REMEDIATION WORK PLAN FOR THE

VOLUNTARY REMEDIATION PROGRAM

FOR AN APPARENT SOURCE AREA IN GROUNDWATER
ON THE FORMER ALLIED STAMPING PROPERTY
VRP SITE # 6020803 (GROUNDWATER)

Located:
601 SOUTH BROADWAY STREET,
NORTH OF CONRAIL PROPERTY,
AND WEST OF FRANKLIN STREET

Prepared for:
THE CITY OF SOUTH BEND
REDEVELOPMENT COMMISSION
1200 COUNTY-CITY BUILDING
SOUTH BEND, INDIANA 46601

MARCH 2005

Hull
& associates, inc.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

TABLES

FIGURES

PLATE

1.0 EXECUTIVE SUMMARY

The purpose of this of this Remediation Work Plan (RWP) is to outline the activities requiring completion to support successful remediation of an apparent source area of volatile organic compounds (VOCs) in groundwater in the southwest portion of the Former Allied Stamping Property (the Site) and to obtain a Covenant Not to Sue from the State of Indiana under the Indiana Department of Environmental Management (IDEM) Voluntary Remediation Program (VRP). The work will be funded by a U.S. EPA Brownfields Cleanup grant. Note that this RWP is only intended to address the activities for remediation of the above referenced apparent source area – specifically, near the former Die Wash Area located at the south end of Building 142. An additional RWP will be submitted to address the remaining (downgradient) groundwater plume and other source areas and dilute plumes at the Site. Based on previous investigations conducted at the Site, only a few chemicals of concern (COCs) detected in groundwater exceed VRP Tier II Nonresidential Cleanup Goals on-Site. COCs exceeding the VRP Tier II Nonresidential Cleanup Goals include tetrachloroethene (PCE), trichloroethene (TCE), arsenic, and lead, as described in Section 2.0.[1] This RWP does not address the remediation of the arsenic and lead, as they do not appear to have originated from the above-referenced source area.

The following migration pathways were identified for VOCs in the southwest portion of the Site, including:

1. migration of groundwater containing VOCs away from the apparent source area and going off-Site;
2. vertical migration of groundwater containing VOCs to a deeper aquifer; and
3. vapor migration of VOCs from groundwater to unsaturated soils and ultimately into ambient or indoor air.

Potential exposure pathways include:

1. ingestion of on-Site and off-Site groundwater; and

[1] Arsenic and lead concentrations in and near the Die Wash area exceeded Tier II Nonresidential cleanup goals in direct-push water samples, but not in groundwater monitoring wells. The elevated concentrations may be a result of turbidity produced via the direct-push sampling technique that was employed.

2. dermal contact with groundwater.

3. inhalation of outdoor ambient air containing VOCs released from groundwater through subsurface soil; and

4. inhalation of indoor air containing VOCs released from groundwater through subsurface soil.

It is anticipated that in the absence of engineering and institutional controls, VRP Tier II Nonresidential Cleanup Goals will be used to verify that remediation of the apparent source area in groundwater has been successfully completed.

Based on Hull's understanding of the apparent source area and hydrogeology at the Site, it is anticipated that groundwater in the apparent source area will be remediated by *in-situ* chemical oxidation. Furthermore, appropriate institutional controls will be put in place by the City of South Bend on groundwater to limit potential migration and exposure to the COCs.

2.0 INTRODUCTION

Hull & Associates, Inc. (Hull) has been retained by the City of South Bend Department of Economic and Community Development (the City) to prepare a Remediation Work Plan (RWP) and supporting documents to remediate the apparent source for VOCs in groundwater at the former Allied Stamping Plant (the Site) in general conformance with Indiana's Voluntary Remediation Program. This Work Plan is intended to only describe the remediation of VOCs in an apparent source area in groundwater in and surrounding a former Die Wash area in the southern portion of Building 142 (the southwest portion of the Site). A separate Work Plan will be prepared to describe the remediation of other apparent source areas in groundwater and dilute plumes that have migrated downgradient from the source areas. Supporting documents contained in the Work Plan include; a Quality Assurance Project Plan (QAPP), a Health and Safety Plan and a Confirmation Sampling Plan. This Remediation Work Plan and associated documents were prepared in general conformance with the requirements contained in the VRP Resource Guide dated July 1996.

2.1 Site Background

2.1.1 Site Location and History

The Site is a portion of Area A (VRP #6020803), shown on Figure 1, that comprises five contiguous properties that occupy approximately 88 acres. The Site occupies approximately 45 acres and is located south of Sample Street, east of Prairie Avenue, north of the Norfolk Southern Property and west of Franklin Street. The Site's address is 601 West Broadway Street, South Bend, Indiana 46601.

The Site was historically used as a lumberyard and later in the manufacture of automobiles and parts for the automobile industry. Operations under Studebaker Corporation began as early as 1927 and consisted of manufacturing facilities. During subsequent years, numerous buildings were added to the Facility. Studebaker's operations at the Site ceased in the early 1960's, and the Site was sold to Allied Products Corporation in 1963. Between 1963 and 1999, the Allied Products Corporation sold the Site to EWI, who in turn sold it to Tecumseh Metals. Between 1999 and 2002 the Site was vacant, until purchased through bankruptcy proceedings by the South Bend Redevelopment Commission.

Since 1992, numerous environmental investigations and underground storage tank (UST) closure activities have been completed at the Site. These investigations and remedial activities are described in detail in a Phase I ESA Report prepared by Hull in January 2001 (Hull Document # SBI002.100.0001). The assessments have focused on assessing soil and shallow and intermediate groundwater, removing USTs, and, where necessary remediating USTs on the Site. This Remediation Work Plan has been prepared based on applicable information derived from documentation of previous investigation and remedial efforts at the Site, which have formed Hull's current understanding of the apparent source area. Additional areas requiring investigation may be identified following demolition of the buildings and the removal of the floor slabs and pavement.

The following provides a summary of the assessment and remedial activities and respective analytical results for soils and groundwater that have been completed at the Site to date.

Phase I Environmental Site Assessment by Hull

In January 2001, Hull completed a Phase I Environmental Site Assessment (ESA) of the Site consistent with ASTM requirements and procedures. Note that this Phase I ESA did not include the Former Studebaker Engineering Building property located 414 West Sample Street. In part, based on the previously completed Phase I and II ESAs, the Hull's Phase I ESA revealed the following Recognized Environmental Conditions (RECs) on the Site:

TABLE 1 - RECOGNIZED ENVIRONMENTAL CONDITIONS

Former Allied Stamping Property (Property D)		
D1	20,000-gallon UST reportedly containing heating oil located near the northwest corner of Building 78	VOCs, SVOCs, TPH
D2	Potential UST of unknown size and contents located south of Building 78 approximately 130 ft. west of the southeast corner of the building	VOCs, SVOCs, metals, TPH
D3	10,000-gallon enamel reducer tank (removed), located on the northeast portion of the property	VOCs, SVOCs, TPH
D4	Former and current rails located on the property	metals and SVOCs
D5	6,000-gallon enamel reducer tank, located west of the south end of Building 79	VOCs, SVOCs, TPH
D6	Tank farm formerly comprised ten USTs reportedly containing gasoline and kerosene	VOCs, SVOCs, TPH, lead
D7	Catch basin with an oily sheen located west of Building 80	VOCs, TPH
D8	4 4,000-gallon USTs reportedly containing TCE and fuel oil locate west of Building 86	VOCs, SVOCs, TPH
D9	5,000-gallon UST reportedly containing gasoline,	VOCs, SVOCs, TPH, lead

	located east of the central portion of Building 86	
D10	5,000-gallon UST reportedly containing diesel fuel, located east of Building 93	VOCs, SVOCs, TPH
D11	Potential releases from PCB-containing transformers	PCBs
D12	Press pits with petroleum product located inside building 80	VOCs, TPH, metals
D13	Oil change pit located near the northeast corner of Building 93	VOCs, TPH
D14	Former die wash area located at the south end of Building 142	VOCs, TPH, SVOCs
D15	Press pits with petroleum product located in Building 142	VOCs, TPH, SVOCs
D16	Press pits with petroleum product located in Building 86	VOCs, TPH, SVOCs
D17	Three potential drywells located in the southern portion of Building 79.	VOCs, TPH, SVOCs, metals
D18	Potential releases from ASTs and 55-gallon drums located south of Building 93.	VOCs, TPH, SVOCs
D19	Potential releases from ASTs that were historically located at the south end of Building 93.	VOCs, SVOCs

The locations of these RECs and other pertinent Site features and property usage are shown on Figure 2. A detailed description of the Site history and background is presented in the Phase I ESA (Hull document # SBI002.100.0001).

Initial Phase II Environmental Site Assessment by Hull & Associates, Inc.

Based on the findings of the Phase I ESA, an Initial Phase II ESA Work Plan (Hull Document # SBI002.100.0003), excluding the Former Studebaker Engineering Building property, was prepared to provide descriptions of investigative and sampling rationale and soil and groundwater sampling methods and analytical methods. To support the Initial Phase II Work Plan, a Quality Assurance Project Plan (QAPP) [Hull Document # SBI002.300.0008] and a Site-Specific Health and Safety Plan (HASP) [Hull Document # SBI002.100.0010] were prepared in general conformance with the July 1996 VRP Resource Guide. This Work Plan was prepared prior to completing the field work for the Initial Phase II ESA. Adherence to the procedures in the Work Plan and QAPP provided for collection of representative soil and groundwater samples.

The Phase II ESA was designed to evaluate the concentrations of COCs (in surface and subsurface soils and groundwater) and to characterize the geologic and hydrogeologic conditions beneath the Site. Field activities, conducted in 2001, included the installation of the numerous groundwater monitoring wells, soil borings and direct-push soil borings. The locations of the soil borings and monitoring wells located on the Site are shown on Plate 1. Selected soil borings and monitoring wells were continuously sampled using 24-inch split-spoon samplers or 48-inch macrocore samplers that were decontaminated between each sampling interval. Monitoring wells were installed in boreholes created by advancing 4.25-inch, inside-diameter (ID), hollow stem augers. The wells were constructed of two-inch ID Schedule 40 PVC screen and casing. Soil boring logs and monitoring well construction diagrams are provided in Appendix A of the Initial Phase II ESA Report (Hull Document # SBI002.200.0012).

As stated in the Initial Phase II ESA Work Plan, the objectives of the soils investigations were to:

1. evaluate the stratigraphy and textural characteristics of the vadose zone and the unconfined aquifer;

2. collect soil samples and conduct geotechnical analyses to evaluate contaminant transport characteristics;

3. provide initial data to demonstrate the completeness or incompleteness of potential exposure pathways of identified COCs; and

4. collect soil samples from identified REC areas and additional areas for chemical analyses to evaluate the absence/presence and concentrations of COCs.

To address these objectives, continuous sampling was completed at 32 shallow direct-push borings (to a depth of four feet below ground surface (bgs), five shallow soil borings, and at selected shallow and deep monitoring well locations to characterize the vadose zone stratigraphy and potential exposure pathways. Note that when nested wells were installed, only the deeper of the borings was continuously sampled.

To evaluate the horizontal and vertical extent of COCs in the vadose zone, 98 discrete samples (excluding quality assurance/quality control (QA/QC) samples) were submitted to the analytical laboratory for analyses. In addition, six samples were submitted to a geotechnical laboratory to evaluate the textural composition and physical properties of the unsaturated soils.

The objectives of the groundwater investigation were to:

1. assess the location and stratigraphy of the unconfined aquifer(s) and the presence or absence of confining layers in the unconsolidated material;

2. determine the nature and concentrations of COCs in groundwater;

3. evaluate the groundwater yield and hydraulic characteristics of the unconsolidated aquifer; and,

4. evaluate the general flow direction and gradient of groundwater.

These objectives were achieved by installing 26 shallow monitoring wells, 9 intermediate monitoring wells, and 21 deep monitoring wells. Continuous sampling of the saturated portion of the unconfined aquifer was completed in selected deep monitoring well locations, and at selected intermediate monitoring well locations where no deep monitoring wells were proposed. In addition, continuous sampling of the upper portion of the unconfined aquifer was completed when only a shallow monitoring well was installed.

The newly installed monitoring wells were properly developed in accordance with procedures described in the Initial Phase II ESA Work Plan.

To determine the extent of COCs in the unconfined aquifer, 72 representative groundwater samples were collected from the newly installed monitoring wells and from selected existing monitoring wells installed by APT, Inc. in 1995 (documented in Hull's Phase I ESA Report – Hull Document # SBI002.100.0001). Field data sheets documenting that the groundwater samples were collected consistent with the procedures in the Work Plan are provided in Appendix C of the initial Phase II ESA Report. In conjunction with the groundwater sampling event, static water levels were collected to evaluate horizontal and vertical groundwater flow.

Additional Phase II Environmental Site Assessment Activities by Hull & Associates, Inc.

In July 2003, Hull installed 31 continuously sampled soil borings, designated SB-6 through SB-37, using direct-push technology that sampled using a 48-inch Macrocore sampler. Fourteen soil samples were selected from the above borings and sent to the laboratory and were analyzed for VOCs, SVOCs, and metals. The objectives of this were to define the vertical and lateral extents of petroleum contaminated soils that are the likely source of VOCs in groundwater. The locations of the soil borings are shown on Figure 3 and 4.

Analytical results from the soil boring program indicate that a source area for PCE exists to the east of Building #93 in an area where petroleum contaminated soils were found, as determined by visual observation and by elevated TPH-DRO concentrations in these samples. PCE was detected at six of the eight sampling locations east of Building #93, with highest concentration of 12,200 ug/kg located at SB-30. Soil remediation activities (i.e., removal and disposal, etc.) would result in removal of this source and therefore eliminating a contributor to VOC plume in groundwater.

Additionally, VOCs were detected in soils beneath the former Die Wash area, a location where chlorinated solvents are believed to have been used during Studebaker's operations at the Site. VOCs detected in shallow soils beneath the concrete floor included PCE, carbon tetrachloride and chloroform. Various SVOCs were also detected in these shallow soils. Given the presence of the compounds and the fact the elevated concentrations of PCE were detected at HMW-9I during the initial Phase II ESA, this area was determined to be a potential contributing source of VOCs for groundwater.

Groundwater samples were collected from selected direct-push soil borings during the above referenced investigation. Sampling results for shallow groundwater (i.e., 35 ft. bgs or less) showed the presence of PCE concentrations ranging from 491 ug/L to 833 ug/L near the former Die Wash area (refer to Figure 3, which also includes a summary of VOCs detected in monitoring wells during the Initial Phase II ESA in 2001).

Groundwater samples were also collected at intermediate depths (i.e., 45 ft. bgs) in direct-push borings. PCE concentrations in these intermediate samples were similar to those found in shallow samples, ranging from 324 ug/L to 974 ug/L (refer to Figure 4).[2]

Petroleum Contaminated Soil Remediation Activities by Keramida Environmental

In February 2005, petroleum contaminated soils containing relatively high concentrations of PCE (described above) were excavated from an area east of Building 93 and disposed off-Site at a licensed facility. Remedial activities for removal of the petroleum impacted soils were funded by

[2] A PCE concentration of 1,620 ug/L was detected in SB-37, located northeast of the former Die Wash area. Based on Hull's understanding of past operations at the Site and in consideration of the distribution of VOCs and local groundwater flow, the PCE detected at SB-37 believed to be attributable to a source area that is distinct from the Die Wash area.

IDEM's Petroleum Remediation Grant Incentive (PRGI) program. Approximately 600 tons of petroleum-impacted soils were removed and the resulting excavation was backfilled with compacted granular material from an off-Site source. At this time, a report describing the remedial activities and subsequent closure sampling results has not been prepared. This report will be forwarded under a separate cover by Keramida Environmental on behalf of the City.

2.1.2 Site Documentation

Hull & Associates, Inc., "*Phase I Environmental Site Assessment for the Area A Properties South Bend, Indiana, Hull Document Number SBI002.100.0001,"* January 2001.

Hull & Associates, Inc., "*Initial Phase II Environmental Site Assessment for the Area A Properties South Bend, Indiana, Hull Document Number SBI002.200.0012,"* January 2002.

Hull & Associates, Inc., "*Letter Report Documenting Additional Phase II Environmental Site Assessment in the Southwest Portion of Area A (Former Studebaker Automotive Manufacturing Facility, South Bend, Indiana, Hull Document Number SBI016.200.0006," December 2003*.

2.2 Summary of Site Investigation Activities

2.2.1 Sources and Extent of Contamination in Groundwater

Based on findings of the previous environmental investigations, the former Die Wash area appears to be a source of VOCs in groundwater. As noted previously, other probable sources are present on the Site; however, these sources will be addressed separately under future RWPs.

Chlorinated solvents such as PCE and potentially other solvents are believed to have been used in the die washing process. PCE has been detected in shallow soils beneath the slab of Building 142, indicating that solvents have entered the subsurface. Although the concentrations of PCE detected thus far in these shallow soils were relatively low (i.e., not exceeding 50 ug/kg), underlying shallow groundwater concentrations are among the highest detected anywhere on the Site, indicating that chlorinated solvents from the former Die Wash area have reached groundwater. Given the relatively long period since probable solvent use occurred in this area (approximately 40 years) and the continued presence of high PCE concentrations in groundwater, it is apparent that there is a persistent source of VOCs under the former Die Wash area. Water infiltration beneath the slab is likely to be limited, therefore reducing the probability that the PCE seen in shallow groundwater is entirely a result of leaching from unsaturated soils.

Therefore, the PCE is likely to exist as a nonaqueous residual source that is resident below the water table. Furthermore, the presence of elevated PCE concentrations at intermediate depths in the aquifer (in the absence of a downward groundwater gradient) suggests that nonaqueous phase liquid at one time migrated tens of feet into the aquifer via gravity flow, leaving a residual source of PCE extending from the water table to at least 45 ft. bgs.

The lateral dimensions of the source area in groundwater have not been completely defined. However, based on the distribution of dissolved VOCs in groundwater samples, the source area appears to be in the vicinity of direct-push borings SB-7 and SB-23, just to the west of the former Die Wash area.

2.2.2 Ecological Assessment Results

The Site is located within the City of South Bend corporate limits in an urban (commercialized and residential) area. The stormwater runoff over the Site is largely controlled by the Site's internal drainage system. Stormwater collected by this system is then diverted to the City's combined sanitary and storm sewer system.

The nearest surface water body is the St. Joseph River, which is located approximately 1.5 miles northeast of the Site. Based on the relatively long distance that COCs in groundwater must travel before discharging to the St. Joseph River, potential threats to terrestrial and aquatic wildlife are limited.

There are no wetland areas, riparian areas, or other environmentally sensitive areas on, or adjacent to the Site. The locations of floodplain and wetland areas are described and mapped in the Phase I ESA Report. There does not appear to be threat to the local wildlife or potential endangered species posed by groundwater.

2.2.3 Baseline Hydrogeological Assessment Results

Based on the geologic information collected from continuously sampled soil borings and monitoring wells during the Initial Phase II ESA, the Site is underlain by brown fine to medium sand with traces of silt and clay. The geologic conditions are illustrated on the generalized geologic cross sections A-A', B-B', C-C', and D-D' shown on Figures 10, 11, 12, and 13, respectively, in the Initial Phase II ESA Report. Detailed descriptions of the unconsolidated materials encountered at each location are included on the soil borings logs provided in Appendix A of the Initial Phase II ESA Report.

As shown on the geologic cross-sections and described on the soil boring/monitoring well logs, the vadose zone ranges in thickness from approximately 20 to 27 ft.. Soil samples collected from this zone were described in the field as predominantly brown fine to medium sand with a trace of gravel and fines (silt and clay). Soil samples submitted to the geotechnical laboratory for grain-size distribution analysis indicate that materials in this zone are primarily classified as SP in accordance with Unified Soil Classification System (USCS), and are described as brown poorly sorted sands with trace to some gravel and trace to little fines.

Selected samples were also submitted to the analytical laboratory for total organic carbon (TOC) analysis – Walkley Black Method. The results of this analysis indicate that the TOC in vadose zone ranges from 0.036% to 0.18% with an average of 0.072%. This range and average appears to be typical of soil types encountered at the Site.

The unconsolidated aquifer ranges in thickness from approximately 40 ft. to greater than 100 ft. As with the vadose zone, the aquifer material was described in the field as predominantly a brown fine to medium sand with secondary percentage gravel and fines. The aquifer was also noted to contain relatively thin layers of sand and gravel and silty sand. These zones were determined to be isolated based on the fact that they were typically not encountered in adjacent soil borings/monitoring wells. These units are considered minor in terms of the overall hydraulics of the aquifer system.

Beneath the aquifer, a lower confining layer was encountered at all locations, except HMW-22D and HMW-28D. Where present, the layer was described in the field as either a very dense, damp, silt or a hard, damp, silty clay. As shown on Figure 14 in the Initial Phase II ESA, the top of this unit was encountered at elevations ranging from 631.1 ft. (NGVD) at HMW-32D to 678.3 ft. at HMW-21D. Review of Figure 14 in the Initial Phase II ESA Report suggests that this surface is likely an erosional surface that was created by fluvial activities prior to the depositional of the unconsolidated aquifer.

Extremely fast recovery rates limited the ability of field personnel to conduct slug tests within monitoring wells. Published hydraulic conductivity values from laboratory analyses indicate a range of hydraulic conductivity from 10^{-3} to 10^{-4} cm/sec for well-sorted sands/glacial outwash (Fetter, 1994). Single well pumping tests may need to be completed to further characterize the hydraulic conductivity of the aquifer.

Static water levels from selected monitoring wells were used to evaluate the groundwater flow conditions in the upper and lower portions of the unconsolidated aquifer. These water levels were collected prior to groundwater sampling event. As shown on Figures 15 and 16 contained in the Initial Phase II ESA Report, groundwater flow in upper and lower portions of the aquifer is to the northeast at a hydraulic gradient of 0.0007 ft/ft. The highly variable nature of the lower confining units does not appear to significantly affect the groundwater flow regime in the lower portion of the aquifer.

3.0 CLEANUP CRITERIA SELECTION

Hull will use the VRP Tier II Nonresidential Cleanup Goals for evaluating the performance and effectiveness of the selected remedial alternative (i.e., chemical oxidation) on VOCs in groundwater. Hull does not currently anticipate the need to complete a Site-specific risk assessment for establishment of VRP Tier III Cleanup Goals. Should calculation of Tier III Cleanup Goals be necessary in the future, an amendment to this Remediation Work Plan will be prepared and submitted to IDEM for approval.

4.0 STATEMENT OF WORK

4.1 Objectives of Remedial Action

The objectives of this Remediation Work Plan are to:

1. provide of a summary of the information collected to date;
2. establish the VRP Cleanup Goals for the Site;
3. describe the selected remedial alternative(s) to achieve the selected VRP Cleanup Goals at the apparent source area at the Site;
4. describe the additional pre-remedial investigations that need to be completed to implement the selected remedial alternative(s) for groundwater in the apparent source area;
5. design the Performance and Confirmatory Sampling Plan;
6. develop the project schedule; and
7. define the requirements, deliverables for completion of the remedial phase and the performance and confirmation sampling program.

4.2 Summary

Upon the acceptance of the Remediation Work Plan, additional pre-remedial investigation activities described in Section 5.0 will be implemented to collect the information necessary to complete the remedial design. The selected remedial alternative for source area reduction is chemical oxidation. It is anticipated that two applications of the oxidation reagent will be required to reduce the concentrations in the apparent source area. Following the initial application of the chemical oxidation reagents, a performance and confirmatory monitoring program, as described in Section 6.4, will be implemented to evaluate the effectiveness of the source area remedial effort.

4.3 Health and Safety Plan

The Site-specific HASP provides the necessary health and safety protocols to be followed during completion of the additional Site investigation activities, implementation of the selected remedial alternatives for soil, and completion of confirmatory sampling activities. This HASP was been prepared in general conformance with the requirements stated in Appendix A of the July 1996 VRP Resource Guide and the applicable requirements of the Occupational Safety and Health Administration's (OHSA) hazard waste site operation rule codified in 29 CFR1910.120. The HASP (Hull Document # SBI013.200.0019) governing this project was previously submitted to IDEM as part of the documentation for the Initial Phase II ESA for Area A.

4.4 Quality Assurance Project Plan

The Quality Assurance Project Plan (QAPP) addresses the laboratory analyses necessary to complete the additional pre-remedial investigation activities and the performance and confirmatory sampling program. The QAPP also outlines the manner by which reliable analytical results will be obtained at the Site and specifies the quality assurance procedures for sample collection and analysis. At this time, there are no known exceptions to the procedures described in the QAPP. The QAPP (Hull Document # SBI013.200.0020) governing this project was previously submitted to IDEM as part of the documentation for the Initial Phase II ESA for Area A.

5.0 RISK ASSESSMENT

At this time, it is anticipated that only VRP Tier II Nonresidential Cleanup Goals and calculated VRP Tier II Nonresidential Cleanup Goals will be used to guide remediation of the apparent source area near the former Die Wash area. Therefore, completion of a risk assessment is not necessary. Should information collected during the additional pre- or post-remedial activities indicate that VRP Tier III Cleanup Goals are necessary to effectively remediate the Site, a risk assessment will be prepared and submitted to IDEM.

6.0 REMEDIATION PLAN

6.1 Additional Pre-Remedial Investigation

To further evaluate the conditions of the apparent source area at the Site and to further determine the approximate vertical and lateral extent of the VOCs in groundwater exceeding VRP Tier II Nonresidential Cleanup Goals, additional pre-remedial investigation tasks will include:

Task 1 – groundwater monitoring well and reagent application well installation;

Task 2 – baseline groundwater sampling and analysis;

Task 3 - bench testing of selected water and soil samples;

Task 4 – pilot testing of *in-situ* chemical oxidation; and

Task 5 – reporting of findings from tasks 1 through 4.

Tasks 1 through 5 are analogous to a Pre-Design, in which a selected remedy is evaluated to determine the most appropriate configuration for a final design. However, given the relatively small area to be remediated, the pilot system may also function as the final remedial system. To the extent that pilot testing and supporting studies indicate that *in-situ* chemical oxidation is an effective means of significantly and permanently reducing VOC concentrations in the apparent source area, the Remedial Design may simply consist of designing a long-term environmental monitoring program and recommending additional applications of reagent or making minor adjustments to the application system. If *in-situ* chemical oxidation using the pilot study configuration is determined not to be effective in significantly reducing VOC concentrations, modification of the remedial system (i.e., changing the reagent chemistry or installing additional application wells) or identifying alternative remedial technologies, potentially including further pilot testing will be necessary.

6.1.1 Task 1 – Groundwater Monitoring Well and Reagent Application Well Installation

Prior to installing the new wells, the groundwater elevations will be measured in existing on-Site monitoring wells in the vicinity of the apparent source area to confirm that the current water table elevations are within the range of historic elevations.

Hull SOP No 3008 in Appendix A describes procedures for water and non-aqueous phase liquid (NAPL) interface measurement.

6.1.1.1 Groundwater Monitoring Well Locations and Depths

Proposed locations for the new source area monitoring wells, designated as SAMW, are shown on Figure 5.[3] The PSAMW-1 well nest is located to identify VOCs at various depths potentially entering the source area from upgradient sources. The PSAMW-2 and PSAMW-3 well nests will be located near to and in a general downgradient location of the apparent source area in soil. These well nests will be used along with existing monitoring wells MW-9S, MW-9I, MW-11I and MW-11D to provide baseline groundwater quality data and information on contaminant destruction in the immediate vicinity of the apparent source area.

Exact locations of the proposed wells will be determined in the field based upon drill rig and support equipment accessibility. The monitoring well installation contractor will be responsible for obtaining all required permits and easements for the proposed drilling, ensuring all utility companies are contacted, and properly marking and avoiding utilities.

Proposed upper wells PSAMW-1U, PSAMW-2U and PSAMW-3U will be constructed using 15-ft. long well screens crossing the groundwater table (approximately 13 ft. of screen below the water table).[4] Based upon previous water level measurements collected at the Site, the water table in the vicinity of the former Die Wash area is approximately 20 ft. bgs. Therefore, the targeted depth for the screened interval at all upper well locations will be approximately 18 to 33 ft. bgs.

Proposed monitoring wells PSAMW-1M, PSAMW-1L, PSAMW-2M and PSAMW-2L will have screened intervals of 10 ft. Proposed screen elevations and depths for these proposed upper wells are summarized on the following table.

---

[3] Designations for proposed monitoring wells have a “P” prefix. The “P” will be deleted from the designation after the well has been installed.

[4] Groundwater monitoring wells in the PSAMW-1 nest and the PSAMW-2 and PMW-3 nests will be constructed using two-inch diameter, Schedule 40, PVC screens and risers. These wells will be constructed in the same manner as the application wells, described in the following section. This construction will allow their use as application wells should pilot studies determine that they are needed.

TABLE 2

PROPOSED MONITORING WELL CONSTRUCTION

Proposed Monitoring Well	Construction	Screened Interval (ft. bgs.)
PSAMW-1U	PVC	18 to 33
PSAMW-1M	PVC	33 to 43
PSAMW-1L	PVC	43 to 53
PSAMW-2U	PVC	18 to 33
PSAMW-2M	PVC	33 to 43
PSAMW-2L	PVC	43 to 53
PSAMW-3U	PVC	18 to 33
PSAMW-3M	PVC	33 to 43
PSAMW-3L	PVC	43 to 53

All wells will be surveyed by a surveyor registered in the State of Indiana and referenced to the same benchmark and coordinate system used in previous investigations.

During the soil boring process, soil samples will be collected continuously using split-spoon samplers from the surface to a depth of the deepest monitoring well at each location. A hydrogeologist will log the collected soil samples and conduct and record headspace screening for VOCs using a photoionization detector (PID) or flame ionization detector (FID). Soil boring and monitoring well installation procedures are detailed in Hull SOP No. F2023 in Appendix A.

6.1.1.2 Reagent Application Well Locations and Depths

Proposed locations for reagent application well couplets are shown on Figure 5.[5] The proposed application wells are to be located within and marginally upgradient of the

[5] Designations for proposed application wells have a "P" prefix. The "P" will be deleted from the designation after the well has been installed.

source are, as defined by previous groundwater sampling efforts. Hull's experience with *in-situ* chemical oxidation at similar sites indicates that the effective reagent treatment radius typically extends to a treatment zone radius of approximately 15 ft. Treatment downgradient of the application well typically extends somewhat further, but less than twice the lateral effective treatment radius. The actual treatment zone radius will be evaluated during these pre-design activities and the location of the application may therefore need to be adjusted.

Exact locations of the application wells will be determined in the field based upon drill rig and support equipment accessibility. The application well installation contractor will be responsible for obtaining all required permits and easements for the proposed drilling, ensuring all utility companies are contacted, and properly marking and avoiding utilities.

Proposed upper application wells PAW-1U, PAW-2U, PAW-3U, PAW-4U and PAW-5U will have 15 ft. well screens crossing the groundwater table (approximately 18 to 33 ft. bgs). Proposed lower application wells PAW-1L, PAW-2L, PAW-3L, PAW-4L and PAW-5L will have screened intervals of 15 ft. (approximately 35 to 50 ft. bgs.).

All application wells will be surveyed by a surveyor registered in the State of Indiana and referenced to the same benchmark and coordinate system used in previous investigations.

Sampling and field screening for application well installation will be accomplished in the same manner as described for monitoring wells. Soil boring and application well installation procedures will be the same as the installation procedure for piezometer and monitoring well are detailed in Hull SOP No. F2023 in Appendix A.

During installation of PAW-2U and PAW-2L, a saturated soil sample may be collected for bench testing, as described in section 6.1.3. Note that the selected consultant and reagent application subcontractor will specify required amounts of aquifer material to be collected.

6.1.1.3 Investigation-Derived Materials Management

Auger cuttings from the drilling operations will be collected and stockpiled separately on-Site based on field screening results. If soils do not contain VOCs above background concentrations, as determined by headspace readings with a PID or FID, the soils will be stockpiled on-Site and secured under polyethylene sheeting. If the soils contain VOCs above background headspace concentrations, they will be stored on-Site in DOT-approved 55-gallon steel drums and properly labeled. After the completion of drilling activities, the stockpiled and drummed soils will be analyzed for waste characterization. The waste characterization analyses will be used to determine the disposition of the stockpiled and/or drummed soils.

Groundwater purged during drilling operations, well development or prior to sampling will be collected and stored on-Site in DOT approved 55-gallon steel drums and properly labeled. After completion of drilling and sampling activities, the containerized water will be properly disposed of as determined by waste characterization analyses.

6.1.2 Task 2 - Baseline Groundwater Sampling and Analytical Procedures

The newly installed monitoring and application wells and existing monitoring wells will be developed and sampled following the procedures described in Hull SOP No. 3023 in Appendix A. Following purging, water from monitoring wells will be measured for temperature, pH, specific conductance, oxidation-reduction potential and dissolved oxygen. One groundwater sample from each well will be submitted to a laboratory and analyzed for VOCs in accordance with U.S. EPA SW-846 Method 8260B.

Groundwater samples collected from the reagent wells, the newly installed monitoring wells and existing monitoring wells MW-9S, MW-9I, MW-11I and MW-11D may also need to be analyzed by a laboratory for a minimum of total iron in accordance with U.S. EPA SW-846 Method 7380; sulfate in accordance with Method 375.4; total organic carbon in accordance with U.S. EPA SW-846 Method 9060 and total dissolved solids in accordance with Method 160.1. Additional analytical parameters and required aliquots may also need to be collected from these wells and submitted to the selected reagent application subcontractor for bench testing, summarized in section 6.1.3.

Field blanks, trip blanks, and duplicate groundwater samples will be analyzed. All analytical procedures and detection limits are fully described in the QAPP.

Results from baseline groundwater analyses will identify the current distribution of VOCs at and in the vicinity of the apparent source area and, in the case of testing for total organic carbon, total dissolved solids and selected inorganic constituents, the data will be used to support formulation of the remedial reagent. Baseline data will also be compared with VOC concentrations following bench testing, pilot testing and the Remedial Action to determine the degree of source area reduction obtained through employment of the chemical oxidation remedial technology.

Field parameters and inorganic analyses, along with VOC concentrations and the reagent application subcontractor's experience treating a wide variety of sites, will form a basis for estimating the lateral extent of aquifer material that can be treated per application well. If the reagent application well array is too widely distributed based on experimental derivations of effective treatment radii, one or more of the reagent application well nests may be replaced by wells more capable of providing VOC treatment in groundwater.

6.1.3 Task 3 – Bench Testing

The selected reagent application subcontractor may need to perform bench scale testing to achieve the following objectives:

1. demonstrate that the oxidative process is effective under Site-specific conditions;
2. demonstrate the effectiveness of the oxidative process in the presence of aquifer solids (i.e., soil);
3. demonstrate that the oxidative process is capable of achieving significant contaminant destruction; and
4. determine the optimum mix for subsequent pilot scale testing by performing the bench testing using various catalyst/oxidizer amendments.

6.1.3.1 Sample Collection

Site soil for bench testing will be collected at a location representative of VOC concentrations in source areas and aquifer characteristics at the Site. Saturated soils may be collected from different locations and composited, if necessary, to obtain a representative sample. A minimum of 6,000 grams of soil is typically collected. The actual amount of soil will need to be determined by the selected reagent application subcontractor. One-liter amber jars with screw top caps may be used to collect soils if they are contaminated. If the soils collected are not contaminated, *Zip Lock* bags may be used for sample collection.

Site groundwater for bench testing will be collected from a monitoring well point exhibiting the highest VOC concentration after three well volumes have been purged. Samples from wells containing free product cannot be used during bench scale testing and will be excluded. A minimum of 5 liters of groundwater is typically collected and stored in 1-liter amber glass containers with zero headspace (no preservative to be used). In addition, one sample is commonly submitted unpreserved in a 250-ml amber glass container with zero headspace. Lastly, two samples will be collected in 40-ml vials preserved in HCl to be used during bench testing for control purposes. Note that actual quantities necessary for bench testing will be determined by the reagent application subcontractor.

6.1.3.2 Bench Test Treatments

The bench scale testing is typically performed by injecting a series of catalyst and oxidizer amendments into reaction vessels. The stoichiometric molar ratio of the reagent combination utilized will be different in each reaction vessel. The merits of stepwise injection will be compared to single aggressive treatment for each reagent combination used. The laboratory study monitoring is commonly conducted by setting up parallel monitoring vessels in a similar manner, which will receive the same doses as the corresponding main reaction vessels. Samples are periodically withdrawn from the monitoring vessels for hydrogen peroxide analysis. Additional treatments to designated reaction vessels will be injected based on residual peroxide concentrations remaining. One of the reaction vessels is initially isolated for control purposes and receives an equivalent volume of distilled water to compensate for reagent volumes injected into treatment vessels.

Following the last treatment, all reaction vessels remain undisturbed at room temperature for 24 hours or until such time that the oxidizer is completely consumed.

Soil and groundwater from each of the reaction vessels are analyzed for residual VOC concentrations.

The above bench testing procedures may be modified depending upon the selected remediation contractor’s standard approach. In Hull’s experience, procedures used by most of the qualified contractors in the United States are similar to the activities described above.

6.1.3.3 Sample Analyses

The results of sample analysis of the 40-ml vials collected in the field will establish groundwater quality in the pilot study area at the Site.

The samples generated from the bench-scale treatability studies will be submitted to a qualified analytical laboratory for VOC analyses by Method 624/8260B. The samples will include:

1. the 40 ml vial “field” collected sample;
2. the 4 oz jar “field” collected soil sample;
3. the "initial conditions" soil and groundwater samples collected during preparation of the reactor vessels;
4. the "control" sample from the reactor vessel to which only distilled water was injected; and
5. the treatment samples from the reactor vessels to which varying volumes of catalyst and chemical oxidation reagent, such as hydrogen peroxide, were injected.

In addition, the selected reagent application subcontractor may submit one untreated Site soil sample to a certified laboratory to be tested for Fe, Mn, and TOC concentrations to evaluate the natural Site conditions. Results of analyses performed on these samples will be evaluated to determine if the objectives of the bench testing stated at the beginning have been achieved.

Bench testing results will be considered in the context of Site-specific geochemical and hydrogeologic conditions to identify an appropriate reagent dosage for each of the application wells.

6.1.4 Pilot Testing

6.1.4.1 Field Reagent Application

A qualified technician from the reagent application subcontractor will measure groundwater depth, pH, dissolved oxygen, temperature, and air quality parameters at selected monitoring well nests, newly installed monitoring well nests and couplets and all application wells. Monitoring will continue at regular intervals in the treatment area monitoring wells and application wells during the oxidation reagent application. A sampling and monitoring schedule is provided in Section 10.0.

Following initial monitoring, the technician will fit each application well with a wellhead seal that includes a riser fitted with two valves. One part of this riser is attached to the aboveground containers of reagents, and the other is used as a reaction vapor off-gassing vent. Catalyst and oxidation reagents will be applied separately to the application wells.

The selected reagent application subcontractor will introduce a patented catalyst formulation which will have been determined in the bench testing phase.

A slight (typically less than 10° C) increase in temperature due to exothermic reaction is expected to be limited to the treatment zone within a few feet of the application wells. However, changes in other groundwater parameters are expected at nearby downgradient treatment area monitoring wells.

During the application events, localized off-gassing will occur. A qualified technician will monitor off-gassing vapors in the breathing zone and headspace of monitoring wells at regular intervals during the application events. Air monitoring will also be completed as needed within the nearby equipment compound and shed. Air monitoring parameters to be measured will include volatile compounds (measured with a PID of FID), percent oxygen, percent carbon dioxide, and lower explosive limit. Other observations made during applications include, but are not limited to, pressure checks and temperature readings at the wellheads and fluid short-circuiting to the surface indicating mounding of groundwater.

Depending upon results obtained from post-treatment sampling, described below, additional applications may be required. If additional treatment is not needed, then post-treatment sampling will be conducted for approximately two months as described in Section 6.1.4.2.

6.1.4.2 Post-Treatment Sampling

The selected contractor will perform post-treatment groundwater sampling at reagent application wells, newly installed monitoring wells and existing monitoring wells MW-9S, MW-9I, MW-11I and MW-11D. The sampling will be conducted approximately one week following completion of each reagent treatment, and again at approximately three weeks following the last treatment. Following purging, groundwater samples will be collected from the selected monitoring wells and all application wells. Sampling will follow the procedures described in the Hull SOP No. 3008 in Appendix A.

Water from the wells will be measured for temperature, pH, specific conductance, oxidation-reduction potential and dissolved oxygen. One groundwater sample from each well will be submitted to a laboratory and analyzed for VOCs in accordance with U.S. EPA SW-846 Method 8260B.

Groundwater samples collected from the reagent wells and the monitoring wells will be analyzed by a laboratory for a minimum of total iron in accordance with U.S. EPA SW-846 Method 7380; sulfate in accordance with Method 375.4; total organic carbon (USEPA Method 9060), and total dissolved solids in accordance with Method 160.1.

Field blanks, trip blanks, and duplicate groundwater samples will be analyzed. All analytical procedures and detection limits are fully described in the QAPP.

Analytical results will be compared with baseline data to identify the percentage of VOC reduction achieved in and near the apparent source area through *in-situ* chemical oxidation.

6.1.5 Task 5 – Pre-Remediation and Pilot Testing Reporting

Following completion of one or two *in-situ* chemical oxidation applications, the selected remedial contractor will prepare a report that includes:

1. a brief discussion of the local geology/hydrogeology at the Site and immediate vicinity, with an emphasis on new information gathered during proposed monitoring well and application well installation;
2. a discussion of field activities performed during well installation and baseline groundwater sampling (Tasks 1 and 2);
3. a scaled base map showing Site structures and existing and newly installed monitoring well and application locations;
4. a water table contour map showing flow direction and gradient;
5. a table presenting baseline groundwater analytical data obtained under Task 2 and, as appropriate, two dimensional isoconcentration maps showing lateral and vertical distribution of VOCs;
6. a discussion of the VOC distribution;
7. boring logs and well construction diagrams for newly constructed monitoring wells and application wells;
8. tables and text describing findings from the bench testing (Task 3);
9. a discussion of field activities performed during pilot testing (Task 4);
10. tables presenting field measurements and observations during Task 4;
11. tables and text describing results of the pilot testing efforts, including estimates of percent contaminant reduction and descriptions of the overall effectiveness of the technology;
12. conclusions as to the efficacy of the remedial technology based on preceding investigations and testing; and
13. general recommendations as to the need for more reagent applications, treatment system modifications or changes in the overall remedial approach, if necessary.

If VOC concentrations are reduced significantly (i.e., concentrations are below Nonresidential Cleanup Goals) as a result of the chemical oxidation, a long-term monitoring program will be implemented. This monitoring program will consist of quarterly monitoring for a two-year period.

Quarterly reports shall be prepared and submitted to IDEM within 75 days of the end of each quarter in which the groundwater samples are collected. These reports shall, at a minimum, include a discussion of sampling event, a summary table of the historical and present analytical results, a map showing the analytical results, time-series plots, and a discussion of the findings.

6.2 Performance and Confirmation Sampling Plan

Following completion of the remedial action, a groundwater sampling program will be implemented for two years on a quarterly basis. Sampling will follow the procedures described in the Hull SOP No. 3008 in Appendix A. Monitoring points will include selected monitoring and application wells in the upgradient, downgradient, and in the vicinity of the remediation area.

Water from the wells will be measured for temperature, pH, specific conductance, oxidation-reduction potential and dissolved oxygen. One groundwater sample from each well will be submitted to a laboratories and analyzed for VOCs in accordance with U.S. EPA SW-846 Method 8260B. Reporting of confirmatory analytical results for VOCs will be provided in a U.S. EPA Level 4 deliverables data package.

Quarterly reports will be prepared and submitted to IDEM within 75 days of the end of each quarter in which the groundwater samples were collected. These reports will, at a minimum, include a discussion of sampling event field activities and observations, a summary table of the historical and present analytical results, a map showing the analytical results, time-series plots, and a discussion of the findings.

6.3 Data Management

All investigative and confirmatory data collected as part of this Remediation Work Plan will be managed via database manager via electronic laboratory report deliverables. These data will be available to the City and IDEM (at IDEM's request) via a password protected Web-based interface. The laboratory will follow the electronic deliverables with mail-out of hard-copy reports for report submittals. Field-recorded data will be kept in indexed storage in preparation for report submittals. In some cases (i.e., field boring logs), data will be transferred into an electronic format via specialized software. In other cases, the data will be summarized in spreadsheets. All of these electronic files will be stored in a computer database indexed by a unique project number.

Upon completion of the remedy, a Remediation Completion Report will be prepared and submitted to IDEM. The Remediation Completion Report will include the following information:

1. a description of Site background, including an overview of operational history and a summary of previous investigations;

2. a summary of the remediation approach employed at the Site;

3. a summary of confirmation sampling activities;

4. tabulated results from data obtained from confirmation sampling and statistical analysis if appropriate;

5. comparison of confirmation sampling results with fate and transport modeling outputs; and

6. conclusions about the long-term effectiveness of the remedy.

7.0 OPERATION AND MAINTENANCE PLAN

A Site-specific Operation and Maintenance Plan to address the selected remedial alternative will be completed by the selected remedial contractor and reagent applicant subcontractor. The required Operation and Maintenance Plan be prepared and submitted to IDEM. To the extent that the selected remedial technology is successful, the Site-specific Operation and Maintenance Plan will describe:

1. how monitoring wells and reagent application wells will be inspected and maintained for ongoing use; and

2. methods for decommissioning the wells at the successful conclusion of performance and confirmation sampling.

The Site-specific Operation and Maintenance Plan will be modified to address applicable elements of a new remedial system and approach if a new system is required.

8.0 COMMUNITY RELATIONS

The Community Relations Plan (CRP) outlines the activities necessary to inform the public of various activities during the VRP. The CRP allows for a flexible community relations approach that will take into account the changing needs of the community and understanding of Site conditions. The CRP highlights the Site description; the community background; the techniques and timing of the various community relation activities including mailing lists, public meetings, information bulletins, and media use; and the key contacts and interested parties for the project.

9.0 COMPLETION OF REMEDIAL ACTION

9.1 Completion Report

A Remedial Completion Report will be prepared to present the results of the remedial activities described in this Work Plan. The report will include a summary of all activities including additional investigations, remediation activities and confirmatory sampling. The information specified in the July 1996 Voluntary Remediation Program Resource Guide for inclusion in the Remediation Completion Report will be provided.

9.2 Future Use of Site

The expected future use of the Site is nonresidential. For approximately the past 120 years use of the Site has been industrial and will probably remain light industrial/commercial because:

1. it is located in an area that is primarily commercial and industrial (the adjoining properties are industrial and commercial);
2. the zoning for the Site is industrial and the adjoining properties are also commercial or industrial; and
3. the City intends to redevelop the Site to increase employment in the area.

As described in the July 1996 VRP Resource Guide, use of Tier II Nonresidential Cleanup Goals will result in a use restriction attached to the Covenant Not to Sue.

10.0 SCHEDULE

An estimated project schedule follows. The estimated start date of April 15 and assumes that IDEM will complete final review of this RWP plan and supporting documents prior to the end of March.

Durations estimated for the fieldwork are based on work being conducted during normal business hours Monday through Friday. The schedule may require modification due to unexpected field conditions.

April 15 through 30, 2005	Task 1- Installation of monitoring and application wells
May 1 through May 10, 2005	Task 2 – Baseline Groundwater Sampling and Analytical Procedures
May 10 through May 30, 2005	Task 3 - Bench Testing
June 1 through June 30, 2005	Task 4 – Pilot Testing[6.]
September 1 through December 31, 2005	Task 5 – Post Remedial Investigation and Pilot Study Report

A Site-specific Operation and Maintenance Plan will be submitted at the same time as the Pre-Remedial Investigation and Pilot Study Report. Long-term quarterly groundwater sampling will begin on September 2005 and extend through March 2008, assuming that the initial application proves successful in significantly reducing VOC concentrations in the source area. To the extent that additional reagent applications or alternative technologies are required, the monitoring will begin at the conclusion of these remedial activities and extend for a two year period. A Remedial Action Completion report will be submitted to IDEM within three months of completing the final groundwater sampling event.

[6.] The schedule assumes one round of reagent application. If a second round of application is conducted, subsequent tasks will be moved back approximately seven weeks.

11.0 COST ESTIMATE

Attachment B contains a cost estimate prepared pursuant to the City of South Bend's U.S. EPA Brownfields Cleanup Grant. Note that costs may require modification at the completion of the bidding process for consulting and remediation contracting.

.

12.0 REFERENCES

APT, Site Investigation Report, Indiana Voluntary Remediation Program, *"Allied Products Corporation Stamping Facility, South Bend, Indiana,"* Project Number 8708, May 1995.

ATEC, "*Interim Phase I Environmental Site Assessment, Studebaker Corridor, South Bend, Indiana. ATEC Project Number 21-07262".* No date provided*.*

ATEC, "*Initial Phase II Final Report, Lot One Studebaker Corridor, South Bend Indiana. ATEC Project Numbers 21-07458, 21-07460 and 21-07461,"* March 1991*.*

EIS Environmental Engineers, Inc., *"Environmental Investigation, South Bend Lathe, 400 West Sample Street, South Bend, Indiana,"* Document number 2295-5126-92. July 1992.

EIS Environmental Engineers, Inc., *"Phase II Investigation at Former Transwestern Building Site, South Bend, Indiana, Attachments,"* August 1995.

Hull & Associates, Inc., "*Phase I Environmental Site Assessment for the Area A Properties South Bend, Indiana, Hull Document Number SBI002.100.0001,"* January 2001*.*

Hull & Associates, Inc., "*Initial Phase II Environmental Site Assessment for the Area A Properties South Bend, Indiana, Hull Document Number SBI002.200.0012,"* January 2002.

Hull & Associates, Inc., "*Letter Report Documenting Additional Phase II Environmental Site Assessment in the Southwest Portion of Area A (Former Studebaker Automotive Manufacturing Facility, South Bend, Indiana, Hull Document Number SBI016.200.0006," December 2003*.

Hull & Associates, Inc., "*Health and Safety Plan for Phase II Environmental Site Assessment Activities at the Area A Properties South Bend, Indiana, Hull Document Number SBI013.200.00019,"* January 2002.

Hull & Associates, Inc., "*Quality Assurance/Quality Contol Project Plan for Phase II Environmental Site Assessment Activities for the Area A Properties South Bend, Indiana, Hull Document Number SBI013.200.0020,"* January 2002.

Hull & Associates, Inc., "*Community Relations Plan for VRP Activities for Area A Properties, South Bend, Indiana, Hull Document Number SBI013.100.0004,*" March 2004.

FIGURES

QUADRANGLE LOCATION

SOURCE: USGS SOUTH BEND EAST, INDIANA – 1969
SOUTH BEND WEST, INDIANA – 1969
QUADRANGLE 1969
PHOTOREVISED 1987

0 500 1000 2000
SCALE IN FEET

Hull & associates, inc.
ENGINEERS | GEOLOGISTS | SCIENTISTS | PLANNERS

4900 PARKWAY
SUITE 100
MASON, OHIO 45040

PHONE: (513) 459-9677
FAX: (513) 459-9869
www.hullinc.com

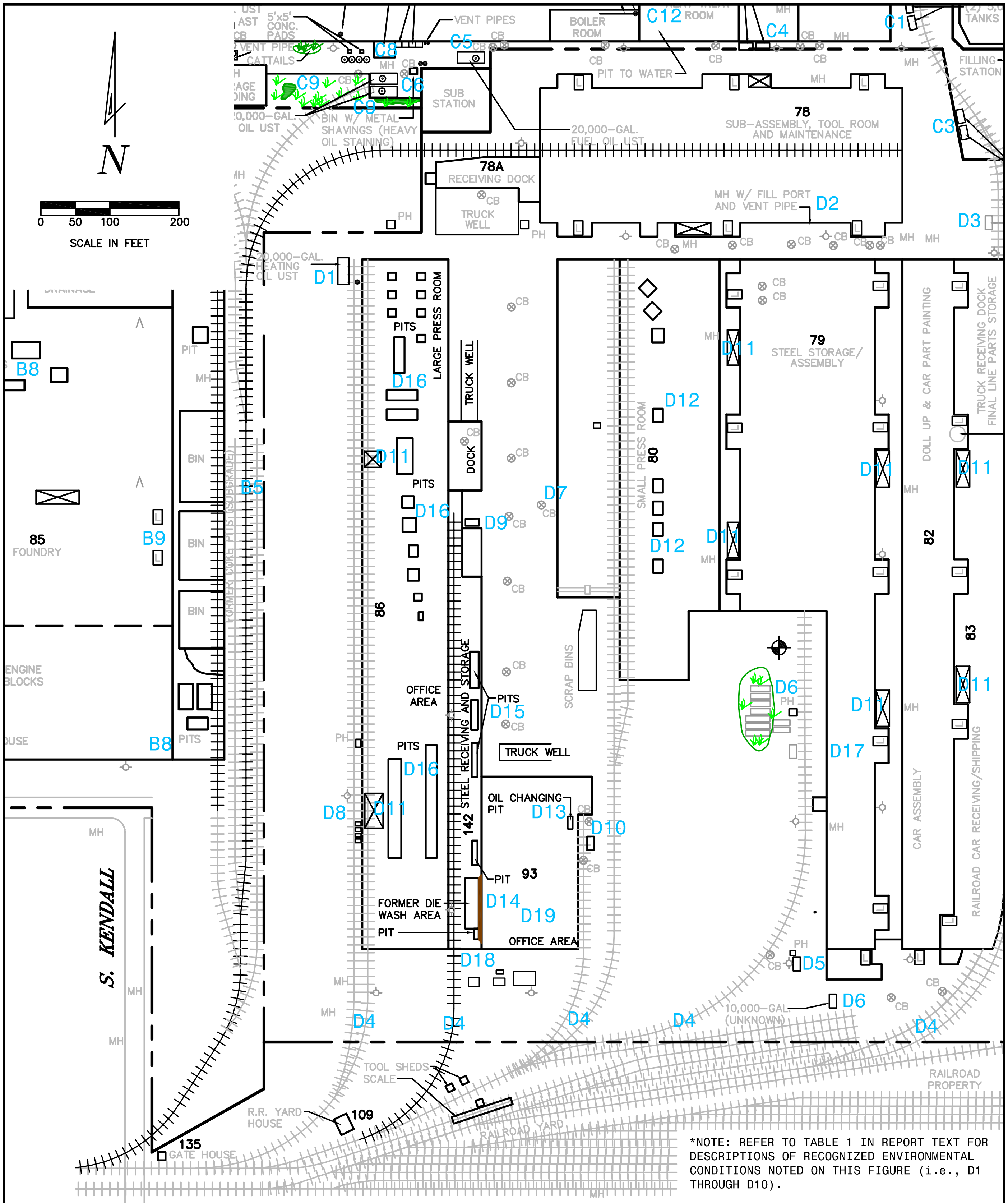
CITY OF SOUTH BEND REDEVELOPMENT COMMISSION
REMEDIATION WORK PLAN FOR AN APPARENT SOURCE AREA
FORMER SOUTH BEND STAMPING PLANT PROPERTY

FIGURE 1

SITE LOCATION MAP

SOUTH BEND, INDIANA

PROJECT NO.: SBI026	SUBMITTAL DATE: MARCH 2005
CAD DWG FILE: SBI026.200.0008	PLOT DATE: 3/17/05



Hull & associates, inc.
ENGINEERS | GEOLOGISTS | SCIENTISTS | PLANNERS

4900 PARKWAY
SUITE 100
MASON, OHIO 45040

PHONE: (513) 459-9677
FAX: (513) 459-9869
www.hullinc.com

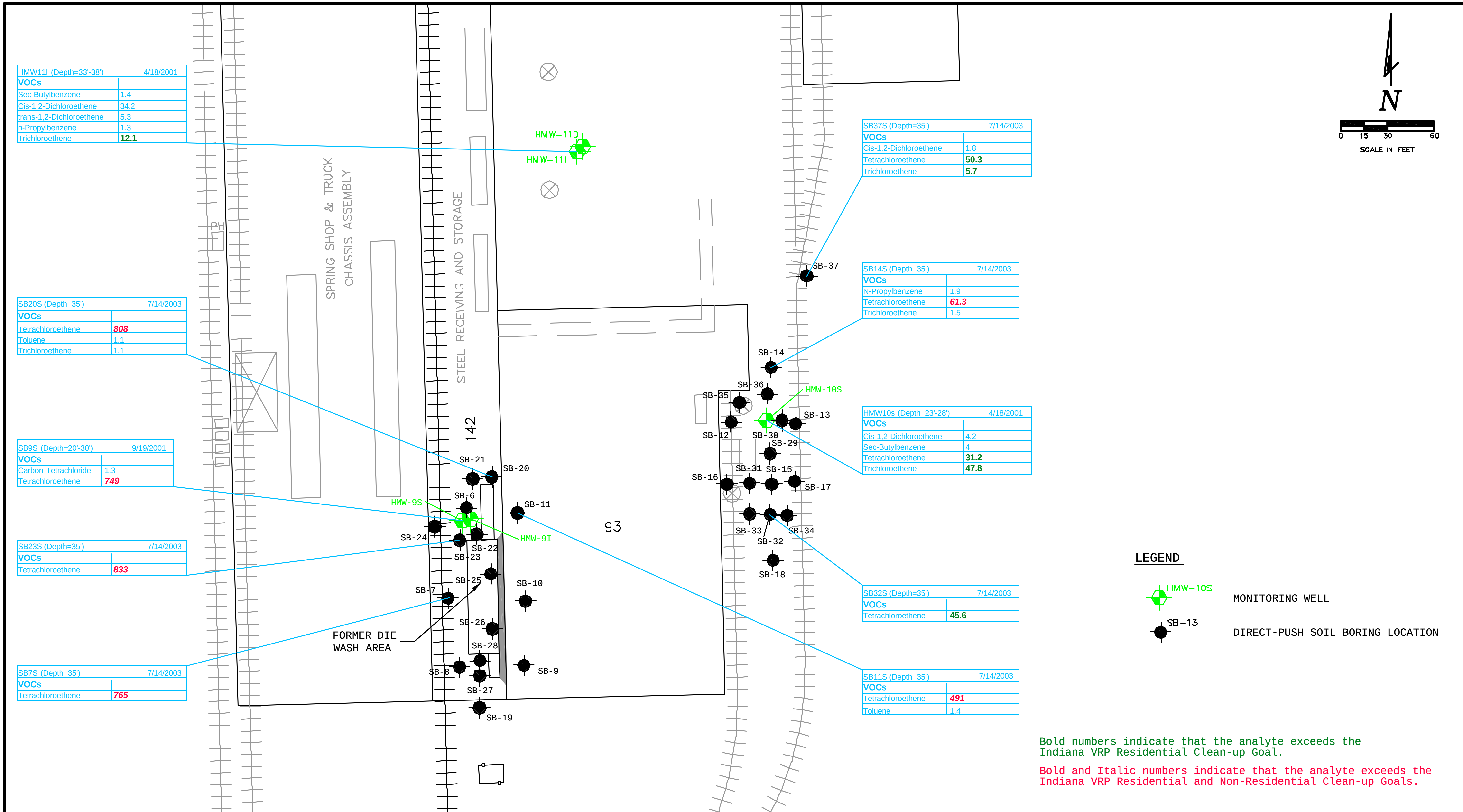
CITY OF SOUTH BEND REDEVELOPMENT COMMISSION
REMEDIATION WORK PLAN FOR AN APPARENT SOURCE AREA
FORMER SOUTH BEND STAMPING PLANT PROPERTY

FIGURE 2

RECOGNIZED ENVIRONMENTAL CONDITIONS FOR THE FORMER ALLIED STAMPING PROPERTY

SOUTH BEND, INDIANA

PROJECT NO.: SBI026	SUBMITTAL DATE: MARCH 2005
CAD DWG FILE: SBI026.200.0006	PLOT DATE: 3/16/05



HMW11I (Depth=33'-38')	4/18/2001
VOCs	
Sec-Butylbenzene	1.4
Cis-1,2-Dichloroethene	34.2
trans-1,2-Dichloroethene	5.3
n-Propylbenzene	1.3
Trichloroethene	**12.1**

SB20S (Depth=35')	7/14/2003
VOCs	
Tetrachloroethene	***808***
Toluene	1.1
Trichloroethene	1.1

SB9S (Depth=20'-30')	9/19/2001
VOCs	
Carbon Tetrachloride	1.3
Tetrachloroethene	***749***

SB23S (Depth=35')	7/14/2003
VOCs	
Tetrachloroethene	***833***

SB7S (Depth=35')	7/14/2003
VOCs	
Tetrachloroethene	***765***

SB37S (Depth=35')	7/14/2003
VOCs	
Cis-1,2-Dichloroethene	1.8
Tetrachloroethene	**50.3**
Trichloroethene	**5.7**

SB14S (Depth=35')	7/14/2003
VOCs	
N-Propylbenzene	1.9
Tetrachloroethene	***61.3***
Trichloroethene	1.5

HMW10s (Depth=23'-28')	4/18/2001
VOCs	
Cis-1,2-Dichloroethene	4.2
Sec-Butylbenzene	4
Tetrachloroethene	**31.2**
Trichloroethene	**47.8**

SB32S (Depth=35')	7/14/2003
VOCs	
Tetrachloroethene	**45.6**

SB11S (Depth=35')	7/14/2003
VOCs	
Tetrachloroethene	***491***
Toluene	1.4

Bold numbers indicate that the analyte exceeds the Indiana VRP Residential Clean-up Goal.

Bold and Italic numbers indicate that the analyte exceeds the Indiana VRP Residential and Non-Residential Clean-up Goals.

Hull & associates, inc.
ENGINEERS | GEOLOGISTS | SCIENTISTS | SURVEYORS | PLANNERS
4900 PARKWAY
SUITE 100
MASON, OHIO 45040
PHONE: (513) 459-9677
FAX: (513) 459-9869
www.hullinc.com

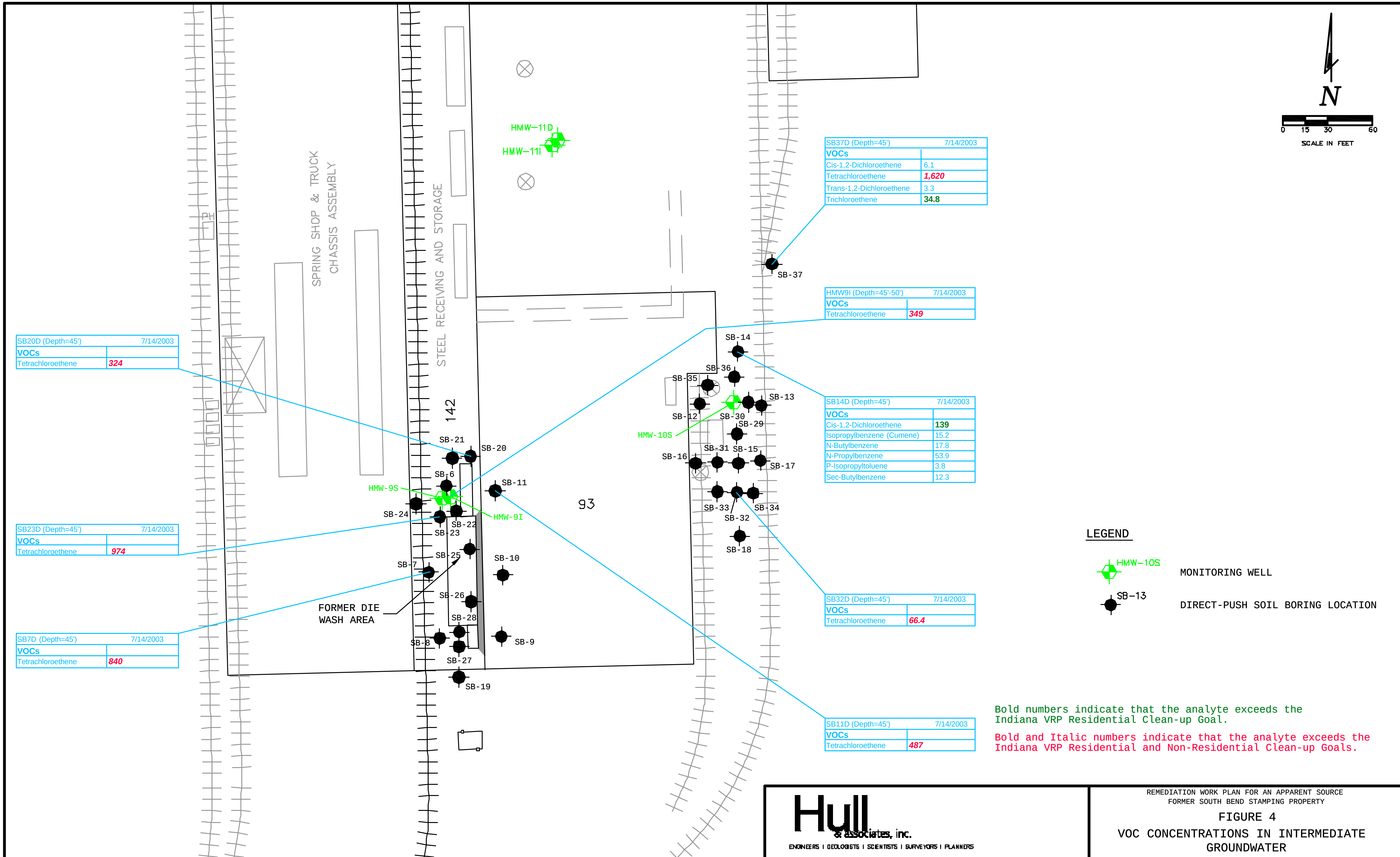
REMEDIATION WORK PLAN FOR AN APPARENT SOURCE AREA
FORMER SOUTH BEND STAMPING PROPERTY

FIGURE 3

VOC CONCENTRATIONS IN SHALLOW GROUNDWATER

SOUTH BEND, INDIANA

PROJECT NO.:	SBI026	**SUBMITTAL DATE:**	MARCH 2005
CAD DWG FILE:	SBI026.200.0001	**PLOT DATE:**	3/17/05



SB37D (Depth=45')	7/14/2003
VOCs	
Cis-1,2-Dichloroethene	6.1
Tetrachloroethene	***1,620***
Trans-1,2-Dichloroethene	3.3
Trichloroethene	**34.8**

HMW9I (Depth=45'-50')	7/14/2003
VOCs	
Tetrachloroethene	***349***

SB20D (Depth=45')	7/14/2003
VOCs	
Tetrachloroethene	***324***

SB14D (Depth=45')	7/14/2003
VOCs	
Cis-1,2-Dichloroethene	**139**
Isopropylbenzene (Cumene)	15.2
N-Butylbenzene	17.8
N-Propylbenzene	53.9
P-Isopropyltoluene	3.8
Sec-Butylbenzene	12.3

SB23D (Depth=45')	7/14/2003
VOCs	
Tetrachloroethene	***974***

SB32D (Depth=45')	7/14/2003
VOCs	
Tetrachloroethene	***66.4***

SB7D (Depth=45')	7/14/2003
VOCs	
Tetrachloroethene	***840***

SB11D (Depth=45')	7/14/2003
VOCs	
Tetrachloroethene	***487***

LEGEND

HMW-10S MONITORING WELL

SB-13 DIRECT-PUSH SOIL BORING LOCATION

Bold numbers indicate that the analyte exceeds the Indiana VRP Residential Clean-up Goal.

Bold and Italic numbers indicate that the analyte exceeds the Indiana VRP Residential and Non-Residential Clean-up Goals.

Hull & associates, inc.
ENGINEERS | GEOLOGISTS | SCIENTISTS | SURVEYORS | PLANNERS
4900 PARKWAY
SUITE 100
MASON, OHIO 45040
PHONE: (513) 459-9677
FAX: (513) 459-9869
www.hullinc.com

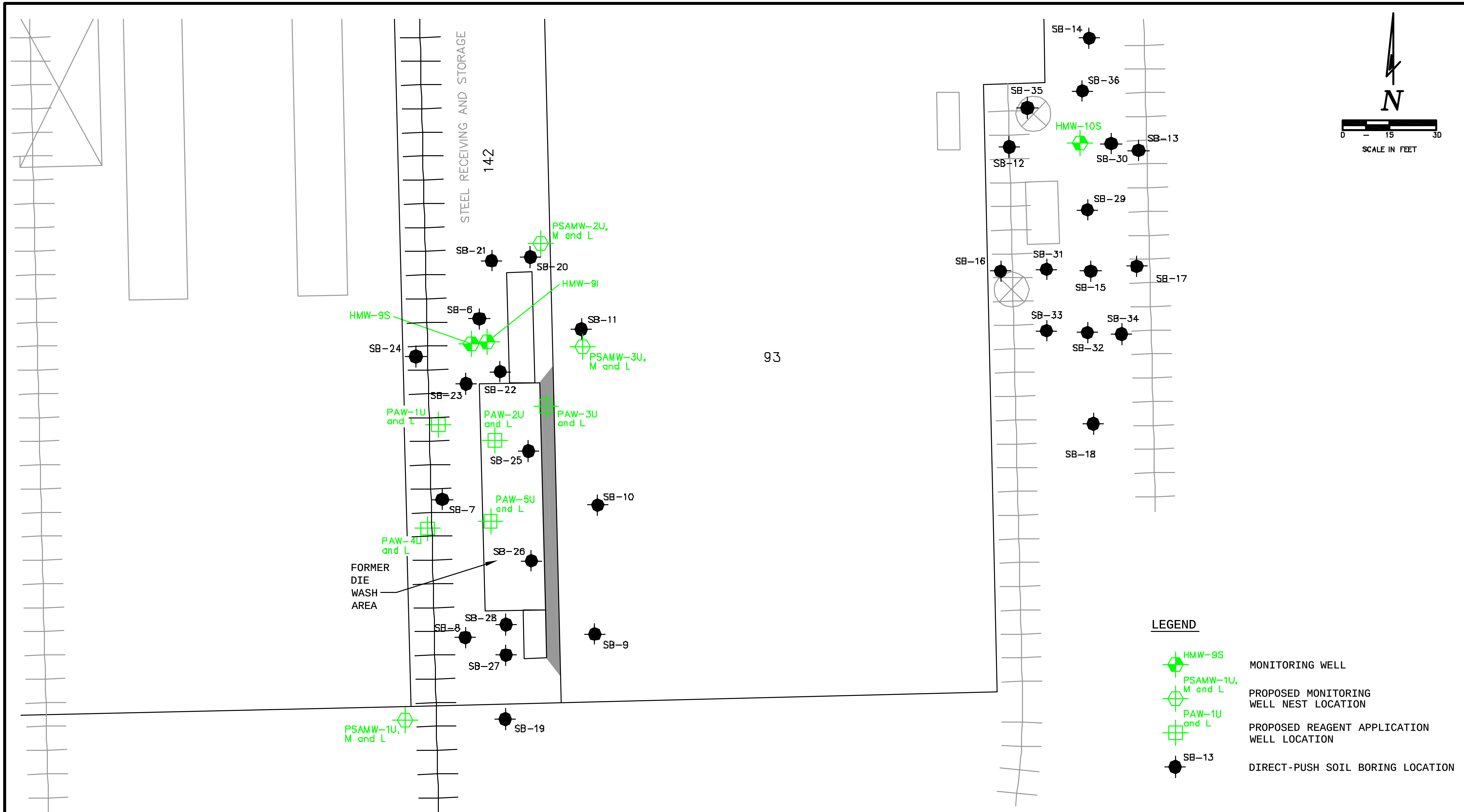
REMEDIATION WORK PLAN FOR AN APPARENT SOURCE
FORMER SOUTH BEND STAMPING PROPERTY

FIGURE 4

VOC CONCENTRATIONS IN INTERMEDIATE GROUNDWATER

SOUTH BEND, INDIANA

PROJECT NO.:	SBI026	SUBMITTAL DATE:	MARCH 2005
CAD DWG FILE:	SBI026.200.0002	PLOT DATE:	3/17/05



Hull & associates, inc.
ENGINEERS | GEOLOGISTS | SCIENTISTS | SURVEYORS | PLANNERS
4900 PARKWAY
SUITE 100
MASON, OHIO 45040
PHONE: (513) 459-9677
FAX: (513) 459-9869
www.hullinc.com

REMEDIATION WORK PLAN FOR AN APPARENT SOURCE
FORMER SOUTH BEND STAMPING PROPERTY

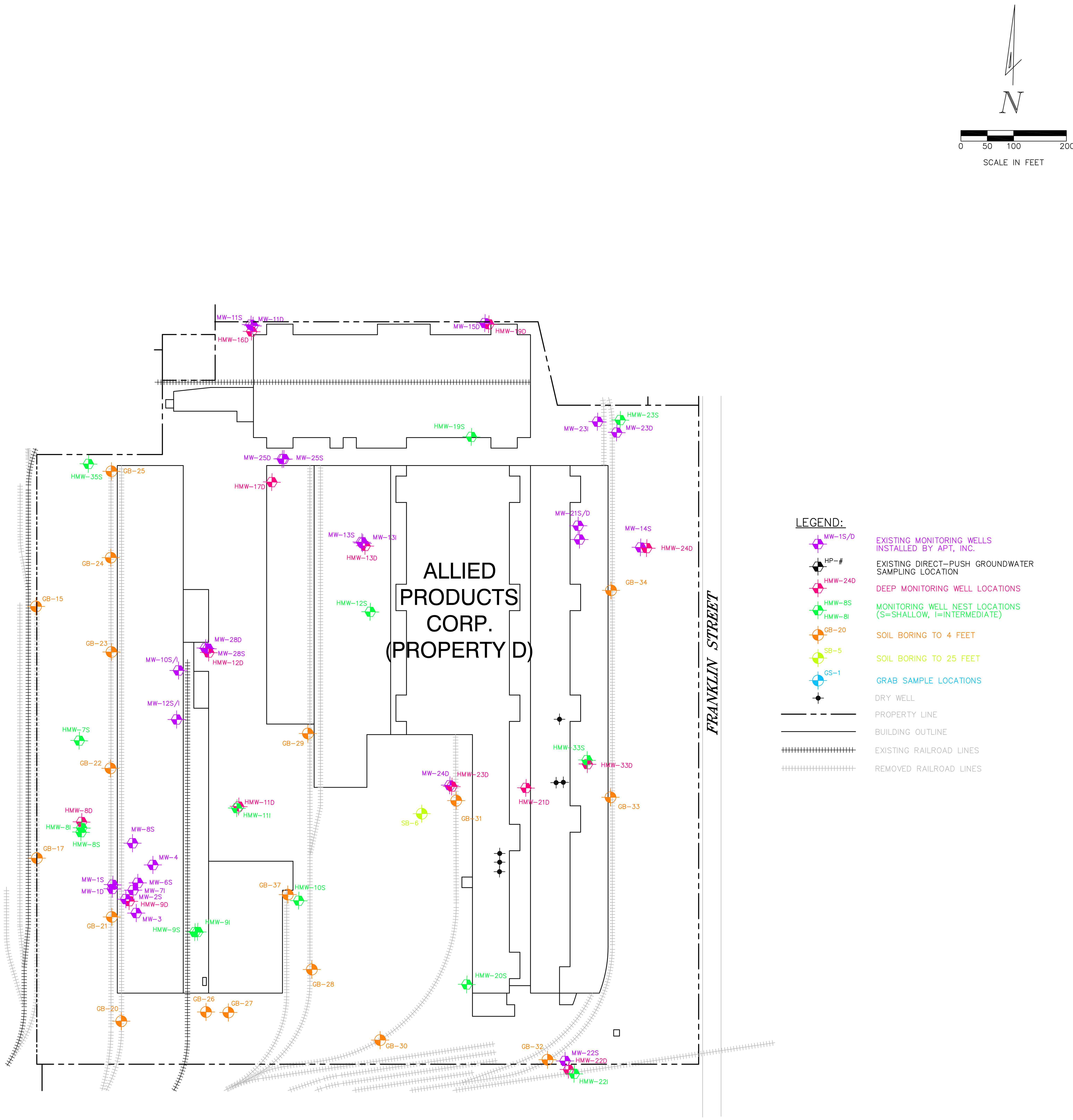
FIGURE 5

PROPOSED GROUNDWATER MONITORING WELL AND REAGENT APPLICATION WELL LOCATIONS

SOUTH BEND, INDIANA

PROJECT NO.:	SBI026	SUBMITTAL DATE:	MARCH 2005
CAD DWG FILE:	SBI026.200.0003	PLOT DATE:	3/17/05

PLATE



Hull & Associates, Inc.
ENGINEERS - GEOLOGISTS - SCIENTISTS - PLANNERS
4900 PARKWAY
SUITE 100
MASON, OHIO 45040
PHONE: (513) 459-9677
FAX: (513) 459-9869
www.hullinc.com

REGISTERED ENGINEER

DATE

REMEDIATION WORK PLAN FOR AN APPARENT SOURCE AREA
FORMER SOUTH BEND STAMPING PLANT
SOUTH BEND, INDIANA

OWNER:

MARK	DATE	DESCRIPTION

PROJECT NO.:	SBI026
CAD DWG FILE:	SBI026.200.0007
PLOT DATE:	3/16/05
LAYOUT BY:	LT
DRAWN BY:	DP
CHECKED BY:	LT
SCALE:	1"=100'
SUBMITTAL DATE:	MARCH 2005

SHEET TITLE:

PLATE 1
MONITORING WELL AND SOIL BORING LOCATIONS UP TO AND INCLUDING INITIAL PHASE II ESA

SHEET 1 OF 1

APPENDIX A

Referenced Standard Operating Procedures

SOP No. F2023 *(1999rev)*
MONITORING WELL AND PIEZOMETER INSTALLATION

1.0 Purpose

Monitoring wells or piezometers are installed in consolidated and unconsolidated materials at a specific depth to collect representative ground-water samples, determine ground-water elevations, and provide observation points for aquifer testing. These monitoring wells or piezometers will be constructed of inert materials to eliminate the effect of construction material on ground-water quality.

2.0 Equipment and Materials

- Pre-cleaned riser pipe and slotted well screen, flush-threaded joints with O-ring, material and diameter as specified in the Project Plan
- Drilling rig with the appropriate capabilities
- Bottom cap
- Sodium-bentonite clay pellets or chips
- Clean filter sand
- Sodium-bentonite or cement-bentonite slurry
- Locking water-tight cap
- Aboveground protective casing
- Flush-mount protective bolted manhole with rubber gasket
- Concrete
- Pipe Cutter

3.0 Procedures

A. Generally, once the specified depth has been reached, approximately one foot of clean filter sand will be placed into the borehole to act as a cushion for the well or piezometer column. while withdrawing the augers or casing. The thickness of the sand pack will be measured and recorded.

B.. After the sand cushion is in place, the well or piezometer column will be assembled and installed. As an added protection, Teflon tape may be wrapped around the joint threads during assembly. **No glue, solvent, or lubricating compound shall be used to make up the connection.** The well or piezometer column will be constructed through the augers or drilling casing and carefully lowered to ensure it is properly centered. Once the well or piezometer column is in place, the top will be fitted with a locking water tight cap to prevent the introduction of foreign materials during later well construction procedures. All construction information will be recorded.

C. After the well column is placed, a filter sand pack will be carefully placed around the well screen for the purpose of reducing the introduction of fines during purging and sampling procedures. The sand will be poured through the augers or casings, which are periodically withdrawn to allow the sand to settle. The filter pack will extend approximately two feet above the top of the screen. Note that when installing bedrock wells, the top of the sand pack only extend to approximately one foot below the bedrock surface. The grain size chosen for the filter sand will be consistent with the slot size of the screen. The depth to the sand pack will be measured and recorded.

D. After the sand pack is firmly placed, a minimum of two feet of sodium-bentonite pellets or chips will be placed above the sand pack. This material will be added slowly to prevent bridging inside the augers.   For bedrock monitoring wells and piezometers, the bentonite seal will be constructed in a manner to bridge the interface between the unconsolidated and consolidated materials. When the sodium bentonite chips are installed in non-saturated conditions, approximately two to five gallons of potable water will be added to the pellets or chips for hydration. All construction data will be recorded.

E. A clean tremie pipe will then be placed inside the augers or casing for the placement of a thick, smooth bentonite or cement-bentonite slurry (cement-bentonite slurry will only be used with approval of the Project Manager). The slurry will be pumped under pressure until the augers or casing are full. The augers or casing will then be withdrawn and additional slurry will be added as needed. The slurry will fill the annular space between the well column and borehole to approximately three feet below ground surface. The slurry will be allowed to settle and stabilize for approximately 18 to 24 hours, at which time the hole is re-inspected for subsidence. If additional slurry is needed, it will be added. The amount of sodium-bentonite slurry, the mixture ratios of the slurry, the thickness of the slurry and any significant subsidence in the slurry level will be recorded.

For installation of shallow monitoring wells, sodium-bentonite chips may used in lieu of slurry or grout if approved by the project manager. These bentonite chips will be periodically hydrated with potable water to promote formation of the impervious seal.

F. Prior to installing the protective casing, the well casing will be cut level with a pipe cutter or saw. The finished height of the well will depend on the type of protective device to be used (e.g., flush-mount or aboveground protective casing).

G. After the bentonite slurry has reached a static level, a protective casing or flush- mount manhole will be installed in concrete (if field construction conditions permit, the concrete will extend to a depth of approximately three feet). The concrete will extend approximately one foot from the edge of the casing. This concrete pad will be constructed so the surface slopes away from the casing enhancing surface water run-off from the wellhead. As an added precaution, the annular space between the well column and protective casing can be filled with a granular material and a small hole drilled near the base of protective pipe to discharge any water that may enter the protective casing.

H. If the well will be completed in a traffic area, a flush-mount protective casing will be utilized. Like the aboveground protective casing, it will be installed in concrete (if field construction conditions permit, the concrete will extend to a depth of approximately three feet) and finished with a slope that drains surface water away from the well.

I. If required, the final step will be to paint the aboveground protective casing using a highly visible and durable paint, to permanently attach a well designation marker, and install a weep hole.

4.0 Documentation

Well installation data will be recorded on the soil boring log or appropriate form. Installation details will include the total depth of the boring, the depth to the top and bottom of the well screen, the type of sand pack, the depth to top and bottom of the sand pack, the type of grout, the depth to top and bottom of the bentonite seal, the top and bottom of the bentonite slurry, the mixture ratios for the bentonite slurry, the depth to the bottom of the concrete, and any problems occurring during the installation of the well.

5.0 Special Notes

Water will not be added to the borehole during drilling activities unless it is approved by the Project Manager. The attached Figures F2023-1, F2023-2 and F2023-3 are examples of well installation construction.

6.0 Applicable Standards and References

ASTM D5092 Practice for Design and Installation of Groundwater Monitoring well or piezometers in Aquifers.

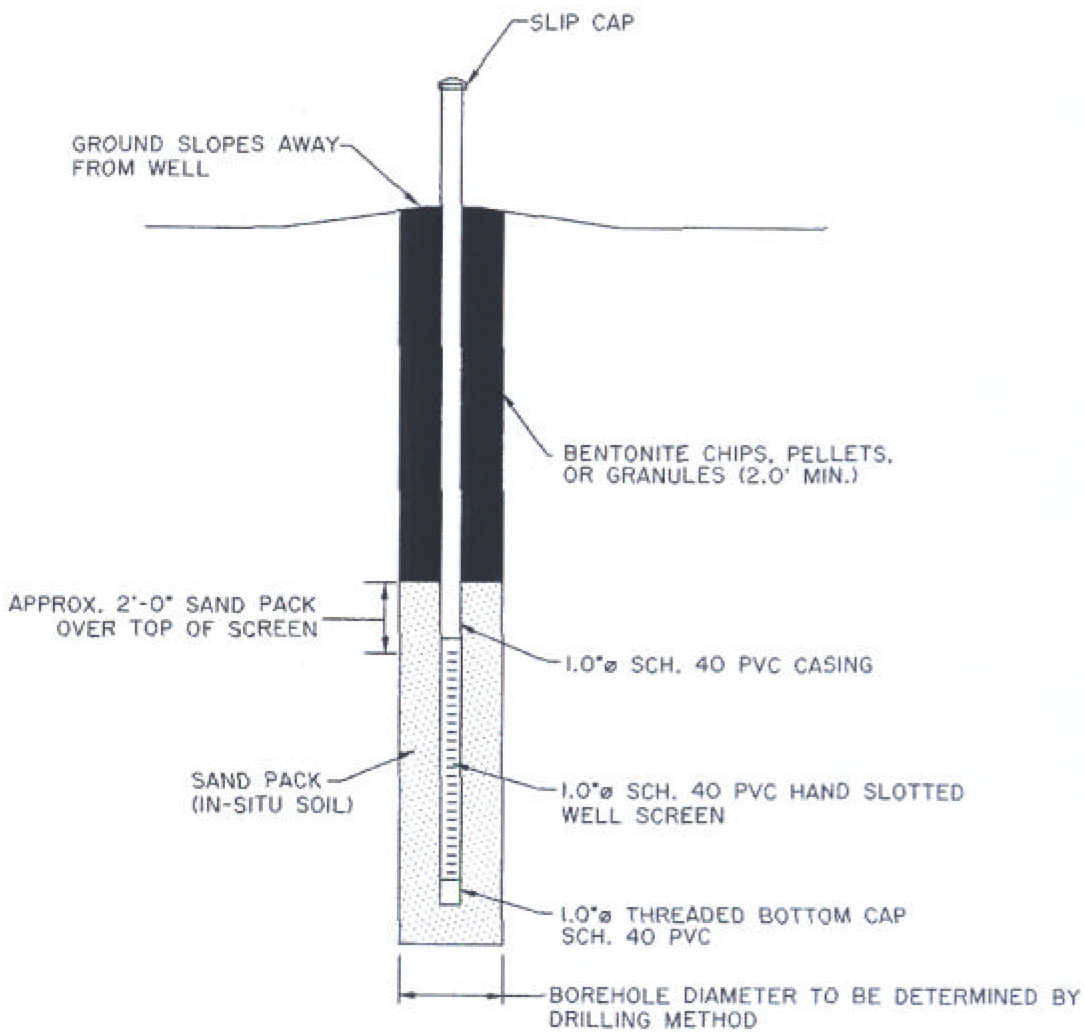


FIGURE F2023-1

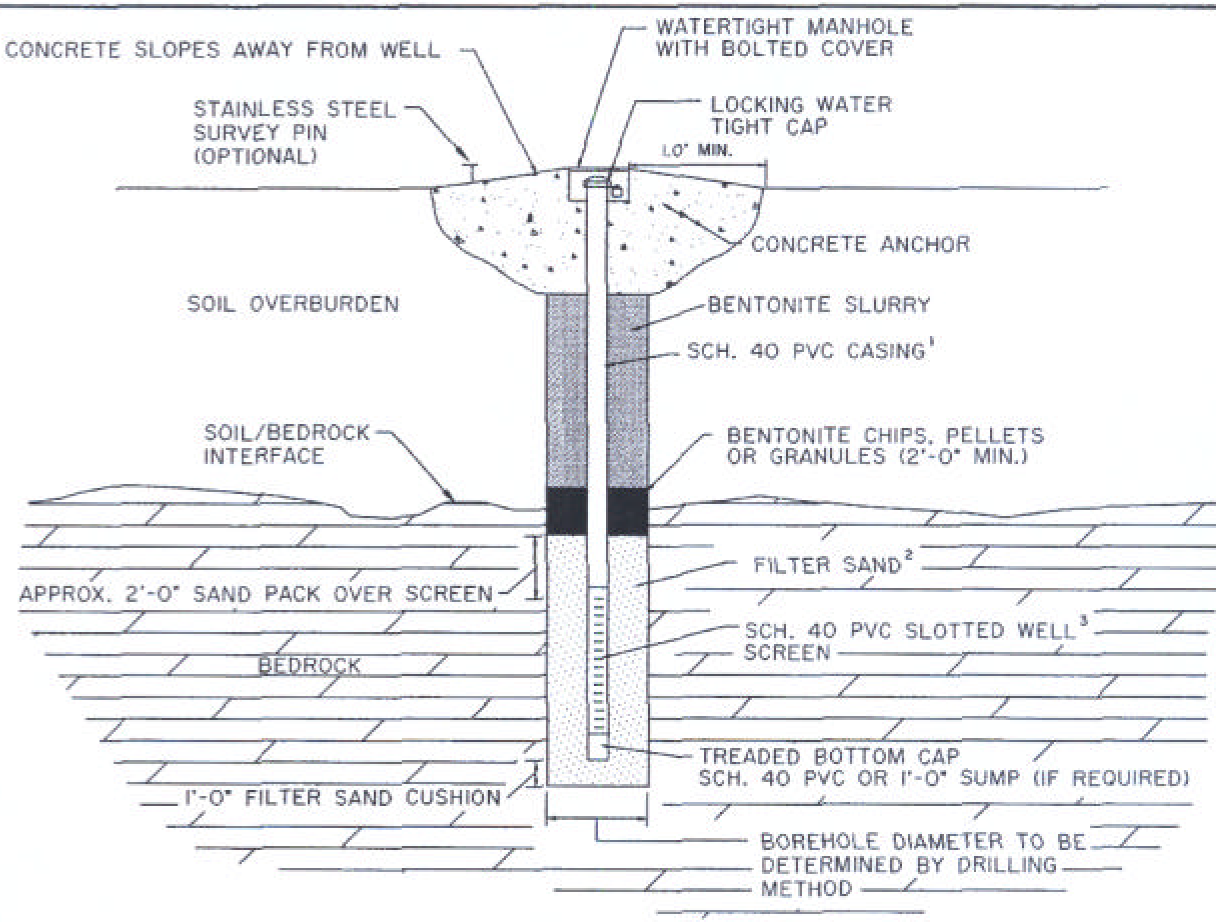
Hull & Associates, Inc.

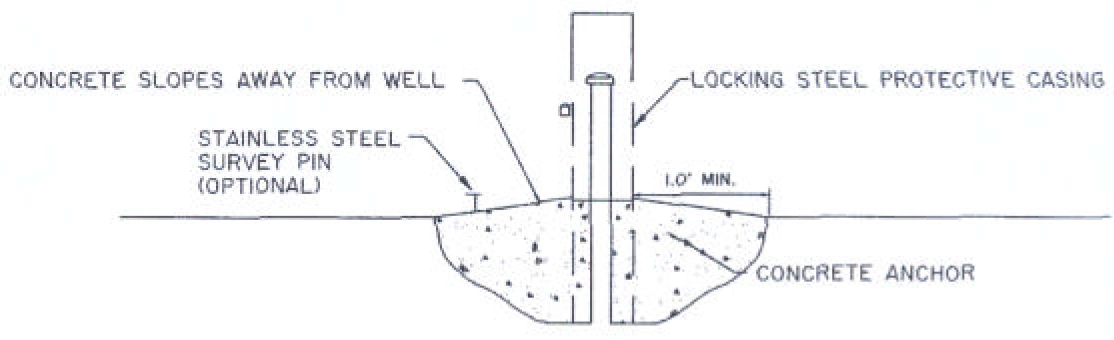
OVERBURDEN/GLACIAL MATERIAL
MINI-PIEZOMETER
CONSTRUCTION DIAGRAM

DATE:
MARCH 2000

STD

1000.300.0165.DWG
03/06/00KMAC
UNIT 1 DISK 1





CONSTRUCTION DIAGRAM WITH
STEEL PROTECTIVE CASING

[1] WELL MATERIALS WILL BE SPECIFIED IN WORK PLAN.

[2] FILTER PACK GRAIN SIZE WILL VARY DEPENDING UPON SCREEN SLOT SIZE.

[3] SCREEN SLOT SIZE WILL VARY DEPENDING UPON FORMATION CHARACTERISTICS.

1000.300.0188.DWG
03/06/DOKMAC
UNIT 1 DISK 1

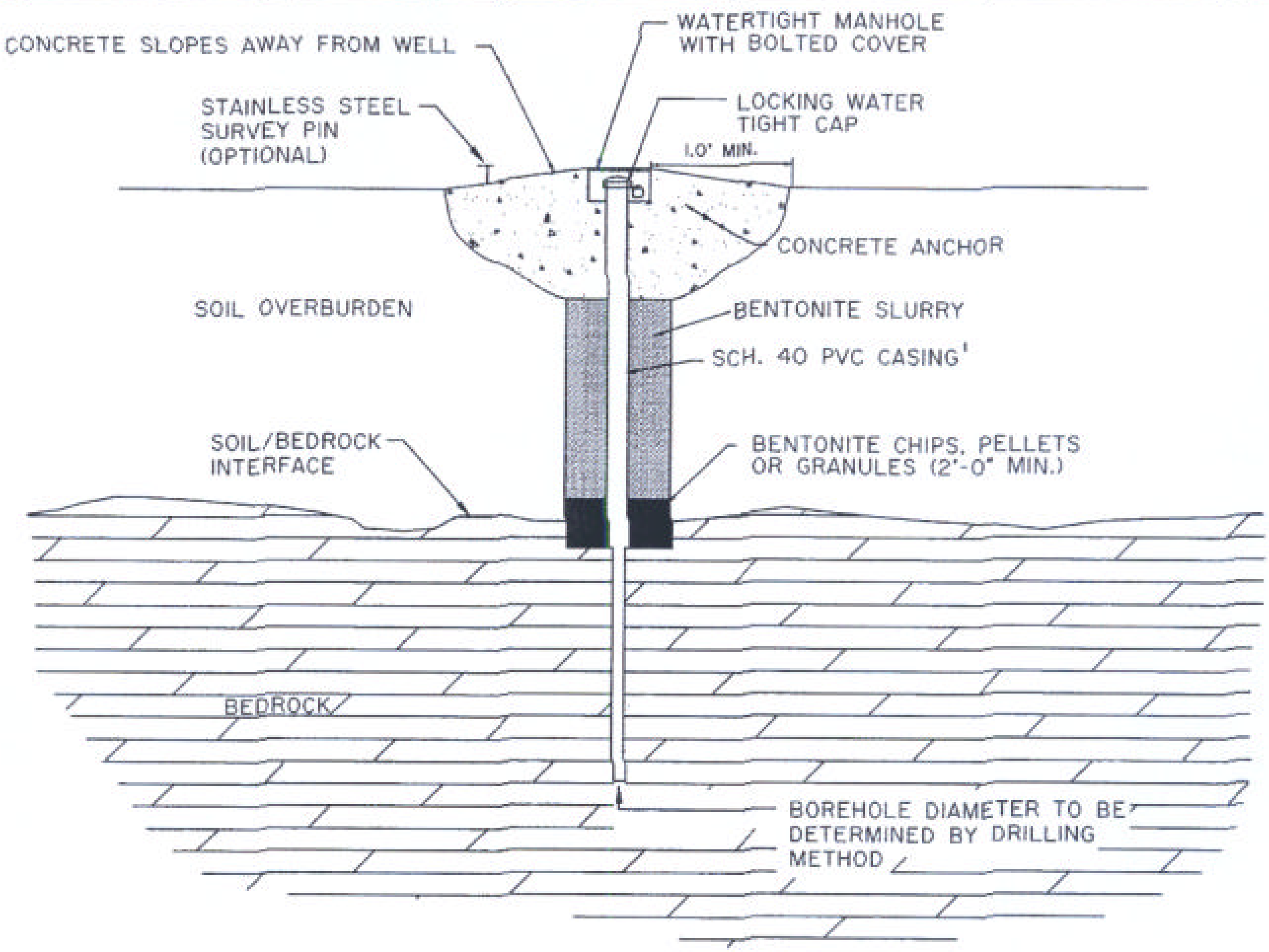
FIGURE F2023-2

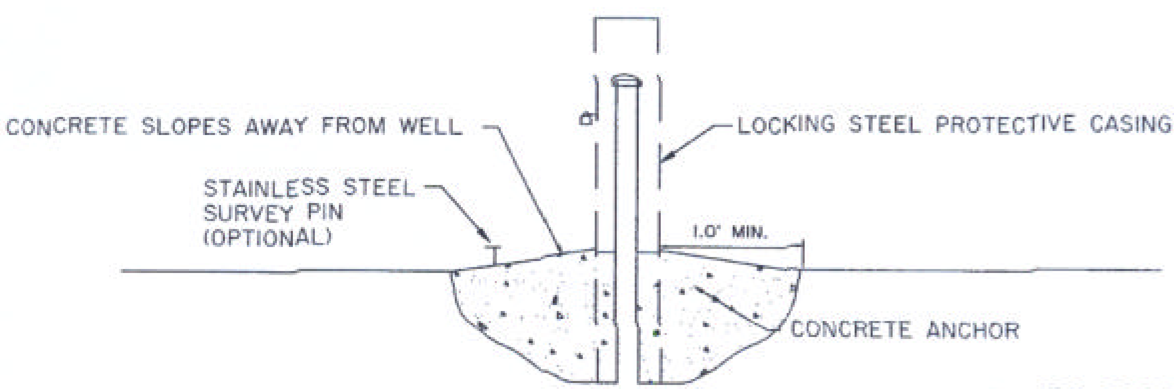
Hull & Associates, Inc.

BEDROCK
GROUNDWATER MONITORING WELL
CONSTRUCTION DIAGRAM
(WITH EITHER FLUSH-MOUNT MANHOLE
OR STEEL PROTECTIVE CASING)

DATE:
MARCH 2000

STD





CONSTRUCTION DIAGRAM WITH STEEL PROTECTIVE CASING

FIGURE F2023-3

Hull & Associates, Inc.

OPEN-CASED BEDROCK PIEZOMETER CONSTRUCTION DIAGRAM (WITH EITHER FLUSH-MOUNT MANHOLE OR STEEL PROTECTIVE CASING)

DATE: MARCH 2000

STD

¹ WELL MATERIALS WILL BE SPECIFIED IN WORK PLAN.

1000.300.0187.DWG
03/06/00KMAC
UNIT I DISK I

SOP No. F3008 *(2001rev)*
GROUNDWATER SAMPLE COLLECTION

1.0 Purpose

This SOP describes the procedures that will be followed during the collection of representative groundwater samples from monitoring wells/piezometers.

2.0 Equipment and Materials (as Required)

- portable photoionization detector (PID) or flame ionization detector (FID);
- multi-gas meter (i.e., O_2, CH_4, percent LEL, percent gas) or equivalent(s);
- interface probe or water level indicator with a tape graduated to 0.01 ft;
- submersible pump, bladder pump, peristaltic pump, foot-valve lift pump, or positive displacement piston pump;
- power source (e.g., generator), if an electric pump is used;
- dedicated or reusable bailer constructed of *Teflon*, stainless steel, disposable polyethylene, or other acceptable material;
- tubing constructed of polyvinyl chloride, polypropylene, polyethylene, stainless steel or other suitable materials sized appropriate for the pump discharge;
- polypropylene rope/ or other suitable bailer cord;
- pH/temperature meter;
- conductivity meter;
- dissolved oxygen meter;
- ORP/eh meter:
- storage container for purge water;
- calibrated container with a capacity of at least five gallons;
- sample gloves (latex, vinyl, or other suitable material).

As an alternative to standard purging and sampling techniques, low-flow sampling may be conducted. Besides equipment and materials listed above (e.g., peristaltic or submersible pump, tubing, etc.), the following additional equipment will be required for low-flow sampling:

- flow-through cell capable of continuously monitoring field indicator parameters during purging and sampling
- turbidity meter (optional); and
- a graduated cylinder.

3.0 Procedures

A. As the monitoring well/piezometer is approached, a visual inspection of the condition will be completed and documented. If warranted in the site-specific Health & Safety Plan (HASP), the ambient air conditions in the vicinity of the wellhead will be documented prior to its opening. The PID or FID will be used to determine if any significant concentrations of volatile organic compounds (VOCs) are present in the ambient air near the well. After screening for VOCs, the appropriate meter(s) will be employed to measure percent LEL and percent O_2 and determine if explosive or oxygen deficient conditions exist in the vicinity of the wellhead. These screening measurements will be conducted at heights and distances from or in the wellhead as directed by the Project Manager, or as described in the site-specific HASP.

If either screening method indicates conditions above action levels are present, the area will be immediately evacuated until the situation can be reevaluated. In any case, the sampling team will make a concerted to perform all groundwater sampling procedures upwind from the wellhead.

B. After the environment in the vicinity of the wellhead is deemed satisfactory, the well will be opened and the air conditions in the well column determined, if specified in the site-specific HASP. The protective casing of the well/piezometer will be unlocked and the cap will be accessed. After removal of the cap, the air quality in the riser will be screened (as applicable) and the findings will be documented. If warranted, the PID of FID probe will be inserted approximately six inches into the well column for accurate determination of VOC concentrations. After completing an assessment for VOCs, the appropriate meter(s) may be employed to determine percent LEL, percent O_2 or other gases, to determine conditions within the well column.

If either screening method indicates conditions above action levels, the area will be immediately evacuated and appropriate actions taken.

C. The monitoring well will be allowed to stabilize prior to collecting water level measurements using a water level meter or an interface probe. The interface probe or water level indicator will be decontaminated in accordance with HAI SOP No. F1000 prior to collecting water level measurements.

D. All measurements (as described below) will be taken from the survey mark indicated on the top of the well casing. If a mark is not already indicated, the north position of the casing should be used as the measurement point. This point should then be marked for future reference.

E. If there is the potential for the presence of non-aqueous phase liquid (NAPL) in the well, a determination of the presence and thickness of immiscible layer(s) will be conducted in accordance with the probe manufacturer's instructions. Care will be taken so that the interface probe and tape do not touch the well casing as they are lowered into the well. The probe will be slowly lowered until the top of fluids is encountered. The interface probe will emit an intermittent tone if NAPL is encountered or a continuous tone if water is encountered. The tape will be slowly raised and lowered to determine the exact measurement (within 0.01 feet). If there is the presence for dense (i.e., heavier than water) NAPL, the probe will be lowered to the bottom of the well. Measurements will be recorded in the field notebook or on the appropriate field data sheet. After the measurements are complete, the probe and all measuring tape lowered into the well will be thoroughly decontaminated in accordance with HAI SOP No. F1000.

F. a water level probe is used to measure water levels, the probe will be slowly and carefully lowered into the well column until the water level is encountered. The water level indicator will emit an audible signal when it makes contact with water. The tape will be slowly raised and lowered to determine the exact measurement (within 0.01 feet). After the water level measurement procedure is complete, the probe and the portion of the measuring tape that was lowered into the well will be thoroughly decontaminated in accordance with HAP SOP No. F1000. The measurement will be recorded in the field notebook or on the appropriate field data sheet.

G. The monitoring well/piezometer can now be purged. The purpose of purging is to evacuate stagnant water that may be present in the well column and filter pack and introduce representative formation water into the well casing. Purging is completed using a variety of bailers and/or pumps, which are described below. The Project Manager will determine the most appropriate purging method. The device selected to purge the well is dependent upon the well construction and hydraulic conditions of the screened interval. The selected purging device will provide an adequate discharge rate without producing a deleterious effect on groundwater quality.

<u>Volume Based Purging</u>

The U.S. EPA recommends that three to five well volumes be purged from a well in order to obtain a representative groundwater sample. Typically, indicator field parameters (pH, temperature and conductivity) stabilize within the period that monitoring wells are purged of three well volumes. In some cases, dissolved oxygen and ORP/eh readings may also be required to document stabilization. Occasionally, it is advisable to purge less than three well volumes (e.g., in conditions where excessive purging may cause contaminant migration or if minimal purge volume technology such as low flow sampling is employed). Furthermore, more than three well volumes will be purged in cases where indicator field parameters have not stabilized. Under these conditions, the well will be purged until the temperature, conductivity and pH of the purge water have stabilized, or up to five well volumes (unless the FSAP or Project Manager specifies that more than five well volumes will be purged). The temperature, pH, and conductivity will be measured initially, as well as after each well volume is purged. The last two values obtained must be within 10 percent of one another. The values will be recorded in the field logbook or on the appropriate field data sheet. The pH meter will be calibrated using a 2-point curve with pH buffer solutions that bracket the suspected groundwater pH. Conductivity will be calibrated using a commercially available standard in accordance with manufacturer's instructions and recommendations. Operation and maintenance of the pH/temperature and conductivity meters will also be in accordance with the manufacturer's instructions and recommendations. Note that some projects will require that meters be used to measure dissolved oxygen and ORP/eh after every well volume is removed. Where required, these meters will be calibrated and operated in accordance with the manufacturer's specifications.

Low yielding wells, from which at least three well volumes cannot be removed, will be completely evacuated before sampling. All wells will be sampled within 24 hours of purging. If a sample cannot be obtained after the initial purging, multiple trips to the well with less than 24 hours between trips will be made in accordance with applicable regulations.

To reduce the possibility of error, purge and well volumes will be calculated in the field based on a conversion factor that represents the gallons of water in the well per foot of standing water. Typical conversion factors used are listed in the table below:

VOLUME PER LINEAR FOOT OF STANDING WATER

Well Diameter	Cubic Feet	Gallons
2.0	.022	.16
4.0	.087	.65
6.0	.196	1.47
8.0	.349	2.61

The following formula was used to determine the conversion factors:

Gallons/feet of water = C x (π x d^2/4 x 1 feet)

Where: π=3.1416
d = Diameter of Well Casing (feet)
C = 7.48 (constant for converting $feet^3$ to gallons)

Then the volume to be purged will be:

V = (gallons/ft. of water) x L x n

Where: V = Volume to be purged (gallons)
L = Column of standing water in well (feet)
n = Number of well volumes to be removed (typically three to five)

Low Flow Purging

As an alternative to purging based on volume, low-flow water extraction may be utilized to purge the well. The pump will be carefully lowered in the well to avoid disturbing sediment that may have settled in the bottom of the well. The pump's intake will be situated within the screened interval – by convention, halfway between the top and bottom of the screen; however, site-specific conditions may warrant setting the intake above or below the halfway point. Pumping will then be initiated, with the flow adjusted such that little or no water level drawdown in measured within the well – U.S. EPA generally recommends keeping the flow rate below 200 ml/min. to avoid aeration of the water. Indicator field parameters will be measured and recorded until stabilization occurs. EPA recommends that the basis for stabilization is three consecutive readings, taken within three to five minute intervals, which fall within the following limits:

- turbidity (10% for values greater than 1 NTU);

- DO (10%);
- Specific conductance (3%);
- temperature (3%)
- pH (+/- 0.1 unit); and
- ORP/Eh (+/- 10 millivolts).

H. There is a wide variety of equipment and acceptable procedures for well purging.

Bailing

Depending on the hydraulic characteristics, depth, and recharge rate of an individual well, bailing may be applicable method for well purging. Bailers used during this operation will be constructed of PVC, stainless steel, *Teflon*, or other acceptable materials. The Project manager will specify the bailer materials based on known geochemical conditions at the site and regional regulatory variances. If dedicated bailers are installed in the wells, they will be used for both purging and sampling unless otherwise authorized by the Project Manager.

When using this purging technique, a new rope will be attached to the bailer when purging each well, unless the rope is dedicated with the dedicated bailer. The bailer will be slowly lowered into the water column to prevent excessive agitation of fines and to prevent aeration of the ground water. The well will be bailed from the top of the water column to the bottom. When the bailer is full, it will be retrieved and the contents carefully transferred into a holding container of known volume to determine the purge volume (e.g., five-gallon bucket). All water removed during purging will be assumed contaminated unless analytical data have been obtained that indicate otherwise. Purge water will be stored on-site and properly disposed of as directed by the Project Manager.

Groundwater Pumps

In some cases, factors such as depth to water, total depth of the well, and/or well diameter make the use of a bailer inefficient. In these instances, the use of pumps will be employed to maximize the efficiency of purging. Any pump used will be properly decontaminated prior to purging, in accordance with HAI SOP No. F1000. The use of any pump to purge a well will be carried out in accordance with the manufacturer's instructions.

1. Submersible Pumps

   Submersible pumps provide an effective means of well purging for deep wells. Submersible pumps are particularly useful in situations where the depth to water is greater than 20 feet, or where the depth or diameter of the well requires that a large volume of water be removed.

   These pumps will only be used with approval of the Project Manager for purging operations and will generally not be used for the collection of groundwater samples.

2. Foot-Valve Lift Pump (e.g., *Waterra*™)

In some instances, where wells are difficult to access, a foot-valve lift pump (e.g., *Waterra*™) will be used. A foot valve is attached to the end of semi-rigid tubing and lowered into the well. The tubing is then moved up and down at a constant rate to allow water to flow through the column of tubing. Once the correct amount of water is purged, the valve shall be removed and the tubing discarded. A new piece of tubing will be used in each subsequent well. The valve will be decontaminated according to HAI SOP No. F1000.

3. Alternate Mechanical Pumps

Peristaltic Pumps - Peristaltic pumps typically provide a low rate of flow in the range of 0.02 - 0.2 gpm. For this reason, these pumps will be suitable for purging situations where recharge rates are low and/or disturbance of the water column must be kept at a minimum. This method may be employed for particularly sensitive analyses or to avoid introduction of excessive fine material.

Positive Displacement Piston Pumps - This type of pump can be used to purge wells of varying depths at rates up to four gallons per minute (gpm). The intermediate flow rates allow for only a minimal introduction of fines into the well column.

4. Low Volume Dedicated Purge Pumps

Dedicated pumps are useful in situations where the excavation of very large volumes of water from wells/piezometers are in equilibrium and representative groundwater samples can be collected prior to purging of three well volumes. Their design allows smaller purge volumes than might be required with conventional pumps. Groundwater samples may also be collected from these types of pumps.

These pumps will only be used with approval of the Project Manager for purging and sampling operations.

I. In many cases, a disposable polyethylene bailer sized for two-inch inside-diameter wells will be used when sampling each well. Acceptable sample collection equipment includes a disposable bailer, dedicated bailer, or properly-decontaminated *Teflon*, stainless steel, or other acceptable bailer. A spool of nylon, polypropylene, or other acceptable rope will be used as the bailer cord. If a *Teflon* or stainless steel bailer will be reused, it will be properly decontaminated in accordance with HAI SOP No. F1000 prior to use in each well. The bailer cord will then be attached to the bailer and the bailer knot tested to ensure that the knot and all parts of the bailer are securely intact prior to lowering into the well.

As an alternative to sampling with a bailer, low-flow purging (as described in G, above) and sampling may be conducted. All reusable down-hole equipment (e.g., tubing, submersible pump, etc.) will be properly decontaminated in accordance with HAI SOP No. F1000 before being lowered into the well.

J. It should be noted that the bailer cord should never touch the ground surface or the protective well casing at any time during the sample collection process. If the bailer cord cannot be prevented from touching the ground, protective plastic sheeting may be placed around the well area to prevent rope from contacting the ground.

K. During sample collection, the bailer will be slowly lowered into the well to prevent agitation of the water to minimize the volatilization of any VOCs. The bailer will then be slowly and smoothly raised to the surface in a manner that will not agitate the sample.

L. The contents will be transferred into the appropriate containers and preserved in accordance with the specified analytical method. Samples will be collected in order of decreasing volatility (i.e., volatiles, semivolatiles, metals, etc.). Sample bottles will be properly labeled in accordance with the relevant plans for the project.

As an alternative to sampling with a bailer, the low-flow technique may be used to collect samples. Samples may be collected from a bypass assembly prior to water entering the flow-through cell or from the discharge of the flow-through cell. If the sample is collected from the flow-through cell, the flow-through cell will be included in the equipment blank sample collection process. To the extent possible, the tubing should remain water-filled while directing water into sample containers. Care will be taken so that minimal turbulence/aeration occurs during transfer of water from the tubing into sample containers.

M. All sample containers will be placed on ice as soon as possible after collection. Samples should remain at 4°C until analysis.

N. Finally, materials for sample collection will be either properly disposed of, or in the case of reusable equipment, will be properly decontaminated per with HAI SOP No. F1000.

4.0 Documentation

A number of documents may be completed and maintained as part of the groundwater sampling effort. The documents should provide a summary of the sample collection procedures and conditions, shipment method, analyses requested and the custody history. Below is a list of the items and documents that should be completed:

- Field notebook
- Groundwater Monitoring Well Field Data Sheets
- Sample labels
- Chain-of-Custody records
- Daily Field Reports

- Request for analysis sheets

All pertinent data including, but not limited to, the type of purging device, the volume purged, pH, conductivity, temperature, and any other relevant information will be recorded on in the field notebook or on the appropriate data sheet. Any deviation from the above-described procedures will be performed only with prior approval of the Project Manager.

5.0 Special Notes

See manufacturer's instructions for specific notes on various equipment and materials used in the collection of groundwater samples from monitoring wells/piezometers.

SOP No. F3023 (2004)
MONITORING WELL/PIEZOMETER DEVELOPMENT

(NOTE: print SOP No. F1000 with this SOP)

1.0 Purpose

This Standard Operating Procedure (SOP) describes the procedures that will be followed during the development of monitoring wells/piezometers. The purpose of monitoring well development is to remove fines from the vicinity of the well screen to allow free flow of formation water through the well screen. Development also reduces turbidity during sampling events. The most common well development methods are surging, jetting, overpumping, and bailing. Development should not be conducted immediately after well installation so that grouting and seal materials can adequately set. A period of 48 hours is typically adequate time for neat cement or bentonite grout mixtures to cure.

Although this procedure is typically implemented shortly after well installation, it may be necessary to redevelop a monitoring well if fines accumulate in the well. Redevelopment may be warranted if, over time, there is a drop in water yield during purging, an increase in turbidity, or sediment accumulation in the bottom of the well.

2.0 Equipment and Materials

Equipment

- portable photoionization detector (PID) or flame ionization detector (FID);
- multi-gas meter (i.e., O_2, CH_4, percent LEL, percent gas) or equivalent(s);
- interface probe or water level indicator;
- pH/conductivity/temperature meter;
- submersible pump (optional);
- turbidity meter (optional); and
- a calculator.

Materials

- Site-specific Health & Safety Plan (HASP);
- inertial lift pump foot valves and tubing (e.g., *Waterra*™);
- surge blocks;
- dedicated or reusable bailer constructed of Teflon, stainless steel, disposable weighted polyethylene, or other acceptable material;
- polypropylene rope or other suitable bailer cord;
- five gallon buckets;
- 55-gallon drums or other appropriate storage container for purge water;
- latex sample gloves;
- decontamination supplies as described in Hull SOP No. F1000 (decontamination).

3.0 Procedures

3.1 Field Preparation

A. All pertinent well construction details including drilling method, well depth, well diameter, borehole diameter, screened interval, and filter length will be obtained from the well construction log for each well to be developed and recorded on the appropriate field data sheet and/or field notebook.

B. Test, calibrate, and charge all instrumentation BEFORE LEAVING FOR THE FIELD.

C. The appropriate well development technique shall be at the discretion of the project manager. Necessary equipment and supplies will vary depending on which technique is employed. It is important to determine the appropriate storage and disposal options for decontamination and development fluids before commencing with field activities.

3.2 Well Development Field Procedure

A. A visual inspection of the wellhead condition will be documented in a field notebook before opening the well.

B. The HASP may require PID, LEL, and/or O_2 readings of the ambient air before opening the wellhead. The PID and LEL meters will be calibrated in the field according to manufacturer's specifications and recorded in the field notebook. The HASP will dictate how to proceed based on the air screening results.

C. After the environment in the vicinity of the wellhead is deemed satisfactory, the well will be opened and the air conditions in the well column determined as specified in the HASP. The protective casing of the well/piezometer will be unlocked and the cap will be removed. The HASP may require PID, LEL, and/or O_2 readings of the air quality in the riser before proceeding. The HASP will dictate how to proceed based on the air screening results.

D. The monitoring well will be allowed to stabilize for at least 10 minutes after removing the well cap.

E. The water level will be measured using a water level meter or, if warranted, an interface probe. The interface probe or water level indicator will be decontaminated in accordance with Hull SOP No. F1000 prior to collecting water level measurements.

The probe will be slowly and carefully lowered into the well column until the water level is encountered. The water level indicator will emit an audible signal when it makes contact with water. Measurements will be taken from the survey mark indicated on the top of the well casing. If a mark is not already indicated, the north position of the casing should be used as the measurement point. This point should then be marked for future reference. Record the depth to water in the field notebook. Proceed by slowly lowering the tape until the probe touches the bottom of the well. Record the depth to bottom in the field notebook. After the water level measurement procedure is complete, the probe and all measuring tape lowered into the well will be thoroughly decontaminated in accordance with HAP SOP No. F1000.

F. Purge and well volumes will be calculated in the field based on a conversion factor that represents the gallons of water in the well per foot of standing water. The following equation is used to calculate the volume of water in a well:

$$Well\ Volume(V) = \pi r^2 h(cf) \quad (1)$$

where:

π	=	pi (3.141592)
r	=	radius of monitoring well in feet (ft)
h	=	height of water column in feet
cf	=	conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3.

The well diameter must be converted to the radius in feet as follows:

$$\frac{diameter}{12} * 0.5 = r\ (ft) \quad (2)$$

The volume, in gallons per linear foot, for various standard monitoring well diameters may be calculated as follows:

$$V\ (gal/ft) = \pi r^2 (cf) \quad (3)$$

Table 1. Volume in gallons/feet for typical monitoring well diameters.

Well Diameter (inches)	**2.0**	**4.0**	**5.0**	**6.0**	**8.0**
Volume (gal/ft)	0.16	0.65	1.0	1.5	2.6

Using table 1, field personnel may calculate well volumes knowing only the gal/ft of water per well diameter and the height of the water column using the following equation, which is modified from equation 1:

$$Well\ Volume(V) = (h)(f) \quad (4)$$

where:

f = the volume in gal/ft as shown in Table 1.

G. The pH/conductivity/temperature meter will be calibrated in the field according to the manufacturer's specifications and recorded in the field notebook. An initial sample of water will be collected from the well to measure the pH, conductivity, and temperature. The pH, conductivity, and temperature readings will be recorded on the field data sheet or field notebook.

H. The well may be developed using one of the following methods at the project manager's discretion.

1. *Surging*. Surging involves raising and lowering a surge block or surge plunger at a constant rate along the screened interval to allow water to flow through the column of tubing. This method is very effective for two-inch and four-inch monitoring wells. The surging motion forces water into the formation and loosens sediment to be pulled from the formation into the well. A foot valve is attached to the end of semi-rigid tubing and lowered into the well. The pH, temperature, and conductivity readings will be recorded for each well volume. Development will continue until the temperature, conductivity, and pH of the purge water have stabilized within 10% of each other over three successive well volumes. The readings and notes on groundwater turbidity will be recorded in the field notebook or on the appropriate field data sheet. Low yielding wells from which at least ten well volumes cannot be removed will be completely evacuated. Once the well is evacuated, a suitable waiting period shall be determined and the well will be allowed to recharge. The well shall be evacuated as many times as is practical. Once the correct amount of water is purged, the valve shall be removed and the tubing discarded. A new piece of tubing will be used in each subsequent well. The valve will be decontaminated according to Hull SOP No. F1000. Note: A two-inch diameter well can be developed manually using the surge block method. An alternate power source (e.g., a drilling rig) should be used to surge wells with a diameter greater than two inches.

2. *Jetting and Vacuuming*. Jetting and vacuuming involves lowering a small diameter pipe into a well a few feet above the well screen and jetting air or water into the well so that the fines are geysered out the top of the well and evacuated with a vac truck. This process will continue until the groundwater is sediment free. It is important not to force water or air across the screened interval. Doing so may cause fines in the well to clog the screen openings and/or cause hydrofracturing near the well screen. Given the difficulty in obtaining temperature, conductivity, and pH readings while conducting jetting and vacuuming, only three readings will be collected: before, during, and after well development. Readings and notes on turbidity will be recorded in the field notebook or well development form. The latter two readings will be compared to each other. If the latter two readings are not within 10% of each other, well development will continue.

3. *Overpumping*. Overpumping involves pumping water from the well using a *Grundfos* or *Whale* pump, for example. Overpumping is often conducted in conjunction with surging using a surge block or surge plunger to agitate the fines. Water will be pumped at a rapid enough rate to draw the water down as low as possible, and allowing it to recharge. Temperature, conductivity, and pH readings will be measured and turbidity will be noted after each well volume as outlined above. This procedure will be repeated until the groundwater is sediment free. The pump will be decontaminated in accordance with SOP F1000 between wells and documented in the field notebook.

4. *Bailing*. Bailing involves using a PVC, stainless steel, Teflon, or other acceptable materials. The bailer will be raised and lowered in the water column to agitate the fines and to move water through the well filter pack. The well will be bailed from the bottom of the water column to remove settled fines. It is important to avoid letting the bailer free fall to the bottom of the well as such an action could cause the bottom of the well casing to break. When the bailer is full, it will be retrieved and the contents carefully transferred into a five-gallon bucket. Temperature, conductivity, and pH readings will be measured and turbidity will be noted after each well volume as outlined above. This procedure will be repeated until the groundwater is sediment free. When using this development technique, a new rope will be attached to the bailer for each well, and the bailer will be decontaminated between wells in accordance with SOP F1000. Decontamination procedures will be recorded in the field notebook.

I. The duration for well development varies based on the well development method used. Generally, development should proceed until temperature, pH, and specific conductance have stabilized +/- 10% over 3 successive well volumes, or until the water has a turbidity of less than 50 nephelometric turbidity units (NTUs).

In some instances the collection of non-turbid samples is difficult or unattainable. If a well does not provide sediment free samples, development may cease if:

1. A minimum of 10 well volumes has been removed, plus any water added during well construction and development;
2. Several procedures have been tried, or historical site data establishes a precedent for the most practical method or duration;
3. Proper well construction has been verified; or
4. Temperature, pH, and specific conductance have stabilized to +/- 10% over at least three successive well volumes. These parameters may not stabilize if water quality has been degraded.

J The Project Manager shall determine the appropriate method for storing and disposing of decontamination and development water. In most cases, decontamination and development water will be stored in properly labeled 55-gallon drums and staged in a safe location.

4.0. Documentation

The following data will be recorded in the field notebook for each well in addition to what is outlined above:

1. Well ID;
2. Date of well installation;
3. Date and time of well development;
4. Static water level and depth to bottom before and after development;
5. Quantity of water removed and time of removal;
6. Type and size/capacity of pump and/or bailer used; and

7. Description of well development technique(s) used.

8. Waste management documentation for decontamination and well development water (drum inventory or label documentation)

Any deviation from the above-described procedures will be performed only with prior approval of the Project Manager.

5.0 Special Notes

Extraction wells are typically better developed using equipment and methods provided by the drilling contractor. These wells typically have diameters greater than four inches and require heavy-duty equipment to achieve proper development. This equipment includes, but is not limited to, large diameter surge blocks, large diameter bailers, water jetting systems, and high capacity submersible pumps. Consult with the Project Manager regarding extraction well development.

6.0 References

Ohio EPA, 1995, Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring, Ohio Environmental Protection Agency, Division of Drinking and Groundwaters.

US EPA, 2001. Monitor Well Development, SOP#: 2044, DATE: 10/23/01, REV. #: 0.1, U.S. EPA Environmental Response Team, Standard Operating Procedures, http://www.ertresponse.com/index.htm.

ATTACHMENT B

Cost Estimate Pursuant to the City of South Bend's U.S. EPA Brownfield Pilot Grant Application

Budget Summary for a U.S. EPA Grant Addressing Cleanup of Hazardous Substances
South Bend Area A

Table 1

	Project Tasks								
Budget Categories	Task 1 - Community Involvement	Task 2 - Source Assessment for Cleanup Planning	Task 3 - Remediation Work Plan and Bid Document Preparation	Task 4 - Pre-Cleanup Activities	Task 5 - Groundwater Cleanup Program	Task 6 - Remediation Completion Reporting	Task 7 - O&M Monitoring and Post-Cleanup Reporting	Task 8 - Quarterly Reports and Fiscal Reports (required in support of the grant)	Total
Personnel	$400 [1.]		$400 [6.]	$800 [9.]	$600 [12.]	$800 [15.]	$4,900 [18.]		$7,900
Travel	$2,600 [2.]								$2,600
Equipment									$0
Supplies	$200 [3.]	***$2,000*** [4.]	$300 [7.]	$9,000 [10.]	$14,000 [13.]	$500 [16.]	$4,000 [19.]		$28,000
Contractual		***$47,484*** [5.]	$9,500 [8.]	$59,000 [11.]	$62,000 [14.]	$10,000 [17.]	$21,000 [20.]		$161,500
Other									$0
Total	$3,200		$10,200	$68,800	$76,600	$11,300	$29,900		**$200,000**
Local Share							$20,000 [21.]	$20,000	**$40,000**
								Total with Local Share	**$240,000**

Notes:

[1.]Includes staff preparation for and participation in community meetings.

[2.]Includes staff time, expenses and travel to and from the 2003 National Brownfields Conference in Portland, Oregon.

[3.]Includes supplies for public mailing and meeting to present the initial proposal document.

[4.]Not included in grant or local share totals

[5.] Not included in grant or local share totals.

[6.] Not included in grant or local share totals.

[7.]Includes supplies and expenses related to preparation of the cleanup plan and bid documents.

[8.]Includes time for preparation of contractor bid documents, a Remediation Work Plan, a project-specific Health & Safety Plan, a Quality Assurance Project Plan and a Community Relations Plan.

[9.]Includes time for review and selection of bids.

[10.]Includes reagent application well and groundwater monitoring well materials (i.e., riser pipes, screens, sand pack, grout, bentonite pellets, surface fittings and surface protectors), as well as a new gate to access the property.

[11.]Includes installation of five clusters of application wells, three monitoring well clusters (or up to five couplets), drilling observation and documentation, groundwater sampling/analysis to establish a baseline, bench-scale cleanup testing and characterization/disposal of investigation-derived materials.

[12.]Includes time for cleanup coordination.

[13.]Includes reagent for Fenton-like reaction, disposable hoses and environmental sampling equipment (i.e., bailers, pumps, hoses, etc.)

[14.]Includes two reagent applications, observation and documentation of cleanup activities, groundwater sampling/analysis during and immediately after cleanup activates, Health & Safety monitoring and investigation-derived waste characterization/disposal.

[15.]Includes time for document review.

[16.]Includes supplies and expenses related to preparation of the report documents.

[17.]Includes time for preparation of the Remediation Completion Report and describing post-treatment monitoring activities.

[18.]Includes time to establish institutional controls on-Site through deed restriction and off-Site via an ordinance plus reporting obligations.

[19.]Includes report supplies, disposable hoses and environmental sampling equipment (i.e., bailers, pumps, hoses, etc.)

[20.]Includes time for quarterly sampling of reagent application wells and selected groundwater wells over a period of two years and time for preparation of quarterly and annual summary reports of findings.

[21.]Includes cost contribution for groundwater sampling and chemical analysis and City review and contribution to post-cleanup reporting.