Golf Course (Figure 2.2, MBWELL-1 and MBWELL-2). These are located in a general downgradient direction from the Facility. As discussed in Section 4.6.4.1.6, these wells have been sampled several times for VOCs compounds and none have been detected.

MBWELL-1 is located on the golf course and supplies the golf course maintenance building to the south. MBWELL-2 is located in the basement of the Meadowbrook Club House and supplies the club house kitchenette, and drinking water fountains. There is a third well on the property located south of the maintenance building, but this well is reportedly not in use.

GM and Strong's Golf LLC, the owners of the Meadowbrook Golf Course (Owners), have entered into an access agreement providing for the following.

1. Owners acknowledge and agree that use of groundwater at, in, or under the property by any person or entity for any purpose, including potable and non-potable use shall be prohibited. Use of surface water located on the property for irrigation purposes only will be permitted.

2. GM will connect the clubhouse and maintenance building on the property to City of Anderson water service.

3. GM will permanently decommission all thee potable wells known to exist on the property.

3.0 ENVIRONMENTAL SETTING

3.1 Location and Physiography

As noted in Section 2.1, the Facility is located on the southwest side of the City of Anderson in Madison County, as shown on Figure 2.1. Madison County is situated in the New Castle Till Plains and Drainageways Section of the Central Till Plain Region as described by Gray (2000). This area was affected by multiple continental glaciations that deposited a thick blanket of glacial sediments over the underlying bedrock. The New Castle Till Plains and Drainageways Section is primarily underlain by complexly stratified glacial diamict deposits, glaciofluvial sand and gravel deposits and glaciolacustrial silt and clay deposits. The area is characterized by broad plains of low relief crossed by relict glacial meltwater drainageways.

3.2 Climate

The climate in the area of the Facility is classified as temperate (Lapham, 1981). During the period from 1961 to 1990, the normal annual average temperature was 50.9°F at the Anderson sewage treatment plant, with a normal annual minimum of 41.6°F and a normal annual maximum of 60.2°F (Owenby and Ezell, 1992). During this 30-year period, normal monthly average temperatures ranged from a low of 24.8°F in January to a high of 73.5°F in July. Normal annual average precipitation during this 30-year period was 38.5 inches with a median of 38.4 inches. Normal monthly average precipitation ranged from a low of 2.0 inches in January to a high of 4.1 inches in July.

3.3 Topography and Surface Water Drainage

The area of the Facility is nearly level with elevations ranging from 860 to 880 feet above mean sea level. Most of the open ground, with the exception of portions of AOI 1, undeveloped areas east of Plant 9, and the former WWTP area at AOC 3, is paved with concrete and asphalt. These other areas are in short grass cover. East of MLK Boulevard the elevation is lowest, and the topography descends into a relict glacial meltwater valley. Former Plant 9, Plant 6, and the Meadowbrook Golf Course are all located in the relict meltwater valley. This valley trends south-southwest from Anderson several miles towards Pendleton, Indiana as mapped by Brown and others (2003). A small underfit stream, Stanley Ditch, occupies the north end of the relict meltwater valley. As shown on Figure 2.1, Stanley Ditch originally flowed to the north between former Plant 6 and Plant 9. As part of the 1963 Boland Drainage Project to provide relieve for the combined Greenbranch Sewer, storm water from Stanley Ditch was diverted to the south through a constructed drainage ditch (Boland Drain) that runs parallel to MLK Boulevard. As a result, Stanley Ditch is tributary to Prairie Creek that flows to the south down the trend of the valley to Pendleton, Indiana where it joins Fall Creek, a tributary to the West Fork White River.

Surface water run-off from paved areas of the property is directed to a combined sewer system that discharges north to the City of Anderson Publicly-Owned Treatment Works (POTW) on the West Fork White River. Water discharged to the combined sewer system flows northward across the Meadowbrook Golf Course property and beneath Plant 9 up the trend of the relict meltwater channel. Surface water on the northern portion of the Meadowbrook Golf course property is directed through piping, and discharges to ponds on the golf course property. Surface water in the southern portion of the Meadowbrook property drains southward toward Stanley Ditch that flows along the southern and eastern property boundaries of the golf course.

A drainage divide between Stanley Ditch and Prairie Creek, draining to the south, and the combined sewer system, draining north to West Fork White River, appears to occur near the south side of former Plant 9, perhaps near and along the South Anderson Cutoff railroad embankment. Areas to the south of the railroad embankment, including most of the Meadowbrook golf Course are floodway and floodway fringe areas subject to flooding (FEMA, February 16, 1994). The floodplain status is reflected in the local land use zoning of the area (see Section 3.8).

3.4 Soils

The general area of the Facility contains six United States Department of Agriculture, Natural Resources Conservation Service soil series mapping units (Schermerhorn, 1967). Soils west of MLK Boulevard are the Miami silt loam (2 to 6% slopes, Crosby silt loam (0 to 2% slopes), Brookston silty clay loam, Celina silt loam (0 to 2% slopes) and Fox silt loam (0 to 2% and 2 to 6% slopes). These soils all develop in glacial drift deposits of Wisconsinan age. The Kokomo mucky silt loam is present east of MLK Boulevard. These soils occur at former Plant 9 within the relic meltwater valley.

The Miami silt loam is a deep, well-drained, and moderately eroded soil found along drainage ways, low knolls, and divides. The estimated permeability of the Miami silt loam is 0.8 to 2.5 inches/hour to a depth of 10 inches below ground surface (bgs) and 0.2 to 0.8 inch/hour from 10 to 36 inches bgs. The Crosby silt loam, which occurs on nearly level slopes, is a deep, somewhat poorly drained soil. The estimated permeability from the surface to 10 inches bgs and from 34 to 42 inches bgs ranges from 0.8 to 2.5 inches/hour. From 10 to 34 inches bgs, the estimated permeability ranges from 0.2 to 0.8 inch/hour. The Brookston silty clay loam is a deep, very poorly drained soil found in upland depressions. The estimated permeability from the surface to 59 inches bgs is 0.2 to 0.8 inches/hour. Celina silt loam, which occurs on uplands, is a deep, moderately well drained soil. Estimated permeability of the Celina silt loam from ground surface to 9 inches bgs is 0.8 to 2.5 inches/hour and from 9 to 42 inches bgs is 0.2 to 0.8 inches/hour. The Fox silt loam is deep, well drained soil found along low ridges or divides between uplands or terraces. The estimated permeability from ground surface to 30 inches bgs is 0.8 to 2.5 inches/hour, from 30 to 36 inches bgs is 5 to 10 inches/hour and from 36 to 40 inches bgs is 0.2 to 0.8 inches/hour.

The Kokomo mucky silt loam, which occurs in low swales of the uplands, is a deep, very poorly drained soil with high organic matter content. The estimated permeability of the Kokomo mucky silt loam ranges from 0.2 to 0.8 inches/hour to a depth of 21 inches bgs, 0.05 to 0.8 inches/hour to a depth of 49 inches bgs and 0.8 to 2.5 inches/hour from 49 to 56 inches bgs.

3.5 Regional Geologic Setting

Madison County and the Anderson area are underlain by glacial drift deposits of varying thickness overlying an irregular bedrock surface developed on carbonate rocks of Silurian age assigned to the Wabash and Pleasant Mills Formations (Gray and others, 1987). The surficial drift deposits are related to the latest (Wisconsinan) glacial stage. Buried pre-Wisconsin deposits are common in the area and occur below a well-developed Sangamon paleosol (a buried soil) and weathering zone.

The Wisconsinan glacial deposits are related to the latest advances of the East White Sublobe of the Huron-Erie ice lobe. These ice sheets advanced eastward and southeastward into central Indiana from the Erie basin during the Woodfordian Substage. The deposits are dated to approximately 20,000 years before present (ybp). Regionally, the latest phases of the East White Sublobe advanced rapidly but stagnated in central Indiana forming a complex array of meltout ablation drift types overlying hard, basal or lodgement tills of loamy texture. The Wisconsin till deposits are generally mapped in Indiana as the Trafalgar Formation (Gray, 1989). The Trafalgar Formation consists of poorly sorted, conglomeratic mudstone (diamict) and associated lenses of gravel, sand, and silt. Concurrent with the massive stagnation and meltout, a system of meltwater channels developed the carried large meltwater streams southward from the stagnated ice front. Many of these relict meltwater channels are preserved in the Madison County landscape today as low, wide topographic troughs occupied by small, underfit surface streams.

3.6 Facility Geology and Hydrogeology

This section provides a summary discussion of the geologic and hydrogeologic data from the Facility and immediate vicinity gathered during the RFI.

3.6.1 Hydrogeologic Units

The soil boring data, collected during the RFI investigations have been utilized to prepare various geologic cross sections of the Facility. These have been revised repeatedly during the course of the investigation as new data have become available. Six new geologic cross sections have been prepared that incorporate the RFI Stage II data, including the results of several borings made into the bedrock units (Figures 3.1 to 3.6). Previous cross sections are presented in the Stage I RFI

Report (Earth Tech/ENVIRON, 2001). The locations of these sections are shown on index maps presented on each figure. Cross section A-A' (Figure 3.1) extends along AOC 1 – South Court Area, beneath the former plating and recovery area of the Main Building to MW 75 / MW 76 located in the North Courtyard. Cross section B-B' (Figure 3.2) extends along the CSXT right-of-way and parking lot east of MLK Boulevard. Cross sections C-C' and D-D' (Figures 3.3 and 3.4) extend along the southwest portion of the Facility and Meadowbrook Golf Course. Cross section E-E' Figure 3.5) extends along the west parking lot, beneath the southern portion of the Main Building, east parking lot and former Plant 9. Cross section F-F' (Figure 3.6) extends from Arrow Avenue to the northern end of the east parking lot.

Five distinct geologic units are recognized in the unconsolidated surficial soil materials. These units are identified from top to bottom as Units 1 to 5 (Figures 3.1 to 3.6).

Unit 1 – Unit 1 consists of a heterogeneous mix of fill materials consisting of silty clay loam, silty clay, sandy clay, sandy clay loam, and loam texture soil intermixed, in places, with debris consisting of wood, glass, brick, concrete, coal fragments, and cinders. A thin perched groundwater zone may occur at the base of the unit.

The unit consists of fill material placed at various times during the developmental history of the Facility. Unit 1 extends from the southwest at MW 21 / 22 toward the northeast to at least MW 28 / 29. Off the Facility, Unit 1 fill is noted on the CSX railroad right-of-way from the southwest at MW 47 toward the northeast to MW 45 / 46. At AOC 1 – South Court, where this unit was originally noted and defined, the material was utilized to fill in a low area between railroad embankments to the northwest and southeast. Historic aerial photographs indicate that the fill was placed from the north to the south during the 1960's. Unit 1 is up to about 14 feet in thickness at SB 156.

Unit 1 also occurs in the AOC 3 area around the former WWTP east of MLK Boulevard. This area is along the western margin of the relict meltwater valley noted in Section 3.3, and fill was used to raise the grade of the area prior to construction of the plant in approximately 1968.

Unit 2 – Unit 2 consists primarily of diamict of silty clay loam, silty clay, and loam texture with occasional thin, interbedded sand and gravel deposits. Sand and gravel lithologies make up a small percentage of the unit. Unit 2 is thin in southern part of the Facility at AOC 1 - South Court, but thickens to the north.

Unit 3 – Unit 3 consists primarily of stratified sand gravel. This unit forms the uppermost aquifer beneath the Facility. In places, a diamict or massive, laminated silty clay occurs in the middle of the unit. Where present, the unit is identified on the cross sections as the Unit 3 Confining Bed. At some locations the confining bed is represented by a distinctive silty texture and laminated structure that aids in distinguishing the Unit 3 Confining Bed from Unit 4. The confining bed is hydrologically significant because it separates the Unit 3 aquifer into an upper portion (Unit 3S) and lower portion (Unit 3D).

Unit 4 – Unit forms a confining bed between Unit 3 and the Silurian carbonate bedrock. Unit 4 consists of hard diamict of loam or clay loam texture in the upper portion, and interbedded loamy diamict and stratified sand in the lower portion. The unit is absent from the eastern part of the area at Plant 9 and portions of the adjacent Meadowbrook Golf Course. A significant paleosol was identified in the upper portion of the unit at some locations and indicates that that at least a portion of Unit 4 is of pre-Wisconsinan age.

Unit 5 – Unit 5 is a cobble bed. Two deep bedrock borings at the north end of the Facility encountered a bed of cobbles above the bedrock surface. This zone is shown on Cross Section E-E' (Figure 3.5). The unit was encountered at no other locations.

Bedrock beneath the Facility consists of carbonate rocks of Silurian age. Figure 3.7 is a bedrock contour map showing the elevation of the bedrock surface at a contour interval of 10 feet. The map includes data from several monitoring wells on and adjacent to the Facility that encountered bedrock, as well as data from some groundwater production wells that have been located and for which reasonable drilling logs and ground surface elevations are available. These later wells include former GM production wells WH-11 and WH-12 and two private water wells (IDNR Reference Numbers 147375 and 147390) located west of the Facility.

The bedrock topography beneath the Facility slopes to the northwest. The bedrock is high (above 840 foot elevation) in the southern portion of the former Plant 9 area and at the Meadowbrook Golf Course. Bedrock is at shallow depth in this area since the bedrock elevation is high and ground surface elevation is low due to the presence of the relict meltwater valley. To the northwest, the bedrock elevation descends to below 730 foot elevation at WH-11, and the bedrock in this area is in excess of 150 feet depth. Regional bedrock mapping suggests that the bedrock low in the western part of the Facility is associated with the pre-glacial Anderson Valley, a southern tributary to the Teays-Mahomet bedrock valley system (see bedrock topographic mapping by Gray (1982) and Bleuer (1991).

Figure 3.8 shows the distribution and top elevation of the Unit 3 Confining Bed. The unit is present beneath AOC 1 – South Court Area and the Main Plant Building (Figure 3.1, Cross Section A-A'). East of MLK Boulevard the unit is absent in the vicinity of AOC 3 at the former WWTP (Figure 3.2 Cross Section B-B') and beneath much of the Plant 9 and the adjacent Meadowbrook Golf Course areas (Figure 3.4, Cross Section D-D'). The thickness of the unit is shown in Figure 3.9. The thickness of this unit ranges from 0 to 24 feet.

Figure 3.10 shows the distribution and top elevation of Unit 4. A prominent high is present in the vicinity of MW 36. From this point, the elevation drops gently to the east at MW 57 and north and northwest at MW 52 and MW 75 respectively. A second high is present near MW 80 in the former WWTP area.

Boring data from MW 53 and 65-A (Figure 3.5) indicate that Unit 4 is absent in some areas west of the Main Plant building. In the Former Plant 9 area and eastern portion of the Meadowbrook Golf Course, Unit 4 is absent and the Unit 3 sand and gravels directly overlie Silurian age bedrock at shallow depth. Previous geotechnical borings advanced in the former Plant 9 area support this interpretation (see RFI Work Plan, Figure 5). The thickness of the Unit 4 is shown in Figure 3.11. The thickness of this unit ranges from 0 to greater than 20 feet.

3.6.2 Hydrogeology

Descriptions of water-bearing units at the Facility are provided in the following sections. Monitoring wells are completed in various hydrogeologic units. Table 3.1 shows the hydrogeologic unit in which each monitoring well is completed and provides a comprehensive tabulation of RFI groundwater elevation data. Potentiometric maps for various RFI monitoring events are included in the Stage I RFI Report and March 30, 2005 Stage II Data Report.

3.6.2.1 Perched Groundwater in Unit 1

In places, the lower portion of the Unit 1 fill is saturated and a localized perched groundwater zone occurs. The clayey diamicts in Unit 2 form an underlying confining unit resulting in this perched groundwater condition. Saturated conditions have been observed in the basal portion of Unit 1 in several shallow AOC 1 – South Court Area soil borings and interior metal plating area soil borings. Perched conditions are clearly evident from water level data. For example, a comparison of water levels in the Unit 1 monitoring well MW 31 with those in the adjacent Unit 3 monitoring wells MW 2, 3 and 5 (Figure 3.1) indicates that the groundwater level in Unit 1, when encountered, is higher than groundwater encountered in Unit 3S wells

At other Unit 1 locations examined during this investigation, no groundwater was encountered, and monitoring wells installed in the unit are dry (MW 32) or the water level is below the bottom of the well screen (Figure 3.3, MW 30). Perched groundwater conditions in the fill material are erratic, and the zone is nowhere observed to be over a few feet in thickness. No attempt is made to determine the direction of groundwater flow in the unit due to discontinuous nature of perched groundwater condition.

3.6.2.2 Unit 3 Aquifer

Unit 3 is almost entirely within the phreatic zone and is the uppermost aquifer unit at the Facility. Water levels measured on October 20, 2004 are shown on the cross sections in Figures 3.1 to 3.6. Generally, groundwater levels occur 15 to 21 feet bgs at AOC 1 – South Court Area. Groundwater may exist in the unit under both confined and unconfined conditions. Where the base of Unit 2 is relatively high in elevation, the upper few feet of Unit 3 are unsaturated, and unconfined conditions occur. At locations where the base of Unit 2 is relatively low in elevation the top of Unit 3 is saturated, and confined conditions occur (see Figure 3.1, Cross section A-A' and Figure 3.5, Cross section E-E').

Conceptually, Unit 3 may be divided into upper (Unit 3S) and lower (Unit 3D) parts. In those places where there is no physical separation between the upper and lower parts of the unit provided by the Unit 3 Confining Bed, the designations 3S and 3D merely provide a convenient way to refer to the upper and lower portions of the Unit 3 aquifer, and the monitoring wells completed therein. Where a physical separation occurs due to the presence of the Unit 3 Confining Bed, Unit 3S refers to that portion of the aquifer above the confining layer and Unit 3D refers to that portion below the confining layer.

The most recent March 10, 2005 potentiometric surface maps for Units 3S and 3D are shown on Unit 3S and 3D VOC isoconcentration maps (Figures 3.12 through 3.17). The Unit 3S potentiometric surface suggests an east-northeast groundwater gradient in the South Court Area and a northeastward gradient beginning near the former metal plating and recovery areas. A high on the potentiometric surface at MW 29 produces a southern deflection of the gradient at this location. An east-southeast oriented potentiometric trough in Unit 3S occurs in the vicinity of the former WWTP at AOC 3. This trough is defined by consistent low water levels at observed at MW 40, 42, and 68. The trough appears to be related to the absence of the Unit 3 Confining Bed in the area. Contaminants in the upper portion of Unit 3 near AOC 1 - South Court would be

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expected to move generally east northeastward, and at the former metal plating and recovery areas in the Main Plant building would be expected to move northeastward.

The hydraulic gradient for Unit 3D is more consistent and the potentiometric surface for this unit suggests an eastward gradient in the South Court Area and along MLK Boulevard. In the eastern portions of the golf course and former Plant 9 a westward hydraulic gradient is present. The north-northeast / south-southwest oriented relict meltwater channel at former Plant 9 and the Meadowbrook Golf Course appears to induce a hydraulic gradient to the south along its axis. Contaminants in the lower portion of Unit 3 would be expected to move generally eastward and then southward near the former WWTP area.

The Unit 3 Confining Bed induces a significant vertical gradient in Unit 3. Where the unit is present, hydraulic heads in Unit 3S are several feet higher than those in Unit 3D. Where the confining bed is absent, water levels in the upper part of Unit 3 are comparable to those in the lower part. Steep lateral gradients may occur in Unit 3S near where the confining bed is absent. This situation occurs at near AOC 3 at the former WWTP. Compare water levels at MW 45 / 46 with those at MW 39 / 40 (Figure 3.2, Cross Section B-B', and Figure 3.12).

A comparison of the groundwater levels and surface water levels measured at the Meadowbrook Golf Course indicates that the golf course ponds are an expression of the potentiometric surface of Unit 3.

3.6.2.3 Bedrock Aquifer

During Stage II, seven bedrock wells were installed in the Silurian carbonate bedrock. These wells were installed in the upper portion of the bedrock. Four perimeter wells (MW 62, 71, 74, and 77) were installed in late 2004 and early 2005. Three additional bedrock wells (MW 81, 82 and 83) were installed within and downgradient of VOC-contaminated areas in Unit 3 to evaluate the possible migration of VOC contaminates to the bedrock. MW 81 was installed west of Plant 9 downgradient from the VOC contamination at the former WWTP. MW 82 was installed downgradient of AOC 1 – South Court, and MW 83 was installed within the Unit 3 VOC plume at the former WWTP.

Three rounds of potentiometric measurements were obtained on the bedrock wells. These measurements were made on January 4, 2005 (three wells), January 18, 2005 (four wells) and March 10, 2005 (seven wells). All three sets of measurements indicate a general eastward gradient similar to that observed in Unit 3D. Potentiometric contour maps for all these events are contained in the Stage II Data Report.

3.7 Background Soil Characterization

Background levels of target metal parameters in soil were evaluated during Stage I of the RFI from site-specific samples collected in two areas of the Facility where no manufacturing or management of production materials or wastes are known to have occurred (Figure 2.2). Soil types are comparable to those found in developed areas of the Facility. Sections 3.15 and 3.16 of the Stage I RFI Report describe the sampling performed to characterize the concentrations of these metals in background soil. The concentrations of metals in the samples from the 0 to 2 ft bgs interval were used to represent background exposures to metals in soil because soil from this interval is encountered by the general population more often than deeper soil. In addition, there is no significant difference between the metal concentrations in the samples collected from the 0-2 ft interval and in those from the deeper intervals. The metal concentrations in background soil from this interval are summarized in Table 3.2, which also include summary statistics describing the concentration distributions.

The upper confidence limits presented in Table 3.2 are nonparametric bootstrap confidence limits on the mean (Efron and Tibshirani, 1998) calculated from 4,000 bootstrap replications and at a 0.05 level of significance. Nonparametric bootstrap statistical limits are more reliable than parametric statistical limits because, unlike parametric limits, they do not rely on assumptions about distribution shapes that are often difficult to justify. A concentration of a metal lower than or equal to its upper confidence limit is considered to be within background levels; a concentration higher than its upper confidence limit is considered to be higher than background levels. The background concentration was not calculated for silver, because it was not detected in background samples.

3.8 Land Use

Figure 3.18 illustrates the current City of Anderson zoning designations for the Facility and surrounding areas. The Facility is in an area zoned predominantly as industrial I-2. This designation incorporates existing industrial developments and provides adequate room for new industrial development. Realizing the need for industrial expansion, the I-2 District does not permit dwellings or small businesses. This area has been zone for industrial use since before 1962 as indicated by the 1962 master plan (City of Anderson, 1962).

Areas adjacent to the Facility are zoned R-2, R-3, R-4, I-1 and I-2. The R designations include single family dwellings, single and two family dwellings and multifamily dwellings respectively. The I-1 designation incorporates many of the existing industrial developments along MLK Boulevard and provides for industrial expansion. Permitted uses include only those where all of the operations, including storage of materials are confined within a building and the performance characteristics are compatible with uses permitted in neighboring districts. Residences and business are permitted in these areas.

The I-2 industrial zoning is also applied to the area south of former Plant 9. This area contains a mobile home park and the Meadowbrook Golf Course. The mobile home park and golf course were grandfathered into the zoning plan when this are was designated as industrial I-2. Only industrial development consistent with the current and proposed zoning classifications (i.e., no new residential development) will be permitted in the future at these locations (Carroll, 1997).

The area between the South Anderson cutoff railroad embankment and 38th Street to the south, including the Meadowbrook Golf Course and the trailer park also has an “F” overlay zoning designation. This area is FEMA designated floodway and floodway fringe (see Section 3.3).

3.9 Groundwater Use

3.9.1 Residential Well Survey

A residential well survey was conducted in December 2000 to identify groundwater wells in use around the Facility. Figure 3.19 shows the location of the survey area and identified wells. The survey concentrated on downgradient areas to the east of the Facility, and now known to encompass the entire area of the VOC plume associated with the Facility. In this survey, GM compared all building addresses within the potentially affected area to city water service records to locate any structure that was not serviced by city water. Owners of the property at these addresses were contacted and ten potable wells were identified and sampled. These included several wells along MLK Boulevard southeast and south of the Facility and two wells on the Meadowbrook Golf Course. In addition, one well was identified at a business on the north side of 29th Street. Although this well was outside the designated survey area, it was included in the survey.

Based on the neighborhood survey and analytical results, GM is confident that none of the ten potable wells have been or will be impacted.

Each well was sampled for VOCs in December 2000, and results were included in the Stage I RFI Report. No VOCs were detected in any of the wells.

The City of Anderson's public water supply is provided by the Anderson Water Utility and is derived entirely from groundwater. The City obtains groundwater from Raney collector wells located adjacent to the White River.

The City of Anderson has an ordinance, dated November 21, 2000 (Ordinance #55-2000), that prohibits the installation of new potable water wells for all areas within 300 feet of an existing and available Anderson Water Utility water supply line. The ordinance also prohibits the installation of any new well and the redrilling of any existing well in the shallow aquifer above the regional till. A site-specific groundwater use restriction will also be put in place for the Facility.

3.9.2 Former GM Production Wells

Prior to about 1989 or 1990, five high capacity groundwater pumping wells operated on the Facility property. Three of these wells (WH-9, WH-10, and an undesignated well apparently installed in 1957) were located in the AOI 1 − North Parking Lot Area. The other two wells (WH-11 and WH-12) were located in the West Parking Lot west of the Main Plant building (Figure 3.19). These wells were used for industrial process water and cooling.

According to the Indiana Department of Natural Resources significant groundwater withdrawal registration, the WH-11 well is 103 feet deep and was equipped with a 1,200 gallon-per-minute (gpm) pump. The WH-12 well was listed as 112 feet deep, and was also equipped with a 1,200-gpm pump. Annual groundwater production reports filed by the Facility pursuant to the groundwater withdrawal registration indicate the following total annual withdrawals in millions of gallons for these two pumping wells. The older wells WH-9 and WH-10 are reported to have not been used after 1985.

Production Well	1985 (MGY)	1986 (MGY)	1987 (MGY)
WH-11	299.7	315.2	143.1
WH-12	314.4	323.5	109.9
Total	614.1	638.7	253.0
Note: MGY = million gallons per year			

The 1985 and 1986 annual withdrawals equate to a continuous, sustained pumping rate in excess of 1,200 gpm. Pumping rates of this magnitude would be expected to have a large impact on both groundwater flow direction and rate at the Facility. All wells were unused after 1987.

3.9.3 Ecological Screening Risk Evaluation

An ecological screening risk evaluation (SRE) performed as part of the Stage I RFI is discussed in Section 4.3.3 of the Stage I RFI Report. The objective of the SRE was to identify the potential for ecological risks associated with releases at the Facility. The ecological SRE evaluated the ecological setting around the Facility and the presence of ecological receptors and complete exposure pathways in conjunction with the available site characterization data to determine the necessity for additional investigation of potential ecological risks. The ecological SRE is based on a review of available information from several sources including the U.S. Geological Survey, National Wetland Inventory (NWI) map, and the Indiana Department of Natural Resources.

Based on the SRE findings, the closest potential ecological receptor to the Facility appeared to be the drainage corridor of White River. Although three areas of apparent palustrine emergent wetland vegetation were identified in the Facility area, these areas are not believed to be of significant ecological value due to the level of anthropogenic disturbance in the vicinity. No endangered or threatened species or significant natural areas are located within two miles of the Facility according to the Indiana Department of Natural Resources. Future use of the Facility is not expected to change these conclusions since no change to the basic ecological setting (and absence of ecological receptors) is expected.

The potential for Facility-related constituents to reach the White River was evaluated as part of the Stage II RFI investigations designed to further characterize the nature and extent of the groundwater contaminant plume. Based on the Stage II RFI findings, the kidney shape pond located on the golf course was determined to be a potential groundwater receptor. In order to evaluate the potential human and ecological exposure to surface water, surface water data were compared to both human and aquatic based screening criteria as described in Section 4.0 of this report. Any exceedance to human or aquatic screening criteria was further evaluated in Section 5.0 of this report.

4.0 INVESTIGATION RESULTS AND DISCUSSION

Sample locations for the RFI Stage I and II areas of investigation are shown on Figures 2.2, and 4.1 to 4.16. Analytical data table are presented in Attachment A for the various sampled matrices (Tables A-1 to A-6). The header rows in each table list the sample location, sample identification (as shown on laboratory reports), sample date, and sample area. The header row may also report the sample depth as feet bgs (*ft BGS*) or (*ft*). The header of the groundwater analytical table (Table A-4) contains an additional row identifying the sample matrix. Matrix codes are as follows:

WB borehole water (groundwater screening)
WG groundwater from a monitoring well

In Tables A-1 to A-5 provide analytical results are provided for all inorganic (metal and cyanide) analytes. For volatile and semivolatile organic compounds, only the compounds that were detected in at least one RFI soil or water are listed. Data validation qualifiers accompany the analytical result as appropriate. Table A-6 shows historic pre-RFI groundwater monitoring data for the seventeen original wells at the Facility.

A screening evaluation was performed using data collected during Stage I and Stage II as well as previous relevant investigations. This evaluation updates the evaluation provided in the Stage I RFI Report by including screening against vapor intrusion criteria and by utilizing updated US EPA Region 9 Preliminary Remediation Goals (PRGs) (US EPA 2004) and soil migration to groundwater criteria. Some of the screening results are thus different than those presented in the Stage I RFI Report.

For each sample matrix, the analytical results were compared to conservative screening criteria based on potential exposure scenarios that are pertinent to current and reasonably expected future land use. Tables 4.1 to 4.4 provide summary data related to the detected compounds at each investigative area. The data are tabulated by area and compound. The right hand portion of each table compares the maximum detected concentration for each compound in each area to relevant risk-screening criteria discussed below. Highlighted values indicate that the maximum site-related concentration exceeds the applicable screening criteria.

For screening of chromium data, the criteria for chromium VI are conservatively used to screen total chromium data where chromium was analyzed for the total concentration only. During Stage II, chromium was also analyzed for hexavalent chromium (chromium VI) in addition to the total chromium. In those cases, trivalent chromium (chromium III) was calculated by subtracting chromium VI from total chromium, and the speciated concentrations are compared with the criteria for chromium III and chromium VI.

The results which exceeded the conservative screening criteria are presented in a series of data box figures (Figures 4.18 to 4.23). Figures 4.18 to 4.21 contain the soil data; Figures 4.22a and 4.22b show the borehole water data; Figure 4.23 shows the groundwater and surface water data. These data box figures show the chemicals that have at least one sample with a concentration that exceeded any of the screening criteria, and the concentrations of these chemicals for every sample, regardless of whether a concentration exceeds criteria in a particular sample. Constituent concentrations that exceed the screening criteria are highlighted. A summary of the conservative screening criteria used for each sample matrix follows.

Soil – The soil characterization data are compared with conservative screening criteria derived from the PRGs published by US EPA Region 9 (US EPA 2004) and risk-based soil volatilization to indoor air criteria for industrial settings. US EPA Region 9 calculates their risk-based PRGs using conservative standard default exposure factors for estimating high-end exposures to soil of workers in commercial/industrial settings. The risk-based volatilization to indoor air criteria are calculated using generic industrial building parameters and site-specific soil properties for constituents in soil that might volatilize and migrate through cracks in the building foundation into indoor air. For AOC 5 (currently an undeveloped field) and AOI 1 (a portion of which is currently used as a park), the soil characterization data are conservatively evaluated using the PRGs for soil volatilization to indoor criteria derived for residential settings. Data for the deepest soil sample collected from the vadose zone in each soil boring are also compared to generic soil migration to groundwater criteria for protection of drinking water sources. The soil migration to groundwater criteria are derived using the procedure outlined in US EPA's Soil Screening

Guidance (EPA, 1996) and the drinking water criteria discussed below. Derivation of these criteria is discussed in Attachment C.

As discussed in the Stage I RFI Report, the risk-based screening criteria used for identifying a potentially significant release at the Facility are based on a target cancer risk of 10^{-5} and a target noncancer hazard quotient (HQ) of 1 for individual chemicals. The target cancer risk of 10^{-5} for a single chemical is selected to develop screening criteria to ensure that cumulative cancer risk from exposure to multiple human carcinogens at a particular site would not exceed the acceptable cumulative risk of 10^{-4} (61 FR 19432, May 1, 1996; US EPA, 1996; US EPA, 1991). This means that as many as 10 human carcinogens can be present in an area at concentrations equal to these screening criteria without exceeding the cumulative risk goal of 10^{-4}. Consistency between using a cumulative cancer risk limit of 10^{-4} for this RFI and IDEM's Risk Integrated System of Closure (RISC) is discussed in Section 5.6.1. A potentially significant release is identified at an area when the highest site-related concentrations of the constituents detected in soil at the area are higher than the aforementioned screening criteria.

Background concentrations of metals in soil are determined as discussed in Section 3.7. Concentrations higher than the background levels are conservatively considered to be site-related, and are used in the comparison with the soil screening criteria. As a conservative assumption, all concentrations of organic constituents are assumed to be site-related. It should be noted that site-related concentrations in soil that are higher than these screening criteria do not necessarily pose an unacceptable risk; it only means that the potential for the concentrations to pose an unacceptable risk should be further evaluated in the risk assessment considering additional site-specific factors.

Groundwater – In a manner similar to that discussed above for screening soil characterization data, the groundwater monitoring data are screened against conservative screening criteria to identify whether a potentially significant release from an area to groundwater has occurred. Most of the groundwater monitoring data were collected from areas that are restricted to industrial or commercial land use, and they are compared with screening criteria based on state and federal maximum contaminant levels (MCLs) established under the Safe Drinking Water Act and equivalent drinking water limits for constituents without MCLs, industrial groundwater volatilization to indoor air criteria, and groundwater contact criteria. The equivalent drinking water limits are generic risk-based drinking water concentrations calculated using conservative standard default exposure factors for estimating high-end exposures through daily drinking water consumption. It should be noted that MCLs and equivalent drinking water limits are designed to be protective of potential exposures through drinking water use and represent highly conservative screening criteria for evaluating groundwater that is not intended for potable use. The risk-based volatilization to indoor air criteria are calculated using generic industrial building parameters and site-specific soil properties and groundwater depth. The groundwater contact criteria are risk-based criteria calculated using exposure factors for estimating exposure of workers who could contact shallow groundwater during subsurface construction activities. Groundwater data collected from areas that are not intended for industrial/commercial use (i.e., AOI 1 and certain areas downgradient of Area 1) are compared with the same drinking water and groundwater contact criteria discussed above, as well as residential groundwater volatilization to indoor air criteria and non-potable groundwater use criteria based on a "kiddie" pool exposure scenario that represents a reasonable worst case among typical non-potable uses. All risk-based groundwater screening criteria are based on a target cancer risk of 10^{-5} and noncancer HQ of 1.

A potentially significant release to groundwater is identified when the highest concentrations of constituents detected in a groundwater monitoring well are higher than any of these screening criteria. The presence of groundwater with constituent concentrations higher than these screening criteria does not mean that the groundwater necessarily poses an unacceptable risk; it only means that the potential for the groundwater to pose an unacceptable risk should be further evaluated considering additional site-specific factors.

Borehole water samples were collected during the RFI at some areas to assist in the assessment of the potential for constituents in soil near the water table to affect groundwater quality and in the identification of appropriate locations for placement of groundwater monitoring wells. Although the procedures for collecting borehole water samples were intended to minimize the potential for introducing contaminants (including soil particles) into the sample by the sampling procedure itself, such influence could not be entirely eliminated due to the nature of the sample collection method.

Surface Water – Generic risk-based screening criteria for evaluating the significance of potential exposure to surface water are not well established. Therefore, as a conservative approach, the surface water characterization data collected during the RFI and previous relevant investigations are compared with the generic risk-based screening criteria described above for groundwater. In addition, surface water data are compared with the IDEM Water Quality Standards (IWPCB, 1987) and US EPA Region 5 Ecological Screening Levels (ESLs) for surface water (US EPA 2003d), which are conservative standards or screening values intended to be protective of human and ecological uses of surface water.

Potable Well Water – Potable well water data collected during Stage II of the RFI are compared with state and federal MCLs and equivalent water limits for constituents without MCLs.

4.1 AOC 2 – Former Fire Training Area

The Former Fire Training Area (FFTA) is located south of the former Plant 9 building between the fire protection system water tank and the south property boundary (Figure 2.2). The area was utilized from approximately 1984 to 1989 for fire protection training. Various combustible materials were placed on the pad and burned as part of fire training exercises conducted by the plant fire brigade in conjunction with the Anderson Fire Department. These materials included, at various times, drums of paint sludge, solvents, automotive components, Styrofoam, plastic, diesel fuel, paints, and auto bodies. Use of the area was discontinued about 1989 and surficial gravel was removed from the area and disposed of. The area was subsequently covered with clean soil and seeded to grass. Currently, there is no physical expression of AOC 2 that allows ready identification of its former location.

AOC 2 consisted of a gravel pad approximately 50 feet square. The approximate boundaries of the unit were established from interviews of knowledgeable GM employees and from examination of historic aerial photographs. Both sources suggest that the FFTA was located slightly east of a north-south line through the center of the Plant 9 fire water holding tank, and approximately midway between the tanks and the south property fence.

4.1.1 Scope and Results

A sampling grid measuring 50 x 50 feet, consisting of 36 grid intersections was employed overlying the FFTA. Pursuant to Section 5.1.2.4 of the Work Plan, four nodes were selected at random for sampling, and in October 2000 four soil borings (SB 140 – SB 143) were made (Figure 4.1). At each location, samples were collected at two (2) depth intervals as described in the Work Plan. Initially, exploratory probes were advanced to obtain soil samples for visual examination of the soil. Samples were collected continuously from the ground surface to the base of each boring. Samples were selected from the 0.5-1.0 and 3.5-4.0 foot intervals for laboratory analysis. Additional soil samples were collected at 2.0 and 3.0 foot depth at one soil boring (SB 143) according to the October 13, 2000 notification to IDEM (see Section 2.3). Samples from the FFTA were submitted for analysis of the target metals, VOCs, and SVOCs.

Lithologic units encountered in the soil borings included a sandy clay loam or very thin gravelly zone (crushed stone) at the surface overlying a lower clay loam unit.

Analytical results for target metals, VOCs, and SVOCs at AOC 2 are presented in Table A-1.

4.1.2 Discussion of Results

The maximum detection of target parameters is presented in Table 4.1a. Target parameters detected in AOC 2 soil include SVOCs (bis(2-ethylhexl)phthalate and phenol) and metals (arsenic, barium, cadmium, total chromium, copper lead nickel lead selenium and zinc). Industrial PRGs were exceeded only for arsenic in one soil sample from SB 140 and one sample from SB 143. In both cases, deeper soil samples show that the arsenic was delineated to the screening criteria.

4.1.3 Conclusions

The exceedance of arsenic in soil indicates that a potential significant release of constituents has occurred at the FFTA. The significance of the arsenic exceedance is discussed further in Section 5 of this report.

4.2 AOC 3 – East Chromium Area

AOC 3 is located east of MLK Boulevard at the former WWTP on property owned by GM (Figure 2.2). This area was the site of a possible release of chromium-bearing wastewater from a ruptured process line that occurred in June 1994. AOC 3 is immediately north of the former aeration basins. The aeration basins were constructed in several feet of fill material placed above the former land surface. The former WWTP was demolished in October 2002. The demolition involved removal of all above grade structures and demolition and filling of the former clarifier, blender and the eight mixing tanks.

4.2.1 Scope and Results

In November 2000 four soil borings (SB-168 – SB-171) were advanced in the area of the process sewer line rupture (Figure 4.2). Soil borings were made at the three locations specified in Section 5.1.2.5 of the Work Plan, and at the request of the IDEM on-site representatives an additional soil boring (SB-170) was made north of the east-west drive leading to the Pump House to evaluate the northward extent of metal contamination in soil. All soil borings were advanced to the top of natural soil material at depths of fourteen to sixteen feet below ground surface. At each boring location samples were collected from the base of the surficial fill material, as described in Section 5.1.2.5 of the Work Plan.

Lithologic units encountered in the East Chromium Area include a 13 – 13.5 foot layer of fill, overlying a native clay loam layer.

Stage I soil data indicated that soil leaching criteria were exceeded for chromium (total) at SB 169 and for chromium (total) and nickel at SB 168. Both of these samples were obtained from the base of the fill surrounding the concrete mixing tanks. Based on these findings, additional soil and groundwater investigations at AOC 3 were conducted during Stage II pursuant to Section 5.2 of the Stage I RFI Report. These investigations included deeper soil sampling at SB-168 and SB-169 to determine if soil leaching criteria were exceeded near the top of Unit 3 and two new soil borings to evaluate a potential release from a process sewer between the Pump house and Tank 4 that may have occurred in 2000. After the collection of these soil samples, the borings were advanced a few feet into the top of the water table and ground water samples were collected. Soil and ground water samples were analyzed chromium, hexavalent chromium, nickel, copper, and VOCs. Metals in ground water were analyzed on both a total and dissolved basis.

The October 2002 WWTP demolition provided a brief opportunity to obtain soil samples from beneath the former tank areas. IDEM was notified of the anticipated sampling on October 3, 2002, and a soil sampling plan was provided. During the demolition, the concrete bottoms of each tank area were broken and the upper portion of the concrete walls was collapsed into the floor area. The demolition of the tank walls allowed entry to the tank bottom areas and direct sampling of the soil from an exposed face.

Soil sampling was scheduled according to the timing of demolition activities. Two site visits were conducted on October 7 and October 15. The October 15 sampling event was observed by IDEM staff. Soil beneath the concrete floor of each tank was exposed using a track hoe equipped with a hydraulic demolition shear. The soil in each excavation was exposed by cleaning an exposed face with hand tools. Samples were collected directly from this face. This was a change from the sampling scheme presented on October 3, 2002 but provided better control of the depth of sampling.

A sample of soil was collected from beneath ten tanks at the locations shown in Figure 4.2. Nine of these samples were "native" soil and these were collected from immediately beneath structural gravelly sand fill that formed the base of each tank floor. This fill was found to range from 0.5 to 1.4 feet in thickness. Native soil was not encountered beneath the Clarifier tank. The bottom of this tank was several feet lower than the other tanks, and the structural fill was found to extend to the water table surface. A sample of the unsaturated portion of the fill was collected from immediately above the water table surface.

Each sample was analyzed for the parameter list specified in Section 5.2 of the Stage I RFI report. These parameters were copper, nickel, and chromium, hexavalent chromium and US EPA target compound list VOCs. Soil samples for VOC analysis were collected in Encore sampling devices.

On February 10 and 11, 2004 four Stage II RFI soil borings (SB 218 to SB 221) were completed at the locations specified in Section 5.2 of the RFI Stage I Report (Figure 4.2). Soil borings SB 218 and SB 219 were completed near Stage I boring locations SB 168 and SB 169, respectively, and borings SB 220 and SB 221 were advanced between the former Pump House and Mixing Tank 4. All these soil borings were advanced a few feet into the top of the water table. Samples were collected continuously from the ground surface to the base of each boring for visual identification. A total of 23 soil samples were analyzed for TCL VOCs, metals (nickel, copper and chromium) and hexavalent chromium during the WWTP demolition and Stage II.

Borehole water samples were collected from the upper portion of Unit 3 at 20 to 24 foot depth at each boring location. A total of five samples, including one duplicate, were collected and analyzed for TCL VOCs, target metals parameters, and hexavalent chromium.

Analytical results for soil and borehole water samples are shown in Tables A-1 and A-4 respectively.

4.2.2 Discussion of Results

Target metals and VOCs detected in AOC 3 soil are shown in Table 4.1a. These detections include 2-butanone, cis-1,2-DCE, vinyl chloride, arsenic, barium, cadmium, total chromium, chromium, (trivalent and hexavalent), copper, lead, nickel, selenium, and zinc. The locations of the detections are shown on Figure 4.21. Although migration to groundwater criteria were exceeded for total chromium and nickel at Stage I soil borings SB 168 and 169, the deeper soil sampling at SB 218 and 219 at these locations indicates that the migration to groundwater criteria are not exceeded in deeper soil above Unit 3 (Figure 4.21). Similarly, hexavalent chromium and copper migration to groundwater exceedances in shallow soil samples from SB 220 and SB 221 are not present at depth. No migration to groundwater criteria are exceeded at the top of Unit 3 at any of the soil boring locations (Figure 4.21).

Target metals and VOCs detected in AOC 3 borehole water samples are shown on Figure 4.22a. Detected metals include total and dissolved chromium, total and dissolved nickel and total and dissolved copper. Several exceedances of groundwater PRG criteria are noted in the total metal fractions due to the extreme turbidity of the borehole water samples. The concentration of total copper and total nickel exceed groundwater PRG criteria in the sample collected from SB 218. Total chromium exceeds the groundwater PRG criteria at all four boring locations.

Dissolved metal concentrations are significantly lower. Only dissolved chromium exceeds groundwater criteria in the sample obtained from SB 221. No hexavalent chromium (chromium VI) was detected in this sample, or any other AOC 3 sample. This suggests that the chromium is predominately present in the trivalent (chromium III) form. Chromium III is far less toxic than chromium VI.

Vinyl chloride, trans-1,2-DCE, cis-1,2-DCE, and 1,1-DCA were the only VOCs detected in borehole water samples. No TCE was detected in any of the AOC 3 borehole water samples. The concentrations of vinyl chloride, trans-1,2-DCE and cis-1,2-DCE were above drinking water criteria at all four sample locations and the concentration of vinyl chloride exceeds the non-potable groundwater use criterion in the sample obtained from SB 220.

4.2.3 Conclusions

The RFI soil and groundwater screening data from AOC 3 do not indicate that a potential significant release of hazardous constituents has occurred at AOC 3. The RFI soil data indicate that all target compounds have been fully delineated to soil screening criteria. Therefore, no additional investigations are required.

The East Chromium Area is impacted by VOCs that are related to the general pattern of VOC contamination in Area 1 which is discussed in Section 4.7.4.

4.3 AOC 4 – Walking Track Area

The Walking Track Area is located northeast of former Plant 9 (Figure 2.2). It is situated in a level, grassed, undeveloped area. The main physical feature of the area is an oval asphalt track about 660 feet in length. The track was constructed in the mid-1980s, and was formerly utilized by Plant 9 employees for exercise during break periods.

In 1997 a verbal complaint was filed with the IDEM alleging that hazardous wastes had been buried beneath the walking track. The type of waste was not disclosed in the complaint, nor was the area of alleged disposal defined. It is not clear from the complaint when the alleged disposal occurred. GM has not been able to locate any information that would support the alleged buried hazardous waste in this area. This statement is based on a diligent search of records and an interview with the former plant superintendent and is supported by the investigation work conducted by GM in this area of the Facility.

4.3.1 Scope and Results

In October 2000, twenty soil borings (Figure 4.3, SB 120 – SB 139) were made in the Walking Track Area consistent with the Walking Track Area Work Plan Amendment (Earth Tech, October 14, 1997). These borings were uniformly spaced, alternating between the inside and outside of the track. Additionally, three borings were placed in the infield area of the track. Each boring was advanced to a depth of four feet bgs in accordance with criteria in the Work Plan Amendment. Soil samples were visually examined for classification purposes to determine if fill or waste materials were present. Each soil sample was screened with a HNu / PID. None of the screened samples produced greater than a background PID response. No fill or buried waste materials were encountered. For this condition, the Work Plan Amendment specified that one soil boring from each side to track would be selected at random, and that a sample from the 2.0 foot depth interval would be obtained for analysis. Sampled borings were SB 123, SB 126, SB 130 and SB 136. One sample from each of these borings at 1.5 to 2.0 foot depth was submitted for analysis of target metals and VOCs.

Soil samples for laboratory analysis were obtained from a second soil core taken within 2 feet of the original soil core location. These samples were obtained in clean, new, stainless steel core liners.

Lithologic units encountered in the Walking Track Area include an upper sandy loam layer above a clay-silt loam. No fill or waste materials were encountered.

Analytical results for target metals and VOCs are provided in Table A-1.

4.3.2 Discussion of Results

Low concentrations of arsenic, cadmium, total chromium, cooper, lead and nickel were detected in Walking Track samples (Table 1A). No VOCs were detected in any of the four Walking Track samples. A comparison of these data to soil screening criteria indicates that no soil screening criteria were exceeded in any of the four Walking Track Area samples (Figure 4.21), so groundwater sampling in this area is not warranted.

4.3.3 Conclusions

Based on the lack of exceedance of any screening criteria for all compounds the RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at the Walking Track Area. Therefore groundwater sampling in this area is not warranted. This area has been fully delineated and no further investigations are planned for AOC 4.

4.4 AOC 5 – West Impoundment Area

The West Impoundment Area is located west of the Main Plant building (Figure 2.2). The area is located on two separate land parcels. The north parcel is bounded by 29th Street to the north, Dewey Street to the west, and the dedicated right-of-way of Arrow Avenue to the south and southeast. This portion of the property is currently utilized as a park and picnic area. The southern part of the area is a portion of GM's larger land holdings in the NW ¼ Section 23, and is currently a secured parking lot.

Both the north and south parcels, consisting of a total of about 2.6 acres and originally platted as Lots 1 to 21 of the Belmont Addition, were transferred to GM on September 1, 1963. A right-of-way over a portion of this ground was later granted to the City of Anderson to allow for an eastward extension of 30th Street to Arrow Avenue.

Prior to purchase by General Motors in 1963, the 2.6 acre tract contained four small impoundments that were the subject of the RFI investigation. The four impoundments were noted in a 1997 US EPA aerial photo analysis (US EPA, April 1997). The impoundments are evident in vertical aerial photographs dated May 16, 1950, June 10, 1956 and May 30, 1961, as well as in several oblique aerials in GM archives from the 1951 to 1963 time frame. The impoundments do not appear on earlier June 5, 1939 photos. Linear patterns of trees evident in the 1950 photograph suggest that the area may have been utilized as an orchard. Locations of the four impoundments identified in the US EPA photo analysis are plotted in Figure 4.4. Three of the impoundments were located side-by-side, north of the 30th Street right-of-way. The fourth impoundment was located south of the 30th Street right-of way in the parking lot.

The AOC 5 area was not purchased by GM until 1963, or 13 years after the impoundments were constructed based on the air photographic record. Filling activities in the AOC 5 area are clearly visible in GM photos dated 1965.

4.4.1 Scope and Results

The scope of work at AOC 5 is described in RFI Work Plan Amendment Number 2 (Earth Tech, October 1, 1998). Pursuant to the Work Plan, four soil borings (Figure 4.4, SB 181 to SB 184) were completed in the AOC 5 area in November 2000; one boring was completed in each of the four former impoundment areas. A portion of each 12-inch interval from each soil boring was screened with a PID. Following completion of the four soil borings, the boring logs and PID screening results were reviewed. None of the samples screened produced a PID response. No obvious anthropogenic fill was encountered in this area. Soil samples collected for laboratory analysis were collected selected two feet bgs, pursuant to the Work Plan.

Soil samples for laboratory analysis were obtained from a second soil core taken within 2 feet of the original soil core location. These samples were obtained in clean, new, stainless steel core liners. Samples from the AOC 5 area were collected for analysis of target metals and VOCs.

Lithologic units encountered in the AOC 5 area include a sandy clay loam at the surface above a lower clay loam unit.

Analytical results for target metals and VOCs are provided in Table A-1.

4.4.2 Discussion of Results

Target metals detected in AOC 5 soil samples include arsenic, cadmium, total chromium, copper, lead, and nickel. No VOC were detected in AOC 5 soil. A comparison of these data to soil screening criteria indicates that no soil screening criteria were exceeded in any of the four AOC 5 samples (Figure 4.18). The area has been fully delineated and no further investigations are planned for AOC 5.

4.4.3 Conclusions

Based on the lack of exceedance of any screening criteria for all target compounds, the RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at AOC 5.

4.5 AOI 1 – North Parking Lot

AOI 1 is property that has not been utilized by GM for manufacturing activities. Two areas of the property are known to have stockpiled high sulfur coal (Figure 4.5). The southern portion of the property is currently used as a parking lot and the northern portion remains undeveloped. Storm water run-off from paved areas associated with AOI 1 is directed, in part, to a combined sewer system that discharges north to the City of Anderson POTW on the West Fork White River. Some run-off occurs to unpaved areas of the property to the north and east.

During a Phase II subsurface soil and groundwater investigation conducted by Conestoga-Rovers & Associates in June 2001, arsenic and iron were found to exceed residential soil screening criteria at BH9-01 at a depth at 2-4 feet bgs. At this location, arsenic also exceeded the industrial soil screening criterion, and the soil screening level for migration to groundwater. Groundwater samples obtained AOI 1 wells detected VOCs (cyclohexane, methylcyclohexane, SVOC (caprolactam), and metals (calcium, magnesium, manganese, sodium, and zinc). No groundwater screening criteria were exceeded in any of the four AOI 1 groundwater samples. Based on these findings further characterization of surface and subsurface soils was warranted to delineate the lateral and vertical of constituents in AOI 1 soil. No additional groundwater characterization was warranted. In addition, no Potential Areas of Concern or Potential Area of Release were identified associated with storm water run-off.

4.5.1 Scope and Results

The scope of the RFI investigations performed during the RFI at AOI 1 and the rationale for the work performed are detailed in the following work plan amendments:

- RFI Work Plan Amendment North Parking Area / Vacant Parcel (Earth Tech, January 30, 2002); and
- RFI Work Plan Amendment Soil and Groundwater Delineation (Earth Tech, November 16, 2004).

The Stage II investigations at AOI 1 involved the additional characterization of soil quality associated with the former coal pile areas, and were a follow up to the 2001 Phase II ESA sampling. The rationale for the follow up soil sampling is explained in a January 30, 2002 work plan amendment. It was noted in the work plan amendment that although historic usage of the area had been coal piles, no surface soil samples (0 to 2 feet bgs), where the highest contaminant concentrations might be expected, had been collected.

Sampling in the former coal pile area was conducted in two phases during the Stage II RFI. The locations for soil sampling are shown in Figure 4.5. On February 11 and 12, 2004, eleven soil borings (BH 1A to BH 9A, BH 11 and BH 12) were advanced at AOI 1 (Figure 4.5). Borings BH 1A through BH 9A were conducted near previous borings BH 1-01 through BH 9-01 for the purpose of collecting surface soil samples in the 0-2 foot bgs interval. All these borings are within the limits of the former coal pile areas. No follow up samples were collected at previous BH 10 location because: 1) the existing 2001 data were all below screening criteria or background, and 2) BH 10 was well outside the former coal pile areas.

In addition, a subsurface soil sample was collected from 8-10 feet bgs to characterize the vertical extent of arsenic and iron previously detected at BH 9-01 from 2-4 feet bgs. Both surface and subsurface samples were collected at borings BH 11 and BH 12 to delineate the northern periphery of potential contamination associated with the former coal piles. Samples were collected continuously from the ground surface to the bottom of each boring. The soil core was examined visually for soil classification. Soil sampling intervals with the highest PID response, staining, or other evidence of contamination were submitted for analysis. All soil samples were analyzed for TCL VOCs, TCL SVOCs, PCBs and target metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc).

Based on the February 2004 investigation results, additional sampling was required to further delineate arsenic concentrations in surface soil beyond the west and east limits of the former north coal pile area and to establish concentrations of SVOCs and metals in surface soil at former boring locations BH 4A, BH 6A and BH 9A. Boring locations BH 13, BH 14 and BH 15 were utilized to delineate the west and east limits of arsenic in the former north coal pile area (Figure 4.5). A total of seven soil samples, including one duplicate, were obtained from a sample interval of 0 to 2 feet at AOI 1 in December 2004. These samples were submitted for a select set of analyses including SVOCs, target metal parameters, or arsenic.

AOI 1 monitoring wells MW1-01, MW2-01 and MW3-01 installed by Conestoga-Rovers & Associates during the June 2001 Phase II Environmental Site Investigations were sampled on June 26, 2001. These samples were analyzed for TCL VOCs, TCL SVOCs, PCBs and dissolved metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc).

Soil analytical results for AOI 1 samples are presented in Table A-1. Groundwater analytical results for AOI 1 samples are presented in Table A-4.

4.5.2 Discussion of Results

Target VOC, SVOC and metal parameters detected in AOI 1 soils are presented in Table 4.1b. VOCs detected include acetone, toluene, 1,1,1-trichloroethene and TCE. SVOCs detected include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoroanthene, bis(2-ethylhexl)phthalate, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and methylphenol. Arsenic, barium, beryllium, cadmium, and chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver vanadium and zinc were also detected. No PCBs were detected in AOI 1 soil samples.

Residential PRGs were exceeded for benzo(a)pyrene in one sample from BH 3A and arsenic in two samples from BH 9A. The deeper soil sample at each of these locations was below soil screening criteria for benzo(a)pyrene and arsenic. Arsenic also exceeded residential PRGs in eight samples from four borings (Figure 4.18; BH 4A, BH 6A, BH 8A, and BH 9A). Deeper soil samples at each of these locations except BH 4A were below the soil screening criteria for arsenic. Although arsenic has not been delineated to soil screening criteria vertically at BH 4A, samples obtained from borings surrounding BH 4A demonstrate that arsenic has been delineated horizontally. Iron exceeded residential PRGs in six samples obtained from three borings (BH 4A, BH 6A, and BH 9A). It should be noted that these iron concentrations are within typical background levels in Eastern United States soil (Dragun and Chiasson, 1991), although no Facility-specific background data for iron are available.

Table 4.1b indicates that arsenic and cadmium exceeded the migration to groundwater criteria. These exceedances are in shallow samples at borings that have deeper soil samples delineated to soil screening criteria for arsenic and/or cadmium (Figure 4.18; BH 4A, BH 6A, and BH 9A). Iron was the only constituent to exceed the migration to groundwater criterion in the deepest samples obtained from ten borings (BH 2A to BH 7A, BH 9A, BH 11, and BH 12).

Target compounds detected in AOI 1 groundwater are presented in Table 4.2b. These detections include VOCs (cyclohexane and methylcyclohexane), one SVOC (caprolactam), and metals (calcium, magnesium, manganese sodium and zinc). The locations of these detections are shown in Figure 4.23. No groundwater screening criteria were exceeded in any of the four AOI 1 groundwater samples.

4.5.3 Conclusions

The RFI soil data from AOI 1 indicate that a potential significant release of hazardous constituents has occurred at AOI 1. The concentrations of benzo(a)pyrene, arsenic, and iron were above soil screening criteria. These exceedances are further considered in the human health risk assessment (Section 5).

Based on the lack of exceedance of any screening criteria for all compounds the RFI groundwater data indicate that no potentially significant release of hazardous constituents to groundwater has occurred at AOI 1.

4.6 AOI 3 – Bay R4 Area

On October 10, 2002 General Motors was notified that a floor sump had been discovered in the Main Plant building of the MLK Boulevard Facility during construction activity being undertaken by tenant Guide Corporation. The sump was located in Bay R4 in the north portion of the plant (Figures 2.2 and 4.6). Bay R4 is an area of the Facility that has been remodeled to accommodate the installation of new four color plastic molding machines. The sump was discovered during excavation of the concrete floor for the installation of the foundation for one of the molding machines.

GM inspected the site with Guide personnel on October 10. The sump had been removed and was observed to be about two feet square and four feet deep. The sump was of metal construction and was observed to have been filled with pea gravel. The pea gravel within the sump had an odor like old gasoline. Observations of the floor area suggested that the sump had been installed after the original floor area was poured. Discolored soil was observed around the sump location.

Due to the need to maintain a tight construction schedule, Guide removed the sump and all discolored concrete and soil. These materials were placed in five lined metal tubs for characterization and appropriate disposal. All visibly discolored soil was removed. A 7-foot long pipe entering the sump from the north was also removed. After removal of contaminated soil, construction continued by backfilling the former sump area and pouring of the new concrete floor and machine foundation.

Samples were taken from each of the five tubs of excavated material on October 10 and submitted for analysis of Toxicity Characteristic Leaching Procedure (TCLP) metals, TCLP VOCs, total cyanide and hexavalent chromium. Cadmium and hexavalent chromium were detected in all tubs and cyanide was detected in two of the five samples. GMs information indicates that 5.43 tons of impacted soil from the excavation was manifested as hazardous waste and shipped off site to Heritage Environmental Services LLC for appropriate disposal. No subsurface investigation was conducted at AOI 3 at the time of the excavation.

4.6.1 Scope and Results

Additional soil samples were collected from two hand auger borings in the area of the R4 sump on October 29, 2002. Due to the presence of the new concrete floor and machine foundation it was not possible to sample from the immediate sump area. Two hand auger soil borings were made in areas where the concrete floor had been saw cut in order to allow new footers for the plastic machines to be poured (Figure 4.6, HA-1 and HA-2). HA-1 and HA-2 were located approximately 13 and 30 feet respectively from the former sump. According to the construction foreman, each area had been excavated to a depth of 28 inches to form and pour the footers.

At each location, the hand auger was advanced to a depth of 30 inches below the top of the concrete floor and a soil core was driven from 30 to 36 inches. The material in each soil boring at that depth was a brown moist, gravelly sand structural fill. A contact with the overlying 28 inches of new construction fill was clearly evident in each boring. Each hand auger boring was advanced to obtain a second sample at 48 inch depth. However, at each soil boring location a buried blacktop pavement surface was encountered at a depth of 45 to 46 inches. The blacktop material and underlying gravel subbase was penetrated to a depth of 56 inches, but no additional core samples could be obtained. No groundwater was encountered in either hand auger boring. The samples from 36 inch depth in each hand auger boring were submitted for analysis of nickel, copper, chromium, hexavalent chromium, lead, cadmium, and cyanide. These inorganic parameters are most likely to be associated with a release from a plating sump. With the exception of cadmium, the parameter list was the same as utilized for other plater areas, as specified in IDEM-approved August 16, 2002 Work Plan Amendment for Metal Plating and Recovery Areas. Cadmium was added to the Bay R4 parameter list because the Bay R4 sump is believed to have serviced a small cadmium plater and because cadmium had been detected in the impacted drummed soil.

Analytical results of the target metals are provided in Table A-1.

4.6.2 Discussion of Results

Target analytes detected in soil at AOI 3 include cadmium, trivalent chromium, copper, lead, and nickel (Table 4.1a). The location of these detections is shown on Figure 4.19. A comparison of these data to soil screening criteria indicates that no soil screening criteria were exceeded in any of the two AOI 3 samples.

4.6.3 Conclusions

Based on the lack of exceedance of any screening criteria for all compounds, the RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at AOI 3.

4.7 Area 1 – South Court and Related Areas

4.7.1 Area 1, AOC 1 - South Court Area

AOC 1 is the general South Court Area of the Facility, and incorporates SWMU 16 - Former Used Oil Area. The area is located immediately southwest of the General Stores Receiving Area of the Main Plant Building. The area was purchased by GM in the early 1960s and at that time was a low marshy areas bounded by railroad embankments to the northwest and southeast. The area was filled for plant expansion beginning shortly after purchase and through the mid 1960s. Various types of soil, cinders, and construction debris comprise the bulk of the fill material. The area was paved in the late 1970s and is currently used for various types of material storage.

The incorporated SWMU 16 - Used Oil Area formerly managed used hydraulic oil from the Main Plant Building. The used oil handling Facility was originally installed in 1975 and consisted of an underground waste oil tank and oil water separator. The area was modified and improved 1992 and 1993. Stage I RFI investigation results documented exceedances of direct exposure soil screening criteria for cis-1,2-DCE and TCE at SB 163, PCBs at SB 156 and SB 163, cyanide at SB 175 (based on 2000 Industrial PRGs) and some PAH compounds at SB 155. SB 155 is the only soil boring location sampled during this investigation where significant SVOC contamination was evident and there was no significant VOC contamination. Exceedances of soil leaching criteria for deep soil were noted for VOCs at most soil borings. In no case was significant cadmium, chromium or lead contamination encountered in deep soil without coexistent significant VOC contamination.

The TCE concentration in the soil sample collected from the 3.5-4 foot depth interval at borehole SB 163, located in the South Court Area, contributes the majority of the risk from soil in this area. It was determined that excavation of soil at this location was an appropriate action to reduced the risk associated with exposure to soil in the South Court Area to acceptable levels. However, the TCE concentration at SB 163 was not well delineated laterally and addressing the soil to the closest soil sample locations in each direction would have resulted in a large volume of soil.

Based on these findings additional sampling was required to evaluate the extent of soil contamination in the South Court Area near Stage I boring locations SB 155 and SB 163.

4.7.1.1 Scope and Results

The scope of the Stage II RFI investigations performed during the RFI at AOC 1 - South Court Area and the rationale for the work performed are detailed Section 5.3 of the Stage I report and the November 2004 Work Plan Amendment Soil and Groundwater Delineation.

On February 19-20, 2004 four soil borings (SB 247 to SB 250) were advance northeast, northwest, southwest and southeast of Stage I boring locations SB 155 to delineate the extent of PAH contamination (Figure 4.7). Surface and two subsurface soil samples were collected from each boring. Borings were continuously samples from ground surface to the water table (14.2 to 17.7 feet). A total of 16 samples, including two duplicates, were submitted for VOC and SVOC analysis.

On December 16, 2004 twelve soil borings (SB 274 to SB 285) were advanced in a radial pattern centered on SB-163 at distances of about 10, 25, and 50 feet in four directions to delineate the extent of direct contact and volatilization to indoor air exceedances for TCE in soil (Figure 4.8). The borings were continuously sampled from ground surface to a depth of 10 feet. At each borehole location, soil samples were collected from the 0-2 foot depth interval and the 2-foot interval with the highest PID reading between 2 and 10 feet bgs. In addition, a surface soil sample was also collected at SB 163. A total of 28 samples, including three duplicates, were submitted to the laboratory for TCL VOC analysis.

Soil analytical results for Area 1 samples are presented in Table A-1.

4.7.1.2 Discussion of Results

Target compounds detected in AOC 1 soil are presented in Table 4.1a. The location of these detections is shown on Figure 4.19. These detections include selected VOCs, SVOCs, metals and total PCBs.

Industrial PRGs were exceeded in at least one sample from boring SB 155 for benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h,)anthracene, and indeno(1,2,3-cd)pyrene, in the deepest sample from borings and SB 156 and SB 163 for total PCBs, in at least one sample from borings SB 163 and SB 276 for TCE, cis-1,2-DCE, and/or vinyl chloride, and in two samples from SB 156 for arsenic. In most cases deeper samples are below Industrial PRGs for all target parameters except cis-1,2-DCE and vinyl chloride at SB 276 and total PCBs at SB 163 and SB 156.

Industrial soil vapor intrusion criteria were exceeded in four samples from SB 163 and one sample from SB 276 for at least one VOC (cis-1,2-DCE or TCE). However, soil screening criteria were met in Area 1 near SB 163 following the completion of corrective interim measures for Area 1 – South Court (Figure 4.19).

PCB concentrations in the soil samples collected from shallower depth intervals are all below the industrial PRG for soil contact, so no additional sampling was necessary according to the approved RFI Work Plan (also the Flowchart for RFI Screening Risk Evaluation subsequently submitted to IDEM on June 5, 1998). The deepest sampling results at SB 156 and SB 163 are below the perched groundwater level in Unit 1. Consequently, delineation for PCBs during the Stage II RFI involved groundwater sampling. PCBs were analyzed in all monitoring wells installed on CSXT property (see Section 4.7.4.3.1). No PCBs were detected in any of the downgadient Unit 3 wells.

The deepest samples exceeded the migration to groundwater criteria for at least one or more VOCs (cis-1,2-DCE, TCE, and/or vinyl chloride) were obtained from borings SB 274, SB 275, SB 276, SB277, SB 278, SB 279, SB 281, SB 282 and SB 285. These data delineate the source area for the Area 1 VOC plume.

4.7.1.3 Conclusions

Extensive RFI soil characterization at AOC 1 indicate that TCE, cis-1,2-DCE, and/or vinyl chloride is present in soil at concentrations higher than screening criteria in an area east and south of SWMU 16. Based on the exceedance of soil screening criteria for selected VOCs, PAHs, total PCBs, and arsenic, the RFI soil data indicate that a potential significant release of hazardous constituents has occurred in Area 1. To reduce the risk associated with AOC 1 soil, corrective interim measures as discussed in Section 2.6.1 have been conducted near SB 163.

4.7.2 Area 1, SWMU 17 – Conrail Ditch

SWMU 17 – Conrail Ditch is located southeast of the Main Plant Building and former West Hazardous Materials Storage Building (Figure 4.9). The area is located immediately adjacent to the Facility property line and borders the South Anderson Cutoff railroad track (formerly Conrail, now CSXT). The area was identified in the RFA as a former storage area for roll-off boxes containing paint sludge and trash. The area is paved with asphalt, and bounded on the south by a chain-link fence on the Facility property line.

The Conrail Ditch Area was investigated by the Indiana State Board of Health (ISBH) on March 19, 1985 in response to a complaint of a release of wastes from this area. The ISBH inspection found an "inconsequential" waste stream leaking from a paint hopper into the ditch, and that surface water from the storage area also would drain to the ditch.

The RFA indicates that wastes managed at this area included plating sludge. To the best of GM's knowledge, storage containers formerly used at SWMU 17 handled non-hazardous paint sludge and trash, but not plating sludge. But, as a conservative measure, metals constituents identified in analyses of plating sludge at the WWTP were incorporated into the RFI target parameter list for SWMU 17.

Prior to the RFI, soil samples were collected from immediately beneath the pavement and gravel fill material at three locations at SWMU 17 in January 1993. Trace levels of acetone (probably a laboratory artifact) were found at all three locations, and nickel occurred at a level of 40 mg/Kg at one of the locations.

4.7.2.1 Scope and Results

Three soil borings (Figure 4.9, SB 165 to SB 167) were completed at SWMU 17 in November 2000. These borings were all completed to a depth of 4.0 feet in the area of previous 1993 soil borings. Samples from each boring were obtained from two depth intervals (0-0.5 and 1.5-2.0 feet) below the pavement and aggregate fill material pursuant to the RFI Work Plan. These samples were submitted for analysis of target metal parameters, VOCs, SVOCs and cyanide.

Lithologic units encountered in the SWMU 17 area include an asphalt and gravel fill overlying a mixed sandy clay loam, or clay loam fill (Unit 1).

Analytical results for target metals and VOCs are provided in Table A-1.

4.7.2.2 Discussion of Results

Arsenic, cadmium, chromium (total), copper, lead, and nickel were the only target compounds detected at SWMU 17. A comparison of these data to soil screening criteria indicates that no soil screening criteria were exceeded at any of the three soil borings at SWMU 17 (Figure 4.19).

4.7.2.3 Conclusions

Based on the lack of exceedance of any screening criteria for all compounds the RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at SWMU 17. Therefore, no additional investigation work is recommended for this SWMU.

4.7.3 Area 1 – West Chromium Area

The West Chromium Area is located at the north end of the South Court in the drive between the Main Plant loading docks and the former West Hazardous Waste Storage Building (Figure 4.10). The area was the site of a process sewer line rupture and chromium wastewater spill in August 1994.

4.7.3.1 Scope and Results

The approved RFI Work Plan stipulated that three soil borings would be made along the length of the utility trench containing the failed process sewer line. In addition, shallow Unit 3 monitoring wells were to be installed in two of these borings. The purpose of the soil sampling and was to address the effects of the chromium wastewater release on the uppermost sand and gravel aquifer (Unit 3) and to provide additional characterization for VOCs present in AOC 1 – South Court Area.

Soil borings and monitoring well installation was completed during Stage I activities in October 2001 Three soil borings (SB 101 to SB 103) were completed. Two of the soil borings were utilized to install monitoring wells. MW 18 was installed at the SB 102 location and MW 19 was installed at the SB 103 location (Figure 4.10). The West Chromium Area was partially repaved between 1994 and 2001, and field notes from previous 1994 investigations were utilized to select soil boring and monitoring well locations stipulated in the Work Plan. The proposed locations for all samples were provided to the IDEM in the 1998 Soil Gas Data Report (Earth Tech, January 26, 1998).

The Work Plan stated that samples from each boring were to be collected at depths corresponding to one-half trench depth (anticipated depth of 2.0 to 2.5 feet) and full trench depth (4.5 to 5.0 feet). Additional soil samples from these borings were collected at depths of 7.5 and 10.0 feet to further delineate the extent of any residual metal contamination in the soil. All samples were analyzed for the target metal parameter list.

Soil borings at MW 18 and MW 19 were completed to depths of 25.0 feet, and monitoring wells at both locations were completed in the upper portion of Unit 3. Both wells were sampled for VOCs and SVOCs, target metal parameters (total), and cyanide (total and amenable) during the first groundwater sampling round in October 2000. MW 19 was also analyzed for dissolved metals in October 2000. Both wells were sampled during the second groundwater sampling round in April 2001 for the target metal parameters (total), VOCs and cyanide (total and amenable). Well MW 18 and 19 were again sampled for VOC's in January or February 2005.

During Stage II of the RFI several downgradient wells along MLK Boulevard and within and adjacent to the Main Plant building were samples for chromium (total and dissolved) and chromium VI. These wells included MW 39, 40, 41, 42, 43, 44, 50, 51, 60, 78 and 79. Sampling of these wells occurred during the period March 2004 to January 2005.

Lithologic units encountered at the West Chromium Area include several feet of surficial soil fill (Unit 1) overlying silty or sandy clay loam material (Unit 2) to a depth of 16 to 20 feet. The Unit 3S potentiometric surface occurs at a depth of about 16 feet.

Analytical results for soil are provided in Table A-1. Groundwater results are provided in Table A-4.

4.7.3.2 Discussion of Results

The target metal parameters arsenic, cadmium, chromium, copper lead and nickel were detected in several soil samples at SB 101, 102 and 103. However, no soil screening criteria were exceeded in any of the samples.

Groundwater monitoring wells MW 18 and MW 19 showed exceedances of groundwater screening criteria for several VOCs including 1,1,1-trichloroethane, TCE, 1,1-dichloroethylene, cis-1,2-DCE, trans-1,2-dichloroethene and vinyl chloride (Figure 4.23). The TCE concentrations in these two wells are among the highest of any Unit 3S wells in the Area 1 – South Court area (Figure 3.12).

Chromium was not detected in either of these two wells, suggesting that the wastewater release associated with the 1994 sewer line rupture did not significantly impact groundwater. Total chromium above the groundwater screening criteria was detected in the lower part of Unit 3S at adjacent monitoring well MW 16 in January 2001, but the dissolved chromium, determined during the second sampling round in April 2001 was not detected (Figure 4.23). The MW 16/17 Unit 3S well cluster is located in a general downgradient direction from the West Chromium Area (Figure 3.12), however only low levels of TCE occur in either the top or bottom of Unit 3S at this location. The fact that dissolved chromium was not detected during the second sampling round suggests the chromium may in fact be related to turbidity of the groundwater samples. Conversely, the lack of chromium in the two West Chromium Area wells suggests that the VOC groundwater contamination at the West Chromium Area is related to the general pattern of VOC groundwater contamination in the Area 1 – South Court Area, and not to a specific release from this unit.

During the Stage II groundwater sampling in March 2004 to January 2005, groundwater screening criteria for target metal parameters were not exceeded in any sample from any of the sampled downgradient wells (Figure 4.23, MW 39, 40, 41, 42, 43, 44, 50, 51, 60, 78 and 79).

4.7.3.3 Conclusions

Based on the lack of exceedance of any soil screening criteria for any target metal compounds, the RFI data indicate that no significant release of hazardous constituents occurred at the West Chromium Area as a result of the 1994 process line rupture and chromium spill. Moreover, groundwater in the immediate vicinity of the spill site is not significantly impacted by target metal parameters, nor are any of the downgradient wells sampled during Stage II.

The West Chromium Area is impacted by VOCs that are related to the general pattern of VOC contamination in Area 1 – South Court and Related Areas. These impacts are further evaluated in Section 5 of this report.

4.7.4 Groundwater

Stage I groundwater investigations in Area 1 documented exceedances of groundwater screening criteria for all shallow Unit 1 wells, and most Unit 3 monitoring wells. Most of the Unit 3 exceedances are related to VOCs. The downgradient extent of VOC contamination to the northeast in Unit 3 was not determined. The extent of VOC contamination to the north, potentially resulting from the pumping of previous high-capacity groundwater withdrawals, was determined in the lower part of Unit 3.

Additional sampling and analysis was required for groundwater associated with the Area 1 – South Court and Related Areas to establish the extent of groundwater contamination. Initial Stage II RFI groundwater investigations included:

- *HydroPunch* survey and monitoring well installation southeast of the South Court;
- *HydroPunch* survey and monitoring well installation along MLK Boulevard; and
- Installation of Unit 3 monitoring wells northwest of the South Court.

Based on initial Stage II groundwater results, it was determined that the extent of the VOC contamination was not fully delineated to the north, east near Plant 9, and south of Plant 9.

Investigations implemented to further delineate the lateral and vertical extent of the VOC contamination included:

- Groundwater screening and well installation Meadowbrook Golf Course;
- Installation of Unit 3 Monitoring wells and bedrock wells; and
- Water supply well sampling.

4.7.4.1 Scope

4.7.4.1.1 Hydropunch Survey and Monitoring Well Installation Southeast of the South Court

The property southeast of the South Court Area is owned CSXT. Permission for access was requested on January 4, 2002 to conduct environmental investigation work within the CSXT right-of-way southeast of the railroad tracks. A Right-of-Entry Agreement (No. NYC-043172) was made effective on April 26, 2002. All work was conducted in accordance with the agreement.

A total seven soil borings (SB 201 to SB 207) were advanced along the CSXT right-of-way for the purpose of further characterizing the nature and extent of groundwater contamination southeast of the South Court Area on November 3-13, 2003. The borings were advanced at the locations shown on Figure 2.2. Borehole water samples were collected from each boring using a *HydroPunch II*® sampler as previously described in Section 3.4.

Based on the hydropunch screening results, six Unit 3 monitoring wells were installed at the locations shown on Figure 2.2. Two Unit 3 well clusters MW 45 / 46 and MW 48 / 49 were installed at boring locations SB 204 and SB 205 respectively. Wells screen the upper and lower parts of Unit 3. In most cases, the bottom of the upper Unit 3 well screen was set penetrating the upper foot, of diamict that in places separate the upper and lower parts of Unit 3, and the lower Unit 3 well screen was set in the upper foot of diamict underlying the base of Unit 3. A single well was installed at boring locations SB 201 (MW 38) and SB 207 (MW 47). MW 38 was screened in the lower portion of Unit 3 and MW 47 was screened in the upper portion of Unit 3 as previously described.

On further evaluation, it was determined that MW 38 was screened across the Unit 3 confining bed as shown on geologic cross section B-B' (Figure 3.2). As constructed, the well screen interval provided a potential pathway for the downward migration of contaminants to Unit 3D. With IDEM approval, MW 38 was properly abandoned in February 2005 following the second round of CSXT well sampling. No VOCs were detected in either round of RFI sampling (March 2004 and January 2005) at this well, and based upon these data GM has no plans to put replacement wells at this location.

4.7.4.1.2 Hydropunch Survey and Monitoring Well Installation Along MLK Boulevard

On November 14-20, 2003, a total of five soil borings (SB 208 to SB 212) were installed along MLK Blvd. for the purpose of further characterizing the nature and extent of groundwater contamination northeast of the South Court Area. The borings were advance at the locations shown on Figure 2.2. Hydropunch samples were collected from each boring as previously described in Section 3.4.

Based on the hydropunch results, three Unit 3 well clusters were installed along MLK Blvd. Well cluster MW 39 / 40 was installed near the south property boundary. Subsequent well clusters MW 41 / 42 and MW 43 / 44 were installed at boring locations SB 210 and SB 211 respectively. Wells screen the upper and lower parts of Unit 3. The bottom of the upper Unit 3 well screen was set penetrating the upper foot of diamict that in places separate the upper and lower parts of Unit 3, and the lower Unit 3 well screen was set in the upper foot feet diamict underlying the base of Unit 3.

4.7.4.1.3 Installation of Unit 3 Monitoring Wells Northwest of Area 1 – South Court and Related Areas

On December 4-17, 2003, four monitoring wells MW 52 to MW 55 were installed northwest of the South Court Area to assess the effects of previous pumping WH-11 and WH-12 on VOC contaminant migration through the Unit 3 sand aquifer (Figure 2.2). MW 52 was placed in the lower part of Unit 3 at well cluster location MW 11 / 12. The well screen was set at the bottom of Unit 3 at the bedrock surface.

A second deep Unit 3 monitoring well MW 53 was installed between pumping well WH-12 and existing monitoring well cluster MW 24 / 25. The well screen was set at the bottom of Unit 3 just below the bedrock surface at 133 feet bgs. The deep well was used to determine if VOC contamination migrated past the WH-12 production well.

A Unit 3 well cluster MW 54 / 55 was installed at boring SB 216 near the northeast corner of the retention pond. Wells screen the upper and lower parts of Unit 3. The less permeable diamict layer is absent at this location. Deep well MW 54 was set at 70 feet where refusal was encountered. An attempt was made to drill beyond 70 feet using a tricone bit. It could not be ascertained from the drill cuttings if bedrock was encountered. Shallow well MW 55 was screened in the upper 10 feet of Unit 3.

4.7.4.1.4 Groundwater Screening and Well Installation Meadowbrook Golf Course

During separate investigations conducted by HydroTech Environmental Consulting and Engineering (HydroTech) in 2003 and 2004, borehole water and groundwater samples were obtained at several locations on the Meadowbrook Golf Course property located at 3429 South Madison Avenue. This property is located directly south of the former Plant 9 property. The golf course monitoring well network, as shown on Figure 2.2 installed by HydroTech is comprised of seven wells MW-1 to MW-7. (Note: the designation of wells installed by HydroTech on the Meadowbrook Golf Course utilizes a "-" to distinguish them from wells MW 1 to MW 7 installed by GM on the MLK property). Borehole water samples collected by HydroTech from two sample locations (Figure 4.22a, B-10 and B-11) along the north property boundary detected concentrations of vinyl chloride, cis-1,2-DCE and trans-1,2-dichloroethene (trans-1,2-DCE) that exceeded drinking water criteria. There is no apparent onsite source for the VOCs detected in groundwater on the northwest portion of the golf course property.

The scope of the Stage II RFI investigations performed on Meadowbrook Golf Course property and the rationale for the work performed are detailed in the RFI Work Plan Amendment Additional Stage II Work (Earth Tech, August 5, 2004). Stage II investigations conducted at the golf course were designed to fully delineate the southern extent of the VOC plume within Unit 3 south of golf course monitoring well MW-4. Borehole water (groundwater screening), groundwater, surface water and potable water samples were collected at locations shown on Figure 2.2.

Borehole Water Samples

Borehole water samples for groundwater screening were collected from borings locations SB 251 to SB 255 and SB 258 to SB 260. Sample locations are shown on Figure 2.2. Borehole water samples were collected from all borings except SB 261. No borehole water samples were collected from boring SB 261 because no VOCs were detected in the northernmost borings.

Groundwater Samples

Based on the borehole water results, three Unit 3 monitoring wells (MW56 to MW 58) and one bedrock monitoring well (MW 77) were installed at the locations shown in Figure 2.2. A total of six groundwater samples were obtained during the Stage II wells investigation. Groundwater samples collected from wells MW-4, MW 56, MW 57, MW 58 and MW 77 were submitted to the laboratory and analyzed for TCL VOCs. The sample obtained from MW-2 was analyzed for total and dissolved lead for the purpose of reevaluating previous lead concentrations detected during HydroTech sampling. In addition to VOCs, the groundwater obtained from MW-4 was also analyzed for natural attenuation parameters.

Surface Water Samples

Surface water sampling conducted during the Stage II RFI is discussed in Section 4.7.5.

Potable Water Samples

The golf course water supply well sampling conducted during the Stage II RFI is discussed in Section 4.7.4.1.6.

4.7.4.1.5 Installation of Unit 3 Monitoring Wells and Bedrock Wells

Stage II borehole water and groundwater sampling using *Hydropunch* and conventional monitoring wells detected the presence of VOC plumes containing TCE, cis-1,2-DCE, and vinyl chloride in the Unit 3 aquifer in the South Court area of the Facility and along MLK Boulevard east of the Main Plant Building. Unit 3 is a shallow sand aquifer that is, in places, separated into shallow (3S) and deep (3D) subunits by intervening clayey diamict units. In some locations the clay is not present but the unit is thick enough that Unit 3S and 3D wells are installed to give complete vertical coverage of the aquifer. The hydrogeologic interpretation of Unit 3 evolved during the Stage II investigations. Unit 3S designates the sand and gravel aquifer above the lowest diamict. Unit 3D designates that part of Unit 3 below the lowest diamict. In the vicinity of the former WWTP (Figure 2.2, MW 39, 40, 41, 42 and SB 212) no diamict units are observed in Unit 3, and the designations 3S and 3D merely indicate relative position within a vertically continuous sand and gravel unit. Where present, the diamicts in Unit 3 induce significant vertical hydraulic gradients in the aquifer.

The predominant VOC contaminants detected in Unit 3 are TCE, cis-12-DCE, and vinyl chloride. These contaminants are present in both the 3S and 3D portions of the aquifer, but concentrations are generally higher in the upper portion of the unit (Figure 4.17).

Preliminary maps showing groundwater potentiometric contours and isoconcentration contours for TCE, cis-1,2-DCE, and vinyl chloride in Units 3S and 3D have been prepared (see Figures 1 to 6; Earth Tech, August 2004). Figures 1, 3, and 6 generally indicate the maximum observed extent of the VOC contaminants and indicate where further groundwater delineation was necessary both on and off the MLK Boulevard property. Areas where delineation was not complete or where additional investigation and sampling was warranted included:

- Unit 3 south of MW-4 on the Meadowbrook property (see Section 4.7.3.1.4);
- Unit 3 east of the former WWTP on MLK Boulevard near the southwest corner of former Plant 9 (Figures 1, 3 and 6; Earth Tech, August 2004);
- Unit 3D north of cluster well MW 43 / 44 (Figure 6; Earth Tech, August, 2004);
- Unit 3 west of MW 33 (Figure 1 and 3; Earth Tech, August 2004);
- Unit 3 southwest corner of the Main Plant Building, northeast of well cluster MW 16 / 17 (Figures 1, 3, and 6; Earth Tech, August 2004);
- Unit 3 on CSXT property (Figure 6; Earth Tech, August 2004); and
- Bedrock aquifer.

The scope for the additional Stage II investigations conducted on and off MLK Boulevard property and the rationale for the work performed is detailed in Work Plan Amendments Additional Stage II Work (Earth Tech; August 5, 2004) and Soil and Groundwater Delineation (Earth Tech; November 16, 2004). The additional Stage II investigations were designed to fully delineate the horizontal and vertical extent of VOCs in groundwater both on and off the MLK Boulevard property. Soil and groundwater screening and direct groundwater sampling was conducted.

Soil and groundwater screening was conducted at borings locations SB 256, SB 257 and SB 262 for the purpose of delineating the horizontal extent of the plume along the south side of Plant 9 using direct push *Geoprobe* to define the horizontal extent of the plume in an east-west direction and select locations for permanent monitoring wells. Sample locations are shown on Figure 2.2. A total of five borehole water samples were obtained from the three boring locations and submitted to the laboratory for TCL VOCs. Based on the results, Unit 3 monitoring wells MW 64 to MW 66 were installed south of former Plant 9.

Additional soil and groundwater screening was conducted beneath the Main Plant building. Soil boring SB 263 was advanced in Bay 39W, located in the southwest part of the Main Plant building, for the purpose of delineating the plume between MW 13 / 14 and MW 49 / 40 (Figure 2.2). Soil and groundwater screening was conducted to the bottom of Unit 3S. Upon completion, monitoring well MW-59 was installed at this location. The well was constructed of nominal 1-inch diameter flush join Schedule 40 PVC, screen and riser.

In addition, two former boring locations SB 237 and SB 238 associated with the former 352 plating area were revisited for the purpose of delineating the VOC plume between MW 13 / 14 and MW 50 / 51. The locations were designated as SB 237B and SB 238B and are shown in Figure 2.2. Soil boring SB 237B was continuously sampled from 15 feet to the bottom of Unit

3S. No soil samples were collected from SB 238B due to the hard dense nature of the soil materials. A total of three borehole water samples were obtained from these boring locations and submitted for TCL VOCs. Based on the soil and groundwater screening results, monitoring well MW 60 was installed at boring SB 237B. Originally the scope of work included revisiting boring location SB 231. But due to the hard dense nature of the soil material encountered in previous interior borings, SB 231 was not sampled. Sampling was not necessary because borehole water data obtained from SB 237B and SB 238B met investigation objectives.

Following the installation of the Unit 3S interior wells, additional Unit 3 and bedrock wells were installed during a period from September to November 2004. At total of 13 Unit 3 wells and four bedrock wells were installed. Monitoring well locations are shown on Figure 2.2

A three well cluster (MW 61, MW 62 and MW 63) was installed south of 25th Street and east of Martin Luther King Jr. Boulevard at the north end of the east parking area (Figure 2.2). This location was continuously split-spoon sampled from the surface to 60 feet, then at five-foot intervals to bedrock at 94.5 feet, and then the bedrock cored to a depth of 105 feet. Monitoring wells MW 61 and MW 63 were installed in the shallow and deeper portions of Unit 3 at this location, and MW 62 was installed in the bedrock.

Three Unit 3 wells MW 64, 65, and 66 were installed south of former Plant 9. Wells MW 64 and MW-65 are located near *Geoprobe* borings SB 262 and SB 257 respectively. MW 66 was sampled continuously from ground surface into the underlying bedrock to a depth of 18 feet.

A well cluster (MW 67, 68) was installed east of the southern portion of main plant building southeast of the Gate 4A guard house. This location was sampled continuously from ground surface to the base of Unit 3 and 2.7 feet into the top of the underlying Unit 4 diamict to a total depth of 48 feet. MW 67 was installed in bottom of Unit 3, and MW 68 was installed in the top portion of Unit 3 at this location.

A new monitoring well cluster (MW 69, 70) was installed on the adjacent property located west of the South Court area (Figure 2.2). This location was sampled continuously from ground surface to the base of Unit 3 and 2.0 feet into the top of the underlying Unit 4 diamict to a total depth of 50.0 feet. MW-69 was installed in Unit 3D, and a paired monitoring well (MW 70) was also installed in Unit 3S at this location.

A three well cluster (MW 71, 72, and 73) was in was installed within the City of Anderson easement along Arrow Avenue west of the Main Plant building (Figure 2.2). This location was sampled continuously from ground surface to 60 feet, then at five-foot intervals to bedrock at a depth of 117 feet. The bedrock was cored to a total depth of 127 feet. During installation of the bedrock well (MW 71), the augers broke, leaving 45 feet of augers in the borehole. The borehole was sealed with a bentonite-based grout. MW 71 was installed in an offset boring. MW 73 was installed in bottom of Unit 3, and MW 72 was installed in the top portion of Unit 3 in off set borings at this location.

Bedrock well MW 74 was installed near monitoring wells MW 21 and 22 in the South Court area (Figure 2.2). Boring SB-269 for the bedrock well was sampled continuously from ground surface to the top of bedrock at a depth of 60.0 feet, and then the bedrock cored to a total depth of 69 feet.

Monitoring well cluster MW 75, 76 was installed in the north courtyard area (Figure 2.2). This location was sampled continuously from ground surface to the base of Unit 3 and 1 foot into the top of underlying Unit 4 diamict to a total depth of 94 feet. MW-75 was installed in Unit 3D, and paired monitoring well (MW 76) was also installed in Unit 3S at this location.

Bedrock well MW 77 was installed on Meadowbrook Golf Course along the west end of the driving range (Figure 2.2). This location was sampled continuously from ground surface into the underlying bedrock to a depth of 15 feet. The bedrock was cored to a total depth of 25 feet.

A *Geoprobe* boring was advanced at location SB 273 for the purpose of characterizing groundwater quality west of former Plant 9 (Figure 2.2). Two borehole water samples were collected from the top and bottom of Unit 3 at 16 and 20 feet respectively. The samples were submitted for rapid turn-around of TCL VOCs. Based on the results, Unit 3 well MW 80 was installed in an off set boring near SB 273.

Selected previously installed and newly installed wells were sampled and analyzed for TCL VOCs in January 2005. Samples obtained from bedrock wells were subject to a forty eight hour turn-around. In addition to VOCs, samples obtained existing wells MW 21, 22, 5, 19, 39 and 40 and Meadowbrook well MW-4 were analyzed for water quality parameters relevant to the natural attenuation of VOC contaminants. These parameters include dissolved oxygen (field), oxidation-reduction potential (ORP), nitrate, iron, sulfate, and total alkalinity.

To further characterize bedrock groundwater quality within and along the boundary of the plume, three additional bedrock wells (MW 81, 82 and 83) were installed. Well MW 81 was installed south of former Plant 9 near Unit 3 well MW 65 to address concerns that the bedrock could be potentially contaminated by VOCs (Figure 2.2). The potential for contaminant migration to the bedrock at this location is supported by the fact that Unit 4 till is absent near eastern extent of the plume and the Unit 3 sand lies directly on bedrock. With no confining clay layer separating Unit 3 from the contaminants could potentially migrate directly into the underlying bedrock.

Well MW 82 installed near well cluster MW 16 / 17 for the purpose of characterizing bedrock groundwater quality down gradient from the Area 1 – South Court VOC plume. Groundwater samples obtained from Unit 3 in this area have had no reported detection of VOCs.

Well MW 83 was installed in the former WWTP area east of MW 39 / 40 to address concerns that constituents could have migrated into the bedrock aquifer.

Unit 3S monitoring well MW 84 was installed on June 14, 2005 to further evaluate the interpretation of two Unit 3S VOC plumes located west and east of the loading dock area. The area between MW 59 and MW 16/17 has had no reported detections of VOCs. However, the surface elevation of the Unit 3 confining bed in this area gently slopes toward the east forming a potential pathway for contaminant migration only if DNAPL is present which does not appear to be the case.

Lithology encountered during groundwater screening and monitoring well installation is discussed in Section 3.6.

4.7.4.1.6 Water Supply Well Sampling

April 2004 Stage II groundwater results from monitoring wells MW 52 and MW 53, located near Guide Production Well 12 (WH-12), indicate that the western extent of the VOC plume had not been fully delineated in the West Parking Area located east of Raible Avenue. Cis-1,2-DCE was detected in groundwater samples collected from wells MW 52 and MW 53 at concentrations exceeding screening criteria (Figure 4.23). Potentiometric surface mapping of Unit 3D in this area indicates that groundwater flow is from west to east (Figure 3.13). And there is no historic use of chlorinated solvents in this area of the Facility.

The existence of the VOC plume in this area is related to two high capacity groundwater pumping wells (WH-11 and WH-12) used for industrial process water and cooling during a period from 1966 to 1989. Both production wells are completed in the lower sand and gravel of Unit 3 and withdrew groundwater at a rate of about 1,100 gallons per minute. During their operation, the production wells would have had a considerable impact on groundwater flow in the South Court Area potentially causing the VOC plume to migrate towards the production wells. Although WH-11 is currently located upgradient of the contaminant plume, additional groundwater sampling was required to establish the western extent of the VOC plume in this area.

The Phase I Site Assessment conducted by HydroTech in March 2003 identified at least two water supply wells that service Meadowbrook Golf Course for potable use. During the Stage II RFI investigation three water supply wells were identified, but only two of the wells are in use. The location of the two functioning golf course water supply wells (MBWell-1 and MBWell-2) is shown on Figure 2.2. MBWell-1 is located in the basement of the club house and MBWell-2 is located north of the maintenance building near Hole 6 tee area. The third well is located southeast of the maintenance building. Currently this well is not used by the golf course.

HydroTech obtained a sample from the club house well in May 2003 and analyzed it for selected metals and VOCs. No metals or VOCs were detected above reportable detection limits. Although the golf course supply wells are located upgradient from the eastern edge of the contaminate plume, additional sampling of the water supply wells was needed to fully evaluate the groundwater quality from the golf course supply wells.

The scope of the Stage II RFI water supply well sampling involved collecting groundwater samples from GM Production Well WH-11 and golf course water supply wells MBWell-1 and MBWell -2 for TCL VOCs. The production well sample was analyzed using SW 846 Method 8260. The golf course well samples were analyzed by a certified drinking water laboratory using EPA Drinking Water Method 524.

4.7.4.2 Results

Potable water analytical results are presented in Table A-3. Analytical results for borehole water and groundwater sampling are presented in Tables A-4 and A-5. Table A-6 shows historic (pre-RFI) groundwater monitoring data for the seventeen original wells at the Facility.

Borehole water results are shown on Figures 4.22a and 4.22b. Groundwater sampling results are provided in Figure 4.23. Historic groundwater results are shown on Figure A-1 (Attachment A).

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4.7.4.3 Discussion of Results

4.7.4.3.1 Groundwater

Various metals were detected in both on-Facility industrial and non-industrial Area 1 RFI groundwater samples and are listed in Table 4.2.a and Table 4.2.b respectively. Concentrations of total arsenic, cadmium, chromium, lead and total and dissolved nickel exceed drinking water criteria in selected samples obtained from Area 1 – South Court and Area 1 – SWMU 16 wells screened in Unit 1 and Unit 3S (MW 2R, MW 3, MW 4, MW 31, and MW 33). Cadmium and chromium was below drinking water screening criteria in the second sample obtained from MW 31 and arsenic was below drinking water criterion in the second sample obtained from MW 2R.

Total lead reportedly exceeded drinking water criterion in three samples obtained in 2003 and 2004 during a Phase II investigations by others at Area 1 – Meadowbrook Golf Course wells MW-2, MW-5, and MW-7. These samples were neither collected nor analyzed by GM. MW-2 is located south of the irrigation pond in the center of the property. MW-5 is located at the south end of a golf course maintenance building where servicing of electric golf carts is likely to have occurred. MW-7 is located at the north end of the golf course maintenance building at the location of a UST removal. GM gathered groundwater level data for the wells on the golf course area and determined that MW-5 and MW-7 are not located downgradient of the Facility (see the March 30, 2005 RFI Stage II Data Report, Figures 23, 24, and 25). As such, any lead in groundwater at these locations is not attributable to the Facility, and no additional investigations at MW-5 or MW-7 were conducted pursuant to the RFI.

MW-2 is located potentially downgradient from the Facility. Followup groundwater sampling at MW-2 for total and dissolved lead was conducted in February 2005. Total lead was detected at 0.0003 mg/L, which is well below the MCL, and the dissolved lead result was non-detect. In addition, no other lead concentrations at the monitoring wells adjacent to and downgradient of the Facility boundary (MW 16, MW 17, MW 20, MW 23, MW 36, MW 37, and MW-4) exceed the drinking water criterion.

Total chromium exceeded drinking water criterion in one sample obtained from Area 1 – East Chromium Area Unit 3S well MW 16. The location of these exceedances is shown on Figure 4.23. No groundwater screening criteria was exceeded for any target metals in samples obtained from on-Facility non-industrial sample locations in Area 1.

The exceedance MW 16 is further discussed in Section 4.7.3. The exceedance of total lead at golf course wells MW-2 and MW-5 are not related to the Facility.

PCBs were analyzed in all monitoring wells installed on CSXT property in response to the detection PCBs in soil samples at water table depth in Area 1 – South Court soil borings SB 156 and SB 163 (see Section 4.7.1.2). No PCBs were detected in any of the downgradient Unit 3 monitoring wells (MW 38, MW 45, MW 46, MW 47, MW 48, and MW 49) on the CSXT property.

Various VOCs and SVOCs are detected in Area 1 Plume. The predominant VOC contaminants detected in Unit 3 are TCE, cis-1,2-DCE, and vinyl chloride (Table A-5). These contaminants are present in both the 3S and 3D portions of the aquifer, but concentrations are generally higher in the upper portion of the unit as shown in Figure 4.17. This is also illustrated on the isoconcentration maps (Figures 3.12 to 3.17) which indicate that the concentrations TCE, cis-1,2-DCE and vinyl chloride are at least one order of magnitude greater in Unit 3S.

Figures 3.12 to 3.17 show the concentration of TCE, cis-1,2-DCE and vinyl chloride in groundwater for hydrogeologic Units 3S and 3D. The isoconcentration maps were compiled from the most recent data available from monitoring well and borehole water sampling locations. At locations where both monitoring well and borehole water data were available the most recent groundwater data was used. In addition, the March 10, 2005 potentiometric surface was added to each isoconcentration map.

Isoconcentration map for Unit 3 (Figures 3.12, 3.14, and 3.16) strongly suggest there are two separate VOC plumes. One plume associated with Area 1 – South Court and the second plume east of MLK Boulevard. The Area 1 – South Court plume extends in a northeast southwest direction with the highest reported concentration of TCE, cis-1,2-DCE and vinyl chloride in Unit 3S are found near the hazardous waste storage building and South Court well MW 8.

The VOC plume east of MLK Boulevard extends towards former Plant 9 and has migrated to the south slightly beyond golf course well MW-4. It should be noted that the Unit 3S confining unit is absent in the area of former Plant 9 and portions of the golf course and as such VOC concentrations have been mapped as both Unit 3S and Unit 3D. The highest reported concentrations of TCE, cis-1,2-DCE and vinyl chloride in Unit 3S are found near wells MW 40 and MW 68.

Although there is a lack of Unit 3D data beneath the Main Plant building, the Unit 3D portion of the VOC plume has been mapped two plumes (Figures 3.13, 3.15, and 3.17). The Unit 3D VOC plume west of MLK Boulevard extends to the west beneath the eastern portion of the Raible Avenue parking lot and north between well clusters MW 50/51 and MW 75/76). Like the Unit 3S plume, the VOC Unit 3D plume east of MLK Boulevard extends beneath former Plant 9 and the northern portion of the golf course near well MW-4.

Both on-Facility industrial and off-Facility restricted areas exceed groundwater screening criteria for various VOCs (Table 4.2a). Drinking water criteria was exceeded for chloroform, cis- and trans-1,2-dichloroethene, toluene, 1,1,1-trichloroethane, TCE, or vinyl chloride in samples obtained from-site industrial and off-site restricted area wells (Figure 4.23). Methylphenol was the only SVOC to exceed drinking water criterion in samples obtained from on-site industrial wells. Direct contact screening criteria (construction scenario) were exceeded for cis-1,2-DCE, TCE, or vinyl chloride in samples obtained from on-site industrial wells MW 5, MW 8, MW 15, MW 23 and MW 31.

Industrial/commercial areas at the Facility and off-Facility (e.g. the Meadowbrook Golf Course) exceed groundwater screening criteria for VOCs and SVOCs (Table 4.2a). Drinking water criteria were exceeded for TCE, cis- and trans-1,2-dichloroethene, or vinyl chloride in samples obtained from off-site restricted area wells (Figure 4.23). Vinyl chloride was the only VOC to exceed non-potable use criterion in both samples obtained from on-site well MW 4.

Bis(2-ethylhexl)phthalate was the only SVOC to exceed drinking water criteria in one sample obtained from MW 34. Because bis(2-ethylhexl)phthalate was detected in field rinsate blanks, the detection of this compound was determined to be related to the field decontamination procedures involving the use of plastic buckets. The decontamination procedure was changed to use stainless steel buckets and the problem was resolved.

Vinyl chloride, which did not exceed any screening criteria, was the only VOC detected in a single bedrock well (MW 81).

Although screening criteria have been exceeded, Area 1 groundwater has been delineated to groundwater screening criteria as appropriate, and placement of HRC in the AOC 1 – South Court IM area is expected to reduce VOC concentrations. Furthermore, historic (pre-RFI) data from 1992 and 1993 (Table A-6) indicate that groundwater monitoring data from wells that define the area of existing groundwater contamination confirm that the migration of contaminated groundwater has stabilized. These data show generally decreasing concentrations of TCE, cis-TCE, and vinyl chloride over time.

4.7.4.3.2 Potable Water

No VOCs were detected in potable water samples obtained from the golf course or from residential wells.

4.7.4.4 Conclusions

The exceedance of screening criteria of VOCs in groundwater indicates that there has been a release of hazardous constituents in Area 1. Data collected during the RFI clearly demonstrates that the Area 1 VOC plume has been fully delineated to applicable industrial and residential criteria, as appropriate. No additional groundwater investigations are proposed for this area except for the continued monitoring of selected wells in order to evaluate the stability of the edge of the plume and the effectiveness of the IM at AOC 1 - South Court.

Based on the exceedance of screening criteria of arsenic, cadmium, lead and nickel, the RFI groundwater data indicates that there has been a significant release of hazardous constituents in Area 1 – South Court and Area 1 – West Chromium Area. The exceedance of screening criterion for lead at the Meadowbrook Golf Course is not related to the significant release of hazardous constituents in Area 1.

The RFI data indicate that the potable wells located on golf course property are not within the area of the delineated Area 1 VOCs plume. Although potable golf course wells were non-detect for VOCs, these wells will be abandoned and will be replaced with city water as previously discussed in Section 2.6.

4.7.5 Surface Water

There are four ponds located on golf course property. The large kidney shaped pond located near the center of the golf course is used to supply water for irrigation. Water level data collected by HydroTech suggests that the ponds on the golf course are connected to groundwater. It is not clear if these ponds recharge or discharge groundwater. HydroTech sampled and analyzed all four ponds in May 2003 for vinyl chloride, trans-1,2-dichloroethene, cis-1,2-DCE, and 1,1-dichloroethane. The exact location of these samples is not clearly documented. All samples were non-detect. To further evaluate surface water quality, surface water samples were collected and analyzed for TCL VOCs from the large pond located down gradient from monitoring well MW-4.

4.7.5.1 Scope and Results

Surface water samples were obtained from the large pond located on the golf course consistent with the Additional Stage II Work Plan Amendment (Earth Tech, August 5, 2004). Two sampling locations were utilized and their location is shown on Figure 2.2. The "Pond Intake" location is at the irrigation pump house located on the west side of the pond. The "Pond North" location is from the north side of the pond between borings SB 253 and SB 254. Both locations were sampled on January 11, 2005 and resampled on April 19.

Analytical results for the eight surface water samples are presented in Table A-2.

4.7.5.2 Discussion of Results

Trace amounts of 1,1-dichloroethane, cis-1,2-DCE, and vinyl chloride were detected in samples collected at both the pond intake and pond north locations on January 11, 2005. Samples collected on April 19 were non-detect for VOCs (Table A-2). The detection of VOCs during the January sampling event appears to be attributable to seasonal fluctuations in surface water temperatures and formation of ice on the pond surface.

The comparison of surface water data to screening criteria is presented in Table 4.4. No surface water screening criteria except drinking water criteria were exceeded in any of the surface water samples. Vinyl chloride was the only constituent to exceed drinking water criteria for both surface water samples collected in January 2005 (Figure 4.23) when the pond was covered with ice.

4.7.5.3 Conclusions

The only slight exceedance of vinyl chloride and subsequent non-detects for VOCs in surface water samples indicates that golf course pond is not significantly impacted by the Area 1 VOC plume. The significance of this impact to human health is further evaluated in Section 5 of this report. Furthermore, the pond will be monitored quarterly as part of the ongoing groundwater monitoring program.

4.8 Area 3 – East Storage Area

Area 3 consists of SWMUs 21 and 22. SWMU 21 is an outdoor pad located east of Plant 9 and immediately east of the East Hazardous Waste Storage Building. The pad measures about 60 x 110 feet and is entirely enclosed by a chain link fence, which defines the SWMU boundary. There is a storm drain opening in the center of the pad near the east end. Wastes known to be stored at this unit included:

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- Paint/thinner waste;
- 1,1,1-trichloroethane;
- Pyridine;
- Methylene chloride;
- Spent acids and caustics;
- Lead;
- Paint sludge;
- Oils, gasoline, kerosene;
- Mold release;
- Used PCB – containing electrical equipment;
- Polyol; and
- Isocyanate.

SWMU 22 is a gravel-covered area lying immediately north and northeast of the East container Storage Building. The SWMU measures approximately 29 x 139 feet. Surface water run-off drains through a drop-inlet located at the west end of the SWMU to a combined sewer system that flows north to the City of Anderson POTW on the West Fork White River. The dates of service for this unit are not known. Information presented in the RFA and in the Part B application indicate the SWMU was used as a storage area for the following wastes:

- Hydraulic oil;
- Antifreeze;
- Polyol;
- Diisocsyanate; and
- "Polygrip" (pliogrip) adhesive.

Area 3 Stage I RFI soil data from the 3.5 to 4.0 foot bgs sample at SB-160 (the deepest sample at this boring) indicate that the soil leaching criteria for deep soil was exceeded for the VOC compounds ethylbenzene and total xylene. This soil boring is located adjacent to a blind sump in the SWMU 21 concrete pad. These data suggest that additional investigations were needed to determine the extent of the VOC soil contamination and whether groundwater quality had been affected.

4.8.1 Scope and Results

The scope of the Stage II RFI investigations performed during the RFI at Area 3 and the rationale for the work performed are detailed Section 5.1 of the Stage I report. In order to further evaluate the exceedance of soil leaching criteria for ethylbenzene and total xylene in the deepest (4.0 foot) soil sample at SB 160, additional soil and groundwater investigations were conducted at SWMU 21 as part of the Stage II RFI investigation. Sample locations are shown on Figure 4.11. Soil boring SB 217 was installed near Stage I boring location of SB 160 to a depth of 12 feet. Soil samples were collected at 8 and 12 feet and screened for xylene and ethylbenzene using an on-site GC. A borehole water sample was also collected at this location. During sampling LNAPL was observed in boring SB 217. Based on the field screening results, both soil and borehole water samples were submitted for rapid turn around VOC analysis.

Based on the rapid turn around results, four additional soil borings (SB 243 through SB 246) were advanced to a depth of 12 feet for the purpose of delineating VOC contamination in soil and groundwater (Figure 4.11). Soil samples were collected from within two feet above the water table. Five borehole water samples were field screened for xylene and ethylbenzene for the purpose of determining the extent of the dissolved plume. No LNAPL was observed in any of the step-out borings. A total of five soil and five borehole water samples, including duplicates, were submitted for laboratory TCL VOC analysis.

Soil and groundwater screening analytical VOC results for Area 3 samples are presented in Tables A-1 and A-5 respectively.

4.8.2 Discussion of Results

The maximum and minimum concentration of detected target compounds in Area 3 soil is presented in Table 4.1a. VOCs detected include acetone, chloroethane, dichlorofluoromethane, 1,1-dichloroethane, ethylbenzene, toluene, 1,1,1-trichloroethane, and xylenes. Phenol was the only SVOC detected in Area 3 soil. Arsenic, barium, cadmium, total chromium, copper, lead, nickel, selenium and zinc were detected in all twenty two samples analyzed, mercury was detected in six samples, and cyanide was detected in two samples. The location of these detections is presented on Figure 4.21. A comparison of these results to soil screening criteria shows that no soil screening criteria were exceeded in any Area 3 samples (Figure 4.21).

Low concentrations of cis-1,2-dichloroethene were detected in borehole water samples obtained from each of the step-out borings and total xylene was detected in boring SB 243. However, all concentrations are below screening criteria.

4.8.3 Conclusions

Based on the lack of exceedance of any screening criteria for all target compounds, the RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at Area 3. No LNAPL was observed in any of the step out borings. Since the extent of contamination in this area has been delineated to appropriate screening criteria and there is no unacceptable exposure based on the screening results, no additional investigations or corrective action is necessary. No additional investigation is proposed for this area.

4.9 Area 4 – Nalco Areas – SWMUs 25 and 26

SWMUs 25 and 26, collectively referred to as the Nalco Areas or Area 4, are located on the east side of the former Plant 9 building near the former Nalco emulsion pit (inside Plant 9) and a former waste methyl ethyl ketone (MEK) aboveground storage tank (Figure 4.12). The MEK tank was a former RCRA unit that was closed in 1998 pursuant to a closure plan approved by the IDEM on September 17, 1997. The closure activities are described in a May 8, 1998 closure certification report. The closure activities involved soil sampling at depths of 0-1 and 1-2 feet below the base of the concrete tank containment slab. Cadmium, lead, mercury, and seven VOC compounds were detected at low levels in some of the soil samples, but no analyte concentrations exceeded the applicable IDEM Tier I residential closure concentration.

SWMU 25 is an outside loading dock located adjacent to an overhead door. The unit was defined in the RFA as a 240 square-foot concrete driveway, used as a staging location for vacuum trucks removing spent Nalco emulsion from the pit inside the building. The unit is bounded on three sides by either the concrete Plant 9 building foundation wall or a concrete dike. Although there is no documentation of any release from SWMU 25, surficial staining observed on the concrete noted during the RFA prompted soil sampling to address a possible release of spent Nalco emulsion.

SWMU 26 is described in the RFA as being just east of the former 8000-gallon waste MEK storage tank. The area was reported used for bulk material storage and drum storage. SWMU 26 is bounded by the 3-foot high concrete containment wall of the tank on the west and by the Plant 9 wall on the south. The edges of the SWMU are defined on the north by stained concrete and blacktop pavement that extends 25 feet north from the edge of the plant wall and 125 feet east from the former MEK tank containment. Investigation at these SWMUs targeted soil beneath the pavement for evaluation of the possible release of used Nalco emulsion.

4.9.1 Scope and Results

In October 2000 seven soil borings were advanced in the Nalco Areas (Figure 4.12, SB 144 – SB 150). Soil borings SB 148, 149, and 150 were completed at expansion joints in the concrete slab at SWMU 25. SWMU 26 is an area of degraded asphalt. A grid pattern consisting of 56 nodes was established for this area pursuant to the RFI Work Plan. A random number generator was utilized to select four grid locations for soil borings (Figure 4.12, SB 144 – SB 147). Samples were collected continuously from the ground surface to the bottom of each boring at a depth of 4.0 feet. The soil core was examined visually for soil classification. Samples were collected from the 0.5-1.0 and 3.5-4.0 foot intervals for laboratory analysis. Additional soil samples were collected at SB 147 pursuant to the October 13, 2000 notification to the IDEM.

Lithologic units encountered in the Nalco Area include a sandy loam and clay loam beneath the pavement surface. A small layer of sand fill was encountered below the pavement.

All soil samples were analyzed for the target metal list, VOCs, and SVOCs.

Analytical results for soil are provided in Table A-1.

4.9.2 Discussion of Results

The target metal parameters arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc were detected in several soil samples at Area 4. The SVOC compounds bis(2-Ethlyhexyl)phthalate and phenol were detected in two soil samples SWMU 26. The VOC compound acetone was detected in one soil sample at SB 147 and one soil sample at SB 148 (Table A-1). However, no soil screening criteria were exceeded in any of the samples from Area 4 (Figure 4.21).

4.9.3 Conclusions

Based on the lack of exceedance of any soil screening criteria for any target metal, VOC or SVOC compound, the RFI data indicate that no significant release of hazardous constituents occurred at Area 4. Therefore, no additional investigations are necessary or proposed for this area.

4.10 Main Plant Metal Plating and Recovery Areas

An inspection of the former plating and recovery areas in the Main Plant building was conducted on October 28, 2003. This inspection was made cooperatively with the IDEM for the purpose of establishing soil sampling locations pursuant to the approved RFI Work Plan Amendment for the seven metal plating and recovery areas subject to ongoing Corrective Action. A total of twenty-one sample locations were selected and marked (Figure 2.2). In general, the selected locations were associated with sump and drain trench areas, or areas of degraded concrete. Eight locations (SB 231 to SB 238) were established in the former 352/309 Plating Areas and Acid / Caustic Strip Tank Area, two (SB 228 and SB 229) in the former 400 Replater Area, six (SB 222 to SB 227) in the former 1002 Preplater Area, four (SB 239 to SB 242) in the former Nickel Recovery Area and one (SB 230) in the Chromium Recovery Area.

Concrete coring was conducted on October 29-31 and November 11, 2003 in the former plating areas for the purpose of providing access for soil coring beneath the plant floor. After utility clearance, cores were cut at all twenty one sample locations established during the October 28 reconnaissance. The concrete coring successfully penetrated the full thickness of the concrete floor at all locations except two at the former 1002 Preplater. At these locations, the concrete was cored to the limits of the coring equipment utilized (18 inches) but the concrete was not fully penetrated. Direct push equipment was utilized to complete concrete removal at these locations.

On February 13 – 18, 2004, twenty one borings (SB 222 to SB 242) were advanced in the former plating and recovery areas, consistent with the Main Plant Metal Plating and Recovery Areas Work Plan Amendment (Earth Tech, July 31, 2002). These borings were advanced to just below the top of the water table surface. Refusal was encountered at borings SB-240 and SB-241 at four feet and at SB 239 at 17 feet measured from the top of the concrete floor in the Nickel Recovery Area. Boring SB 242 was the only boring to encounter groundwater in the Nickel Recovery Area at 29.6 feet.

Samples from the former plating and recovery areas were collected within the upper two feet of fill or soil beneath the concrete floor, at a depth of 8 to 10 feet, and from a depth immediately above the water table surface. Samples were submitted for nickel, chromium, copper, lead, hexavalent chromium and cyanide (total and amenable).

In addition, a Unit 3 well cluster MW-50 / 51 was installed at a location outside the Main Plant and believed to be down gradient from the plating areas (Figure 2.2).

4.10.1 AOC 7 – 400 Plater

The 400 Plater Area was located in bays H44 and J44, and adjoined the south part of the 1002 Preplater. This was a relatively small plating area that was utilized as a repair operation to strip and replate plastic parts with defective chromium plating. The plater was removed in 1996, and an additional thickness of concrete was placed over the area. There are no visible remains of the plater or plater containment remaining.

Facility drawings dated 1983 suggest that the plating area was about 18 x 48 feet in size. The entire area was surrounded by a concrete curb and a 12-inch wide collection trench. The trench drained to one or two sump areas. The 1983 drawing shows an existing sump location about midway along the north side of the unit, and a new sump location about midway along the south side of the unit. The locations of both sumps may be readily established from pillar lines H/J and 44/45. The area currently has a new concrete floor, and is used for bulk material storage. No subsurface investigations had been conducted in this area.

4.10.1.1 Scope and Results

Two *Geoprobe* borings (Figure 4.13, SB 228 and SB 229) were completed in AOC 7 to characterize subsurface soil near the location of each of the two sump areas identified on Facility plans. Both these borings were completed to a depth of 24 feet. Samples from each boring were obtained from three depth intervals below the concrete floor pursuant to the RFI Work Plan Amendment. These samples were submitted for analysis of target metal parameters and cyanide.

Lithologic units encountered in the AOC 7 area include concrete overlying a sand fill beneath the southern port of the unit (Unit 1), a mixed silty clay loam with interbedded sand (Unit 2), and Unit 3 sand.

Analytical results for target metals and cyanide are provided in Table A-1.

4.10.1.2 Discussion of Results

Chromium (trivalent), copper, lead, and nickel were detected in all six AOC 7 soil samples. Hexavalent chromium was detected in the shallow and intermediated samples obtained from each boring. Cyanide (amenable and total) was detected in the shallow samples obtained from boring SB 228 and cyanide (total) was detected in sample interval from 9.5 to 10.0 feet from boring SB 229. No soil screening criteria were exceeded in any of the six AOC 7 area samples (Figure 4.19).

4.10.1.3 Conclusions

Based on the lack of exceedance of any screening criteria for all compounds the RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at AOC 7. Therefore, no additional investigation is proposed in this area.

4.10.2 AOC 6 – Electroform Area

The Electroform Area was located in bay C45 and includes the adjoining SWMU 5 – Cyanide Plating Area located in bays B45 and B46. AOC 6 is completely enclosed and comprises approximately 3,740 square feet. Operations included creation of an electroform, a die insert used to mold the reflex surface of a lens, through plating of copper, nickel, and chrome. Cyanide was used in conjunction with copper or silver in an older version of the process. Parts to be plated were dipped in a series of solution tanks, acid/alkaline baths, and rinse tanks. Plating operations were conducted in this area from the mid-1960s until 1998 at which time the area was decommissioned. All tanks, piping and ancillary equipment were removed.

A network of concrete floor trenches in the various plating rooms, (Figure 4.14; Rooms 4, 5, and 6) is all that remains. These trenches were used to conduct solutions and rinsates to a central collection sump (Room 1) where the liquids were pumped to the Facility's WWTP. The area was inspected by Conestoga-Rovers & Associates on November 27, 2001 with IDEM and US EPA Region V representatives. Following the inspection, decontamination activities at AOC 6 were conducted during a period between December 2001 and January 2002. Concrete from the north trench in Room 5 and the threshold trench in Room 6 was removed. These areas of the floor currently remain open with the underlying soil exposed.

4.10.2.1 Scope and Results

The characterization of soil and groundwater at AOC 6 was conducted during various sampling events. Work was performed by Conestoga-Rovers & Associates pursuant to the approved Closure Plan for Electroform Area Trenches (Conestoga-Rovers & Associates, July 17, 2002). Following each event, analytical results were compared to industrial closure levels to determine whether the extent of constitutes had been fully delineated.

In January 2003, Phase I subsurface investigations were performed as described in the approved Closure Plan for Electroform Area Trenches (Conestoga-Rovers & Associates, July 2002). Eight soil borings (Figure 4.14, BH-1 to BH-8) were completed beneath the concrete floor a depths ranging from 17 to 24 feet. A total of 50 soil samples were obtained from AOC 6 borings. These samples were submitted for analysis of target metal parameters, hexavalent chromium, and cyanide.

In addition, borehole water samples were collected from Phase I boring locations BH-3, BH-4A, BH-5, BH-6, and BH-7 (Figure 4.14). These samples were submitted for analysis of target metal parameters, hexavalent chromium, and cyanide.

Based on the Phase I results, additional subsurface soil and groundwater investigations were required to delineate the extent of constituents. Thirteen soil borings (Figure 4.14; BH-2A, BH-5A, BH-6A, BH-7A, BH-9 to BH 12, BH-12A, and BH-13 to BH-16) were completed at AOC 6 in April 2003. A total of 30 soil samples were obtained from these borings. These samples were submitted for analysis and each sample was analyzed for a specific set of parameters including hexavalent chromium, copper, and cyanide.

Several Phase II sample results continued to exceed the default closure levels for copper, cyanide, and hexavalent chromium. Therefore, a second round of sampling to delineate soil contamination was required. During this round of sampling, fifteen soil borings (Figure 4.14; BH-10A through BH-10C, BH-11A, BH-11B, BH-12B, BH-17 through BH-21, and BH-23 through BH-26) were completed at AOC 6 in May 2003. A total of 41 soil samples were collected and analyzed for hexavalent chromium, copper and cyanide as appropriate based on the results of the April 2003 sampling.

In order to delineate the extent of cyanide and copper contamination north of Room 6, a third round of sampling was required. Eleven soil borings (Figure 4.14, BH-27 to BH-37) were completed at AOC 6 in June 2003. At each location, samples were obtained from three four-foot intervals (0-4, 4-8, and 8-12 feet). These samples were submitted for analysis of copper and cyanide. Samples obtained from locations BH-35 and BH 36 were analyzed only for copper. Samples obtained from BH-37 were not analyzed.

Three temporary one-inch monitoring wells (Figure 2.2, MW-ER-1 to MW-ER-3) were installed at AOC 6 to evaluate elevated copper and nickel concentrations detected in the borehole water sample obtained from BH-4. These wells and four exiting wells (MW 9, MW 11, MW 27, and MW 29) were sampled in April 2003 and resampled in May. Samples were submitted for analysis of total copper and nickel. In order to resolve a turbidity issue, the three AOC 6 wells were sampled on June 25 and 27, 2003. Both filtered and non-filtered samples were obtained from each well and submitted for total and dissolved copper and nickel analysis. AOC 6 wells were sampled a fifth time in January 2005 for TCL VOCs.

Soil and groundwater analytical results for TCL VOCs, target metals, hexavalent chromium and cyanide are presented in Tables A-1 and A-5 respectively. Reports prepared by Conestoga-Rovers & Associates that document these investigations and results include:

- Electroform Room Closure Soil and Groundwater Sampling Summary, July 17, 2003; and
- Closure Plan for Electroform Area Trenches – Revision 2, April 2004.

4.10.2.2 Discussion of Results

A summary of detected target inorganic parameters in AOC 6 is presented in Table 4.1a. Parameters detected in soil include chromium (total, trivalent and hexavalent), copper, nickel, silver, and cyanide (total and amenable). The location of these detections is shown on Figure 4.20. Constituents exceeding soil screening criteria are also shown in Table 4.1a.

Industrial PRGs were exceed for total chromium and/or copper in shallow samples obtained form four borings (Figure 4.20; BH-5, BH-6, BH-7, and BH-7A). Samples obtained from adjacent confirmatory borings evaluated for hexavalent chromium and copper did not exceed industrial PRGs except for copper from 0 to 4 feet at BH-7A.

The deepest soil sample from eight borings (Figure 4.20; BH-11B, BH-10B, BH-12, BH-19, BH-20, BH-23, BH-25, BH-29) and five borings (Figure 4.20; BH-7 BH 12 BH-19, BH-25, BH-29) exceeded the migration to groundwater screening criteria for copper and cyanide (total or amenable) respectively. Total chromium also exceeded migration to groundwater in shallow samples obtained from BH-2, BH-5, BH-6, and BH-7. However, deeper samples obtained from these locations and analyzed for trivalent and hexavalent chromium are below soil screening criteria.

Unit 1 borehole water samples obtained from locations BH-3, BH-4A, BH-5, BH-6, and BH-7 detected low levels of chromium, copper and nickel (Figure 4.22a). Groundwater samples obtained from AOC 6 wells detected concentrations of cis-1,2-dicholoroethene, copper and nickel (Table A-5). The target parameters exceeding groundwater screening criteria are shown in Table 4.2a. Figure 4.23 shows the location of these exceedances. Unit 1 groundwater samples obtained from MW-ER-1 exceeded drinking water criteria for nickel during the April sampling event and for copper during the May 2003 sampling event. Nickel concentrations exceeded drinking water criteria at MW-ER-2 for all four sampling events. Copper was exceeded in the unfiltered sample collected from MW-ER-2 on June 25, 2003. Both copper and nickel exceeded drinking water criteria in all unfiltered samples obtained from MW-ER-3. Based on the June 2003 groundwater data, copper and nickel exceedances have been delineated. No VOCs exceeded any groundwater screening criteria.

4.10.2.3 Conclusions

The exceedance of soil screening criteria for nickel, chromium, copper, and cyanide indicate that a significant release of hazardous constituents has occurred at AOC 6 and that a site specific risk assessment will be conducted for closure of this AOC.

The exceedance of copper and nickel in groundwater indicates that a potential release of hazardous constituents has occurred at AOC 6. Groundwater sampled in AOC 6 is perched groundwater from Unit 1. Groundwater in Unit 1 is not found continuous throughout the Facility and is an unlikely potable water source in the area. Furthermore, the low levels of cooper and nickel do not represent significant groundwater contamination. As with soil, a site specific risk assessment will be conducted for closure of AOC 6 – Electroform Area.

4.10.3 AOI 2 – Chromium Recovery

The chromium recovery unit was located in portions of bays K43, 44 and L 43, 44. The area contained several tanks utilized in chromium recovery from plating solutions. The area is shown on Facility plans dating to 1976. Chromium recovery operations ceased in 1998, and the area was decommissioned in 2002. All tanks, piping and ancillary equipment were removed.

The area was constructed on a raised concrete slab and is surrounded by a raised concrete containment curb. The area within the curbing is approximately 45 feet x 38 feet in maximum dimensions. The containment area drained via a collection trench to a single lined sump on the south side of the area. All of these structures remain. The area is currently surrounded by a low chain link fence and is not utilized.

There are no previous soil or groundwater sampling and analysis data for this area.

4.10.3.1 Scope and Results

One soil boring (Figure 4.15, SB 230) was completed in February 2004 at AOI 2 to characterize subsurface soil near the Chromium Recovery sump. The boring was completed to a depth of 24 feet. Samples were obtained from three depth intervals (2-2.5, 9.5 10.0, and 23.5-24.0 feet) below the concrete floor. These samples were submitted for target metal parameters and cyanide.

Lithologic units encountered in the AOI 2 area include concrete overlying a mixed silty clay loam or loam (Unit 2) and Unit 3 sand. No Unit 1 fill was encountered in this boring.

Analytical results for target metals and cyanide are provided in Table A-1.

4.10.3.2 Discussion of Results

Target metals detected in AOI 2 area soil include copper, lead, nickel, and chromium (trivalent and hexavalent (Table 4.1a). The location of these detections is shown on Figure 4.19. No soil screening criteria except migration to groundwater were exceeded in the six AOI 2 area samples. The concentration of hexavalent chromium in both the investigative and duplicate samples collected from a depth of 9.5 to 10.0 feet at SB 230 exceeded the migration to groundwater soil screening criteria. In this case, the deeper soil sample shows that the hexavalent chromium was delineated to the screening criteria.

4.10.3.3 Conclusions

Based on the lack of exceedances in any screening criteria for all target compounds except an exceedance of the migration to groundwater criteria for hexavalent chromium in shallow soil and that deeper soil concentrations of hexavalent chromium are below the migration to groundwater criterion, RFI soil data indicate that no potentially significant release of hazardous constituents has occurred at AOI 2.

4.10.4 Area 2 – 309/352 Platers, Acid/Caustic Strip

The former 352 Plating Area was located in bays N31 to N37, and portions of bays M31 to M37 (Figure 2.2). The area was constructed in 1983, and, in part, overlays an older plating unit (SWMU 3 – Plater 309). Plating operations ceased in this area in 1998, and the area was decommissioned in 2002. Decommissioning activities included removal of all plating tanks, piping and controls, cleaning of the floor, trench and sump areas.

The plating area contained tanks utilized in copper, nickel and chromium plating operations. Individual tanks stood on cast concrete bases. The tank, floor trench and sump areas were recessed approximately 6 inches below the surrounding floor area. The entire area was surrounded by a 6-inch by 6-inch concrete curb that formed the outside containment for the plater unit. These concrete structures remain. Currently, the area is surrounded by a low chain link fence constructed along the former concrete curb containment area, and is not utilized.

During the construction of the 352 Plater in 1983, soils beneath the older 309 Plater were excavated to a depth of 42 inches, and contaminated soils were removed. These excavations were made in bays N31 to N37 and within a smaller area in bays M33 to M36. Following the soil excavation, a 40 mil Chloraloy 240 flexible membrane liner (FML) was installed within both excavated areas. The bay N excavated area became the location of the 352 Plater whereas the bay M excavation area became the location of the Acid / Caustic Strip Area (SWMU 7), associated with the 352 Plater area. Compacted bank-run gravel was placed above the FML up to the base of the new concrete floor. A collection piping system was installed in the gravel to collect and remove for appropriate treatment and disposal any accumulated leakage through the concrete floor within the respective containment areas. The collection piping network is accessed through four inspection ports in the former 352 area and two inspection ports in the former Acid / Caustic strip area.

Wastewater from the 352 Plating Area was routed through prefabricated vinyl ester lined floor trenches to one of six floor sumps. Sumps are located in each corner of the former plating area, and roughly midway along the long axis of the containment area on each side. These sumps are six feet deep and are located within the FML area. The sumps were reported to be constructed of prefabricated fiberglass.

The six sumps were equipped with pumps that removed the plating wastewaters via overhead piping in the manufacturing plant to the Facility WWTP. The plating wastewaters were not conveyed via a sewer system, and there is no underground process sewer piping associated with this unit.

The former 309 Plating Area was located in bays N31 to N37, and portions of bays M31 to M36 (Figure 2.2). No detailed drawing for the area could be located during preparation of this Work Plan. The area was later occupied by the former SWMU 2 – 352 Plater (see Section 2.2.1) and the former SWMU 7 – Acid / Caustic Strip Tank Area. The 309 Plater was a former electroplating unit, employing cyanide solutions. The area was constructed in 1962 and removed in March 1982. Plating wastes and solutions managed in this area contained copper, nickel, chromium and cyanide.

No plans of the 309 plating area were located during the development of the RFI Work Plan. The 309 plating area was reportedly surrounded by a concrete trench system to catch spilled plating fluids. The trench system reportedly led to blind sump areas from which accumulated fluids were pumped for appropriate treatment and disposal. The locations of these sumps are not known.

Contaminated soil was removed from beneath the 309 Plating Area when the 352 Plater and Acid / Caustic Strip Tank Area were constructed (see section 2.2.1). Soil samples were collected from the area of the excavation, but it is unclear from the available documentation whether these were samples of soil excavated or samples of soil remaining after the excavation was completed.

Several soil samples from the excavated area were characterized by a soil leachate procedure. These samples were analyzed for cadmium, chromium, copper, nickel and cyanide and all of these compounds were detected in the soil leachate.

The Acid / Caustic Strip Tank Area was located immediately northwest of the 352 Plating Area in bays M33 to M36 (Figure 2.2). The unit was placed in operation in 1983, concurrent with the 352 Plater. Operations ceased in 1998. The unit was decommissioned in 2002. The area formerly contained tanks to perform two metal stripping operations. The caustic strip tank was utilized to strip plated chromium from the dip racks utilized in the adjacent 352 Plater operations. The nitric acid strip tanks removed plated copper and nickel from the dip racks. The area was used to manage metal sludges and acid and caustic wastewaters containing chromium, copper and nickel. Sludges accumulating in the tanks were periodically removed, drummed and shipped to offsite disposal facilities. Spent stripping acids and caustic were pumped to the on site WWTP.

During the construction of the Acid / Caustic Strip Tank Area, soils beneath the older 309 Plater were excavated to a depth of 42 inches, and contaminated soils were removed (see Section 2.2.1). A 40 mil Chloraloy 240 FML was installed within the excavated area. The FML acted as a secondary containment barrier. Compacted bank-run gravel was placed above the FML up to the base of the concrete floor. A collection piping system was installed in the gravel to collect and remove any accumulated leakage through the concrete floor within the respective containment areas. The collection-piping network is accessed through two inspection ports.

The floor area of the Acid / Caustic Tank Area consisted of non-coated concrete. The primary containment system consisted of a concrete curb about eight inches high. Within the curbed area, the floor slopes to a central floor trench that directed any spills, overflows and tank drainage to a single centralized sump.

Liquids within the sumps were pumped via overhead lines in the manufacturing plant to the WWTP. There were no underground process sewers conveying liquid wastes from this unit.

Decommissioning activities in 2002 included removal of all plating tanks, piping and controls, and cleaning of the floor, trench and sump areas. All of the containment structures remain. The area is currently not utilized and is surrounded by a low chain link fence.

Contaminated soil was removed from the Acid / Caustic Strip Tank Area prior to construction of the unit in 1983. Soil samples were collected from the area of the excavation, but it is unclear from the available documentation whether these were samples of soil excavated or samples of soil remaining after the excavation was completed. The soil was characterized by a soil leachate procedure and the leachate was analyzed for cadmium, chromium, copper and nickel. As received soil samples were also analyzed for cyanide. Cadmium, chromium, copper and nickel were reported in the soil leachate and cyanide was reported from some as received soil samples.

No subsurface soil or groundwater investigations have been conducted in association with these units.

4.10.4.1 Scope and Results

Eight soil borings (Figure 4.16, SB 231 to SB 238) were completed in Area 2 to evaluate subsurface soil near sumps and suspected release areas. All borings, except SB 233 and SB 237, were advanced into the upper portion of Unit 3 at depths ranging from 20 to 31 feet below the concrete floor. Refusal was encountered at borings SB 233 and SB 237 at a depth of 16 feet below the top of the concrete floor. A total of 25 samples, including two duplicates were obtained at discrete sample intervals from Area 2 borings in February 2005. These samples were submitted for analysis of target metal parameters and cyanide.

In addition, MW 60 installed in off set boring SB 237B pursuant to the August 5, 2004 Work Plan Amendment was sampled in January 2005 consistent with the November 16, 2004 Work Plan Amendment. This sample was submitted for TCL VOCs, target metal parameters, and hexavalent chromium.

Lithologic units encountered in Area 2 beneath the concrete floor include a silty clay loam or loam (Unit 1) overlying loam with thin interbedded sand layers (Unit 2) and sand (Unit 3).

Soil and groundwater analytical results for Area 2 samples are presented in Tables A-1 and A-4 respectively.

4.10.4.2 Discussion of Results

Area 2 target parameters detected in soil include copper, lead, nickel, chromium (trivalent and hexavalent), and total cyanide (Table 4.1a). Table 4.1a indicates that copper and nickel exceed the migration to groundwater screening criteria in a shallow sample obtained from a depth of 2.0 to 2.5 feet at SB 234. In this case, deeper samples show that copper and nickel were delineated to screening criteria. No soil screening criteria were exceeded in any of the 25 Area 2 samples as shown on Figure 4.19.

Both VOCs and metals were detected in groundwater collected from well MW 60. VOCs detected include 1,1,1-thrichloroethane, 1,1-dichloroethene, cis and trans-1,2-dichloroethene, TCE, and vinyl chloride. Nickel (total and dissolved) was the only metal detected. No groundwater screening criteria were exceeded for target metal parameters in the sample obtained from MW 60 (Figure 4.23). However, 1,1-dichloroethene, cis- and trans-1,2-dichloroethene, TCE, and vinyl chloride concentrations exceeded drinking water criteria.

4.10.4.3 Conclusions

Based on the lack of exceedance of any screening criteria for all target compounds except the migration to groundwater criteria for copper and nickel in shallow soil, and that deeper soil concentrations of copper and nickel are below the migration to groundwater criteria, the RFI soil data indicate that no potentially significant released of hazardous constituents has occurred at Area 2.

The lack of exceedance of any screening criteria for all target metal compounds indicates that there has not been a potential signification release of hazardous constituents from this unit to groundwater. Detected VOCs in groundwater beneath this unit are related to the Area 1 VOC plume which is further discussed in Section 4.7.4.

4.10.5 SWMU 4 – 1002 Preplater

The 1002 Preplate Area was located in portions of bays H37 to H43 and J37 to J43 (Figure 2.2). This area was put in operation in 1983 and was utilized to preplate copper and chromium onto plastic parts utilizing an electroless process. Plating operations ceased in 1998. The area was decommissioned in 2002 and all tanks, piping and ancillary equipment were removed. Trench and sump areas were cleaned.

The area was constructed on a raised 5-½ inch concrete slab poured over older concrete. Individual plating tanks stood on cast concrete bases. Rinse water and tank decantations were discharged through hard piping or vinyl ester coated trenches to lined or coated sumps. There were a total of four six-foot, or deeper, sumps associated with the unit. All of these concrete structures remain.

There was no underground process sewer system associated with this unit. The entire area is surrounded by a low chain link fence and is not utilized.

No subsurface soil or groundwater investigations have been conducted in association with this unit.

4.10.5.1 Scope and Results

Six soil borings (Figure 4.13, SB 222 to SB 227) were completed in SWMU 4 to characterize subsurface soil in selected locations were associated with sump and drain trench areas, or areas of degraded concrete. All borings were advanced into the top of the saturated portion of Unit 3. Samples from each boring were obtained from three intervals consistent with the Main Plant Metal Plating and Recovery Areas Work Plan Amendment (Earth Tech, July 31, 2002). These samples were submitted for target metal parameters and cyanide.

In addition, monitoring well MW 78 was installed near boring location SB 224 to assess groundwater quality associated with exceedance of migration to groundwater criteria for chromium VI, and for the purpose of delineating the VOC plume between MW 13 / 14 and MW 50 / 51. Installation was consistent with the Work Plan Amendment Soil and Groundwater Delineation (Earth Tech, November 16, 2004). The sample obtained from MW 78 in January 2005 was submitted for target metal parameters and TCL VOCs.

Soil and groundwater analytical results for SWMU 4 samples are presented in Table A-1 and A-4 respectively.

4.10.5.2 Discussion of Results

Target analytes detected in soil at SWMU 4 include copper, lead, nickel, chromium (trivalent and hexavalent), and total cyanide (Table 4.1a). Hexavalent chromium detected in the deepest soil samples obtained at boring location SB 224 (18.5 to 19.0 feet) exceeded the migration to groundwater screening criteria. The location of this exceedance is shown on Figure 4.19. No other soil screening criteria were exceeded in SWMU 4 soil samples.

Both VOCs and metals were detected in groundwater obtained from well MW 78 (Figure 4.23). Detected VOCs include 1,1,1-trichloroethane, cis- and trans-1,2-dichloroethene, TCE, and vinyl chloride. Total and dissolved copper and nickel were the only target metals detected. No groundwater screening criteria were exceeded for target metals in the sample obtained from MW 78 (Figure 4.23). However, cis-1,2-dichloroethene, TCE, and vinyl chloride concentrations exceeded drinking water criteria in groundwater obtained from MW 78.

4.10.5.3 Conclusions

The exceedance of hexavalent chromium in soil indicates that a potentially significant release of hazardous constituents has occurred near boring SB 224. The lack of exceedances in the remaining samples indicates that this unit has been fully delineated to screening criteria.

Based on the lack of exceedance of any screening criteria for target metal parameters, the RFI groundwater data indicate that no potentially significant release of hazardous constituents to groundwater has occurred at SWMU 4. The detection of VOCs in groundwater are not related to the operation of this unit and is further evidence that the Area 1 VOC plume in Unit 3S has migrated to the north beneath the Main Plant building.

4.10.6 SWMU 6 – Nickel Recovery

This unit was located in bays M42, M43 and N42, and was installed in 1978. Rinse water from an electroplating area was processed through the system to recover nickel. The nickel was precipitated as nickel carbonate and was sold to a nickel processor. The system consisted of several treatment and settling tanks, and a filter press.

Containment for the tank systems consisted of concrete curbing. Separate curbed areas had trenches and or blind sumps to collect spills. Operation of the nickel recovery system ceased in 1998. The unit was decommissioned in 2002 and all tanks and process equipment were removed. Trench and sump areas were cleaned. The concrete containment curbing, sumps and trenches remain.

There are no previous soil or groundwater sampling and analysis data for this unit.

4.10.6.1 Scope and Results

Four soil borings (Figure 4.15, SB 239 to SB 242) were completed in SWMU 6 to characterize subsurface soil near sumps and drain trenches. Borings were to be advances to the top of the water table. However, refusal was encountered at borings SB 240 and SB 241 at four feet and at SB 239 at 17 feet measured from the top of the concrete floor. Boring SB 242 was the only boring to encounter groundwater in this area at 29.6 feet. A total of nine soil samples, including one duplicate, were obtained from these borings. These samples were submitted for target metal parameters and cyanide.

In addition, monitoring well MW 79 was installed in an off set boring near SB 224 to assess groundwater quality associated with exceedance of migration to groundwater criteria for copper and nickel, and for the purpose of delineating the VOC plume between MW 13 / 14 and MW 50 / 51. Installation was consistent with the Work Plan Amendment Soil and Groundwater Delineation (Earth Tech, November 16, 2004). The sample obtained from MW 79 in January 2005 was submitted for target metal parameters and TCL VOCs.

Lithologic units encountered in SWMU 6 beneath the concrete floor include loam / silt loam fill (Unit 1), silty clay loam / loam (Unit 2), and Unit 3 sand.

Soil and groundwater analytical results for SWMU 6 samples are presented in Tables A-1 and A-4 respectively.

4.10.6.2 Discussion of Results

Target RFI parameters detected in SWMU 6 soil include trivalent chromium, copper, lead, nickel and total cyanide (Table 4.1a). No soil screening criteria except migration to groundwater were exceeded in this area. The location of these exceedances is shown on Figure 4.19. Shallow samples collected from a depth of 2 to 2.5 feet beneath the concrete floor exceeded copper and nickel at SB 240 and total cyanide at SB 239. Deeper samples from SB 239 are delineated to soil screening criteria for total cyanide. Due to refusals, deeper samples were not collected at SB 240.

No groundwater screening criteria were exceeded for target metal parameters in the sample obtained from MW 79 (Figure 4.23). However, cis-1,2-DCE, TCE, and vinyl chloride concentrations exceeded drinking water criteria.

4.10.6.3 Conclusions

The exceedance of copper and nickel indicate that a potential significant release to soil of hazardous constituents has occurred at SWMU 6. These exceedances are further evaluated in Section 5 of this report.

Based on the lack of exceedance of any screening criteria for target metal parameters, the RFI groundwater data indicate that no potentially significant release of hazardous constituents has occurred at SWMU 6. The detection of VOCs in groundwater is not related to a release of hazardous constituents form this unit, but provides additional evidence that the Area 1 VOC plume in Unit 3S has migrated to the north beneath the Main Plant building.

4.11 Plant 9

Former Plant 9 consists of the east manufacturing Facility located east of MLK Boulevard and South of 25th Street and is comprised of approximately 88 acres. Plant 9 construction commenced in 1969, and building additions were performed in 1973, 1977, 1981, 1985, and 1989. An AOC and several SWMUs and Areas are associated with Plant 9. These include the AOC 4 – Waking Track Area, Area 3 – SWMU 22 and the former Hazardous Waste Storage, and Area 4 – SMWUs

25 and 26 (Nalco Area). RFI investigations and the results of these areas have been previously discussed in Section 4.

4.11.1 Scope and Results

Sampling and analysis for soil and groundwater investigations at former Plant 9 were initiated in February 1998 by ATC Associates, Inc. (ATC). This work was conducted as part of a Phase 2 Site Assessment and separately from the RFI. A shallow soil sample was collected using a *Geoprobe®* direct push sampler at each of 13 sampling locations (Figure 2.2, GP-1 to GP-13). In addition, borehole water were collected using the *Geoprobe®* at five of these locations (Figure 2.2, GP-1, -5, -6, -8, and -11). Because some of the proposed sampling locations were at or near SWMUs subject to RCRA Corrective Action requirements, GM requested that Earth Tech collect "split" soil and borehole water samples from some of the ATC sampling locations. Split soil samples were obtained by Earth Tech at four locations (GP-5, -6, -7 and -8) adjacent to SWMUs 25 and 26 on February 9, 1998. These samples were analyzed for analysis of VOCs and RCRA metals, following the analytical program established by ATC. Split borehole water samples were collected at GP-5, -6 and -8, and these samples were also analyzed for total RCRA metals and VOCs.

Additional borehole water samples for analysis of RCRA metals was completed by Earth Tech on March 23 and 24 based on the presence of elevated concentrations of total RCRA metals in certain borehole water samples collected in February. These samples were collected in close proximity to the previous GP-1, -5, -6 and -11 locations. All samples obtained by Earth Tech during the February and March sampling events were analyzed for total and dissolved RCRA metals and VOCs.

Soil and borehole water analytical results for former Plant 9 samples are presented in Tables A-1 and A-4 respectively.

4.11.2 Discussion of Results

VOCs were detected at least once in soil samples obtained by ATC include acetone, 2-butanone, 1,1DCA, naphthalene, tetrachlorethene, 1,1,1-trichloroethene, 1,2,4-trimethylbenze and m,p-xylene. No VOCs were detected in any split samples collected by Earth Tech. Arsenic was detected in eleven soil samples obtained by ATC and all four split samples collected by Earth Tech. Barium and lead were detected at all ATC sample locations and Earth Tech split sample locations. Cadmium was detected at three Earth Tech split sample locations GP-5, -7, and -8 at concentrations less than the reported detection limit of <2.0 used for ATC samples. No cadmium was detected in ATC samples. No soil screening criteria were exceeded for VOCs in the soil samples obtained from former Plant 9 locations (Figure 4.21).

Borehole water samples obtained by ATC detected low levels of 1,1,-1TCA, 1,2,4-trmethylbenzene, acetone, chloroethane, m,p,-xylene n-propylbenzene and napthalene at locations GP-5, -6 and -7. Split samples collected by Earth Tech at these same locations detected 1,1,1-TCA, 1,1-DCA, cis-1,2-DCE, chloroethane, and total xylene. The highest levels of VOCs were detected in locations GP-5 and GP-6 inside former Plant 9 and adjacent to SWMUs 25 and 26 (Figure 4.22b). No groundwater screening criteria were exceeded for VOCs in the borehole water samples obtained from former Plant 9 locations (Figure 4.22b).

Total metals detected at least once in borehole water samples collected by ATC and Earth Tech in February 1998 include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Earth Tech split samples obtained from GP-1, -5, -6, and -11 in March 1998 detected dissolved arsenic and barium. A comparison of metal concentrations to screening criteria indicates that total metals (arsenic, barium, cadmium, chromium, lead and selenium) exceed drinking water criteria. However, no groundwater screening criteria were exceeded for dissolved metals.

In every case where a "total" metal constituent was detected, the corresponding "dissolved" concentration is significantly lower. Furthermore, duplicate results for "dissolved" metals agree much more favorably than those for "total" metals. The distinctions between "total" and "dissolved" data indicate that the "total" data are strongly affected by the presence of suspended solids (> 0.45 µm particles) entrained in the unfiltered samples. This material, comprised largely of clay-sized soil particles, is dissolved by the preservative reagent in the sample container, releasing detectable quantities of various naturally occurring metals from the solids to the water matrix. Filtration of the samples prior to preservation, as was performed in the collection of samples for "dissolved" analyses, dramatically reduces the concentration of suspended solids, eliminating the source for the aberrant metals concentrations.

4.11.3 Conclusions

Based on the lack of exceedance of any soil screening criteria for RCRA metals and VOCs, the data indicate that no potentially significant release of hazardous constituents to soil has occurred at former Plant 9.

Based on the lack of exceedance of any groundwater screening criteria for VOCs, the data indicate that no potentially significant release of hazardous constituents to soil has occurred at former Plant 9. Furthermore, the absence of dissolved metals in ground water at concentrations in excess of groundwater screening criteria demonstrates that total metal concentrations in excess of the drinking water criteria are artifacts of sample turbidity, and that there is no significant risk from the detected levels of RCRA metals in groundwater at former Plant 9.

5.0 HUMAN HEALTH RISK ASSESSMENT

5.1 Introduction

The human health risk assessment discussed in this section uses the Facility characterization data that have been collected during the RFI field investigation to evaluate the potential significance of reasonable maximum exposures under current and reasonably expected future land use at and around the Facility. The results of the risk assessment are used to identify where a release of hazardous waste or constituents from the Facility may cause reasonable maximum exposures to be significant enough to warrant corrective measures.

The scope of the human health risk assessment is summarized in the conceptual site model (CSM) shown in Table 5.1. The CSM identifies the scenarios for potential human exposure under current and reasonably expected future conditions at and around the Facility in terms of the potentially exposed populations, the environmental media to which they could be exposed, and the potential routes of exposure. The CSM was developed based on the Facility information and data discussed in Sections 3 and 4, respectively. The scenarios for potential human exposure are further discussed in Section 5.4.

Discussion of the human health risk assessment is organized as follows:

- The evaluation of data used in the risk assessment is discussed in Section 5.2 – Data Collection and Evaluation.
- Section 5.3 – Potentially Significant Releases summarizes the areas and environmental media that have been affected by a potentially significant release, and the primary constituents found in these media.
- The scenarios for potential human exposure are discussed in Section 5.4 – Exposure Assessment, which also discusses the estimation of exposure concentrations and chemical intakes for each exposure scenario.
- Toxicity information for the constituents included in the risk assessment is summarized in Section 5.5 – Toxicity Assessment.
- The risks associated with the potential exposures discussed in Section 5.4 are quantified and their significance is discussed in Section 5.6 – Risk Characterization. Uncertainties associated with the risk estimates are also discussed in this section.
- The findings and conclusions of the human health risk assessment are summarized in Section 5.7 – Summary and Conclusions.

The methods used in the risk assessment are based on US EPA risk assessment guidance, and the interpretation of the risk assessment results is based on US EPA risk management policies for RCRA corrective action, and is also consistent with IDEM's Risk Integrated System of Closure (RISC) (IDEM, 2001).

5.2 Data Collection and Evaluation

5.2.1 Data Collection

The objectives of data collection during the RFI and strategies for determining when additional data collection is necessary were described in the RFI Work Plan (Earth Tech, October 14 1997), the RFI Stage I Report (Earth Tech/ENVIRON 2001), and subsequent work plan amendments. The scope of the RFI field investigation completed to date and a summary of the data collection activities are described in Section 2 of this report.

5.2.2 Data Evaluation

Validation of data collected during the RFI was performed in accordance with the QAPP in the RFI Work Plan. All soil, groundwater, surface water, borehole water, and private water supply well water data included in the data summary tables discussed in Section 4 were validated. In addition, the following procedures were used to prepare the data in these summary tables to support quantitative risk assessment. These procedures, which are based on US EPA guidance on human health risk assessment (US EPA, 1989), are as follows:

- Constituent concentrations qualified as not detected (i.e., U or UJ-qualified data) during data validation are evaluated as non-detects.
- Constituent concentrations qualified as not usable (i.e., R-qualified data) during data validation are not included in the risk assessment.

- Concentrations qualified as estimated (i.e., J-qualified data) are included for quantitative assessment.
- Concentrations in duplicate field samples are averaged to obtain a representative concentration for the sample location. When a constituent was detected in only one sample of a duplicate pair, the average of the detected concentration and one-half the quantitation limit is used in further calculations.
- The concentrations of 1,3-dichloropropene (total), methylphenol (total), and xylenes (total) in a sample are the sums of the concentrations of the detected isomers and half the quantitation limits of isomers not detected in the sample but detected in the same matrix at the Facility. If no isomer is detected in a sample, the constituent is considered to be not detected in the sample.
- Similarly, the concentration of PCBs (total) in a sample is the sum of the concentrations of the detected Aroclors and half the quantitation limits of Aroclors not detected in the sample but detected in the same matrix at the Facility. If no Aroclor is detected in a sample, PCBs are considered to be not detected in the sample.
- Concentrations of metals in soil that are at or below the site-specific background concentrations discussed in Section 3.7 are considered to be within background levels. Concentrations higher than the background levels are conservatively considered to be Facility-related, and are used in the calculation of Facility-related risks. As a conservative assumption, all concentrations of organic constituents are assumed to be Facility-related.

The RFI soil, groundwater, surface water, and water supply well data are evaluated in the risk assessment, but groundwater data from boreholes are not used because they were collected primarily to support the RFI field investigation and they are not the best representation of groundwater quality in the aquifer. The soil data for samples that represent soil that is no longer present in the South Court Area since the Interim Measure has been completed (i.e., SB163 and SB276) are also not included in the risk evaluation. The RFI soil, groundwater, surface water, and water supply well data used in the risk assessment are summarized in Attachment A. The complete laboratory data reports and summaries of the data validation results are provided in the RFI Stage I Report (Earth Tech/ENVIRON 2001) and the RFI Stage II Data Report (Earth Tech 2005).

For this risk assessment AOC 06 and AOI 01 are considered separately from the Area 1 VOC plume as most of the constituents detected in these areas are not associated with the Area 1 groundwater plume. Groundwater data from all other areas investigated during the RFI that are or may be associated with the Area 1 plume are grouped into four areas based on current and potential future groundwater use:

- Area 1 (South Court);
- Area 1 (Plant 6/9);
- Area 1 (West of AOC 05); and
- Area 1 (Golf Course).

5.3 Potentially Significant Releases

5.3.1 Soil

Tables 4.1a and 4.1b summarize the soil characterization data for each area at the Facility, and show the ratios of the highest measured concentrations for each constituent at each area to the screening criteria. As discussed in Section 4.0, the screening criteria used to guide the RFI soil characterization efforts included criteria that are based on direct contact, vapor intrusion, and migration to groundwater (for comparison with the deepest soil samples only). A potentially significant release to soil at an area is identified in the Section 4 tables by comparing the highest concentration of each constituent in surface and subsurface soil at the area to these screening criteria. Ratios of the highest Facility-related concentrations in surface or subsurface soil to the screening criteria that exceed 1.0 (based on two significant figures) are considered indications of a potentially significant release to soil. As shown in Tables 4.1a and 4.2b, the ratios for certain constituents exceed 1.0 at the following areas investigated during the RFI:

- AOC 2 – Former Fire Training Area;
- AOC 6 – Electroform Room;
- AOI 1 – North Parking Lot);
- Area 1 – South Court and Related Areas;
- SWMU 4 – 1002 Preplate Area; and
- SWMU 6 – Nickel Recovery Area.

At AOC 2, AOI 1, and Area 1, arsenic concentrations are higher than the screening criteria based on direct contact. Chromium (total) concentrations are higher than the migration to groundwater criterion at AOC 6 and AOC 3. However, deeper soil sampling at AOC 3 indicates that the chromium concentrations at the locations where such exceedance occurs are below the migration to groundwater criterion (Figure 4.21). Hexavalent chromium was detected at concentrations higher than the migration to groundwater criterion at SWMU 4. Copper concentrations are higher than both the screening criteria based on direct contact and migration to groundwater at AOC 6; copper was also detected at concentrations higher than the migration to groundwater criterion at SMWU 6. Cyanide (total) and cyanide (amenable) concentrations are higher than the migration to groundwater criteria at AOC 6. One soil sample at SWMU 6 showed a nickel concentration higher than the migration to groundwater criterion. Iron concentrations are higher than both the screening criteria based on direct contact and migration to groundwater at AOI 1. It should be noted that these iron concentrations are within typical background levels in Eastern United States soil (Dragun and Chiasson, 1991), although no Facility-specific background data for iron are available.

Four chlorinated VOCs (TCE, 1,1-DCE, cis-1,2-DCE,, and vinyl chloride) are higher than the migration to groundwater criteria at Area 1. Several PAHs (i.e. benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected at concentrations higher than the screening criteria based on direct contact at one location (SB 155) in Area 1. Benzo(a)pyrene was also detected at a concentration that is slightly higher than the screening criterion based on direct contact at one location (BH 3A) in AOI 1. PCBs (total) concentrations are higher than both direct contact and migration to groundwater criteria at Area 1. No constituent has a concentration in soil that is higher than the screening criteria based on vapor intrusion.

The potential for human exposure to constituents in soil at all the areas where field investigations were conducted during the RFI, including the areas where a potentially significant release was identified, is discussed in Section 5.4. The significance of the potential exposures is discussed in Section 5.6.

5.3.2 Groundwater

Groundwater quality data were collected during the RFI from various water-bearing units at and around the Facility, as discussed in Sections 2 and 3. Tables 4.2a and 4.2b show the ratios of the highest concentrations in each of these water-bearing units to the screening criteria. As discussed in Section 4, the screening criteria used to guide the RFI groundwater characterization efforts included criteria that are based on drinking water consumption, vapor intrusion, groundwater direct contact, and nonpotable groundwater use.

A potentially significant release to groundwater is identified in the Section 4 summary tables for groundwater by ratios of the highest concentrations to the screening criteria that exceed 1. Although the screening criteria used for identifying a potentially significant release to groundwater include drinking water criteria, the groundwater at the Facility is not a current or reasonably expected future potable water supply. As discussed in Section 3, the Facility and most of properties adjacent to the Facility are supplied with potable water from the City of Anderson. In addition, a City of Anderson ordinance prohibits installation of new water supply wells in the shallow aquifer. Several off-Facility potable wells are located at adjacent properties, including three at the Meadowbrook Golf Course that will be properly abandoned and will be replaced by the city water supply. However, these potable well locations are outside the area where groundwater is affected by the Facility. Some of the potable wells were sampled during the RFI and the results are discussed in Section 5.3.3.

As shown in Tables 4.2a and 4.2b, constituents with concentrations in the shallow perched aquifer (Unit 1) that are higher than the drinking water criteria consist of metals (i.e. arsenic, cadmium, chromium (total), copper, lead, and nickel), VOCs (i.e. 1,1-DCE; cis-1,2-DCE; trans-1,2-DCE; toluene; 1,1,1-trichloroethane; TCE; and vinyl chloride), and two SVOCs (i.e. methylphenol (total) and bis(2-ethylhexyl)phthalate). Concentrations of TCE, cis-1,2-DCE and vinyl chloride at MW 31 in Area 1 are also are higher than the groundwater direct contact criteria. This well is currently addressed as part of the IM in the South Court Area. No constituent has a concentration in groundwater that is higher than the screening criteria based on vapor intrusion.

Constituents with concentrations in the shallow overburden aquifer (Unit 3s) that are higher than the drinking water criteria consist primarily of metals (i.e. arsenic, cadmium, chromium (total), and lead) and VOCs (i.e. 1,1-DCE; chloroform; cis-1,2-DCE; trans-1,2-DCE; 1,1,1-trichloroethane; TCE; and vinyl chloride). Concentrations of cis-1,2-DCE and vinyl chloride also are higher than the screening criteria based on groundwater direct contact in Area 1. No constituent has a concentration in groundwater that is higher than the screening criteria based on vapor intrusion.

Concentrations in the deeper overburden (Unit 3d) groundwater that are higher than the screening criteria are associated with three VOCs (i.e., TCE, cis-1,2-DCE and vinyl chloride) and two metals (arsenic and lead). However, the metal concentrations exceeding the screening criteria are from monitoring wells located near the maintenance building at the Meadowbrook Golf Course and do not appear to be Facility-related. The concentrations of these constituents are higher than only the drinking water criteria, and are lower than the screening criteria based on vapor intrusion and groundwater direct contact.

Three VOCs (i.e. vinyl chloride, chloroform, and cis-1,2-DCE) were detected in bedrock groundwater. Only vinyl chloride has a concentration that exceeds the drinking water criterion (in bedrock well MW 81 located at the former Plant 9 property). No other concentration in bedrock groundwater exceeds any screening criteria.

The potential for human exposure to constituents in groundwater is discussed in Section 5.4, and the significance of any potential exposures is discussed in Section 5.6.

5.3.3 Surface Water and Off-Site Well Water

Water samples were collected during the RFI from a pond and two potable wells at the Meadowbrook Golf Course and analyzed for VOCs. In addition, analytical data from previous non-RFI investigations are available for water samples collected from the ponds at the Meadowbrook Golf Course and several private potable wells near the Facility, as discussed in Section 3.9. As discussed in Section 4.0, the screening criteria for the potable well water samples are the drinking water criteria, and the screening criteria for the surface water samples are the same as groundwater screening criteria, which are based on drinking water consumption, groundwater direct contact, and non-potable groundwater use.

As shown in Table 4.3 and discussed in Section 3.9, no constituents were detected in any of the off-Facility potable wells. Therefore, potential exposure through potable use of private well water is not evaluated in the risk assessment. However, the potential for human exposures to groundwater through non-potable use of private well water is discussed in Section 5.4, and the significance of any potential exposures is discussed in Section 5.6.

As shown in Table 4.4, several VOCs and one metal (zinc) were detected in surface water samples collected from the ponds at Meadowbrook Golf Course. Vinyl chloride was the only constituent detected at a concentration (in two samples) higher than the drinking water screening criterion. No other screening criteria were exceeded. The samples with the vinyl chloride concentration exceeding the drinking water criterion was collected near the irrigation pump house and along the northern end of the pond in January 2005 when ice on the pond recently melted and was not used for irrigation at the time. The same locations were re-sampled in April and vinyl chloride was not detected in those samples. The potential for human exposures to surface water through irrigation use is discussed in Section 5.4, and the significance of any potential exposures is discussed in Section 5.6.

5.4 Exposure Assessment

This section discusses the potential exposures that are relevant under current and reasonably expected future land use at and around the Facility. The exposure setting, potentially exposed populations, and exposure pathways are discussed in Sections 5.4.1 to 5.4.3, respectively.
For the potential exposures discussed in this section, exposure is quantified as a dose, which is defined as follows:

$$Dose = Concentration \cdot Intake$$

The dose for evaluating cancer risk is averaged over a lifetime and is called a lifetime average daily dose (LADD). For evaluating long-term (or chronic) noncancer effects, the dose is averaged over the period of exposure and is called an average daily dose (ADD).

The concentration term in the dose equation refers to the concentration in an environmental medium to which a population is exposed over a specified period. The intake term refers to the intake rate of the contaminated environmental medium, which is a function of the magnitude, frequency, and duration of exposure. The methods for estimating the concentration term are discussed in Section 5.4.4. The exposure factors that are used to quantify the magnitude, frequency, and duration of potential exposures are discussed in Section 5.4.5.

5.4.1 Exposure Setting

The environmental setting at and around the Facility, including climate, geology, hydrogeology, surface water hydrology, land use, and groundwater use, are discussed in Section 3, and are not repeated in this section.

5.4.2 Potentially Exposed Populations

Based on the discussion of land and groundwater use at and around the Facility in Section 3, the potentially exposed populations at and around the Facility under current and reasonably expected future land use include the following:

- On-Facility: Routine workers
  Construction workers
  Trespassers
  Recreational users (AOC 5 and AOI 1 only)
- Off-Facility: Residents
  Routine workers (Meadowbrook Golf Course)
  Construction workers
  Recreational Users (Meadowbrook Golf Course)
  Trespassers (Meadowbrook Golf Course)

Currently, the main receptor population at the Facility consists of "routine workers," who typically spend most of the work day indoors conducting industrial activities. When outdoors, these routine workers could be exposed to surface soil in unpaved areas and where pavement is removed. Routine workers could also be exposed to volatile constituents in subsurface soil or shallow groundwater via vapor migration into indoor air. A small fraction of the workers ("construction workers") at the Facility conduct occasional subsurface construction or maintenance activities (e.g., installation or repair of underground utilities, or removal or repair of pavement). In areas where surface soil becomes exposed and access is not restricted, trespassers also could be potentially exposed. Additionally, most of the AOC 5 area is currently leased to the City of Anderson and is being used as a small city park where people could be exposed to soil during typical recreational use (e.g., picnics, play, and exercise).

In the future, land use at most of the Facility is expected to remain commercial/industrial. At AOC 5 (currently a city park) and AOI 1 (the currently unused North Parking Lot), land use is expected to be recreational or other non-residential use. Therefore, potentially exposed populations at the Facility in the future are expected to be the same as under current conditions.

The potentially exposed populations in off-Facility areas include routine workers, construction workers, residents, trespassers, and recreational users. Routine workers at the Meadowbrook Golf Course and nearby residents could be potentially exposed to constituents in soil at the Facility via windblown dust and vapors from unpaved areas of the Facility. While indoor, workers and recreational users at the golf course and residents could be exposed to volatile constituents in shallow groundwater via vapor migration into indoor air. Construction activities that extend into the water table downgradient of the Facility could expose workers to constituents in shallow groundwater. In addition, as discussed in Section 3, the Meadowbrook Golf Course uses surface water from a pond for irrigation. As such, trespassers, recreational users, and workers performing groundskeeping activities at the golf course could potentially be exposed to constituents in surface water.

Exposure to groundwater via potable use is not expected in the vicinity of the Facility except for the private wells discussed in Section 5.3.3. However, these wells are not located within the area where groundwater is affected by the Facility, and they have been sampled and found to have no Facility-related constituents, as discussed in Section 5.3.3. Exposure to groundwater via non-potable use is possible, however, since the well survey discussed in Section 3.9 was designed to identify only potable groundwater use.

5.4.3 Exposure Pathways

The exposure pathways evaluated in the risk assessment are summarized in the conceptual site model shown on Table 5.1. Exposure pathways for receptors at the Facility are discussed in Section 5.4.3.1, and exposure pathways for off-Facility receptors are discussed in Section 5.4.3.2.

5.4.3.1 Potential On-Facility Exposures

The potentially exposed populations at the Facility include routine workers, construction workers, trespassers, and recreational users. The types of potential exposures for each receptor population are discussed below.

<u>Routine Workers</u>

Routine workers are expected to be engaged in commercial and/or industrial activities that generally take place indoors. During limited time outdoors, workers could contact soil in unpaved areas and where pavement is removed. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

These workers also could be exposed to constituents in subsurface soil or groundwater if the constituents were to volatilize and migrate through cracks in a building foundation into indoor air.

Exposure of workers via potable or non-potable groundwater use is not expected because groundwater is not used as a water supply at the Facility, and future use of groundwater is not reasonably expected, as discussed in Section 3.9.

Construction Workers

A small fraction of the workers at the Facility could conduct occasional subsurface construction or maintenance, which could put them in contact with surface and subsurface soil in paved and unpaved areas of the Facility. Such subsurface activities are expected to be of limited size and duration.

Potential routes of exposure to soil would include incidental ingestion, dermal contact, and inhalation of vapor and airborne particulates. Construction worker exposures to soil in this risk assessment are indirectly evaluated using risk estimates for routine workers. This streamlines the risk assessment and is conservative because construction worker exposures to soil during occasional excavations would be lower than routine worker exposures to soil (ENVIRON, 2003).

The maximum depth of excavations during occasional construction and maintenance activities is expected to be approximately 10 feet. Where groundwater is present within 10 feet of ground surface, construction workers could be exposed to constituents in groundwater during excavations that extend into groundwater. Potential routes of exposure would include incidental ingestion, dermal contact, and inhalation of vapor. Exposures via these routes are evaluated using exposure factors that are specific to construction workers and assume that the workers do not wear personal protective equipment.

Trespassers

Potential exposure of trespassers is currently possible, although fencing and plant security would control access to the majority of the Facility. Where present, access controls make trespassing unlikely, and would limit the duration of any unauthorized access as well as the types of activities. While at the Facility, trespassers could come into contact with soil in unpaved areas and in paved areas if pavement is removed. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates.

Trespasser exposures to soil at the Facility are indirectly evaluated in this risk assessment using risk estimates for routine workers. This streamlines the risk assessment and is conservative because trespasser exposures to soil would be lower than routine worker exposures to soil (ENVIRON, 2003).

Recreational Users

Recreational users could contact surface soil in unpaved areas at AOC 5, which is currently leased to the City of Anderson and used as a public park. If AOI 1 (a portion of which is currently an undeveloped field) is also developed for similar use, recreational users could contact surface soil in unpaved areas. Potential routes of exposure to surface soil would include incidental ingestion, dermal contact, and inhalation of soil vapor and airborne particulates. Potential exposures of these receptors to soil in this risk assessment are conservatively evaluated using risk estimates based on residential exposures. This streamlines the risk assessment and is conservative because recreational user exposures to soil for current and possible future uses of these areas (e.g., park and playground) are expected to be lower than residential exposures to soil.

While indoor (e.g., in a recreational Facility), these receptors could be exposed to constituents in soil and shallow groundwater if the constituents volatilize and migrate through cracks in building foundations. Such exposures are conservatively evaluated in this risk assessment using risk estimates for residents.

5.4.3.2 Potential Off-Facility Exposures

The potentially exposed off-Facility populations include residents, routine workers, and construction workers. The types of potential exposures for each receptor population are discussed below.

Residents

As discussed in Section 4, the soil characterization data collected during the RFI show that the extent of potentially significant releases to soil does not extend to locations near any residential areas. Therefore, the only potential exposure of residents to soil constituents is via airborne transport from Facility areas that are not paved or otherwise covered. In this risk assessment, such potential exposures are indirectly evaluated using risk estimates for routine workers at the Facility. This approach streamlines the risk assessment and is conservative because airborne exposures in the residential areas are expected to be lower than exposures at the Facility due to much greater air dispersion between an emission source and residential receptors as compared to air dispersion directly over an emission source.

Groundwater from private potable wells is currently used at several residential properties in the vicinity of the Facility. However, these potable wells are not located within the area where groundwater is affected by the Facility, and they have been sampled and found to have no Facility-related constituents. Groundwater is not a reasonably expected future potable water supply at other residences in the vicinity of the Facility, as discussed in Section 3.9. Therefore, potential exposure via potable groundwater use is not evaluated in the risk assessment.

However, the previous well survey of nearby properties was not designed to determine whether non-potable groundwater use exists. As such, it is possible that residents could have non-potable private wells within the area where groundwater is affected by the Facility, and could be exposed to constituents in groundwater during non-potable uses. Potential exposure of residents via non-potable use of groundwater is evaluated in this risk assessment using a “kiddie” pool exposure scenario, which represents a reasonable worst-case among typical non-potable uses. Exposure routes evaluated in this scenario include incidental ingestion, dermal contact, and inhalation of vapors. In addition, indoor inhalation exposure is also possible if constituents in shallow groundwater volatilize and migrate through cracks in building foundations.

Routine Workers

Similar to residents, the only potential exposure of workers at Meadowbrook Golf Course to soil constituents is via airborne transport from Facility areas that are not paved or otherwise covered. To streamline the risk assessment, such potential exposures are indirectly evaluated using risk estimates for routine workers at the Facility as discussed above.

While indoors (e.g., in the club house), workers could be exposed to constituents in shallow groundwater if the constituents volatilize and migrate through cracks in building foundations. To streamline the risk assessment, such exposures are indirectly evaluated using risk estimates for residents as discussed above. In addition, golf course workers could potentially be exposed to surface water through irrigation use of the pond water. Exposure routes evaluated in this scenario include dermal contact and inhalation of vapors, and are conservatively evaluated in this risk assessment using the "kiddie" pool exposure scenario as exposures to surface water from irrigation activities are expected to be much lower than exposures in the residential "kiddie" pool scenario.

Construction Workers

Construction workers at or near Meadowbrook Golf Course who perform excavations that encounters shallow groundwater could be exposed to constituents in groundwater. Potential routes of exposure would include incidental ingestion, dermal contact, and vapor inhalation. Exposures via these routes are evaluated using exposure factors that are specific to construction workers and assume no use of personal protective equipment.

Trespassers

Trespassers at the Meadowbrook Golf Course could potentially be exposed to surface water through irrigation use of the pond water. To streamline the risk assessment, such potential exposures are indirectly evaluated using risk estimates for routine workers at the golf course as discussed above because trespasser exposures to surface water are expected to be lower than routine worker exposures to surface water.

Recreational Users

Recreational users at the Meadowbrook Golf Course could potentially be exposed to surface water through irrigation use of the pond water, and to constituents in shallow groundwater if the constituents volatilize and migrate through cracks in building foundations (e.g. in the clubhouse). To streamline the risk assessment, such potential exposures are indirectly evaluated using risk estimates for routine workers at the golf course as discussed above because recreational user exposures to these media are expected to be lower than those for routine workers.

5.4.4 Estimation of Exposure Concentrations

This section discusses the estimation of exposure concentrations for the media to which receptors could be exposed in the exposure scenarios summarized in the conceptual site model (Table 5.1).

Section 5.4.4.1 discusses the calculation of exposure concentrations in soil. The calculation of exposure concentrations in groundwater and surface water is discussed in Section 5.4.4.2. The fate and transport models used to estimate exposure concentrations in certain exposure scenarios are discussed in Section 5.4.4.3.

5.4.4.1 Soil

Reasonable maximum exposures (RME) are conservatively estimated in this risk assessment by using the maximum detected concentrations at each area for most constituents and the 95% upper confidence limits (UCLs) on the mean for certain constituents, if sufficient data are available. In this approach, maximum concentrations are first used to calculate bounding estimates of cumulative cancer and noncancer risks. If these bounding estimates of RME risks do not exceed EPA's cumulative cancer and noncancer risk triggers for corrective measures (i.e., cumulative cancer risk of 10^{-4} and noncancer hazard index (HI) of 1), then further calculations are not necessary. Consistency between using a cumulative cancer risk limit of 10^{-4} for this RFI and IDEM's RISC is discussed in Section 5.6.1.

If a bounding estimate exceeds a trigger for corrective measures, then the bounding estimate is refined by replacing the maximum concentrations that contributed the most to the bounding estimate with 95% UCLs. Experience with this approach at many facilities shows that cumulative cancer and noncancer risk estimates are often influenced by only a few constituents. This means the computation of 95% UCLs, which can be time-consuming, is usually necessary for only a few constituents.

The use of maximum concentrations for many constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure to many constituents constantly, when the RME generally would not have so many constituents at worst-case concentrations at all times. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.6.5.

The 95% UCL for a constituent is calculated using the nonparametric bootstrap method known as the bias-corrected and accelerated (BCa) method with 4,000 bootstrap replications (Efron and Tibshirani 1998). A nonparametric bootstrap confidence interval does not rely on assumptions about the data's underlying probability distribution which are often difficult to confirm, but instead are based on statistical re-sampling of the empirical distribution of the observed concentrations. For an empirical distribution that is approximately normal, the bootstrap confidence interval will be essentially the same as the normal confidence interval. For an empirical distribution that is not normal, however, the bootstrap confidence interval will be more accurate than a confidence interval calculated assuming a normal (or even lognormal) distribution (US EPA, 1997c).

The constituents selected for 95% UCL calculations are those with maximum concentrations that contribute the most to the initial bounding estimates of the RME cumulative risks, if these data sets have at least eight data points. Using 95% UCLs for these constituents and maximum concentrations for other constituents still overestimates the RME cumulative risks, but is an efficient approach that avoids 95% UCL calculations that would not materially affect cumulative risk estimates, and is consistent with US EPA guidance (1989; p 6-25). UCLs were not calculated for data sets with less than eight data points, because nonparametric BCa bootstrap UCLs might be less reliable for these smaller data sets.

5.4.4.2 Groundwater and Surface Water

Exposure concentrations for groundwater and surface water are conservatively estimated using the highest detected concentrations in these media in each area. As discussed above, the use of maximum concentrations introduces more conservatism than necessary for RME estimates. In addition, the maximum concentrations in unfiltered and filtered water samples for metals, where both data are available, are conservatively used to evaluate all exposure routes even though filtered concentrations are more appropriate for calculating risks for the dermal and inhalation exposure routes. The uncertainties associated with the use of such conservative estimates of exposure concentrations in evaluating the significance of potential exposures is discussed in Section 5.6.5.

5.4.4.3 Fate and Transport Models

The following models are used to estimate exposure concentrations for the exposure scenarios discussed in Section 5.4.3. These models are used by US EPA and state regulatory agencies for screening-level analysis. The following are brief descriptions of the models. Further details of these models are provided in Attachment C.

<u>Vapor Intrusion into Buildings</u>

Indoor air concentrations that might result from migration of vapors from soil or groundwater into a building are estimated using the model described by Johnson and Ettinger (1991), which US EPA recommends for screening-level evaluations (US EPA 2003a). The calculations in this risk assessment are conservatively based on hypothetical commercial/industrial buildings that are smaller than the actual buildings at the Facility. The characteristics of the hypothetical commercial/industrial and residential buildings are modeled using conservative assumptions from regulatory guidance for these building types (US EPA, 2003a; MDEQ, 2004). Site-specific data for soil properties collected during the RFI are also used in the calculations, which include estimation of the soil moisture profile using HYDRUS (1998). A discussion of the Johnson and Ettinger model and HYDRUS model, and the input parameters used in the assessment is provided in Attachment C.

<u>Vapor Emission from Exposed Groundwater</u>

The model for estimating vapor emissions from exposed groundwater in an open excavation pit that extends into the water table and from a residential kiddie pool is based on mass-transfer coefficients recommended in US EPA guidance (US EPA, 1995c). The vapor emission from excavation is modeled as a 15-ft by 15-ft open pit. The residential kiddie pool is modeled as a 6-ft diameter tank that is 9 inches deep, and is assumed to be filled with groundwater once per day.

<u>Air Dispersion</u>

Air concentrations are estimated using US EPA's SCREEN3 air dispersion model (US EPA, 1995a). The area-source algorithm in SCREEN3 is used with default and region-specific meteorological parameters to estimate maximum 1-hour concentrations at ground level. Source areas are approximated as square sources.

For the construction worker scenario, the maximum 1-hour air concentrations are converted to maximum 24-hour average air concentrations using a conservative factor of 0.4. The air concentrations estimated in this approach are conservative (i.e., expected to predict concentrations higher than actual concentrations to which receptors would be exposed). The outdoor air concentrations due to vapor emission from a kiddie pool are conservatively based on maximum 1-hour air concentrations, to correspond with the time-scale of these potential exposures (as discussed in Section 5.4.5.4).

Uncertainties inherent in the models and assumptions used in estimating exposure concentrations are discussed in Section 5.6.5.

5.4.5 Estimation of Intakes

The exposure factors for evaluating the exposure scenarios summarized in the CSM and discussed in Section 5.4.3 are discussed in this section. In this risk assessment, standard default exposure factors recommended by US EPA for estimating reasonable maximum exposures are used where available and appropriate. Where standard default exposure factors are not available or not appropriate for an exposure scenario, the evaluation is conducted using similarly conservative exposure factors that are based on site-specific considerations and professional judgment.

5.4.5.1 Routine Workers

In this risk assessment, potential exposure of routine workers to soil is conservatively evaluated using the exposure factors that US EPA Region 9 used in deriving its PRGs (2004a). These exposure factors are standard default exposure factors recommended by US EPA (1991a) for estimating RME, except Region 9 used a soil ingestion rate of 100 mg/day which is twice the standard default rate of 50 mg/day. According to US EPA, the standard default exposure factors are conservative assumptions about the magnitude, frequency, and duration of exposures, which in combination are intended to provide estimates of exposures that are higher than actual exposures to a large portion (90% to 99%) of a potentially exposed population.

Although it is recognized that the use of these exposure factors, rather than site-specific factors, results in overestimation of RME risks at the Facility, this approach streamlines the risk assessment by allowing risk estimates to be calculated very efficiently from the PRGs. The evaluation is also streamlined because the added conservatism in the PRG-based risk estimates allows them to be used as conservative estimates for other receptors. In this risk assessment, the industrial PRGs are conservatively used to evaluate potential exposures of construction workers and trespassers to soil, because the exposure to these receptors are expected to be lower than those assumed in the PRGs (ENVIRON 2003).

For the evaluation of potential exposures associated with vapor intrusion from soil and groundwater, the number of days for routine workers to be at the Facility is assumed to be 250 days, which is assumed to occur at a frequency of 5 days/week for 50 weeks per year. The exposure duration is assumed to be 25 years. US EPA has recommended the use of these values for evaluating high-end routine worker exposures (US EPA, 1991a). The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (US EPA, 1989).

5.4.5.2 Construction Workers

Potential exposure of construction workers to soil is conservatively evaluated using the risk estimates for routine workers as described in Section 5.4.5.1. The exposure factors used for evaluating potential exposure of construction workers to groundwater are as follows:

Groundwater Ingestion Rate

A rate of 0.005 L/hour is used for incidental ingestion of groundwater during construction work in excavations that extend into groundwater. This rate is 10% of the rate that US EPA (1989) recommends for ingestion while swimming, and represents a very conservative estimate of incidental groundwater ingestion that could occur while workers are in an excavation pit.

Groundwater Dermal Contact Rates

The exposed skin surface area of 3,300 cm^2 is the US EPA-recommended skin area for evaluating high-end contact by workers in industrial settings (US EPA 2004a). Workers are conservatively assumed to be covered with groundwater over this exposed skin surface area for 2 hours per event. The absorbed dose for organic chemicals is estimated using a nonsteady-state approach (US EPA 2004b), which is more conservative than the steady-state approach (US EPA, 1989), particularly for hydrophobic chemicals.

Exposure Frequency and Duration

The number of days of construction/maintenance activities is assumed to be 50 days, which is assumed to occur at an average frequency of 5 days/year for a period of 10 years. This combination of exposure frequency and exposure duration is expected to be conservative for the amount of time that workers are actually in contact with groundwater (as opposed to the total time for maintenance or construction, which typically includes time not associated with excavation). The assumption of 5 days/year can represent the time for a few small repairs per year or one larger repair. The duration of 10 years is more than twice the length of time that workers typically work at one location (US EPA, 1997b).

Body Weight

The body weight of 70 kg is the standard US EPA-recommended body weight for assessing exposure to adults (US EPA, 1989).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (US EPA, 1989).

5.4.5.3 Recreational Users

In this risk assessment, potential exposure of recreational users to soil is conservatively evaluated using the exposure factors that US EPA Region 9 used in deriving its residential PRGs (2004a). These exposure factors are standard default exposure factors recommended by US EPA (1991a) for estimating RME. Although it is recognized that the use of these exposure factors, rather than site-specific factors, results in overestimation of RME risks for these receptors, this approach streamlines the risk assessment by allowing risk estimates to be calculated very efficiently from the PRGs.

5.4.5.4 Residents

The exposure factors for evaluating potential exposures of residents in the kiddie pool scenario and via vapor intrusion are as follows.

<u>Groundwater Ingestion Rate</u>

A rate of 0.05 L/hour is conservatively used for incidental ingestion of groundwater in the kiddie pool scenario. This rate is the rate that US EPA (1989) recommends for ingestion while swimming.

<u>Groundwater Dermal Contact Rate</u>

The exposed skin surface areas of 6,880 cm^2 and 18,150 cm^2 are used for evaluating high-end residential exposure of children and adults, respectively, in the kiddie pool scenario. These skin surface areas based on the average of male and female total body area for these age groups (US EPA, 1997). Residents are assumed to be covered with groundwater over this exposed skin surface area for 2 hours per event. The absorbed dose for organic chemicals is estimated using the nonsteady-state approach (US EPA 2004b).

<u>Exposure Frequency</u>

An exposure frequency of 36 days per year is used for evaluating high-end residential exposure of children and adults in the kiddie pool scenario, based on three events/week for 3 months when the air temperature is above 70 F (NOAA, 1993). An exposure frequency of 350 days per year is used for evaluating high-end residential exposure of children and adults via vapor intrusion (US EPA, 1991a). This exposure frequency assumes daily exposure at the residence, except for two weeks per year away from home (e.g., while on vacation).

<u>Exposure Duration</u>

The exposure duration is 30 years and is based on the US EPA-recommended exposure duration for evaluating high-end residential exposures (US EPA, 1991a). The exposure duration for the age-adjusted resident is 6 years and 24 years for the child and adult (US EPA, 1999a). It is the 95th percentile number of years residents live at one location.

<u>Body Weight</u>

The body weights of 70 kg and 15 kg are the standard US EPA-recommended body weights for assessing exposure to adults and children, respectively (US EPA, 1989).

Averaging Time

The averaging time for evaluating cancer risk is equal to a lifetime of 70 years, and the averaging time for evaluating noncancer risk is equal to the exposure duration (US EPA, 1989).

Uncertainties associated with the exposure factors used in estimating chemical intakes are discussed in Section 5.6.5.

5.5 Toxicity Assessment

A toxicity assessment identifies potential adverse health effects that are associated with exposure to chemicals, and determines the dose-response relationship between exposure and the occurrence of adverse effects. Toxicity information used in the risk assessment is derived from two categories of sources. The toxicity values that US EPA Region 9 used in developing its PRGs are implicitly used in cancer and noncancer risk estimates that are derived using the PRGs. The toxicity values used in deriving site-specific soil and groundwater screening criteria, and the associated estimates of cumulative cancer and noncancer risks, were compiled from the following US EPA hierarchy of sources (US EPA 2003b):

1. Integrated Risk Information System (IRIS)
2. Provisional Peer Reviewed Toxicity Values (PPRTV)
3. Other Toxicity Values (e.g., historical HEAST and NCEA provisional values)

When a toxicity value was not available from the first two tiers of sources, other US EPA sources of toxicity values were consulted. Provisional Peer Reviewed Toxicity Values from the National Center for Environmental Assessment (NCEA) are preferred over values from HEAST (Health Effects Assessment Summary Tables; US EPA, 1997a) when they represent more recent Agency guidance. When a toxicity value was not available from these sources, other US EPA and non-US EPA sources of toxicity values were consulted. The toxicity values used in the risk assessment and their sources are summarized in Attachment C, and are discussed below.

5.5.1 Toxicity Values for Carcinogens

US EPA considers chemicals belonging to the following US EPA cancer weight-of-evidence groups as human carcinogens:

Group A	Known Human Carcinogen: Sufficient evidence of carcinogenicity in humans
Group B1	Probable Human Carcinogen: Limited evidence of carcinogenicity in humans
Group B2	Probable Human Carcinogen: Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans
Group C	Possible Human Carcinogen: Limited evidence of carcinogenicity in animals and inadequate or lack of evidence in humans

As shown in Attachment C, US EPA has designated some of the constituents as Group B2 or Group C, which means that US EPA acknowledges that there is either inadequate or a lack of evidence that these constituents actually cause cancer in humans. Therefore, evaluating these constituents as human carcinogens in the risk assessment is highly conservative.

US EPA-derived cancer slope factors (SFs) and inhalation unit risk factors (URFs) for these constituents and their sources are shown in Attachment C. The oral SFs and URFs represent 95% upper confidence bounds on the probability of getting cancer over a lifetime per unit dose. As recognized by US EPA, there is significant scientific evidence that some of the SFs and URFs may be overly conservative and may ignore the potential existence of threshold doses. Nonetheless, they are used here as conservative assessment tools.

5.5.2 Toxicity Values for Noncarcinogens

Constituents designated by US EPA as belonging to the cancer weight-of-evidence Group D (Not Classifiable as to Human Carcinogenicity) are considered noncarcinogens. Constituents not designated as belonging to any cancer group are treated as noncarcinogens. US EPA-derived chronic reference doses (RfDs) and chronic inhalation reference concentrations (RfCs) for these constituents and their sources are shown in Attachment C.

The oral RfDs and inhalation RfCs represent conservative estimates of the daily exposure to the human population, including sensitive subpopulations (e.g., children), which are likely to be without an appreciable risk of deleterious effects during a lifetime. These RfDs and RfCs typically incorporate several safety factors to account for uncertainties in their derivation, which in combination often result in overall uncertainty factors of 1,000 or more. Furthermore, for many constituents, there is significant scientific debate about the validity of these RfDs and RfCs, and the association of these doses and concentrations to actual adverse health consequences. Nonetheless, the RfDs and RfCs are used here as conservative assessment tools.

5.5.3 Extrapolation of Toxicity Values

The US EPA sources of toxicity values do not provide dermal toxicity values for any of the constituents. Therefore, oral toxicity values (i.e., oral SFs and RfDs) are used as dermal toxicity values in this risk assessment. Adjustments to the oral toxicity values are made in this route-to-route extrapolation based on US EPA guidance (US EPA 2004b).

The US EPA sources of toxicity values do not provide inhalation toxicity values (URFs and RfCs) for all of the constituents. For a constituent that has no inhalation toxicity value, the oral SF and/or RfD, if available, is converted to an URF and/or RfC using default US EPA assumptions (US EPA, 1997a).

Uncertainties introduced by using extrapolated toxicity values are discussed in Section 5.6.5.

5.6 Risk Characterization

The health significance of the potential exposures identified in Section 5.4 is discussed in the following subsections. Section 5.6.1 describes the methods for quantifying cancer risks and noncancer hazard indices. Section 5.6.2 discusses the risk estimates and the significance of the potential exposures associated with chemicals other than lead. Section 5.6.3 discusses the significance of potential exposures to lead. Uncertainties in the risk evaluation are discussed in Section 5.6.5.

5.6.1 Cancer Risk and Noncancer Hazard Index

The cancer risk associated with potential exposure to a carcinogenic chemical is calculated by multiplying an estimate of the lifetime average daily dose (LADD) for a particular exposure scenario by the cancer slope factor (SF) for the chemical, as follows:

$$Risk = LADD \cdot SF$$

For the inhalation route, the inhalation cancer risk is calculated using the chemical concentration in air (C_{air}) and the URF, as follows:

$$Risk = C_{air} \cdot URF \cdot \frac{EF \cdot ED}{AT}$$

where EF is exposure frequency, ED is exposure duration, and AT is averaging time.
The noncancer hazard quotient (HQ) associated with potential exposure to a noncarcinogenic chemical is calculated by dividing an estimate of the average daily dose (ADD) for a particular exposure scenario by the reference dose (RfD) for the chemical, as follows:

$$HQ = \frac{ADD}{RfD}$$

For the inhalation route, the inhalation HQ is calculated using C_{air} and the RfC, as follows:

$$HQ = \frac{C_{air}}{RfC} \cdot \frac{EF \cdot ED}{AT}$$

The potential cancer risk and noncancer effects that may result from exposure to the combination of constituents at an area are estimated following US EPA guidance (1989), as follows:

$$Cumulative\ Risk = \sum_i Risk_i$$

$$Hazard\ Index = \sum_i HQ_i$$

where:

$Risk_i$	=	estimated cancer risk for the *i*th constituent
HQ_i	=	hazard quotient for the *i*th constituent

This approach may result in estimates of cumulative cancer and noncancer risks that are more conservative than necessary. For example, different chemicals may cause different and unrelated health effects, so summing the HQs for their individual effects would overestimate the significance of their combined effect. As such, estimates based on this approach are further evaluated where necessary (e.g., by segregating HIs by target organs and/or mode of action). Uncertainties associated with this approach are discussed in Section 5.6.5.

The cumulative cancer risk and HI estimates for each receptor population are compared with US EPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively, for determining whether corrective measures are warranted for a particular area of the Facility (61 FR, 19432 May 1, 1996; US EPA, 1991b). These limits are also consistent with the target levels for a non-default risk assessment in IDEM's Risk Integrated System of Closure (RISC) (IDEM, 2001). In particular, this risk assessment uses many highly conservative assumptions to address uncertainties in a way that ensures the estimated cumulative cancer risks and noncancer risks are virtually certain to be higher than the risks actually associated with the reasonable maximum exposure, The preceding discussion throughout Section 5 described these conservative assumptions and how they were used to address uncertainties in the spatial and temporal distribution of chemicals (Section 5.4.4), uncertainties in the magnitude, frequency, and duration of exposure to receptors (Section 5.4.5), uncertainties in the potential for chemicals to cause adverse health effects (5.5), and uncertainties in interactions between these other uncertainties (Section 5.6.1). These conservative methods for addressing uncertainties are summarized below in Section 5.6.5 (Uncertainty Analysis). Because this risk assessment addresses uncertainties in a highly conservative manner, using a cumulative cancer risk limit of 10^{-4} is consistent with IDEM's RISC guide (IDEM 2001). The risk estimates and results of the comparison to the cancer and noncancer risk limits are discussed in the following sections.

5.6.2 Risk Estimates for Potentially Exposed Populations

5.6.2.1 Routine Workers

The significance of estimated risks associated with potential exposure of Facility routine workers to soil via direct contact (e.g. incidental ingestion, dermal contact, and inhalation of vapors and airborne particulates), and to soil and groundwater via vapor intrusion is discussed below.

Soil

Potential exposure of routine workers at the Facility to exposed outdoor soil through direct contact was first evaluated using upper-bound estimates of RME cumulative cancer and noncancer risks to streamline the risk evaluation, as explained in Section 5.4.4. The initial estimates were calculated using maximum Facility-related concentrations for all constituents detected in soil at an area and the US EPA Region 9 PRGs (2004a). These estimates are considered bounding estimates because the RME risks for an area would be lower if concentrations representative of the area were used instead of maximum concentrations, and if site-specific exposure factors were used to account for the magnitude, frequency, and duration of exposures appropriate for the area.

The bounding estimates of Facility-related cumulative cancer and noncancer risks were compared to US EPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively. The bounding estimates of cumulative cancer risk and HI for potential exposure of routine workers to exposed outdoor soil based on the maximum concentrations for all constituents detected in soil are summarized on Table 5.2. The table shows that the bounding risk estimates for the following areas investigated during the RFI do not exceed the cumulative cancer risk limit of 10^{-4} and the HI limit of 1:

- AOC 2 − Former Fire Training Area;
- AOC 3 − East Chromium Area;

- AOC 4 − Walking Track Area;
- AOC 5 − West Impoundment Area;
- AOC 7 − 400 Plating Area;
- AOI 1 − North Parking Lot;
- AOI 2 − Chromium Recovery Unit;
- AOI 3 − Bay R4 Area;
- Area 2 − 352 Plating, 309 Plating, and Acid Caustic Strip Tank Areas;
- Area 3 − East Storage Area;
- Area 4 − Nalco Areas (SWMU 25 and SWMU 26);
- SWMU 4 − 1002 Preplater Area; and
- SWMU 6 − Nickel Recovery Area.

In addition, the bounding estimates of cumulative cancer risk and noncancer HI associated with background levels of metals in soil (see Section 3.7) are shown in Table 5.2. The estimates of risks associated with background metal concentrations are low relative to the risk limits, and are not included in the Facility-related risk estimates. As shown on Table 5.2, no estimate for these areas exceeds the cancer risk limit of 10^{-4} or the HI limit of 1.

As shown in Table 5.2, the bounding estimates of Facility-related cumulative cancer risk and/or HI exceed the US EPA limits for the following areas:

- AOC 6 − Electroform Room; and
- Area 1 − South Court and Related Areas.

The risk estimates for these two areas were refined by using data from only the top 2 feet of soil, which is the maximum depth that routine workers are expected to encounter in unpaved areas. The risk estimates were also refined by using 95% UCLs for the constituents that contributed greatest to the bounding estimates of risks, as explained in Section 5.4.4.1. Attachment C shows the constituents that were selected for 95% UCL calculations at each area, and the associated high-end risk calculations that use the 95% UCLs along with the maximum detected concentrations for the other constituents. The high-end risk estimates for these areas are included on Table 5.3, which shows that no estimate exceeds the cancer risk limit of 10^{-4} or the HI limit of 1.

In areas where buildings are currently located or where constructed in the future, routine workers also could be exposed to volatile constituents in subsurface soil to the extent that such constituents volatilize and migrate through building foundation cracks into indoor air, as discussed in Section 5.4.3. These exposures were evaluated by comparing the maximum concentrations for all volatile constituents detected in soil at the areas investigated during the RFI to conservative screening criteria derived from occupational inhalation limits that are applicable to current operations at the Facility. Derivation of these screening criteria is discussed in Attachment C. The ratios of the maximum detected concentrations to the screening criteria for each area are also included in Attachment C. The sum of the ratios for each area is summarized on Table 5.4, which shows that all sums are much less than 1. This means that vapor intrusion, if it were to occur as assumed, would contribute insignificantly to the allowable level of occupational exposure under OSHA.

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The vapor intrusion pathway is also evaluated for the case where OSHA regulations are not applicable either currently or in a future scenario. This evaluation is conducted by calculating upper-bound estimates of cumulative cancer risk and HI using maximum detected concentrations of all volatile constituents in soil at each area. Details of these calculations are provided in Attachment C. The bounding estimates for this scenario are summarized on Table 5.4, which shows that none of the risk estimates exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

Groundwater

In areas where buildings are currently located or where constructed in the future, routine workers could be exposed to volatile constituents in the groundwater to the extent that such constituents volatilize and migrate through building foundation cracks into indoor air, as discussed in Section 5.4.3. These exposures were evaluated by comparing the maximum concentrations for all volatile constituents detected in groundwater at the areas investigated during the RFI to conservative screening criteria derived from occupational inhalation limits that are applicable to current operations at the Facility. Derivation of these screening criteria is discussed in Attachment C. The ratios of the maximum detected concentrations to the screening criteria for each area are also included in Attachment C. The sum of the ratios for each area is summarized on Table 5.5, which shows that all sums are much less than 1. This means that vapor intrusion from volatile constituents in groundwater, if it were to occur as assumed, would contribute insignificantly to the allowable level of occupational exposure under OSHA.

The vapor intrusion pathway is also evaluated for the case where OSHA regulations are not applicable either currently or in a future scenario. This evaluation is conducted by calculating upper-bound estimates of cumulative cancer risk and HI using maximum detected concentrations of all volatile constituents in groundwater at each area. Details of these calculations are provided in Attachment C. The bounding estimates for this scenario are summarized on Table 5.5, which shows that none of the risk estimates exceed the cancer risk limit of 10^{-4} and the HI limit of 1. The highest cumulative cancer risk estimate is 3×10^{-6}, and the highest HI estimate is 0.2.

5.6.2.2 Construction Workers

The significance of risks associated with potential exposure of construction workers to soil and groundwater is discussed below.

Soil

Potential exposure of Facility construction workers to soil is evaluated indirectly using exposure estimates for routine workers for all areas investigated during the RFI as explained in Section 5.4.3. This streamlines the risk assessment and is conservative because construction worker exposures for occasional excavations would be lower than routine worker exposures. Therefore, the cumulative risk and HI estimates for construction workers are expected to be no higher than the estimates for routine workers that are discussed in Section 5.6.2.1 and summarized in Table 5.2, which shows that AOC 6 and Area 1 are the only areas with estimates that are higher than the cancer risk limit of 10^{-4} and the HI limit of 1.

The cumulative cancer risk and HI risk estimates for AOC 6 and Area 1 were refined by using soil data from 0 to 10 ft bgs, which is the depth interval that construction workers are expected to encounter. The estimates were also refined by using the 95% UCLs for the constituents that contributed greatest to the bounding estimates of risks. Attachment C shows the constituents that were selected for 95% UCL calculations at each area, and the associated high-end risk calculations that use the 95% UCLs along with the maximum detected concentrations for the other constituents. The high-end risk estimates for these areas are included on Table 5.6, which shows that no estimate exceeds the cancer risk limit of 10^{-4} or the HI limit of 1.

Groundwater

Potential exposure of Facility and off-Facility construction workers to groundwater through direct contact is evaluated using the highest detected constituent concentrations in groundwater. The bounding estimates of cumulative cancer risk and HI for potential exposure of construction workers to groundwater are summarized in Table 5.7, which shows that all areas have estimates that do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1, except the South Court portion of Area 1 where the noncancer HI is higher than 1.

For the South Court area, refined bounding estimates were calculated using the highest detected groundwater constituents from the shallow groundwater (up to 10 ft bgs), except for MW-31 where institutional control will be implemented until the interim measure on the groundwater is completed. The refined estimates for the South Court portion of Area 1 are included on Table 5.8, which shows that no estimate exceeds the cancer risk limit of 10^{-4} or the HI limit of 1.

5.6.2.3 Recreational Users

The significance of risks associated with potential exposure of recreational users to soil and groundwater at AOI 1 and AOC 5 is discussed below.

Soil

Recreational users at AOC 5 (currently a park) and potential future receptors at AOI 1 (a portion of which is currently an undeveloped field), could be exposed to constituents in exposed soil. These exposures are evaluated indirectly using exposure estimates for residents. This streamlines the risk assessment and is conservative because recreational exposures associated with typical activities at parks would not exceed residential exposures, as described in Section 5.4.3.1. The bounding estimates of cumulative cancer and noncancer risks were calculated using maximum Facility-related concentrations for all constituents detected in soil at these areas, and were compared to US EPA's cancer risk limit of 10^{-4} and HI limit of 1, respectively. Table 5.9 shows that the bounding risk estimates for cumulative cancer risk for both areas and the noncancer HI for AOC 5 do not exceed the US EPA limits.

The bounding estimate of noncancer HI exceeds the limit of 1 for AOI 1, so the significance of potential exposure to exposed soil at this area was refined by using the maximum concentrations in shallow soil (i.e., 0 to 2 ft bgs) and the 95% UCLs for the constituents in that contributed greatest to the bounding estimates of risks (i.e., arsenic and cadmium). The constituents that were selected for calculation of 95% UCLs and the risk calculations for this area are shown in Attachment C. Table 5.10 shows the refined cumulative cancer risk and HI estimate for AOI 1 based on the use of 95% UCLs, which is below the US EPA limits.

If either AOI 1 or AOC 5 were to be developed with buildings for recreational use in the future, recreational receptors could potentially be exposed to volatile constituents in soil through migration of vapors through building foundations into indoor air. Potential indoor inhalation exposure of future receptors is indirectly evaluated using exposure estimates for residential users. This streamlines the risk assessment and is highly conservative because exposures of these receptors via vapor intrusion would not be expected to exceed residential exposures. Details of the calculations are provided in Attachment C. The bounding estimates were calculated using maximum detected concentrations of all constituents in soil at AOI 1 and AOC 5. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 5.11, which shows that soil at these areas has estimates that do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

Groundwater

If AOI 1 and the portion of Area 1 west of AOC 5 were to be developed with buildings in the future, recreational receptors in these areas could potentially be exposed to volatile constituents in groundwater through migration of vapors through building foundations into indoor air. Potential exposure to these receptors for this scenario, are indirectly evaluated using exposure estimates for residential users. This streamlines the risk assessment and is conservative because exposures via vapor intrusion in these areas would not be expected to exceed residential exposures. Details of the calculations are provided in Attachment C. The bounding estimates were calculated using maximum detected concentrations of all constituents in groundwater at each area. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 5.12, which shows that groundwater at all areas has estimates that do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

5.6.2.4 Residents

The significance of risks associated with potential exposure of residents in the vicinity of the Facility to soil and groundwater is discussed below.

Soil

As discussed in Section 4, the soil characterization data collected during the RFI show that the extent of potentially significant releases to soil does not extend to locations near any residential areas. Therefore, the only potential exposure of residents to soil constituents is via airborne transport from the Facility areas that are not paved or covered.

In this risk assessment, such potential exposures to soil via windblown soils from the Facility are indirectly evaluated using risk estimates for routine worker exposure to soil at the Facility. Therefore, the cumulative risk and HI estimates for this scenario are expected to be no higher than the estimates for routine workers discussed in Section 5.6.2.1. (see

Table 5.2 and 5.3). These results show that no estimate exceeds the cancer risk limit of 10^{-4} or the HI limit of 1.

Groundwater

Bounding estimates of cumulative cancer risk and HI were calculated for residential exposures to constituents in groundwater that are assumed to volatilize and migrate through foundation cracks into indoor air of residential buildings located downgradient of the Facility (e.g., around the golf course). The bounding estimates were calculated using maximum detected concentrations of all constituents in groundwater downgradient of the Facility investigated during the RFI. Details of the calculations are provided in Attachment C. The estimates of cumulative cancer risk and HI for this scenario are summarized in Table 5.13, which shows that cumulative risk estimates do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

As discussed in Section 5.4.3.2, the groundwater sampling at potable wells located on properties near the Facility, including residential properties, did not detect the presence of any Facility-related constituents. However, the previous well survey of nearby properties was not designed to determine whether nonpotable private wells are present. Therefore, potential exposure of residents to groundwater constituents through nonpotable use of well water is possible. The exposure via nonpotable use of groundwater is evaluated using a "kiddie" pool exposure scenario, which represents a reasonable worst-case among typical nonpotable uses. Details of the "kiddie" pool calculations are provided in Attachment C. The bounding estimates were calculated using maximum detected concentrations of all constituents in groundwater downgradient of the Facility investigated during the RFI, i.e, Area 1 (Golf Course). The results are shown in Table 5.13, which shows that the noncancer HI for the nonpotable groundwater use does not exceed the US EPA limit of 1, but the cancer risk of 2 x 10^{-4} slightly exceeds the US EPA limit of 10^{-4}. The exceedance of the cumulative cancer risk for this exposure scenario is primarily attributed to the vinyl chloride concentration at one monitoring well (MW-4) in Unit 3d. However, no wells currently exist in the area of MW-4, and a City of Anderson ordinance prohibits installation of new water supply wells in the shallow aquifer. The cumulative cancer risk based on the maximum concentrations for the remaining groundwater data (excluding MW-4) does not exceed the cancer risk limit of 10^{-4}.

5.6.2.5 Golf Course Workers

The significance of risks associated with potential exposure of Meadowbrook Golf Course workers to soil, groundwater, and surface water is discussed below.

Soil

As discussed in Section 4, the soil characterization data collected during the RFI show that the extent of potentially significant releases to soil does not extend to locations near Meadowbrook Golf Course. Therefore, the only potential exposure of golf-course workers to soil constituents is via airborne transport from the Facility areas that are not paved or covered. In this risk assessment, such exposures are indirectly evaluated using risk estimates for routine worker exposure to soil at the Facility. Therefore, the cumulative risk and HI estimates for this scenario are expected to be no higher than the estimates for routine workers discussed in Section 5.6.2.1 (see Table 5.2 and 5.3). These results show that no estimate exceeds the cancer risk limit of 10^{-4} or the HI limit of 1.

Groundwater

As discussed in Section 2.6.2, the Meadowbrook Golf Course currently has two potable wells currently in use. However, these potable wells are not located within the area of the plume, and will be properly abandoned and will be replaced by the city water supply. Nor is groundwater a reasonably expected future potable water supply, as discussed in Section 3.9. Therefore, potential exposure to golf course workers via potable groundwater use is not evaluated.

Potential exposures of golf course workers to volatile constituents in groundwater while indoor (e.g., in the club house) via the vapor intrusion pathway are evaluated indirectly using the risk estimates for residential exposures shown on Table 5.13. This streamlines the risk assessment and is conservative because golf course worker exposures would be lower than resident exposures. Therefore, the risk and HI estimates for golf course workers are expected to be no higher than the estimates shown on Table 5.13, which show that the upper-bound estimates do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

Surface Water

Workers at Meadowbrook Golf Course could be exposed to constituents in the pond, which is used for irrigation, through dermal contact and inhalation of vapors. Potential exposures in this scenario are indirectly evaluated using a residential "kiddie" pool exposure scenario (see Section 5.6.2.5), which is conservative because exposures to surface water used for irrigation is expected to be lower than exposures in the "kiddie" pool scenario. Details of the "kiddie" pool calculations for this scenario are provided in Attachment C. The bounding estimates were calculated using maximum detected concentrations of all constituents in the surface water. The results are shown in Table 5.14, which shows that these areas do not exceed the cancer risk limit of 10^{-4} and the HI limit of 1.

5.6.2.6 Golf Course Recreational Users

Groundwater

As discussed in Section 2.6.2, the Meadowbrook Golf Course currently has two potable wells currently in use. However, these potable wells are not located within the area of the plume, and will be properly abandoned and will be replaced by the city water supply. Nor is groundwater a reasonably expected future potable water supply, as discussed in Section 3.09. Therefore, potential exposure to golf course recreational users via potable groundwater use is not evaluated.

Potential exposures of golf course recreational users to volatile constituents in groundwater while indoor (e.g., in the club house) via the vapor intrusion pathway are evaluated indirectly using the risk estimates for golf course workers. This streamlines the risk assessment and is conservative because recreational user exposures would be lower than worker exposures. Therefore, the risk and HI estimates for golf course recreational users are expected to be no higher than the estimates discussed in Section 5.6.2.5, which shows that the upper-bound estimates of cancer risks and HIs do not exceed the limit of 10^{-4} and 1, respectively.

Surface Water

Recreational users at the Meadowbrook Golf Course could be exposed to constituents in the pond, which is used for irrigation, through dermal contact and inhalation of vapors. Potential exposure to surface water is evaluated indirectly using exposure estimates for golf course workers. This streamlines the risk assessment and is conservative because recreational user exposures would be lower than any golf course worker. Therefore, the risk and HI estimates for recreational users are expected to be no higher than the estimates discussed in Section 5.6.2.5, which shows that the upper-bound estimates of cancer risks and HIs do not exceed the limit of 10^{-4} and 1, respectively.

5.6.2.7 Trespassers

Soil

Potential exposure of trespassers to soil at Facility areas is evaluated indirectly using exposure estimates for routine workers, as explained in Section 5.4.3. This streamlines the risk assessment and is conservative because trespasser exposures would be lower than routine worker exposures. Therefore, the risk and HI estimates for trespassers are expected to be no higher than the estimates discussed in Section 5.6.2.1 and summarized in Tables 5.2 and 5.3, which show that the upper-bound or high-end estimates of cancer risks and HIs do not exceed the limit of 10^{-4} and 1, respectively.

Surface Water

Trespassers at the Meadowbrook Golf Course could be exposed to constituents in the pond, which is used for irrigation, through dermal contact and inhalation of vapors. Potential exposure to surface water is evaluated indirectly using exposure estimates for golf course workers. This streamlines the risk assessment and is conservative because recreational users or trespasser exposures would be lower than any golf course worker. Therefore, the risk and HI estimates for recreational users and trespassers are expected to be no higher than the estimates discussed in Section 5.6.2.5, which shows that the upper-bound estimates of cancer risks and HIs do not exceed the limit of 10^{-4} and 1, respectively.

5.6.3 Exposures to Lead

US EPA has not developed a cancer slope factor or a reference dose for lead. Therefore, risks from exposures to lead are not expressed in terms of cancer risks or noncancer HQs. The significance of potential exposures to lead in soil and groundwater is discussed below.

US EPA evaluates the risk from exposure to lead in soil using blood lead level as an index of exposure. Using a blood lead model, US EPA has established a conservative soil screening level of 400 mg/kg that is protective of residential exposure to lead in soil. US EPA has also recommended a blood lead modeling methodology for deriving criteria that are protective of routine worker exposure to lead in soil (US EPA 2003c). Criteria derived using this methodology can range from approximately 750 mg/kg to 1,750 mg/kg, with an average of approximately 1,000 mg/kg. As shown in the Section 4 tables, the maximum detected concentrations of lead in soil in all areas are below this range of the soil screening criteria. Therefore, potential exposure to lead in soil is not significant.

The significance of exposure to lead in groundwater is conservatively evaluated in this risk assessment by comparing the concentrations of lead in these media with the drinking water standard for lead of 0.015 mg/L. This approach is highly conservative because potential exposure to lead in these media is much lower than exposure via drinking water consumption. However, this comparison is useful because the results can be easily interpreted to show that potential exposures to lead in groundwater would not be significant.

The highest concentrations of lead in groundwater samples collected during the RFI from the industrial areas is 0.4 mg/L. This concentration is approximately 30 times higher than the MCL. However, the exposure of construction workers in this scenario is more than 1,000 times lower than exposure via drinking water, as shown in Attachment C. Therefore, potential exposure of constructions workers to the concentrations of lead in groundwater in the industrial areas is not significant.

The concentrations of lead in three groundwater samples collected from monitoring wells located at the non-industrial areas are higher than the MCL. As discussed in Section 4.7.4.3.1, total lead reportedly exceeded drinking water criterion in three samples obtained in 2003 and 2004 during a Phase II investigations by others at Area 1 – Meadowbrook Golf Course wells MW-2, MW-5, and MW-7. These samples were neither collected nor analyzed by GM. Because MW-5 and MW-7 are not located downgradient of the Facility, GM believes that any lead detected in these wells is not attributable to the Facility.

MW-2 is located potentially downgradient from the Facility. Followup sampling at MW-2 conducted pursuant to the RFI was conducted in February 2005. Total lead was detected at 0.0003 mg/L, which is well below the MCL, and the dissolved lead result was non-detect. Therefore, potential exposure to Facility-related lead in groundwater in the non-industrial areas is expected to be insignificant.

5.6.4 Soil Migration to Groundwater Pathway

In addition to the assessment of potential exposures to constituents detected in groundwater discussed in Sections 5.6.2, the significance of potential exposures to constituents that could potentially migrate from soil to groundwater was evaluated. Soil migration to groundwater criteria were derived using the procedure outlined in US EPA's Soil Screening Guidance (US EPA, 1996). Concentrations in soil were compared to the soil migration to groundwater criteria that were based on the nonpotable groundwater exposure scenarios for the potentially exposed populations discussed above. The results of this evaluation, presented in Attachment C, indicate that there is no potential for significant exposure to the constituents in groundwater from the soil migration to groundwater pathway.

5.6.5 Uncertainty Analysis

5.6.5.1 Exposure Concentrations

As discussed in Section 5.4.4, most exposure concentrations for soil in this risk assessment are based on the highest concentrations detected in soil at each area, and 95% UCLs are calculated only when a bounding estimate of the RME cumulative cancer risk or HI exceeds the cancer risk limit of 10^{-4} or the HI limit of 1, respectively. This approach streamlines the risk assessment by avoiding calculation of 95% UCLs that would not materially affect risk assessment conclusions regarding the need for corrective measures.

However, this approach inflates the cumulative cancer risk and HI estimates that do not exceed 10^{-4} and 1, respectively, since these estimates are entirely based on maximum concentrations. As explained in Section 5.4.4, the use of maximum concentrations for all constituents introduces more conservatism than necessary for RME estimates because it assumes simultaneous worst-case exposure to all constituents constantly, when the RME generally would not have all constituents at worst-case concentrations at all times. The inflation of these risk and HI estimates makes them closer to the cumulative cancer risk limit of 10^{-4} and the HI limit of 1 than they would be if 95% UCLs were used.

The above discussion regarding soil exposure concentrations also applies to groundwater exposure concentrations for the excavation scenario, since construction workers would not be expected to contact groundwater with the maximum concentrations of every constituent during every excavation.

For the groundwater vapor intrusion scenarios, the use of maximum concentrations also overstates the RME risk. This is because the groundwater under an individual building is unlikely to have the maximum concentrations of all constituents. However, these bounding estimates can be useful for identifying constituents for which significant risk is possible, so that risk-based concentration limits for such constituents can be used to identify specific locations where significant exposures might occur.

Most exposure concentrations that are based on mathematical modeling of constituent transfer from soil or groundwater to air are conservative for the same reasons discussed above, since the model estimates are based on the use of maximum concentrations in soil or groundwater. In addition, the model estimates are conservative because they generally do not account for the reduction of constituent concentrations in the soil or groundwater as constituent transfer from these media. As a result, risk estimates that are based on the sum of risk estimates for multiple media are more conservative than necessary for RME estimates. These include almost all the risk estimates discussed in Section 5.6.

5.6.5.2 Exposure Factors

As discussed in Section 5.4.5, most of the exposure factors used in the risk assessment are high-end (i.e., 90^{th} to 95^{th} percentile) estimates of the magnitude, frequency, and duration of potential exposures. When several such high-end factors are multiplied, the resulting estimates of dose will be higher than the 90^{th} percentile of the distribution of exposures in the potentially exposed population and could be higher than the exposure to the maximally exposed individual, particularly when such exposure factors are combined with exposure concentrations that are based on maximum concentrations.

Also, the use of generic default exposure factors for evaluation of potential exposure of workers to soil is more conservative than necessary for RME estimates, which allow the use of site-specific considerations (US EPA, 1989). For example, the "fraction contacted" terms used in this evaluation assume that routine workers are exposed to soil for an entire work day at each area, but workers at commercial/industrial sites generally spend only a part of the work day at a particular part of a site.

As noted in Section 5.4.5.1, the ingestion rate used for estimating exposure of routine workers to soil is twice the US EPA-recommended standard default value of 50 mg/day. Therefore, the risk estimates for this scenario are more conservative than necessary, particularly for constituents with risk estimates that are dominated by the ingestion route (e.g., most SVOCs, PCBs, and metals).

5.6.5.3 Toxicity Values

As discussed in Section 5.5.3, the dermal toxicity values used in the risk assessment are oral toxicity values that were extrapolated to the dermal route without chemical-specific judgment regarding whether such extrapolation might be appropriate for a particular chemical. This is a conservative approach to ensure that potential risk via the dermal route is not overlooked. However, some constituents might exhibit different degrees of toxicity for the dermal route relative to the oral route. For such constituents, the extrapolation approach used in the risk evaluation could introduce uncertainty.

The conversion of an oral toxicity value to an inhalation toxicity value generally should be justified by consideration of a number of factors, including point of entry effects, pharmacokinetic data on the chemical's behavior in the different routes of exposure, and differences in the target organs affected. However, as a conservative measure for constituents without any inhalation toxicity values, oral SFs and RfDs were converted to inhalation URFs and RfCs in this risk assessment. Use of these extrapolated inhalation toxicity values reduces the potential for underestimating inhalation risks, but could introduce uncertainty.

As noted on the tables in Attachment C (e.g., Attachment C.1), the estimates of cancer risk and HQ for TCE are calculated using toxicity values that are currently in effect, rather than the draft toxicity values that are currently under US EPA review and subject to significant ongoing scientific and regulatory debate regarding their appropriateness. This risk assessment did not use the draft TCE toxicity values because their current status makes them inappropriate for use to support RCRA corrective action decisions.

5.6.5.4 Risk Characterization

The summation of cancer risks and HQs for multiple constituents, as described in Section 5.6.1, is based on US EPA guidance (1989) to assume dose additivity, which means that constituents in a mixture are assumed to have no synergistic or antagonistic interactions and each constituent has the same mode of action and elicits the same health effects. In general, this approach can introduce significant uncertainty. However, the majority of the cumulative cancer risk and HI estimates in this risk assessment are dominated by contributions from no more than a few constituents, so that the cumulative risk estimates are nearly the same as those for the few key constituents.

5.7 Summary and Conclusions

The significance of potential exposures to concentrations of constituents in soil, groundwater, and surface water is evaluated based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use at and around the Facility. The evaluation uses the RFI data that were discussed in Section 4 and methods that are consistent with US EPA risk assessment guidance. The significance of potential exposures is determined by comparing estimates of Facility-related cumulative cancer and noncancer risks with a cancer risk limit of 10^{-4} and a HI limit of 1, respectively, which US EPA has established as triggers for corrective measures under RCRA corrective action (US EPA, 1991b). The risk assessment determined that current and future potential exposures to constituents in soil, groundwater, and surface water do not pose a significant risk except for the areas that are currently addressed by the interim measures discussed in Section 2.6.

6.0 SUMMARY AND CONCLUSIONS

The RFI included initial field investigations at the following SWMUs, AOCs, AOIs, and Areas as described in the RFI Work Plan and Work Plan Amendments.

- SWMU 4 – 1002 Preplater
- SWMU 6 – Nickel Recovery
- AOC 2 – Former Fire Training Area
- AOC 3 – East Chromium Area
- AOC 4 – Walking Track Area
- AOC 5 – West Impoundment
- AOC 6 – Electroform Room
- AOC 7 – 400 Plater
- AOI 1 – North Parking Lot
- AOI 2 – Chromium Recovery
- AOI 3 – Bay R4 Area
- Area 1 – South Court and Related Area
    - AOC 1 – South Court
    - SWMU 17 Conrail Ditch
    - West Chromium Area
- Area 2
    - SWMU 2- 352 Plater
    - SWMU 3 – 309 Plater
    - SWMU 7 – Acid / Caustic Strip Tank
- Area 3 – East Storage Area
    - SWMU 21 – Concrete Pad
    - SWMU 22 – Site Assessment Area
- Area 4 – Nalco Areas
    - SWMU 25 – Nalco Pit Area
    - SWMU 26 – Bulk Materials Loading Area

The objective of the field investigations was to determine whether a significant release of hazardous constituents to soil, groundwater, potable water and surface water has occurs from these SWMUs, AOCs, AOIs, and Areas. Based on the results on the initial RFI field investigation, it was determined that a significant release has not occurred at six investigated areas. These determinations were documented to US EPA and IDEM in the Stage I Report (Earth Tech; July 31, 2001). These determinations and their basis are discussed in Section 4 of this RFI report. Areas where results show that a significant release has not occurred are summarized in Section 6.1.

For areas where a release was identified, further phases of field investigation were conducted under additional approved work plan amendments. The finding of these field investigations are discussed in Section 4 of this RFI Stage II Report. The potential health significance of the constituents found in soil, groundwater, potable water, and surface water was evaluated in baseline risk assessment to determine whether any of the identified releases warrant corrective measures. The baseline risk assessment and its results are discussed in Section 5 of this RFI Stage II Report. The conclusions regarding the need for corrective measures for each area evaluated in the baseline risk assessment are summarized below in Section 6.2.

Interim measures to address soil and groundwater concerns at AOC 1 – South Court and Meadowbrook Golf Course are being conducted concurrently with the RFI. Interim measures at AOC 1 – South Court consisted of excavation to remove TCE concentrations in soil and the mixing of HRC® into the saturated material at the bottom of the excavation to enhance reductive dechlorination of residual contamination in the soil and perched groundwater. Furthermore, groundwater monitoring of the area will be conducted now that the IM has been completed. At Meadowbrook Golf Course, GM and Strong's Golf LLC, the golf course owners, have entered into an access agreement that will provide city water connections to the clubhouse and maintenance building, and will permanently decommission all thee potable wells known to exist on the property.

6.1 No Significant Release Found

Among the SWMUs, AOCs, AOI, and Areas investigated during the RFI, the following areas have no significant release of hazardous constituents to soil. The determination is based on a comparative approach in which the highest concentration of a constituent at an area is compared with conservative generic risk-based screening criteria.

- AOC 3 – East Chromium Area
- AOC 4 – Walking Track Area
- AOC 5 – West Impoundment
- AOC 7 – 400 Plater
- AOI 2 – Chromium Recovery
- AOI 3 – Bay R4 Area
- Area 1
    - SWMU 17 Conrail Ditch
    - West Chromium Area
- Area 2
    - SWMU 2 – 352 Plater
    - SWMU 3 – 309 Plater
    - SWMU 7 – Acid / Caustic Strip Tank
- Area 3 – East Storage Area
    - SWMU 21 – Concrete Pad
    - SWMU 22 – Site Assessment Area
- Area 4 – Nalco Areas
    - SWMU 25 – Nalco Pit Area
    - SWMU 26 – Bulk Materials Loading Area

The RFI findings indicate that no further investigation of these areas is warranted.

Water samples collected during the RFI from potable wells at the Meadowbrook Golf Course and from several private residential wells near the Facility are all below screening criteria. Based on the lack of exceedance of screening criteria, no significant release of hazardous constituents has occurred to off-Facility potable wells.

6.2 Potentially Significant Releases

A potentially significant release of hazardous constituents was identified in soil at six areas and in groundwater as well as surface water, based on a conservative approach in which the highest concentration of a constituent at an area is compared with conservative risk-based screening criteria. Using the RFI characterization data on the nature and extent of constituents at these areas and media, the health significance of these releases under current and reasonably expected future land use was evaluated in a baseline risk assessment. The findings of the RFI field investigation and conclusions of the risk assessment are summarized below:

6.2.1 AOC 2 – Former Fire Training Area

AOC 2 arsenic concentrations in soil are higher than the screening criteria based on direct contact. However, based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use, the baseline risk assessment determined that exposures arsenic do not pose a significant risk to human health. Therefore, no further action is warranted in AOC 2.

6.2.2 AOC 6 – Electroform Room

AOC 6 concentrations of chromium (total) and cyanide (total and amenable) in soil are higher than the migration to groundwater criteria; and copper concentrations are higher than the screening criterion based on direct contact and migration to groundwater criteria. The potential for human exposure to chromium, cyanide and copper in soil was evaluated. The bounding risk estimate of noncancer HI is higher than the US EPA limits for routine work exposure to soil via direct contact in AOC 6. However, refined cumulative risk and HI estimates for AOC 6, based on the use of 95% UCLs, are below US EPA limits. Therefore, no action is warranted in AOC 6.

6.2.3 AOI 1 – North Parking Lot

The concentrations of arsenic and iron in soil are higher than both the screening criteria based on direct contact and migration to groundwater, and the concentration benzo(a)pyrene is higher than the screening criterion based on direct contact at one location (BH 3A) in AOI 1. These iron concentrations are within typical background levels in Eastern United States soil (Dragun and Chiasson, 1991, although no Facility-specific background data for iron are available.

The potential for human exposure to arsenic, iron and benzo(a)pyrene in soil was evaluated. The bounding estimate of noncancer HI is higher than the US EPA limit for recreational use exposure to surface soil via direct contact in AOI 1. However, refined cumulative risk and HI estimates for AOI 1, based on the use of 95% UCLs using cadmium and arsenic, are below US EPA limits. Based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use, the risk assessment determined that exposures to iron and benzo(a)pyrene do not pose a significant risk to human health. Therefore, no further action is warranted in AOI 1.

6.2.4 Area 1 – South Court and Related Areas

Area 1 arsenic concentrations in soil are higher than the screening criteria based on direct contact at one location SB 156. Four chlorinated VOCs (1,1-DCE, cis-1,2-DCE, TCE, and vinyl chloride) are higher than the migration to groundwater criteria at Area 1. Several PAHs (i.e. benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected at concentrations higher than the screening criteria based on direct contact at one location (SB 155) in Area 1. PCBs (total) concentrations are higher than both direct contact and migration to groundwater criteria at two locations (SB 156 and SB 163) in Area 1.

The potential for human exposure to arsenic, VOCs, PAHs, and PCBs in soil was evaluated. The bounding risk estimates of Facility-related cumulative cancer risk and non-cancer HI after the IM are below the US EPA limits for routine work exposure to soil via direct contact in Area 1. Therefore, no further action is warranted in Area 1.

6.2.5 SWMU 4 – 1002 Preplater

The hexavalent chromium concentration detected in the deepest sample soil sample obtained from location SB 224 is higher than the migration to groundwater criteria. Groundwater obtained from monitoring well MW 78, installed in an offset boring near SB 224, detected no reportable concentration of hexavalent chromium. The lack of hexavalent chromium is groundwater at SWMU 4 indicates that the concentration of hexavalent chromium in soil poses no threat to groundwater. In addition, risk assessment determined that exposures to hexavalent chromium do not pose a significant risk to human health. Therefore, no further action is warranted in SMWU 4.

6.2.6 SWMU 6 – Nickel Recovery Area

The concentrations of nickel and copper in one sample are higher than the migration to groundwater criteria at SWMU 6. The sample was obtained from boring SB 240 a sample interval of 2 to 2.5 feet beneath the concrete floor. No deeper samples were obtained from this location due to refusal encountered at 4 feet. The potential for human exposure to nickel and cooper in soil was evaluated. Based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use, the risk assessment determined that exposures to nickel and cooper do not pose a significant risk to human health. Therefore, no further action is warranted in SWMU 6.

6.2.7 Groundwater

Concentrations of metals (arsenic, cadmium, chromium (total), copper, lead, and nickel), VOCs (1,1-DCE; cis-1,2-DCE; trans-1,2-DCE; toluene; 1,1,1-trichloroethane; TCE; and vinyl chloride), and two SVOCs (methylphenol (total) and bis(2-ethylhexyl)phthalate) are higher than the drinking water criteria in the shallow perched aquifer (Unit 1). Concentrations of cis-1,2-DCE, TCE and vinyl chloride at MW 31 in Area 1 are also are higher than the groundwater direct contact criteria.

Constituents with concentrations in the shallow unconsolidated aquifer (Unit 3S) that are higher than the drinking water criteria consist primarily of metals (arsenic, cadmium, chromium (total), and lead) and VOCs (1,1-DCE; chloroform; cis-1,2-DCE; trans-1,2-DCE; 1,1,1-trichloroethane; TCE; and vinyl chloride). Concentrations of cis-1,2-DCE and vinyl chloride also are higher than the screening criteria based on groundwater direct contact in Area 1.

Concentrations of metals (arsenic and lead) and VOCs (cis-1,2-DCE, TCE and vinyl chloride) are higher than drinking water criteria in the deeper unconsolidated aquifer (Unit 3D). The metal concentrations exceeding the screening criteria are from monitoring wells located near the maintenance building in the Meadowbrook Golf Course and are not Facility-related.

Concentration of vinyl chloride is higher than drinking water criterion in bedrock well MW 81 located near the southwest corner of former Plant 9. No other concentration in bedrock groundwater exceeds any screening criteria.

The potential for human exposure to groundwater was evaluated for both on-Facility and off-Facility receptor populations. Bounding estimate of noncancer HI is higher than the US EPA limits for construction worker exposure to groundwater via direct contact in Area 1. Refined bounding estimates of cumulative cancer risk and noncancer HI for construction workers contacting shallow groundwater in Area 1 are below US EPA limits, except for MW-31 where institutional control will be implemented until the interim measure on the groundwater is completed.

The risk assessment determined that routine worker, recreational and residential exposure to groundwater via vapor instruction does not pose a risk to human health.

6.2.8 Surface Water

Vinyl chloride is the only constituent detected at a concentration higher than the drinking water screening criteria in samples obtained from the large kidney shaped pond located on the Meadowbrook Golf Course. The potential for human exposure to surface water was evaluated. Based on conservative estimates of reasonable maximum exposures under current and reasonably expected future land use, the risk assessment determined that exposures to surface water dose not pose a significant risk to human health.

6.3 Recommendations

Based on the findings and conclusions of the RFI, GM plan to proceed with the following:

1. Implement a site-wide groundwater monitoring plan. The objectives of this plan will be to monitor and evaluate groundwater quality and overall plume stability, monitor the effectiveness of interim measures completed in Area 1 – South Court, and provide data to evaluate the need for additional corrective measures, if required.

2. Evaluate alternative interim or final corrective measures, including both engineering and administrative controls, as necessary for addressing on-Facility soil and on and off-

Facility groundwater conditions. The evaluation will incorporate data collected from the implementation of the Site-Wide Groundwater Monitoring Plan. The corrective measures evaluated along with selected corrective measures will be submitted in the Final Corrective Measures Proposal due in March 2008. GM will include a plan for groundwater monitoring in the Final Corrective Measures Proposal.

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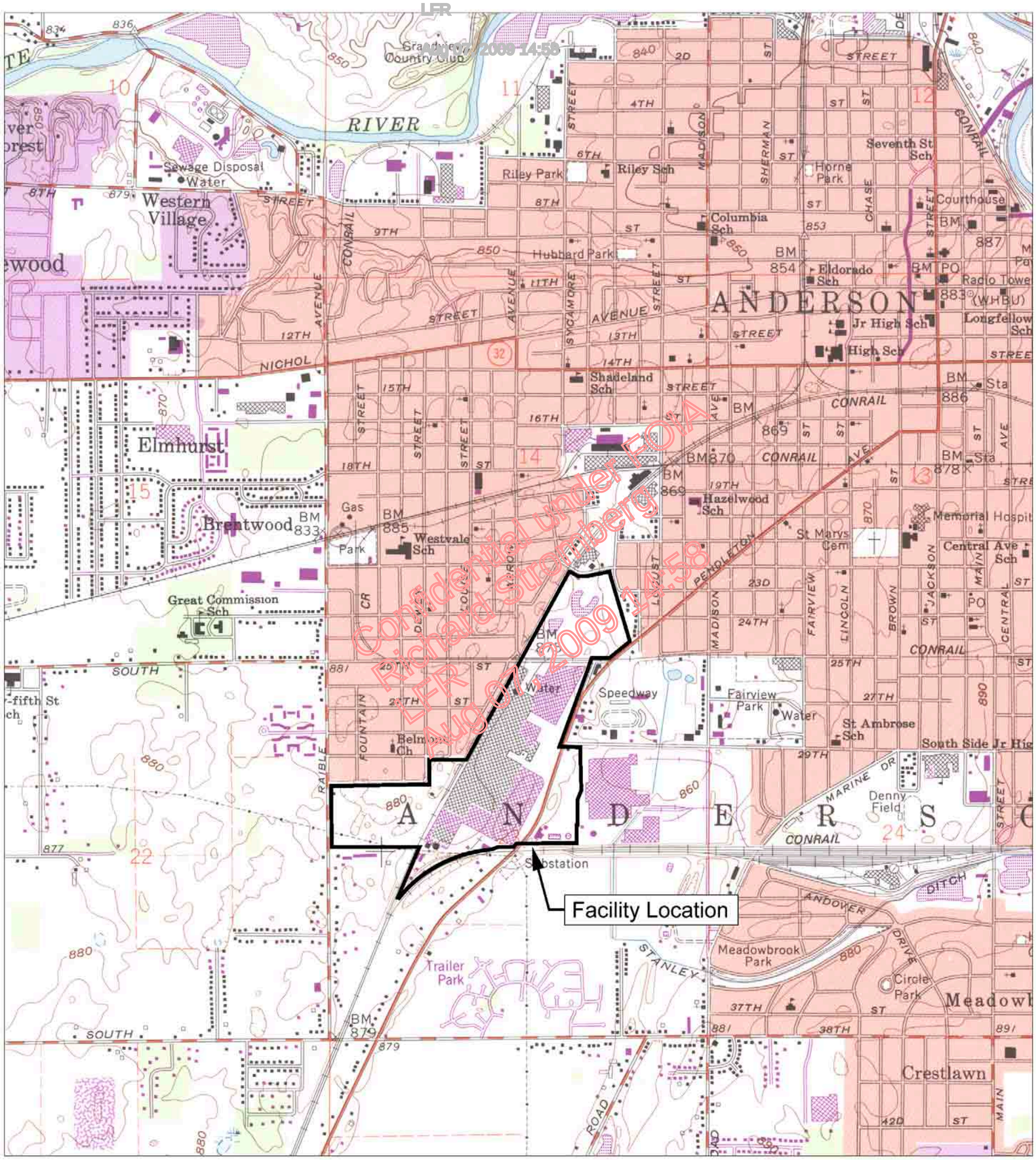


Base map taken from USGS Anderson South, Ind. 7.5' Topographic Quadrangle, 1994.

NORTH

0 2000

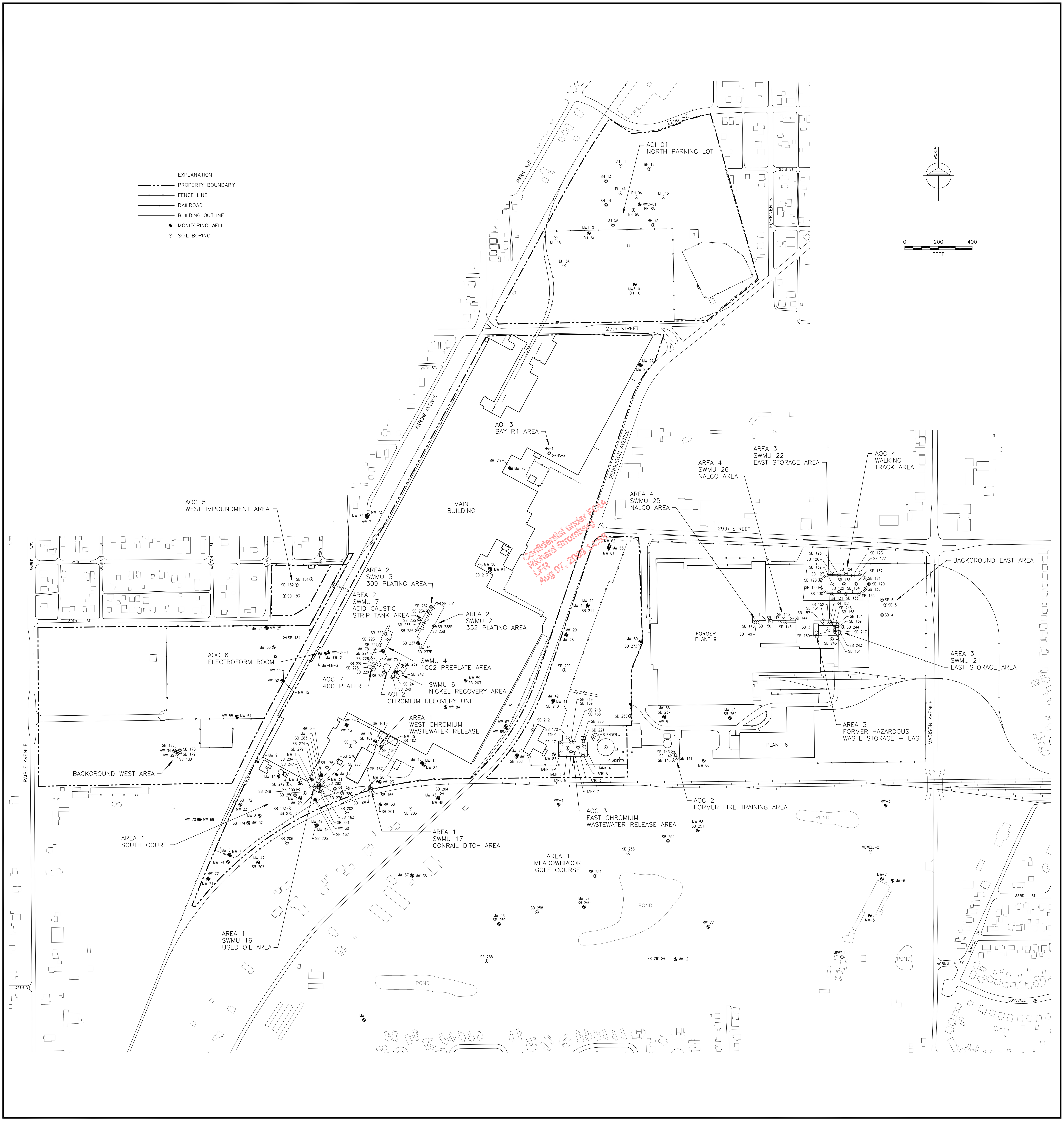
Feet

FACILITY LOCATION MAP

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure
Project No. 62806		2.1

L:\Work\62806.01\Dwg\StageIIReport\StIIRpt-F2_1.psd NW062705



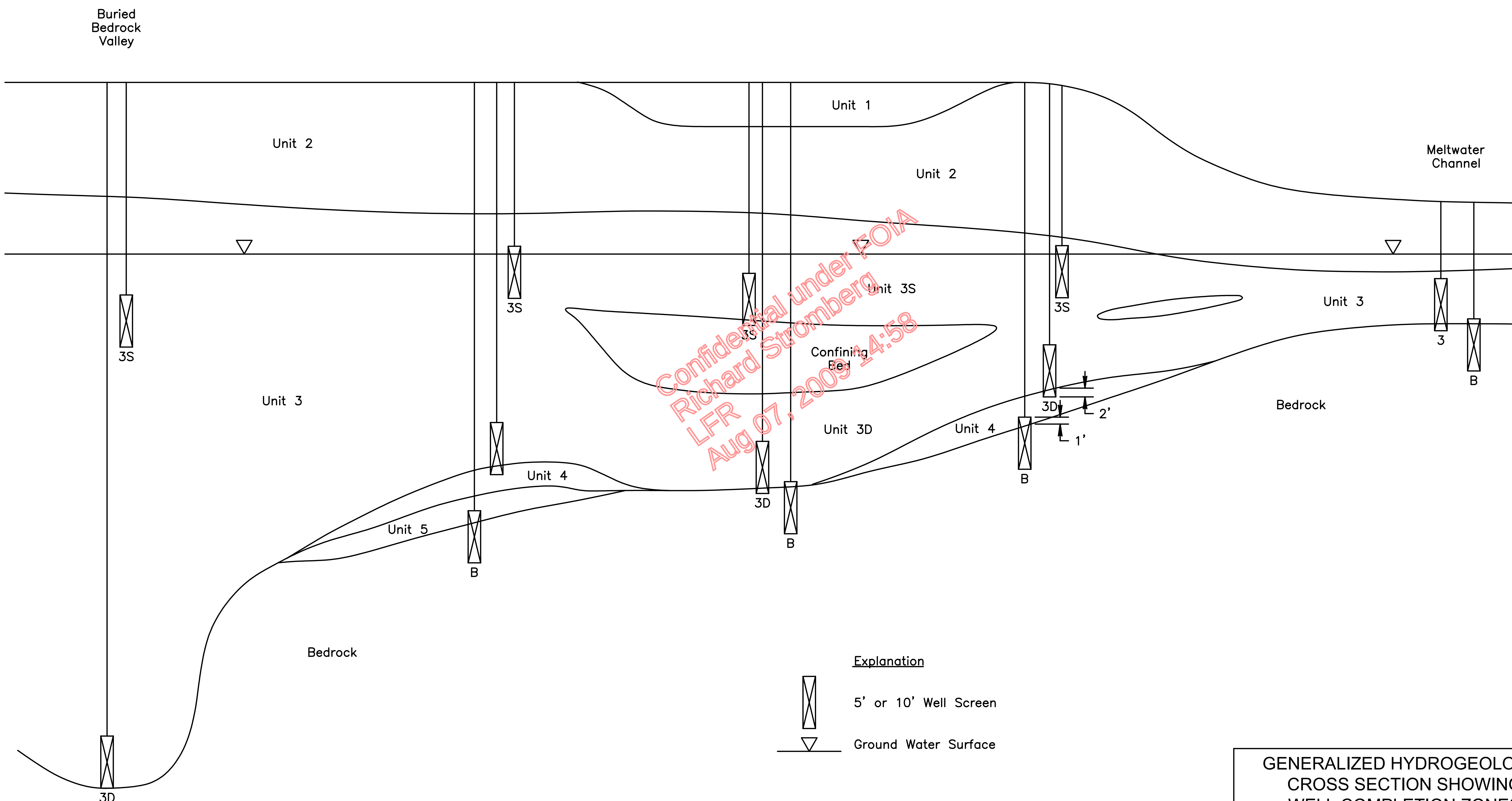
EarthTech
A Tyco International Ltd. Company

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

LOCATIONS OF AOIs, MONITORING WELLS, AND SOIL BORINGS

DESIGNED BY: NW	DATE: JUNE 2005
DRAWN BY: NW	DATE: JUNE 2005
CHECKED BY:	DATE:
FILE: StIRpt-F2_2	EDIT: NW062905
SCALE: 1"=200'	DRAWING: 1:200
PROJECT: 62806	

2.2
FIGURE NO.

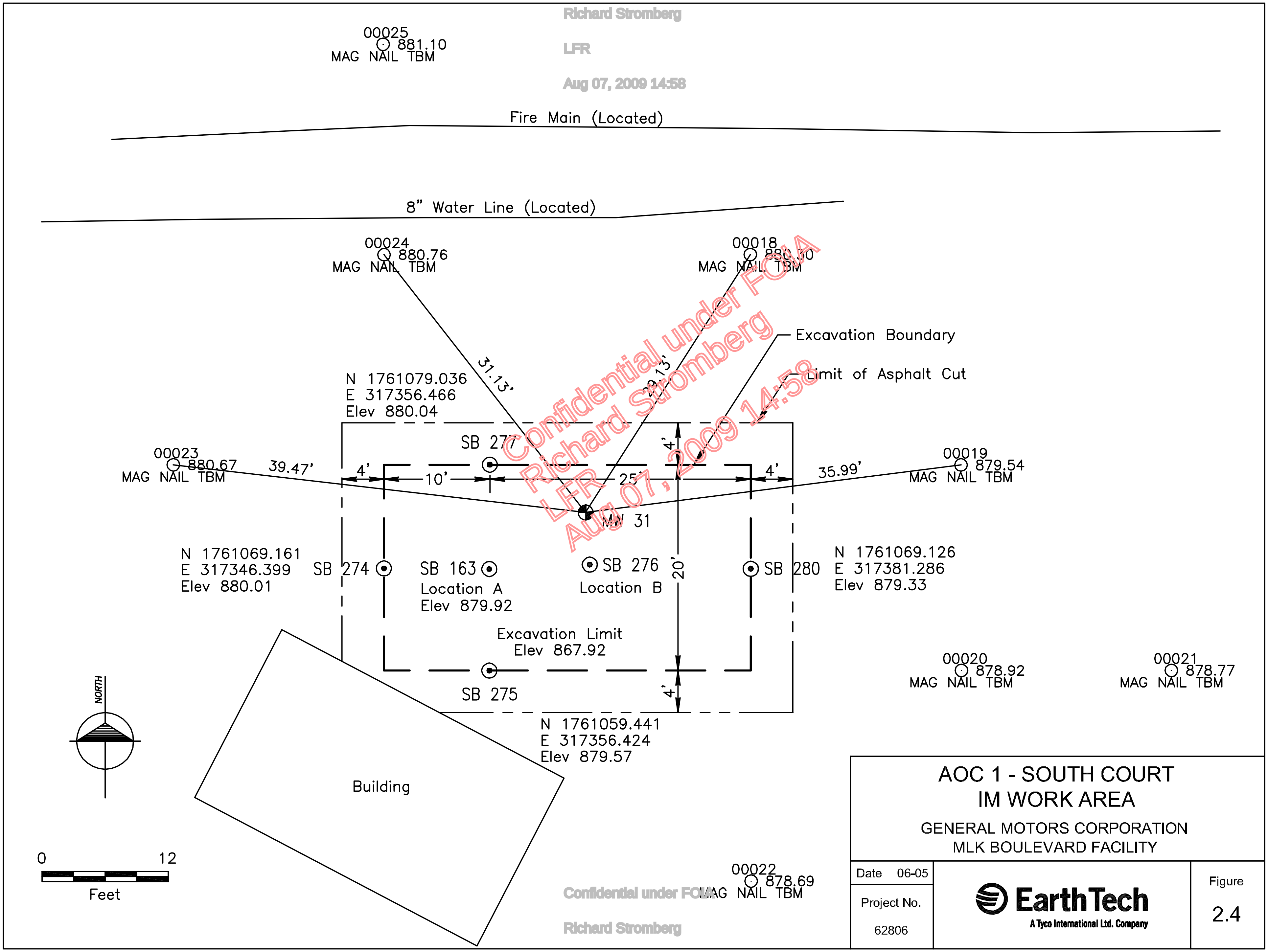


GENERALIZED HYDROGEOLOGIC CROSS SECTION SHOWING WELL COMPLETION ZONES

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05 Project No. 62806	EarthTech A tyco International Ltd. Company	Figure 2.3

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F2_3.dwg NW061605



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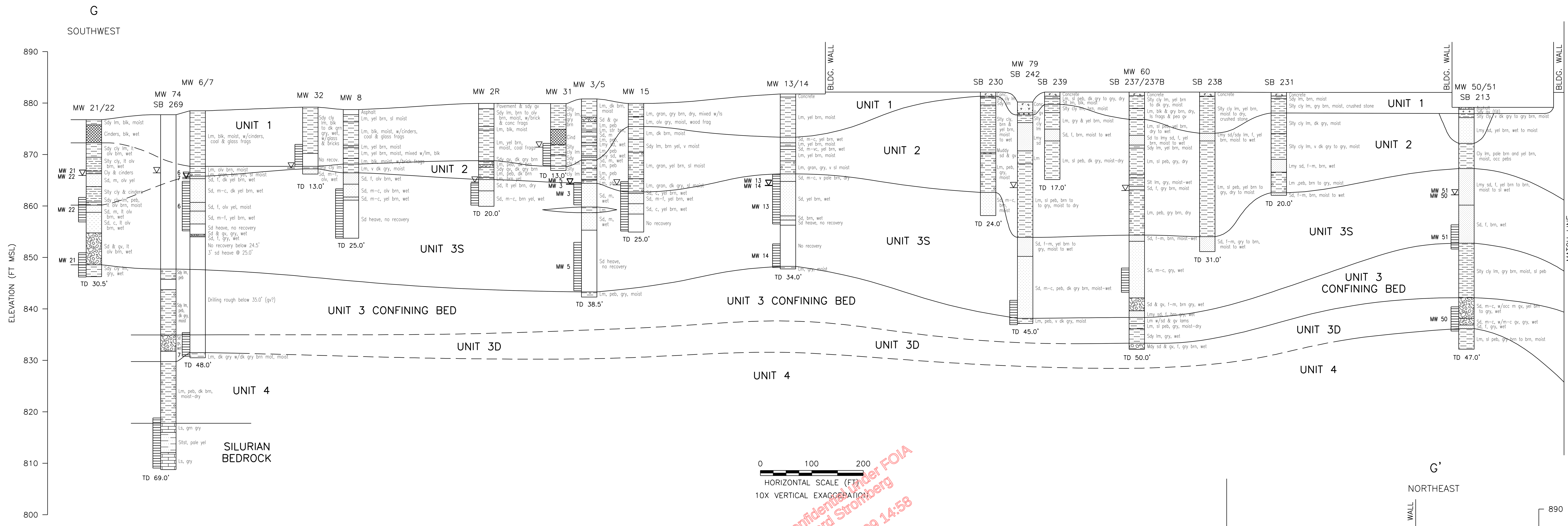
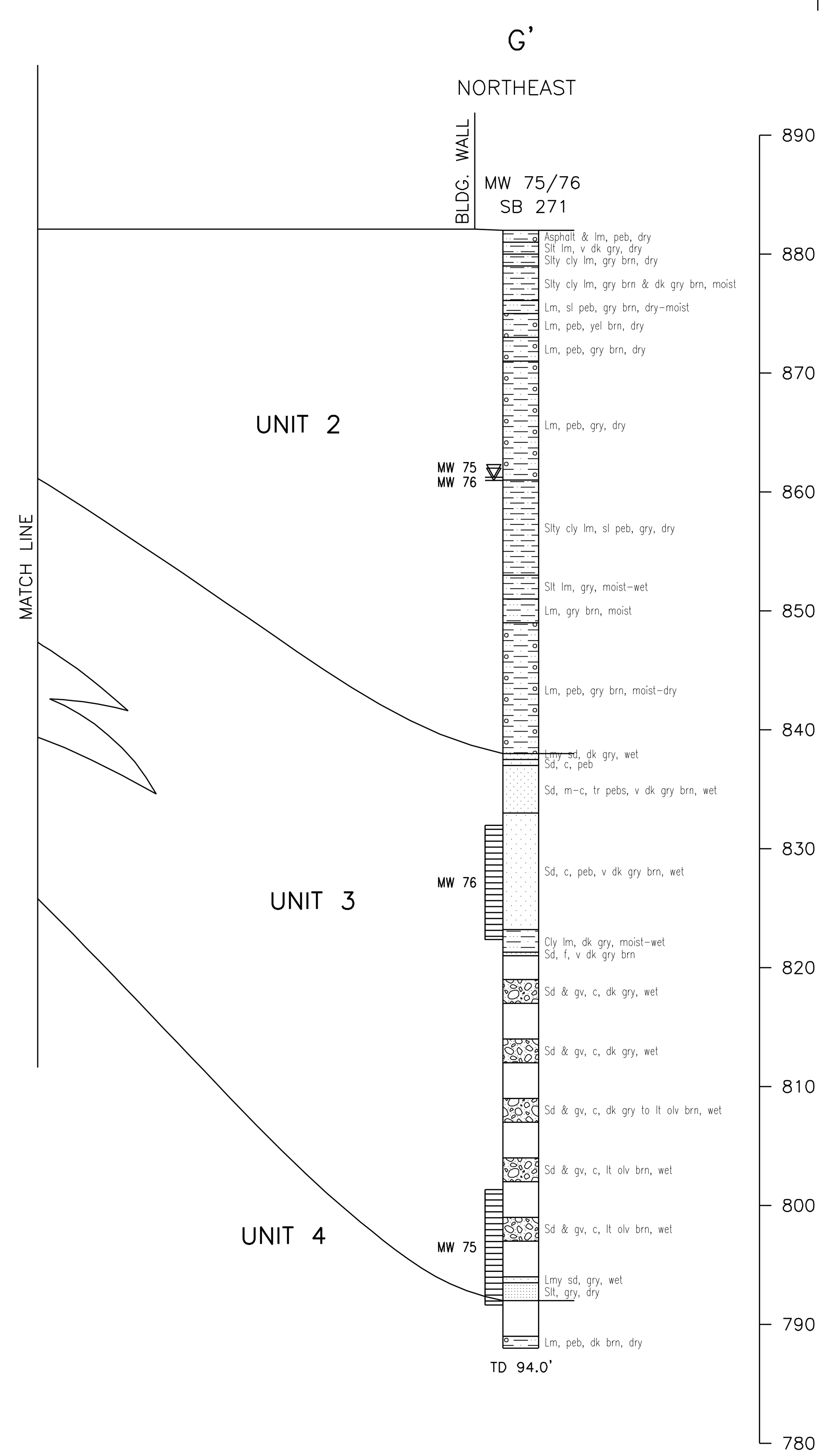
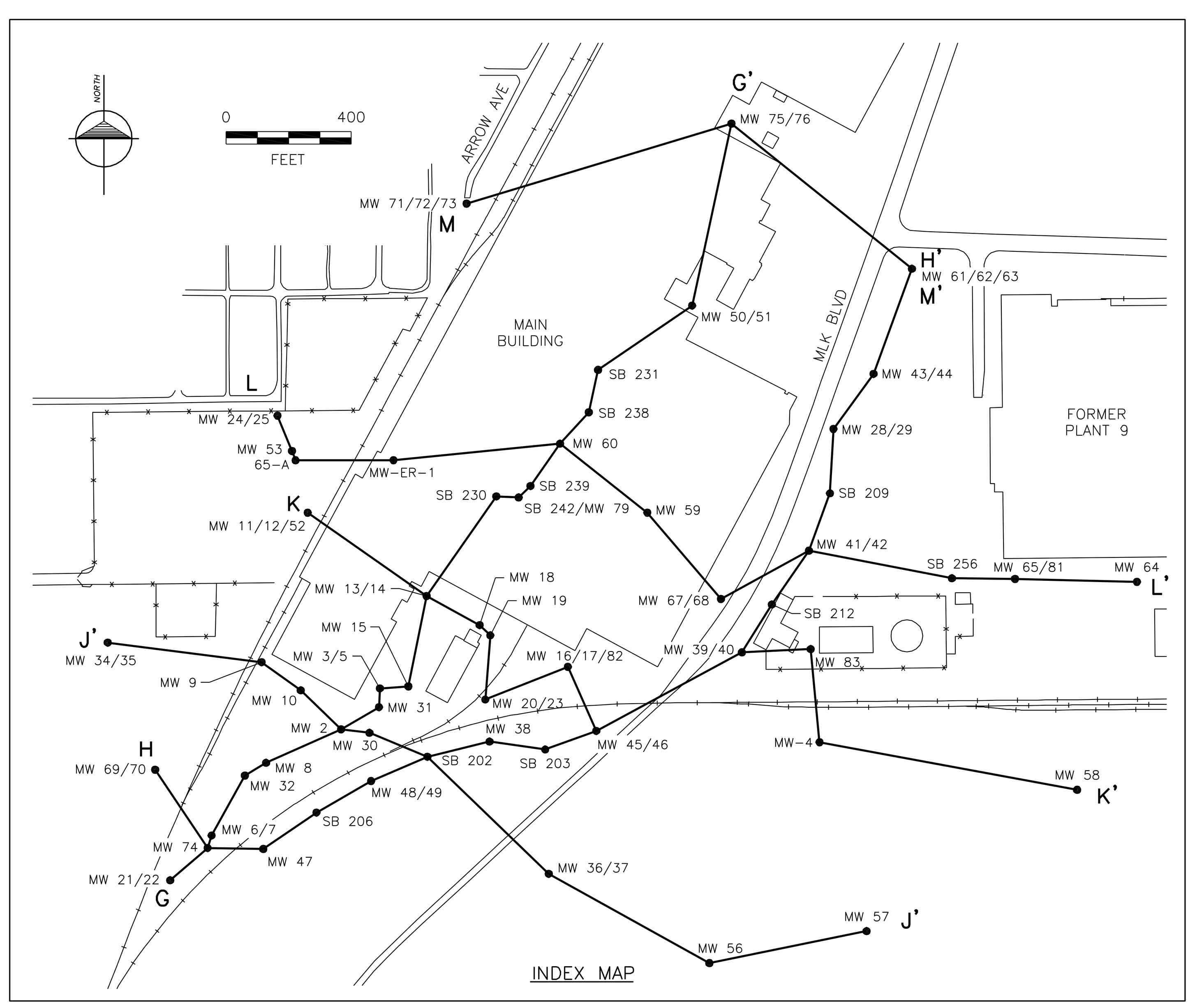




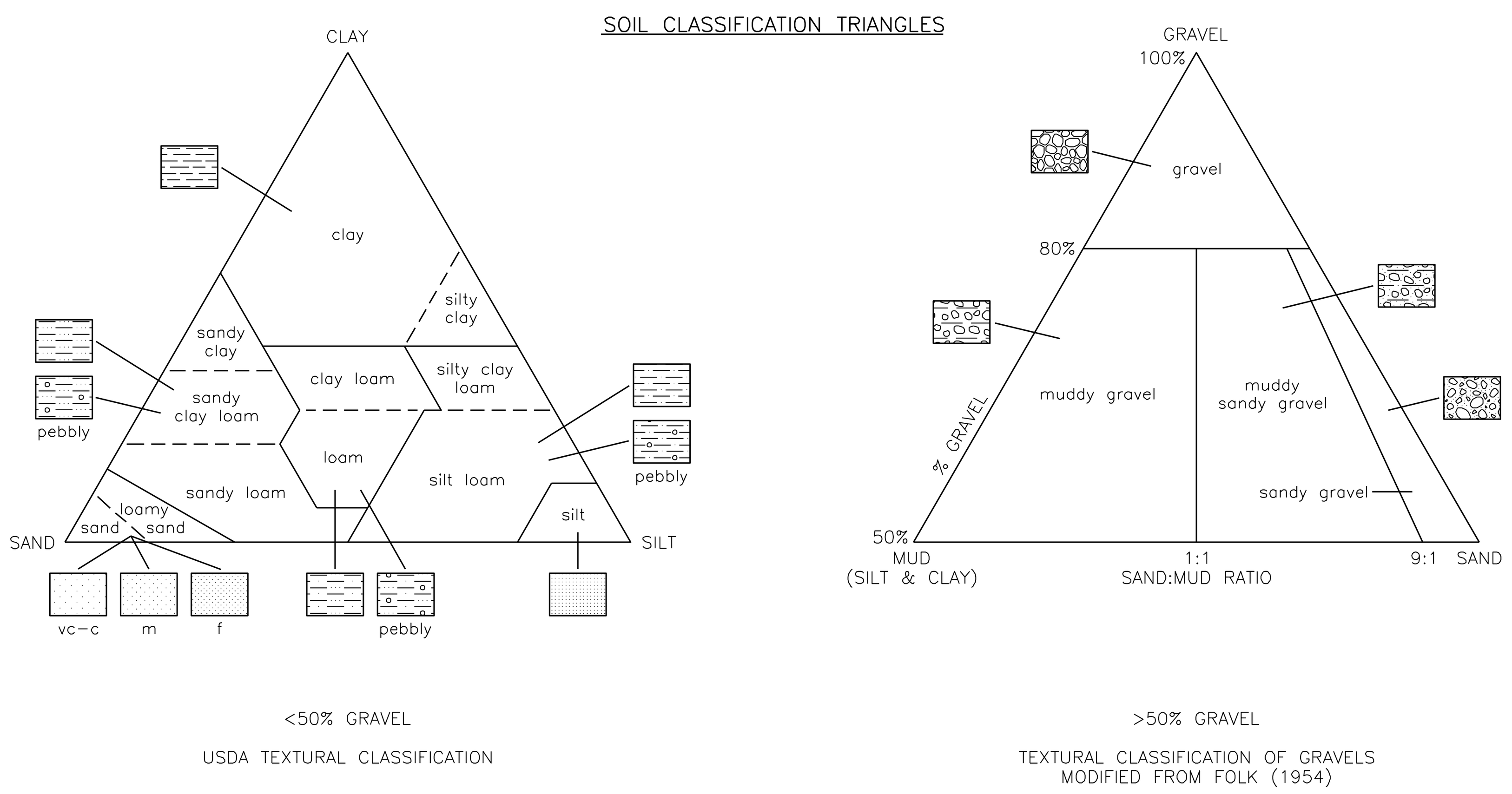
EXPLANATION

WELL SCREEN

STATIC GROUND WATER LEVEL ON MARCH 10, 2005



SOIL CLASSIFICATION TRIANGLES



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A tyco International Ltd. Company

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

HYDROGEOLOGIC CROSS SECTION G-G'

DESIGNED BY NW	DATE JUNE, 2005
DRAWN BY NW	DATE JUNE, 2005
CHECKED BY	DATE
FILE StillRpt-F3_1	EDIT NW061605
SCALE AS SHOWN	DRAWING 1:10
	PLOT
PROJECT 62806	

3.1
FIGURE NO.

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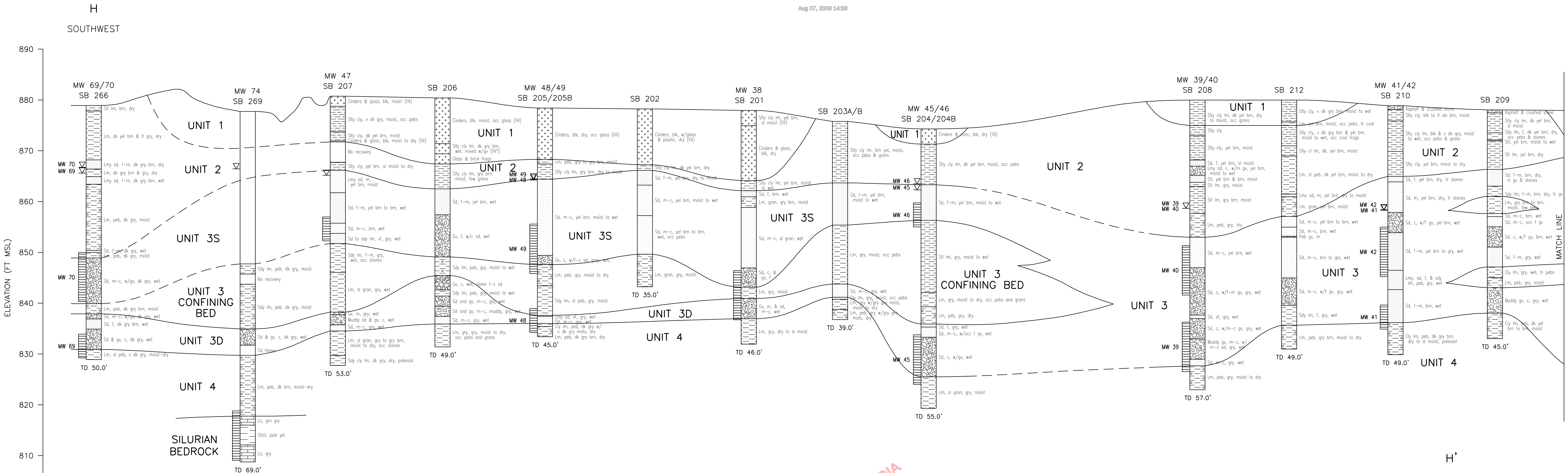
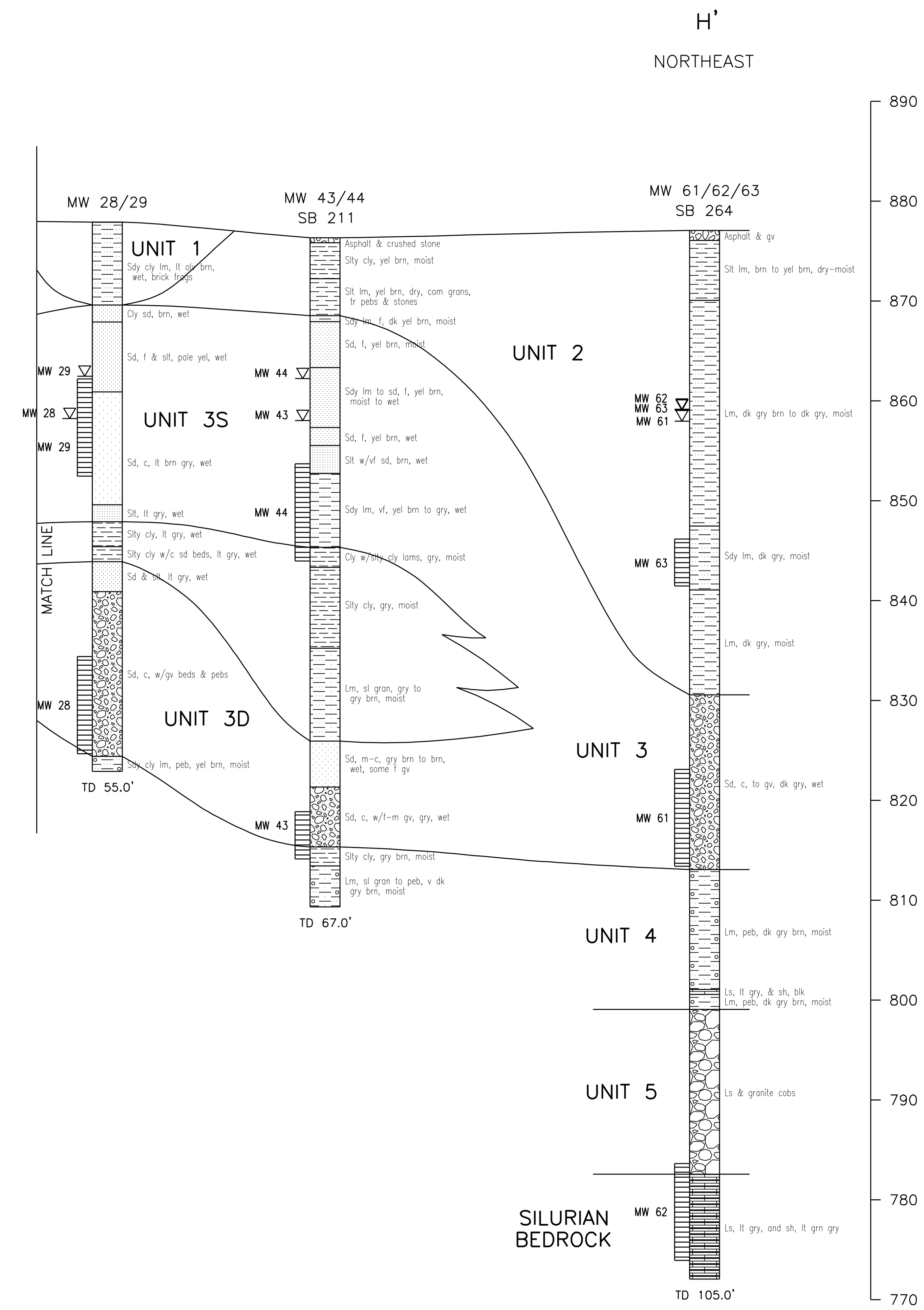


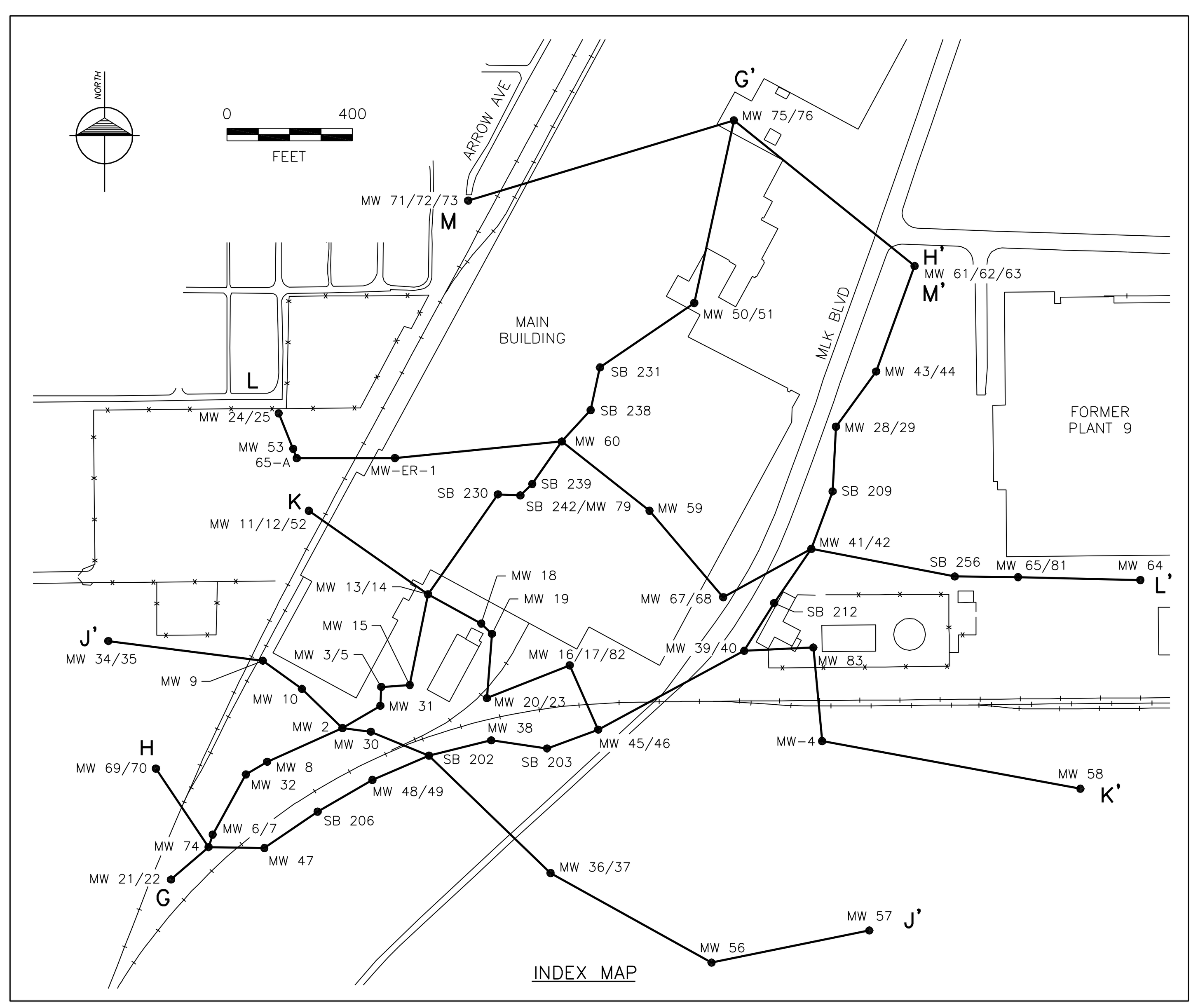
0 100 200
HORIZONTAL SCALE (FT)
10X VERTICAL EXAGGERATION



EXPLANATION

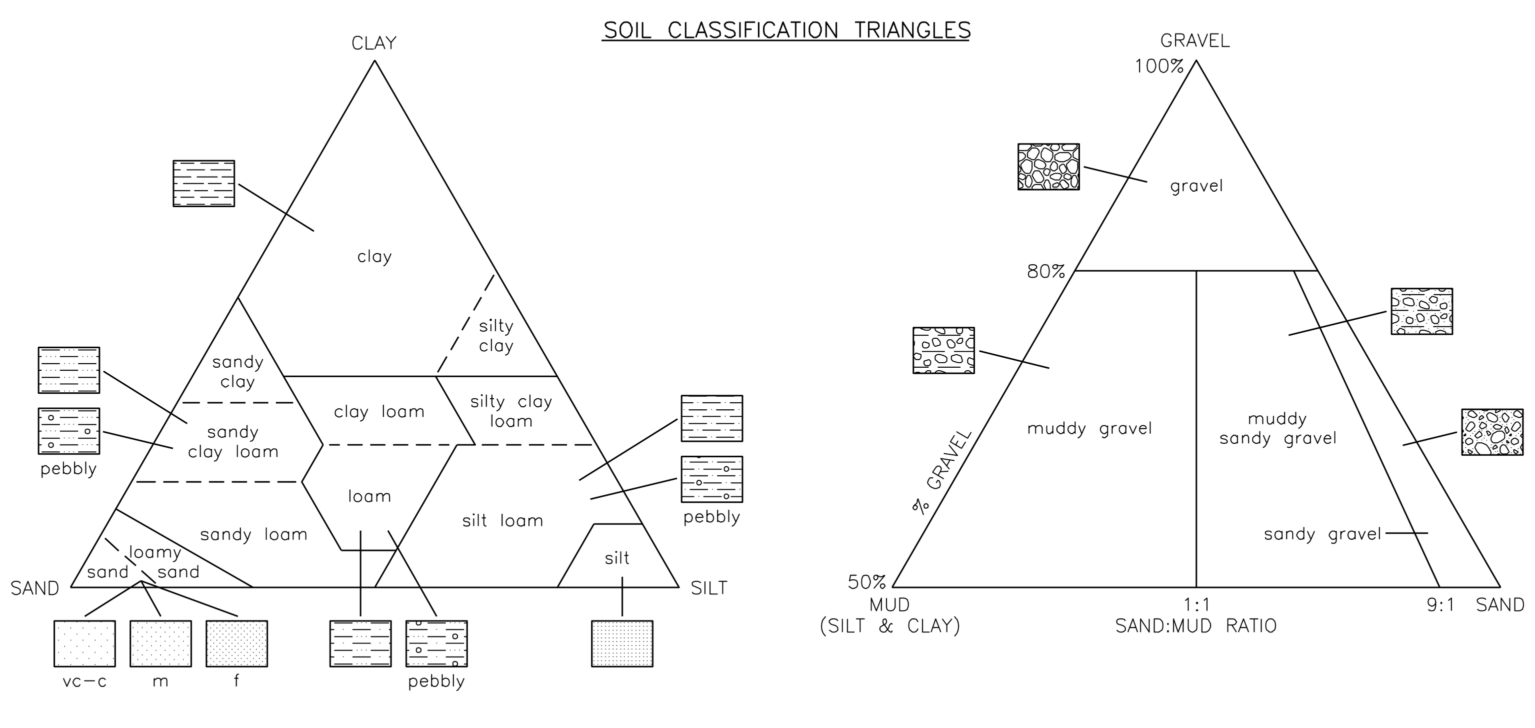
WELL SCREEN

STATIC GROUND WATER LEVEL ON MARCH 10, 2005



INDEX MAP

SOIL CLASSIFICATION TRIANGLES



<50% GRAVEL
USDA TEXTURAL CLASSIFICATION

>50% GRAVEL
TEXTURAL CLASSIFICATION OF GRAVELS MODIFIED FROM FOLK (1954)

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REVISIONS | NO. | DATE | BY

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

HYDROGEOLOGIC CROSS SECTION H-H'

DESIGNED BY NW	DATE JUNE, 2005
DRAWN BY NW	DATE JUNE, 2005
CHECKED BY	DATE
FILE StlRpt-F3_2	EDIT NW061605
SCALE AS SHOWN	DRAWING 1:10
	PLOT
PROJECT 62806	

3.2
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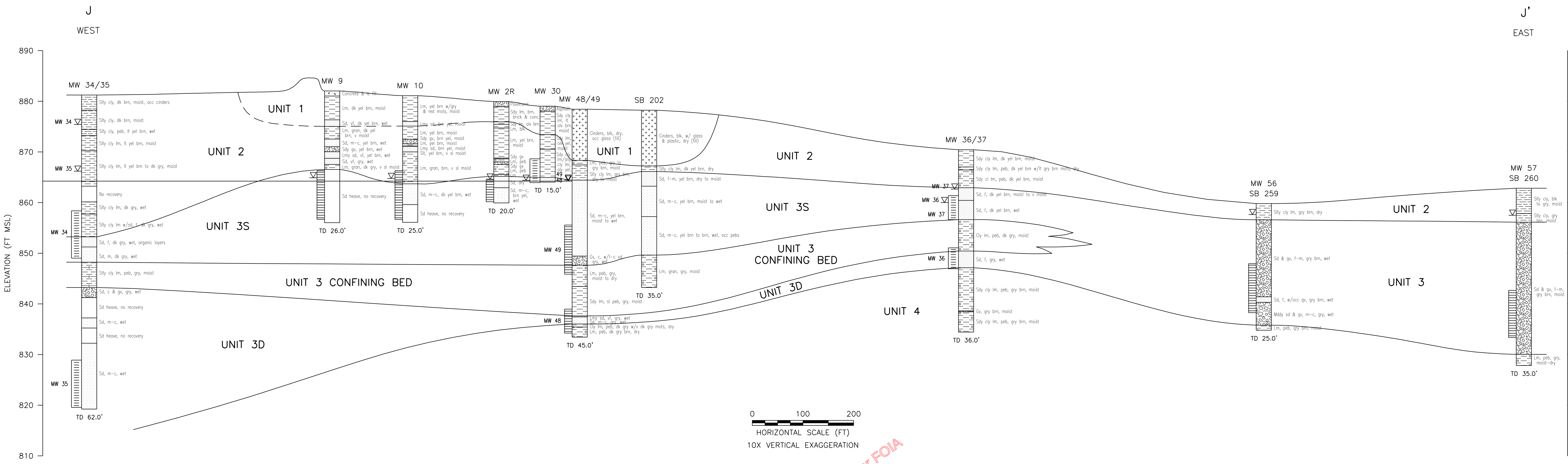
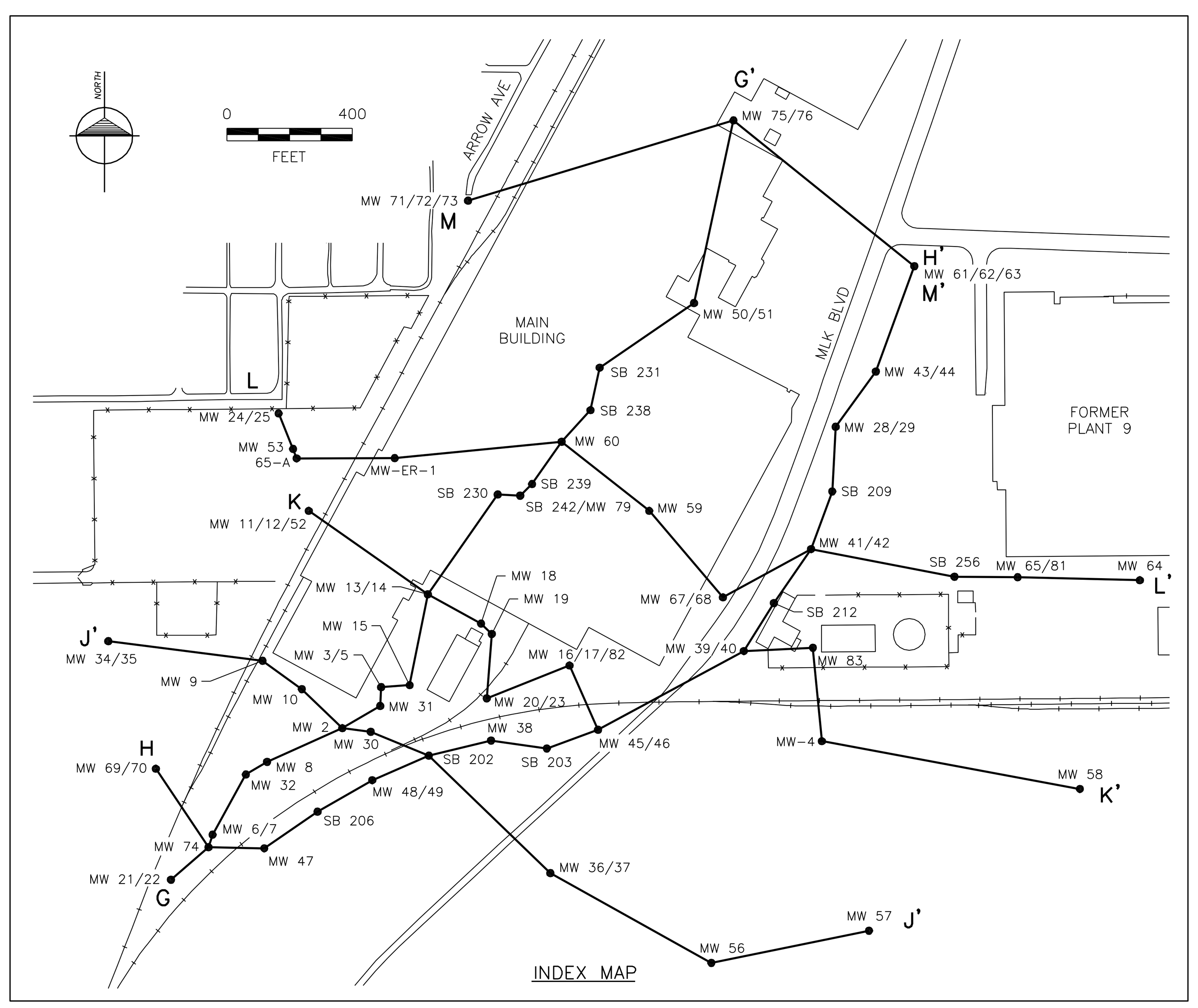


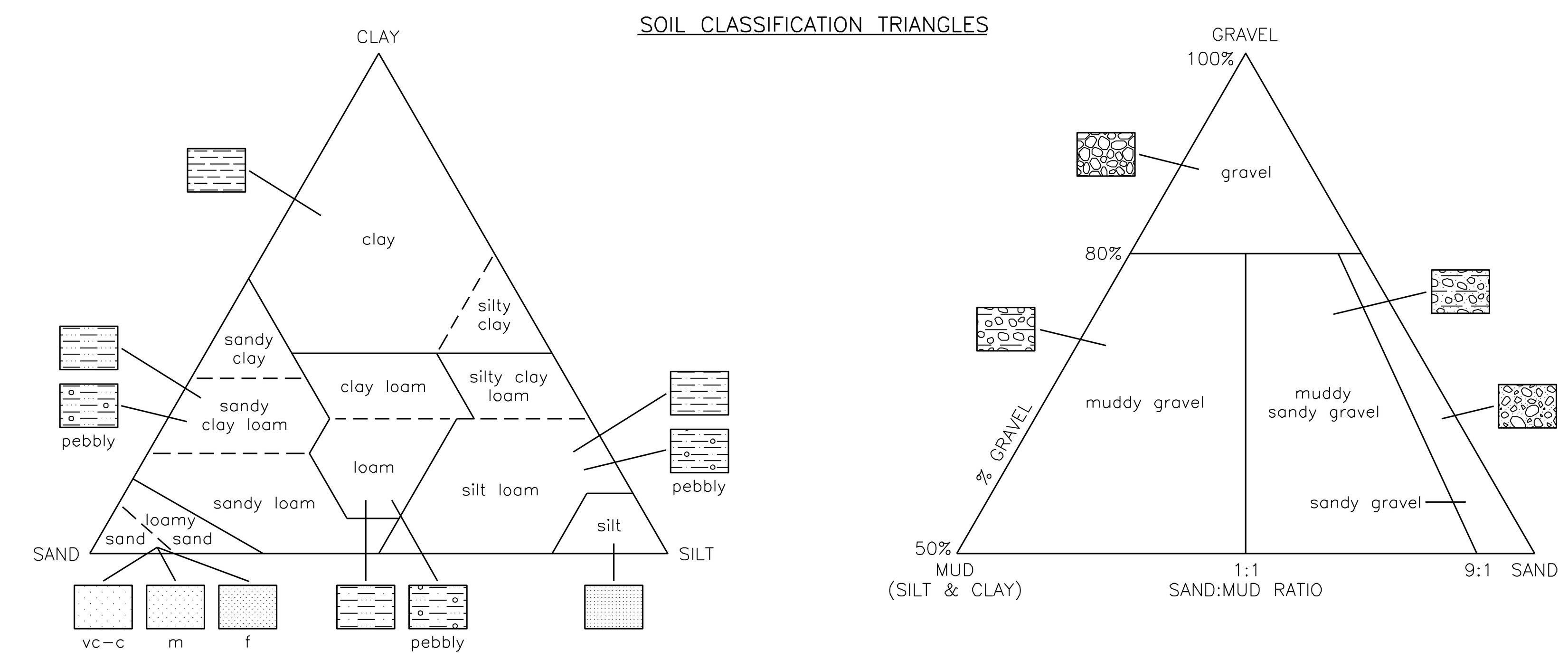


EXPLANATION

WELL SCREEN

STATIC GROUND WATER LEVEL ON MARCH 10, 2005

SOIL CLASSIFICATION TRIANGLES



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USDA TEXTURAL CLASSIFICATION

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TEXTURAL CLASSIFICATION OF GRAVELS MODIFIED FROM FOLK (1954)

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NO.	DATE	BY	REVISIONS

NO.	DATE	BY	REVISIONS

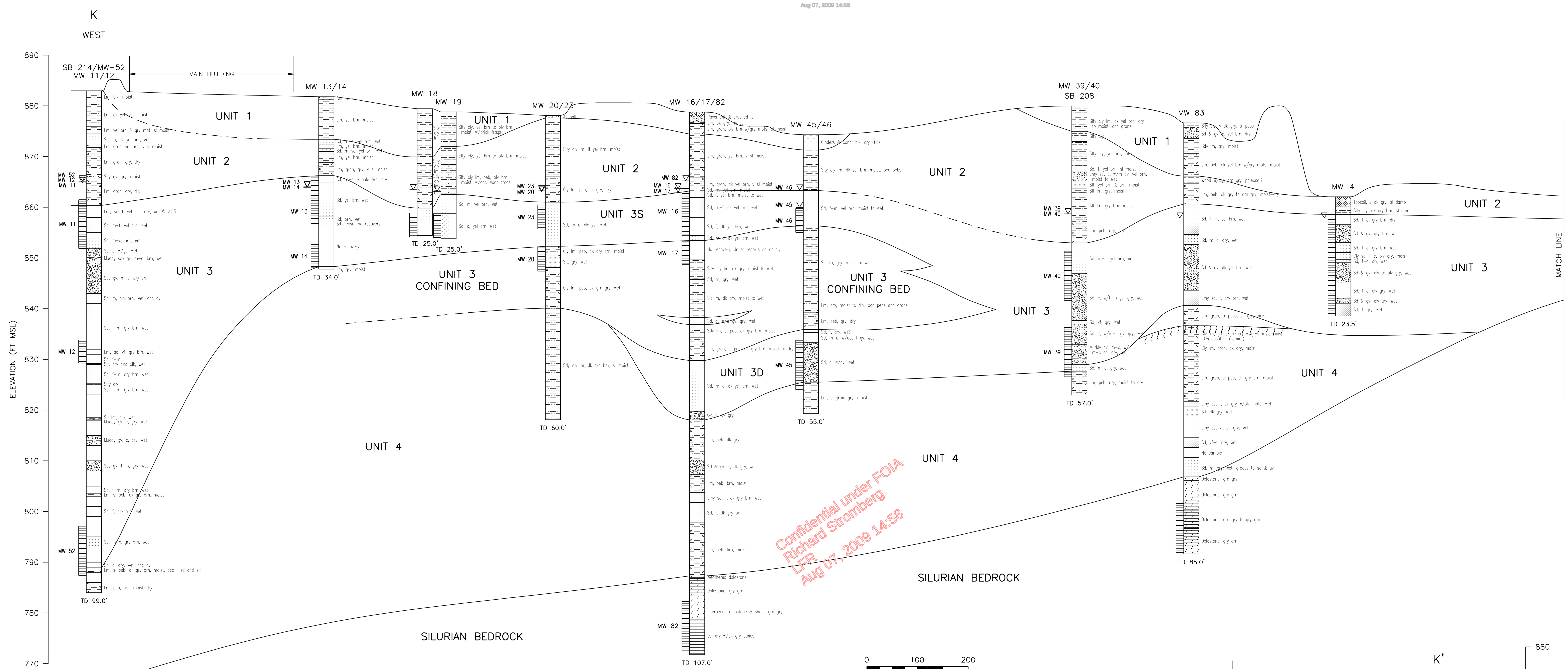
GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

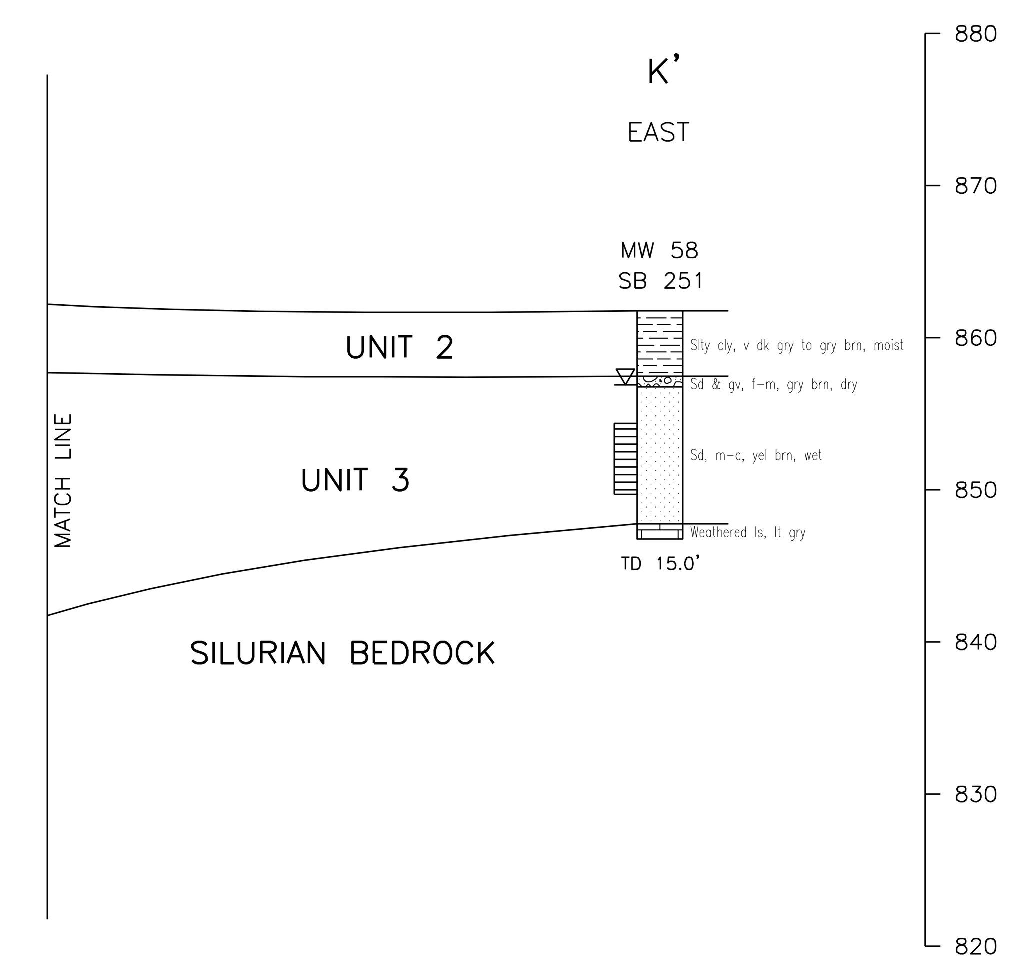
HYDROGEOLOGIC CROSS SECTION J-J'

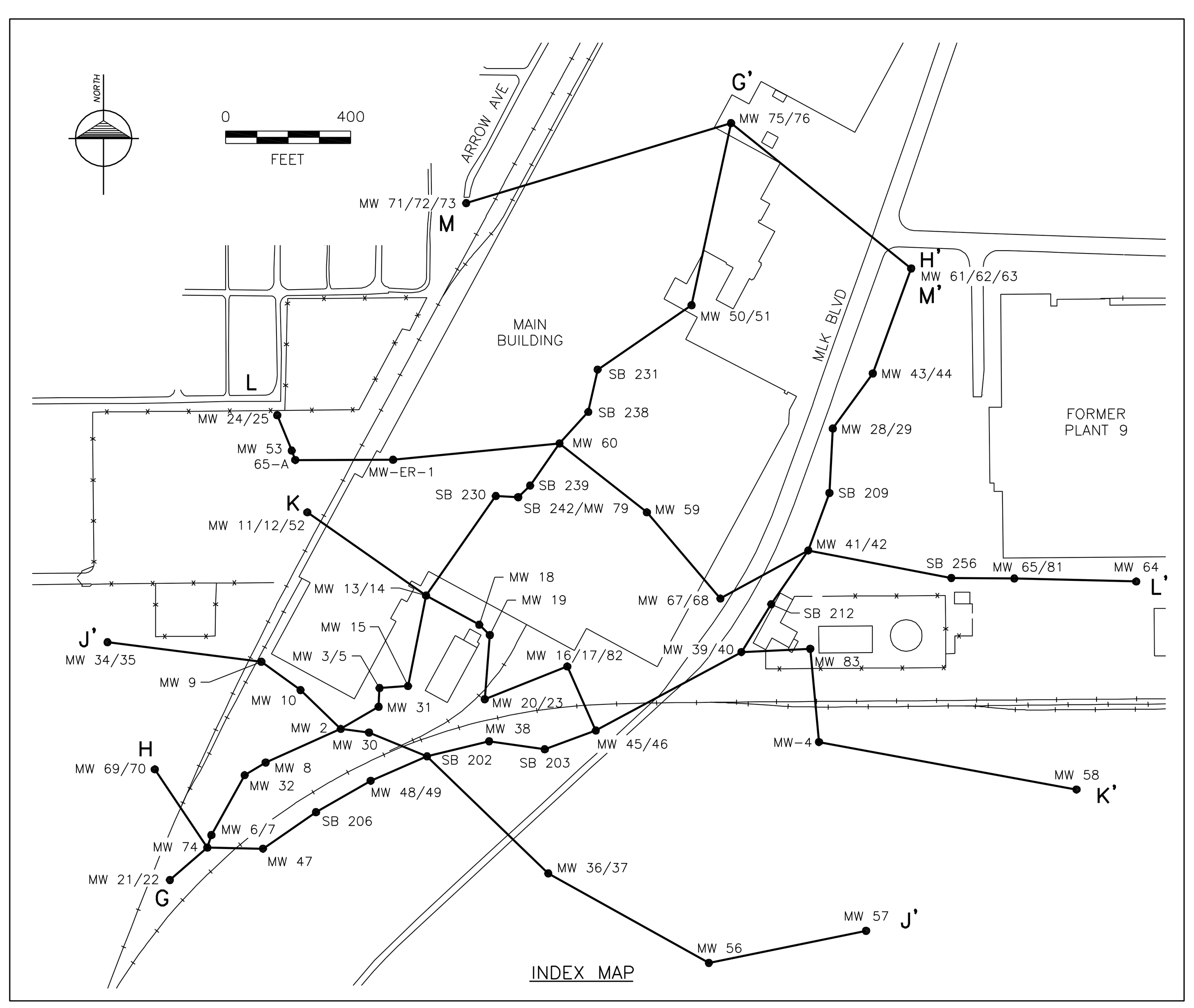
DESIGNED BY NW	DATE JUNE, 2005
DRAWN BY NW	DATE JUNE, 2005
CHECKED BY	DATE
FILE StIIRpt-F3_3	EDIT NW061605
SCALE	AS SHOWN
DRAWING	1:10
PLOT	
PROJECT	62806

3.3

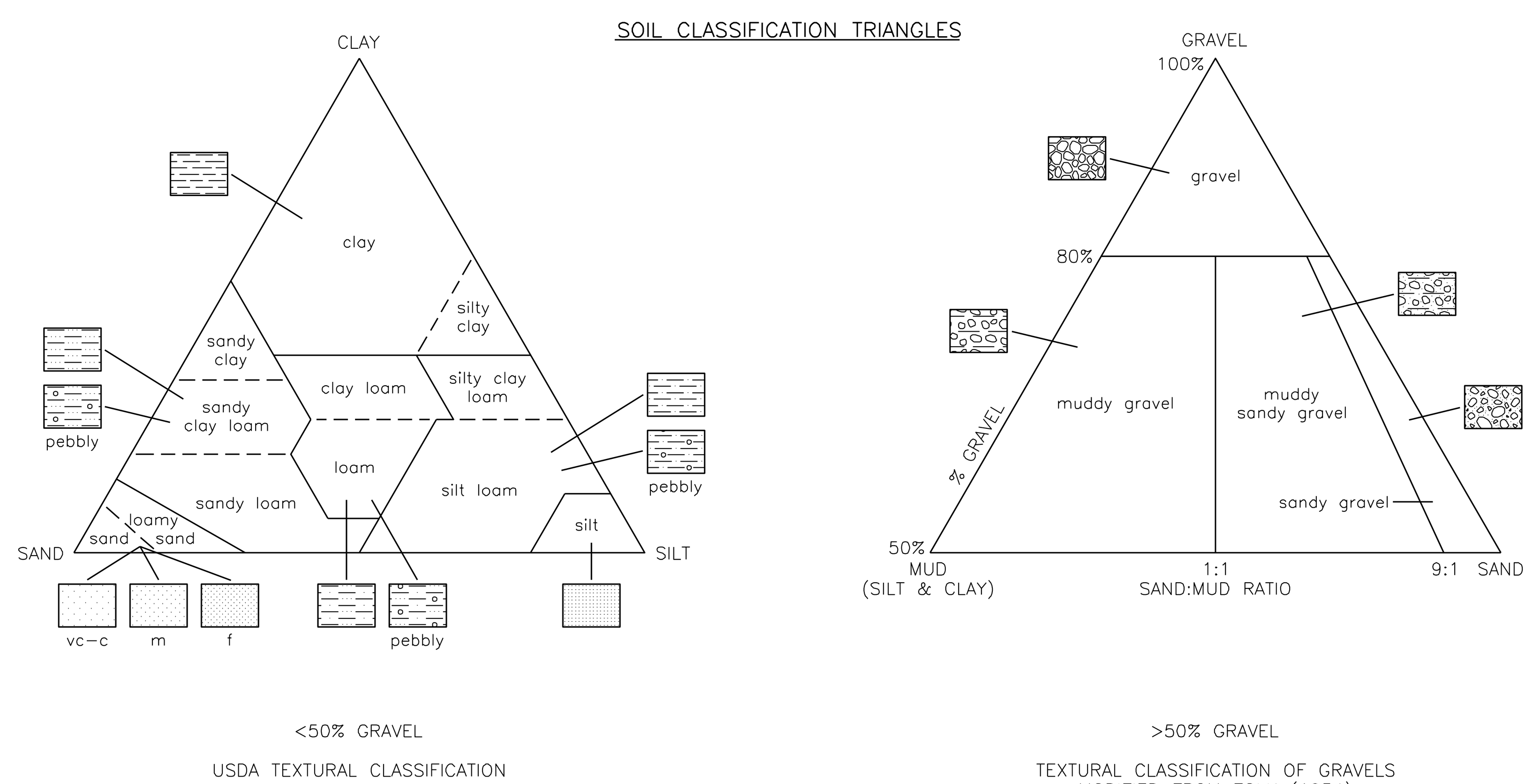
FIGURE NO.







SOIL CLASSIFICATION TRIANGLES



EXPLANATION

WELL SCREEN

STATIC GROUND WATER LEVEL ON MARCH 10, 2005

EarthTech
A tyco International Ltd. Company

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

HYDROGEOLOGIC CROSS SECTION K-K'

DESIGNED BY NW	DATE JUNE, 2005
DRAWN BY NW	DATE JUNE, 2005
CHECKED BY	DATE
FILE StlRpt-F3_4	EDIT NW061605
SCALE	AS SHOWN DRAWING 1:10 PLOT
PROJECT	62806

3.4
FIGURE NO.

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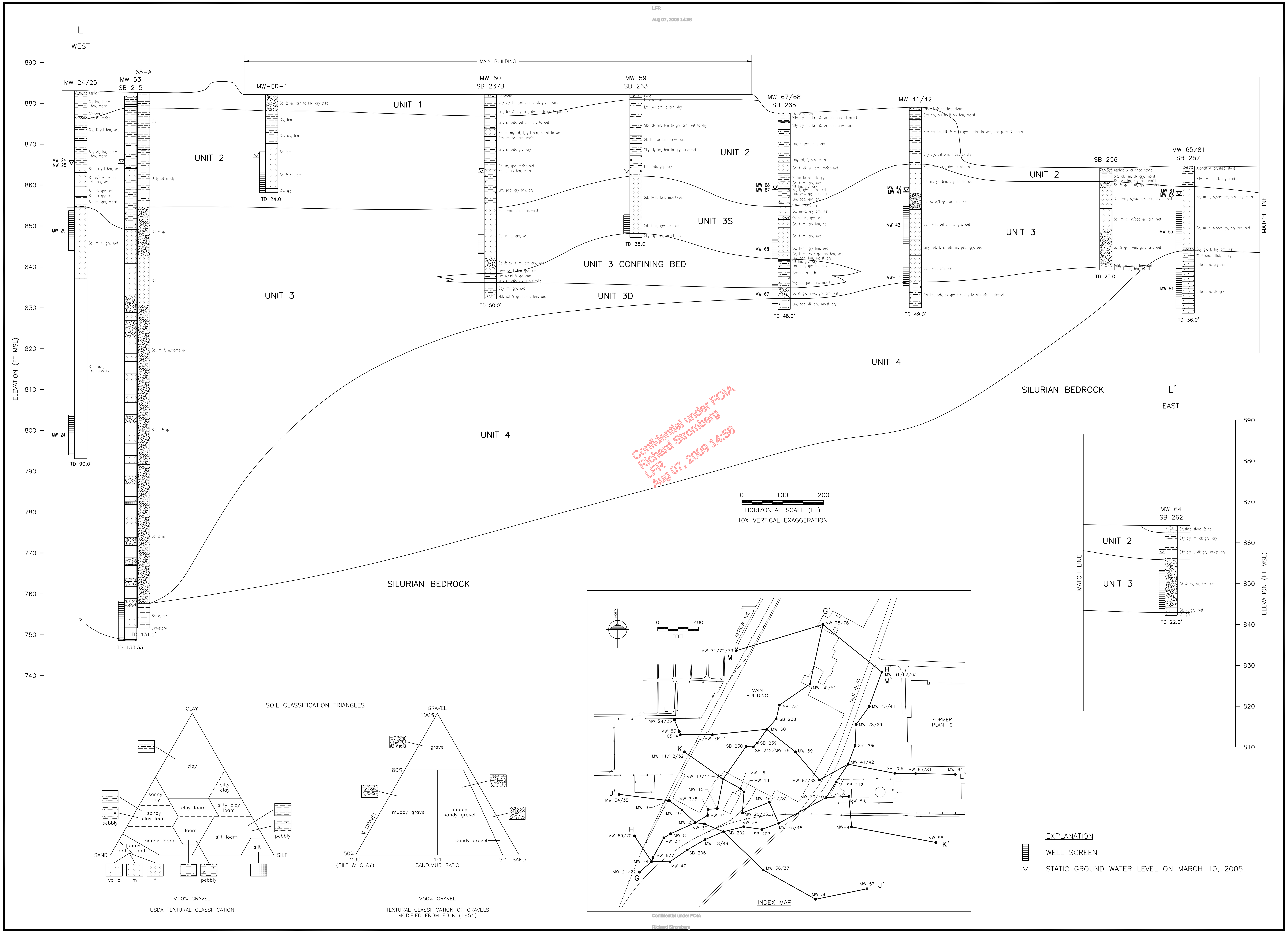

EarthTech
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GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

HYDROGEOLOGIC CROSS SECTION L-L'

DESIGNED BY NW	DATE JUNE, 2005
DRAWN BY NW	DATE JUNE, 2005
CHECKED BY	DATE
FILE StillRpt-F3_5	EDIT NW061605
SCALE AS SHOWN	DRAWING 1:10
	PLOT
PROJECT 62806	

3.5
FIGURE NO.

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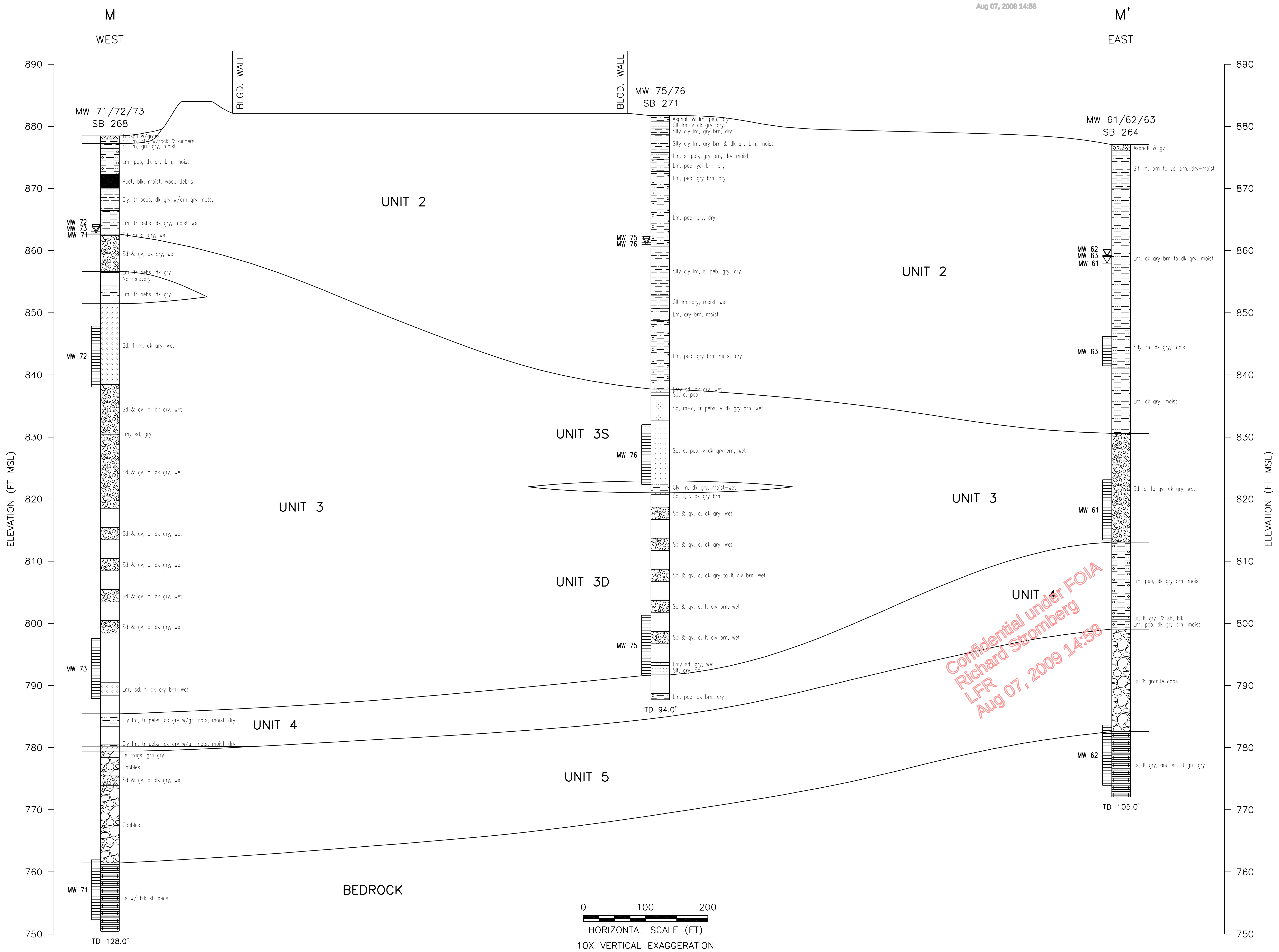
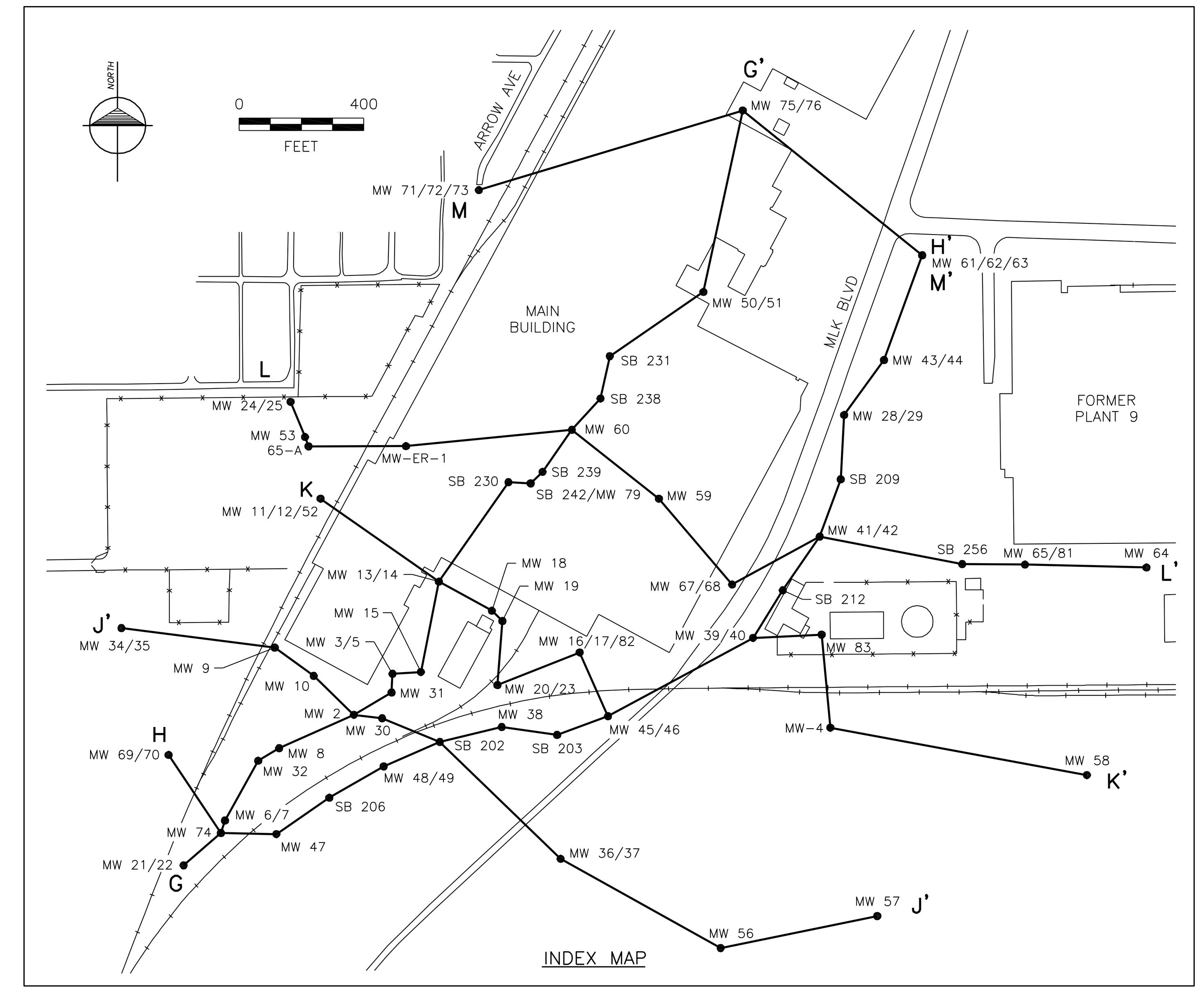


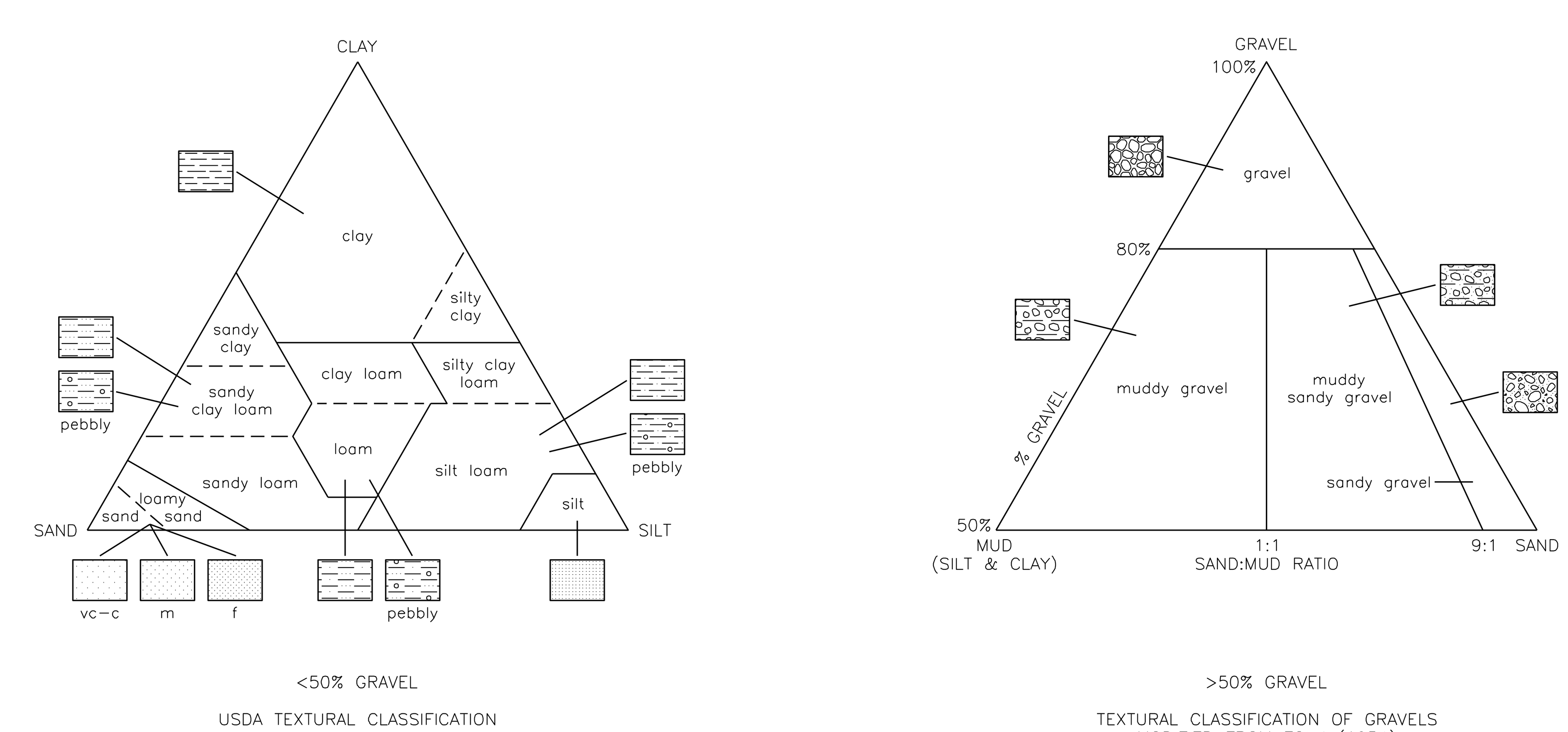


EXPLANATION

WELL SCREEN

STATIC GROUND WATER LEVEL ON MARCH 10, 2005

SOIL CLASSIFICATION TRIANGLES



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GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

HYDROGEOLOGIC CROSS SECTION M–M'

DESIGNED BY NW	DATE JUNE, 2005
DRAWN BY NW	DATE JUNE, 2005
CHECKED BY	DATE
FILE StillRpt-F3_6	EDIT NW061605
SCALE	AS SHOWN
DRAWING	1:10
PLOT	
PROJECT	62806

3.6
FIGURE NO.

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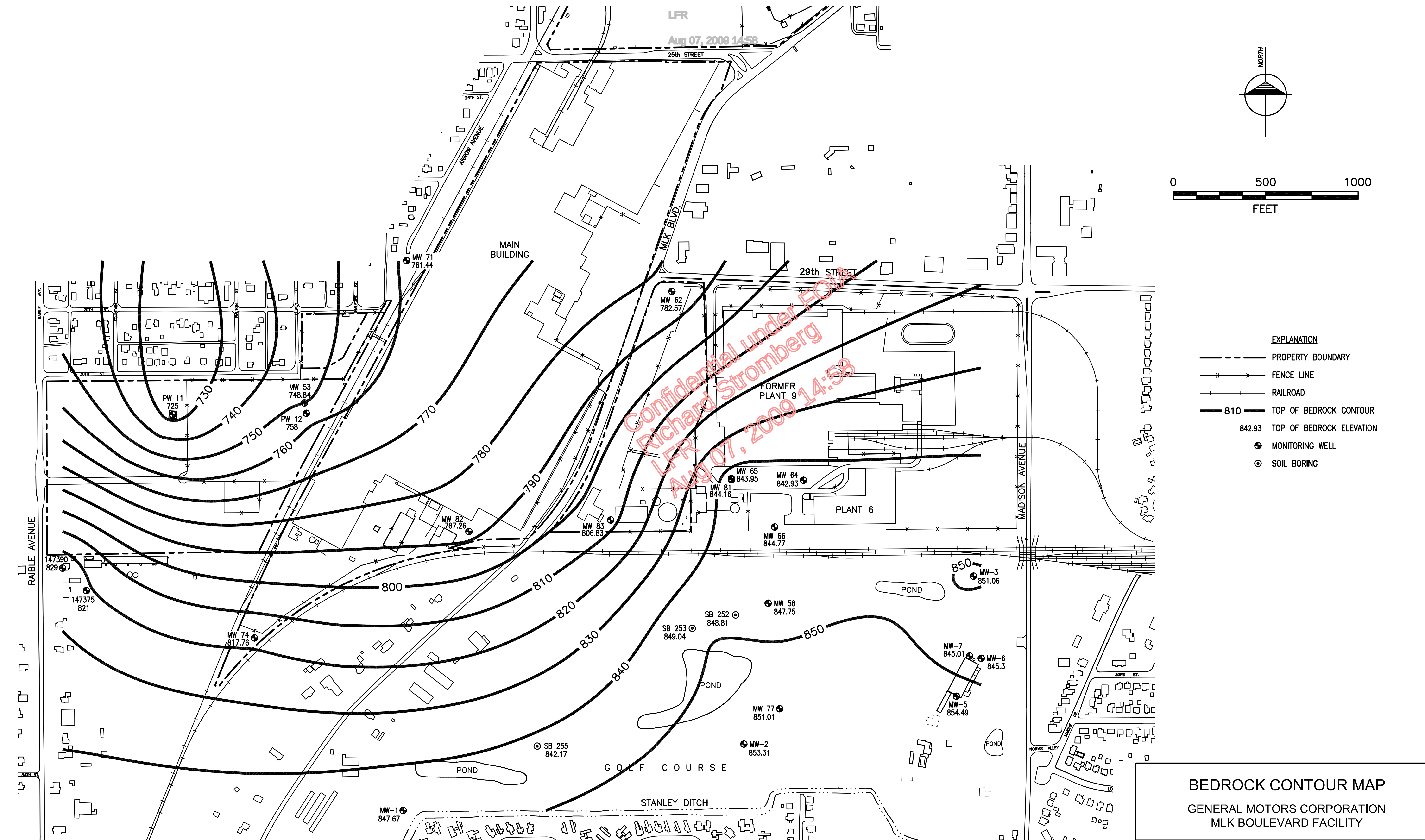

BEDROCK CONTOUR MAP

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05

Project No. 62806

EarthTech
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Figure 3.7

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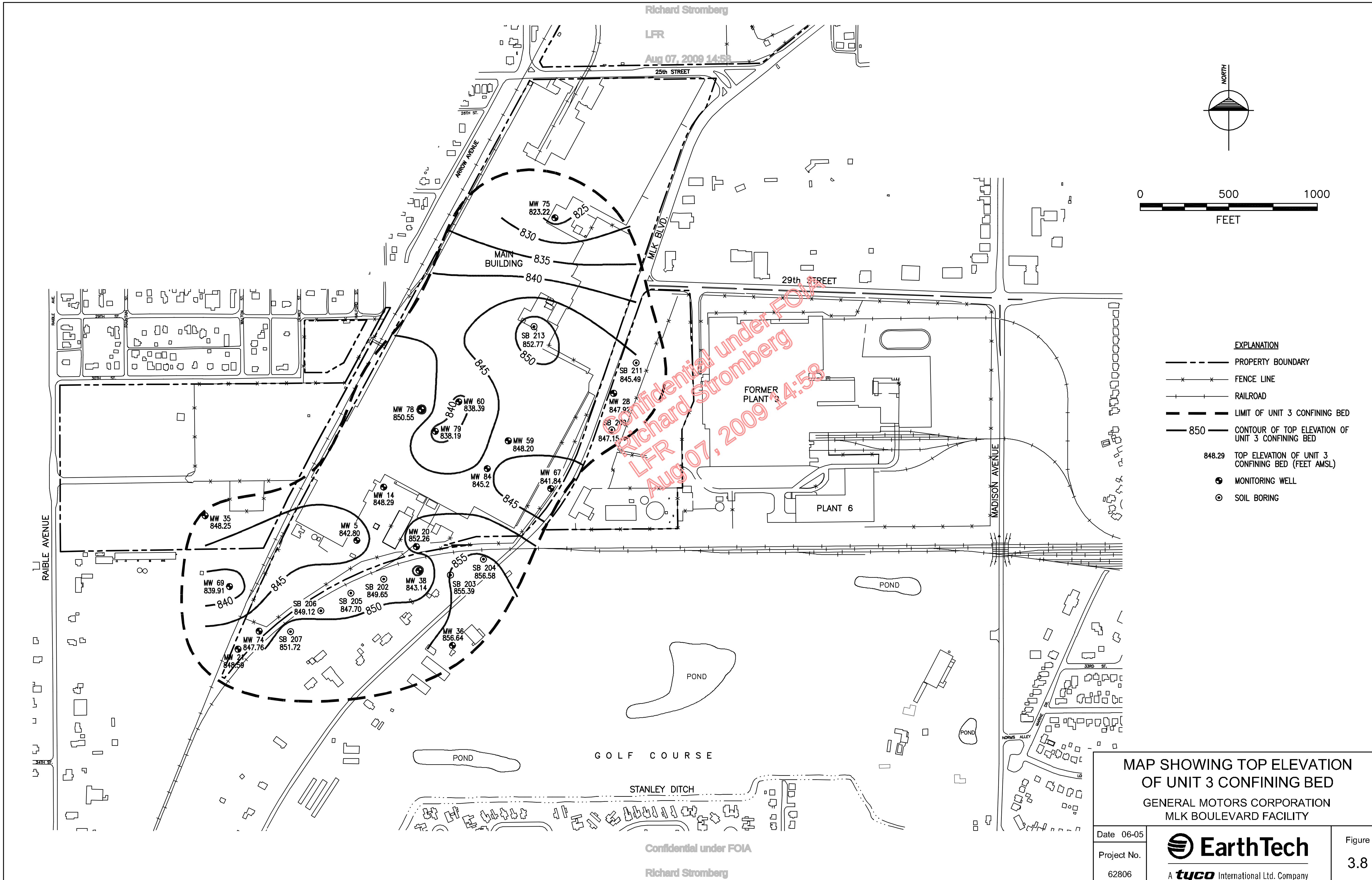

MAP SHOWING TOP ELEVATION OF UNIT 3 CONFINING BED

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 3.8

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F3_8.dwg NW062705

MAP SHOWING THICKNESS OF UNIT 3 CONFINING BED

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
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Figure 3.9

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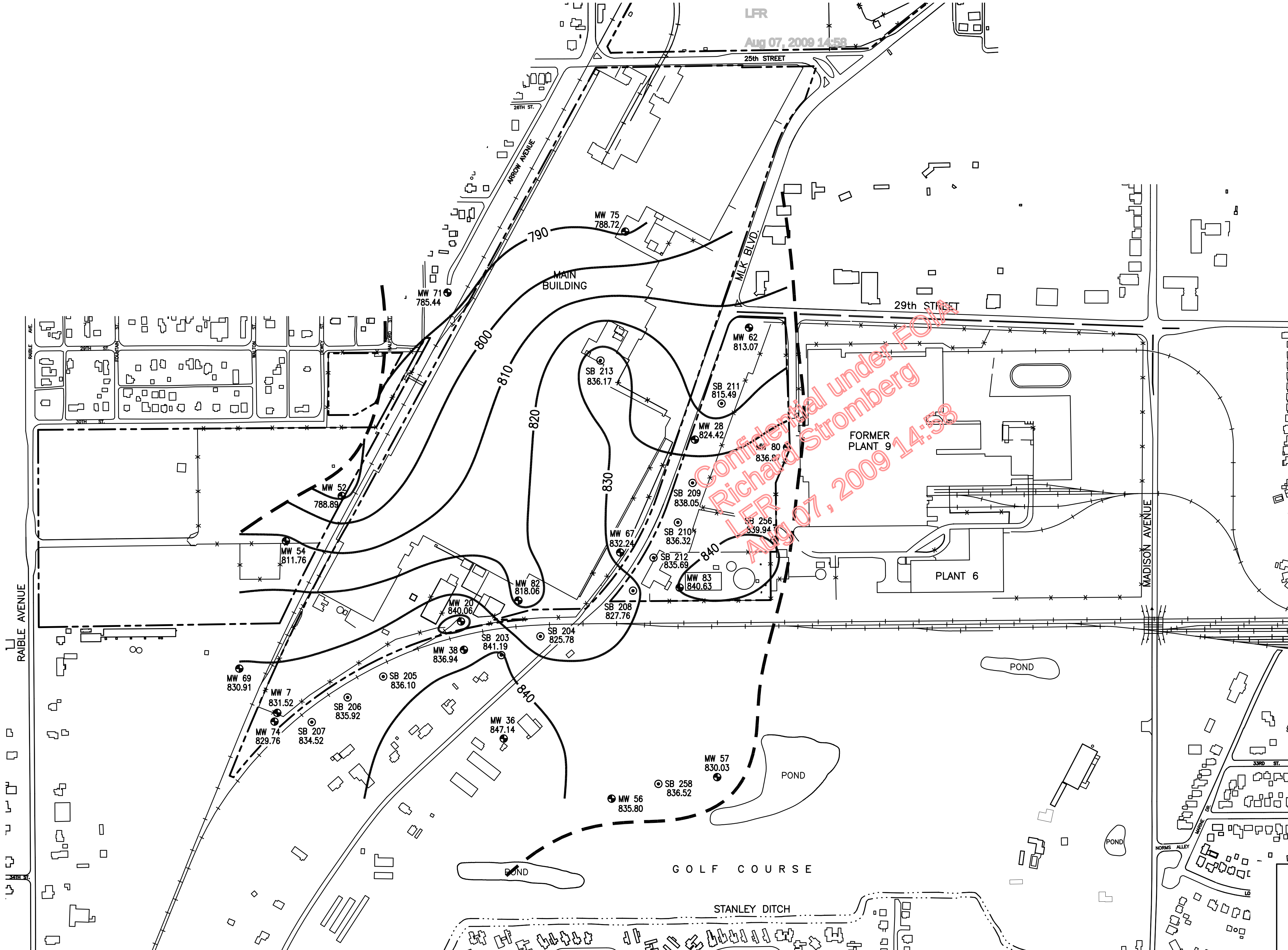

EXPLANATION

- PROPERTY BOUNDARY
- FENCE LINE
- RAILROAD
- LIMIT OF UNIT 4 CONFINING BED
- 820 CONTOUR OF TOP ELEVATION OF UNIT 4 CONFINING BED
- 836.32 TOP ELEVATION OF UNIT 4 CONFINING BED (FEET AMSL)
- MONITORING WELL
- SOIL BORING

MAP SHOWING TOP ELEVATION OF UNIT 4 CONFINING BED

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 3.10

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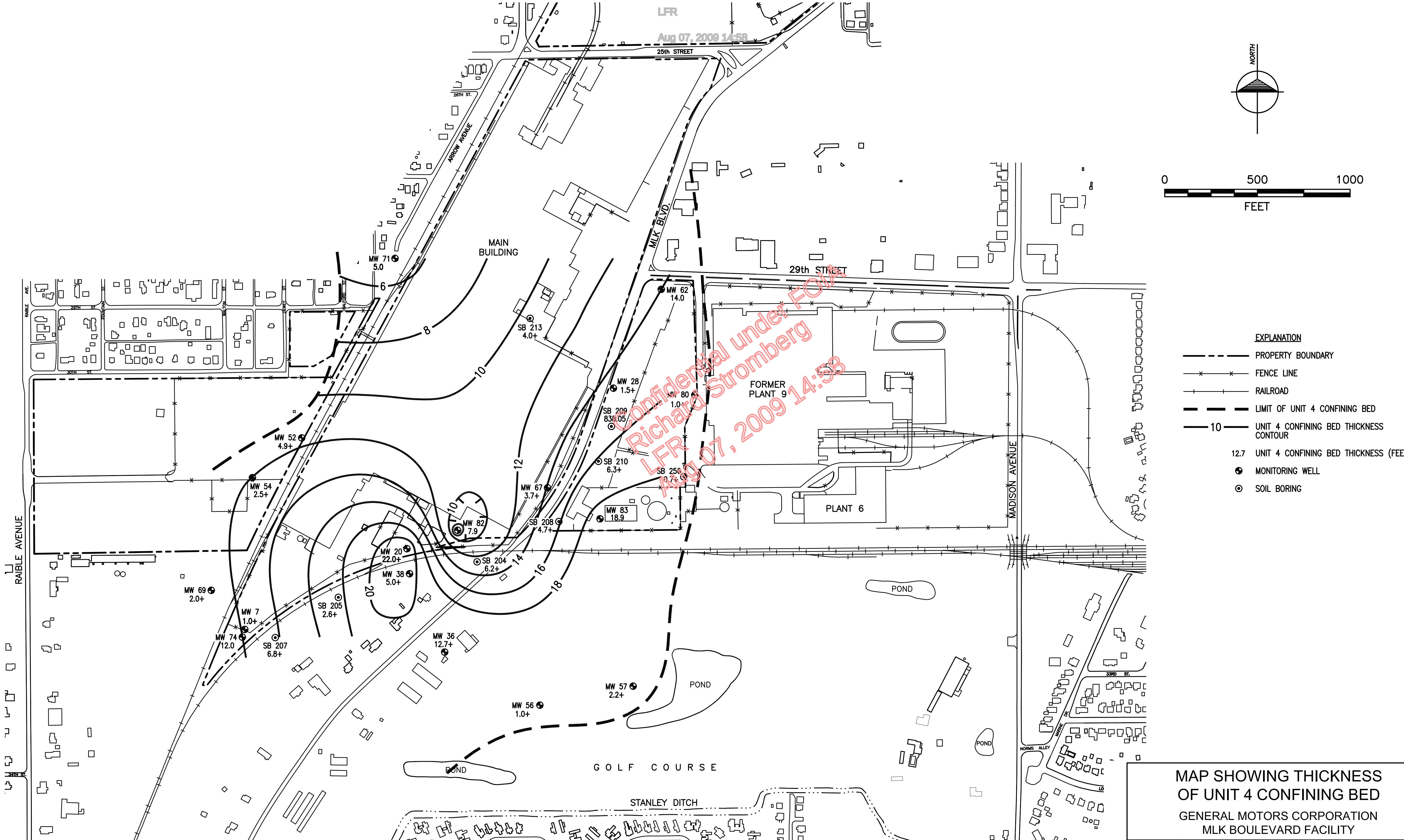

MAP SHOWING THICKNESS OF UNIT 4 CONFINING BED

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure 3.11
Project No. 62806		

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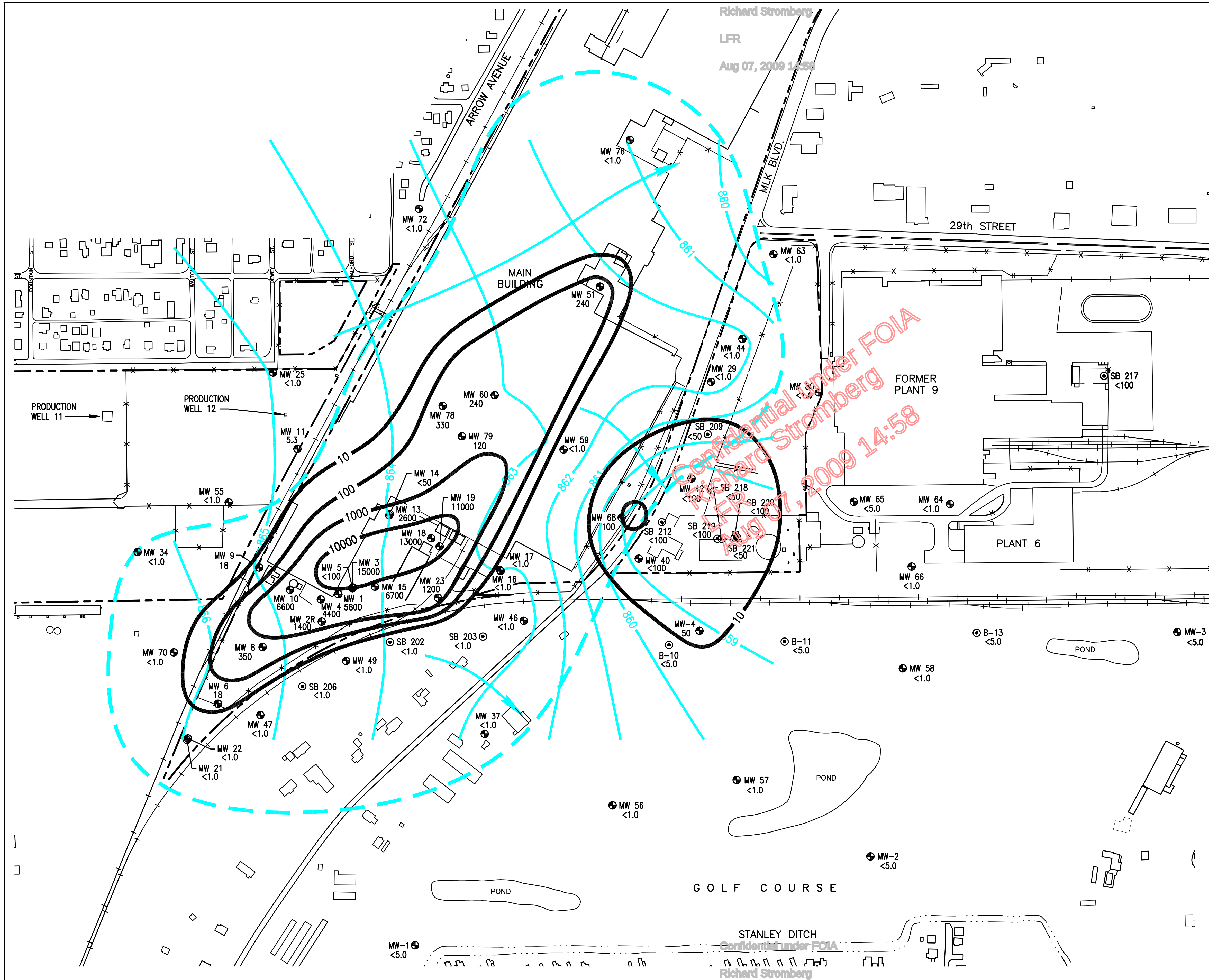

CONCENTRATION OF TRICHLOROETHYLENE IN GROUNDWATER - UNIT 3S

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech	Figure
Project No. 62806	A tyco International Ltd. Company	3.12

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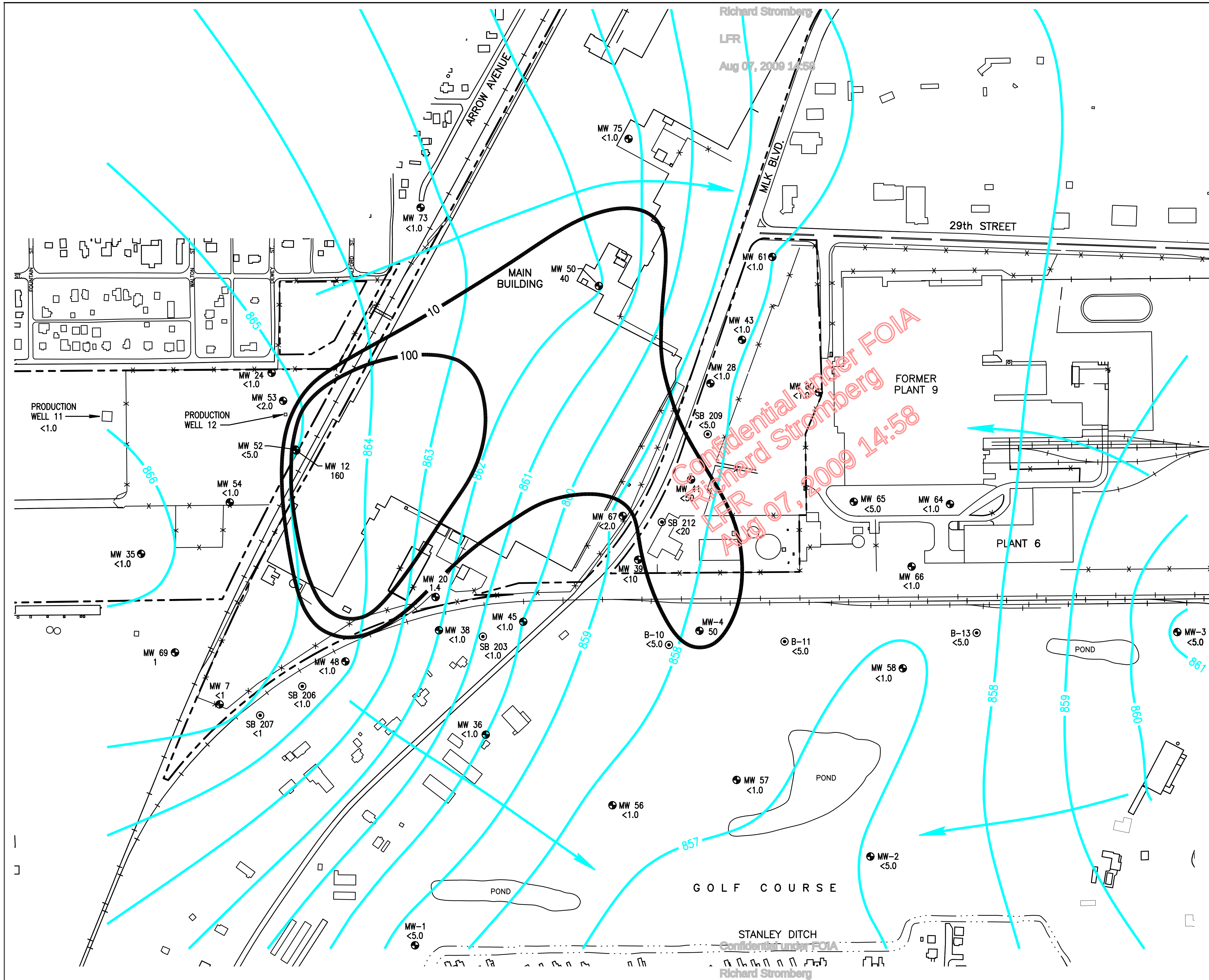

CONCENTRATION OF TRICHLOROETHYLENE IN GROUNDWATER - UNIT 3D

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 3.13

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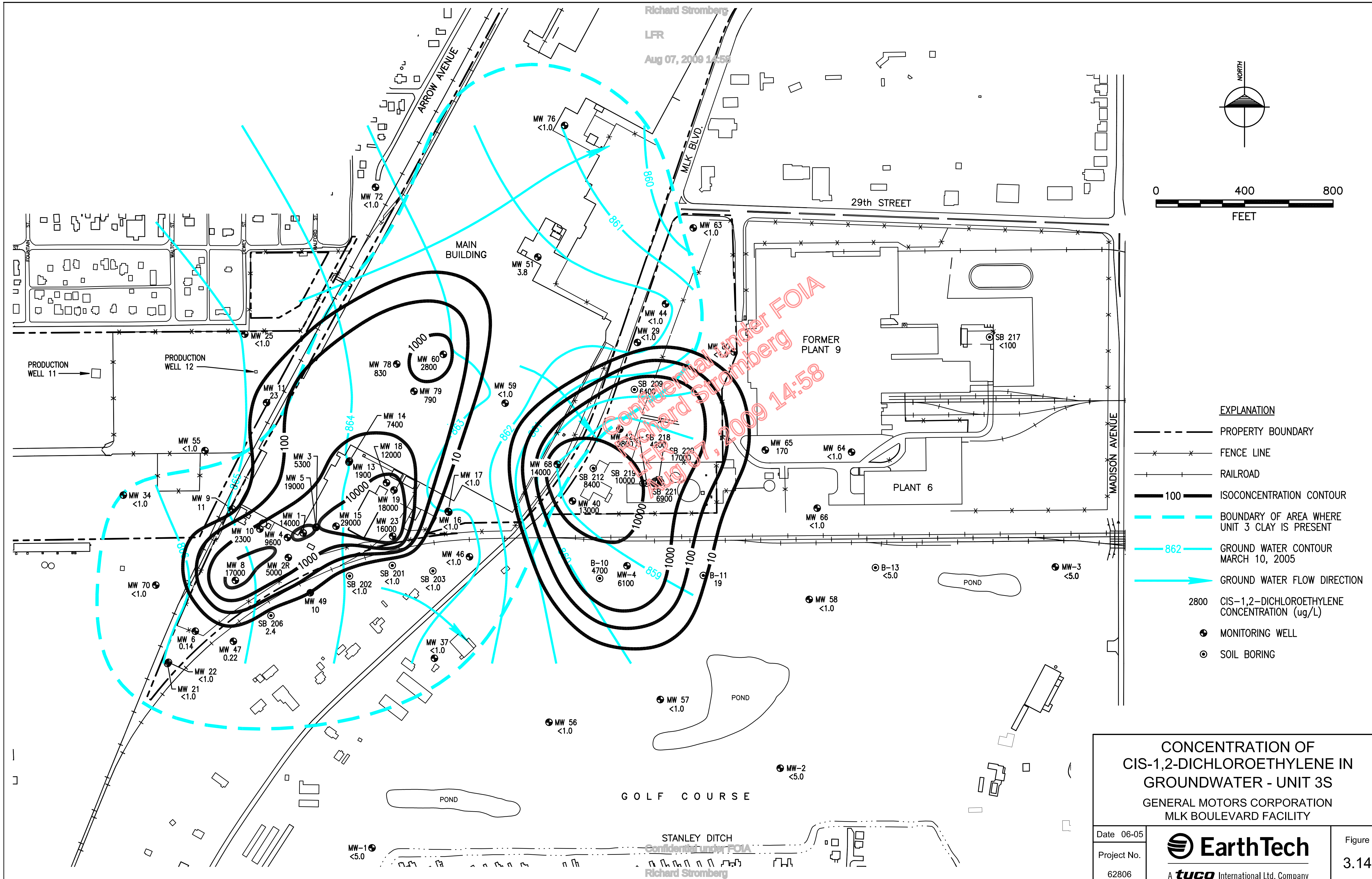

CONCENTRATION OF CIS-1,2-DICHLOROETHYLENE IN GROUNDWATER - UNIT 3S

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 3.14

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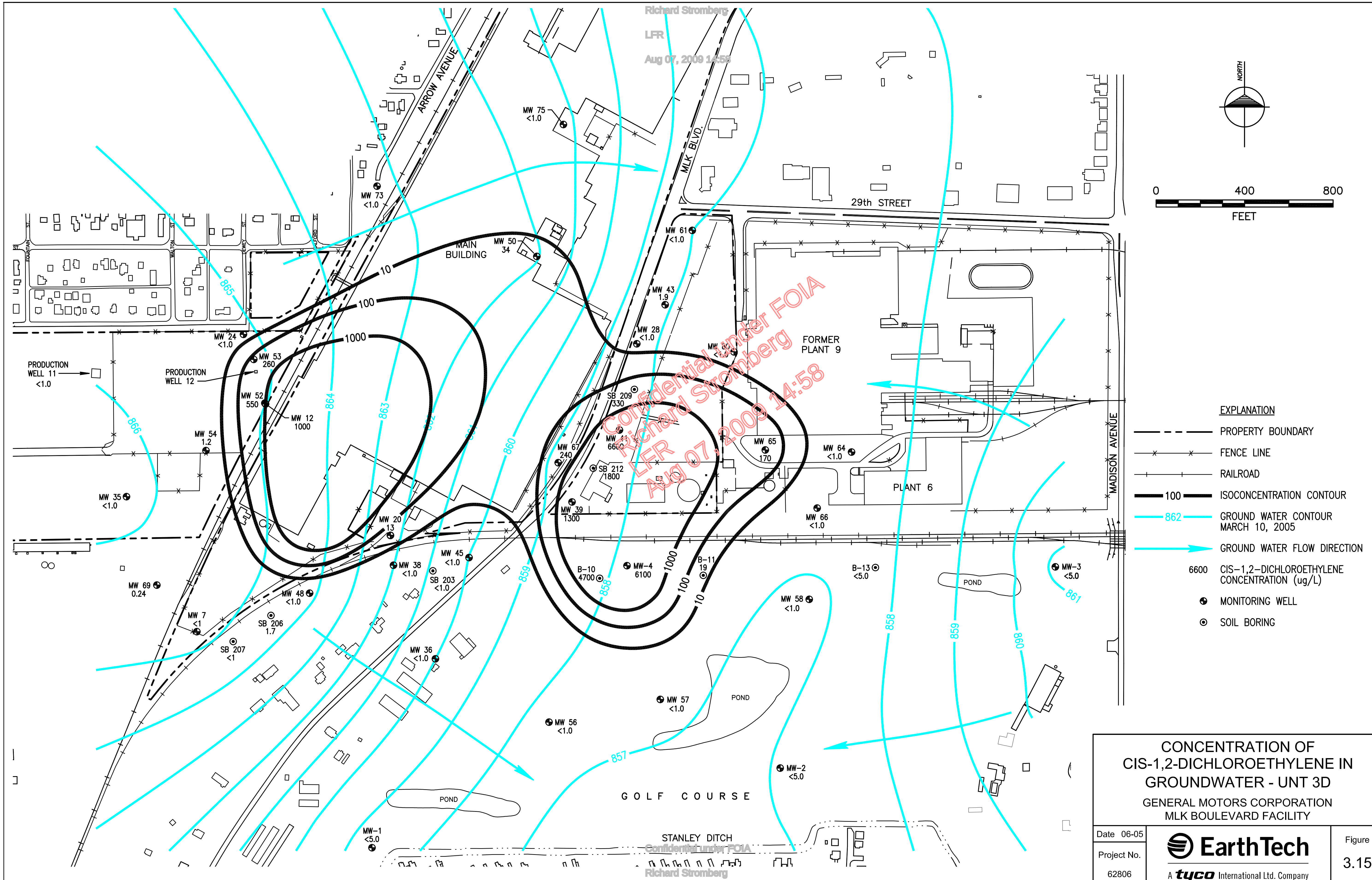

CONCENTRATION OF CIS-1,2-DICHLOROETHYLENE IN GROUNDWATER - UNT 3D

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 3.15

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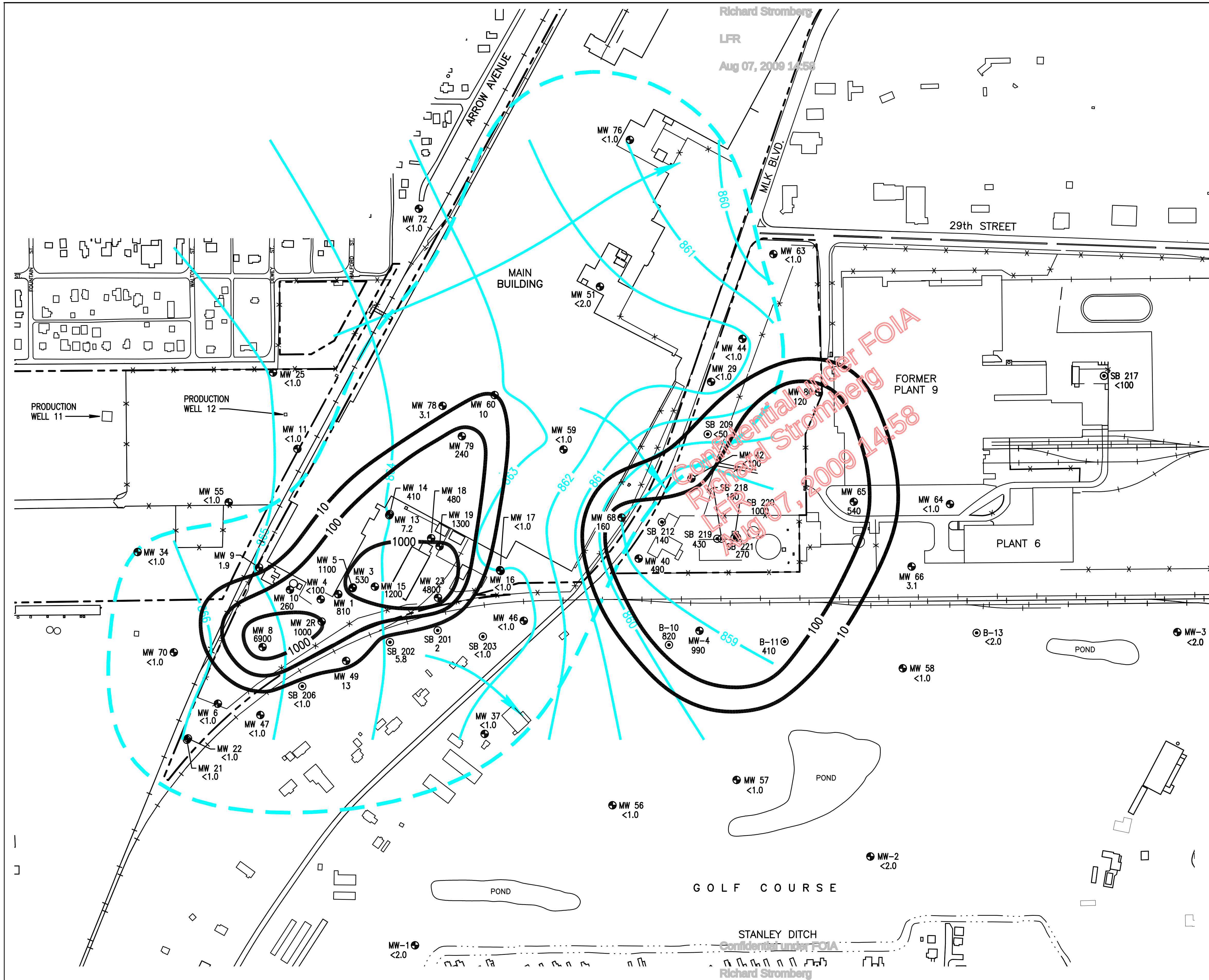
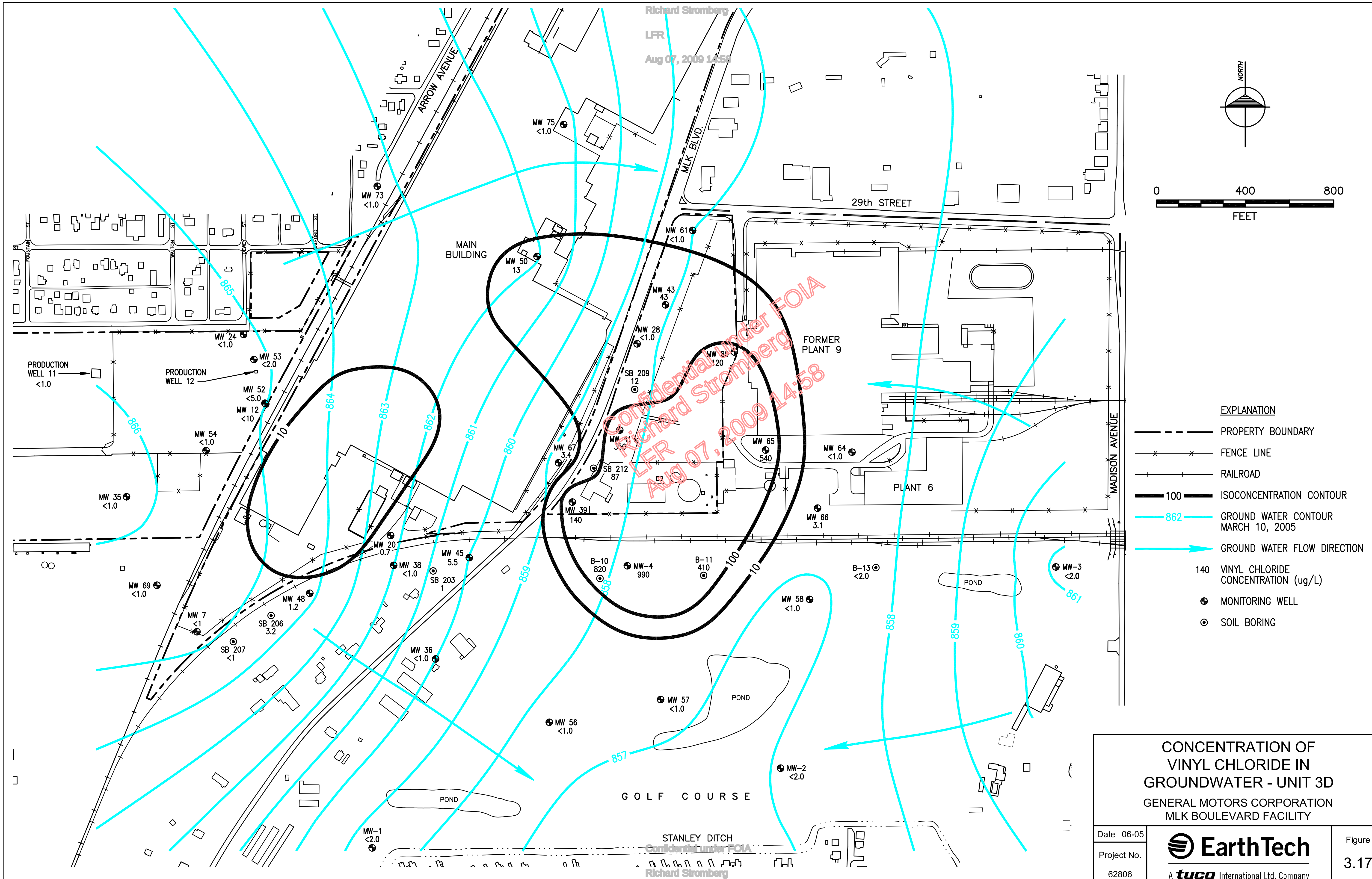


CONCENTRATION OF VINYL CHLORIDE IN GROUNDWATER - UNIT 3S

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure
Project No. 62806		3.16

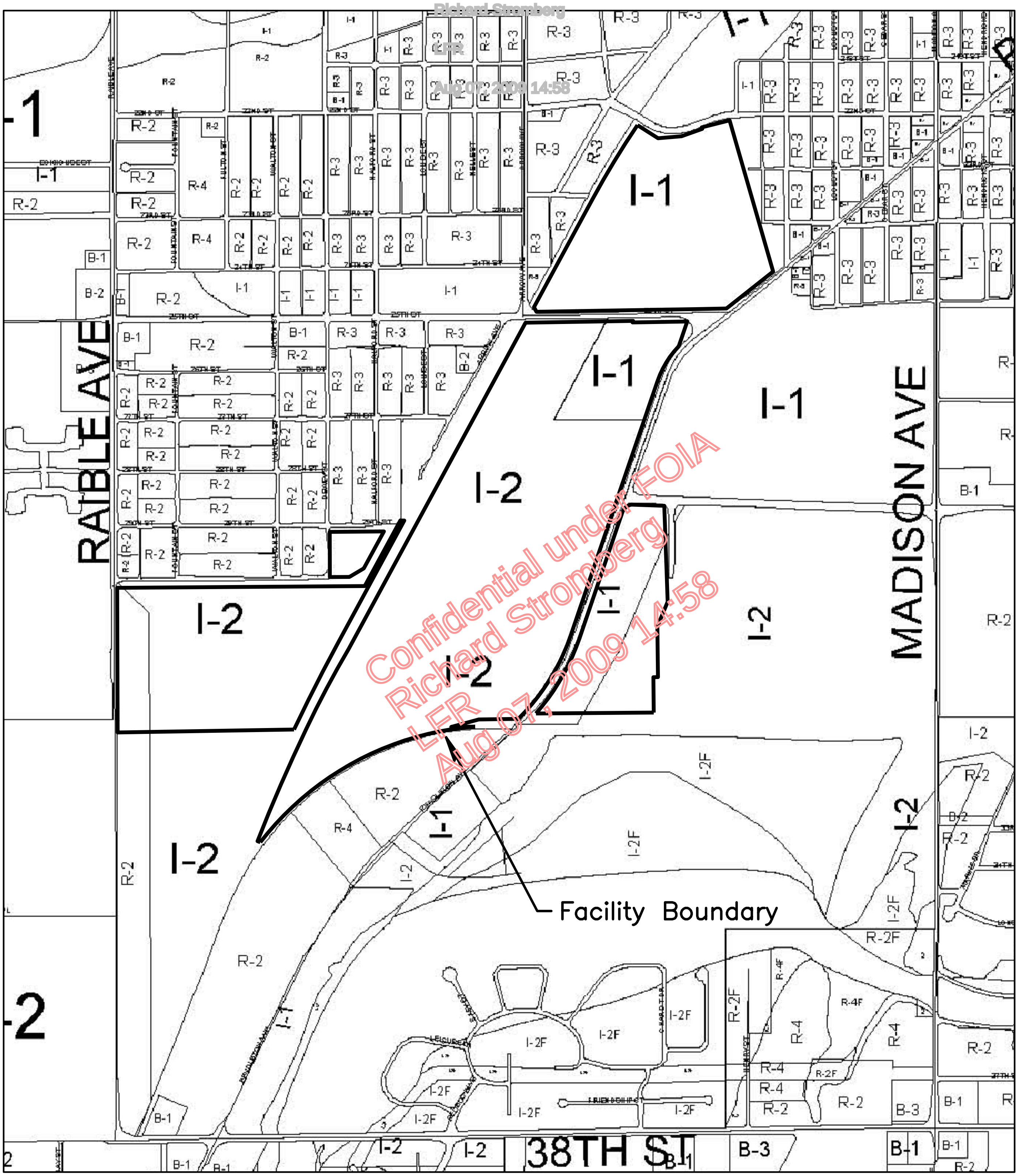
L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F3_16.dwg NW062705



CONCENTRATION OF
VINYL CHLORIDE IN
GROUNDWATER - UNIT 3D

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure
Project No. 62806		3.17



Explanation

B–1, B–2, B–3	Business Districts
I–1, I–2	Industrial Districts
R–2, R–3, R–4	Residential Districts
F	Floodway

NORTH

Map provided by City Planning Department. Last updated September 1996.

AREA ZONING MAP

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05

Project No.
62806

EarthTech
A tyco International Ltd. Company

Figure
3.18

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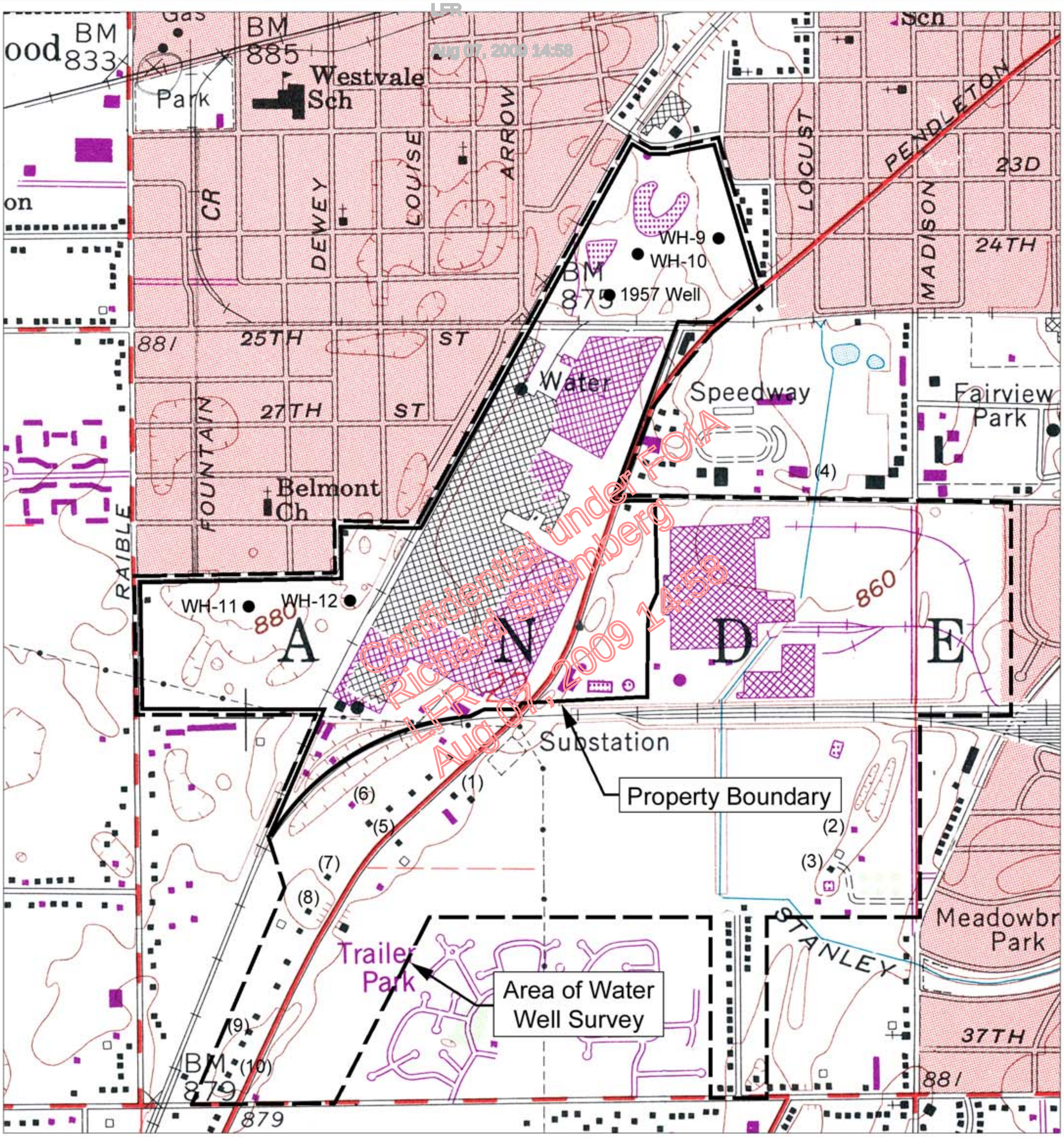

NORTH

0 1000
Feet

Addresses:
(1) 3232 MLK Boulevard
(2) 3429 S. Madison Ave.
(3) 3429 S. Madison Ave.
(4) 1400 W. 29th Street
(5) 3503 MLK Boulevard
(6) 3523 MLK Boulevard
(7) 3535 MLK Boulevard
(8) 3633 MLK Boulevard
(9) 3923 MLK Boulevard
(10) 4003 MLK Boulevard
● Former GM Production Well

Base map taken from USGS Anderson South, Ind. 7.5' Topographic Quadrangle, 1994.

GROUNDWATER USE MAP
GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 09-07	EarthTech	Figure
Project No. 62806	A tyco International Ltd. Company	3.19

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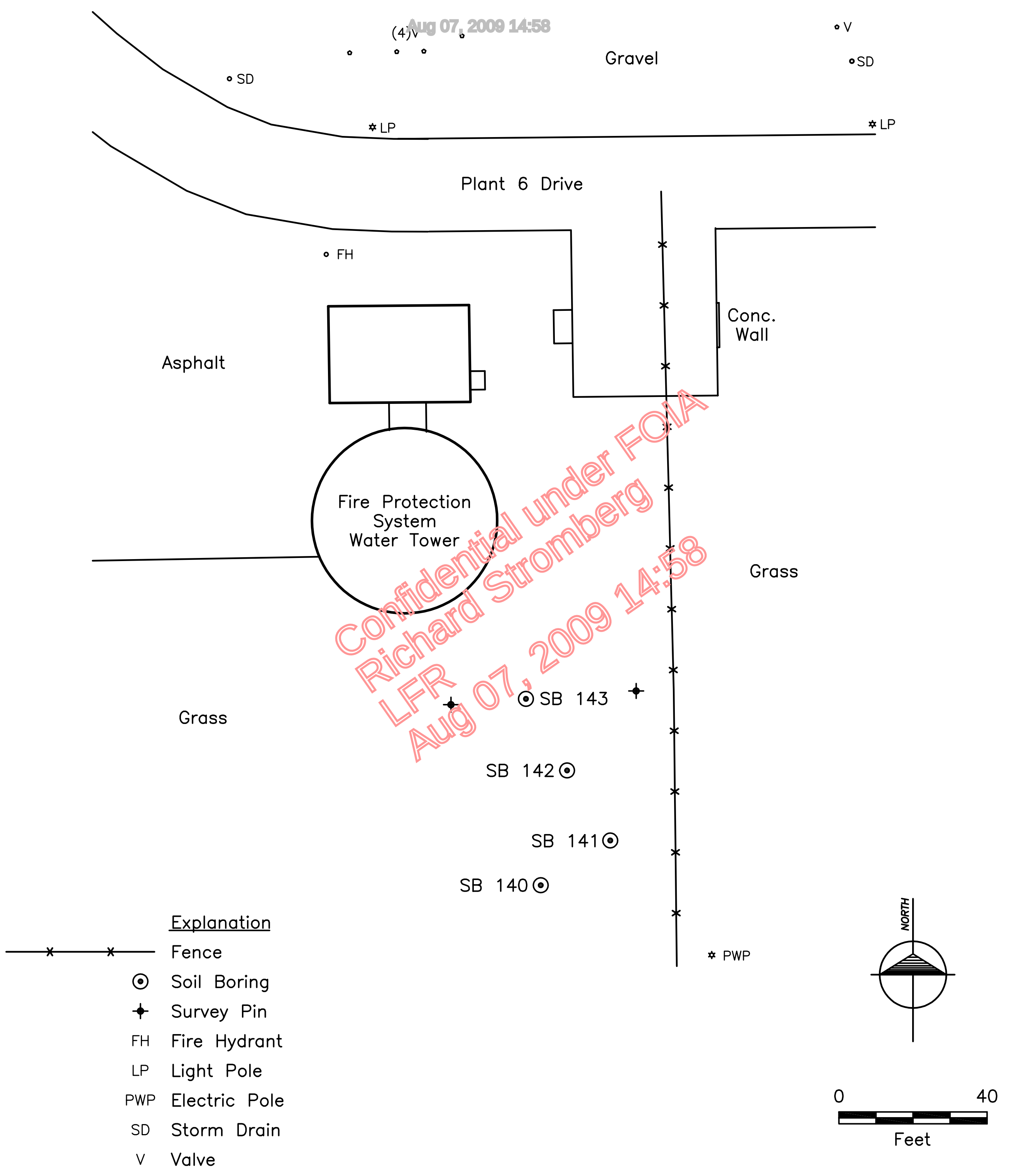


See Figure 2.2 for general area location. Drawing base modified from property plat and description prepared by Alta Land Title Survey. Plat drawing was transformed and rotated to the Indiana State Plane (IN 1301 East) Coordinate System (NAD 83) using USGS monument PID LA 1286. Soil boring and survey pin locations based on GPS and total station field survey, November 2000.

SAMPLING LOCATIONS
AOC 2 - FORMER FIRE TRAINING AREA

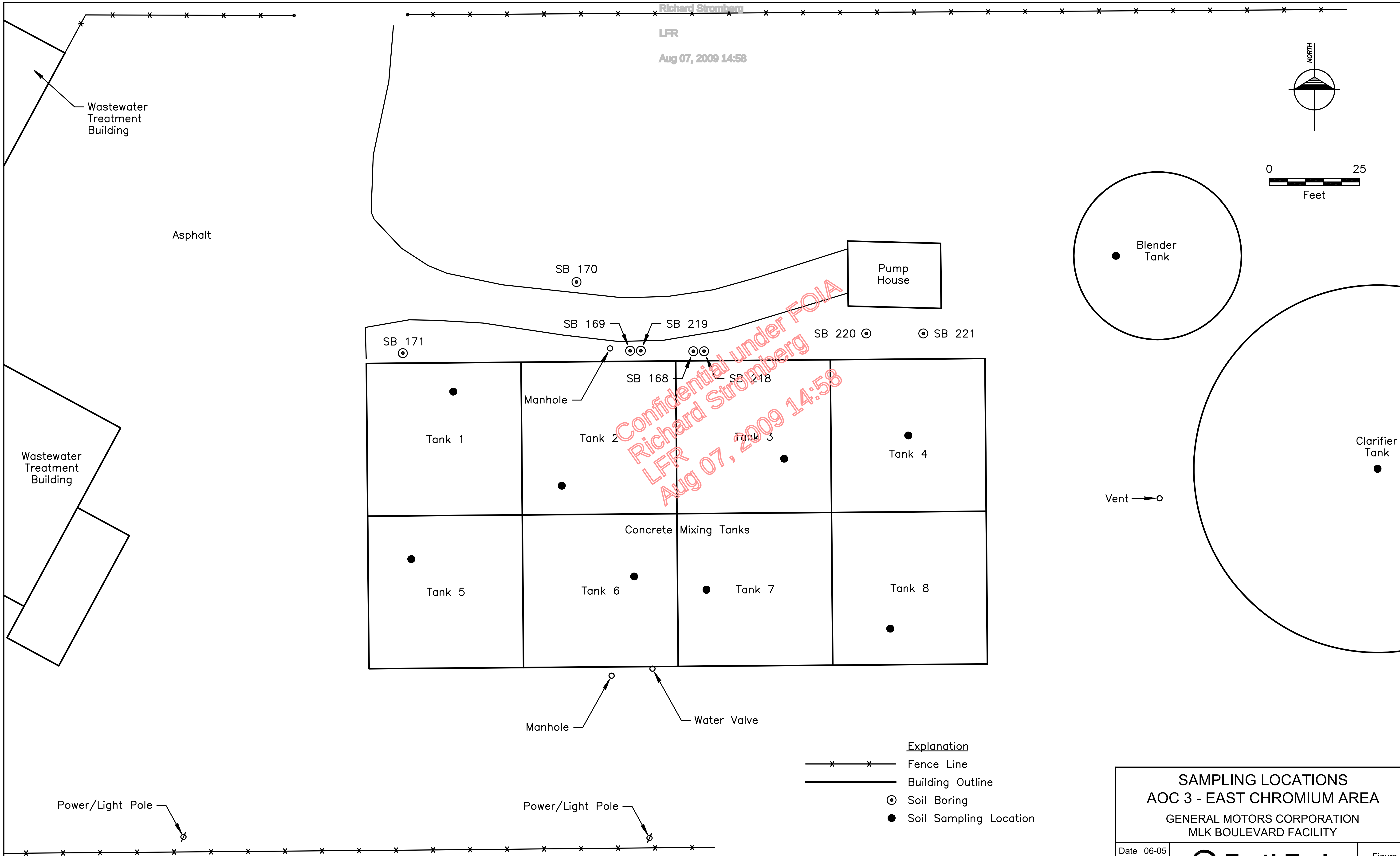
GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 4.1

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F4_1.dwg NW062005



Note: The WWTP buildings and associated structures were demolished in October 2002.
See Figure 2.2 for general location.

SAMPLING LOCATIONS
AOC 3 - EAST CHROMIUM AREA

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

EarthTech
A tyco International Ltd. Company

Figure 4.2

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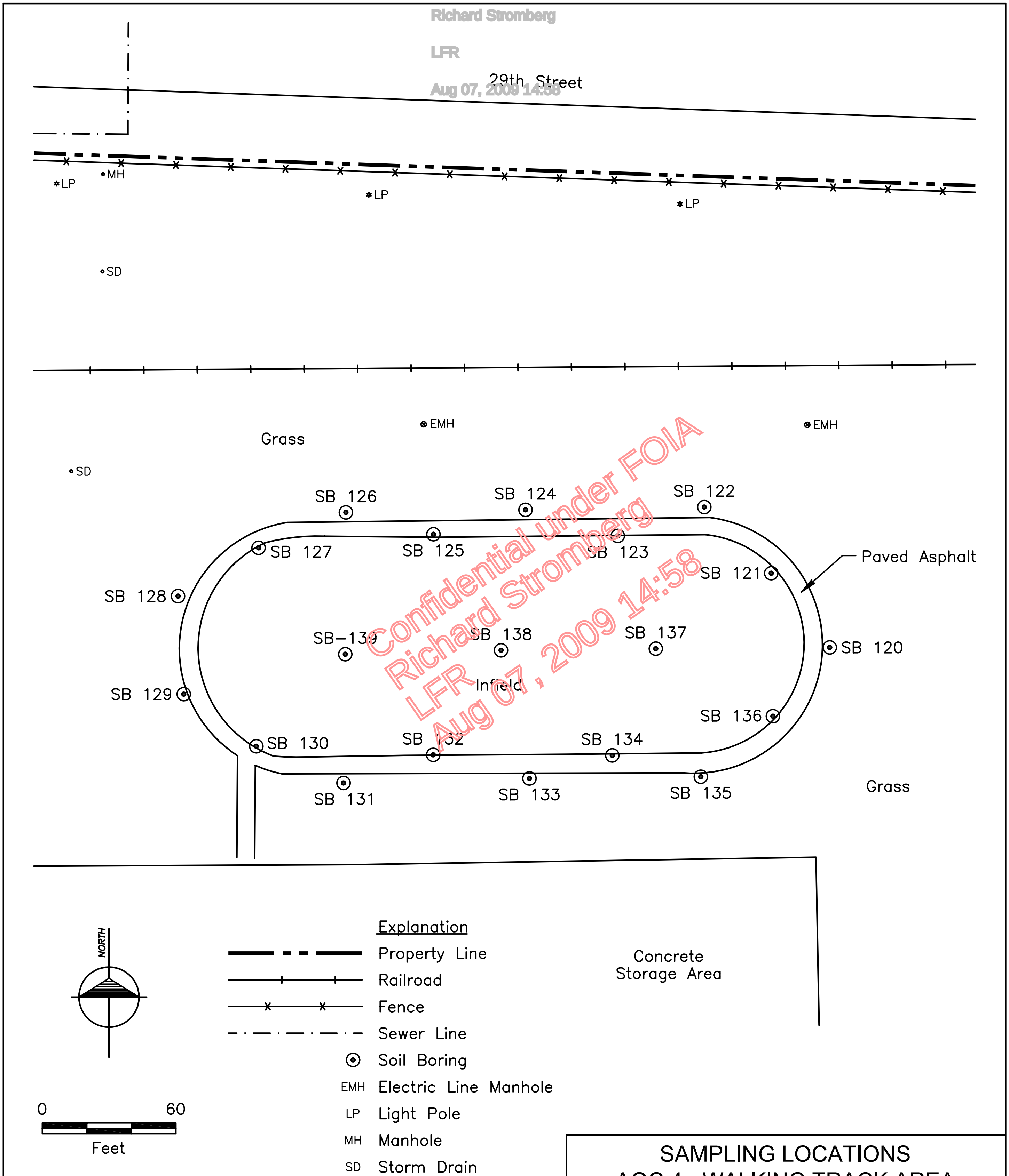


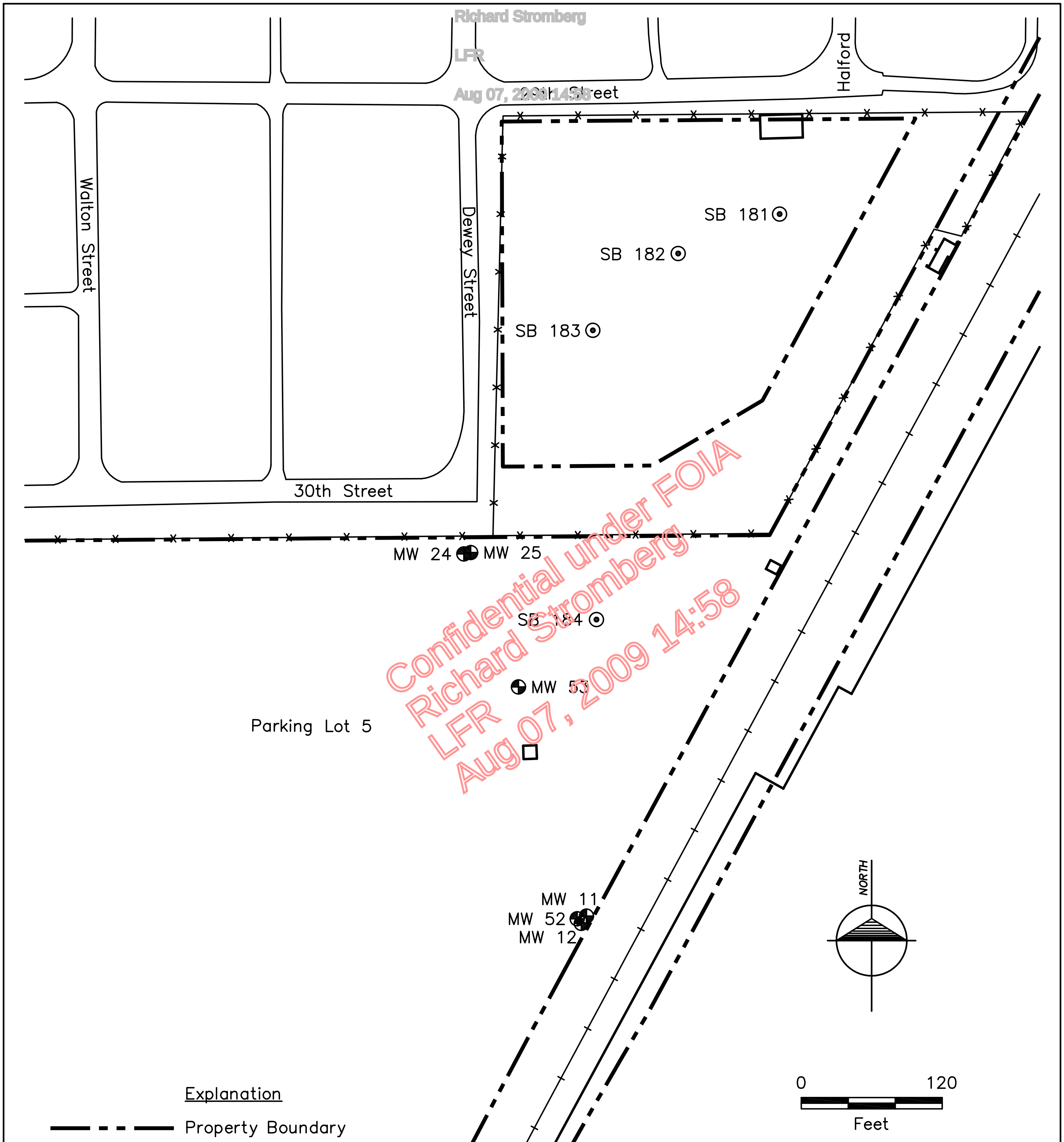
See Figure 2.2 for general site location. Drawing base modified from property plat and description prepared by Alta Land Title Survey. Plat drawing was transformed and rotated to the Indiana State Plane (IN 1301 East) Coordinate System (NAD 83) using USGS monument PID LA 1286. Soil boring locations based on GPS and total station field survey, November 2004.

SAMPLING LOCATIONS
AOC 4 - WALKING TRACK AREA

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech	Figure
Project No. 62806	A tyco International Ltd. Company	4.3

L:\work\62806.01\Dwg\StageIIReport\StIIRpt–F4_3.dwg NW062005



Explanation

- Property Boundary
- Fence Line
- Railroad
- Building Outline
- Monitoring Well
- Soil Boring

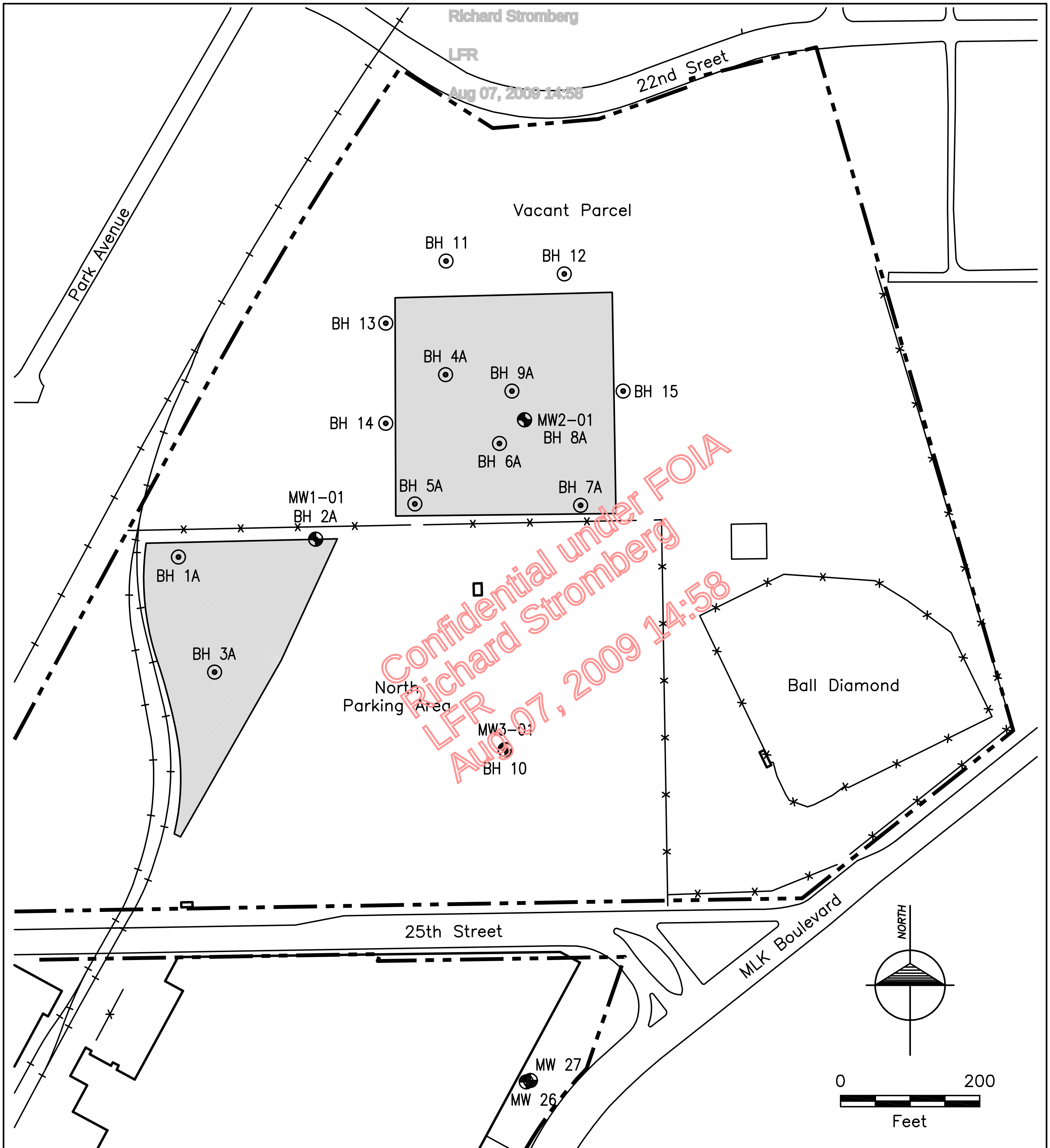
See Figure 2.2 for general area location.

SAMPLING LOCATIONS
AOC 5 - WEST IMPOUNDMENT AREA

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure 4.4
Project No. 62806		

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F4_4.dwg NW062005



Confidential under FOIA
Richard Stromberg
LFR
Aug 07, 2009 14:58

Explanation

- Property Boundary
- Fence Line
- Railroad
- Building Outline
- Monitoring Well
- Soil Boring
- Former Coal Pile Area

SAMPLING LOCATIONS
AOI 1 NORTH PARKING LOT

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05

Project No.
62806

EarthTech
A tyco International Ltd. Company

Figure
4.5

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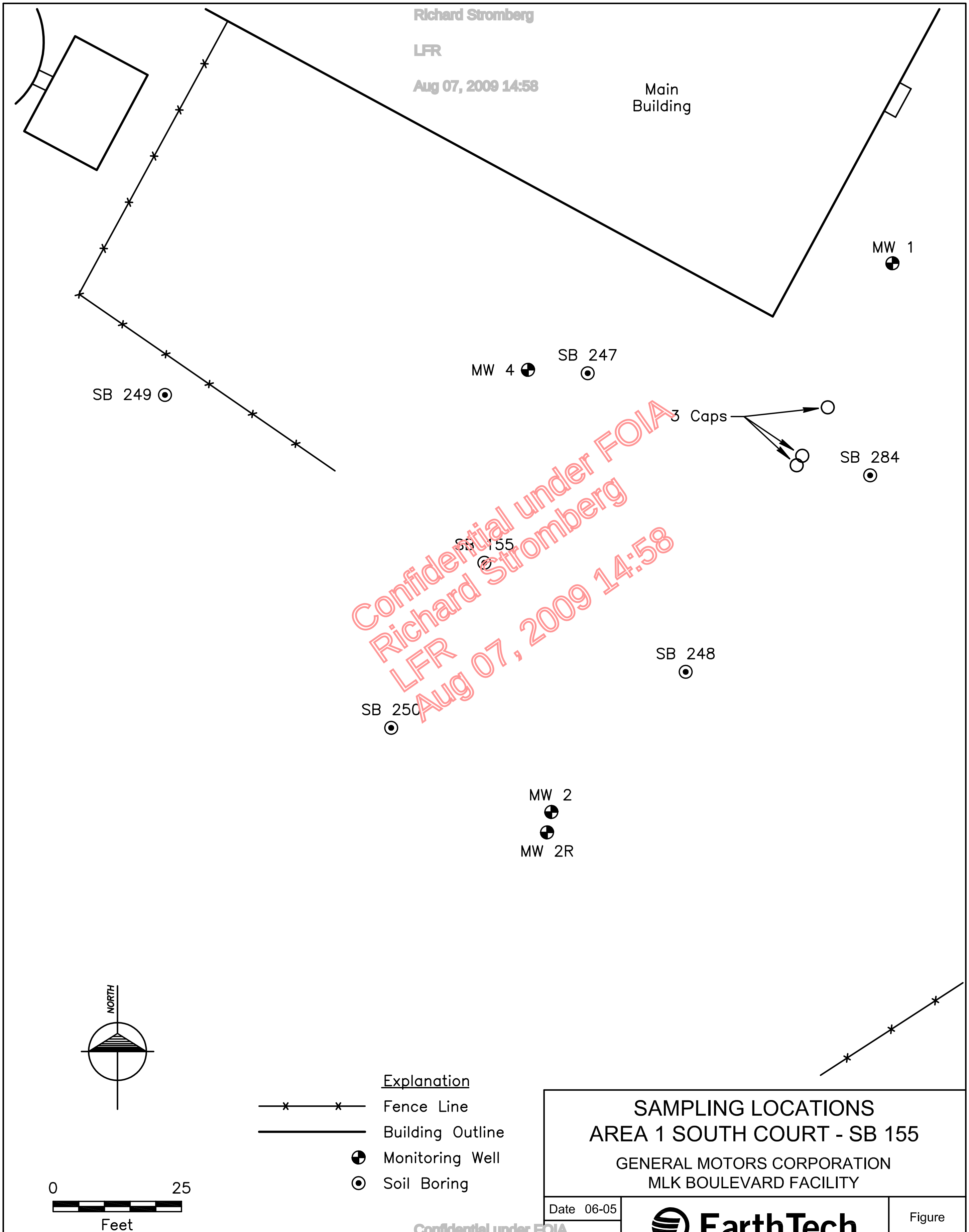
Aug 07, 2009 14:58

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F4_5.dwg NW062805



SAMPLING LOCATIONS
AREA 1 SOUTH COURT - SB 155

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure 4.6
Project No. 62806		

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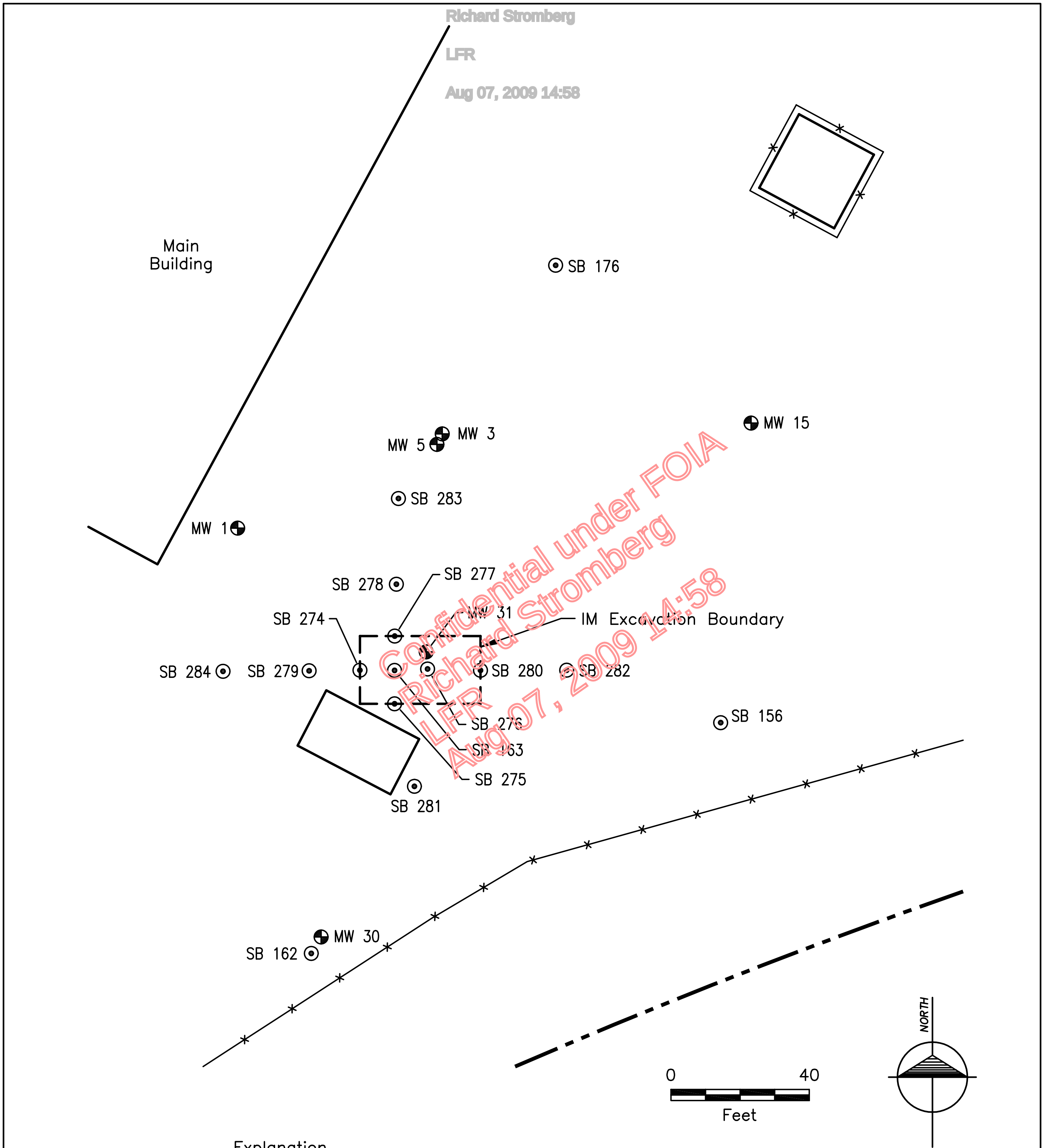

Explanation

- Property Line
- Fence
- Building Outline
- Monitoring Well
- Soil Boring

See Figure 2.2 for general location.

SAMPLING LOCATIONS
AREA 1 SOUTH COURT - SB 163

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure 4.7
Project No. 62806		

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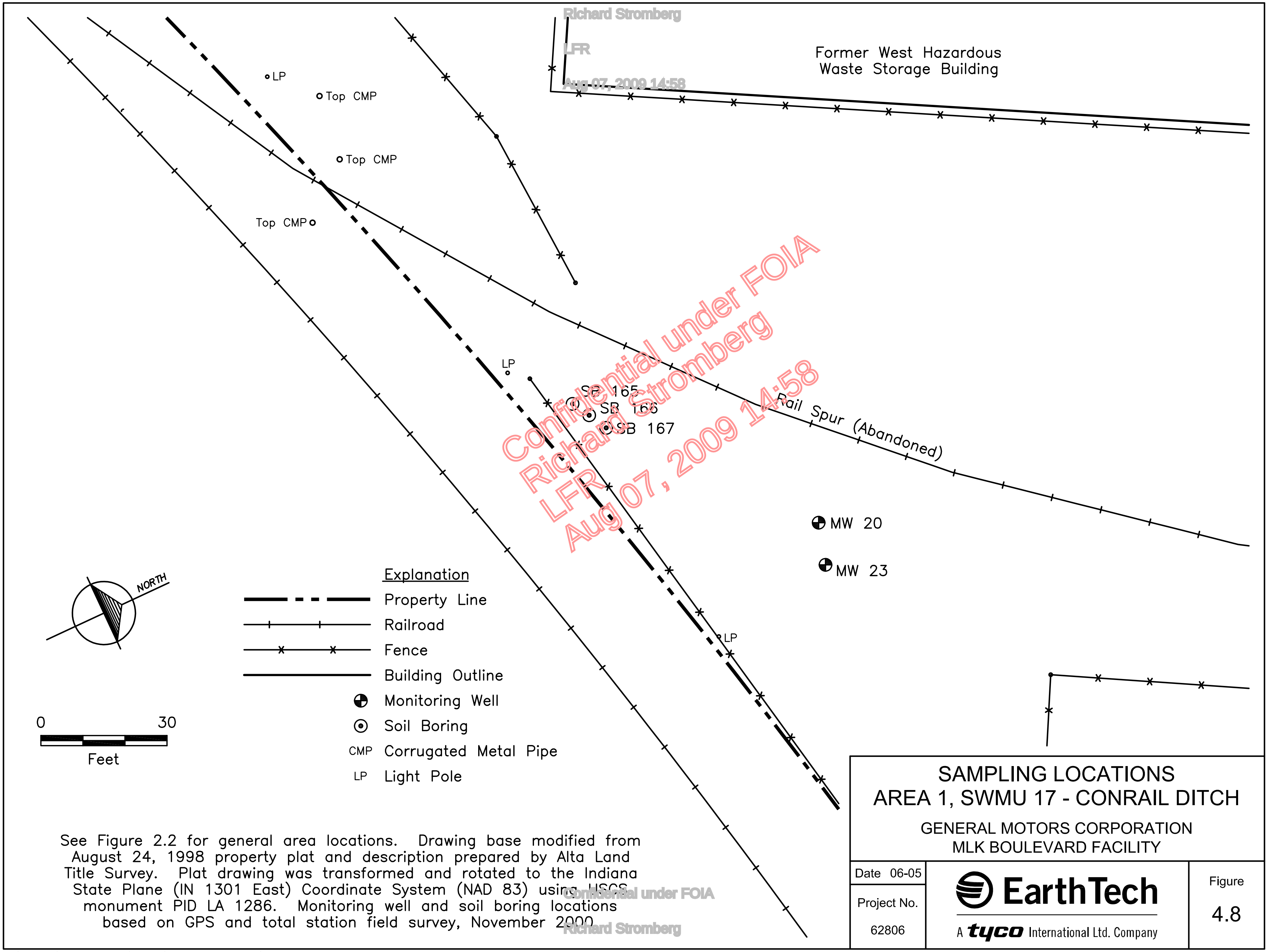


See Figure 2.2 for general area locations. Drawing base modified from August 24, 1998 property plat and description prepared by Alta Land Title Survey. Plat drawing was transformed and rotated to the Indiana State Plane (IN 1301 East) Coordinate System (NAD 83) using USGS monument PID LA 1286. Monitoring well and soil boring locations based on GPS and total station field survey, November 2000.

SAMPLING LOCATIONS
AREA 1, SWMU 17 - CONRAIL DITCH

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

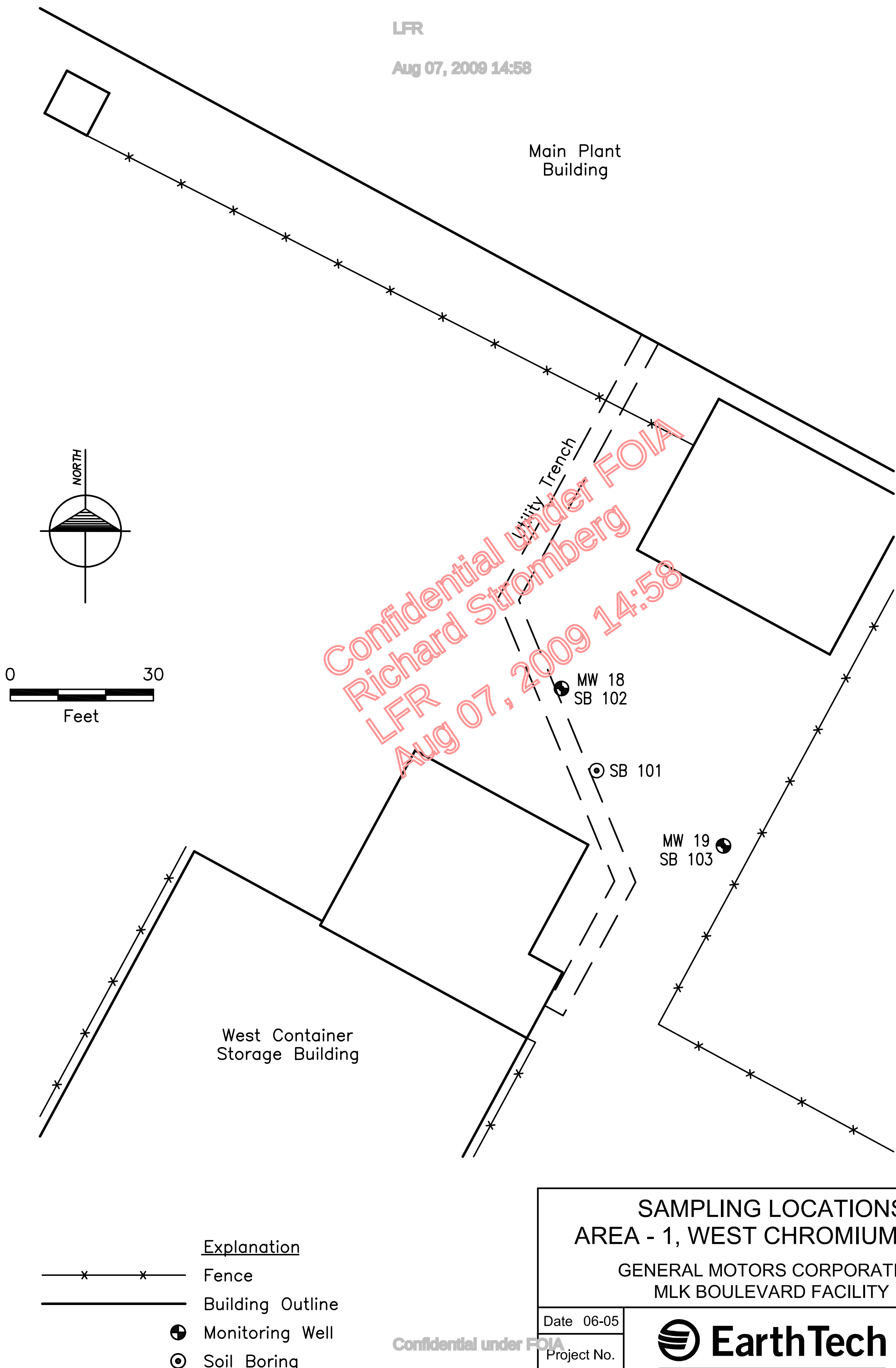
Date 06-05

Project No.
62806

EarthTech
A tyco International Ltd. Company

Figure
4.8

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F4_8.dwg NW062105



SAMPLING LOCATIONS
AREA - 1, WEST CHROMIUM AREA

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05

Project No.
62806

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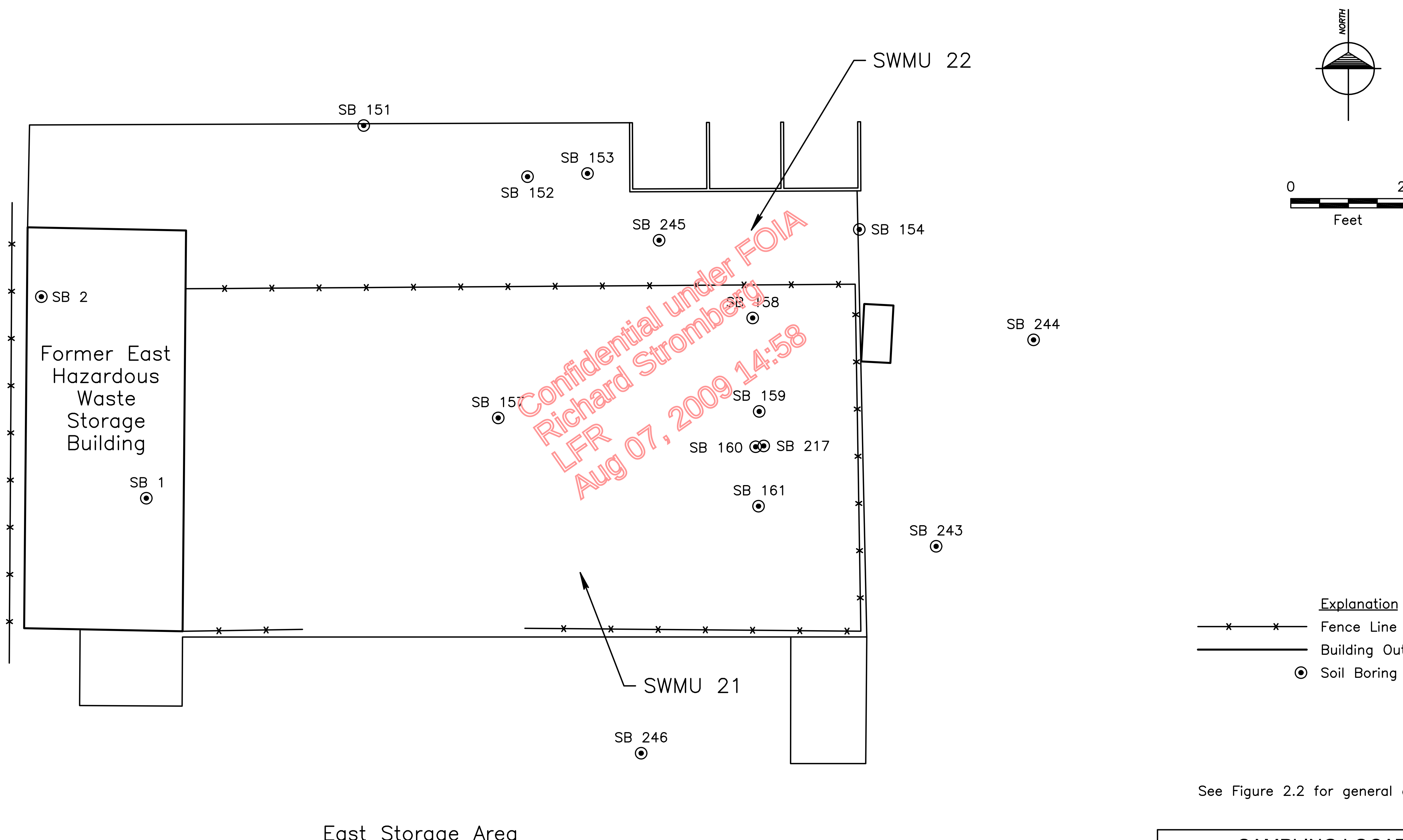
Figure
4.9

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F4_9.dwg NW062805



See Figure 2.2 for general area location.

SAMPLING LOCATIONS
AREA 3 - EAST STORAGE AREA
GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05 Project No. 62806	EarthTech A tyco International Ltd. Company	Figure 4.10

L:\work\62806.01\Dwg\StageIIReport\StIIRpt–F4_10.dwg NW062805

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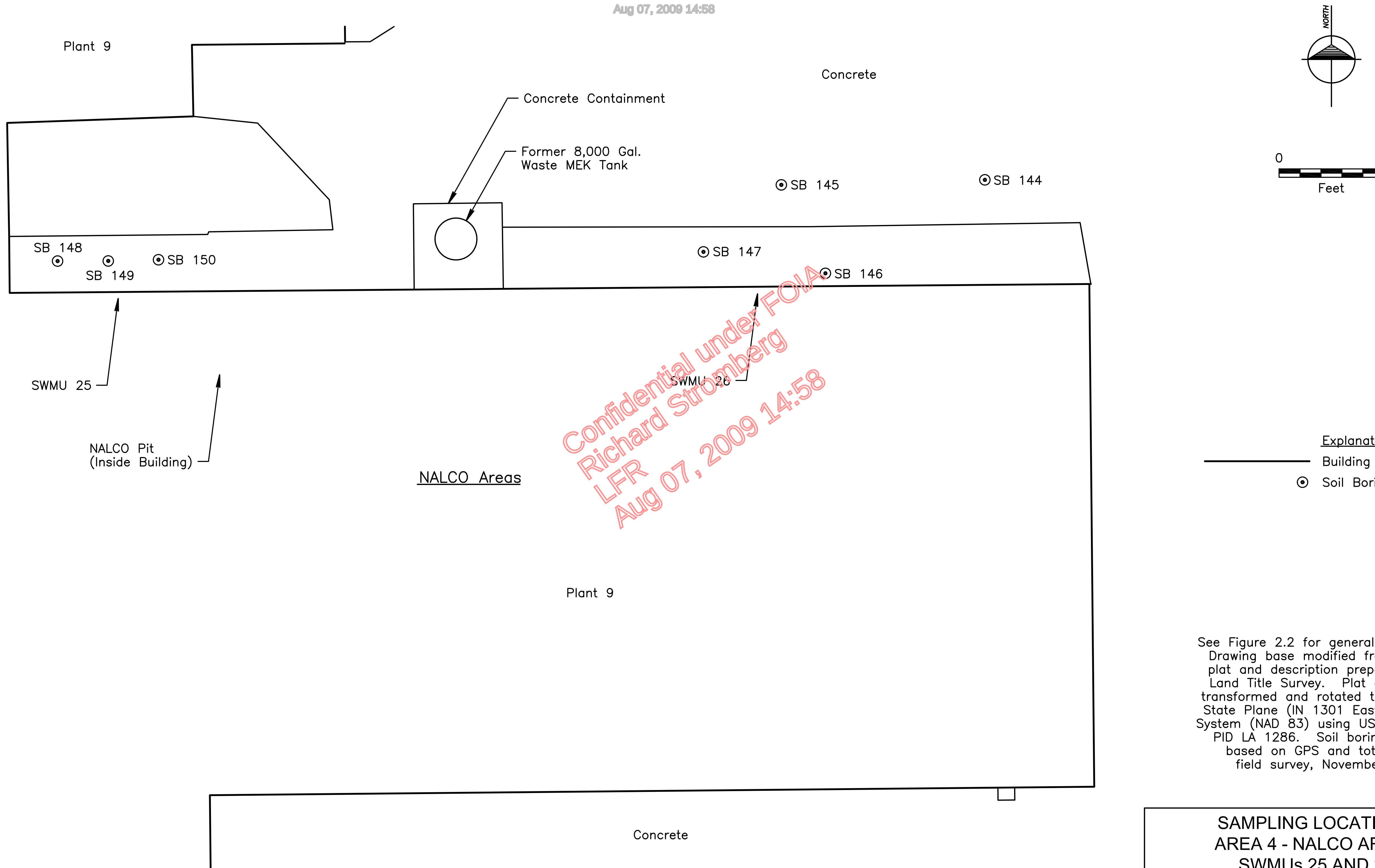
LFR
Aug 07, 2009 14:58



See Figure 2.2 for general site location. Drawing base modified from property plat and description prepared by Alta Land Title Survey. Plat drawing was transformed and rotated to the Indiana State Plane (IN 1301 East) Coordinate System (NAD 83) using USGS monument PID LA 1286. Soil boring locations based on GPS and total station field survey, November 2000.

SAMPLING LOCATIONS
AREA 4 - NALCO AREAS
SWMUs 25 AND 26

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No.
62806

EarthTech
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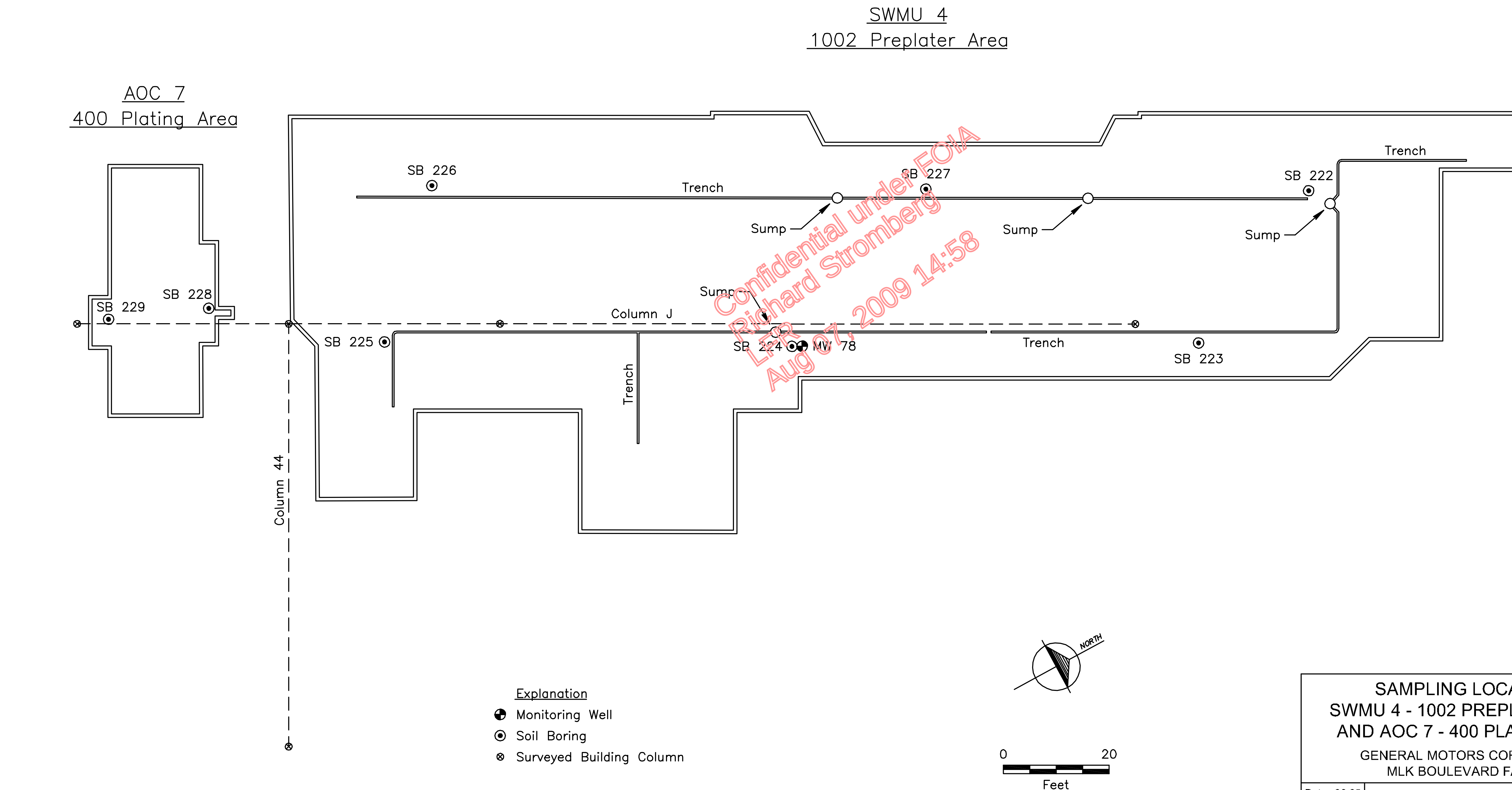
Figure
4.11

L:\work\62806.01\Dwg\StageIIReport\StIIRpt–F4_11.dwg NW062805



SAMPLING LOCATIONS
SWMU 4 - 1002 PREPLATER AREA
AND AOC 7 - 400 PLATING AREA

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05
Project No. 62806

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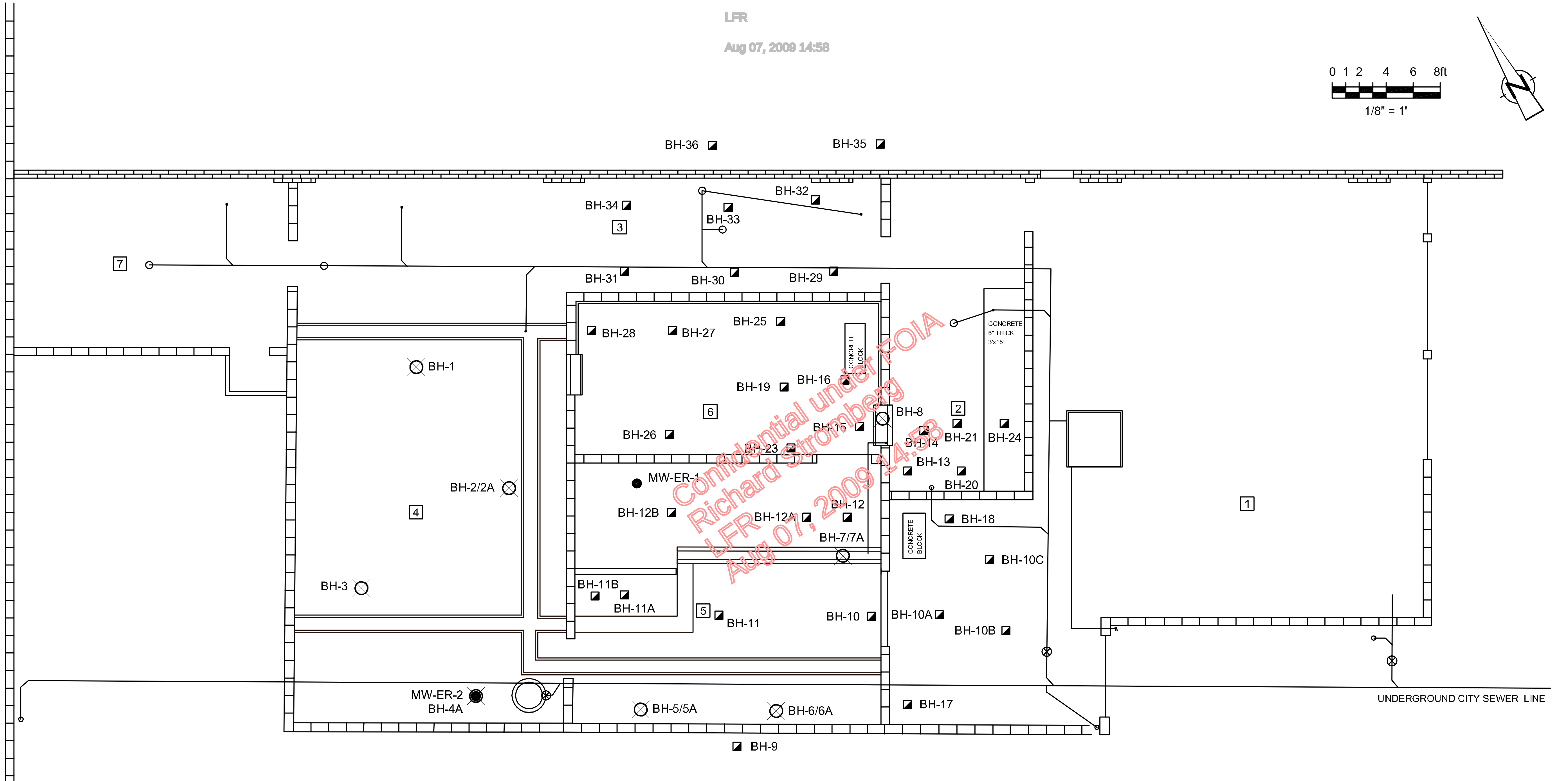
Figure 4.12

L:\work\62806.01\Dwg\StageIIReport\StIIRpt-F4_12.dwg NW062805



LEGEND

- FORMER FLOOR TRENCH - FILLED IN PLACE (10/91)
- 7 ROOM NUMBER
- SEWER DISCONNECT (DISCONNECTED 10/91)
- BRICK WALL
- MASONRY WALL
- BH-3 SOIL BORING/SAMPLING LOCATION FOR SUBSURFACE SOIL SCREENING EVALUATION JANUARY 2003
- SOIL BORING/SAMPLING LOCATION FOR EXTENT OF CONTAMINATION INVESTIGATION APRIL, MAY, AND JUNE 2003
- TEMPORARY MONITORING WELL LOCATION

MW-ER-3

NOTES:

DRAWING PROVIDED BY GUIDE CORPORATION, ANDERSON, INDIANA ON 4/30/01

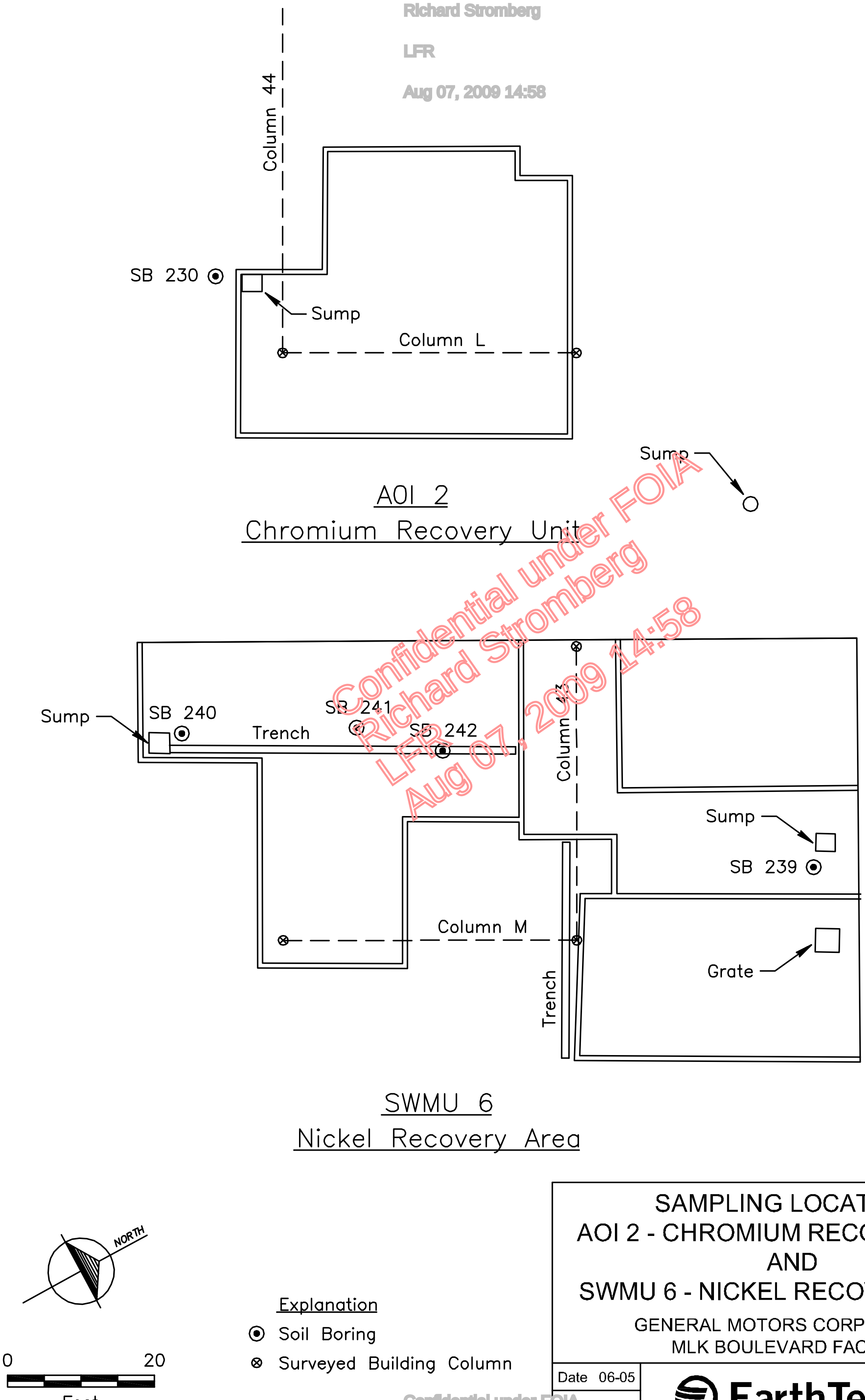
SEE FIGURE 4.18 FOR GENERAL LOCATION

FIGURE 4.13

SAMPLING LOCATIONS
AOC 6 - ELECTROFORM ROOM
GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

CRA

L:\work\62806.01\Dwg\StageIIRpt\StIIRpt-F4_13 NW062805



SAMPLING LOCATIONS
AOI 2 - CHROMIUM RECOVERY UNIT
AND
SWMU 6 - NICKEL RECOVERY AREA

GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure
Project No. 62806		4.14

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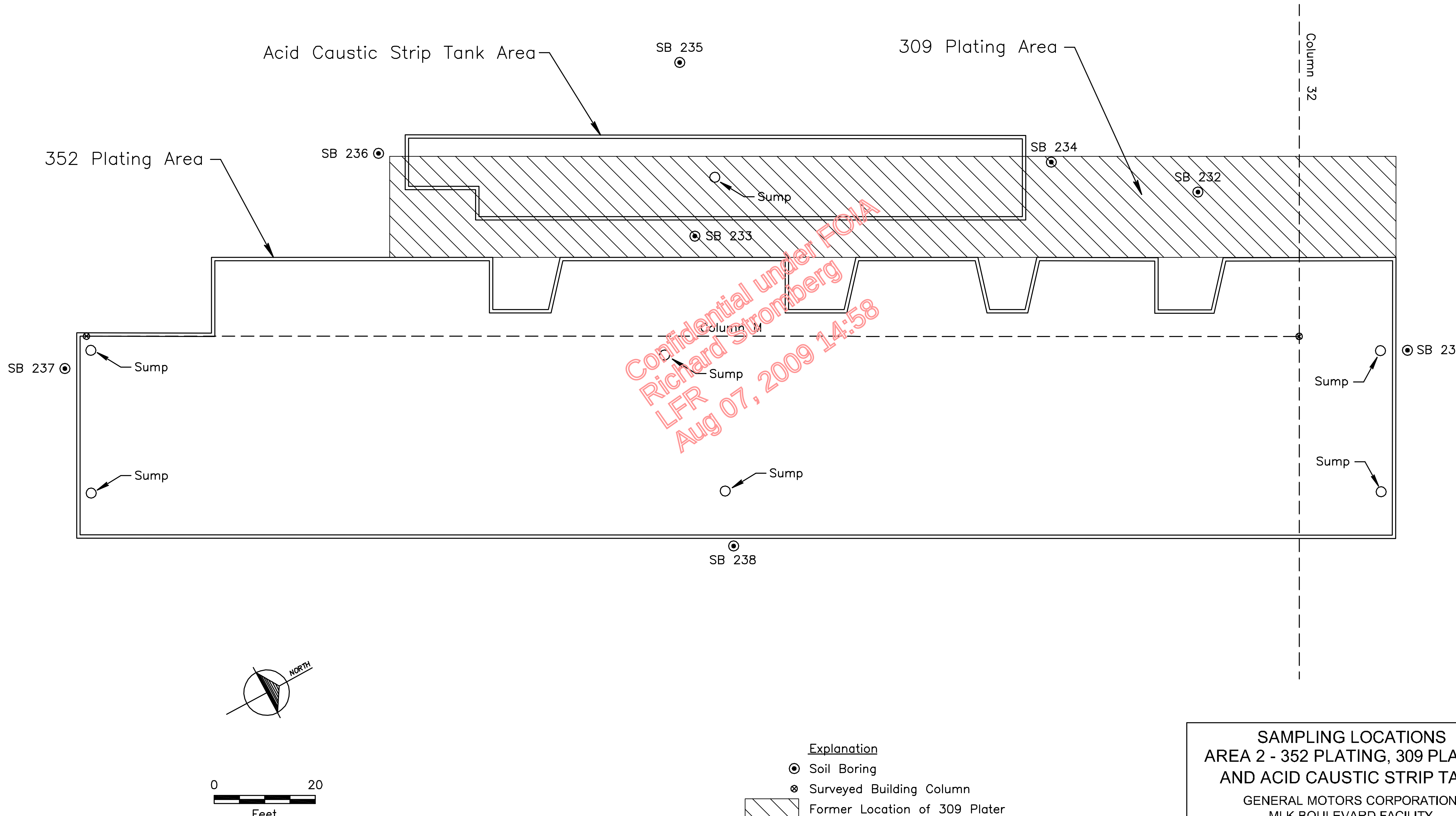
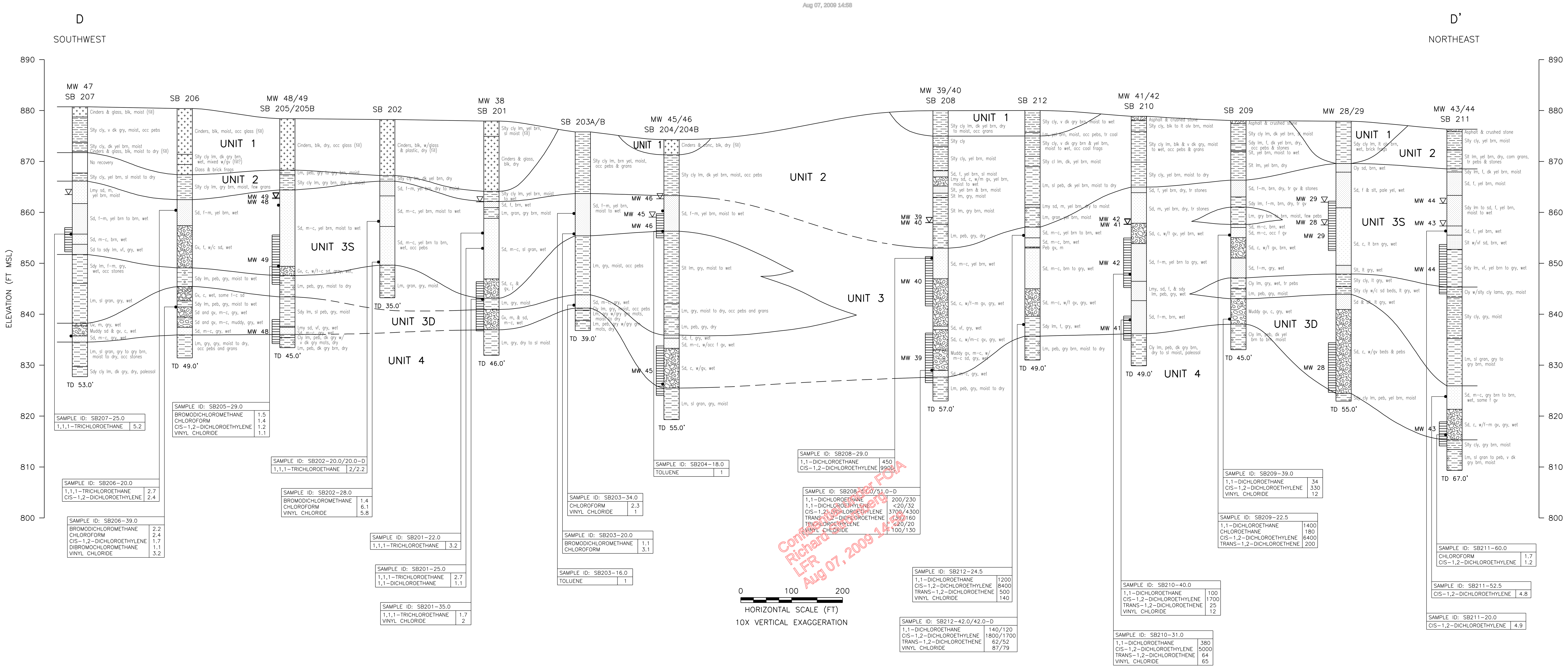


SAMPLING LOCATIONS
AREA 2 - 352 PLATING, 309 PLATING AND ACID CAUSTIC STRIP TANK
GENERAL MOTORS CORPORATION
MLK BOULEVARD FACILITY

Date 06-05	EarthTech A tyco International Ltd. Company	Figure
Project No. 62806		4.15

L:\work\62806.01\Dwg\StageIIReport\StIIRpt–F4_15.dwg NW062805



SAMPLE ID: SB207-25.0	
1,1,1-TRICHLOROETHANE	5.2

SAMPLE ID: SB206-20.0	
1,1,1-TRICHLOROETHANE	2.7
CIS-1,2-DICHLOROETHYLENE	2.4

SAMPLE ID: SB206-39.0	
BROMODICHLOROMETHANE	2.2
CHLOROFORM	2.4
CIS-1,2-DICHLOROETHYLENE	1.7
DIBROMOCHLOROMETHANE	1.1
VINYL CHLORIDE	3.2

SAMPLE ID: SB205-29.0	
BROMODICHLOROMETHANE	1.5
CHLOROFORM	1.4
CIS-1,2-DICHLOROETHYLENE	1.2
VINYL CHLORIDE	1.1

SAMPLE ID: SB202-20.0/20.0-D	
1,1,1-TRICHLOROETHANE	2/2.2

SAMPLE ID: SB202-28.0	
BROMODICHLOROMETHANE	1.4
CHLOROFORM	6.1
VINYL CHLORIDE	5.8

SAMPLE ID: SB201-22.0	
1,1,1-TRICHLOROETHANE	3.2

SAMPLE ID: SB201-25.0	
1,1,1-TRICHLOROETHANE	2.7
1,1-DICHLOROETHANE	1.1

SAMPLE ID: SB201-35.0	
1,1,1-TRICHLOROETHANE	1.7
VINYL CHLORIDE	2

SAMPLE ID: SB203-34.0	
CHLOROFORM	2.3
VINYL CHLORIDE	1

SAMPLE ID: SB203-20.0	
BROMODICHLOROMETHANE	1.1
CHLOROFORM	3.1

SAMPLE ID: SB203-16.0	
TOLUENE	1

SAMPLE ID: SB204-18.0	
TOLUENE	1

SAMPLE ID: SB208-29.0	
1,1-DICHLOROETHANE	450
CIS-1,2-DICHLOROETHYLENE	9900

SAMPLE ID: SB208-51.0/51.0-D	
1,1-DICHLOROETHANE	200/230
1,1-DICHLOROETHYLENE	<20/32
CIS-1,2-DICHLOROETHYLENE	3700/4300
TRANS-1,2-DICHLOROETHENE	130/160
TRICHLOROETHYLENE	<20/20
VINYL CHLORIDE	100/130

SAMPLE ID: SB212-24.5	
1,1-DICHLOROETHANE	1200
CIS-1,2-DICHLOROETHYLENE	8400
TRANS-1,2-DICHLOROETHENE	500
VINYL CHLORIDE	140

SAMPLE ID: SB212-42.0/42.0-D	
1,1-DICHLOROETHANE	140/120
CIS-1,2-DICHLOROETHYLENE	1800/1700
TRANS-1,2-DICHLOROETHENE	62/52
VINYL CHLORIDE	87/79

SAMPLE ID: SB210-40.0	
1,1-DICHLOROETHANE	100
CIS-1,2-DICHLOROETHYLENE	1700
TRANS-1,2-DICHLOROETHENE	25
VINYL CHLORIDE	12

SAMPLE ID: SB210-31.0	
1,1-DICHLOROETHANE	380
CIS-1,2-DICHLOROETHYLENE	5000
TRANS-1,2-DICHLOROETHENE	64
VINYL CHLORIDE	65

SAMPLE ID: SB209-39.0	
1,1-DICHLOROETHANE	34
CIS-1,2-DICHLOROETHYLENE	330
VINYL CHLORIDE	12

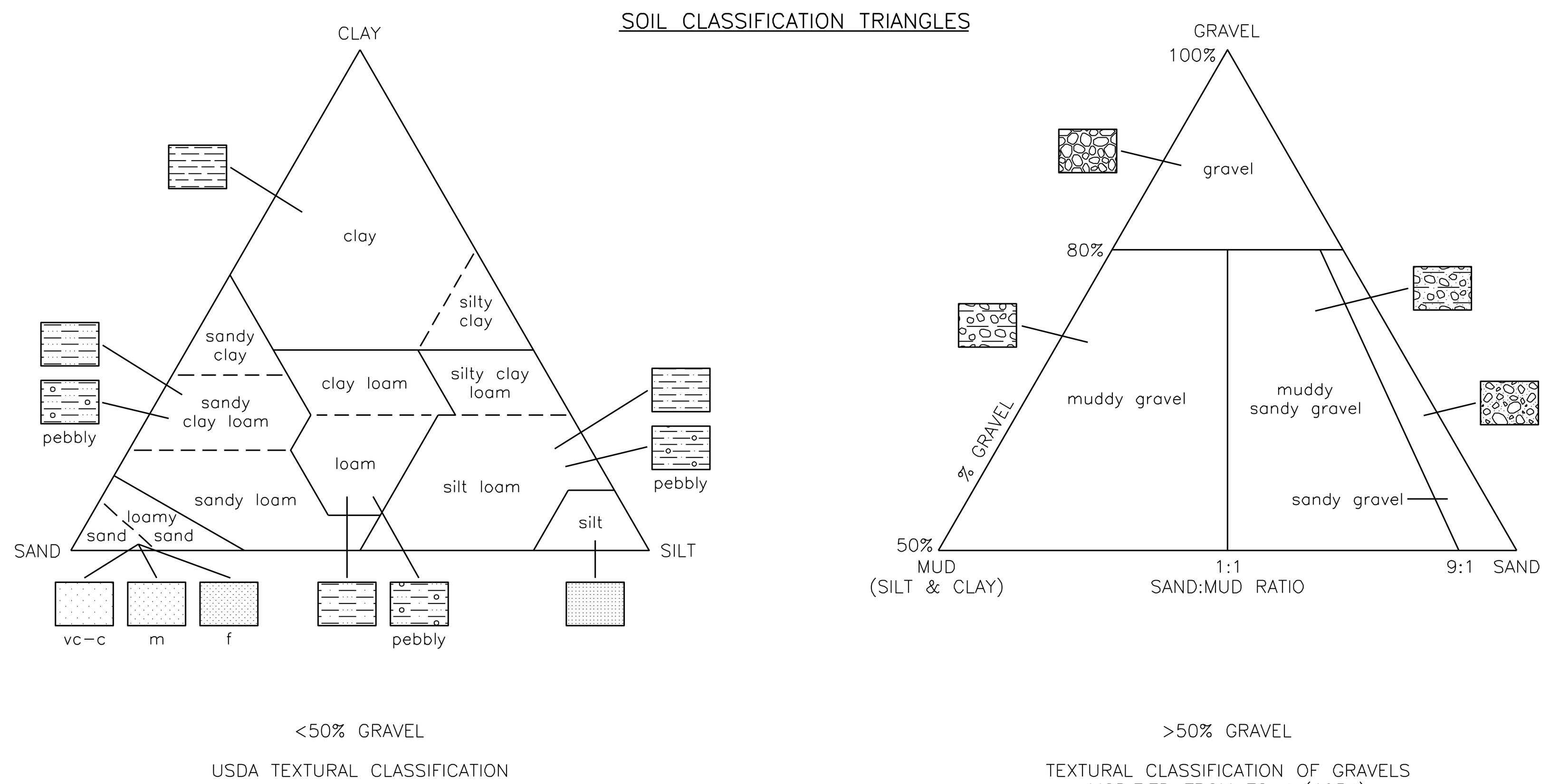
SAMPLE ID: SB209-22.5	
1,1-DICHLOROETHANE	1400
CHLOROETHANE	180
CIS-1,2-DICHLOROETHYLENE	6400
TRANS-1,2-DICHLOROETHENE	200

SAMPLE ID: SB211-60.0	
CHLOROFORM	1.7
CIS-1,2-DICHLOROETHYLENE	1.2

SAMPLE ID: SB211-52.5	
CIS-1,2-DICHLOROETHYLENE	4.8

SAMPLE ID: SB211-20.0	
CIS-1,2-DICHLOROETHYLENE	4.9

SOIL CLASSIFICATION TRIANGLES



<50% GRAVEL
USDA TEXTURAL CLASSIFICATION

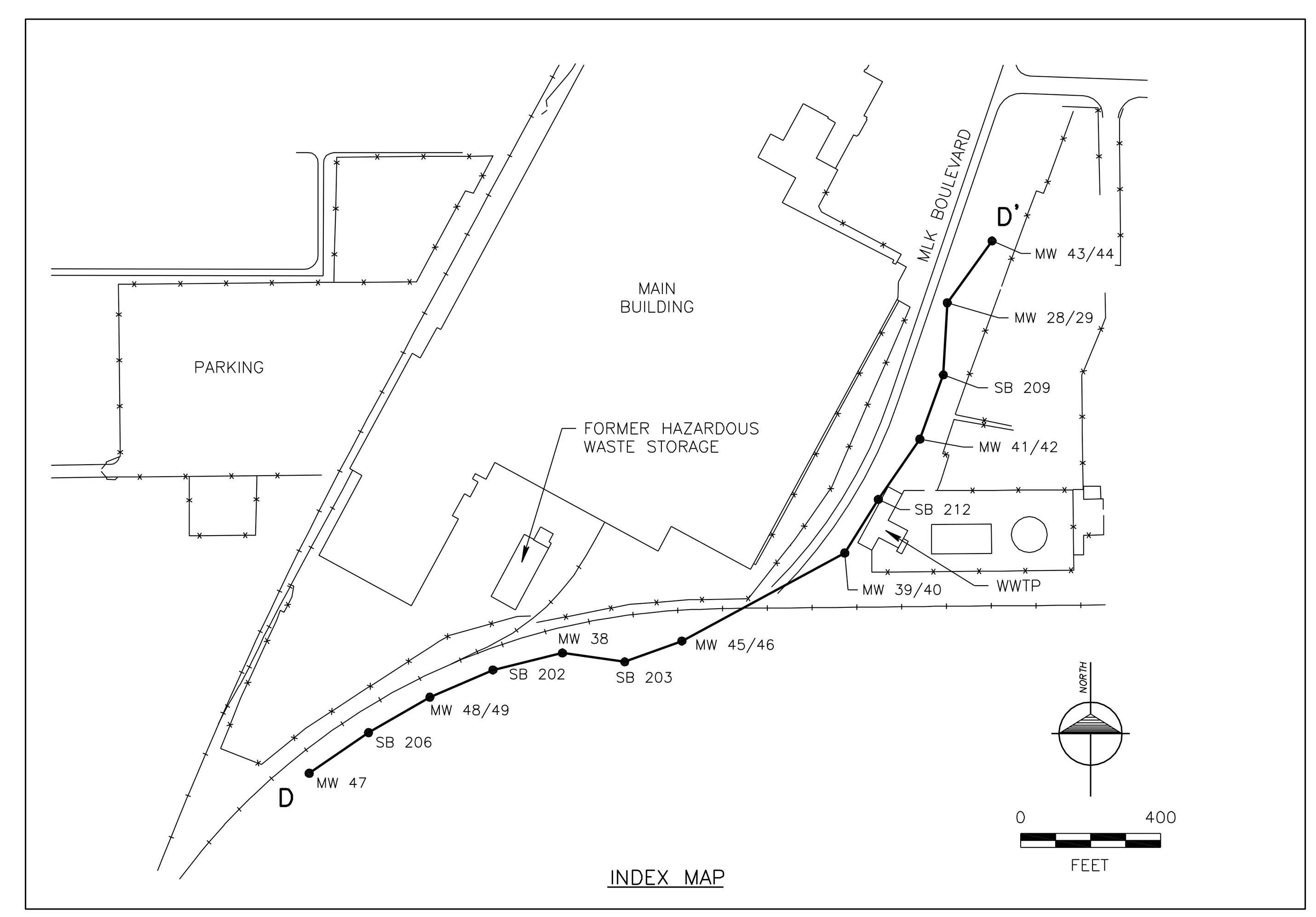
>50% GRAVEL
TEXTURAL CLASSIFICATION OF GRAVELS MODIFIED FROM FOLK (1954)

EXPLANATION

- WELL SCREEN
- GROUND WATER ELEVATION ON MAY 17, 2004
- HYDROPUNCH GROUND WATER SCREENING SAMPLE
- HYDROPUNCH SAMPLE IDENTIFICATION NUMBER
- CONSTITUENT CONCENTRATION IN MICROGRAMS PER LITER (ug/L)
- CONSTITUENT NAME

SAMPLE ID: SB204-18.0	
TOLUENE	1

NOTE: ONLY RESULTS ABOVE METHOD DETECTION LIMIT ARE LISTED



INDEX MAP

EarthTech
A tyco International Ltd. Company

NO.	DATE	BY	REVISIONS

GENERAL MOTORS CORPORATION
PENDLETON AVENUE FACILITY RFI
STAGE II REPORT

GEOLOGIC CROSS SECTION D-D'

DESIGNED BY: NW	DATE: JUNE, 2005
DRAWN BY: NW	DATE: JUNE, 2005
CHECKED BY	DATE
FILE: StIIRpt-F4_16	EDIT: NW062805
SCALE: AS SHOWN	DRAWING 1:10 / PLOT
PROJECT	62806

4.16
FIGURE NO.

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