Brazil
2000-50016B
Vol. 1

Companhia de Tecnologia de Saneamento Ambiental

Underground Fuel Storage Systems in the State of São Paulo

September 2002

4

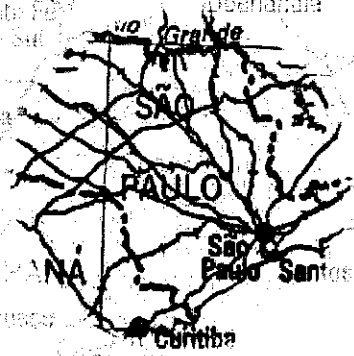
Submitted by:

CDM International Inc.

in association with

Cobrape Cia Brasileira de Projetos e Empreendimentos

Final Report



This report was funded by the U.S. Trade and Development Agency (TDA), an export promotion agency of the United States Government. The opinions, findings, conclusions, or recommendations expressed in this document are those of the author(s) and do not necessarily represent the official position or policies of TDA.

Mailing and Delivery Address: 1621 North Kent Street, Suite 300, Arlington, VA 22209-2131
Phone: 703-875-43579 **Fax:** 703-875-4009 **Web site:** www.tda-gov **email:** info@tda.gov

The U.S. Trade and Development Agency

The U.S. Trade and Development Agency assists in the creation of jobs for Americans by helping U.S. companies pursue overseas business opportunities. Through the funding of feasibility studies, orientation visits, training grants, conferences, and various forms of technical assistance, TDA enables American businesses to become involved in the planning stages of infrastructure and industrial projects in middle-income and developing countries. By doing this, the agency provides American firms with market entry, exposure, and information, helping them establish a position in markets that are otherwise difficult to penetrate.

Mailing and Delivery Address: 1621 North Kent Street, Suite 300, Arlington, VA 22209-2131
Phone: 703-875-4357 • **Fax:** 703-875-4009 • **Web site:** www.tda.gov • **email:** info@tda.gov

Contents

1.0 Background 1

2.0 UST Census and Database (Task 1) 2
- 2.1 UST Management System 2

3.0 Site Investigation Preparation 4
- 3.1 Site Selection Criteria (Task 2) 4
  - 3.1.1 Facility Factors 4
  - 3.1.2 Location Factors 5
- 3.2 Selection of UST Sites (Task 3) 6

4.0 Field Study (Task 4) 6
- 4.1 Soil Vapor Survey Methodology 7
  - 4.1.1 Probe Installation 7
  - 4.1.2 Vapor Analysis 7
  - 4.1.3 Subsurface Soil Investigation 8
- 4.2 Site Investigations 9
  - 4.2.1 Collection of Background Site Data 9
  - 4.2.2 Site Survey and Clearance Plan 10
  - 4.2.3 Sampling Point Selection 10
  - 4.2.4 Vapor Probe Installation 10
  - 4.2.5 Soil Vapor Analysis 11
  - 4.2.6 Soil Sample Analysis 11
- 4.3 Analytical Results 12

5.0 Recommendations for Site Assessments 12

6.0 UST Licensing Program Framework 14

7.0 Sample Population Data Analysis 15

8.0 UST Licensing Program Recommendations (Task 6) 16
- 8.1 Strategies for Control and Remediation 16
  - 8.1.1 Groundwater Remediation Alternatives 17
  - 8.1.2 Soil Remediation Alternatives 18
- 8.2 UST Upgrade and Conversion Technology 19
- 8.3 Regulatory Requirements for UST Systems 19

9.0 Strategy for Enhancing US Export Potential 20

Appendices

Appendix A ..... UST Management System Software Development
Appendix B ..... Field Study Data
Appendix C ..... Site Assessment Methodology
Appendix D ..... Excerpts from "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites," (US EPA, March 2001)
Appendix E ..... Summary of E1739-95 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites

List of Attached Tables

Table 1: ..... UST Sites Selected for Study
Table 2: ..... Site Assessment Options
Table 3: ..... Soil Boring Analytical Results
Table 4: ..... Initial Screening of Remedial Actions for Contaminated Groundwater
Table 5: ..... Initial Screening of Remedial Actions for Contaminated Soil

List of Attached Figures

Figure 1: ..... Surface Penetration
Figure 2: ..... Vapor Probe Installation
Figure 3: ..... Vapor Analysis Equipment
Figure 4: ..... Site Investigation Approach
Figures 5-13: ..... Site Investigation Plans
Figure 14 ..... Proposed Guidance for Vapor, Soil and Groundwater Sampling
Figure 15: ..... Possible Framework for UST Licensing Program

CETESB
Underground Storage Tank Systems Project
Final Report

1.0 Background

Technical assistance for the Underground Fuel Storage Tank Systems Project in the State of São Paulo was conducted for Companhia de Tecnologia de Saneamento Ambiental (CETESB) by Camp Dresser & McKee International Inc. (CDM) of Cambridge, Massachusetts, USA, under a grant from the United States Trade and Development Agency (USTDA) and matching funds from CETESB.

The national inventory of underground storage tank (UST) systems in Brazil is estimated to number in the range of 30,000 to 35,000, including service stations, wholesale distribution centers, motor pool refueling centers, refineries and industrial installations. Of the 28,600 service stations nationwide, no more than 10-15 percent have acceptable leak, corrosion and spill protection (estimated by Envirolatina Associates, USTDA Definitional Mission Report). The Brazilian Association of Technical Standards (ABNT) published UST design standards in 1997, but they cannot be enforced in the absence of environmental licensing. The current lack of enforceable regulations and standards regarding the storage of fuels contributes to a high incidence of leaking UST, the reduction of which would result in better control of associated environmental liabilities such as contamination of soil and groundwater.

CETESB requested technical assistance from USTDA to help initiate the process of regulation and upgrading of UST systems in the state of São Paulo. Approximately 25 percent of the total service stations in Brazil are in the State of São Paulo, where 2,000 are in the City of São Paulo alone. The Underground Fuel Storage Tank Systems Project in the State of São Paulo is designed to support the development of a definition of a regulatory framework to limit environmental liabilities from leaking UST.

The first phase of the UST project was a technical, operational, and environmental characterization of the relative risk associated with retail service stations in the State of São Paulo. Using an existing database of service station information developed by CETESB, a computerized ranking system was designed to prioritize sites for licensing investigation.

The second phase of the UST project consisted of a field study of service stations in São Paulo for development of a licensing program protocol and methodology for site investigations. Using data supplied by CETESB and by Shell do Brasil, Ltda., a representative sample of UST was selected for detailed site characterizations and testing for leakage and soil contamination. These phases were developed through meetings between CETESB, CDM and Cobrape, the dates, attendees and subjects of which are included in Appendix A.

2.0 UST Census and Database (Task 1)

As part of the UST project, CETESB developed a census questionnaire for retail service stations and fuel depots in the state of São Paulo. The questionnaire was designed using ABNT design standards and applicable Brazilian Federal Regulations NBR 13786 and CONAMA 273. CONAMA 273 provides the regulatory framework for licensing of UST systems and standard operating procedures.

NBR 13786 establishes general principals for selection of equipment for UST and distribution systems at service stations. The required equipment for a service station falls under one of three classes, based on the surrounding land use and potential environmental receptors of contamination. Under NBR 1376, a UST site in an area of sensitive land use and potential receptors receives a higher equipment classification. A summary of these classes is included in Appendix A.

The census was carried out through distribution of a detailed questionnaire to UST system owners and operators, and all resultant information was input into a computerized database. Although Task 1 had originally provided for assistance on the questionnaire and its distribution, CETESB's initiative in this work resulted in a successfully developed census and database before CDM's involvement officially began. A translated copy of the census questionnaire is attached in Appendix A.

2.1 UST Management System

Completion of the census and UST information database at the earliest stage of the project made it possible for development of specialized computer software for calculating relative risk associated with retail service stations in the State of São Paulo. During the period of July 2-6, 2001, CDM and CETESB representatives engaged in a series of meetings to explore the UST project objectives that a risk-ranking tool should fulfill. It was decided to build and implement the ranking system in accordance with the following requirements:

- Risk rankings are database-driven;
- The database is an amended version of the developed UST database maintained in SQL-7; and
- The logic and mathematics of the ranking methodology relies solely on data provided to CETESB by the UST owners in the form of responses to the census.

In a September 4, 2001 memorandum to CETESB, CDM summarized the preliminary discussion of UST Management System (UMS) software development (attached in Appendix A). The complete UMS software package envisioned by CETESB is to contain facility data, ranking data, compliance data and digital map data, all of which work seamlessly to support data management and reporting requirements of the UST

program; CDM services for UMS software development involved working with facility and ranking data only.

Subtask 1: Existing Systems Review
The first subtask in UMS software development was an existing systems review to gain a complete understanding of the technology environment within which the UMS was intended to operate. This included detailed discussions and correspondence between CETESB information technology staff, analysis of the SQK-7 data model, and evaluation of the facility data.

Subtask 2: Ranking System Analysis
At meetings on September 4, 2001, the relative risk ranking methodology as well as a "data dictionary" was developed with CETESB. These items are included in Appendix A. In summary, the risk ranking methodology is based on a derivation of a site's risk to health and safety (RTHS):

$$RTHS=PIF+LLF+RRF$$

Where

$$PIF=\text{Sum of Potential Impact Factors}$$
$$LLF=\text{Sum of Leak Likelihood Factors}$$
$$RRF=\text{Sum of Risk Reduction Factors}$$

The PIF includes risk associated with water supply receptors, physical receptor types, and land use. The LLF is derived from the risk associated with the type of equipment and other factors affecting a system's likelihood to leaks, such as its age, filter type, cathodic protection, and line type. RRF are used to incorporate the assumed reduced risk at a facility due to the use of leak detection or prevention equipment, e.g., overflow protection, an overflow alarm, and a pump containment chamber. All of these factors were described in detail during a presentation made in March 2002, when CDM delivered the relative risk ranking software to CETESB. The presentation is included in Appendix A.

Subtask 3: UMS Software Environment
Because the risk-ranking tool is only a part of the UMS software envisioned by CETESB, CDM developed the tool in an environment that will accommodate additional data management and reporting requirements. The result of this effort was a framework under which to carry out Subtask 4, Input/Output Design and system configuration.

Subtask 4: Input/Output Design
In this subtask, CDM revised the existing SQL-7 facility information database to include tables and fields to store ranking data. Business logic was implemented to relate data fields, as well as logical operations that comprise the ranking methodology. The output for the relative risk ranking procedure is a single Crystal Report; this report is a tabular summary of the ranking of UST facilities for which facility data exist. The system configuration and input/output design details were

presented to CETESB during a presentation made in March 2002. The presentation is included in Appendix A.

Task 1 was concluded with Subtasks 5 and 6, in which the input/output design was peer-reviewed and tested for quality assurance by an applications developer that was not a part of the project team, and the product was formally delivered to CETESB.

With the facility data storage and ranking tool portion of the UMS software developed and in hand, CETESB is currently able to prioritize UST sites for assessment and licensing. Further, CETESB is working on compliance data and digital mapping tools for the program. In discussions during the preliminary stages of Task 1, CETESB expressed a need for intranet access to the UMS software. After a full review of the developmental cost of intranet access tools, it was determined that the level of effort required was in excess of the UST project budget. However, in the future this work may be available to a U.S. consultant.

3.0 Site Investigation Preparation

Before field characterizations of a representative sample of UST sites in São Paulo could begin, it was necessary to develop site selection criteria and choose sites for investigation.

3.1 Site Selection Criteria (Task 2)

The criteria used to choose UST sites for detailed evaluation were developed in consideration of the following:

- Brazilian and United States Technical Standards;
- Experience acquired through the USEPA led UST conversion program;
- Human and environmental risk factors, including land use patterns around UST system sites;
- Physical characteristics of UST systems and sites; and
- Stored product inventories.

Specific criteria were placed in two categories, the first encompasses UST facility characteristics and the second includes UST site location factors.

3.1.1 Facility Factors

Facility age

Sites were selected to represent the age range of service stations throughout São Paulo State. Fuel releases are more likely to be encountered at stations with older equipment or where older equipment was previously installed.

Facility Tanks and Equipment
Service stations in Brazil may sell three grades of gasoline (comum, aditivada, premium), alcohol and diesel; many tanks may be present and contaminants varied or commingled. Conjunctive releases of alcohol and gasoline/diesel can result in greater solubility, and mobility of petroleum contaminants. The longevity of certain petroleum fractions such as the volatile aromatics benzene, toluene, ethyl-benzene and xylene (BTEX) may be increased due to the process of relatively rapid biodegradation of ethanol utilizing most available electron acceptors. Service stations with a variety of potential spill scenarios (mixed releases) were considered. Sites of different storage capacity and sales volume were considered.

Previous Assessments and Known Releases
Some service stations were previously assessed for contaminant releases via soil borings and monitoring wells, or direct-push sampling methods. At least one São Paulo station was under active remediation by a combined air sparging/soil vapor extraction system. Stations that have and have not been assessed were also included.

3.1.2 Location Factors

Receptor Pathways
Service stations in the vicinity of pathways to human and environmental receptors are also included in the representative sample. For instance, some service stations adjacent to the Metro (underground railway) were known to have leaked gasoline into the Metro tunnel. Multiple-level underground parking, common throughout metropolitan São Paulo, may act as collection points for petroleum releases—particularly those with sump units. Local groundwater flow and plume migration can be more influenced by a local effect than by overall hydrogeologic conditions of a wider area.

Land Use
Criteria for site selection included a variety of land uses including residential, commercial, industrial, undeveloped, aquifer/surface water protection zone or wildlife protection zone. Also considered was the presence of buried high-voltage power lines that may increase the corrosion potential of tanks and piping.

Ownership and Access
Stations considered were within the metropolitan São Paulo district and thereby readily accessible to the field investigation team and visiting CETESB personnel. Owners and operators of stations included were willing to cooperate with the pilot site study. Management structure, including ownership type and lease arrangements were also factors considered in site selection.

Hydrogeologic Setting
In metropolitan São Paulo, groundwater is relatively shallow (2-3 meters) in the Quaternary sediment of the Rio Tiete and Rio Tamanduatei valleys, and 12 meters deep or more in the upland areas. Stations from a range of hydrogeologic settings were included to represent a variety of soil conditions and geochemical conditions, including the alluvial soils close to the rivers and upland soils.

3.2 Selection of UST Sites (Task 3)

Using the criteria developed in Task 2, 38 underground fuel storage sites in the State of São Paulo were selected for immediate use in making a preliminary assessment of the range of existing UST conditions.[1] In discussions during the July 2001 meetings, CETESB and CDM agreed that because of time and budget constraints, it was not feasible to conduct site visits to all 38 sites. For expedience of the impending UST licensing program, CDM and CETESB selected ten sites for full-scale field investigations, and elected to conduct paper studies of the remaining 28 using the existing data previously collected by CETESB. The ten sites for field investigation were chosen mainly because the station owners were willing to give access permission for field investigations. Just before fieldwork began, the owner of one site selected for full-scale investigation rescinded access permission to the site, leaving only 9 sites available for field study.

Table 1 presents the final list of 37 underground storage tank sites that were selected for study. Many of the sites listed in Table 1 have known contamination. The nine stations selected for site investigation are shaded in yellow. In many cases, information for sites is limited because of a lack of historical records for the stations.

4.0 Field Study (Task 4)

The field characterization pilot study was intended to assist in achieving two goals:

- Developing a cost effective site assessment procedure applicable to a UST licensing program; and
- Collecting field data from a representative sample of UST installations for extrapolation to the total population of UST systems in São Paulo.

CDM developed alternatives for investigation of the selected field study sites. Table 2 presents an overview of the level of effort, cost, and the advantages and disadvantages of seven different options for the assessment of soil contamination at UST sites. Based consultation with CETESB, pilot site assessments included Option 4 and Option 5, to test the performances of both a photo ionization detector (PID) and a portable gas chromatograph (GC) in conducting site-wide soil vapor surveys in a grid pattern.

Soil vapor sampling provides instantaneous screening of volatile organic compounds (VOC), with minimal disturbance to the subsurface. It allows semi-quantitative measurement of VOC in the unsaturated pore spaces of soils, where movement of contaminant vapors is primarily by diffusion. Soil samples for laboratory analysis are targeted from soil vapor survey results, i.e., soil samples are taken from areas with the highest levels of contamination detected in soil vapor.

[1] Although the Terms of Reference called for 40 sites, preliminary assessment data was immediately available for only 38 sites. In the interest of timely development of the UST licensing program, CETESB elected to proceed without pursing data from two more sites.

4.1 Soil Vapor Survey Methodology

4.1.1 Probe Installation

Soil vapors were extracted through probes driven or drilled through paved surfaces into underlying soil. A steel rod with a tapered point and an expendable plug were driven into the soil to a depth of approximately 1 meter. The probe was pulled back approximately 0.1 meter and the expendable plug driven out. The annular hole surrounding the probe was sealed to prevent ambient air from entering the sample collection system. A vacuum pump was connected to the rod to induce soil vapor flow from the subsurface, and soil vapors were typically extracted for approximately 2-5 minutes prior to collecting any measurements. Figures 1 and 2 are photographs of surface penetration and vapor probe installation, respectively.

4.1.2 Vapor Analysis

Photoionization Detector (PID)

Several models of PID instruments may be equally applicable for this type of survey. In these investigations, the soil vapor was monitored with an Organic Vapor Monitor (OVM) PID with a 10.2 eV lamp to provide a qualitative measurement of total VOC concentration. Figure 3 presents a photograph of an OVM-PID. VOC concentrations were plotted on a site map, and each sample location was reviewed for proximity to known tanks, piping, pump islands and tank fill points to assess likely contaminant origin. High VOC concentrations in the vicinity of pump islands or tank fill points can often be a result of surface spills infiltrating through joints, cracks or holes in pavement.

Portable Gas Chromatograph (GC)

A portable GC was used at some sites to test the efficacy of the instrument for increased definition of the nature and type of VOC contamination. Figure 3 presents a photograph of a portable GC. A GC automatically compares compounds in samples to a calibration library prepared daily from standard gases. The compounds are tentatively identified and quantified from their relative retention times, chromatogram signature, and response area. To ensure the quality of the data, a standard gas sample must be injected at least twice per day to ensure that calibration of the instrument remains within a specific tolerance (typically +/- 10%). To prevent cross-contamination of the samples and establish ambient air quality at the station, an ambient air blank is analyzed prior to each soil vapor sample.

Initially, total VOC concentration was monitored with a PID. A Photovac 10S Plus portable GC (photograph unavailable) was used to measure concentrations of specific aromatic constituents of gasoline, including BTEX. Soil vapors were extracted through probes driven through concrete/pavement and into the underlying soil, similar to those described above. A "T" fitting was installed on the exposed end of the soil probe, with a connector to a vacuum pump and a septum for sampling with a gas-tight syringe. A vacuum pump induced soil vapor flow from the subsurface and soil vapors were typically extracted for approximately 2-5 minutes prior to collecting any measurements.

In addition to the OVM PID and portable GC, two other instruments were available for soil gas constituent analysis:

- Gastech Explosimeter for detection of the lower explosive limit (LEL)
- MSA Explosimeter (LEL/H_2S/O_2)

The OVM PID was used at all sites, and the Photovac GC was used at three stations; the Gastech and MSA were used intermittently at the sites depending on availability, equipment malfunction and site conditions (photographs of each are included in Figure 3).

4.1.3 Subsurface Soil Investigation

One soil boring per site was advanced to the water table or 6-meters depth to obtain soil samples for headspace vapor analysis and laboratory testing. Borings were advanced with a GeoProbe® direct push sampler supplied by American Drilling do Brasil Ltda.

At each site, borings were located in the area of highest VOC concentration in soil vapor. Samples were evaluated for the presence of separate phase fuel products, and screened for total VOC content by the headspace method (see Appendix C) using the PID. The soil sample with the highest VOC concentration determined by the headspace method was used for laboratory analysis.

Soil samples were analyzed for the following parameters:

- Benzene, toluene, ethylbenzene and xylenes (BTEX) by EPA Method 8260;
- Total Petroleum Hydrocarbons (TPH) by EPA Method 8015;
- Polycyclic Aromatic Hydrocarbons (PAHs) by EPA Method 8270; and
- Ethanol.

After screening of local laboratory capabilities and consultation with CETESB, Ciemic Analises Ambientais S/C Ltda. was chosen for use during the field study.

4.2 Site Investigations

An investigation team that included CDM, Cobrape, EC Americas, American Drilling and CETESB personnel completed the required field investigation pilot study at each site. Station owners Shell, ASTER and BR Site provided site access and support during fieldwork. The nine study sites were:

Site 1 – Shell AP Monterrey

Site 2 – Shell AP Mundo Novo

Site 3 – ASTER AP San Martin Ltda.

Site 4 – Shell AP Fernao Dias

Site 5 – Shell AP 3º Milenio

Site 6 – Shell AP Super Ltda.

Site 7 – BR A.D. Servicios Automotivos, Ltda.

Site 8 – Shell AP No. 45

Site 9 – Shell AP Praia do Hawaii, Ltda.

The site investigations required up to three days for completion per site. Stations remained in service during sampling although some pump islands were closed during vapor probe installation and sampling. Figure 4 is a flow chart of the pilot study approach at the ten UST sites.

4.2.1 Collection of Background Site Data

The first task of the field study was an initial site visit to collect background site data to supplement that available from CETESB. Information requested included the construction and fueling history, major improvements, demolitions and renovations, fueling schedules, monthly fueling reports, the current status of tanks and lines, and a fueling system overview. Site investigation activities included the following at each site:

- Preparation of a local map to delineate surrounding land use information, subsurface utility/transportation corridors or basements, groundwater or surface water sources, industrial activities and sensitive receptors (per NBR-13786/1997) within a 100-meter radius of the site;
- Preparation of a Site Plan at a scale of 1:100 or 1:200;
- Collection of detailed facility infrastructure information related to UST, piping and related equipment as detailed in the census questionnaire;

- Review of the typical operating procedures, maintenance activities, conditions and historical operations at the site;
- Identification of on-site opportunities for contaminant transport including sanitary sewers, floor drains, underground utilities, oil water separators or similar devices;
- Completion of an initial site survey using such equipment as an explosion meter (LEL) and PID.

4.2.2 Site Survey and Clearance Plan

Site plans were created on AutoCAD to clear each station for safe work. Included on the site plans is information about drainage, fueling system schematics, and underground utilities. These site plans were reviewed with site personnel and supplemented as necessary. In some cases, information about underground utilities is unavailable. Sampling points for vapor extraction were chosen based on the site plan and physical inspection of each station. The site plans are attached as Figures 5 through 13.

4.2.3 Sampling Point Selection

The preferred method of setting sample points is on a grid within cleared areas. Grid spacing near or flanking underground fueling system components should be no greater than 5 meters in permeable soils and 3 meters in tight clay. In fine-grained soils, even closer spacing may be necessary. Points should be located no closer than one meter to any underground feature to account for uncertainty in the site clearance process. Grid spacing in areas not suspect for sources or migration pathways may be 10 meters. Additional sample points should be located near any place where two or more elements of the fuel system join, such as tank fill ports, distribution line corners, pump to fuel line (base of pump) and adjacent tank walls. During the field investigations it was found that most of the sites did not have adequate clearance for 5-meter grid spacing.

For this investigation, adequate characterization of a site was defined as the ability to detect a release, but not necessarily indicate the point source. Sites in this investigation were adequately characterized by 20 to 25 sample locations. Relatively small sites may require only 10-15 sample points. Large sites, such as fleet fueling stations and truck stops, may require 30 to 40 points, or more. Sampling points for each site are indicated on the site plans (Figures 5-13).

4.2.4 Vapor Probe Installation

For sample probe installation, concrete and other paved surfaces were penetrated by a coring drill, sledgehammer, jackhammer and impact hammer and drill. The cement coring service was the most cost-effective, safe and least obtrusive method available. Impact hammer methods were most likely to damage utilities immediately below a paved surface before the operator was aware of a problem. The equipment for vapor probe installation is available locally, and readily useable under most site conditions.

In general, the best results are obtained with permanent monitoring points, since the average of repeated measurements over time provides the most reliable detection of releases. Depending on the materials available, large and small diameter probes, 2 to 3-inch and 2.5 centimeters or less, respectively, were permanently installed at the sites during field investigations. All probes were installed to a depth of 1 meter below grade. Large diameter probes were pushed down by means of a pneumatic impact hammer; small diameter probes were installed by hand with a sledgehammer through a carrier tube.

Past studies have shown that smaller diameter probes provide more reliable results than larger probes (see Appendix C). This is because there is less soil displacement and compaction immediately around the probe, which maintains soil permeability in the immediate annular zone, and they are easier to target for depth. Open tube probes, such as those used in the site investigations, are partially retrieved (approximately 0.25 meter) before drawing soil gas. The open hole provides a larger surface area for soil gas transfer than perforated tubes. The open tube probes can also be adapted to carry perforated Teflon or nylon tubing that may be left in place for permanent soil vapor monitoring.

4.2.5 Soil Vapor Analysis

Because significant variations in readings can result from instrument operation, wind, humidity, sewer gases, barometric pressure and ambient VOC, the average of repeated measurements over time provides more reliable results than just one sample. Most of these variations will result in lower measurement than the true value. For this investigation, the average of repeated measurements (three minimum) at each sample point over a one to two hour time period is reported.

Soil gas analysis results with each instrument at all sites are included in Appendix B. At each site the soil gas measurements were plotted on a site map and contoured; the contour plans are also included in Appendix B. One point for soil sampling was selected in the area of strongest concentration as indicated by the contours.

4.2.6 Soil Sample Analysis

A push-tube sampler was used to collect a continuous core of soil into contaminant-free, disposable plastic tubes to a maximum depth of 6 meters or contact with groundwater. Sub-samples of 0.5 meter were created from the retrieval tube and the sub-samples headspace gas analyzed for VOC using the PID. The sub-sample that exhibited the highest level of contaminants in its headspace gas was placed on ice for later delivery to CEIMIC, the environmental laboratory. Laboratory analytical results and boring log information are included in Appendix B. Table 3 summarizes the soil analysis results.

4.3 Analytical Results

The analytical results from soil samples were notable because of their generally low levels of contaminants. Laboratory results for these samples were often not in agreement with soil vapor results, although there is no indication of laboratory quality failure. Soil vapor readings with high levels of fuel-derived contaminants that are associated with low to undetectable levels of contaminated soil may be indicative of contaminated groundwater.

5.0 Recommendations for Site Assessments

One of the goals of this field study was to develop and pilot techniques for site assessment that can be used by CETESB for licensing of UST systems. The following recommendations are made based on direct experience with equipment and methods during the pilot studies. The entire methodology for performing site assessments (soil vapor survey and vertical profiling of soil samples) at fueling facilities in São Paulo is included in Appendix C. Although groundwater sampling was not part of this pilot study, methods for groundwater sampling and analysis are generally straightforward and well defined. A method for groundwater sampling that may be adopted by CETESB for the UST project is also included in Appendix C.

Location and Number of Sample Points

Due to the density of underground utilities and site layout of most fueling facilities in São Paulo, it is not possible to install soil vapor sampling points on a standard 5 meter grid. Sample locations should be selected from clear areas identified by site clearance methods. Where possible in open areas, place sample locations on a grid. Grid spacing near or flanking underground fueling system components should be no greater than 5 meters. In fine-grained soils closer spacing is desirable wherever possible. In areas not considered potential contaminant sources or migration pathways, grid spacing may be 10 meters.

Additional sample points should be located near any point where two or more elements of the fuel system join together. Sample points should be no closer than one meter to any underground feature identified during site clearance for safe installation.

Adequate characterization of a site is defined as the ability to detect that a release exists, but does not necessarily pinpoint the source. The average site encountered in the field study was adequately characterized by 20 to 25 sample locations. Very small sites may be adequately characterized with no less than 10 sample points. Larger sites, such as truck stops, will require 30 locations or more.

Monitoring Well Installation

Concrete coring using a local coring service is the most cost-effective, safe and least obtrusive method of surface penetration. Jackhammer and impact hammer methods are most likely to damage utilities immediately below a paved surface before the operator realizes there is a problem.

Small-diameter open tube soil vapor probes provide better results than large diameter probes. This is in part because there is less soil displacement and compaction immediately around the probe, and it is more likely to be successfully placed at the target depth. An open tube probe is partially retrieved before exhausting soil vapor, providing a larger surface area for vapor transfer than a perforated tube. Further, open tube probes can be adapted to carry perforated Teflon or nylon tubing to be left in place as a permanent soil vapor monitoring well. Permanent monitoring wells are recommended because they provide consistent results for multiple measurement episodes.

Sampling Equipment

Operating and functional comparisons of the four instruments available for soil vapor sample analysis were part of the field study. The OVM PID was the only instrument to perform consistently for all sites. It did not perform well in the presence of high humidity or high concentrations of methane. The Gastech performed well in the presence of methane, but had an analog meter inadequate for use across the observed range of field soil vapor concentrations. The portable GC, used at three sites, consistently identified and quantified BTEX components but was difficult to calibrate in the service station environment. The MSA LEL was simple to use and stood up well to harsh field conditions.

Soil gases are often a mix of components from fuel and non-fuel sources. For example, methane and hydrogen sulfide from sewer gas were commonly encountered during the study. It is possible to attribute a sewer gas anomaly to a fuel system if vapor components are not identified. Although none of the instruments used can identify all gases encountered, a reduction in oxygen percentage is often indicative of a fuel-related detection. Sampling equipment should be capable of identifying the following soil vapor parameters:

- Percent oxygen
- Percent LEL
- Hydrogen sulfide
- VOC

For sample analysis and identification of anomalies, use of both an MSA LEL and OVM PID is recommended for site assessments. Both are available locally. Each sample point should be sampled three times with each instrument, using the average values as the reported results.

Consistent sampling protocol and minimal operator error are the most important components for accuracy. One operator using one set of sampling and analysis equipment should obtain all the readings for a single site. Permanent monitoring points should be used to obtain three sample readings over one to two hours, using

the same equipment and protocol each time. The reported result is an average of the three readings.

Figure 14 is a proposed guidance matrix to assist in selecting the number and type of environmental samples from an UST site based on the general conditions at the site, include the condition/age of the fueling system, the number of USTs and the areal extent of the site. The guidance for sample numbers is intended to be a general guide that may be modified as necessary.

6.0 UST Licensing Program Framework

Figure 15 presents a possible framework for the UST licensing program. The level of contamination at which cleanup is required depends on the contaminant of concern (COC) and factors such as receptors (human, ecological, etc.), exposure pathways (inhalation, consumption, contact), and exposure levels (contact time and intensity). In the United States, the Environmental Protection Agency (US EPA) and American Society for Testing and Materials (ASTM) both issue risk-based guidelines for cleanup of petroleum-contaminated sites.

In March 2001 the US EPA published a draft guidance document "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites." This document contains generic, risk-based soil screening levels (SSL) of compounds commonly found at superfund sites. Relevant excerpts of Section 2 of the document are included in Appendix D. The use of these SSL are for preliminary screening purposes only, to identify the contaminants and areas of concern, and gather necessary information for the later phases of the remediation process. Individual states are responsible for implementing protective institutional controls and legal requirements for contaminated sites. International standards for corrective action of petroleum-contaminated sites are currently not well defined. In many cases, the US EPA and ASTM guidelines have been adopted internationally.

Site assessment data collected using the methodologies included in Appendix C provide adequate information by which to determine whether clean up is necessary under guidelines such as the ASTM Standard Guide for Risk-Based Corrective Action (RBCA) Applied at Petroleum Release Sites (1995). The ASTM guidelines are available for a fee from ASTM at http://www.ASTM.org. However, CDM recommends that social, political and economic factors unique to the State of São Paulo and relevant to remediation of UST sites undergo a thorough examined before any RBCA levels are adopted for the UST licensing program.

The definition of a contaminated site may be based on one or more of the following:

- Previously identified contamination based on known or evidenced releases;
- A potentially explosive atmosphere in areas removed from the immediate vicinity of tank ports, fuel fill lines and fuel dispensing nozzles;

- Comparison of field study data to established criteria;
- Results of laboratory analysis of soil and/or groundwater samples and comparison to established criteria; and
- Detection of subsurface free-phase petroleum.

The environmental setting of the site, i.e., the potential impact of petroleum releases to surrounding buildings/populations/resources, is an important aspect of site assessment and site prioritization. However, determination of site contamination is independent of the environmental setting. Potential environmental impacts are considered under a comprehensive site assessment, which is required in cases where the initial field study indicates the presence of contamination.

7.0 Sample Population Data Analysis

Analysis of the site investigation results indicates that while VOC concentrations detected with the PID exceeded 200 ppm[2] at 6 of the 9 sites, soil concentrations of BTEX components were consistently low. Most BTEX concentrations in soil samples were below the laboratory detection limit (89 percent), and none of the BTEX components were above the US EPA generic soil screening levels for a commercial/industrial sector outdoor worker through the inhalation pathway (see Appendix D, Exhibit A-2). However, no groundwater samples were analyzed in this effort; the possibility exists that groundwater contamination may be the cause of VOC detection in soil vapor.

Out of 9 field study sites, three had experienced confirmed releases of petroleum products, three had reported possible but unconfirmed releases and three had no known releases. The level of VOC concentrations detected in soil vapor surveys did not appear to be related to detection of BTEX components or other contaminants in laboratory analysis of soil samples. Station No. 8, which had the highest detected concentration of a BTEX component of all sites, had only one soil vapor VOC concentration greater than 200 ppm. Station No. 7, which had no soil vapor VOC concentrations greater than 200 ppm, had an extremely high ethanol concentration detected in the soil sample.

A critical step in the development of the UST licensing program is setting the soil vapor threshold for VOC concentration that triggers further site investigation, i.e., collecting soil and groundwater samples. This threshold may be based upon:

- An absolute level, e.g., if a soil vapor VOC concentration criteria of 200 ppm for the highest detection is used, three of the stations studied might be considered "clean".
- A percentage of total VOC concentrations recorded, e.g., if a soil vapor threshold of 200 ppm for 90 percent of the PID measurements is the threshold, then six of the stations studied might be considered clean.

[2] The value of 200 ppm is arbitrary, and used for discussion purposes only.

CDM recommends that CETESB consider the economic and political factors relevant to the service and fleet station facilities in São Paulo when setting the VOC concentration threshold for licensing of UST systems. In the first scenario, over 60 percent of the stations surveyed would be required to perform additional site assessment. In the second scenario, only approximately 30 percent of the stations would need further investigation.

Of the remaining 27 stations for which preliminary site data was available, 85 percent had confirmed releases of petroleum products. This particular statistic is not applicable to the UST population of São Paulo because at the time that the site assessment protocol was being developed, most of the stations in CETESB's existing database were there because of reported releases. However, of the stations with known releases, age and tank size do not appear to be relevant to predicting the occurrence of a release. Specifically:

- For stations where equipment was of known age, half were less than 10 years old and half were over 10 years old.
- For stations where tanks were of known size, approximately half were less than 20,000L and half were over 20,000L.

The number of tanks at a station, however, may be relevant to the likelihood of a release; of 23 stations with confirmed releases, 15 had more than five tanks in use. At the time that the UST population for field and paper study was chosen, there was no information available regarding tank construction or leak protection equipment for comparison to release rates in the sample population. However, overall, the sample population shows that the likelihood of a release cannot accurately be extrapolated to the entire São Paulo population of UST through separate analyses of single factors.

8.0 UST Licensing Program Recommendations (Task 6)

For practical implementation of the UST licensing program, CDM recommends prioritizing UST sites for site investigation using the UMS software developed in Task 1 (see Section 2.0). The soil vapor survey, soil and groundwater sampling methods and analysis presented in Appendix C are recommended for UST licensing program site investigations. Concentration thresholds for VOC in the soil vapor survey that trigger soil and groundwater sampling and analysis should be determined by CETESB after consideration of all social, political and economic factors that are relevant to the process of UST system licensing. These factors must also be considered when defining a "contaminated" site and setting action levels for contaminant concentrations in soil and groundwater.

8.1 Strategies for Control and Remediation of Contaminated Soil and Groundwater

Remedial options are developed from consideration of various general response actions (GRA) to meet the Remedial Action Objectives (RAO) or to provide a baseline

for comparison with other actions. The GRA proposed for the UST sites in São Paulo include both passive and active measures. Passive measures involve no direct containment or treatment, such as continued monitoring of contaminant plume migration and associated evaluation of natural attenuation mechanisms. Active measures include the installation of systems that will contain and/or treat contaminated groundwater and soil. GRA defined below could be performed to monitor contaminant distribution and assess both potential and actual risks.

Institutional Controls are non-engineered methods by regulatory agencies or private parties that restrict access to contaminated or affected areas. These may include simple physical actions such as posting warning signs, or more complex regulatory actions such as implementing well restrictions or zoning controls.

Containment provides a means by which contaminant migration is minimized or eliminated. Containment response actions can be implemented both above and below ground.

Removal response actions are operations that partially or completely remove contaminants from the original site location to another, either onsite or offsite, for treatment or disposal.

Treatment response actions serve to reduce the toxicity, mobility, and/or volume of contaminants through physical or chemical alteration. There are four classes of treatment technologies that fall under the treatment GRA: physical, chemical, biological, and thermal.

8.1.1 Groundwater Remediation Alternatives

The GRA considered for the groundwater contamination generally encountered at UST sites in São Paulo are shown in the following Table:

General Response Action For Groundwater	Description
No Further Action	Provides baseline for evaluation with all other alternatives.
Monitoring Only	Establishment of institutional controls for groundwater use.
Natural Attenuation	Physical, chemical and biological degradation as a remedial technology for mitigation of groundwater contamination.
Containment	Control contaminant migration by installation of physical barriers (e.g., slurry wall, interceptor trench) or hydraulic controls. Containment may include free-product recovery to prevent product migration off-site.

Groundwater Collection/Extraction	Extract contaminated groundwater from the aquifer.
Ex Situ Treatment of Contaminated Groundwater	Treat contaminated groundwater on-site in ex-situ bioreactor, carbon adsorption or oxidation.
In Situ Treatment of Contaminated Groundwater	Treat contaminated groundwater in place using biological, air stripping, and in-situ oxidation systems. Biological oxidation is frequently used for petroleum contamination.

The GRA listed above provide a basis upon which to assemble and then screen remedial technologies, depending on the characteristics of a given UST site and its contaminants. Process options for each technology type should evaluated based on their ability to meet Remedial Action Objectives and their effectiveness, implementability, and relative cost. Effectiveness is judged primarily in terms of protecting human health and the environment. Implementability has two components, technical feasibility of construction and operation, and the administrative ability to gain institutional approval from CETESB and other agencies. Process options considered applicable to UST sites in São Paulo are described in Table 4.

8.1.2 Soil Remediation Alternatives Analysis

The general response actions considered for soil contamination generally encountered at São Paulo UST sites are shown in the following Table:

General Response Action For Soil	Description
No Further Action	Provides baseline for evaluation with all other alternatives.
Monitoring Only	Establishment of institutional controls for land use, including deed restrictions and zoning.
Natural Attenuation	Physical, chemical and biological degradation for non-leaching soil contamination.
Containment	Installation of physical barriers such as capping and slurry walls.
Extraction & Removal	Move contaminated soil to secure landfill or off-site treatment facility.
In Situ Soil Treatment	Biological, physical or chemical treatment systems. Biological oxidation through bioventing or air stripping is frequently used for petroleum contamination.

Ex Situ Soil Treatment	On-site ex-situ land treatment unit (LTU), bioreactor, Biopile, or soil washing with solvents or surfactants.

Remedial Action Process Option Screening
The process options considered for remediation of contaminated soil at UST sites are described in Table 5.

8.2 UST Upgrade and Conversion Technology

Existing tanks may be upgraded through being fitted with an interior lining and/or cathodic protection. In areas of more than limited corrosion potential, e.g., near buried electric lines, all metal piping should have cathodic protection. Upgraded systems should have both spill and overflow prevention.

For tanks and suction piping, leak detection and prevention methods include:

- Tank tightness testing;
- In-tank monitoring systems;
- On-going vapor monitoring in the soil;
- On-going groundwater monitoring;
- Interception barriers; and
- Double-walled tanks with interstitial monitoring.

New tanks may be made of fiberglass-reinforced plastic (FRP), steel with cathodic protection, or a composite of steel/FRP. Metal tanks should be allowed only if a corrosion expert determines that the site has limited corrosion potential.

8.3 Regulatory Requirements for UST Systems

Leak detection methods and equipment are heavily dependent on the ability of UST owners to use the technology and interpret signs of a petroleum product release. CETESB may consider requiring all UST system owners and/or operators to undergo a certification program. Programs of this type should be developed in cooperation with UST owners/operators, and consider the types of UST systems and leak detection and prevention equipment relevant to the São Paulo UST population.

For suspected or confirmed releases, CETESB should be notified within 24 hours. All corrective action steps should require submission of progress reports, data collected, and/or compliance reports. CETESB should confirm that remedial action is taking place, and certify the site when cleanup is completed.

Compliance with release detection requirements should be documented. This may include manufacturer schedules for maintenance and calibration, as well as results of testing, sampling, and monitoring. Corrosion protection (installation and operation) must be documented. Repairs to the tank, piping, corrosion protection, or release detection equipment should be documented and the records maintained. Any site investigation data and reports should be maintained both at the site and within CETESB's UMS program.

9.0 Strategy for Enhancing US Export Potential

The field study suggests that more than 15 percent (as originally estimated) of UST installations in the city of São Paulo may be in need of repair or upgrade. However, the actual number is dependent upon regulatory enforcement requirements for UST system licensing and technical standards.

CETESB has a planned program in place to implement full UST equipment conversion in São Paulo over the next 12 years. However, at this time, the "whole picture" has not been assembled for station owners to make informed decisions and take action that can avoid or reduce more stringent regulatory requirements. The final version of CETESB's overall program is clear: new equipment at all stations, including design/installation specifications for requirements such as double-walled tanks, leak detection, non-metallic piping, spill prevention measures, etc.

If station owners are informed of this 12-year plan, the market will likely respond quickly as owners plan their investments. In order to fully inform owners about the UST conversion program, CETESB will need informational and educational materials that include the timing and phasing of upgrade implementation requirements and their relationship to licensing procedures. With assistance provided from USTDA, during the educational campaign, US suppliers can enhance their position in the Brazilian UST market through advertising and making local business contacts.

Table 1: UST Sites Selected for Study

Station	Location	Age of Equipment	Tanks and Equipment	Products	Known Contamination Event?	Surrounding Land Use	Area Hydrogeologic Characteristics	Other Information
A.P. Bandeira Paulista	R. Bandeira Paulista 370, Itaim Bibi	unknown	6 tanks total. 4 double-walled, 2 disused	Alcohol, gasoline	Yes, gasoline	residential and commercial	Sedimentos terciário-quaternários (Bacia de São Paulo),solo argiloso, N.A. 3,5 m, K=3,75xE-5 cm/s	Benzene detected in area groundwater. Product-related vapors previously detected in underground garage of nearby building
A.P. Antártico	Av. Antártico 511, Jd. Mar, S. Bernardo do Campo	unknown	5 product storage tanks (15 e 10 m3) and one lubricating oil storage tank	Alcohol, gasoline, diesel	Yes, gasoline, lubricating oil, diesel	residential and commercial	Sedimentos terciário-quaternários (Bacia de São Paulo), solo argilo-arenoso, N.A. 3,0 m, K=7,4x10-3 cm/s	Product-related vapors previously detected in an underground garage of nearby building.
A.P. Monterey (Site 1)	R. Carlos Petit 36, Vila Mariana	unknown	5 product tanks (15 000 L) and 1 used oil storage tank (10.000 L)	Alcohol, gasoline	Yes, gasoline	residential and commercial	solo argiloso, Sedimentos de Idade Terciária (Formação São Paulo), com litologia local formada por aterro constituído por diferentes camadas argilosas intercaladas, N.A. 11,5 m, K=3,89xE-6 cm/s	Product-related vapors detected in nearby Metro tunnel. Free-phase product detected in nearby unused groundwater well.
A.P. MA	Av. Rio das Pedras 35, Vila Formosa	5 years	4 double-walled tanks (30,000 L each)	Alcohol, gasoline, diesel	Yes, gasoline and alcohol	residential and commercial	Sedimentos de Idade Terciária (Formação São Paulo), com litologia formada por camadas argilosas intercaladas com camadas e lentes arenosas, N.A. 3,0 m, K=4,5x1E-3 cm/s	Product-related vapors detected onsite.
Posto de Serviços Femão Dias Ltda. (Site 4)	Ru aPadre Eugenio Lopes, 540, CEP: 05615-010	11 years	9 tanks	Alcohol, gasoline, diesel	Possible releases	residential and commercial	Water table at 0.5-1.5 meters	
A.P. Gasamérica	Praça Panamericana 183 - Alto de Pinheiros	unknown	4 double-walled tanks	Alcohol, gasoline	Yes, gasoline	residential and commercial	Contexto Geológico - Quaternário, com solo aluvial alternando camadas de argila orgânica e areia fina à média. Nível d'água em média com 2,5 m e K = 1xE-3 cm/s	Groundwater and soil remediation efforts made in May 1998, however, free product still exists on the groundwater. A new groundwater remediation system is planned
Auto Posto Praia do Hawai Ltda. (Site 9)	Av. Robert Kennedy, 4695 Guarapiranga CEP: 04772-005	unknown	9 tanks	Alcohol, gasoline, diesel	No	residential and commercial	none available	Moderately-sized station with oil change services.
A.P. RR	R. Santa Cruz, 2388 - Alto do Ipiranga	3 years	3 double-walled tanks (30,000 L each)	Alcohol, gasoline, diesel	Possible contamination from other sources in the area.	residential and commercial	sedimentos terciário-quaternários, solo argilo-arenoso, N.A. 7,0 m, K = 2,71E-5 cm/s	In 1998 station repaired tanks and passed inspection
A.P. Virginia Vidal	Av. Eng. Armando de Arruda Pereira, 3433, Vila Fanchini	unknown	6 tanks, 2 alcohol (30.000L), 3 gasoline (40.000L) and one diesel (15.000L)	Alcohol, gasoline, diesel	Yes	residential and commercial	Sedimentos terciários-quaternários, solo argilo-arenoso, com níveis quartzosos, N.A. 0,8 a 11,0 m, K=5,31XE-5 cm/s	Risk assessment indicated low risk of exposure to potential receptors
A.P. Bela Vista	R. Gonçalo Fernandes, 441, Jardim Bela Vista - Santo André	unknown	5 tanks (15.000 L), 1 disused	Alcohol, gasoline, diesel	Yes, diesel	residential and commercial	Sedimentos terciario-quaternarios, solo argiloso, com intercalações arenosas, N.A. 8 m, K=9,51XE-5 cm/s	During a tank replacement about 500 L of diesel was leaked into the subsurface. Free product has been detected in a temporary monitoring well.
A.P. Cristal	Av. Francisco Morato 3677, V. Sônia	unknown	3 double-walled tanks (15.000 L)	Alcohol, gasoline, diesel	Yes, gasoline and diesel	residential and commercial	Sedimentos terciario-quaternarios, solo argilo-arenoso, N.A. 0,5-1,8 m, K=1,53XE-4 cm/s	Contamination event in 1995, at this time risk for potential exposure to environmental receptors is minimal.
A.P. 710	R. Clodomiro Amazonas 710, Itaim Bibi	3 years	3 tanks (30.000) L	Alcohol, gasoline, diesel	Yes, gasoline and diesel	residential and commercial	Sedimentos terciário-quaternários, solo arenoso, N.A. 5 m	Benzene detected in soil and groundwater onsite
A.P. Dois	Av. Padre Pereira de Andrade, 13, Alto da Lapa	Tanks=37 years, Pumps=15-20 years	5 product tanks (15.000 L) 1 used oil (10.000 L)	Alcohol, gasoline, diesel	Yes, gasoline and diesel	residential and commercial, recreational, burial	migmatitos e gnaisses graníticos Pré-Cambrianos, solos de alteração areno-argilosos, N.A. 3 m, K=3,89E-4 cm/s	Evidence of pump leakage.
A.P. Mundo Novo (Site 2)	Av. Marginal Direita 201, Parque Novo Mundo	unknown	9 product tanks(15.000 L),1 waste oil tank (5.000 L)	Alcohol, gasoline, diesel	Yes, gasoline and diesel	residential and commercial	Sedimentos quaternarios, na planicie de inundação do Rio Tietê, solo argilo-arenoso, N.A. 3 m, K=4,08XE-3 cm/s	The gas station is situated approximately 50 m from Tietê River.

Table 1: UST Sites Selected for Study (continued)

Station	Location	Age of Equipment	Tanks and Equipment	Products	Known Contamination Event?	Surrounding Land Use	Area Hydrogeologic Characteristics	Other Information
A.P. Chegada	R. Nazaré Paulista, 210, Vila Madalena	unknown	3 tanks (15.000) L	Alcohol, gasoline	Yes, gasoline	residential and commercial	Sedimentos terciários, solo argilo-arenoso, N.A. 4,5 m, K=2,4XE-5 cm/s	Free-phase product detected in July 2001
A.P. Esplanada	R. Cel. Marcílio Franco, 1046, Vila Izolina	unknown	5 tanques de 15.000 L, e 1 de 10.000 L	Alcohol, gasoline, diesel	Yes, gasoline and diesel	residential	Sedimentos terciários, solo areno-argiloso, N.A. 4,5 m, K=4,77XE-5 cm/s	Two disused tanks onsite.
A.P. Super (Site 6)	Av. Pedroso de Moraes, 752, Pinheiros	unknown	6 tanks (15.000) L	Alcohol, gasoline	Yes, gasoline and alcohol	residential and commercial	Sedimentos terciário-quaternários, solo areno-siltoso com níveis de cascalho quartzosos a cerca de 4 m , N.A. 4 m, K=1,86XE-2 cm/s	
A.P. Jaceguai	R. Santo Amaro, 633, Bela Vista	8 years	5 tanks, 2 (15.000 L), 2 (30.000 L), 1 (4.000 L)	Alcohol, gasoline	Yes, gasoline	hospital, residential and commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A. 6,5-9,5 m, K=1,58XE-5 cm/s	Risk assessment indicated low risk of exposure to potential receptors
A.P. JK	R. Voluntários da Pátria , 233, Santana	9 years	7 tanks (15.000 L)	Alcohol, gasoline, diesel	No	commercial	Sedimentos quaternários, solo argilo-arenoso, N.A. 3,5 m, K=3,22XE-5 cm/s	
Posto de Serviços Terceiro Millenium Ltda. (Site 5)	Av. Cortfeu de Azevedo Marques, CEP: 05339-000	unknown	6 product tanks, 1 waste oil	Alcohol, gasoline, diesel	No	residential and commercial	none available	Moderately-sized station with oil change and car wash services.
A.P. Fernão Dias	Rodovia Fernão Dias, Km 86, Jaçanã	11 years	8 (30.000 L), and 2 (15.000 L)	Alcohol, gasoline, diesel	Yes, gasoline and diesel	residential and commercial	Sedimentos quaternários, solo argilo-arenoso com níveis de cascalho, N.A. 0,5-1,5 m, K=3,58XE-5 cm/s	Two areas of contamination were identified, one in the tank area (gasoline+diesel), and the other near the diesel pump.
A.P. Janaína	Al. Northmann, 833, Campos Elísios	unknown		Alcohol, gasoline, diesel	Possibly	residential and commercial	Sedimentos quaternários, solo argilo-arenoso, N.A. 2 m, K=3,13XE-5 cm/s	Possible diesel spill in 1991
A.P. Poliserviços II	Av. Monteiro Lobato, 5505, Jardim Cumbica	12 years	6 tanks (15.000 L)	Alcohol, gasoline, diesel	Yes, diesel	residential and commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A. 5,7-7,7 m, K=2,23XE-4 cm/s	Area of contamination is approximately 70 meter radius around station
A.P. Brigadeiro	Av. Brigadeiro Luiz Antônio, 3535, Jardim Paulista	30 years	7 tanks (15.000 L), 1 (10.000 L)	Alcohol, gasoline, diesel	Yes, gasoline	residential and commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A. 3,1 m, K=2,92XE-6 cm/s	
A.P. Jaguar do Mandaqui	R. Voluntários da Pátria, 4380, Mandaqui	unknown	9 product tanks (15.000 L), 1 disused, 1 waste oil	Alcohol, gasoline, diesel	Yes, diesel	hospital, residential and commercial	Sedimentos quaternários, solo argilo-arenoso, N.A. 2,5 m, K=4,55XE-5 cm/s	Underground garages nearby. Free-phase product detected in one existing monitoring well.
A.P. Gualhu	Rodovia BR-116, Km 314, cidade de Juquitiba-SP	unknown	7 product tanks (15.000 L), 1 disused	Alcohol, gasoline, diesel	Yes, diesel	residential and commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A. 6 m, K=4,95XE-5 cm/s	The São Lourenço River is located approximately 100 m from the gas station
Auto Posto 45 Ltda..(Site 8)	Rodovia Raposo Tavares km 45 Vargem Grande Paulista CEP; 06730-000	unknown	8 product tanks, 1 waste oil	Alcohol, gasoline, diesel	No	commercial	none available	Large truck stop with oil change service.
A.P. Umarizal	Estrada do Campo Limpo, 5746, Campo Limpo	15 years	7 tanks (15.000 L)	Alcohol, gasoline, diesel	Yes, gasoline	residential	Sedimentos terciários, solo argilo-arenoso, N.A. 2 m, K=4,65XE-5 cm/s	Two areas of contamination were identified, one onsite and the other in nearby residential area. Second area found to be unrelated to service station.
A.P. Valente	Estrada Guarulhos-Nazaré Paulista, 2750, Jardim Novo Portugal-Guarulhos	unknown	6 tanks (15.000 L)	Alcohol, gasoline, diesel	Yes, gasoline	residential and commercial	none available	In January of 1992 more than 2.000 L gasoline was removed from wells onsite.
A.P. Carijós	Av. Lions, 2, Rudge Ramos-S.B. do Campo	unknown	6 tanques de 15.000 L	Alcohol, gasoline	Yes, gasoline	residential and commercial	Sedimentos terciários, solo argilo-arenoso, N.A. 4 m, K=3,8XE-4 cm/s	Possible contamination from other service station in vicinity.
A.P. San Martin (Site 3)	Av. General Olimpio da Silveira, 324, Santa Cecília	3 years	4 tanks (15.000 L), 1 disused	Alcohol, gasoline	Possibly gasoline	residential and commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A. 3 m, K=1,76XE-3 cm/s	Product-related vapors detected in nearby building, no product detected in monitoring wells.
A.P. Universitários	Av. Afrânio Peixoto,Cidade Universitária-Butantã	unknown	7 tanques de 15.000 L	Alcohol, gasoline	Yes, gasoline	university campus, day care	Migmatitos e gnaisses graníticos Pré-Cambrianos, solos de alteração areno-argilosos, N.A. 1 m, K=1,98E-6 cm/s	No free-phase product in monitoring wells.

Table 1: UST Sites Selected for Study (continued)

Station	Location	Age of Equipment	Tanks and Equipment	Products	Known Contamination Event?	Surrounding Land Use	Area Hydrogeologic Characteristics	Other Information
A.P. AD (Site 7)	R. Tamoio, 620, Jardim Aeroporto	unknown	5 tanks (10.000 L), 1 tank (15.000) L	Alcohol, gasoline	Possible contamination from other sources in the area.	airport, residential, commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A.15 m, K=1,33XE-7 cm/s	Contaminants found in the saturated zone of subsurface, not the vadose zone, indicating that the likely source is upgradient of the site.
A.P. Rio de Janeiro	Rodovia Ayrton Senna, Km 29,5 ,Guarulhos	unknown	16 tanks (15.000 L), 1 (30.000 L), 1 waste oil	Alcohol, gasoline, diesel	Yes, gasoline	residential and commercial	Sedimentos terciário-quaternários, solo argilo-arenoso , N.A. 7,5-11m, K=9,20XE-4 cm/s	Previous risk assessment indicated elevated exposure risk for service station employees and residents downgradient of the station.
Farol Comercial Ltda. Posto de combustíveis	Rodovia Presidente Dutra Km 212,8 - Guarulhos	5 years	11 tanks	Alcohol, gasoline, diesel	Possible diesel release	rural residentiel, commercial	Solo argiloso, N.A. entre 3,0 e 6,0 m, K=4,0 x E-5 cm/s	Very large station, sells more than 1 million L per month.
Posto de Serviços Piqueri Ltda.	Rua Pedro Colaço 6 - Piqueri -SP	unknown	9 tanks (15.000 L)	Alcohol, gasoline, diesel	Yes, gasoline and diesel	industrial, commercial, residential	Contexto Geológico - Quaternário, com solo aluvial alternando camadas de argila. Nível d'água em média com 1,40 m e K = ?	Product-related vapor detected in nearby sewers. Possibly contributed to by other stations in vicinity.
Auto Posto Mupira Ltda.	Rua Manoel de Carvalho, 73 - Piqueri	unknown	11 product tanks, 4 disused tanks	Alcohol, gasoline, diesel	Yes	industrial, commercial, residential	Contexto Geológico - Quaternário, com solo aluvial alternando camadas de argila e areia. Nível d'água em média com 1,40 m e K = ?	Product-related vapor detected in nearby sewers. Possibly contributed to by other stations in vicinity.

Table 2: Site Assessment Options

Survey Type	Equipment	Duration	Level of Effort	Samples	Relative Cost	Comments
OPTION 1 **PID Vapor Survey/Grid**	*Sampling* Percussion drill Air pump Steel probes *Monitoring* PID/calibration gas (Isobutylene) Explosimeter	1 day	Technician: 1 Engineer/Scientist: 1	Vapor: 10-15 Soil: 0 Water: 0	Low	Rapid Survey Low Cost Contaminant definition poor Danger of striking buried equipment
OPTION 2 **GC Vapor Survey/Grid**	*Sampling* Percussion drill Air pump Steel probes *Monitoring* GC/calibration gas (BTEX) PID/calibration gas (Isobutylene) Explosimeter	2 days	Technician: 1 Engineer/Scientist: 2	Vapor: 10-15 Soil: 0 Water: 0	Low-Medium	Use of GC improves contaminant definition, but increases duration and level of effort. Danger of striking buried equipment
OPTION 3 **PID Vapor Survey/Grid** **and** **Manual Soil Sampling**	*Sampling* Percussion drill Air pump Steel probes *Monitoring* PID/calibration gas (Isobutylene) Explosimeter *Soil Sampling* Hand auger or power auger *Laboratory Analysis* BTEX (8260) TPH (8015) PAH (8270) Ethanol	1 day	Technician: 1 Engineer/Scientist: 2	Vapor: 10-15 Soil: 1-2 Water: 0	Low-Medium	Soil sampling for laboratory analysis improves contaminant definition Soil samples collected in area(s) of highest detected vapor contamination Groundwater sampling not possible except where very shallow Danger of striking buried equipment

Table 2: Site Assessment Options (continued)

Survey Type	Equipment	Duration	Level of Effort	Samples	Relative Cost	Comments
OPTION 4 **GC Vapor Survey/Grid** **and** **Manual Soil Sampling**	*Sampling* Percussion drill Air pump Steel probes *Monitoring* GC/calibration gas (BTEX) PID/calibration gas (Isobutylene) Explosimeter *Soil Sampling* Hand auger or power auger *Laboratory Analysis* BTEX (8260) TPH (8015) PAH (8270) Ethanol	2 days	Technician: 1 Engineer/Scientist: 2	Vapor: 10-15 Soil: 2-3 Water: 0	Medium	Use of GC improves contaminant definition, but increases duration and level of effort. Danger of striking buried equipment
OPTION 5 **PID Vapor Survey/Targetted** **and** **Manual Soil Sampling**	*Sampling* Percussion drill Air pump Steel probes *Monitoring* PID/calibration gas (Isobutylene) Explosimeter *Soil Sampling* Hand auger or power auger *Laboratory Analysis* BTEX (8260) TPH (8015) PAH (8270) Ethanol	1 day	Technician: 1 Engineer/Scientist: 2	Vapor: 10-15 Soil: 2-3 Water: 0	Low-Medium	Target vapor sample locations with potential for highest contaminant levels based on assessment of entire site Reduced risk of striking buried equipment

Table 2: Site Assessment Options (continued)

Survey Type	Equipment	Duration	Level of Effort	Samples	Relative Cost	Comments
OPTION 6 **PID Vapor Survey/Targetted** **and** **Geoprobe Soil/Water Sampling**	*Sampling* Percussion drill Air pump Steel probes *Monitoring* PID/calibration gas (Isobutylene) Explosimeter *Soil/Water Sampling* Geoprobe *Laboratory Analysis* BTEX (8260) TPH (8015) PAH (8270) Ethanol	2 days	Technician: 1 Engineer/Scientist: 2 Geoprobe Operator: 1	Vapor: 10-15 Soil: 3-4 Water: 1-2	High	Target vapor sample locations with potential for highest contaminant levels based on assessment of entire site Reduced risk of striking buried equipment
OPTION 7 **Geoprobe Soil/Water Sampling/** **Targetted**	*Monitoring* PID/calibration gas (Isobutylene) Explosimeter *Soil/Water Sampling* Geoprobe *Laboratory Analysis* BTEX (8260) TPH (8015) PAH (8270) Ethanol	1 day	Technician: 1 Engineer/Scientist: 1 Geoprobe Operator: 1	Vapor: 0 Soil: 3-4 Water: 1-2	Medium-High	Target soil/water sample locations with potential for highest contaminant levels based on assessment of entire site

Table 3: Soil Boring Analytical Results

Analyte	Benzene ug/Kg		Ethylbenzene ug/KG		Toluene ug/Kg		Xylenes ug/Kg		TPH DRO mg/kg			PAH ug/Kg		Ethanol ug/kg	
Sample	Result	LPQL	Result	LPQL	Result	LPQL	Result	LPQL	Result	Match	LPQL	Result	LPQL	Result	LPQL
1-SB1	<13	13	<13	13	<13	13	6 *J	13	90	None	NR	ND	45	2200*J	
2-SB1	<14	14	11	11	20	14	14	14	**230**	**Diesel**	NR	ND	45	<7000	7000
3-SB1	<11	11	<11	11	<11	11	<11	11	60	None	NR	ND	36	<5500	5500
4-SB1	<13	13	<13	13	<13	13	<13	13	30	None	NR	ND	42	<6500	6500
5-SB1	<11	11	<11	11	<11	11	<11	11	40	None	NR	ND	39	<5500	5500
6-SB1	<13	13	<13	13	<13	13	<13	13	20	None	NR	ND	42	<6500	6500
7-SB1	<13	13	<13	13	<13	13	<13	13	20	None	NR	ND	43	**1730000 *1**	5000
8-SB1	<13	13	<13	13	<13	13	25	13	90	None	NR	ND	43	<6500	6500
9-SB1	<12	12	<12	12	<12	12	6 *J	12	30	None	NR	ND	41	2160 *J	5500

LPQL = Lower Practical Quantitation Limit
ug/Kg = micrograms per kilogram
mg/Kg = milligrams per kilogram
TPH DRO = Total Petroleum Hydrocarbons Diesel Range Organics (C8-C30)
PAH = Polyaromatic Hydrocarbons
* J = This result has been identified, but as it is less than the LPQL it is noted as an estimate.
EPA 8260 BTEX + Ethanol by GC/MS
EPA 8270 PAH by GC/MS
EPA 8015 B TPH DRO by GC/FID
*1 = The laboratory QA/QC information did not indicate that the machine subsample was diluted. In that case the upper PQL may be suspect, and all that can be said with certainty about this result is that it is very high.
NR = Not reported

Table 4: Initial Screening of Remedial Actions for Contaminated Groundwater at UST Sites in São Paulo

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Comment
No Action	No Action	No Action	Low	High	Low	Only potentially applicable in areas where no environ-mental or health impacts exist
Monitoring	Institutional Controls Use Restrictions	Deed & Zone Restrictions; Groundwater use restrictions	Low	Moderate	Moderate	Groundwater use restrictions will mitigate additional human health impacts
Containment	Hydraulic Containment	Pump and treat with Bioreactor	Low	High	High	Potentially applicable, however long timeframe and expensive operation and maintenance
Containment	Hydraulic Containment	Pump and treat with carbon treatment	Low	Low	High	Potentially applicable, however long timeframe and problems with plugging make implementation costly
Containment	Product Recovery	Recovery trench	Moderate	Moderate	Moderate	Only applicable if product moving and significant product
Treatment	Physical	Groundwater recirculation	Low	Moderate	High	Only applicable if plume is within or close to UST site
Treatment	Physical	Air Sparging Trench	Moderate	Moderate	Moderate	Avoids problem of pumping but contains migration only, sparging is done in gravel filled trench
Treatment	Physical	Groundwater pump and treat	Low	Moderate	High	Very long remediation time frame required. Better used as containment option.
Treatment	Biological	Enhanced aerobic	Moderate	Moderate	Moderate	Potentially applicable but biomass plugging is problem
Treatment	Biological	Monitored natural attenuation	High	Moderate	Moderate	Applicable to plume and should be Included as a component for all alternatives
Treatment	Chemical	Fenton's reagent In-situ chemical oxidation	Low	Moderate	High	Applicable to source areas

Table 5: Initial Screening of Remedial Actions for Contaminated Soil At UST Sites in São Paulo

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Comment
No Action	No Action	No Action	Low	High		Only potentially applicable in areas where no environmental or health impacts exist
Monitoring	Institutional Controls Natural Attenuation	Soil access and construction restrictions.	Low	High	Low to Moderate	Applicability depends on biodegradation rates of soil contaminants.
Containment	Capping with Hydraulic Containment	Impermeable cap	Low	Moderate	High	Removes land from potential future use, high cost
Extraction and Removal	Product Recovery	Soil Recycling to Asphalt plant or other beneficial reuse	Moderate	Moderate	Moderate	Only applicable to highly contaminated soils that are accessible
In Situ Soil Treatment	Physical	Soil Vapor Extraction	Moderate	High	Moderate	Applicable at UST sites where groundwater at depth of >3m. Generally requires exhaust gas control.
In Situ Soil Treatment	Physical	Air Sparging	Moderate	High	Moderate	Applicable to gasoline remediation. Not applicable when free-product present or in proximity to basements/confined spaces. Ideally combined with soil vapor extraction.
Ex Situ Soil Treatment	Physical	Low temperature desorption	Moderate	Moderate	Moderate to High	Potentially applicable foe variety of UST releases if product can be recovered. Requires large volume for cost effective operation. Soils below water table require initial dewatering
In Situ Soil Treatment	Biological	Bioventing	Moderate	High	Moderate to high	Applicable to treatment of petroleum contamination in the unsaturated soils. Promotes aerobic bio-degradation. Ineffective in low permeability soils.
Ex Situ Soil Treatment	Biological	Biopiles	Moderate	Moderate	Moderate	Applicable to large volumes with limited treatment area. Soils must be accessible for excavation. Biopile may require exhaust gas control.

Table 5: Initial Screening of Remedial Actions for Contaminated Soil At UST Sites in São Paulo (continued)

General Response Action	Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Comment
Ex Situ Soil Treatment	Biological	Landfarming	High	Moderate	Low to Moderate	Highly applicable to petroleum and reuse of soils. However, soils must be accessible for excavation
In Situ Soil Treatment	Biological	Biosparging	Moderate	High	Moderate to High	Most applicable for mid-weight petroleum releases. Not applicable when free-product present or in proximity to basements/confined spaces. Often combined with soil vapor extraction or bioventing.
In Situ Soil Treatment	Chemical	Fenton's reagent In-situ chemical oxidation	Moderate	Low	High	Potentially applicable for in situ chemical oxidation of petroleum releases at UST sites.

Figure 1
Surface Penetration

Figure 2
Vapor Probe Installation

Figure 3
Field Analysis Equipment

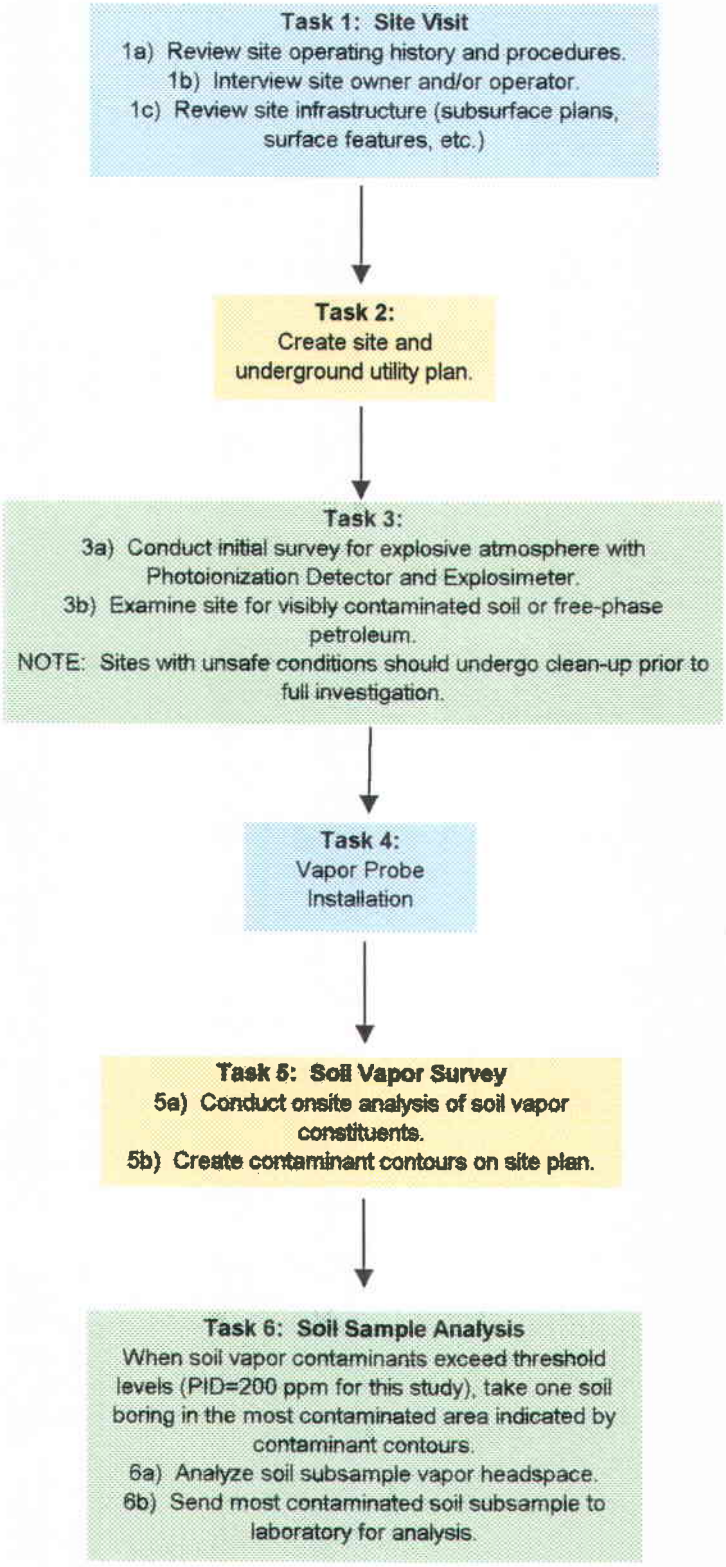
OVM-PID

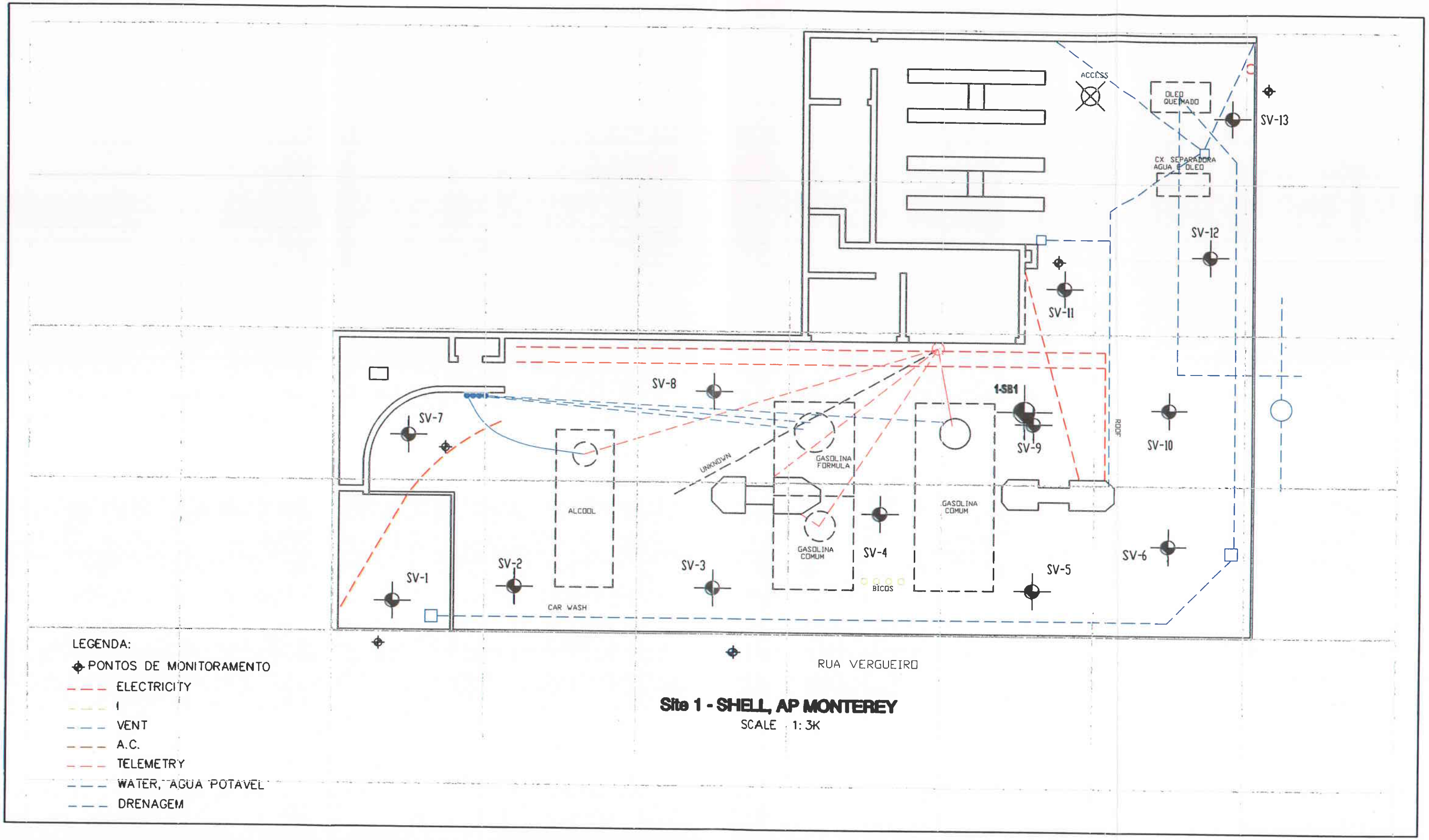
MSA LEL/O2/H2S

Portable Gas Chromatograph

Gastech

Figure 4: Site Investigation Approach





Site 1 - SHELL, AP MONTEREY

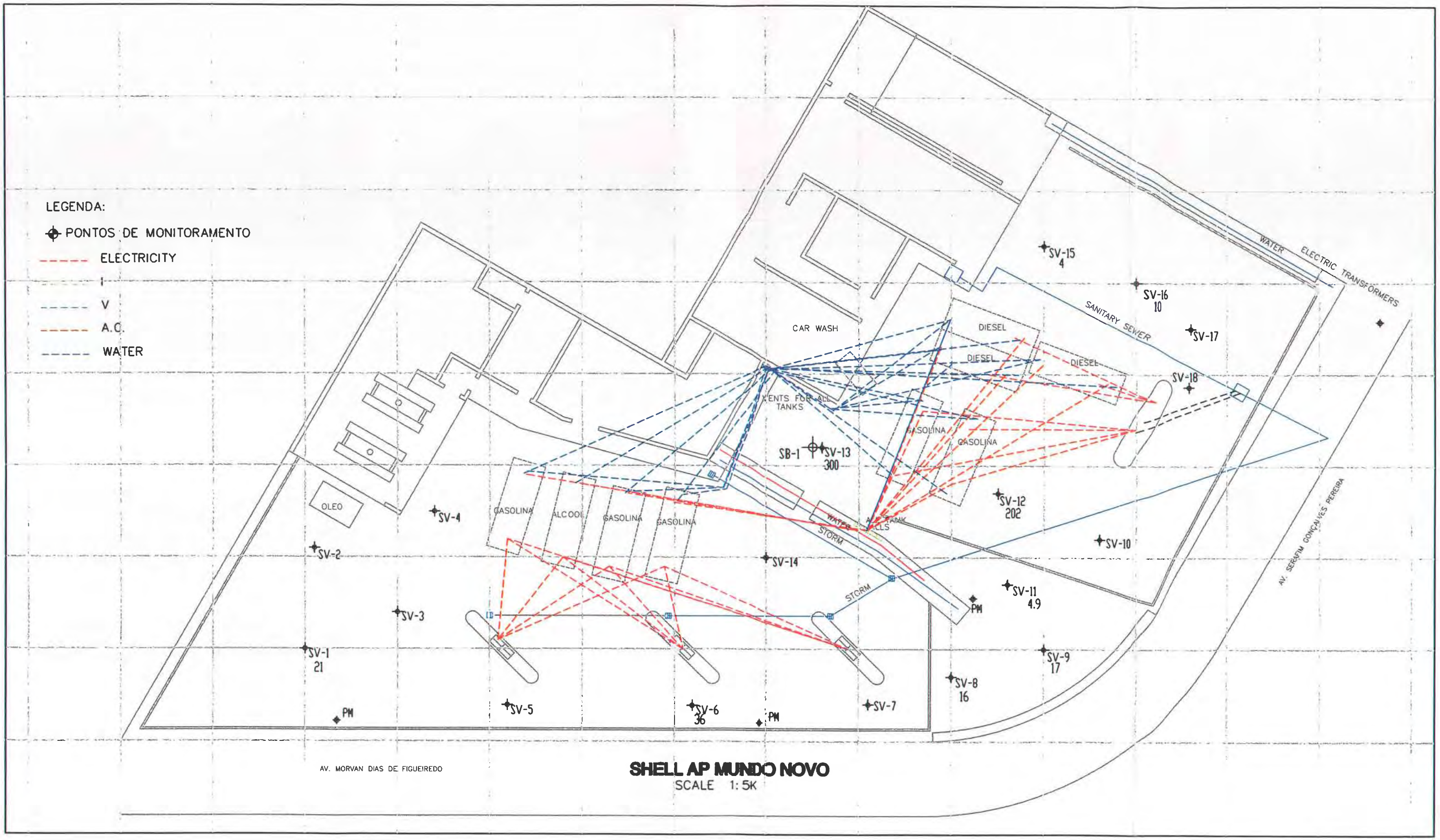
SCALE 1: 3K

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 1
SHELL AP MONTEREY

Figure No. 5

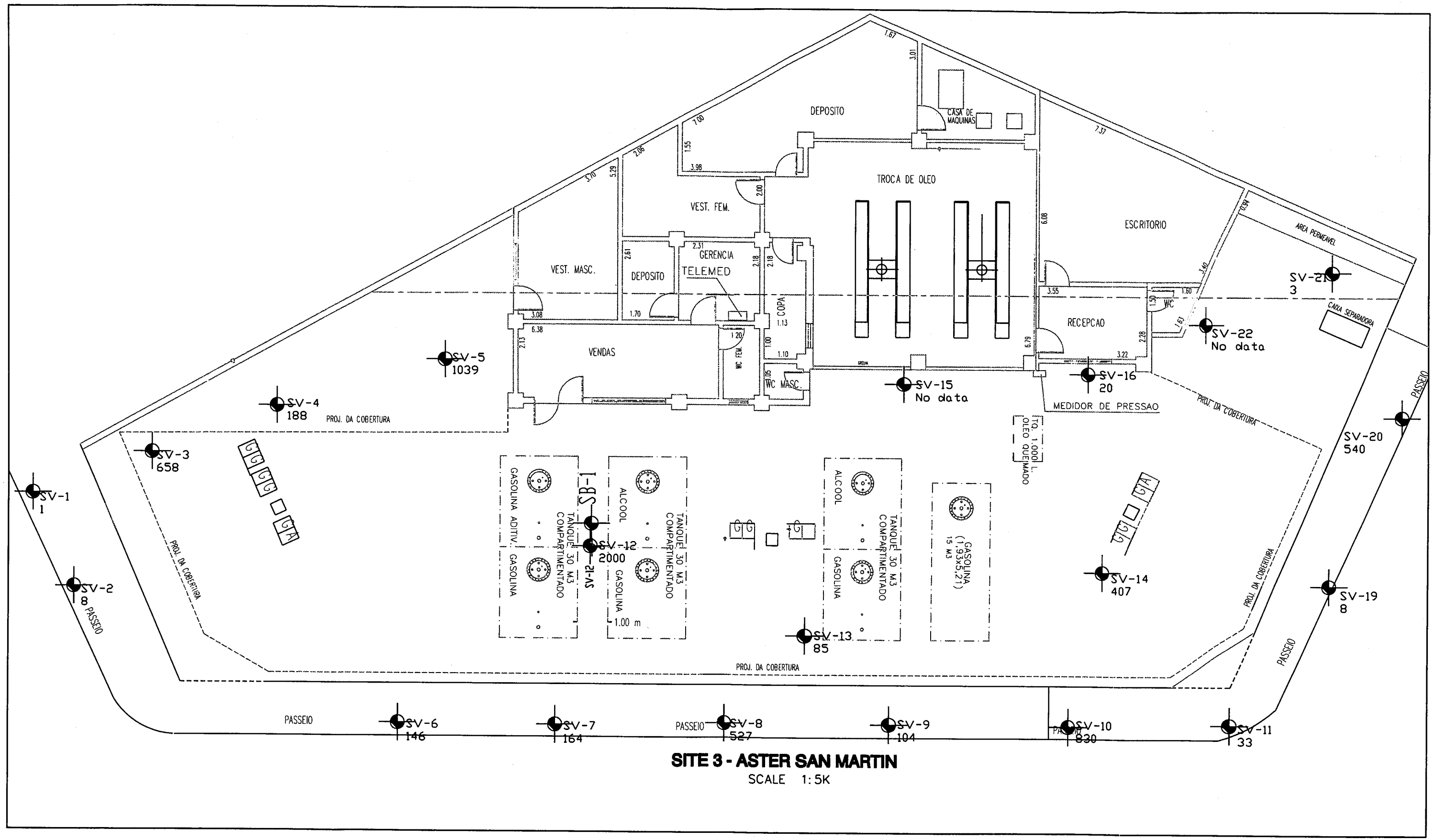


CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 2
SHELL AP MUNDO NOVO

Figure No. 6



SITE 3 - ASTER SAN MARTIN

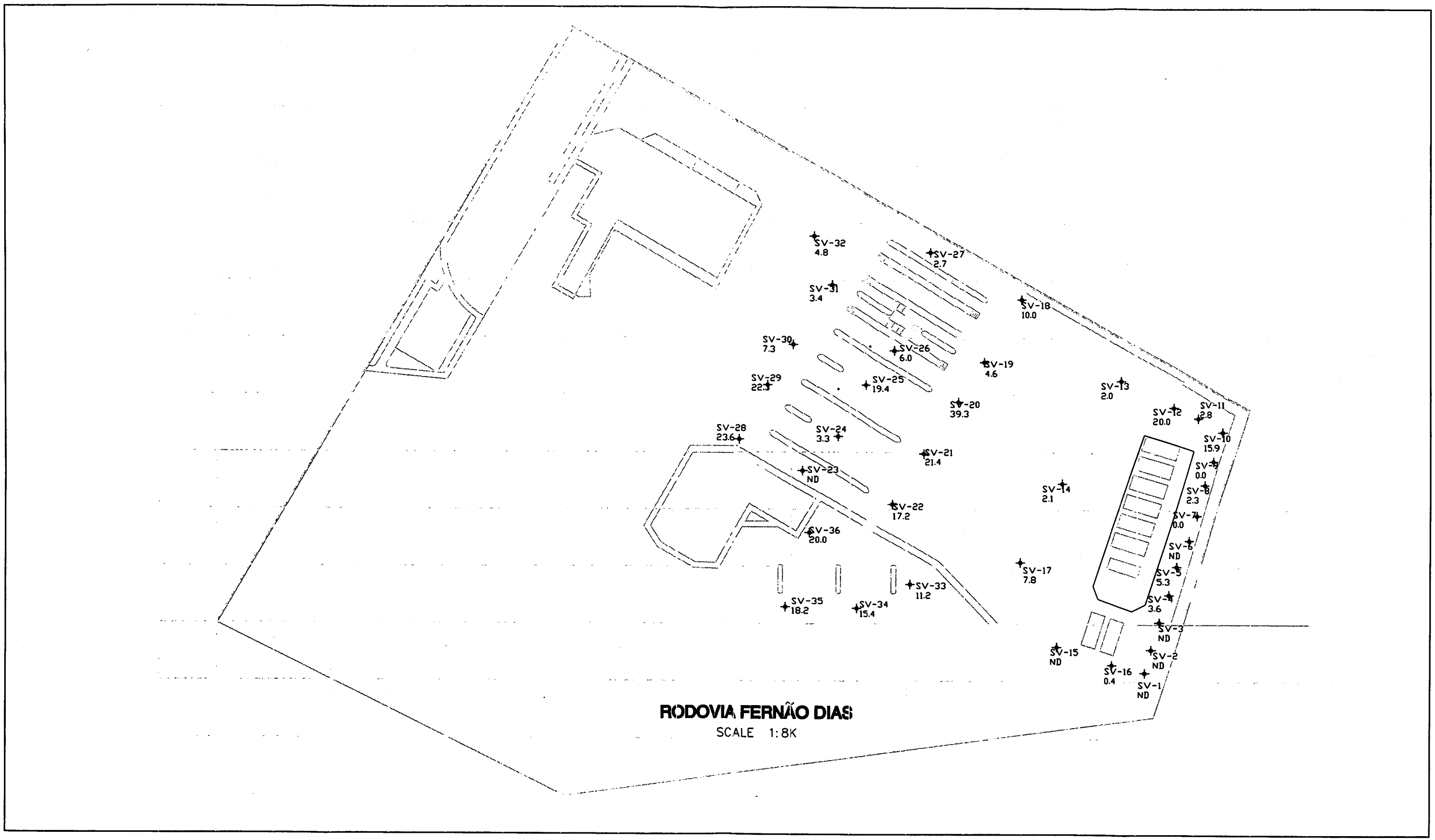
SCALE 1:5K

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 3
ASTER SAN MARTIN

Figure No. 7

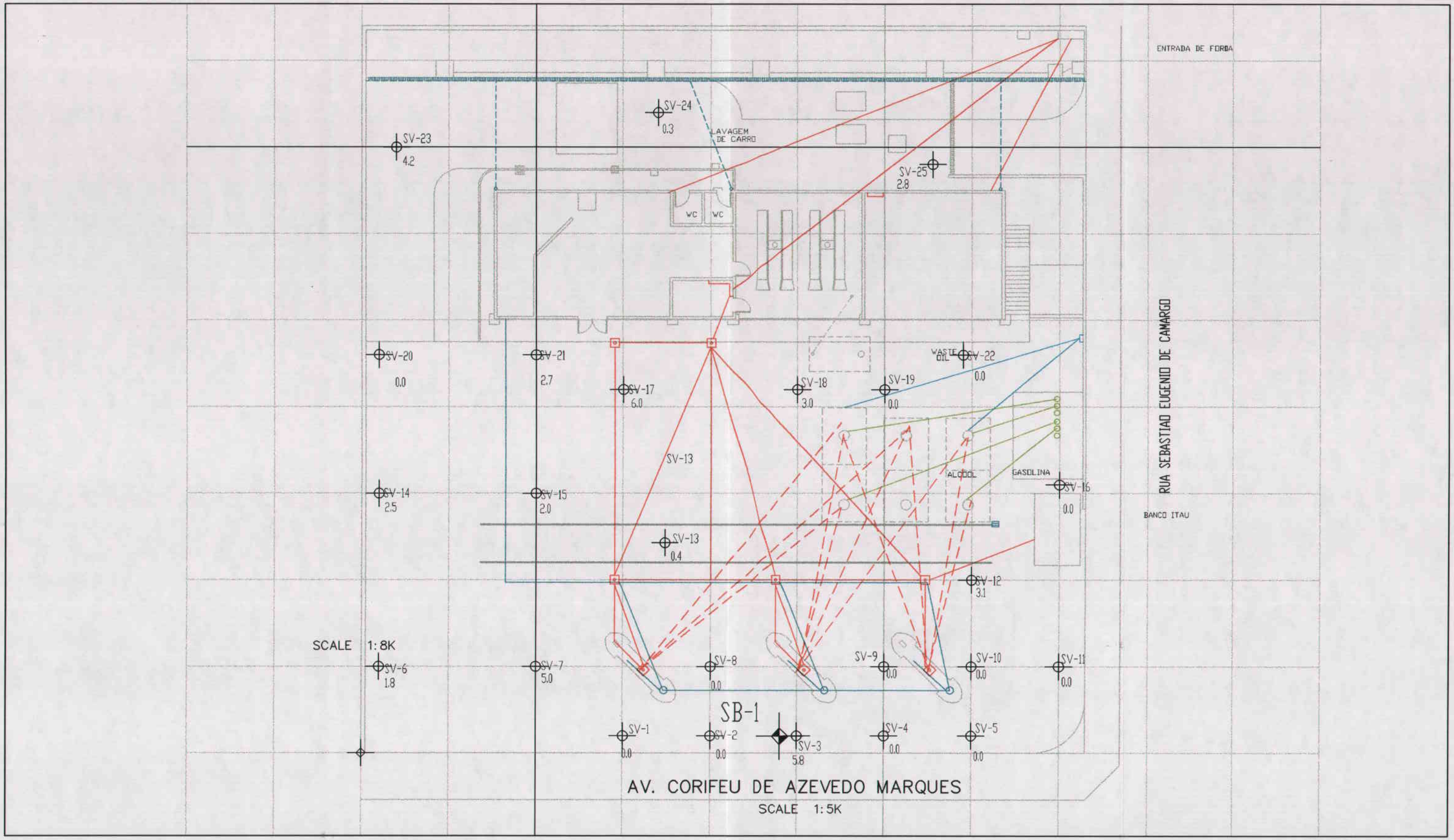


CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 4
SHELL AP FERNÃO DIAS

Figure No. 8

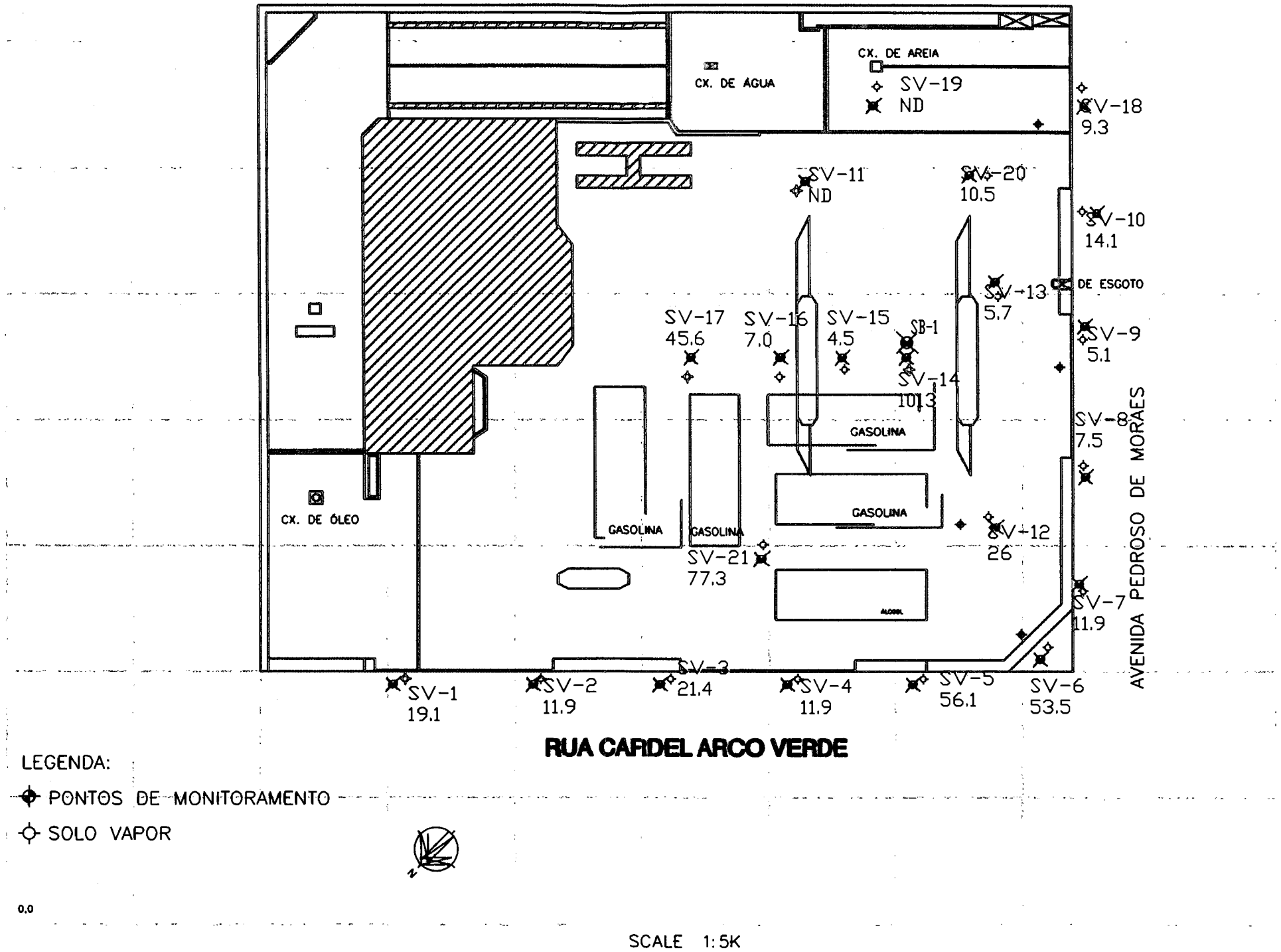


CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 5
SHELL AP 3rd MILENIUM

Figure No. 9



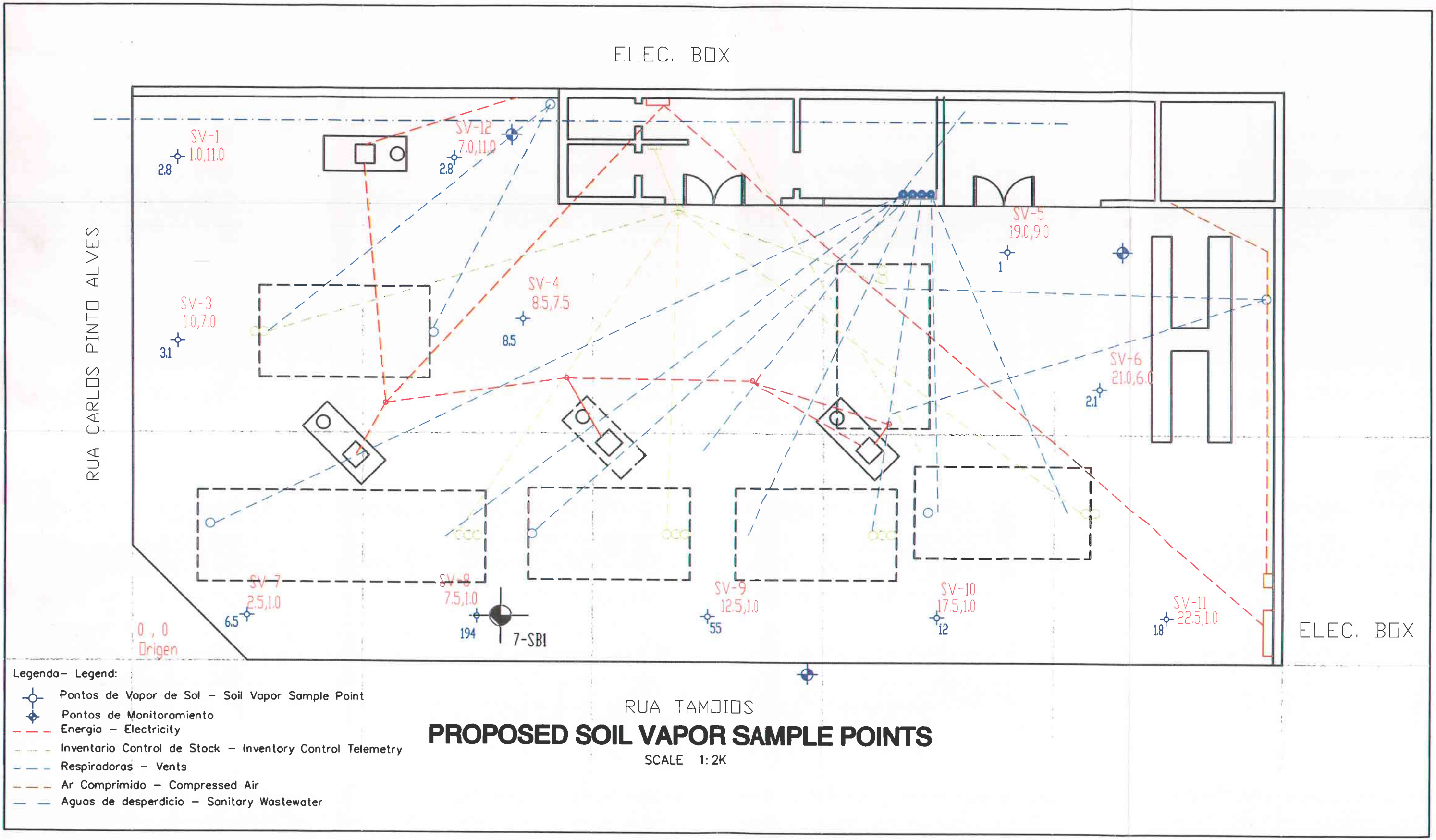
SCALE 1:5K

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 6
SHELL AP SUPER LTDA

Figure No. 10



Legenda– Legend:

- Pontos de Vapor de Sol – Soil Vapor Sample Point
- Pontos de Monitoramiento
- Energia – Electricity
- Inventario Control de Stock – Inventory Control Telemetry
- Respiradoras – Vents
- Ar Comprimido – Compressed Air
- Aguas de desperdicio – Sanitary Wastewater

PROPOSED SOIL VAPOR SAMPLE POINTS

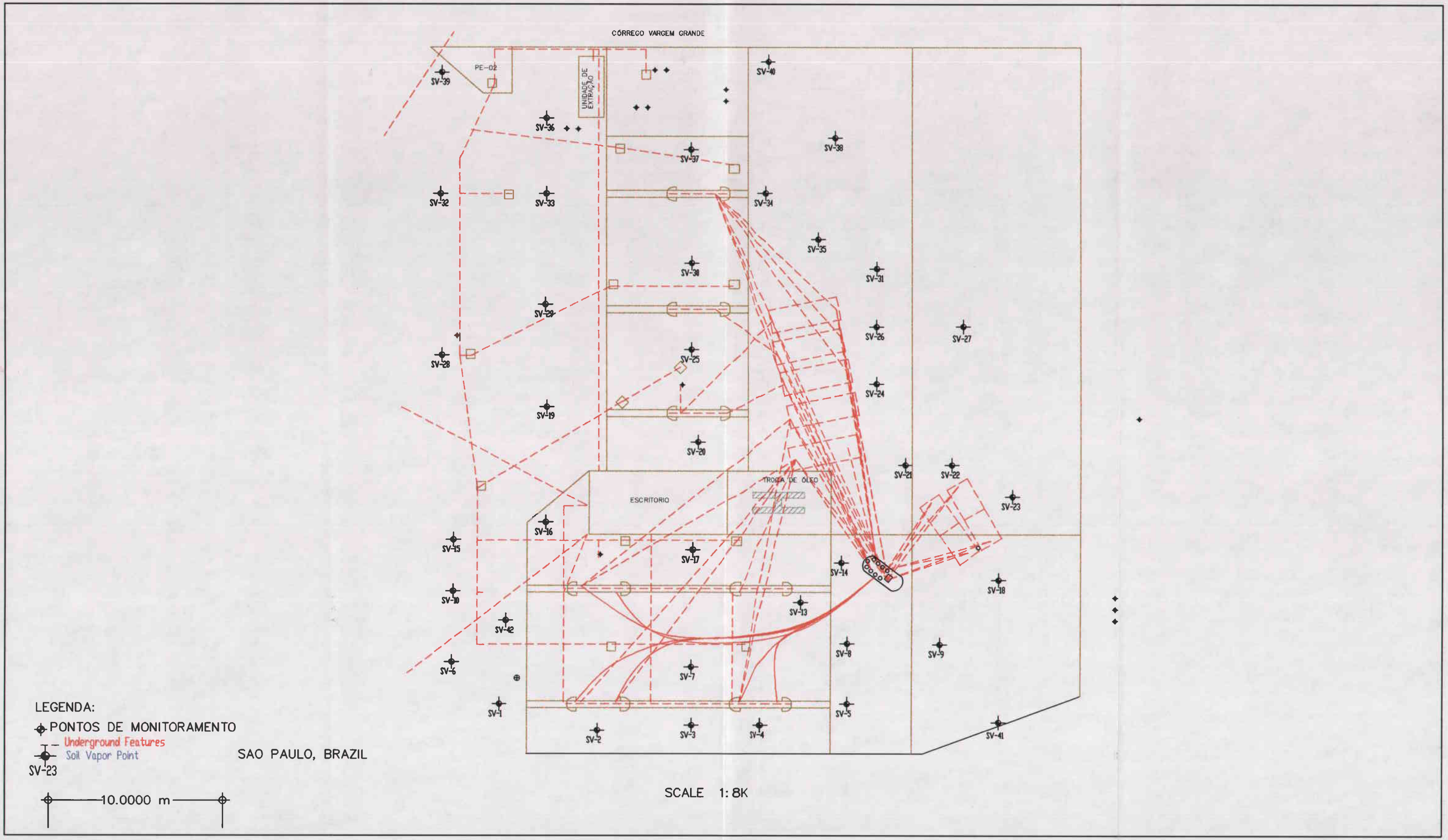
SCALE 1: 2K

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 7
BR A. D. SERVICOS AUTOMOTIVOS LTDA.

Figure No. 11

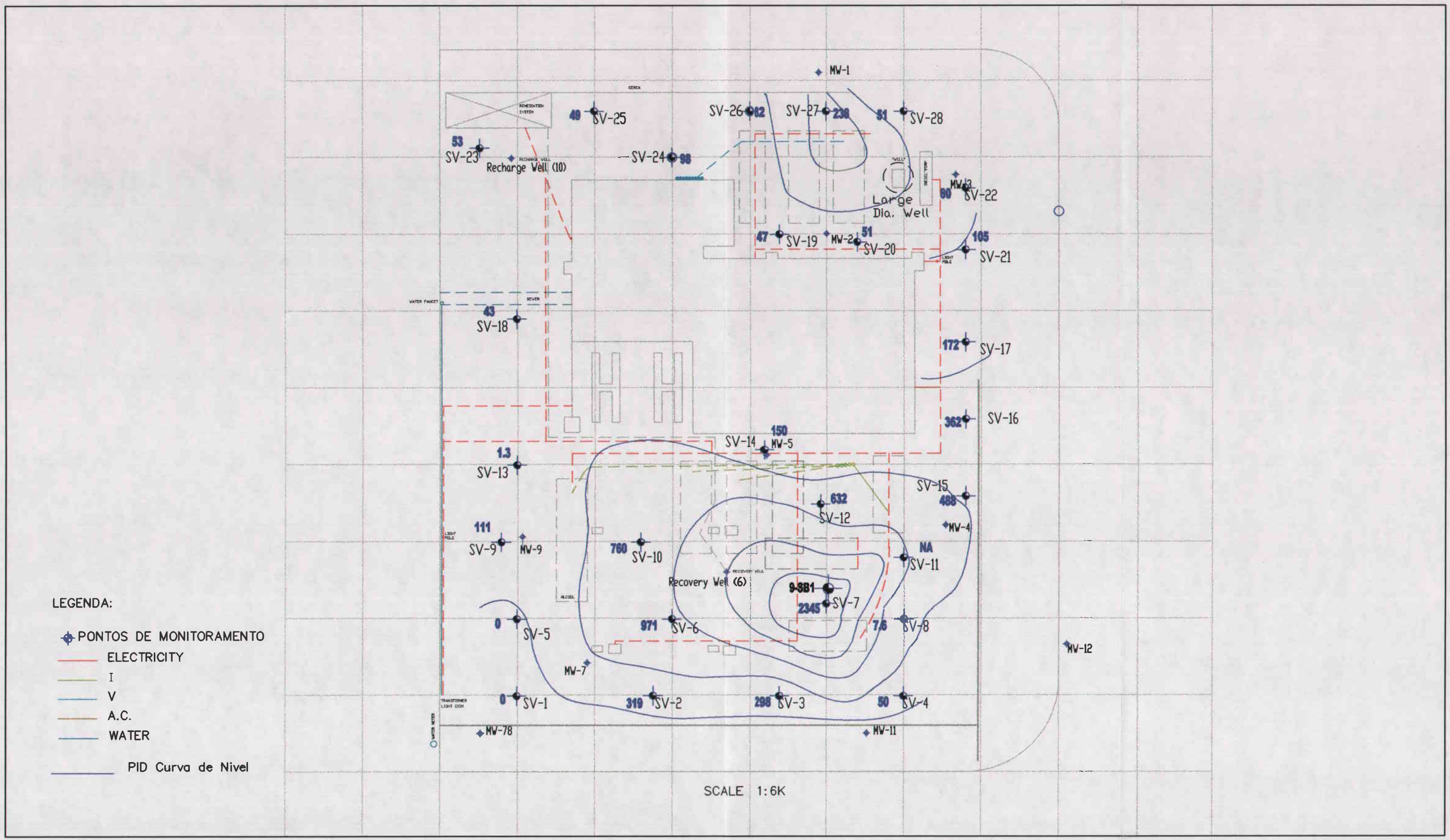


CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 8
SHELL AP 45

Figure No. 12



CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 9
SHELL AP PRAIA HAWAI LTDA.

Figure No. 13

Figure 14: Proposed Guidance for Vapor, Soil and Groundwater Sampling Based on Site Conditions

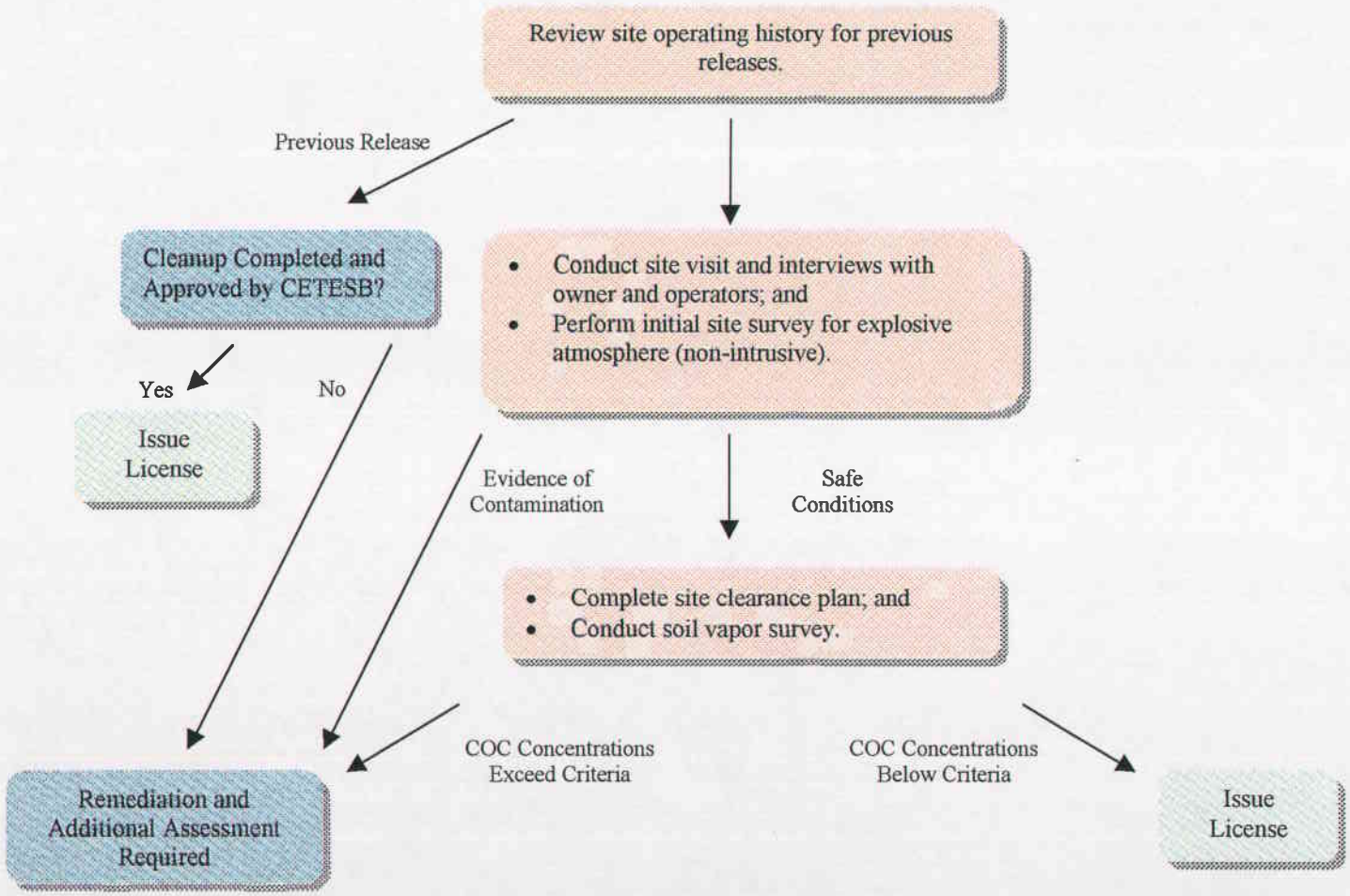
Sampling Program Parameters		UST System Condition (1)										
		Good			Fair				Poor			
Soil Vapor Points		A_1	A_2	A_3		A_1	A_2	A_3		A_1	A_2	A_3
	T_1	16-20	16-22	20-30	T_1	10-14	16-22	20-30	T_1	Not Needed (2)		
	T_2	18-22	24-30	28-38	T_2	10-14	16-22	20-30	T_2			
	T_3	20-24	26-34	30-40	T_3	10-14	16-22	20-30	T_3			
Soil Samples		A_1	A_2	A_3		A_1	A_2	A_3		A_1	A_2	A_3
	T_1	1	1	1	T_1	6-8	9-11	12-14	T_1	4	4	4
	T_2	1	1	1	T_2	8-10	11-13	13-15	T_2	6	6	6
	T_3	1	1	1	T_3	10-12	13-15	16-18	T_3	8	8	8
Groundwater Samples		A_1	A_2	A_3		A_1	A_2	A_3		A_1	A_2	A_3
	T_1	N/A			T_1	N/A			T_1	6-8	8-10	10-12
	T_2				T_2				T_2	9-11	11-13	13-15
	T_3				T_3				T_3	12-14	14-16	16-18

Key:			System Condition (1)
A_1=<2,000 m^2 A_2=2,000–10,000 m^2 A3=>10,000 m^2		T_1=1-4 tanks T_2=5-9 tanks T_3=10-15 tanks	Good: • In compliance with the standards and specifications that CETESB intends to require everywhere after 12 years, **OR** • System newer than 5 years old with leak detection equipment or inventory control procedures in place since installation.
Color:		See note 3.	Fair: • Systems between 5 and 15 years old in good operating condition with leak detection equipment or inventory control procedures in place, **AND** • No known or suspected release incidents.
		See note 4.	
			Poor: All others.

Notes:

(1) Classifications and classification criteria shown are used for purposes of example only.
(2) Groundwater and soil samples supercede soil vapor samples for reliability.
(3) Mandatory sampling procedure to apply for license.
(4) Sampling that may be prudent and cost effective to sufficiently characterize sub-surface condition of contaminated sites prior to remedial action. Not required for licensing process.

Figure 15: Possible Framework for UST Licensing Program



Appendix A

UST Management System Software Development

Project Development Meetings

Date: July 3-4, 2001
Location: CETESB
Attendees: Edson Haddad, Manager, Emergency Operations Sector, CETESB
Rodrigo Cesar de Araújo Cunha, Manager, Preventive Action Group, CETESB
Jorge Luiz Nobre Gouveia, Chemist, Emergency Operations Sector, CETESB
Elton Gloeden, Remediation Group, CETESB
Antonio de Castro Bruni, Information Technology Department, CETESB

Dr. Myron Rosenberg, Project Director, CDM
Philip Chernin, GIS Specialist, CDM
Peter Shilland, Project Manager, CDM
Kevin Molloy, UST/IMS Specialist, CDM
Alceu Bittencourt, Steering Committee, Cobrape
José Antonio Oliveira de Jesus, Deputy Project Manager, Cobrape
Dr. Robert Cleary, Steering Committee

Topics **July 3**
Introductions
Presentations
1. *Overview and Objectives*
2. *Risk-Based Decision Making Techniques*
3. *Potential Applications for CETESB*
4. *Technology Transfer*

Discussion
July 4
Matching CETESB needs with Project Scope

Date: September 12-14, 2001
Location: CETESB
Attendees: Peter Shilland, Project Manager, CDM
José Antonio Oliveira de Jesus, Deputy Project Manager, Cobrape
Luiz Fernando, Cobrape
Rivalso França de Mello Júnior, Diretor Técnico, Angel Geologia e Meio Ambiente
Marcelo Sadeck Burlamaqui, Engo. Remediação Ambiental, Shell Brasil S.A.

Rodrigo Cesar de Araújo Cunha, Manager, Preventive Action Group, CETESB
Jorge Luiz Nobre Gouveia, Chemist, Emergency Operations Sector, CETESB
Elton Gloeden, Remediation Group, CETESB
Vicente Aquino Neto, Remediation Group, CETESB

Topics: **September 12**
Presentation of Criteria for Developing a Shortlist of UST sites for Pilot Studies and presentation of the selected sites
September 13
Discussion of factors and weights for the Risk to Human Health and Safety (RTHS) ranking system
September 14
Discusion of field pilot study procedures used by Shell Brasil and those proposed for use under CETESB/TDA study

Date: December 4, 2001
Location: CETESB
Attendees: Peter Shilland, Project Manager, CDM
José Antonio Oliveira de Jesus, Deputy Project Manager, Cobrape
Alceu Bittencourt, Steering Committee, Cobrape
Luiz Fernando, Cobrape
Cesar Garcia, Shell Brasil S.A.
Claudio Alexandre de Souza, Gerente de Operações, American Drilling de Brasil Ltda.
Bruno Melche, Gerente Geral, American Drilling de Brasil Ltda.
Bob Francis, President, American Drilling Services, Inc.
Alejandra Peñaloza Fuentes, Geóloga, Ambiterra Ltda.
Michael Munsil, EC Americas
James Chamness, EC Americas
Rodrigo Cesar de Araújo Cunha, Manager, Preventive Action Group, CETESB
Jorge Luiz Nobre Gouveia, Chemist, Emergency Operations Sector, CETESB
Elton Gloeden, Remediation Group, CETESB
Vicente Aquino Neto, Remediation Group, CETESB

Topics: Scheduling and procedures for field work at the UST pilot sites

Date: March 14-15, 2002
Location: CETESB
Attendees: Peter Shilland, Project Manager, CDM
José Antonio Oliveira de Jesus, Deputy Project Manager, Cobrape
Fernando Gonçalves de Castro, Cobrape

Edson Haddad, Manager, Emergency Operations Sector, CETESB
Rodrigo Cesar de Araújo Cunha, Manager, Preventive Action Group, CETESB
Jorge Luiz Nobre Gouveia, Chemist, Emergency Operations Sector, CETESB
Elton Gloeden, Remediation Group, CETESB
Vicente Aquino Neto, Remediation Group, CETESB

Topics: **March 14**
Presentation of Field Study procedures, results, conclusions and recommendations.
March 15
Presentation of Risk to Human Health and Safety (RTHS) ranking system, including derivation, results and interpretation.

Software Development Memorandum
September 4, 2001

CDM

Appendix A

M E M O R A N D U M

TO: CETESB

FROM: Myron S. Rosenberg

DATE: Sept 4, 2001

SUBJECT: CETESB UST Technical Assistance – Preliminary Discussion of Software Development

---

This memorandum presents CDM's current understanding of the software development-related scope of services on the above project. This scope is based loosely on the language contained in Task 1 of CDMs proposal, and more specifically on the agreements made during our meeting of 20 July, 2001.

Background

During the period 2-6 July, 2001, CDM and CETESB representatives engaged in a series of in-person meetings to explore needs and objectives of the referenced project. One of the needs is to design and execute a ranking system that prioritizes pre-remedial activities of the UST Program in the State of Sao Paulo. A project objective to address this need is to build and implement the ranking system in accordance with the following requirements:

- The rankings should be database-driven;
- The database should be an amended version of the UST database already developed by CETESB and maintained in SQL-7 over a wide area network;
- The logic and mathematics of the ranking methodology must rely solely on the data being provided to CETESB by the UST owners in the form of responses to the UST census questionnaire already distributed by CETESB.

CETESB expressed a **secondary** need as having intranet (web) access to the ranking system including exploration, reporting and system maintenance tools. However, at an internal (CDM) meeting on 20 July 2001, based on a full review of the developmental costs of such tools, it was determined that the level-of-effort required to address this desire is in excess of available project budget. Therefore, this work will **not** be included in the project at this time. However, CDM will be happy to discuss this web-based work , as a separate contract, in the future.

Terminology

Adoption of the following nomenclature will improve communication on the project and better enable us to achieve our Task 1 objectives and deliverables most easily.

> Census questionnaire - a set of questions UST owners must answer in order to become registered under the Sao Paulo state UST program. CETESB has constructed a data structure to house the information provided by owners as fields in a SQL-7 database.
>
> Back-end - the database that holds the information and performs procedures within a software application.

The back-end of the UST Management System I software to be developed for this project will be an augmented version of the SQL-7 database that has already been implemented by CETESB to maintain census questionnaire data, also referred to as "facility data.".

Facility data - data about the characteristics of facilities and facility ownership that is being provided in the census questionnaire and that will be maintained within the UST Management System.

Field - a specific item in the SQL-7 database of the UST Management System

Mock-up - a storyboard, or "facsimile" of what a software product will look and behave like, when finished.

Prototype - a roughly-constructed, but functioning piece of software that contains some or all of the functional capabilities that a finished product will have.

Ranking data - data that CDM will develop during this project, that will be maintained in the UST Management System

Ranking Methodology - a set of equations and logic that results in an ordinal ranking of USTs based on a quantitative value of risk. The ranking methodology will be developed by CDM as part of this project.

Ranking System - the ranking methodology as implemented in the UST Management System. The ranking system will be developed by CDM as part of this project.

SQL-7 - a relational database management system software product produced by MicroSoft. SQL-7 is the corporate standard database of CETESB as well as the back-end of the CETESB UST Management System.

Tables - a collection of database fields into logical groupings for purposes of efficiency of data access. CETESB has already developed a number of SQL-7 tables to maintain facility data.

UST Management System - the name, proposed by CDM, for the software CETESB has begun developing to contain census questionnaire (facility) data and that CDM will augment during this project to include the ranking system.

Web interface - Browser software, and the network over which it operates, that allows multiple users to view, analyze and report on ranking system data contained in the back-end of the Ranking System.

Application Environment

Because Task 1 involves implementing software that will operate on an already-developed back-end database, it is important to understand the full environment within which the software will be deployed. The UST Management System (UMS) is envisioned by CETESB to contain facility data, ranking data, compliance data and digital map data, all of which work seamlessly to support the data management and reporting requirements of the UST program. The status of each of these data sets is as follows:

- Facility data is being collected by CETESB;
- Ranking data will be derived automatically from the facility data within the ranking system software being developed by CDM as part of this project;
- Compliance data has not yet been planned by CETESB;
- Map data is being collected by CETESB under a different project

While CETESB envisions the UMS to ultimately contain all the above data, CDMs scope of services under Task 1 involves working with facility and ranking data only.

As envisioned by CETESB, the UMS data will **ultimately** be accessible to users through a web interface. CDM's Task 1 work, therefore, will be performed in a manner that facilitates the development of a web interface to the ranking system by CETESB, at a future date.

In order to establish a detail;ed Task 1 methodology, CDM developed a high-level design of the UMS in the form of a Powerpoint mock-up. This mock-up, attached, illustrates both the functional hierarchy of

the application and what the web interface to the application may look like, if developed by CETESB at a later date. **Even though CDM will not be developing the web interface, this mock-up is an important element of CDM's planning since, if it is consistent with the client's vision of the application, it will enable us to streamline Task 1 work to deliver the most efficient back-end database possible for the ranking system.**

Scope of Services

1.Existing Systems Review - The purpose of this task is to gain a complete understanding of the technology environment within which the UMS will operate. This includes detailed discussions and email correspondence with CETESB information technology staff, analysis of the ErWIN SQL-7 data model, evaluation of the Facility Data entity relationship diagram, field and table definitions, business rules, naming conventions and software development standards.

2.Ranking System Analysis - The purpose of this task is to understand fully the ranking methodology to be discussed with CETESB at meetings on 4 September 2001, so that CDM's "systems analysts" can implement it within SQL-7. This task includes preparing written specifications to use in developing and documenting the methodology.

3.Set up Development Environment - This task provides for setting up the hardware and software on which the development work will take place. The development environment established by CDM must emulate the environment the client maintains.

4.SQL Design/build - This task is where the SQL-7 back-end database development takes place. In this task, the following activities will occur:

- The Facility Database provided by CETESB will be augmented to include tables and fields to store the ranking data
- Business logic will be implemented to relate data fields to domain tables and other validation mechanisms to enforce referential integrity
- Computations and logical operations that comprise the ranking methodology (as finally defined and documented) will be implemented
- Stored procedures, if necessary, will be implemented
- **A single Crystal Report will be developed and implemented as a single button within a VisualBasic interface screen. The report will be a simple tabular summary of the ranking of UST facilities for which facility data (and, therefore ranking data) exist. The specific contents of the report will be defined in the prototype, with the understanding that the report will be a simple listing of the values of ranking data and results.**

5.SQL Test - The results of subtask 4 will be tested by an applications developer that is not a part of the project team. The purpose o f this task is exercise appropriate peer review/quality assurance prior to delivering the software product to theclient.

6. Documentation - electronic documentation and a written letter of transmittal of the Task 1 product will be produced in this task.

CDM will continue to communicate with CETESB as the ranking methodology and its SQL-7 coding is moving towards finalization and completion.

Memorandum

To: *Edson Haddad, CETESB*

From: *Myron Rosenberg, Peter Shilland CDM*

Date: *September 24, 2001*

Subject: *Task 3 Progress Report*

This memorandum provides a report of CDM's progress on Task 3 (Census Questionnaire and Database Development Guidance) of the CETESB Underground Storage Tank Project. This report follows the meetings held between CDM and CETESB during the week of September 3, 2001 when Dr. Myron Rosenberg of CDM presented an interim report of progress on this task and adjustments made to CDM's proposed scope of services since the Workshop Meetings of the week of July 2, 2001.

Background

During the period July 2-6, 2001, CDM and CETESB representatives engaged in a series of meetings to explore needs and objectives of the referenced project. One of the needs is to design and execute a ranking system that prioritizes pre-remedial activities of the UST Program in the State of São Paulo. A project objective to address this need is to build and implement the ranking system in accordance with the following requirements:

- The rankings should be database-driven;
- The database should be an amended version of the UST database already developed by CETESB and maintained in SQL-7 over a wide area network;
- The logic and mathematics of the ranking methodology must rely solely on the data being provided to CETESB by the UST owners in the form of responses to the UST census questionnaire already distributed by CETESB.

CETESB expressed a secondary need for intranet (web) access to the ranking system including exploration, reporting and system maintenance tools. However, at an internal (CDM) meeting on 20 July 2001, based on a full review of the developmental costs of such tools, it was determined that the level-of-effort required to comply with this request is in excess of available project budget. An initial estimate of the development and implementation costs of a web-access system is approximately $150,000, which would compromise the adequate completion of other project tasks.

Application Environment
Because Task 3 involves implementing software that will operate on an already-developed back-end database, it is important to understand the full environment within which the software will be deployed. The UST Management System (UMS) is envisioned by CETESB to contain facility data, ranking data, compliance data and digital map data, all of which work seamlessly to support the data management and reporting requirements of the UST program. The status of each of these data sets is as follows:

- Facility data is being collected by CETESB;
- Ranking data will be derived automatically from the facility data within the ranking system software being developed by CDM as part of this project;
- Compliance data has not yet been planned by CETESB;
- Map data is being collected by CETESB under a different project

While CETESB envisions the UMS to ultimately contain all the above data, CDMs scope of services under Task 3 involves working with facility and ranking data only. As envisioned by CETESB, the UMS data will ultimately be accessible to users through a web interface. CDM's Task 3 work, therefore, will be performed in a manner that facilitates CETESB's future development of a web interface.

In order to establish a detailed Task 3 methodology, CDM developed a high-level design of the UMS in the form of a Powerpoint mock-up to illustrate both the functional hierarchy of the application and what a future web interface would look like. This mock-up is provided to CETESB on a disk in conjunction with this progress report. Although development of the web interface will not be conducted under the current project, its future incorporation is being considered in designing the most efficient back-end database possible for the ranking system.

Scope of Services
CDM's scope of services for Task 3 is summarized below:

1. **Existing Systems Review**: The purpose of this on-going task is to gain a complete understanding of the technology environment within which the UMS will operate. This includes detailed discussions and email correspondence with CETESB information technology staff (principally Antonio Bruni), analysis of the ErWIN SQL-7 data model, evaluation of the Facility Data entity relationship diagram, field and table definitions, business rules, naming conventions and software development standards.

2. **Ranking System Analysis**: The purpose of this task is to understand fully the ranking

methodology that was discussed with CETESB during the weeks of September 3 and September 10, 2001. CDM Systems Analysts (Phil Chernin, Ange Roeske) are currently implementing this within SQL-7. This task includes preparing written specifications to use in developing and documenting the methodology.

3. **Setup Development Environment:** This task provides for setting up the hardware and software on which the development work will take place. The development environment established by CDM must emulate the environment the client maintains.

4. **SQL Design/Build:** This task is where the SQL-7 back-end database development takes place. In this task, the following activities will occur:

   - The Facility Database provided by CETESB will be augmented to include tables and fields to store the ranking data;
   - Business logic will be implemented to relate data fields to domain tables and other validation mechanisms to enforce referential integrity;
   - Computations and logical operations that comprise the ranking methodology (as finally defined and documented) will be implemented;
   - Stored procedures, if necessary, will be implemented.

   A single Crystal Report will be developed and implemented as a single button within a Visual Basic interface screen. The report will be a simple tabular summary of the ranking of UST facilities for which facility data (and, therefore ranking data) exist. The specific contents of the report will be defined in the prototype, with the understanding that the report will be a simple listing of the values of ranking data and results.

   Once a Crystal Report has been generated, the Viewer includes the capability to download the ranking data to MS Excel via a button. CETESB personnel may then perform additional sorting tasks with the utility of MS Excel.

5. **SQL Test**: The results of subtask 4 will be tested by an applications developer that is not a part of the project team. The purpose o f this task is exercise appropriate peer review/quality assurance prior to delivering the software product to the client.

6. **Documentation:** Electronic documentation and a written letter of transmittal of the Task 3 product will be produced in this task.

CETESB UST Facility Questionnaire
(Translated)

	CHARACTERIZATION OF **RANKS AND RETAIL SYSTEMS FOR FUELS**	**SAMPLE DATE** **___ / ____ / 200__**

1 - IDENTIFICATION

1.1 – TYPE OF ESTABLISHMENT (*)

RANK OF VENDOR	☐	RANK OF SUPPLIER	☐
RETAILING SYSTEM INSTALLATION	☐	FLOATING RANK	☐

1.2- DATA ON THE ESTABLISHMENT(*)

SOCIAL RATIO:

FULL NAME: FLAG:

ADDRESS:

NUMBER: COMPLEMENT: CEP: QUARTER:

CITY: TELEPHONE: UF:

FAX: e-mail:

GEOGRAPHIC COORDINATES (UTM) LATITUDE: LONGITUDE: ALTITUDE:

HYDROGRAPHIC BASIN: UGRHI:

CÓD. ACTIVITY (IBGE) C.N.P.J. Nº:

REG. CURRENT ANP: REG. PREVIOUS ANP:

STATE INSC.: CITY INSC.:

START DATE: _____/ _____/ _____

1.3-THOSE RESPONSIBLE (*)

CURRENT BEARER OF THE SOCIAL RATIO:

IDENTITY DOC.: DISPATCHING ORGÃO: UF: CPF:

ADDRESS:

NUMBER: COMLEMENT: CEP: QUARTER :

CITY: TELEPHONE:

FAX: e-mail:

1.4 – PEOPLE TO CONTACT

IN ROUTINE SITUATIONS:

NAME:

POSITION: TELEPHONE:

FAX: e-mail:

IN EMERGENCY SITUATIONS:

NAME:

POSITION: TELEPHONE:

FAX:		e-mail:
CELLULAR:	PAGER COD.:	TEL. DRIVE:

(*) Filling instructions are attatched.

1.5- DELIVERER

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDANCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:	TELEPHONE:	UF:	
FAX:	e-mail:		

1.6 FORNECEDORA(*)

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDENCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:	TELEPHONE:	UF:	
FAX:	e-mail:		

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDENCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:	TELEPHONE:	UF:	
FAX:	e-mail::		

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDENCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:	TELEPHON:	UF:	
FAX:	e-mail::		

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDENCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:	TELEPHONE:	UF:	
FAX:	e-mail::		

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDENCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:	TELEPHONE:	UF:	
FAX:	e-mail::		

(*) Filling instructions are attatched.

2 – GENERAL CHARACTERISTICS

CLASSIFICATION: (Conform NBR 13.786, of ABNT – Brazilian Association of NormTechniques) Applicable only for SACS (*)

☐ CLASS 0 ☐ CLASS 1 ☐ CLASS 2 ☐ CLASS 3

AREA (m^2):

TOTAL LAND:_____ CONSTRUCTED:_____ OUTDOOR ACTIVITY:_____

WORKING HOURS:

_____ HOURS / DAY _____ DAYS / MONTH _____ DAYS / YEAR

FUNCTION SCHEDUAL:

FROM: _____ TO _____ (TIME)

NUMBER OF EMPLOYEES:

ADMINISTRATION: _____ OPERATION: _____ TOTAL: _____

FEATURES OF THE NEIGHBORING REGION (*)

- MULTIFAMILIAR BUILDING WITH UP TO FOUR FLOORS, WITHOUT AN UNDERGROUND GARAGE (NBR 13786) ☐
- MULTIFAMILIAR BUILDING WITH MORE THAN FOUR FLOORS, WITH AN UNDERGROUND GARAGE (NBR 13786) ☐
- COMMERCIAL / CLERICAL BUILDINGS WITH MORE THAN FOUR FLOORS (NBR 13786) ☐
- SLUM QUARTER WITH AN EQUAL OR INFERIOR QUOTA (NBR 13786) ☐
- SCHOOL ☐
- DAY CARE CENTER ☐
- HOSPITAL (NBR 13786) ☐
- RELIGIOUS TEMPLE (NBR 13786) ☐
- HOUSE OF SPECTACLES (NBR 13786) ☐
- OVERTHROWN BUILDING FOR THE HISTORICAL PATRIMONY ☐
- RISKY INDUSTRIAL ACTIVITY (CONFORME NB- 16) (NBR 13786) ☐
- UNDERGROUND GARAGE (NBR 13786) ☐
- TUNNEL (NBR 13786) ☐
- RAILROAD ☐
- SUBWAY (NBR 13786) ☐
- HIGHWAY ☐
- PLUVIAL WATER DRAINING GALLERY (NBR 13786) ☐
- SUPPLYING WATER NETWORK (NBR 13786) ☐
- SEWER NETWORK (NBR 13786) ☐
- FOSSA (NBR 13786) ☐
- GAS NETWORK (NBR 13786) ☐
- ELECTRICAL NETWORK (NBR 13786) ☐
- PIPELINE ☐
- GASLINE ☐
- AIRPORT ☐
- MILITARY AREA ☐
- CEMITARY ☐

(*) Filling instructions are attatched.

PARK	☐
SPORTS AREA	☐
AGRICULTURAL AREA	☐
CATTLE AREA	☐
HORTAS	☐
MINING	☐
NATURAL FOREST	☐
AREA OF AMBIENT PROTECTION	☐
AREA OF RESOURCE PROTECTION	☐
BODIES OF WATER DESIGNATED FOR PUBLIC SUPPLY (NBR 13786)	☐
BODIES OF WATER DESIGNATED FOR FOR THE PROTECTION OF AQUATIC COMMUNITIES (NBR 13786)	☐
BODIES OF WATER DESIGNATED FOR PRIMARY CONTACT RECREATION (NBR 13786)	☐
BODIES OF WATER DESIGNATED FOR IRRIGATION (NBR 13786)	☐
BODIES OF WATER DESIGNATED FOR THE GROWTH OF SPECIES FOR FOOD (NBR 13786)	☐
BODIES OF WATER DESIGNATED FOR PUBLIC SUPPLY (NBR 13786)	☐
USE OF UNDERGROUND WA TER FOR PUBLIC SUPPLY (NBR 13786)	☐
USE OF UNDERGROUND WATER FOR DOMESTIC SUPPLY (NBR 13786)	☐
INDUSTRIAL USE OF UNDERGROUND WATER	☐
VALLEY SUBJECT TO FLOODING	☐
LAGOON/DAM/OCEAN	☐

3- THE ESTABLISHMENT'S AGGREGATE COMMERCE AND JOBS (*)

☐ LAUDERING SIMPLE/COMPLETE	☐ FAST WASHING
☐ SPRAYING	☐ LUBRICATION
☐ BORRACHARIA	☐ ELECTRIC AUTO
☐ AUTO PARTS STORE	☐ PARKING
☐ BAR / SNACK BAR	☐ GARAGE
☐ CONVENIENCE STORE	☐ DUCHA
☐ OIL CHANGE	☐ MECHANIC
☐ RESTAURANT	☐ SALE OF GLP
☐ OTHERS (SPECIFY)	

(*) Filling instructions are attatched.

4.1.4- Description of Emptyings: (*)

Event Date	Pump Nº	Tank Nº	Identification Number	Line	Respiration	Extracting Machine Valve	Filter	Other Equipment	Emptied Product

4.1.5- Cathodic Protection: (*)

Tank Nº	Possul protection system (yes/no)	Type (Specify one of three options- anodo of sacrifice, current printed, or other)	System Maintenance	
			Frequency	Last Date

4.2- ARIAL

4.2.1- STORED PRODUCTS AND FEATURES: (*)

Reservation Nº	Identification Number	Installation Number	Type and Material	Location	* Number of Compartments	Requalification Date	Breathing		*Proprietor (List one of three options – Proprietor of the enterprise, distributor or other)
							Altitude	Distance of Recepticle	

Type or Material = TS: Simple Mettalic Wall; TN: Simple Non-Metallic Wall; TD: Double Metallic Wall; TJ: Non - Metallic Double Wall; TO: Other.
Feed = BB:Individual - Simple; BT: Individual w/ Contaminant Reservoir; SS: Individual Stamped; ST: Individual Stamped w/ Contaminant Reservoir; BO: Others.
Location = A: Tank in Use; D: Disactivated Tank
Stored Product = GC: Common Gasoline; GA: Gasoline w/ additives; GE: Special Gasoline; GT: Special Gasolin w/ Additives, AC: Common Alcohol; AA: Alcohol w/ Additives; DC: Common Diesel; DA: Diesel w/ Additives; DM: Metropolitan Diesel; DD: Maritime Diesel; QE: Kerosene, OC: Combustíble Oil.

(*) Filling instructions are attatched

This Table will reflect the number of compartments of the tank.

Compartments			
Identification	Capacity(liters)	Stored Product	Storage Opening

This table will be open so that the selected option in the last column of item 4.1.3. will always be for others.
Others

SOCIAL RATIO:		CONTACT NAME:	
CORRESPONDANCE ADDRESS:			
NUMBER:	COMPLEMENT:	CEP:	QUARTER:
CITY:		TELEONE:	UF:
FAX:	e-mail:		

4.2.2- SUPPLY SYSTEM CONTROL: (*)

☐ RULER ☐ HYDRAULIC ☐ ELECTRONIC

☐ OTHER (SPECIFY) :

☐ LCM - BOOK OF FUEL MO VEMENT UP TO DATE ? YES NO ☐ ☐

4.2.3- Equipment: (*)

Unid. de Abastec. Nº	Identification Number	Connection to Tank Nº	Line Material	Installation Date	Retention Valve	Filter Type	Date of Last Integrity Finding	*Proprietor (List one of three options - Proprietor of the enterprise, distributor or other)

Line Material= LM: Rigid-Metallic; LS: Non-Mettallic w/ Simple Wall; LD: Non-Metallic w/ Double Wall; LL: Other.
Type= *S: Suction; P: Pressurized.*
Retention Valve= VS: Installed at the foot of the pump (Check Valve); VT: Inststalled on the inside of the tank (Cebola);.I: Non-existant
Type of Filter= FP: Filtro Presses; FC: w/ Ceramic Element; FM: w/ Metallic Element; FT: w/ Woven Filter; FO: Others., i: Non -existant

(*) Filling instructions are attatched.

6.3- WASHING OF VEHICLES: (*)

☐ W/O PAVMENT	☐ CONCRETE	☐ ASPHALT	☐ BLOCRETE	☐ COBBLESTONE	☐ OTHER
☐ GOOD		☐ REASONABLE			☐ POOR

COLLECTION OF SERVED WATER: YES NO RETENTION BOX FOR SOLIDS: ☐ YES ☐ NO

CONNECTED TO THE S.A.O.: ☐ YES ☐ NO PROPER S.A.O ☐ YES ☐ NO SLOT S.A.O. ☐ YES ☐ NO

6.4- DISCHARGE AREA: (*)

☐ CONCRETE	☐ ASPHALT	☐ BLOCRETE	☐ COBBLESTONE	☐ OTHER
☐ GOOD		☐ REASONABLE		☐ POOR

DISCHARGE AREA W/ DRAINAGE CANALS: YES ☐ NO ☐ INTERLINKED TO S.A.O. ☐ YES ☐ NO

7- INFORMATION REGARDING WATER UASGE

7.1- MONTHLY CONSUMPTION OF WATER (m^3) (*)

Source of supply	Identification	Consumption (m^3/month)		Total (m^3/month)
		Sanitary	Commercial	
Wells				
Superficial				
Network				
Other				
Total (m^3/month)				

8- POLLUTION CONTROL SYSTEMS

8.1- Effluent Liquids: (*)

Type	Quantity (m^3 / month)	Treatment System (Including the dictionary - dbo_DICNRTRATM)	Final Disposal (Including the dictionary - dbo_DICNRDISPSFINAL)
Domestic Sewer			
Service Effluents			

8.2- Residues: (*)

Type (Including the dictionary - dbo_DICNRRESDU)	Quantity	Unit	Storage (Including the dicionary - dbo_DICNR**)	Final Disposal (Including the dictionary - dbo_DICNR*****)
Domestic				
Burnt Oil				
Tank Drainage				
Retention Box for Solids				
Packings				
Other				

(*) Filling instructions are attatched.

8.3- Prevention / Detainment of Emptyings and spillings: (*)

☐ MONITERING INTERSTICIAL	☐ MONITERING WELLS	☐ OTHER (SPECIFY)
☐ FIXED SENSORS FOR THE SUMP PUMPS AND FOR THE VISIBLE TANK OPENINGS		
☐ SUPPLY RECONCILIATION	☐ CONTINUOUS CONTROL FOR THE SUPPLY (ELECTRONIC)	
☐ OVERFLOW PROTECTION VALVE	☐ PUMP CONTAINMENT CHAMBER	
☐ CLAMPING VALVE FOR FLOATING SPHERE	☐ DISCHARGE CONTAINMENT CHAMBER	
☐ VAPOR MONITORING WELLS	☐ ACCESS CHAMBER FOR VISIBLE OPENINGS	

8.4- Amosheric Emissions: (*)

RESPIIRATIONS ☐ YES ☐ NO	SUPPLYING POINTS ☐ YES ☐ NO	DISCHARGE TUB ☐ YE ☐ NO
SPECIFY:		

9- ACCIDENT PREVENTION AND EMERGENCY

9.1- FIRE COMBAT SYSTEM: (*)

APPROVED BY THE FIREFIGHTERS CORPS :	☐ YES ☐ NO	DATE OF APPROVAL / /
N° OF AUTO INSPECTION:	☐ YES ☐ NO	VALIDATION / /

9.2 EPAE – Emenrgency attendance team: (*)

POSESSION OF EMERGENCY ATTENDANCE TEAM:	☐ YES	☐ NO
☐ PROPER	☐ TERCEIRIZADA	☐ DELIVERING COMPANY
COMPANY:		
CONTACT:		POSITION:
TEL. COM.:		
CELLULAR:	PAGE COD.:	TEL. DRIVE:

10- COMPLIMENTARY INFORMATION

10.1- Source of Noise and Vibration: (*)

Equipment	Quantity	Functioning Schedule	Control Measurements

(*) Filling instructions are attatched.

11- DELIVERY AND RECEIVING

11.1- Representative of the do Establishment:

I declare for the due ends of right, duly warned criminal and civil responsibility, that the information above given are the purest expression of the truth.

NAME:	POSITION:
SIGNATURE:	R.G.:
MCE [ ]	ATTATCHED: [ ] YES [ ] NO [ ] QUANTITY

11.2- Protocol:

RECEIVED BY:	REG. Nº:
DATE:	VISA OF EMPLOYEE:

(*) Filling instructions are attatched

CETESB Database Data Dictionary
(Translated)

CDM

Document Code

Table/Column

Table Name	Table Column Name	Table Column Comment (portuguese)	Table Column Comment (english)
COMBS	NMUNCP		
	NSEQNC		
	AINFRM		
	NCOMBS		
	NCOMBSIDENT		
	QCOMBS		
	CUNIDDMEDDA		
	PTEORENXFR		
	ISITCA		
DICNRBASE	NBASE	Tipo da Base do Tanque Aéreo	Type of Base of the Above-Ground Tank
	DBASE	Descrição da Base do Tanque Aéreo	Description of the Above-Ground Tank's Base
	DBASERESMD	Descrição Resumida da Base do Tanque Aéreo	Summarized Description of the Base of the Aerial Tank
	ISITCA	Situação do registro	Location of Register
DICNRBOCACARRG	NBOCACARRG	Número da Boca de Carregamento	Number of Tank Fill Ports
	DBOCACARRG	Descrição da Boca de Carregamento	Description of the Tank Fill Ports
	DBOCACARRGRESMD	Descrição Resumida da Boca de Carregamento	Summarized Description of the Shipment Mouth
	ISITCA	Situação do registro	Location of Register
DICNRCOMBS	NCOMBS		
	DCOMBS		
	DCOMBSRESMD		
	CESTDOFISCO		
	ISITCA		
DICNRCOMRCSERVC	NCOMRCSERV	Número do Comércio e Serviço	Number of the Commerce and Job
	DCOMRCSERV	Descrição do Tipo de Comércio e Serviço agregado ao Posto	Description of the Type of Commerce and aggregate Job to the Rank
	DCOMRCSERVRESMD	Descrição Resumida do Tipo de Comércio e Serviço agregado ao Posto	Summarized Description of the Type of Commerce and aggregate Job to the Rank.
	ISITCA	Situação do registro	Location of Register
DICNRDESTNRESDU	CDESTNRESDU		
	DDESTNRESDU		
	DDESTNRESDURESMD		
	ISITCA	A-Armazenado, D-Disposto, B-A/D	A-Armazenado (storage), D-Disposto (disposition), B-A/D
DICNRDISPSFINAL	NDISPSFINAL		
	DDISPSFINAL		
	DDISPSFINALRESMD		
	ISITCA		
DICNRESTDOFISCO	CESTDOFISCO		
	DESTDOFISCO		
	DESTDOFISCORESMD		
	ISITCA		
DICNRFILTRO	NFILTRO	Tipo do Filtro	Type of the Filter
	DFILTRO	Descrição do Tipo do Filtro	Description of the Type of the Filter
	DFILTRORESMD	Descrição Resumida do Tipo do Filtro	Summarized Description of the Type of the Filter
	ISITCA	Situação do registro	Location of the register
DICNRMATRLTANQU	NMATRL	Número do Material do Tanque	Number of the Tank's Material
	DMATRL	Descrição do Material do Tanque	Description of the Material in the Tank
	DMATRLRESMD	Descrição Resumida do Material do Tanque	Summarized Description of the Material in the Tank
	IMATRLTANQULINHA	Tipo do Material do Tanque ou Linha: T-Tanque, L-Linha	Type of the Material of the Tank or Line: T-Tank, L-Line
	ISITCA	Situação do registro	Location of Register
DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
	DMONTR	Descrição do Monitoramento Ambiental	Description of the Ambient (environmental) Monitoring
	DMONTRRESMD	Descrição Resumida do Monitoramento Ambiental	Summarized Description of the Ambient (environmental) Monitoring
	ISISTM	Tipo do Sistema: S-Subterrâneo, A-Aéreo, D-Subterrâneo e Aéreo, G-Geral	Type of the System: S-subterranean, A- Aerial D-Subterranean and Aerial, G-General
	IEQUPM	Tipo do Equipamento:T-Tanque, B-Bomba, P-Poço, O-Outros	Equpment type: T-tank; B- pump; P - well; O - others
	ISITCA	Situação do registro	Location of Register
DICNRRESDU	CRESDU		
	DRESDU		
	DRESDURESMD		
	IMATRLRESDU		

	ISITCA		
DICNRTRATM	NTRATM		
	DTRATM	Descrição do Tratamento	Description of the Handling
	DTRATMRESMD	Descrição Resumida do Tratamento	Summarized Description of the Handling
	ISITCA	Situação	Situation
DICNRUNIDDMEDDA	CUNIDDMEDDA		
	DUNIDDMEDDA		
	DUNIDDMEDDARESMD		
	CSIGLAUNIDDMEDDA		
	NCONVRMULTP		
	ISINALOPERC		
	NEXPNT		
	ISITCA		
DICNRUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo	Number of the land Use and Occupation
	DUSOOCUPCSOLO	Descrição do Uso e Ocupação do Solo	Description of the land Use and Occupation
	DUSOOCUPCSOLORESMD	Descrição Resumida do Uso e Ocupação do Solo	Summarized Description of the land Use and Occupation
	ISITCA	Situação do registro	Location of Register
DICNRVALVLRETNC	NVALVLRETNC	Válvula de Retenção	Clamping Valve
	DVALVLRETNC	Descrição da Válvula de Retenção	Description of the Clamping Valve
	DVALVLRETNCRESMD	Descrição Resumida da Válvula de Retenção	Summarized Description of the Clamping Valve
	ISITCA	Situação do registro	Location of Register
EMPRS	NMUNCP		
	NSEQNC		
	DFANTS		
	DRAZAOSOCIL		
	DLOGRD		
	NLOGRD		
	DLOGRDCOMPM		
	DBAIRR		
	CCEP		
	NDDD		
	NTELFN		
	NTELEX		
	CCGC		
	NRCQA		
	NBACIA		
	NUGRHI		
	CIBGE		
	DATIVD		
	ACADST		
	NSITCA		
	SMICROEMPRS		
	QLATTD		
	QLONGT		
	QALTTD		
	CCPF		
	DEMAIL		
	NINSCRESTDL		
	NINSCRMUNCP		
	CSITU		
MUNCP	NMUNCP		
	DMUNCP		
	DRESMDMUNCP		
	NREGNL		
	NRCQA		
	ISITCA		
MUNCPPOCO	NMUNCP		
	DFORNC	Descrição do Fornecedor	Supplying Description
	NPOCO	Número de poços	Number of wells
	ISITCA	Situação do registro	Location of Register
REGNL	NREGNL		
	DREGNL		
	DRESMDREGNL		
	CSIGLAREGNL		

	NREGNLMAE		
	NREGNLRESPN		
	IREGIA		
	CCGC		
	DLOGRD		
	NLOGRD		
	DLOGRDCOMPM		
	DBAIRR		
	NMUNCP		
	CCEP		
	NDDD		
	NTELFN		
	NDDDFAX		
	NFAX		
	NINSCRESTDL		
	ISITCA		
RESDU	NMUNCP		
	NSEQNC		
	AINFRM		
	CRESDU		
	NRESDUIDENT		
	QRESDU		
	CUNIDDMEDDA		
	ICLASSRESDU		
	CESTDOFISCO		
	CIO		
	KRESDUORIGN		
	KCOMPS		
	KMETDO		
	KASPCT		
	ISITCA		
RESDUDESTN	NMUNCP		
	NSEQNC		
	AINFRM		
	CRESDU		
	NRESDUIDENT		
	CDESTNRESDU		
	DLOCAL		
	QRESDU		
	CUNIDDMEDDA		
	ISITCA		
SUGESTOES	NMUNCP		
	NSEQNC		
	DRAZAOSOCIL		
	SUGESTAO		
	COD		
TB_POSTO	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential Number
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Request Number
	IESTBL	Tipo do posto: A-Abastecimento, R-Revendedor, F-Flutuante, I-Instalação Retalhista	Type of the rank: A- Supplying, R-Resale, F-Fluctuant, I-Instalation of retailer
	DBANDR	Nome da Bandeira	Name of the Flag
	NANP	Número da Agencia Nacional de Petróleo - (RJ1234567)	Number of the National Agency of Petroleum - (RJ1234567)
	NANPANTRR	Número da Agencia Nacional de Petróleo anterior - 7 dígitos numéricos	Number of the National Agency of previous Petroleum - 7 numerical digits
	ICLASSABNT	Classificação ABNT(0, 1, 2, 3)	Sorting ABNT(0, 1, 2, 3)
	QAREATERRN	Area do terreno	Area of the land
	QAREACONST	Area construida	Constructed Area
	QAREAARLIVRE	Area de atividade ao ar livre	Area of the outdoor activity
	QFUNCNADMNS	Número de Funcionários administrativos	Number of administrative Employees
	QFUNCNOPERC	Número de Funcionários operacionais	Number of operational Employees
	HINICIFUNCM	Hora Início de funcionamento	Beginning Time of functioning
	HTERMNFUNCM	Hora Término de funcionamento	Ending Time of functioning
	NHORASJORNDDIA	Número horas de jornada de trabalho por dia	Number working hours per day
	NDIASJORNDMES	Número de dias de jornada de trabalho por mes	Number of working days per month
	NDIASJORNDANO	Número de dias de jornada de trabalho por ano	Number of working days per year

	ILOCLZATIVD	Localização da atividade: U-Urbana, R-Rural, E-Residencial, C-Comercial, I-Industrial	Location of the activity: U-Urban, R—rural , E-Residential, C-Commercial, I-Industrial
	AINICIATIVD	Data de início de atividade (DD/MM/AAAA)	Date of beginning of activity (DD/MM/YYYY)
TB_POSTOAREAABAST	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential Number
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	SSEMPAVMN	Se a Área de Abastecimento é sem Pavimento	If the Supplying Area of is not paved.
	SCONCR	Se a Área de Abastecimento é em Concreto	If the Supplying Area is Concrete
	SASFLT	Se a Área de Abastecimento é em Asfalto	If the Supplying Area is Asphalted
	SBLOCR	Se a Área de Abastecimento é em Blocrete	If the Supplying Area is in Blocrete
	SPARLL	Se a Área de Abastecimento é em Paralelepípedo	If the Supplying Area is cobble stone.
	SOUTRO	Se a Área de Abastecimento é Outro Tipo	If it is another type of Supplying Area
	SDRENG	Se a Área de Abastecimento tem Canaleta de Drenagem	If the Supplying Area has a Narrow channel of Draining
	SDRENGSAO	Se a Área de Abastecimento tem Canaleta de Drenagem Interligada ao SAO	If the Supplying Area of Supplying has Narrow channel of Linked Draining to the SAO
	SDRENGDEMAS	Se as Demais Áreas tem Canaleta de Drenagem	If the Excessive Areas have a Narrow channel of Draining
	SDRENGDEMASSAO	Se as Demais Áreas tem Canaleta de Drenagem Interligada ao SAO	If the Excessive Areas have a Narrow channel of Linked Draining to the SAO
TB_POSTOAREADESCG	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential number
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	SCONCR	Se a Área de Descarga é em Concreto	If the Dumping Area is Concrete
	SASFLT	Se a Área de Descarga é em Asfalto	If the Dumping Area is Asphalted
	SBLOCR	Se a Área de Descarga é em Blocrete	If the Dumping Area is Blocrete
	SPARLL	Se a Área de Descarga é em Paralelepípedo	If the Dumping Area is cobble stone.
	SOUTRO	Se a Área de Descarga é Outro Tipo	If it is a Another Type of Dumping Area
	SDRENG	Se a Área de Descarga tem Canaleta de Drenagem	If the Dumping Area has a Narrow Draining channel
	SDRENGSAO	Se a Área de Descarga tem Canaleta de Drenagem Interligada ao SAO	If the Dumping Area has Narrow channel of Linked Draining to the SAO
	SSEMPAVMN	Se a Área de Descarga é Sem Pavimento	If the Dumping Area is unpaved.
TB_POSTOAREALAVGM	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential Number
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	SSEMPAVMN	Se a Área de Lavagem é sem Pavimento	If the Laudering Area has an unfinished Floor.
	SCONCR	Se a Área de Lavagem é em Concreto	If the Laudering Area of is Concrete
	SASFLT	Se a Área de Lavagem é em Asfalto	If the Laudering Area is Asphalted.
	SBLOCR	Se a Área de Lavagem é em Blocrete	If the Laudering Area is in Blocrete
	SPARLL	Se a Área de Lavagem é em Paralelepípedo	If the Laudering Area is cobble stone
	SOUTRO	Se a Área de Lavagem é Outro Tipo	If it is Another Type of Laudering Area
	SCOLTAAGUASERVD	Se a Área de Lavagem tem Coleta de Àguas Servidas	If the Laudering Area has a Collection of Served water
	SCAIXARETNCSOLDO	Se a Área de Lavagem tem Caixa de Retenção de Sólidos	If the Laudering Area has Box of Solid Clamping
	SSAO	Se a Área de Lavagem é interligada ao SAO	If the Laudering Area is linked to the SAO
	SSAOPROPR	Se a Área de Lavagem é interligada ao SAO Próprio	If the Laudering Area is linked to the Proper SAO
	SSAOPISTA	Se a Área de Lavagem é interligada ao SAO Pista	If the Laudering Area is linked to the SAO Slot
TB_POSTOAREATROCAOLEO	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential Number
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	SSEMPAVMN	Se a Área de Troca de Oleo é sem Pavimento	If the Oil Swamp Area of is not paved.
	SCONCR	Se a Área de Troca de Oleo é em Concreto	If the Oil Swamp Area is Concrete
	SASFLT	Se a Área de Troca de Oleo é em Asfalto	If the Oil Swamp Area is Asphalted
	SBLOCR	Se a Área de Troca de Oleo é em Blocrete	If the Oil Swamp Area is in Blocrete
	SPARLL	Se a Área de Troca de Oleo é em Paralelepípedo	If the Oil Swamp Area is cobble stone.
	SOUTRO	Se a Área de Troca de Oleo é Outro Tipo	If it is another type of Oil Swamp Area
TB_POSTOBACIA	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential Number
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBACIA	Número da Bacia (Identificação)	Basin Number (Identification)
	QCONTN	Capacidade de Contenção Bacia em metros cúbicos	Capacity of Containment Basin in cubic meters
	IREVST	Tipo de Revestimento: Concreto, Manta, Solo Natural, Outros(Especificar)	Type of Covering: Concrete, Blanket, Soil, Others (specify)
	SDRENG	Se Existe Sistema de Drenagem ou Não	Weather a Draining System Exists or not
	DDESTN	Se Existe, informar o Destino	If it exists, location it drains to.

TB_POSTOBACIARESRV	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Company's Sequential Number
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBACIA	Número da Bacia (Identificação)	Number of the Basin (Identification)
	ITANQU	Tipo do Tanque (A-Aéreo)	Type of Tank (A-Aerial)
	NTANQU	Número do Resevatório	Number of the reservoir
TB_POSTOBALNCHIDRC	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	IFONTEABAST	Tipo de Fonte de Abastecimento d'água:1P-Poços, 2S-Superficial, 3R-Rede, 4O-Outros, 5T-Total(m3/mês)	Type of Source of Supplying of water:1P-wells , 2S-Superficial, 3R-net, Ô-Other, 5T-Total(m3/month)
	NFONTEABASTIDENT	Número de Identificação da Fonte de Abastecimento	Identification number of the Source of Supplying
	DFONTEABAST	Identificação da Fonte de Abastecimento	Identification of the Source of Supplying
	QCONSMSANTR	Consumo Sanitário em m3/mes	Bathroom consume in m3/mes
	QCONSMCOMRC	Consumo Comercial em m3/mes	Commercial consumption in m3/month
TB_POSTOBOMBA	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	NBOMBA	Número da Bomba	Number of the pump
	NIDENT	Número de identificação da bomba	Identification number of the pump
	AINSTL	Data da Instalação	Date of the Installation
	NVALVLRETNC	Válvula de Retenção (Dicionário de Válvula de Retenção)	Clamping Valve (Dictionary of Valve of Clamping)
	NFILTRO	Tipo do Filtro (Dicionário de Tipo de Filtro)	Type of the Filter (Dictionary of Type of Filter)
	ATESTEESTNQ	Data do Ultimo Teste de Estanqueidade	Date of the Last Test of stanching
	SSISTMPROTC	Possui Sistema de Proteção	Has System of Protection
	IPROTC	Tipo de Proteção (A-Anodo de Sacrifício, C-Corrente Impressa, O-Outros)	Type of Protection (A-Anodo de Sacrifício, C-Corrente Printed, O-Other)
	DPROTC	Descrição da Proteção quando IPROTC=O (Outros)	Description of the Protection when IPROTC=O (Other)
	IPROPR	Tipo do Proprietário: P-Proprietário, D-Distribuidora, O-Outros	Type of the Proprietor: P-Proprietor, D-Distributor, O-Other
	ITESTEESTNQ	R-Realizado, NR-Não Realizado, ND-Não Disponível	R-Realized; NR- not realized, ND-not available
TB_POSTOBOMBAPROPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	NBOMBA	Número da Bomba	Number of the pump
	DRAZAOSOCIL	Razão Social Proprietário da Bomba	Social Ratio Proprietor of the pump
	DCONTT	Nome do contato	Name of the contact
	DLOGRD	Logradouro	Public park
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPDISTRFORNC	Número do Município	Number of the City
	DMUNCPDISTRFORNC	Município (preenchido quando for outro estado)	City (filled when it will be another state)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTOBOMBATANQU	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	NBOMBA	Número da Bomba	Pump number
	NTANQU	Número do Tanque	Tank number
	NCOMPR	Número do Compartimento	Compartment number
	NMATRL	Número do Material (Dicionário de tipo de material do tanque, linha)	Number of the Material (Dictionary of type of material of the tank, string)
	ILINHA	Tipo da Linha: S-Sucção, P-Pressurizada	Type of the String: S-Suction, P-Pressurized
TB_POSTOCOMRCSERVC	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company

	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NCOMRCSERVC	Número do Comércio e Serviço (Dicionário de Comércio e Serviços)	Number of the Commerce and Job (Dictionary of Commerce and Jobs)
	DCOMRCSERVC	Descrição do Tipo de Comércio e Serviço para Outros	Description of the Type of Commerce and Job for Others
TB_POSTOCONTRESTQU	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	ICONTRESTQUREGUA	Tipo do Controle de Estoque: R-Régua	Type of the Control of Supply: R-Rule
	ICONTRESTQUHIDRL	Tipo do Controle de Estoque: H-Hidráulico	Type of the Control of Supply: H-Hydraulic
	ICONTRESTQUELETR	Tipo do Controle de Estoque: E-Eletrônico	Type of the Control of Supply: E-Electronic
	ICONTRESTQUPNEMT	Tipo do Controle de Estoque: P-Pneumático	Type of the Control of Supply: P-Pneumatic
	ICONTRESTQUMAGNT	Tipo do Controle de Estoque: M-Magnético	Type of the Control of Supply: M-Magnetic
	ICONTRESTQUOUTRO	Tipo do Controle de Estoque: O-Outros	Type of the Control of Supply: O-Other
	DCONTRESTQU	Descrição do Controle de Estoque quando ICONTRESTQUOUTRO=O	Description of the Supply Control of when ICONTRESTQUOUTRO=O
	SLMC	Se existe o LMC (Livro de Movimentação de Combustíveis)	If it exists what is the LMC (Book of Fuel Movement)
	SATULZ	Se o LMC é atualizado	If the LMC is brought up to date
TB_POSTOCONTT	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	DNOMEROTNR	Nome do contato rotineiro	Name of the routine contact
	DCARGOROTNR	Cargo	Position
	NDDDROTNR	DDD	DDD
	NTELFNROTNR	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAILROTNR	Email	email
	NCELLRROTNR	Celular	cell phone
	DNOMEEMERG	Nome do contato emergencial	Name of the emergent contact
	DCARGOEMERG	Cargo	Position
	NDDDEMERG	DDD	DDD
	NTELFNEMERG	Telefone	Telephone
	NFAXEMERG	Fax	Fax
	DEMAILEMERG	Email	email
	NCELLREMERG	Celular	cell phone
	NPAGEREMERG	Pager	Pager
	NDDDACINM	DDD acionamento	DDD drive
	NTELFNACINM	telefone acionamento	telephone drive
TB_POSTODISTRFORNC	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NIDENT	Número de identificação do distribuidor ou fornecedor	Identification number of the deliverer or supplier
	DRAZAOSOCIL	Razão Social Distribuidora/Fornecedora	Social Ratio Distributor/Furnisher
	IDISTRFORNC	Tipo Distribuidora/Fornecedora: D-Distribuidora, F-Fornecedora	Type of Distribution/Fornushing: D-Distributer, F-Fornusher
	DCONTT	Nome do contato	Name of the contact
	DLOGRD	logradouro	street
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPDISTRFORNC	Número do Município	Number of the City
	DMUNCPDISTRFORNC	Município (preenchido quando for outro estado)	City (filled when its another state)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTOEFLNTLIQDO	NMUNCP	Número do Município da Empresa	City Number of the Company

	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	IEFLNTLIQDO	Tipo de Efluente Líquido: D-Doméstico, S-Serviço, D-Drenagem de Tanque	Type of Liquid Effluent: D-Domestic, S-Service, D-Drainage of Tanks
	QEFLNTLIQDO	Quantidade de Efluente Líquido em m3/mes	Amount of Liquid Effluent in m3/month
	NTRATM	Número do Sistema de Tratamento (Dicionário de Sistema de Tratamento)	Number of the System of Handling (Dictionary of System of Handling)
	NDISPSFINAL	Número da Disposição Final (Dicionário de Disposição Final)	Number of the Final Disposal (Final Dictionary of Disposal)
TB_POSTOENTRG	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	DNOME	Nome do Responsável	Name of the Responsible
	DCARGO		
	NRG	RG	ID
	IANEXO		
	NQUANT		
TB_POSTOGASBATRI	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBATRI	Número da Bateria de Armazenagem	Number of the Battery of Storage
	AINSTL	Data da Instalação	Dates of the Installation
	QCILND	Quantidade de Cilindros	Amount of Cylinders
	AMANTNULTMA	Data da Ultima Manutenção	Dates of the Last Maintenance
	IPROPR	Tipo do Proprietário: P-Proprietário, D-Distribuidora, O-Outros	Type of the Proprietor: P-Proprietor, D-Distributer, O-Other
	ISITCA	Situação da Bateria Tanque: A-Em uso, D-Desativado	Situation of the Battery Tank: A-in use, D-not active
TB_POSTOGASBATRIPROPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBATRI	Número da Bateria	Number of the Battery
	DRAZAOSOCIL	Razão Social Proprietário da Bateria	Social Ratio Proprietor of the Battery
	DCONTT	Nome do contato	Name of the contact
	DLOGRD	Logradouro	Public park
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPDISTRFORNC	Número do Município (Dicionário de Muncicípio)	Number of the City (Dictionary of Muncipality)
	DMUNCPDISTRFORNC	Município (preenchido quando for outro estado)	City (filled when it will be another state)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTOGASBOMBA	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBOMBA	Número da Bomba	Pump number
	NIDENT	Número de Identificação da Bomba	Pump Identification number
	AINSTL	Data da Instalação	Installation Dates
	NBICO	Número de Bicos	Number of Peaks
	AMANTNULTMA	Data da Ultima Manutenção	Date of the Last Maintenance
	IPROPR	Tipo do Proprietário: P-Proprietário, D-Distribuidora, O-Outros	Type of the Proprietor: P-Proprietor, D-Distributer, O-Other
	ISITCA	Situação da Bomba: A-Em uso, D-Desativado	Location of the Pump: A – in use, B – not active
TB_POSTOGASBOMBABATRI	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBOMBA	Número da Bomba	Pump number
	NBATRI	Número da Bateria	Battery Number
	NMATRL	Número do Material (Dicionário de tipo de material da linha)	Number of the Material (Dictionary of type of material of the string)

TB_POSTOGASBOMBAPROPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Number of the Request
	NBOMBA	Número da Bomba	Pump number
	DRAZAOSOCIL	Razão Social Proprietário da Bomba	Ratio Social Proprietor of the Pump
	DCONTT	Nome do contato	Name of the contact
	DLOGRD	Logradouro	Public park
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPDISTRFORNC	Número do Município (Dicionário de Muncicípio)	Number of the City (Dictionary of Muncipality)
	DMUNCPDISTRFORNC	Município (preenchido quando for outro estado)	City (filled when its in another state)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTOGASCOMPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	NCOMPR	Número do Compressor	Compressor Number
	NIDENT	Número de identificação do Compressor	Compressor Identification Number
	AINSTL	Data da Instalação	Date of the Installation
	AMANTNULTMA	Data da Ultima Manutenção	Date of the Last Maintenance
	IPROPR	Tipo do Proprietário: P-Proprietário, D-Distribuidora, O-Outros	Type of proprietor: P-Proprietor, D-Distributer, O-Other
	ISITCA	Situação do Compressor: A-Em uso, D-Desativado	Situation of the Compressor: A-in use, D-nor active
TB_POSTOGASCOMPRBATRI	NMUNCP	Número do Município da Empresa	Number of the City of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	NCOMPR	Número do Compressor	Compressor Number
	NBATRI	Número da Bateria	Number of the Battery
	NMATRL	Número do Material (Dicionário de tipo de material da linha)	Number of the Material (Dictionary of type of material of the string)
TB_POSTOGASCOMPRPROPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	NCOMPR	Número do Compressor	Compressor Number
	DRAZAOSOCIL	Razão Social do Proprietário do Compressor	Social Ratio of the Proprietor of the Compressor
	DCONTT	Nome do contato	Name of the contact
	DLOGRD	Logradouro	Public park
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPDISTRFORNC	Número do Município	Number of the City
	DMUNCPDISTRFORNC	Município (preenchido quando for outro estado)	City (filled when its in another state)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTOGASVAZMN	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Request Number
	AVAZMN	Data do Vazamento	Emptying Dates
	ILOCAL	Local do Vazamento: U-Unidade de Abastecimento, B-Bateria, C-Compressor, O-Outros Equipamentos	Emptying location: U-Unit of supplying, B-Battery, C-Compressor, O-Other
	NBOMBA	Número do Tanque - deve ser informado quando o ILOCAL=T, opcional quando ILOCAL=R ou V	Equipment Number of the Tank - it must be informed when the ILOCAL=T, optional when ILOCAL=R or V

	NCOMPR	Número do Compartimento - opcional quando o ILOCAL=T ou V ou R	Number of the Compartment - optional when ILOCAL=T or V or R
	NBATRI	Número da Bateria - deve ser informado quando o ILOCAL=B, opcional quando ILOCAL=L	Number of the Battery - it must be informed when the ILOCAL=B, optional when Local ILOCAL=L
	DLOCAL	Local do Vazamento quando ILOCAL=O	Local of the Emptying when ILOCAL=O
	DACAO	Ação tomada	Action taken
TB_POSTOMONTRAMBNT	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	NMONTR	Tipo do Monitoramento Ambiental	Type of the Ambient (environmental) Monitoring
	IEQUPM	Tipo do Equipamento Monitorado: T-Tanque, B-Bomba, O-Outros	Type of the Monitored Equipment: T-Tank, B-Pump, O-Other
	NEQUPM	Número do Tanque ou Bomba ou Nulo quando IEQUPM=O(Outros)	Number of the Tank or Pump or Null when IEQUPM=O(Other)
	DMONTR	Tipo do Monitoramento Ambiental preenchido quando IEQUPM=O(Outros)	Type of the filled Ambient (environmental) Monitoring when IEQUPM=O(Other)
B_POSTOMOVMN	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	NCOMBS	Número do Combustível (Dicionário de Combustível)	Number of the Fuel (Fuel Dictionary)
	NSEQNCCOMBS	Número de Sequência do Combustível	Sequential Number of the Combustible
	DCOMBS	Descrição do Combustível quando o Combustível Selecionado for Outros	Description of the Fuel when the Selected Fuel will be Other
	QCOMBS	Quantidade de Combustível Movimentado	Amount of Moving Fuel
	CUNIDDMEDDA	Unidade de Medida (Dicionário de Unidade de Medida)	Unit of Measure (Dictionary of Unit of Measure)
TB_POSTOPREVNACIDN	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	AAPRVC	data da aprovação pelo corpo de bombeiros	Approval date for the body of firemen
	NAUTOVISTR	Número do auto de vistoria	Number of the auto one of inspection
	AAUTOVISTR	Data de validade do auto de vistoria	Date of validity of the auto one of inspection
	SEQUPEEMERG	Se existe a Equipe de Atendimento à Emergência	If the Emergency exists the Team of Attendance
	SEQUPEEMERGPROPR	Se existe a Equipe Própria de Pronto Atendimento à Emergência	If the Proper Team exists to the Emergency
	SEQUPEEMERGTERCR	Se existe a Equipe Terceirizada de Pronto Atendimento à Emergência	If the external Team exists Attendance to the Emergency
	SEQUPEEMERGDISTR	Se existe a Equipe da Companhia Distribuidora de Pronto Atendimento à Emergência	If the Team of the Deliverering Company of Ready Attendance to the Emergency exists
	DRAZAOSOCIL	Razão Social de Pronto Atendimento à Emergência	Social Ratio of Ready Attendance to the Emergency
	DCONTT	Nome do contato	Name of the contact
	DCARGO	Cargo	Position
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NCELLR	Celular	Cell phone
	NPAGER	Pager	Pager
	NDDDACINM	DDD acionamento	DDD drive
	NTELFNACINM	telefone acionamento	telephone drive
TB_POSTOPREVNEMISSAO	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	IFONTE	R-Respiro, B-Bico de Abastecimento, C-Braço de Carregamento, T-Tubo de Descarga, O-Outros	R-Breathing, B-Peak of supplying, C-Arm of shipment, T-Pipe of discharge, O-Other
	DFONTEOUTRO	Descrição da fonte para IFONTE=OUTRO	Description of the source for IFONTE=Other
	DDISPSCONTR	Dispositivo de Controle	Control Device
TB_POSTOPREVNVAZMN	NMUNCP	Número do Município da Empresa	Number of the City of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Dates of the Information
	NSOLCT	Número da Solicitação	Request Number
	NPREVNVAZMN	Número da Prevenção de Vazamento e Derramamento (Dicionário de Prevenção de Vazamento)	Number of the Prevention of Emptying and Spilling (Dictionary of Prevention of Emptying)
	DPREVNVAZMN	Prevenção de Vazamento e Derramamento para NPREVNVAZMN=Outros	Prevention of Emptying and Spilling for NPREVNVAZMN=Other
TB_POSTORESDU	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company

	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	IRESDU	Tipo de Resíduo: D-Doméstico, Q-Óleo Queimado, L-Limpeza de Tanque, C-Caixa de Retenção de Sólidos, E-Embalagens, S-Estopa, F-Filtros, O-Outros	Type of Trash: D-Domestic, Q-Processed Oil, L-Tank cleaning, C-Solid retention box, E-packing, S-cloth, F-Filter, O-Other
	DRESDU	Resíduo quando Tipo de Resíduo=Outros	Trash when Type of Waste=Other
	QRESDU	Quantidade de Resíduo	Amount of Trash
	CUNIDDMEDDA	Código da Unidade de Medida (Dicionário de Unidade de Medida)	Code of the Unit of Measure (Dictionary of Unit of Measure)
	CDESTNRESDUARMZN	Código da Destinação de Resíduo (Dicionário de Destinação de Resíduo) Armazenamento	Code of the Destination of Trash (Dictionary of Destination of Trash)
	CDESTNRESDUTRATD	Código da Destinação de Resíduo (Dicionário de Destinação de Resíduo) Disposição Final	Storage Code of the Destination of Trash (Dictionary of Destination of Trash) Final Disposal
TB_POSTORESPN	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	DRESPN	Nome do Responsável	Name of the Responsible
	NRG	RG	ID
	DRGORGAO	Orgão Emissor	Emitting Organism
	IUF	UF	UF
	CCPF	CPF	CPF
	DLOGRD	Logradouro	Public park
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPRESPN	Número do Município	Number of the City
	DMUNCPRESPN	Município (preenchido quando é de outro Estado)	City (filled when it is from another State)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTORUIDO	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential number of the company
	AINFRM	Data da Informação	
	NSOLCT	Número da Solicitação	Request Number
	IFONTE	C-Compressor para Serviço, A-Aspirador, V-Ventilador para Secagem de Veículos, N-Compressor para GNV, G-Gerador, O-Outros	C – compressor for service, A-Aspirator, V-Ventilator for Drying of Vehicles, N-Compressor for GNV, G-Generator, O-Other
	DFONTEOUTRO	Descrição do Equipamento para IFONTE=Outros	Description of the Equipment for IFONTE=Other
	QFONTE	Quantidade de Equipamentos Fontes de Ruido	Amount of Equipment Sources of singing
	HINICIFUNCM	Hora Início de funcionamento	Start time of functioning
	HTERMNFUNCM	Hora Término de funcionamento	End time of functioning
	DMEDDACONTR	Medida de Controle	Control Measurement
TB_POSTOTANQU	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterráneo	Type of the Tank: A-Aerial, S-Subterranean
	NTANQU	Número do Tanque	Number of the Tank
	NIDENT	Número de identificação do tanque	Identification number of the tank
	AINSTL	Data da Instalação	Date of the Installation
	NMATRL	Número do Material (Dicionário de tipo de material do tanque)	Number of the Material (Dictionary of type of material of the tank)
	QCOMPRT	Quantidade de Compartimentos	Amount of Compartments
	ATESTEESTNQ	Data do Ultimo Teste de Estanqueidade	Date of the Last Test of stanches
	SSISTMPROTC	Possui Sistema de Proteção: S-Sim, N-Não	Exist System of Protection: S-Yes, N-No
	IPROTC	Tipo de Proteção (Subter: A-Anodo de Sacrifício, C-Corrente Impressa, O-Outros; Aéreo: S-Sem proteção, P-Primer, R-Primer e Resina Epoxi, O-Outros)	Type of protection (Subter: A-Anodo de Sacrifício, C-Corrente Printed, O-Other; Aerial: S-without protection, P-Primer, R-Primer and Resina Epoxi, O-Other)
	DPROTC	Descrição da Proteção quando IPROTC=O (Outros)	Description of the Protection when IPROTC=O (Other)
	IPROPR	Tipo do Proprietário: P-Proprietário, D-Distribuidora, O-Outros	Type of Proprietor: P-Proprietor, D-Distributer, O-Other
	IPOSCA	Posição do Tanque Aéreo: H-Horizontal, V-Vertical (obrigatório para Aéreo)	Position of the Aerial Tank: H-Horizontal, V-Vertical (obligator for Aerial)
	NBASE	Tipo da Base do Tanque Aéreo (obrigatório para Aéreo) Dicionário de Base p/ Tanque Aéreo	Type of Aerial Tank Base (obligator for Aerial) Dictionary of Base p / Aerial Tank
	DMATRLOUTRO	Descrição do Material para Tanque Aéreo para NMATRL=>Outro	Description of the Material for Aerial Tank for NMATRL=>Other
	ITESTEESTNQ	R-Realizado, NR-Não Realizado, ND-Não Disponível	R-Realized, NR – not realized ND – not available

	AMANTNULTMA	Data da Ultima Manutenção	Last Date of Maintenance
	IFREQNMANTN	D, M, Q, S	D, M, Q, S
	ISITCA	Situação do Tanque: A-Em uso, D-Desativado	Location of the Tank: A-in use, D-not active
TB_POSTOTANQUCOMPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	NTANQU	Número do Tanque	Tank Number
	NCOMPR	Número do Compartimento	Compartment Number
	NBOCACARRG	Número da Boca de Carregamento/Alimentação (Dicionário de Boca de Carregamento)	Number of Shipment/furnishing opening (Dictionary of Shipment opening)
	QCAPCD	Capacidade de Armazenamento em m3-2 casas decimais	Capacity of Storage in m3-2 decimal houses
	NCOMBS	Número do Combustível (Dicionário de Combustível)	Fuel Number (Fuel Dictionary)
	QRESPRALTRA	Altura do Respiro em m	Respiration Height in meters
	QRESPRDISTCRECPT	Respiro - Distância do Receptor em m	Respiration - Receptor distance in meters
TB_POSTOTANQUPROPR	NMUNCP	Número do Município da Empresa	City Number of the Company
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	AINFRM	Data da Informação	Date of the Information
	NSOLCT	Número da Solicitação	Request Number
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	NTANQU	Número do Tanque	Tank Number
	DRAZAOSOCIL	Razão Social Proprietário do Tanque	Social Ratio Proprietor of the Tank
	DCONTT	Nome do contato	Name of the contact
	DLOGRD	Logradouro	Public park
	NLOGRD	Número	Number
	DLOGRDCOMPM	Complemento	Complement
	DBAIRR	Bairro	Quarter
	CCEP	CEP	CEP
	NMUNCPDISTRFORNC	Número do Município (Dicionário de Muncicípio)	Number of the City (Dictionary of Muncipality)
	DMUNCPDISTRFORNC	Município (preenchido quando for outro estado)	City (filled when it will be another state)
	NDDD	DDD	DDD
	NTELFN	Telefone	Telephone
	NFAX	Fax	Fax
	DEMAIL	Email	email
TB_POSTOUSOOCUPCSOLO	NSOLCT	Número da Solicitação	Request Number
	AINFRM	Data da Informação	Date of the Information
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	NMUNCP	Número do Município da Empresa	City Number of the Company
	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)
TB_POSTOVAZMN	NSOLCT	Número da Solicitação	Number of the Request
	AINFRM	Data da Informação	Date of the Information
	NSEQNC	Número de Sequência da Empresa	Sequential Number of the Company
	NMUNCP	Número do Município da Empresa	City Number of the Company
	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean
	AVAZMN	Data do Vazamento	Emptying Dates
	ILOCAL	Local do Vazamento: T-Tanque, B-Bomba, L-Linha, R-Respiro, V-Válvula Extratora, F-Filtro, O-Outros Equipamentos, C-Boca de carregamento	Local of the Emptying: T-Tank, B-Pump, L-Line, R-Breathing, V-Valve Extracting machine, F-Filter, O-Other Equipment, shipment C-Shipment Mouth
	NTANQU	Número do Tanque - deve ser informado quando o ILOCAL=T, opcional quando ILOCAL=R ou V	Tank Number- it must be informed when the ILOCAL=T, optional when ILOCAL=R or V
	NCOMPR	Número do Compartimento - opcional quando o ILOCAL=T ou V ou R	Compartment Number - optional when ILOCAL=T or V or R
	NBOMBA	Número da Bomba - deve ser informado quando o ILOCAL=B, opcional quando ILOCAL=L	Number of the Pump - it must be informed when the ILOCAL=B, optional when Local ILOCAL=L
	DLOCAL	Local do Vazamento quando ILOCAL=O	Local of the Emptying when ILOCAL=O
	NCOMBS	Produto Vazado (Dicionário de Combustível)	Leaked Product (Fuel Dictionary)
	DACAO	Ação Decorrente (Substituição, Desativação, Impermeabilização, Reparo e Nenhuma)	Action current (Substitution, Deactivation, Waterproofing, Repair and None)
	DACAOSITCA	Situação da Ação	Situation of the Action

Risk Ranking Calculation Factors and Relationship to CETESB SQL-7 Database

CDM

Appendix A

RISK TO HEALTH AND SAFETY (RTHS): Derivation

RTHS = PIF + LLF - RRF

Relative RTHS = PIF + LLF – RRF / max (PIF + LLF - RRF)

Where: RTHS = Risk to Human Health and Safety

PIF = Potential Impact Factor

LLF = Leak Likelihood Factor

RRF = Risk Reduction Factors

POTENTIAL IMPACT FACTOR (PIF) Description

PIF includes risk associated with water supply receptors, physical receptors types, and land use. These factors are derived from yes/no fields in the questionnaire database.

POTENTIAL IMPACT FACTOR (PIF) Derivation

$$PIF = f\,[(SRw)w + (SRb)w + (Lu)w]$$

Where:

PIF = Potential Impact Factor
SRw = Sensitive Receptor water/environmental
SRb = Sensitive Receptor building or facility
Lu = Land use
w = weight factor

POTENTIAL IMPACT FACTOR (PIF)
Category Weights

	Weights
Sensitive Receptor water/environmental (SRw)	4
Sensitive Receptor building or facility (SRb)	2
Land use (Lu)	1

PIF: *Water Resources* (SRw) Values and Weights

Field Name	Field Description	Field Type	Value	Weight
Areas of Ambiant Protection	ÁREA DE PROTEÇÃO AMBIENTAL	Yes/No	0 or 1	1
Areas of Resource Protection	ÁREA DE PROTEÇÃO DE MANANCIAIS	Yes/No	0 or 1	1
Water Body: Public Supply	CORPOS D` ÁGUA DESTINADOS AO ABASTECIMENTO PÚBLICO (NBR 13786)	Yes/No	0 or 1	4
Water Body: Aquatic Community	CORPOS D` ÁGUA DESTINADOS À PROTEÇÃO DAS COMUNIDADES AQUÁTICAS (NBR 137	Yes/No	0 or 1	2
Water Body: Irrigation	CORPOS D` ÁGUA DESTINADOS À IRRIGAÇÃO (NBR 13786)	Yes/No	0 or 1	2
Water Body: Food Growth	CORPOS D` ÁGUA DESTINADOS À CRIAÇÃO DE ESPÉCIES DESTINADAS À ALIMENTAÇÃO	Yes/No	0 or 1	2
Groundwater: Public Supply	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA ABASTECIMENTO PÚBLICO (NBR 13786)	Yes/No	0 or 1	5
Groundwater: Domestic Supply	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA ABASTECIMENTO DOMÉSTICO (NBR 13786)	Yes/No	0 or 1	4
Groundwater: Industrial Use	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA USO INDUSTRIAL	Yes/No	0 or 1	1
Lagoon/Dam/Ocean		Yes/No	0 or 1	1

PIF: *Building/Facility* (SRb) Values and Weights

Field Name	Field Description	Field Type	Value	Weight
Multifamily without underground garage	Edificio de multifamiliar sem sub	Yes/No	0 or 1	1
Multifamily with underground garage	Edificio de multifamiliar com sub	Yes/No	0 or 1	3
Commercial	Edificio de ecritoio commerciales	Yes/No	0 or 1	1
Slum Quarter	Favela	Yes/No	0 or 1	2
School	Escola	Yes/No	0 or 1	2
Day Care Center	Creche	Yes/No	0 or 1	3
Hospital	Hospital	Yes/No	0 or 1	2
Underground Garage	Garagem subterranea	Yes/No	0 or 1	1
Tunnel	Tunel	Yes/No	0 or 1	1
Subway	Metro	Yes/No	0 or 1	1
Gas Network	Rede de gas	Yes/No	0 or 1	1
Oil Pipeline	Oleduto	Yes/No	0 or 1	1
Gasline (LGE)	Gasoduto	Yes/No	0 or 1	1

PIF: *Land Use* (Lu) Values and Weights

Field Name	Field Description	Field Type	Value	Weight
Residential		E	1	4
Commercial		C	2	3
Industrial		I	3	1
Urban		U	4	3
Rural		R	5	1

LEAK LIKELIHOOD FACTOR (LLF) Description

Leak likelihood is derived from the risk associated with the type of equipment or factors affecting the ability for an UST facility to have a leak.

LEAK LIKELIHOOD FACTOR (LLF) Derivation

$$LLF = f\,[T(tw+Vw+Aw)+Pw+Ltw+Lnw+Fw+Cw+Sw+Phw+Osw]$$

Where:

w = Weight Factor
T = Tank (AST or UST)
t = Tank Type
V = Tank Volume
A = Tank Age
P = Pump Type
Lt = Line Type
Ln = Line Amount
F = Filter
C = Cathodic Protection
S = Total Sales Volume
Ph = Service Area/Physical Features
Os = Used Oil Storage

LEAK LIKELIHOOD FACTOR (LLF)
Values and Weights

	Field Name	Field Desc.	Field Type	Value	Weight
T=	Tank (AST or UST)	If only AST fields are filled Tank = 0 risk	by Type	A=0, S=1	1
t=	Tank Type	by category	range by value, see attached table LLF		
V=	Tank Volume	Computed from table	range by value, see attached table LLF		
A=	Tank Age	Assume oldest	range by value, see attached table LLF		
P=	Pump Type	by category	type	S=1, P=5	1
Lt=	Line Type	by category	range by value, see attached table LLF		
Ln=	Line Amount	Computed from Line table, # of lines will be greater risk	range by value, see attached table LLF		
F=	Filter	presence/absence	yes/no	0, 1	2

LEAK LIKELIHOOD FACTOR (LLF)
Values and Weights *(continued)*

	Field Name	Field Desc.	Field Type	Value	Weight
C=	Cathodic Protection	yes/no, or by category	Yes/No	0 or 1	5
S=	Total Sales Volume	Computed from table	range by value, see attached table LLF		
Ph=	Service Area/Physical Features	by category	yes/no for several tables/fields, see LLF table		
		if Supply area/Oil change area has a yes in			
		any pervious category risk is assumed			
Os=	Used Oil Storage	by category	range by value, see attached table LLF		
	Oleo Queimado				

LEAK LIKELIHOOD FACTOR (LLF)
Tank Type detail

Tank Type		TB_POSTOTANQU		
see DICNRMATRLTANQU material dictionary table		DMATRL	NMATRL	
Code	**Type and Material**	**Tipo e Material**	**Number?**	**Value**
TS	simple metallic wall	Parede Simples Metalico	1	14
TN	simple non-metallic wall	Parede Simples nao Metalico	2	10
TD	metallic double wall	Parede Dupla Metalico	3	3
TJ	non-metallic double wall	Parede Dupla nao Metalico	4	2
TO	Other	Outros	5	15
Source: Texcao and BP				
Initial Weights at 1.				

LEAK LIKELIHOOD FACTOR (LLF)
Tank Volume Detail

TB_POSTOTANQUCOMPR	NCOMPR	Número do Compartimento	Number of the Compartment
	QCAPCD	Capacidade de Armazenamento em m3-2 casas decimais	Capacity of Storage in m3-2 decimal places
Need to total all compartments at a facility. Convert to K liters			
	Total Tank Volume thousands of liters	**Value**	
	< 40	1	
	40 - 90	3	
	91 - 140	5	
	141 - 250	9	
	251 - 375	12	
	> 375	15	

LEAK LIKELIHOOD FACTOR (LLF)
Sales Volume Detail

Volume of Sales by Month			
Source Table	**Field**	**Desc.**	**Desc.**
TB_POSTOMOVMN	QCOMBS	Quantidade de Combustível Movimentado	Amount of Moving Fuel
	CUNIDDMEDDA	Unidade de Medida (Dicionário de Unidade de Medida)	Unit of Measure (Dictionary of Unit of Measure)
Need total fuel sale by month.			
in K l/month ?			
	Total Sales Volume (thousands of liters/month)	**Value**	
	< 400	1	
	400 - 900	3	
	910 - 1400	5	
	1410 - 2500	9	
	2510 - 3750	12	
	> 3750	15	

RISK REDUCTION FACTORS (RRF) Description

Risk reduction factors are factors used to incorporate the assumed reduced risk posed at a facility due to the use of leak detection or prevention equipment

RISK REDUCTION FACTORS (RRF) Derivation

$$RRF = f\,(Imw+Ww+Fsw+Rcw+Csw+Ow+Cvw+Vpw+Ccw+Dcw+Acw)$$

Where:

Im	=	Monitoring Interstitial	Ac	=	Access Chamber
Fsp	=	Fixed Sensors Sump Pump	Pm	=	Monitoring Wells
Fst	=	Fixed Sensors Tank	Pv	=	Vapor Monitoring Wells
O	=	Overflow Protection	At	=	Overflow Alarm
Cv	=	Check Valve	ML	=	Leveling Device
Vp	=	Pump Containment Chamber			

RISK REDUCTION FACTORS (RRF)
Values and Weights

	Field Name	Field Desc.	Field Type	Value	Weight
Im=	Monitoring Intersticial	Monitoramento Intersticial	Yes/No	0 or 1	3
Fsp=	Fixed Sensors Sump Pump	Sensores Fixos em Câmara de Contenção da Bomba	Yes/No	0 or 1	4
Fst=	Fixed Sensors Tank	Sensores Fixos em Boca de Visita de Tanques	Yes/No	0 or 1	2
O=	Overflow Protection	Válvula de Proteção para Transbordamento	Yes/No	0 or 1	2
Cv=	Check Valve	Válvula de Retenção de Esfera Flutuante	Yes/No	0 or 1	2
Vp=	Pump Containment Chamber	Câmara de Contenção da Bomba	Yes/No	0 or 1	1
Ac=	Access Chamber	Câmara de Acesso à Boca de Visita	Yes/No	0 or 1	4
Pm=	Monitoring Wells	Poços de Monitoramento	Yes/No	0 or 1	4
Pv=	Vapor Monitoring Wells	Poços de Monitoramento de Vapor	Yes/No	0 or 1	2
At=	Overflow Alarm	Alarme Contra Transbordamento	Yes/No	0 or 1	2
ML=	Leveling Device	Medidor de Nível	Yes/No	0 or 1	1

RISK TO HEALTH AND SAFETY
Summary RTHS Report *(15 sites)*

NREGNL	DMUNCP	DRAZAOSOCIL	NSOLCT	PIF	LLF	RRF	RTHS
1	SÃO PAULO	SPEED GAS POSTO DE ABASTECIMENTO DE COMBUS	31000872	6.00	79.00	0.00	85.00
1	SÃO PAULO	VIAÇÃO GATO PRETO LTDA.	29003065	5.00	52.00	0.00	57.00
3	SÃO JOSÉ DOS CAMPOS	PORTAL VILA EMA AUTOMOTIVOS LTDA.	3002255	5.00	79.00	0.00	84.00
4	JARDINÓPOLIS	TRR GROTTI COMERCIAL LTDA	4002241	5.00	79.00	0.00	84.00
4	RIBEIRÃO PRETO	MAX PETRO COMÉRCIO DE COMBUSTIVEL LTDA	4002219	5.00	79.00	0.00	84.00
6	SOROCABA	AUTO POSTO CAPELARI E MORAIS LTDA.	6004333	4.00	79.00	0.00	83.00
7	AREALVA	AUTO POSTO MENDONÇA NICOLIELO LTDA	7001778	6.00	80.00	0.00	86.00
12	PRACINHA	RAIMUNDO FRANCISCO BEZERRA & CIA LTDA ME	12000774	6.00	69.00	0.00	75.00
12	PRESIDENTE PRUDENTE	AUTO POSTO PICOLI LTDA	12000758	7.00	79.00	0.00	86.00
12	PRESIDENTE PRUDENTE	E C DE OLIVEIRA & CIA LTDA	12000787	4.00	79.00	0.00	83.00
12	PRESIDENTE PRUDENTE	SHELL BRASIL S/A	12000792	8.00	79.00	0.00	87.00
37	PAULÍNIA	CAT CENTRAIS DE APOIO AO TRANSPORTE S/A	37000438	4.00	51.00	4.00	51.00
40	BARRETOS	CARREFOUR COMÉRCIO E INDÚSTRIA LTDA	40000273	6.00	52.00	14.00	44.00
43	MOGI GUAÇU	ESTRELA COMÉRCIO E ADMINISTRAÇÃO LTDA.	431919	4.00	79.00	0.00	83.00
60	ITATIBA	J. GAVA AUTO POSTO LTDA	5004445	5.00	56.00	0.00	61.00

Crystal Report Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Messenger

Address http://caml262/cetesb/summary.rpt

100% 1 of 1

Preview

- REGNL 1
- REGNL 3
- REGNL 4
  - JARDINÓPOLIS
  - RIBEIRÃO PRETO
    - MAX PETRO COM
- REGNL 6
- REGNL 7
- REGNL 12
- REGNL 37
- REGNL 40
  - BARRETOS
    - CARREFOUR COI
- REGNL 43
- REGNL 60

CETESB

UMS RTHS Summary Report

NREGNL	DMUNCP	DRAZAOSOCIL	NSOLCT/ AINFRM	PIF	LLF	RRF	RTHS
1	SÃO PAULO	SPEED GAS POSTO DE ABASTECIMENTO DE COMBUSTIVEIS LTDA	31000872 17-Oct-2001	6.0 detail	79.0	0.0	85.0
1	SÃO PAULO	VIAÇAO GATO PRETO LTDA.	29003065 26-Sep-2001	5.0 detail	52.0	0.0	57.0
3	SÃO JOSÉ DOS CAMPOS	PORTAL VILA EMA AUTOMOTIVOS LTDA.	3002255 08-Nov-2001	5.0 detail	79.0	0.0	84.0
4	JARDINÓPOLIS	TRR GROTTI COMERCIAL LTDA	4002241 22-Oct-2001	5.0 detail	79.0	0.0	84.0
4	RIBEIRÃO PRETO	MAX PETRO COMERCIO DE COMBUSTIVEL LTDA	4002219 15-Oct-2001	5.0 detail	79.0	0.0	84.0
6	SOROCABA	AUTO POSTO CAPELARI E MORAIS LTDA.	[illegible] 22-Oct-2001	[illegible] detail	[illegible]	[illegible]	[illegible]
7	AREALVA	AUTO POSTO MENDONÇA NICOLIELO LTDA	7001778 31-Oct-2001	6.0 detail	80.0	0.0	86.0

Details for RIBEIRÃO PRETO - MAX PETRO COMÉRCIO DE COMBUSTIVEL LT

Done

Local intranet

Crystal Report Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Messenger

Address http://caml262/cetesb/summary.rpt

100% 1 of 1

Preview RIBEIRÃO PRETO - MAX PETRO COMÉRCIO DE COMBUSTIVEL LTDA

- 4
  - RIBEIRÃO PRETO
    - MAX PETRO COM
      - RTHS
      - PIF
      - LLF
      - RRF

4

RIBEIRÃO PRETO .

MAX PETRO COMÉRCIO DE COMBUSTIVEL LTDA

	Item	Value	Blanks
Total	*RTHS*	84	77
Total	*PIF*	5	28
	SRw	0	10
	SRb	0	13
	LU	5	5
Total	*LLF*	79	38
	T	1	1
	Tt	15	6
	V	15	1
	A	12	1
	P	5	2
	LT	14	5
	F	1	7
	C	1	1
	S	15	1
	PH	0	8
	Os	0	5
Total	*RRF*	0	11
	Im	0	1
	Sb	0	1

Done Local intranet

CETESB Risk Calculation Factors Summary

RTHS= PIF+LLF-RRF **Relative RTHS= PIF+LLF-RRF/max(PIF+LLF-RRF)**

where RTHS=Risk to Human Health and Safety
PIF= Potential Impact Factor
LLF=Leak Likelyhood Factor
RRF=Risk Reduction Factors

PIF Potential Impact Factors

PIF will include risk associated with water supply receptors, physical receptors types, and land use. These factors are derrived from yes/no fields in the questionaire database.

PIF= f[(SRw)w + (SRb)w + (Lu)w]
where PIF= Potential Impact Factor
SRw=Sensitive Receptor water/environmental
SRb=Sensitive Receptor building or facility
Lu=land use
w=weight factor

Sensitive Receptor: Water/etc

Field Name	Field Desc.	Field Type	Value	Weight	Questionaire Source Table #	Database Table Name	Database Field Name	Field Name Desc. Port.	Field Name Desc. English	Note
Areas of Ambiant Protection	ÁREA DE PROTEÇÃO AMBIENTAL	Yes/No	0 or 1	1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Areas of Resource Protection	ÁREA DE PROTEÇÃO DE MANANCIAIS	Yes/No	0 or 1	1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Water Body: Public Supply	CORPOS D` ÁGUA DESTINADOS AO ABASTECIMENTO PÚBLICO (NBR 13786)	Yes/No	0 or 1	4	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Water Body: Aquatic Community	CORPOS D` ÁGUA DESTINADOS À PROTEÇÃO DAS COMUNIDADES AQUÁTICAS (NBR 13786)	Yes/No	0 or 1	2	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Water Body: Irrigation	CORPOS D` ÁGUA DESTINADOS À IRRIGAÇÃO (NBR 13786)	Yes/No	0 or 1	2	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Water Body: Food Growth	CORPOS D` ÁGUA DESTINADOS À CRIAÇÃO DE ESPÉCIES DESTINADAS À ALIMENTAÇÃO HUMA	Yes/No	0 or 1	2	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Groundwater: Public Supply	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA ABASTECIMENTO PÚBLICO (NBR 13786)	Yes/No	0 or 1	5	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Groundwater: Domestic Supply	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA ABASTECIMENTO DOMÉSTICO (NBR 13786)	Yes/No	0 or 1	4	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Groundwater: Industrial Use	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA USO INDUSTRIAL	Yes/No	0 or 1	1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Lagoon/Dam/Ocean		Yes/No	0 or 1	1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO

Sensitive Receptor: Building/Facility

Multifamily without underground garage	Edificio de multifamiliar sem sub	Yes/No	0 or 1	1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Multifamily with underground garage	Edificio de multifamiliar com sub	Yes/No	0 or 1	3	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Commercial	Edificio de ecritoio commerciales	Yes/No	0 or 1	1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Slum Quarter	Favela	Yes/No	0 or 1	2	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
School	Escola	Yes/No	0 or 1	2	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
Day Care Center	Creche			3						

	Hospital	Hospital	Yes/No	0 or 1		2	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
	Underground Garage	Garagem subterranea	Yes/No	0 or 1		1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
	Tunnel	Tunel	Yes/No	0 or 1		1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
	Subway	Metro	Yes/No	0 or 1		1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
	Gas Network	Rede de gas	Yes/No	0 or 1		1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
	Oil Pipeline	Oleduto	Yes/No	0 or 1		1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Número do Uso e Ocupação do Solo (Dicionário de Uso e Ocupação do Solo)	Number of the land Use and Occupation (Dictionary of land Use and Occupation)	see DICNRUSOOCUPCSOLO
	Gasline (LGE)	Gasoduto	Yes/No	0 or 1		1	2.0	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	Solo (Dicionário de Uso e	and Occupation	see DICNRUSOOCUPCSOLO
Land Use	Residential		E		1	4	2.0	TB_POSTO	ILOCLZATIVD	Localização da atividade: U-Urbana, R-Rural, E-Residencial, C-Comercial, I-Industrial	Location of the activity: U-Urban, R—rural , E-Residential, C-Commercial, I-Industrial	
	Commercial		C		2	3	2.0	TB_POSTO	ILOCLZATIVD	Localização da atividade: U-Urbana, R-Rural, E-Residencial, C-Comercial, I-Industrial	Location of the activity: U-Urban, R—rural , E-Residential, C-Commercial, I-Industrial	
	Industrial		I		3	1	2.0	TB_POSTO	ILOCLZATIVD	Localização da atividade: U-Urbana, R-Rural, E-Residencial, C-Comercial, I-industrial	Location of the activity: U-Urban, R—rural , E-Residential, C-Commercial, I-Industrial	
	Urban		U		4	3	2.0	TB_POSTO	ILOCLZATIVD	Localização da atividade: U-Urbana, R-Rural, E-Residencial, C-Comercial, I-Industrial	Location of the activity: U-Urban, R—rural , E-Residential, C-Commercial, I-Industrial	
	Rural		R		5	1	2.0	TB_POSTO	ILOCLZATIVD	Localização da atividade: U-Urbana, R-Rural, E-Residencial, C-Comercial, I-Industrial	Location of the activity: U-Urban, R—rural , E-Residential, C-Commercial, I-Industrial	

LLF - Leak Likelyhood Factors

Leak likelyhood is derived from the risk associated with the type of equipment or factors affecting the ability for an UST facility to have a leak.

LLF = f[T(tw+Vw+Aw)+Pw+Ltw+Lnw+Fw+Cw+Sw+Phw+Osw]

where LLF=Leak Likelyhood Factor

w=weight factor

and

	Field Name	Field Desc.	Field Type	Value	Weight						
T=	Tank (AST or UST)	If only AST fields are filled Tank = 0 risk	by Type	A=0, S=1	1	4.11	TB_POSTOBOMBATANQU or TB_POSTOTANQU ??	ITANQU	Tipo do Tanque: A-Aéreo, S-Subterrâneo	Type of the Tank: A-Aerial, S-Subterranean	
t=	Tank Type	by category	range by value, see attached table LLF			4.11	TB_POSTOTANQU	NMATRL	Número do Material (Dicionário de tipo de material do tanque, linha)	Number of the Material (Dictionary of type of material of the tank, string)	see DICNRMATRLTANQU material dictionary table
V=	Tank Volume	Computed from table	range by value, see attached table LLF			4.11	TB_POSTOTANQUCOMPR	QCAPCD	Capacidade de Armazenamento em m3-2 casas decimais	Capacity of Storage in m3-2 decimal houses	
A=	Tank Age	Assume oldest	range by value, see attached table LLF			4.11	TB_POSTOTANQU	AINSTL	Data da Instalação	Date of the Installation	
P=	Pump Type	by category	type	S=1, P=5	1	4.1.3	TB_POSTOBOMBA	ILINHA	Tipo da Linha: S-Sucção, P-Pressurizada	Type of the String: S-Suction, P-Pressurized	
Lt=	Line Type	by category	range by value, see attached table LLF			4.1.3	TB_POSTOBOMBA	ILINHA	Tipo da Linha: S-Sucção, P-Pressurizada	Type of the String: S-Suction, P-Pressurized	do we need material type from stringa and tanque, does the table address both tanks and lines?
Ln=	Line Amount	Computed from Line table, # of lines will be greater risk	range by value, see attached table LLF			4.1.3					Need to loal number of lines? From TB_POSTOBOMBA ? Or use total number of pumps?tanks, make sure pump is active ISITCA
F=	Filter	presence/absence	yes/no	0, 1	2	4.1.3	TB_POSTOBOMBA	NFILTRO	Tipo do Filtro (Dicionário de Tipo de Filtro)	Type of the Filter (Dictionary of Type of Filter)	see dic table In 42
C=	Cathodic Protection	yes/no, or by category	Yes/No	0 or 1	5	4.1.5	TB_POSTOBOMBA	IPROTC	Tipo de Proteção (Subter: A-Anodo de Sacrifício, C-Corrente Impressa, O-Outros; Aéreo: S-Sem proteção, P-Primer, R-Primer e Resina Epoxi, O-Outros)	Type of protection (Subter: A-Anodo de Sacrifício, C-Corrente Printed, O-Other; Aerial: S-without protection, P-Primer, R-Primer and Resina Epoxi, O-Other)	see DPROTC for other?
S=	Total Sales Volume	Computed from table	range by value, see attached table LLF			5.0	TB_POSTOMOVMN	QCOMBS	Quantidade de Combustível Movimentado	Amount of Moving Fuel	not by type, liquids only

					5.0		CUNIDDMEDDA	Unidade de Medida (Dicionário de Unidade de Medida)	Unit of Measure (Dictionary of Unit of Measure)
Ph=	Service Area/Physical Features	by category	yes/no for several tables/fields, see LLF table		6.0	Mulitple tables, see atttached.			
		if Supply area/Oil change area has a yes in				TB_POSTOAREAABAST	SSEMPAVMN	Se a Área de Abastecimento é sem Pavimento	If the Area of Supplying is without Floor
		any pervious category risk is assumed				TB_POSTOAREAABAST	SBLOCR	Se a Área de Abastecimento é em Blocrete	If the Area of Supplying is in Blocrete
Os=	Used Oil Storage Oleo Queimado	by category	range by value, see attached table LLF		8.2	TB_POSTORESDU	IRESDU where = Q oleo queimado	CDESTNRESDUTRATD storage container type	

if yes, high risk due to non-impervious to spills.	
Only looks at supply and oil change area	
	DICNRRESDU, waste dictionary

RRF - Risk Reduction Factors 8.3

Risk reduction factors are factors used to incorporate the assumed reduced risk posed at a facility due to the use of leak detection or prevention equipment

RRF = f(Imw+Vw+Fsw+Rcw+Csw+Ow+Cvw+Vpw+Ccw+Dc+Acw)
where RRF=Risk Reduction Factors
w=weight factor

	Field Name	Field Desc.	Field Type	Value	Weight					
						8.3				
Im=	Monitoring Intersticial	Monitoramento Intersticial	Yes/No	0 or 1	3	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Fsp=	Fixed Sensors Sump Pump	Sensores Fixos em Câmara de Contenção da Bomba	Yes/No	0 or 1	4	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Fst=	Fixed Sensors Tank	Sensores Fixos em Boca de Visita de Tanques	Yes/No	0 or 1	2	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
O=	Overflow Protection	Válvula de Proteção para Transbordamento	Yes/No	0 or 1	2	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Cv=	Check Valve	Válvula de Retenção de Esfera Flutuante	Yes/No	0 or 1	2	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Vp=	Pump Containment Chamber	Câmara de Contenção da Bomba	Yes/No	0 or 1	1	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Ac=	Access Chamber	Câmara de Acesso à Boca de Visita	Yes/No	0 or 1	4	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Pm=	Monitoring Wells	Poços de Monitoramento	Yes/No	0 or 1	4	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
Pv=	Vapor Monitoring Wells	Poços de Monitoramento de Vapor	Yes/No	0 or 1	2	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring
At=	Overflow Alarm	Alarme Contra Transbordamento	Yes/No	0 or 1	2	8.3	DICNRMONTRAMBNT	NMONTR	Tipo do Monitoramento Ambiental	Type of the ambient (environmental) monitoring

Tank Type

see DICNRMATRLTANQU material dictionary table	TB_POSTOTANQU	
	DMATRL	NMATRL

Code	Type and Material	Tipo e Material	Number?	Value
TS	simple metalic wall	Parede Simples Metalico	1	14
TN	simple non-metalic wall	Parede Simples nao Metalico	2	10
TD	metalic double wall	Parede Dupla Metalico	3	3
TJ	non-metalic double wall	Parede Dupla nao Metalico	4	2
TO	Other	Outros	5	15

Source: Texcao and BP
Initial Weights at 1.

Tank Volume

TB_POSTOTANQUCOMPR	NCOMPR	Número do Compartimento	Number of the Compartment
	QCAPCD	Capacidade de Armazenamento em m3-2 casas decimais	Capacity of Storage in m3-2 decimal places

Need to total all compartments at a facility. Convert to K liters

Total Tank Volume thousands of liters	Value
< 40	1
40 - 90	3
91 - 140	5
141 - 250	9
251 - 375	12
> 375	15

Tank Age

Assumes oldest tank selected

Age range from present	Value
1 to 5	1
5 to 10	3
10 to 15	5
15 to 25	9
> 25	12

Line Type

Table	Field	Desc.
see DICNRMATRLTANQU material dictionary table	IMATRLTANQULINHA for tank and Line?	
TB_POSTOTANQU ?? Location not found for line type	NMATRL	Material Number
TB_POSTOTANQU	DMATRL	Material Descritption

Code	Type and Material	Tipo e Material	Number?	Value
LM	rigid metalic	Metalica Rigida	1	14
LS	non-metalic single wall	Nao Metalico Parede Simples	2	10
LD	non-metalic double wall	Nao Metalico Parede Dupla	3	3
LL	Other	Outros	4	14

Initial Weights at 1.

Line Amount

Total Length of Lines (or number) meters	Value
< 40	1
40 - 90	3
91 - 140	5
141 - 250	9
251 - 375	12
> 375	15

Volume of Sales by Month

Source Table	Field	Desc.	Desc.
TB_POSTOMOVMN	QCOMBS	Quantidade de Combustível Movimentado	Amount of Moving Fuel
	CUNIDDMEDDA	Unidade de Medida (Dicionário de Unidade de Medida)	Unit of Measure (Dictionary of Unit of Measure)

Need total fuel sale by month.
in K l/month ?

Total Sales Volume (thousands of liters/month)	Value
< 400	1
400 - 900	3
910 - 1400	5
1410 - 2500	9
2510 - 3750	12
> 3750	15

Note: Requires adjustement after population.

Facility Physical Feature/Surface

Table	Field	Desc.	Desc.	Type	Value
TB_POSTOAREAABAST	SSEMPAVMN	Se a Área de Abastecimento é sem Pavimento	If the Area of Supplying is without Floor	yes/no	0,1
TB_POSTOAREAABAST	SBLOCR	Se a Área de Abastecimento é em Blocrete	If the Area of Supplying is in Blocrete	yes/no	0,1
TB_POSTOAREAABAST	SPARLL	Se a Área de Abastecimento é em Paralelepípedo	If the Area of Supplying is in stone blocks	yes/no	0,1
TB_POSTOAREAABAST	SOUTRO	Se a Área de Abastecimento é Outro Tipo	If the Area of Supplying is Another Type	yes/no	0,1
TB_POSTOAREATROCAOLEO	SSEMPAVMN	Se a Área de Troca de Óleo é sem Pavimento	If the Area of Oil Swap is without Floor	yes/no	0,1
TB_POSTOAREATROCAOLEO	SBLOCR	Se a Área de Troca de Óleo é em Blocrete	If the Area of Oil Swap is in Blocrete	yes/no	0,1
TB_POSTOAREATROCAOLEO	SPARLL	Se a Área de Troca de Óleo é em Paralelepípedo	If the Area of Oil Swap is in stone blocks	yes/no	0,1
TB_POSTOAREATROCAOLEO	SOUTRO	Se a Área de Troca de Oleo é Outro Tipo	If the Area of Oil Swap is Another Type	yes/no	0,1

Used Oil Storage

Table	Field	Desc.	Desc.
TB_POSTORESDU	IRESDU	Tipo de Resíduo: D-Doméstico, Q-Óleo Queimado, L-Limpeza de Tanque, C-Caixa de Retenção de Sólidos, E-Embalagens, S-Estopa, F-Filtros, O-Outros	Type of Trash: D-Domestic, Q-Processed Oil, L-Tank cleaning, C-Solid retention box, E-packing, S-cloth, F-Filter, O-Other
	CDESTNRESDUARMZN	Código da Destinação de Resíduo (Dicionário de Destinação de Resíduo) Armazenamento	Code of the Destination of Trash (Dictionary of Destination of Trash)

confirm this contains storage vessel type?

Code ?	Type and Material	Tipo e Material	Number?	Value	
ASTC	AST contained		1	1	Process oil
ASTC	AST		2	2	Need DIC?
DC	Drum contained		3	3	
DC	Drum		4	5	
UST	UST		5	6	

Initial Weights at 1.

Note: Codes and Numbers needed

NMONTR	DMONTR	Desc.	Type	Value	Weight
1	Monitoramento Intersticial	Monitoring Intersticial	yes/no	0 or 1	
2	Sensores Fixos em Câmara de Contenção da Bomba	Fixed Sensors Sump Pump	yes/no	0 or 1	
3	Sensores Fixos em Boca de Visita de Tanques	Fixed Sensors Tank	yes/no	0 or 1	
4	Válvula de Proteção para Transbordamento	Overflow Protection	yes/no	0 or 1	
5	Válvula de Retenção de Esfera Flutuante	Check Valve	yes/no	0 or 1	
7	Câmara de Contenção da Bomba	Pump chamber container	yes/no	0 or 1	
8	Câmara de Acesso à Boca de Visita	Pump Containment Chamber	yes/no	0 or 1	
9	Poços de Monitoramento	Access Chamber	yes/no	0 or 1	
10	Poços de Monitoramento de Vapor	Monitoring Wells	yes/no	0 or 1	
11	Alarme Contra Transbordamento	Vapor Monitoring Wells	yes/no	0 or 1	
13	Medidor de Nível	Level monitor	yes/no	0 or 1	

This form has changed field have been added since 1st questionaire.

PIF Data Elements

Dictionary Table	Table	Field	Field
DICNRUSOOCUPCSOLO	TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	DUSOOCUPCSOLO (from dictionary)
		1	EDIFÍCIO MULTIFAMILIAR COM ATÉ QUATRO ANDARES, SEM GARAGEM SUBTERRÂNEA (NBR 13786)
		2	EDIFÍCIO MULTIFAMILIAR COM MAIS DE QUATRO ANDARES, COM GARAGEM SUBTERRANEA (NBR 13786)
		3	EDIFÍCIOS DE ESCRITÓRIO COMERCIAIS COM MAIS DE QUATRO ANDARES (NBR 13786)
		4	FAVELA EM COTA IGUAL OU INFERIOR (NBR 13786)
		5	ESCOLA
		6	CRECHE
		7	HOSPITAL (NBR 13786)
		8	TEMPLO RELIGIOSO (NBR 13786)
		9	CASA DE ESPETÁCULOS (NBR 13786)
		10	EDIFÍCIOS TOMBADOS PELO PATRIMÔNIO HISTÓRICO
		11	ATIVIDADE INDUSTRIAL DE RISCO (CONFORME NB-16) (NBR 13786)
		12	GARAGEM SUBTERRÂNEA (NBR 13786)
		13	TÚNEL (NBR 13786)
		14	FERROVIA/METRÔ DE SUPERFÍCIE
		15	METRÔ (NBR 13786)
		16	RODOVIA
		17	GALERIA DE DRENAGEM DE ÁGUAS PLUVIAIS (NBR 13786)
		18	REDE DE ÁGUA PARA ABASTECIMENTO (NBR 13786)
		19	REDE DE ESGOTO (NBR 13786)
		20	FOSSA (NBR 13786)
		21	REDE DE GÁS (NBR 13786)
		22	REDE ELÉTRICA (NBR 13786)
		23	AEROPORTO
		24	ÁREA MILITAR
		25	CEMITÉRIO
		26	PARQUE, ÁREA VERDE
		27	PARQUE INFANTIL
		28	ÁREA DE DESPORTO
		29	ÁREA AGRÍCOLA
		30	ÁREA PECUÁRIA
		31	HORTAS
		32	MINERAÇÃO
		33	MATA NATURAL
		34	ÁREA DE PROTEÇÃO AMBIENTAL
		35	ÁREA DE PROTEÇÃO DE MANANCIAIS
		36	CORPOS D` ÁGUA DESTINADOS AO ABASTECIMENTO PÚBLICO (NBR 13786)
		37	CORPOS D` ÁGUA DESTINADOS À PROTEÇÃO DAS COMUNIDADES AQUÁTICAS (NBR 13786)
		38	CORPOS D` ÁGUA DESTINADOS Á RECREAÇÃO DE CONTATO PRIMÁRIO (NBR 13786)
		39	CORPOS D` ÁGUA DESTINADOS Á IRRIGAÇÃO (NBR 13786)
		40	CORPOS D` ÁGUA DESTINADOS Á CRIAÇÃO DE ESPÉCIES DESTINADAS Á ALIMENTAÇÃO HUMANA (NBR 13786)
		41	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA ABASTECIMENTO PÚBLICO (NBR 13786)
		42	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA ABASTECIMENTO DOMÉSTICO (NBR 13786)
		43	UTILIZAÇÃO DE ÁGUA SUBTERRÂNEA PARA USO INDUSTRIAL
		44	AREA INUNDÁVEL, VÁRZEA
		45	LAGOA, REPRESA, OCEANO, OUTROS CORPOS D` ÁGUA
		46	GASODUTO
		47	OLEODUTO

[redacted]

RTHS= PIF+LLF-RRF

Relative RTHS= PIF+LLF-RRF/max(PIF+LLF-RRF)

where RTHS=Risk to Human Health and Safety
PIF= Potential Impact Factor
LLF=Leak Likelyhood Factor
RRF=Risk Reduction Factors

PIF Potential Impact Factors

PIF will include risk associated with water suppty receptors, physical receptors types, and land use. These factors are derrived from yes/no fields in the questionaire database.

PIF= f[(SRw)w + (SRb)w + (Lu)w]

where PIF= Potential Impact Factor

	Weights
SRw=Sensitive Receptor water/environmental	4
SRb=Sensitive Receptor builging or facility	2
Lu=land use	1
w=weight factor	

	Field Name	Field Desc.	Field Type	Value	R Value	Result	
Sensitive Receptor: Water/etc							
	Areas of Ambiant Protection		Yes/No	0 or 1	1	1	0
	Areas of Resource Protection		Yes/No	0 or 1	1	1	0
	Water Body: Public Supply		Yes/No	0 or 1	4	4	0
	Water Body: Aquatic Community		Yes/No	0 or 1	2	2	0
	Water Body: Irrigation		Yes/No	0 or 1	2	2	0
	Water Body: Food Growth		Yes/No	0 or 1	2	2	0
	Groundwater: Public Supply		Yes/No	0 or 1	5	5	0
	Groundwater: Domestic Supply		Yes/No	0 or 1	4	1	0
	Groundwater: Industrial Use		Yes/No	0 or 1	1	1	0
	Lagoon/Dam/Ocean		Yes/No	0 or 1	1	1	0
Sensitive Receptor: Building/Facility							
	Multifamily without underground garage	Edificio de multifamiliar sem sub	Yes/No	0 or 1	1	1	0
	Multifamily with underground garage	Edificio de multifamiliar com sub	Yes/No	0 or 1	3	3	0
	Commercial	Edificio de ecritoio commerciales	Yes/No	0 or 1	1	1	0
	Slum Quarter	Favela	Yes/No	0 or 1	2	2	0
	School	Escola	Yes/No	0 or 1	2	2	0
	Day Care Center	Creche			3	3	0
	Hospital	Hospital	Yes/No	0 or 1	2	2	0
	Underground Garage	Garagem subterranea	Yes/No	0 or 1	1	1	0
	Tunnel	Tunel	Yes/No	0 or 1	1	1	0
	Subway	Metro	Yes/No	0 or 1	1	1	0
	Gas Network	Rede de gas	Yes/No	0 or 1	1	1	0
	Oil Pipeline	Oleduto	Yes/No	0 or 1	1	1	0
	Gasline (LGE)	Gasoduto	Yes/No	0 or 1	1	1	0
Land Use	Residential (from multifamilar, slum etc)		Yes/No	1	3	3	
	Commercial		Yes/No	2	2		
	Industrial ?		Yes/No	3	1		
	Agricultural Area		Yes/No	4	1		
	Ranching/Grazing Area		Yes/No	5	1		
	Natural Forest		Yes/No	6	1		1
					PIF=	123	1

LLF - Leak Likelyhood Factors

Leak likelyhood is derived from the risk associated with the type of equipment or factors affecting the ability for an UST facility to have a leak.

LLF = f[T(tw+Vw+Aw)+Pw+Ltw+Lnw+Fw+Cw+Sw+Phw+Osw]

where LLF=Leak Likelyhood Factor
w=weight factor
and

	Field Name	Field Desc.	Field Type	Value	Weight	R Value/Data	Result		
T=	Tank (AST or UST)	If only AST fields are filled Tank = 0 risk	by Type	A=0, S=1	1	1	1	0	0.25
t=	Tank Type	by category	range by value, see attached table LLF		2	TO	15	TJ	2
V=	Tank Volume	Computed from table	range by value, see attached table LLF		2	378	15	37	1
A=	Tank Age	Assume oldest	range by value, see attached table LLF		4	26	12	1	1
P=	Pump Type	by category	type	S=1, P=5	1	P	5	S	1
Lt=	Line Type	by category	range by value, see attached table LLF		2	LM	14	LD	3
Ln=	Line Amount	Computed from Line table, # of lines will be greater risk	range by value, see attached table LLF		1				
F=	Filter	presence/absence	yes/no	0, 1	2	1	2	0	0
C=	Cathodic Protection	yes/no, or by category	Yes/No: Note No = 1	1	5	1	5	0	0
S=	Total Sales Volume	Computed from table	range by value, see attached table LLF		2	3752	15	399	1
Ph=	Service Area/Physical Features	by category if Supply area/Oil change area has a yes in any pervious category risk is assumed	yes/no for several tables/fields, see LLF table		3	1	1	0	0

	LLF=	211	13.5

RRF - Risk Reduction Factors

Risk reduction factors are factors used to incorporate the assumed reduced risk posed at a facility due to the use of leak detection or prevention equipment

RRF = f(Imw+Ww+Fsw+Rcw+Csw+Ow+Cvw+Vpw+Ccw+Dcw+Acw)
where RRF=Risk Reduction Factors
w=weight factor

Field Name	Field Desc.	Field Type	Value	-R Value		Result		Result
Im= Monitoring Intersticial	Presence or absence of item	Yes/No	0 or 1	3	0	0	1	3
Fsp= Fixed Sensors Sump Pump	Presence or absence of item	Yes/No	0 or 1	4	0	0	1	4
Fst= Fixed Sensors Tank	Presence or absence of item	Yes/No	0 or 1	2	0	0	1	2
O= Overflow Protection	Presence or absence of item	Yes/No	0 or 1	2	0	0	1	2
Cv= Check Valve	Presence or absence of item	Yes/No	0 or 1	2	0	0	1	2
Vp= Pump Containment Chamber	Presence or absence of item	Yes/No	0 or 1	1	0	0	1	1
Ac= Access Chamber	Presence or absence of item	Yes/No	0 or 1	4	0	0	1	4
Pm= Monitoring Wells	Presence or absence of item	Yes/No	0 or 1	4	0	0	1	4
Pv= Vapor Monitoring Wells	Presence or absence of item	Yes/No	0 or 1	2	0	0	1	2
At= Overflow Alarm	Presence or absence of item	Yes/No	0 or 1	2	0	0	1	2
ML= Leveling Device	Presence or absence of item	Yes/No	0 or 1	1	0	0	1	1
					RRF =	0		27

RTHS Maximum = 334
RTHS Minimum = 1

Underground Storage Tank (UMS)
Risk to Health and Safety (RTHS) Report
Program Installation Manual

CDM

Document Code

CETESB UMS - UST Management System - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Mess

Address http://caml262/cetesb/default.asp?lang=eng

CETESB

UMS RTHS Report Criteria

Select your report criteria and click "View Report"

NREGNL: -ANY-

DMUNCP: -ANY-

DRAZAOSOCIL: -ANY-

View Report

Portuguese

CETESB UMS - UST Management System - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Messenger

Address http://caml262/cetesb/default.asp?lang=port

CETESB

UMS RTHS - Critério do Reporte

Por favor selecione seu critério do reporte e clique "Veja Reporte"

NREGNL: -TODAS-

DMUNCP: -TODAS-

DRAZAOSOCIL:

-TODAS-
AREALVA
BARRETOS
ITATIBA
JARDINÓPOLIS
MOGI GUAÇU
PAULÍNIA
PRACINHA
PRESIDENTE PRUDENTE
RIBEIRÃO PRETO
SÃO JOSÉ DOS CAMPOS

English

Done

Local intranet

CETESB UMS - UST Management System - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Messenger

Address http://caml262/cetesb/default.asp?lang=port

CETESB

UMS RTHS - Critério do Reporte

Por favor selecione seu critério do reporte e clique "Veja Reporte"

NREGNL: -TODAS-

DMUNCP: -TODAS-

DRAZAOSOCIL: -TODAS-

- CAT CENTRAIS DE APOIO AO TRANS...
- E C DE OLIVEIRA & CIA LTDA
- ESTRELA COMÉRCIO E ADMINISTRAÇ...
- J. GAVA AUTO POSTO LTDA
- MAX PETRO COMÉRCIO DE COMBUSTI...
- PORTAL VILA EMA AUTOMOTIVOS LT...
- RAIMUNDO FRANCISCO BEZERRA & C...
- SHELL BRASIL S/A
- SPEED GAS POSTO DE ABASTECIMEN...
- TRR GROTTI COMERCIAL LTDA
- VIAÇAO GATO PRETO LTDA.

English

Done

Local intranet

Crystal Report Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Messenger

Address http://caml262/cetesb/summary.rpt

100% 1 of 1

Preview

- REGNL 1
- REGNL 3
- REGNL 4
  - JARDINÓPOLIS
  - RIBEIRÃO PRETO
    - MAX PETRO COM
- REGNL 6
- REGNL 7
- REGNL 12
- REGNL 37
- REGNL 40
  - BARRETOS
    - CARREFOUR COI
- REGNL 43
- REGNL 60

CETESB

UMS RTHS Summary Report

NREGNL	DMUNCP	DRAZAOSOCIL	NSOLCT/ AINFRM	PIF	LLF	RRF	RTHS
1	SÃO PAULO	SPEED GAS POSTO DE ABASTECIMENTO DE COMBUSTIVEIS LTDA	31000872 17-Oct-2001	6.0 detail	79.0	0.0	85.0
1	SÃO PAULO	VIAÇAO GATO PRETO LTDA.	29003065 26-Sep-2001	5.0 detail	52.0	0.0	57.0
3	SÃO JOSÉ DOS CAMPOS	PORTAL VILA EMA AUTOMOTIVOS LTDA.	3002255 08-Nov-2001	5.0 detail	79.0	0.0	84.0
4	JARDINÓPOLIS	TRR GROTTI COMERCIAL LTDA	4002241 22-Oct-2001	5.0 detail	79.0	0.0	84.0
4	RIBEIRÃO PRETO	MAX PETRO COMÉRCIO DE COMBUSTIVEL LTDA	4002219 15-Oct-2001	5.0 detail	79.0	0.0	84.0
6	SOROCABA	AUTO POSTO CAPELARI E MORAIS LTDA.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	AREALVA	AUTO POSTO MENDONÇA NICOLIELO LTDA	7001778 31-Oct-2001	6.0 detail	80.0	0.0	86.0

Details for RIBEIRÃO PRETO - MAX PETRO COMÉRCIO DE COMBUSTIVEL LT

Done

Local intranet

Crystal Report Viewer - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss Messenger

Address http://caml262/cetesb/summary.rpt

100% 1 of 1

Preview RIBEIRÃO PRETO - MAX PETRO COMÉRCIO DE COMBUSTIVEL LTDA

- 4
  - RIBEIRÃO PRETO
    - MAX PETRO COM
      - RTHS
      - PIF
      - LLF
      - RRF

4

RIBEIRÃO PRETO

MAX PETRO COMÉRCIO DE COMBUSTIVEL LTDA

	Item	Value	Blanks
Total	*RTHS*	84	77
Total	*PIF*	5	28
	SRw	0	10
	SRb	0	13
	LU	5	5
Total	*LLF*	79	38
	T	1	1
	Tt	15	6
	V	15	1
	A	12	1
	P	5	2
	LT	14	5
	F	1	7
	C	1	1
	S	15	1
	PH	0	8
	Os	0	5
Total	*RRF*	0	11
	Im	0	1
	Sh	0	1

Done Local intranet

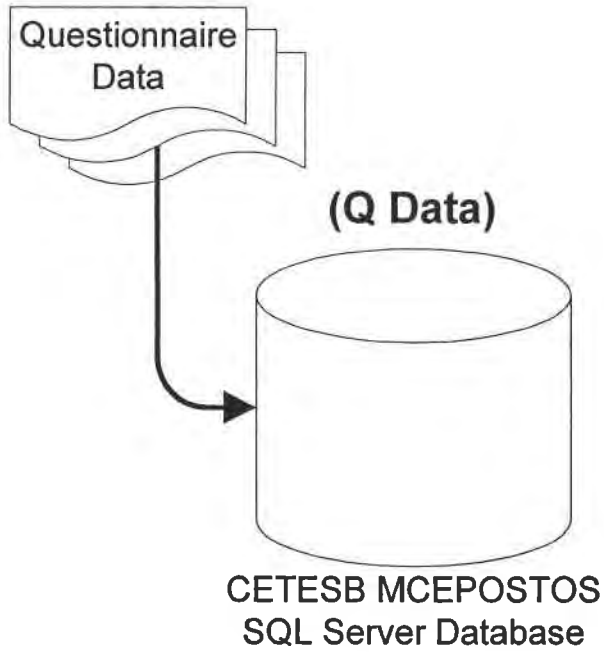
UMSReport System – Architecture & Design

- Objectives – modular, rules-based, easy dba maintenance in time/budget constrained environment.
- Design factors – communication/language; offsite installation; rules definitions; dynamic rules parameters.
- Technologies – SQL Server, Visual Basics, Crystal Reports, IIS/ASP.

System Preconditions – Client-side

Assumes client has loaded survey /questionnaire data into the domain database

Load Domain Data



System Preconditions – CDM-side

- CDM rules for calculating environmental risk are located in an Excel document.
- Information includes formulas to generate risk factors from risk terms - formulas are available as text only.
- Formula terms apply to responses to a survey questionnaire. Terms are presented in the spreadsheet and mapped to domain database tables and fields.

Arial 10

D6 =

	A	B
2		
3		
4	**RTHS= PIF+LLF-RRF**	
5	where	RTHS=Risk to Human Health and Safety
6		PIF= Potential Impact Factor
7		LLF=Leak Likelyhood Factor
8		RRF=Risk Reduction Factors
9		
10		
11	**PIF Potential Impact Factors**	
12		
13	PIF will include risk associated with water supply receptors, physical	
14	in the questionaire database.	
15		
16	PIF= f[(SRw)w + (SRb)w + (Lu)w]	
17	where	PIF= Potential Impact Factor
18		SRw=Sensitive Receptor water/environmental
19		SRb=Sensitive Receptor builging or facility
20		Lu=land use
21		w=weight factor

System Preconditions – CDM-side

A111 = USI

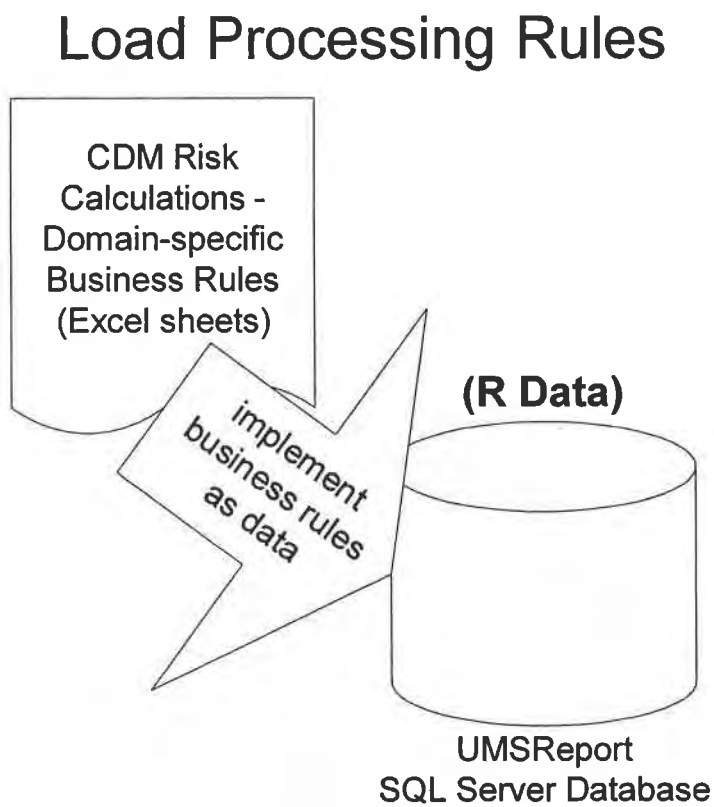
	A	B	C	D	E	F
70	**Volume of Sales by Month**					
71						
72	**Source Table**	**Field**	**Desc.**	**Desc.**		
73	TB_POSTOMOVMN	QCOMBS	Quantidade de Combustível Movimentado	Amount of Moving Fuel		
74		CUNIDDMEDDA	Unidade de Medida (Dicionário de Unidade de Medida)	Unit of Measure (Dictionary of Unit of Measure)		
75	Need total fuel sale by month.					
76	**in K l/month ?**					
77		**Total Sales Volume (thousands of liters/month)**	**Value**			
78		< 400	1			
79						
80						
81						
82						
83						
84	Note: Re					
85						
86	**Facility**					
87						
88	**Table**				**Type**	**Value**
89	TB_POSTC			plying	yes/no	0,1
90	TB_POSTC			plying	yes/no	0,1
91	TB_POSTOAREAABAST	SPARLL	Se a Área de Abastecimento é em Paralelepípedo	If the Area of Supplying is in stone blocks	yes/no	0,1
92	TB_POSTOAREAABAST	SOUTRO	Se a Área de Abastecimento é Outro Tipo	If the Area of Supplying is Another Type	yes/no	0,1
			Se a Área de Troca de Óleo é sem	If the Area of Oil Swap is		

- Each Factor consists of many terms.
  Terms map to tables/fields.
  Some dictionary tables used for value lists.

- Bus. Rules algorithms use:
  summary values, range values, uniqueness, co-dependent values, max/min values, true/false, absent values, etc.

System Design – Initialize

- Risk Calculation Business rules in the Excel docs were converted into rules tables, UMS_Factor and UMS_FactorValue



System Design - Initialize

dbo_UMS_FACTOR : Table

FactorID	Factor	FactorSeq	Term	TermSeq	S	T	DataTable	DataField	DataWhere
1002	PIF	1	SRb	2	2	S	MCEPOSTOS.dbo.TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	
1003	PIF	1	LU	3	2	L	MCEPOSTOS.dbo.TB_POSTO	ILOCLZATIVD	
1001	PIF	1	SRw	1	2	S	MCEPOSTOS.dbo.TB_POSTOUSOOCUPCSOLO	NUSOOCUPCSOLO	
1014	LLF	2	PH	11	6	S	MCEPOSTOS.dbo.TB_POSTOAREAABAST	SRLOCR	
1004	LLF	2	T						
1005	LLF	2	Tt						
1006	LLF	2	V						
1007	LLF	2	A						
1008	LLF	2	P						
1009	LLF	2	LT						
1010	LLF	2	F						
1011	LLF	2	C						
1013	LLF	2	PH	10	6	S	MCEPOSTOS.dbo.TB_POSTOAREAABAST	SSEMPAVMN	
1015	LLF	2	PH	12	6	S	MCEPOSTOS.dbo.TB_POSTOAREAABAST	SPARLL	
1017	LLF	2	PH	14	6	S	MCEPOSTOS.dbo.TB_POSTOAREATROCAOLEO	SSEMPAVMN	
1018	LLF	2	PH	15	6	S	MCEPOSTOS.dbo.TB_POSTOAREATROCAOLEO	SRLOCR	

- Business rules converted to structured data

DataTable	DataField	DataWhere	NullEQ	DataType	Weight	OPName	OPType	OPSubOP	P	
MCEPOSTOS.c	NUSOOCUPCS		0	N	1	SUM	EACH			
MCEPOSTOS.c	NUSOOCUPCS		0	N	1	SUM	EACH		ARMZN	IRESDU = 'Q'
MCEPOSTOS.c	ILOCLZATIVD		5	C	1	SELECT	ONE			
MCEPOSTOS.c	ITANQU		1	C	1	EXISTS	ANY			
MCEPOSTOS.c	NMONTR		0	N	3	EXISTS	ANY			
MCEPOSTOS.c	NMONTR		0	N	4	EXISTS	ANY			
MCEPOSTOS.c	NMONTR		0	N	2	EXISTS	ANY			
MCEPOSTOS.c	NMATRL		15	N	1	SELECT	MAX			
MCEPOSTOS.c	QCAPCD		15	N	1	SUM	ALL	RANGE		
MCEPOSTOS.c	AINSTL		12	D	1	SELECT	MAX	AGEYEARS		
MCEPOSTOS.c	ILINHA		5	C	1	EXISTS	ANY			
MCEPOSTOS.c	NMATRL		14	N	1	SELECT	MAX			
MCEPOSTOS.c	NFILTRO		1	N	1	EXISTS	ANY			

System Design - Initialize

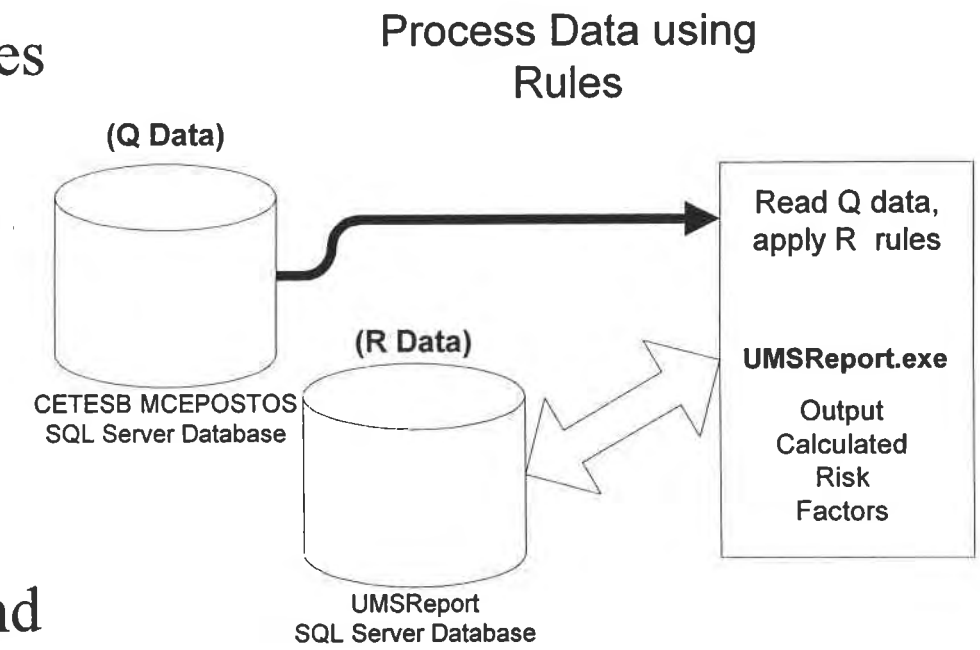
- UMS_FactorValue has one row per possible response value for every Factor/Term
- Data types are various, identified in the parent table

dbo_UMS_FACTORVALUE : Table

FactorID	Factor	Term	?	N	V	A	V	MatchValue	ReturnValue
1002	PIF	SRb	0	1	N	E	N	1	1
1002	PIF	SRb	0	1	N	E	N	2	1
1002	PIF	SRb	0	1	C	E	C	3	1
1002	PIF	SRb	0	1	S	F	S	4	1
1002	PIF	SRb	0	1	S	E	S	5	1
1002	PIF	SRb	0	1	D	C	D	6	1
1002	PIF	SRb	0	1	H	H	H	7	1
1002	PIF	SRb	0	1	U	C	U	12	1
1002	PIF	SRb	0	1	T	T	T	13	1
1002	PIF	SRb	0	1	S	N	S	15	1
1002	PIF	SRb	0	1	G	F	C	21	1
1002	PIF	SRb	0	1	C	C	C	47	1
1002	PIF	SRb	0	1	G	C	C	46	1
1003	PIF	LU	0	1	F	F	F	E	5
1003	PIF	LU	0	1	C	C	C	C	3
1003	PIF	LU	0	1	In	In	I	I	2
1003	PIF	LU	0	1	U	U	U	R	1
1003	PIF	LU	0	1	F	F	F	U	4
1023	RRF	Im	0	1				1	1
1034	RRF	St	0	1				3	1
1024	RRF	Pm	0	1				9	1
1025	RRF	Sb	0	1				2	1
1035	RRF	At	0	1				11	1
1028	RRF	Vt	0	1				4	1
1029	RRF	Vr	0	1				5	1

System Design - Process

- UMSReport.exe applies table-based business rules to generate calculated risk data.
- Calculated risk data is persisted in: UMS_ReportDetail and UMS_ReportSummary



System Design - Process

- ums_factor(..)

accepts site PKeys and Factor name as inputs.

loops terms for each Factor.

calculates values via procedural code and SQL stored procedures

```
Function ums_factor(ByVal NMUNCP As Long, ByVal NSEQNC As Long, _
        ByVal AINFRM As Variant, ByVal NSOLCT As Long, _
        sFactor As String) As Boolean

1160    Select Case sOperation
            Case "SUMEXISTSNEXT", "SUMEXISTSEND"
            'This op finds values in different table/field combos and accrues them
            ' e.g., LLF/PH

1170        Do While True
        'Need new DataTable & DataField values on every pass
1180        With gorsFactorFactorValue
1190            DataTable = .Fields("DataTable").Value
1200            DataField = .Fields("DataField").Value
1210            DataType = UCase(.Fields("DataType").Value)
1220        End With
1230        nRetval = SiteMatchValueScore(ReturnValue, Weight, NullEQ, nNullEQ

        'Since this is a SUM operation, add each occurence
1240        nTermValue = nTermValue + nRetval

        'Move to the next combo of datatable/datafield in this term.
1250        gorsFactorFactorValue.MoveNext
1260        If gorsFactorFactorValue.EOF Then Exit Do
1270        If gorsFactorFactorValue.Fields("Term").Value <> Term Then Exit Do
1280    Loop

        Case "SELECTMAXAGEYEARS"
```

System Design - Output

- The process log file is toggled on with startup parameter /L
- Other startup parameters: /I, /D, /L+
  /I and /D are for developer testing only

  /L+ creates a detailed process log with all the calculation data. The file format is TAB-delimited, which allows you to copy/paste the log into Excel for analysis.

```
Start: Jan 03 2002 18:04:55
Provider=SQLOLEDB.1;Persist Security Info=False;User ID=UMSReport;Password=p
Source=192.168.26.128
Connection OK.
PIF name loaded into FactorList().
LLF name loaded into FactorList().
RRF name loaded into FactorList().
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : PIF    SRw     0       10
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : PIF    SRb     1       12
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : PIF    LU      4       4
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : PIF (SQL)
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    T       1       0
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    Tt      15      5
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    V       3       0
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    A       1       0
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    P       1       1
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    LT      14      4
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    F       1       0
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    C       1       1
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    S       15      1
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    PH      0       8
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF    Os      0       5
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : LLF (SQL)
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : RRF    Im      0       1
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : RRF    Sb      0       1
100 - 476446 - Sep 26 2001 00:00:00 - 29003065 : RRF    Sr      0       1
```

System Design - Output

- Report data goes to UMS_Report_Summary (master) and UMS_Report_Detail (drill-down detail)

UMS_Report_Detail

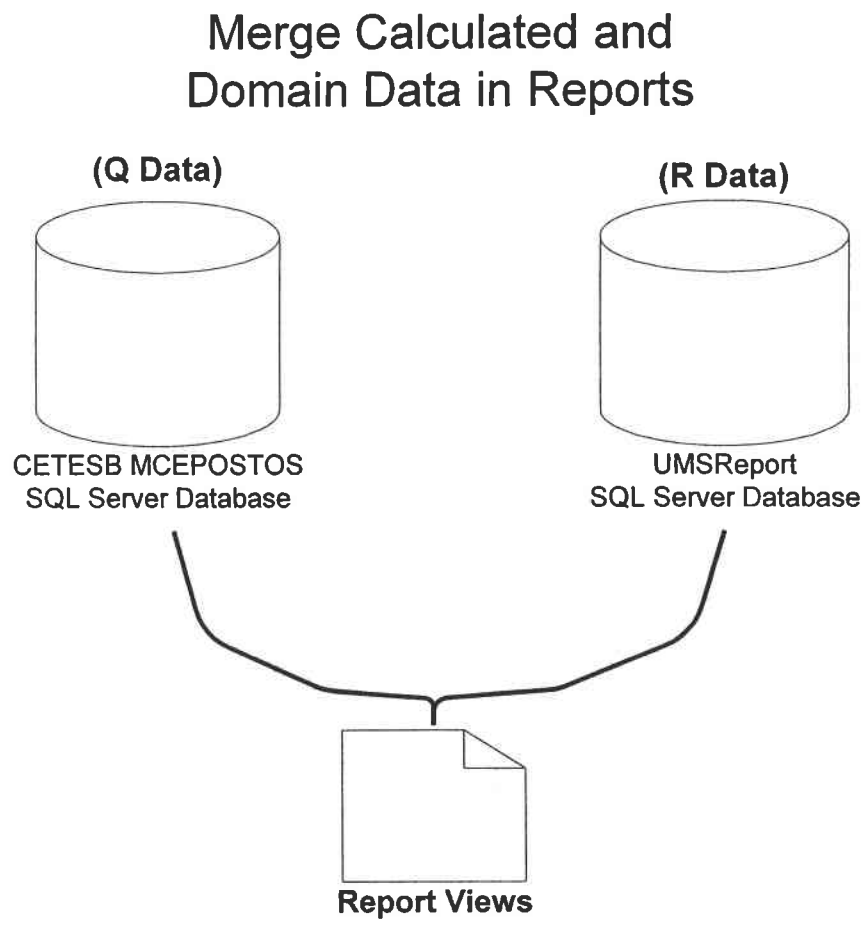
NMUNCP	NSEQNC	AINFRM	NSOLCT	Factor	Term	Value	NullItemCount
100	476446	9/26/2001	29003065	PIF	SRw	0	10
100	476446	9/26/2001	29003065	PIF	SRb	1	12
100	476446	9/26/2001	29003065	PIF	LU	4	4
100	476446	9/26/2001	29003065	PIF	PIF	5	26
100	476446	9/26/2001	29003065	LLF	T	1	0
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
100	476446	9/26/2001	29003065	LLF	P	1	1
100	476446	9/26/2001	29003065	LLF	LT	14	4
100	476446	9/26/2001	29003065	LLF	F	1	0
100	476446	9/26/2001	29003065	LLF	C	1	1
100	476446	9/26/2001	29003065	LLF	S	15	1

UMS_Report_Summary

DMUNCP	DRESMDMUNCP	NREGNL	DRAZAOSOCIL	AINFRM	PIF	LLF	RRF	RTHS	NullItemCount
SÃO PAULO	SÃO PAULO	1	VIAÇAO GATO PRETO LTD	9/26/2001	5	52	0	57	62
SÃO PAULO	SÃO PAULO	1	SPEED GAS POSTO DE AI	10/17/2001	6	79	0	85	74
AREALVA	AREALVA	7	AUTO POSTO MENDONÇA	10/31/2001	6	80	0	86	73
BARRETOS	BARRETOS	40	CARREFOUR COMÉRCIO E	11/27/2001	6	52	14	44	60
ITATIBA	ITATIBA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	61	73
JARDINÓPOLIS	JARDINÓPOLIS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	84	75
MOGI GUAÇU	MOGI GUAÇU	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	83	76
PAULÍNIA	PAULÍNIA	37	CAT CENTRAIS DE APOIO	9/19/2001	4	51	4	51	60
PRESIDENTE PRUDE	PRES PRUDENTE	12	AUTO POSTO PICOLI LTDA	9/11/2001	7	79	0	86	73
PRESIDENTE PRUDE	PRES PRUDENTE	12	E C DE OLIVEIRA & CIA LT	10/23/2001	4	79	0	83	76
PRESIDENTE PRUDE	PRES PRUDENTE	12	SHELL BRASIL S/A	10/25/2001	8	79	0	87	72

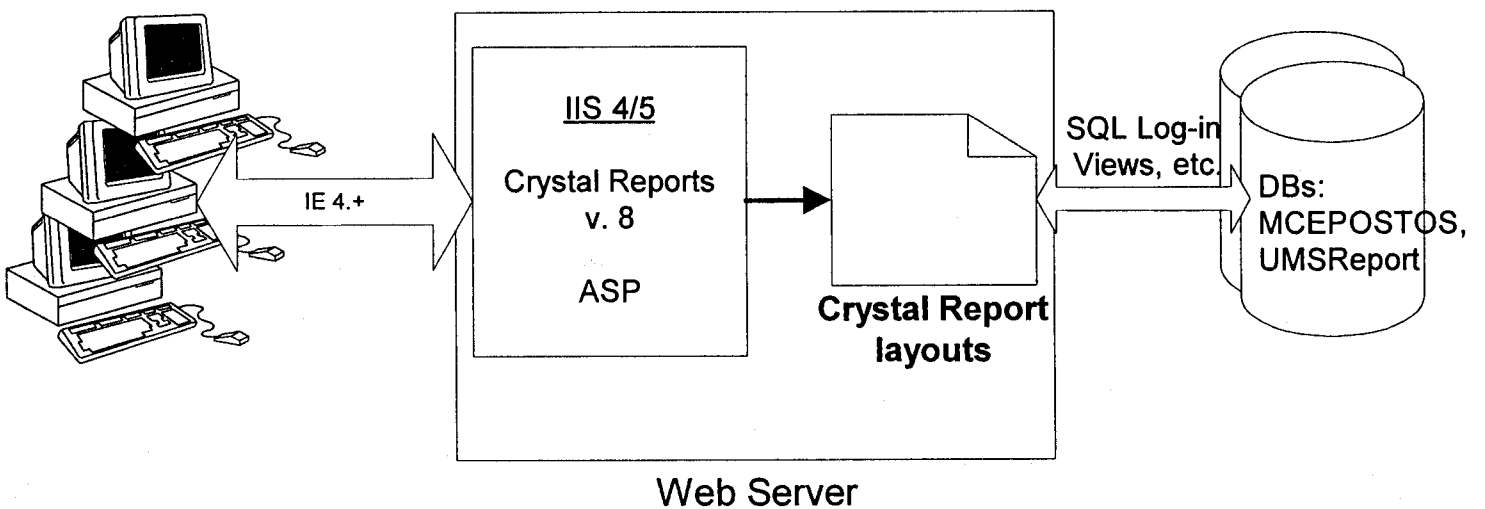
System Design - Reports

- Use Views in UMSReport database to link calculated data and domain data (for site description and filtering).
- Manage logins and priviledges via UMSReport views
- Decouple report database security from domain data database security



System Design – Reports

Report Delivery



- Users browse intranet to UMSReport *default.asp*, enter criteria, view reports in Crystal Reports ActiveX viewer hosted in MS IE 4+

System Design - Reports

- Bi-lingual Home page
- Dynamic report criteria via ASP/ADO
- <Form action = "summary.rpt"...> and hidden form values for ODBC login via Crystal.

default.asp

```
}
if (lang.indexOf("lang=port")>-1){
  document.all.pagetitle.innerHTML="UMS RTHS - Crit&eacu
  document.all.instructions.innerHTML='Por favor selecione :
  document.frm.submit.value=" Veja Reporte ";
  document.frm.nregnl.options[0].text = '-TODAS-';
  document.frm.dmuncp.options[0].text = '-TODAS-';
  document.frm.drazaosocil.options[0].text = '-TODAS-';
  documen[illegible]ll.hrefaltlang.href='default.asp?lang=eng';
```

```
<select na[illegible]="nregnl" class="dataentry" id="nregnl" onChange="updateSel(this);">
 <option class="data1" id="any" value="0">-TODAS-</option>
 <%
Response.Write optionList("NREGNL")
%>
</select>
```

```
<FORM action="summary.rpt" method="post" name="frm" id="frm
onsubmit="submitReport();">
  <input type="Hidden" name="sf" id="sf" value="">
  <input type="hidden" name="user0" value="">
  <input type="hidden" name="password0" value="">
  <input type="hidden" name="user0@detail.rpt" value="">
  <input type="hidden" name="password0@detail.rpt" value="">
```

System Configuration

Three subsystems to configure:

1. SQL Server – UMSReport
2. UMSReport.exe – UMSReport.ini
3. IIS / ASP / Crystal Reports

System Configuration – SQL Server

- Install UMSReport database on the same SQL Server as MSCEPOSTOS database.
- Restore UMSReport data from UMSReport.BAK
- Create SQL Server report user account and permissions

System Configuration – SQL Server

- Notes for: Create and test the report user account
  - Customize the sample script on the CD: use MiscScripts/PermissionsAccounts.sql to create a SQL Server login and user permissions for the necessary SQL objects. The necessary objects are listed in the sample script.
  - Login with the new account and test access with the "Select.." scripts in TestUMSReport_User.sql

System Configuration – Visual Basic

- Install the Visual Basic application on a PC that has network access to SQL Server.
- Use setup.exe on the CD to create program group and menu items for UMSReport
- Within the directory that contains UMSReport.exe open the configuration file, UMSReport.ini

System Configuration – Visual Basic

In UMSReport.ini edit the section below [UMSReport] - change the ConnectionString values for your SQL Server:

ConnectionString=Provider=SQLOLEDB.1;Persist Security Info=False;**User ID=UMSReport;Password=password**;Initial Catalog=UMSReport;**Data Source=192.168.26.128**

- ConnectionString assignment must be on one, long line
- Change the values of User ID=UMSReport and Password=password to the name and password of the report user account you created for SQL Server
- Data Source value can be IP address or sql server name

System Configuration – Visual Basic / SQL Server

- Testing
  - From a command prompt in the UMSReport.exe directory, type:
    `UMSReport.exe /P /L+`
  - You will get a "ping" message box telling you if the connection to the database succeeded or failed.
  - If the "ping" message box is OK, click OK to continue. This will process all your current MCEPOSTOS data.
  - As a guideline, when we process the December 2001 MCEPOSTOS data (15 unique sites), UMSReport.exe completed on our test servers in less than 30 seconds. The best way to tell if the program is complete is to open the log file and check the bottom of file for a date/time stamp.
  - Inspect the log file: UMSReport.log for results and run-time information. The /L+ log format is TAB-delimited for analysis in Excel.

System Configuration – Visual Basic / SQL Server

- Generating Report Data in production
  - Type UMSReport.exe /L+ at the prompt. This will begin the process to calculate all the current report data, re-populate the report tables in the UMSReport database, and create a detailed log file of all the data calculations.
  - You can also edit the UMSReport.bat file to run production as a batch process.
  - Once the system is in regular production, you may omit the /L+ entry to improve processing time and save disk space from the log generation. Or use /L to generate a smaller, summary log file.
  - You can inspect the report data using SQL Server Query Analyser – the report tables are UMS_DATA_DETAIL and UMS_DATA_SUMMARY.

System Configuration – IIS / ASP / Crystal Reports

- Install Crystal Reports version 8.0 on the PC that has IIS installed. IIS must have network access to SQL Server.
- Copy the ASP application and report files and subdirectories from the ASP/umsreport directory on the CD to a directory x:\asp\umsreport on your web server
- Create a new IIS virtual directory called *umsreport* with the root path as the x:\asp\umsreport file directory.
- Set the default document for the application virtual root to *default.asp*

System Configuration – IIS / ASP / Crystal Reports

- Use a text editor to update the SQL Server login values in the asp web site to match your UMSReport user account values by editing the javascript file, located at:

  x:\asp\umsreport\inc\umsreport.js

- Change the username/password assignments in

  function sqlLogin()

  – The values for user and password must match the values in the SQL Server account and the UMSReport.ini file.

System Configuration – IIS / ASP / Crystal Reports

- To test the web site, open your browser to your umsreport site's homepage, for example:
  http://yourWebServer/umsreport/default.asp
- Slide 2 shows what this page looks like.
- This page queries the SQL Server database to populate the drop-down boxes. If the boxes are empty, your SQL Server connection is invalid or the report data is missing. Sometimes the SQL Server may be too busy – try refreshing the page.

System Configuration – IIS / ASP / Crystal Reports

- Click the View Report button.
- This sends the report data query to SQL Server and returns the results to Crystal Reports.
- When the Crystal Reports page loads for the first time, it may take a few moments to load the Crystal Reports ActiveX viewer. This is normal. The next time will be faster.
- See other information about using the report viewer in the user instructions at the beginning of this document.

System Configuration – Other Important Notes

- This site provides intranet users with RTHS data from the UMSReport system. However, web security is limited with Crystal Reports in its basic web configuration. Crystal Reports makes more advanced web reporting products for internet use that are more secure and handle many users.
- Report data is only as recent as the last UMSReport batch update. Whenever new data is entered into the MCEPOSTOS database, you will need to re-run the UMSReport.exe program to refresh the RTHS calculations.

System Configuration – Other Important Notes

- Changing the values for risk factors is a manual process via SQL Server. Backup data first!
- Some SQL update examples are:
  - To update the value of response 'E' for Factor: *PIF*, Term: *LU* from 5 to 6, query UMS_FactorValue:

```
Update UMS_FactorValue Set ReturnValue=6
WHERE Factor='PIF' AND Term='LU' AND
MatchValue='E'
```

- A FactorValue that measures a range of values, like LLF/V, occupies two rows in the UMS_FactorValue table for each range – one row is the lower range in the group and the next row is the upper range in that group. You must keep the range ReturnValues consistent.

System Configuration – Other Important Notes

- Some operators and values affect all the responses for a factor's term, like Weight and how to interpret Null (missing) responses. To update Factor values use table UMS_Factor. For examples:
  - To update the weight of LLF/A (tank age) from 1 to 2: query UMS_Factor:

    ```
    Update UMS_Factor Set Weight=2
    WHERE Factor='LLF' AND Term='A'
    ```
- UMS_Factor also contains the value for "NullEQ" – this is the value that will occur if no response is found for this Term. You can adjust this just like the other values.

Appendix B

Field Study Data

Summary of Direct-Push Sampling Equipment Costs and Availability and Laboratory Qualifications and Capabilities Available in São Paulo

CDM

Appendix B

CETESB Underground Storage Tank Project
Table B1: Summary of Direct-Push Sampling Equipment Costs and Availability

(Preços em Reais)	Engesolos		American Drilling		Geoklock
Tipo de Geoprobe	Direct Push		Grande	Pequeno	não alugam Geoprobe, apenas o utilizam como ferramenta para realizar seus próprios projetos
Disponibilidade em outubro e novembro	sim/ deve se fazer a contratação logo para garantir a disponibilidade		sim	sim	
Custo de hora de equipe e equipamento parados (eq/hora)	200.00				
Custo (por dia)	2000.00		1400.00	1200.00	
Custo (por metro)	30.00		40.00		
Taxa de mobilização	650.00		300.00	250.00	
Liner (unidade)	amostrador de 1 1/4" (large bore)	amostrador de 2" (macro core)	1,5m	44mm e 1,2m	
	46.00	55.00	12.00	10.00	
Operador incluído	sim		sim	sim	
almoço (se não for fornecido) - em alguns casos esta taxa não é cobrada	40.00				
Amostragem de água (unidade)	85,00 (usando ponteira de aço descartável)			50.00	
Amostragem de gás usando ponteira de aço descartável (unidade)	130.00		estas informações serão coletadas até o final da tarde		
Preenchimento de furos (grout) de amostragem com hastes de até 2" de diâmetro (Geoprobe) com calda de bentonita, quando solicitado (m)	3.20				
Hora extra do sondador	15.30				
Hora extra de servente	6.42				
Hora extra de motorista	12.84				
Hora extra de encarregado	17.12				
Hora extra de engenheiro ou geólogo	64.20				
Qualificações e Experiência	possuem experiência em trabalhos com postos de gasolina		2 anos no Brasil / 800 projetos de postos no Brasil (SP/ RJ/PR/MG)		
Contato	Rosana		Cláudio		Angelo/Carlos Galo/Margareth
Telefone	38492166		69674849		51816499 /55063115
Fax	38497875		69674849		
E-mail	engesolos@engesolos.com.br				
Web site	www.engesolos.com.br		www.americandrilling.com		

CETESB Underground Storage Tank Project
Table B2: Summary of Brazilian Laboratory Qualifications and Capabilities

Especificações			Unidade	ECOLABOR	CEIMIC	AMBIENTAL	FEMAS	QUALITEX	ISATEC	TASQA
Qualificações	O LAB está cadastrado na CETESB		sim/não	sim	sim	sim	laboratório em mudança, não estarão disponíveis	Não forneceu informações via telefone; dados solicitados via correspondência	Responsáveis não localizados	sim
	Lista de Equipamentos		Unidade	(HPLC) - cromatógrafo líquido	GC/MS	envia amostras para análise nos EUA				ver web site
	Certificações		ISO, ETC.	Tem ISO 9002, e está credenciando ISO Guide 25, trabalha com Petrobrás, Texaco, Shell, Hudson em postos	está estudando p/ certificar ISO 17.025 - INMETRO, mas acham custo elevado e não devem implantar por que presidente (nos EUA, na matriz) não autorizou	está certificando ISO Guide 25 - INMETRO				certificação em andamento
Capacidade Analítica	Comp Orgânicos Voláteis (VOC)	solo	sim/não	sim	sim	sim/GC				sim
		água	sim/não	sim	sim	sim/GC				sim
	Utiliza método EPA 8260/B-GC/MS		sim/não	Standard Methods	sim	sim/GC				sim
	BTEX	solo	sim/não	sim	sim	sim/GC				sim
		água	sim/não	sim	sim	sim/GC				sim
	Utiliza método GC/MS ou GC - EPA 8260		sim/não	Standard Methods	sim	sim/GC				sim
	TPH (hidrocarbonetos totais de petróleo)	solo	sim/não	sim	sim	sim, pelo fingerprint				sim
		água	sim/não	sim	sim	sim, pelo fingerprint				sim
	Utiliza método EPA 8015 (GC)=GRO/DRO - provenientes da gasolina e do diesel		sim/não	Standard Methods	sim	sim, pelo fingerprint				sim
	TPH (infra vermelho) EPA 418.1	solo	sim/não	sim	sim	não				
		água	sim/não	sim	sim	não				
	FINGERPRINT (Impressão Digital) de petróleo	solo	sim/não	sim	sim					sim
		água	sim/não	sim	sim					sim
	Utiliza método GC de alta resolução - HRGC-FID - EPA 8015		sim/não	Standard Methods	sim					GC normal
	PAH (hidrocarbonetos policíclicos aromáticos)	solo	sim/não	sim	sim	sim				sim
		água	sim/não	sim	sim	sim				sim
	Utiliza método EPA 8270 (GC/MS)		sim/não	Standard Methods	sim	sim				sim
Lista de Preços	VOC	R$	solo	unidade - R$ 380,00	unidade - R$ 270,00	1 a 5 = R$ 410,00 6 a 10 = > 11 = R$ 410,00				
			água		unidade - R$ 250,00	1 a 5 = R$ 340,00 6 a 10 = > 11 = R$ 340,00				
	BTEX	R$	solo	R$ 150.00	unidade - R$ 160,00	1 a 5 = R$ 190,00 6 a 10 = > 11 = R$ 190,00				deve-se passar proposta comercial por e-mail para obter preços (com CGC da empresa)
			água		unidade - R$ 140,00	1 a 5 = R$ 170,00 6 a 10 = > 11 = R$ 170,00				
	TPH	R$	solo	R$ 140.00	unidade - R$ 220,00	1 a 5 = R$ 410,00 6 a 10 = > 11 = R$ 410,00				
			água		unidade - R$ 200,00	1 a 5 = R$ 340,00 6 a 10 = > 11 = R$ 340,00				
	TPH (INFRA)	R$	solo		unidade - R$ 120,00					
			água		unidade - R$ 100,00					
	FINGERPRINT	R$	solo		unidade - R$ 230,00					
			água		unidade - R$ 210,00					
	PAH	R$	solo	R$ 380.00	unidade - R$ 370,00	1 a 5 = R$ 430,00 6 a 10 = > 11 = R$ 430,00				
			água		unidade - R$ 350,00	1 a 5 = R$ 380,00 6 a 10 = > 11 = R$ 380,00				
Duração das Análises e de resultados	VOC		dias	15 dias em média	20 dias corridos em média (flexível para até 48 horas, dobrando o preço)	20 (úteis)				14 dias corridos, em média
	BTEX		dias	15 dias em média	20 dias corridos em média (flexível para até 48 horas, dobrando o preço)	20 (úteis)				14 dias corridos, em média
	TPH		dias	15 dias em média	20 dias corridos em média (flexível para até 48 horas, dobrando o preço)	20 (úteis)				14 dias corridos, em média
	TPH (INFRA)		dias	15 dias em média	20 dias corridos em média (flexível para até 48 horas, dobrando o preço)					14 dias corridos, em média
	FINGERPRINT		dias	15 dias em média	20 dias corridos em média (flexível para até 48 horas, dobrando o preço)					14 dias corridos, em média
	PAH		dias	15 dias em média	20 dias corridos em média (flexível para até 48 horas dobrando] o preço)	20 (úteis)				14 dias corridos, em média
Forma de publicação de resultados	VOC		relatórios/ laudos/ internet/ digital	laudo analítico, por fax, ou por e-mail e depois manda o original	laudos analíticos, em inglês (internet e digital também)	laudo analítico, enviado via fax, e o original vem com a fatura				laudos analíticos (enviam fax e correio e disponível eletronicamente)
	BTEX		relatórios/ laudos/ internet/ digital	laudo analítico, por fax, ou por e-mail e depois manda o original	laudos analíticos, em inglês (internet e digital também)	laudo analítico, enviado via fax, e o original vem com a fatura				laudos analíticos (enviam fax e correio e disponível eletronicamente)
	TPH		relatórios/ laudos/ internet/ digital	laudo analítico, por fax, ou por e-mail e depois manda o original	laudos analíticos, em inglês (internet e digital também)	laudo analítico, enviado via fax, e o original vem com a fatura				laudos analíticos (enviam fax e correio e disponível eletronicamente)
	TPH (INFRA)		relatórios/ laudos/ internet/ digital	laudo analítico, por fax, ou por e-mail e depois manda o original	laudos analíticos, em inglês (internet e digital também)					laudos analíticos (enviam fax e correio e disponível eletronicamente)
	FINGERPRINT		relatórios/ laudos/ internet/ digital	laudo analítico, por fax, ou por e-mail e depois manda o original	laudos analíticos, em inglês (internet e digital também)					laudos analíticos (enviam fax e correio e disponível eletronicamente)
	PAH		relatórios/ laudos/ internet/ digital	laudo analítico, por fax, ou por e-mail e depois manda o original	laudos analíticos, em inglês (internet e digital também)	laudo analítico, enviado via fax, e o original vem com a fatura				
Contatos	Nome			Edemilson / Sr. Natal / Antonio Carlos	Adriana	Josiane				Raquel
	Telefone			39555011	38322234	38458770				19-38741267
	Fax			39555011	38322234	38450800				19-38741268
	e-mail			em@ecolabor.com.br	celmic@8415.com.br	ambiental-com@uol.com.br				rturian@tasqa.com.br
	web-site			www.ecolabor.com.br	www.celmic.com	www.ambiental-lab.com.br				www.tasqa.com.br
Normas do Laboratório	Fornecimento de frascos para coleta		sim/não	(1) poderiam coletar; (2) enviam frascos com reagentes, sem custos	(1) fornece frascos de coleta com reagentes, com caixas térmicas	(1) fornecem frascos com reagentes para preservação				(1) fornece frascos; e (2) podem coletar
	Custo pela coleta		R$	não cobrará pela coleta	cobra a parte	cobra a parte				R$ 120,00/dia
	Responsabilidades		sim/não	responsabilidade da Ecolabor	por conta de quem coletar	por conta de quem coletar				da Tasqa
Observações				(*) - os preços referem-se aos custos de análise de solo. Para águas, para grandes volumes, pode haver negociação, baixando os valores	para grandes volumes tem negociação, baixando os valores	manda amostras para fora do Brasil, pois não tem cromatógrafo instalado, por não ter sido aprovado pelo IPEN (equipto. radioativo)				

Field Study Notebook Transcription

CDM

Appendix B

12- 05-2001

Site 4

Posto Fernao Dias.

Introduction of the Crew (CDM, Cobrape, Ambiterra and Cetesb)

Informed the station manager about the intention of marking the points to be bored.

Informed the station manager the security procedures to be used.

Rules: manager has and will provide Emergency Plan: he has the EPI and uses the 0800 number from Shell (number from problems when unloading truck)

Next to the Station runs Corrego Cabucu

Identified uses: residential and commercial

Mike explained the risks: being run by a vehicle, contamination (since we are not wearing adequate clothes)

Jorge added the risk of robbery, but the station manager says that the station has a security guard (wearing civilian clothes)

Leakage – another company

Pump – Jubaca (company responsible for the pumps maintenance)

Oil tanques – oil flows straight down to the tank

Next to the station is Vila Galvão. The guard can accompany us.

They will rebuild many parts of the station

Salvador works at the station since 1985. He started there as an office boy and has been a manager for 3 years.

In 1985 the stations was completely rebuilt, the tanks and pumps were replaced.

The reason for that was that Shell wanted to modernize the station, there was no request from government.

The station is 25 years old. We asked for old station maps but Ivandra (Ambiterra) said that Shell usually doesn't have old maps. We showed him the map we received from Shell and he said that it really shows what is underground, but there is one more tank (15.000L with gasoline). He has *croquis* showing what pipes go to what tanks or filters. Some of the ways can be seen on the floor. There are four (4) filters that distribute the fuel for all the pumps.

None of the tanks are inactive. Three of the tanks are only used in emergency situations. Water lines pass beside the coverage and the sewer.

There is no PU, only an inspection box.

There is no system to separate water from oil, everything goes down the drain.

For inventory control, they use Maklear.

They sell, per month:

450,000L of Diesel;

80,000L of gasoline and

15,000L of alcohol

They don't have a leakage detection system. The inventory system and the *teste de estanqueidade* guarantee that there is no leakage.

The monitoring wells are all locked. There is no car wash, no water well. The oil tank has 7000L capacity.

There are 9 pumps. 27 drums for remediation were counted.
Monitoring Wells:

Number	O2 %	LEL%	Other
1	Deficiency at 1.0m	0	Diesel
2	Deficiency at 1.5m	0	No product/ water level – 3 to 4 meters
3	Deficiency at 2.0m	0	Water level – 1.5m
4			Probably made on the last leakage
7	15% at 1m	130	Water level- 4 to 5 meters

During the drilling, one person must watch the traffic. Behind the tanks there's a house, probably for inventory control.
There may be some line close to the station's entrance.
Sewer line from the old restaurant until the *fossa* next to the bathroom. This line is not used anymore.

12-05-2001

Site 6
Posto Super
Rua Pedroso de Moraes, 752
Arrived at 16:00
Responsible for the station – Arlon
The station is 30 years old, it was built in 1972.
Jorge, from CETESB, introduced us to the station owners. Started interviewing at 16:10. The tanks have been replaced. There is no cathodic protection.
The owner has no knowledge of any accident. He has been on this station for 3 years. They have Veeder Root – TLS 350 for inventory control. It controls temperature, fuel quantity, etc.
They sell 140,000L/month of gasoline and 10,000L/month of alcohol. There has never been diesel there.
The days when they have more movement are Thursday, Friday and Saturday (and before holidays). Tuesday is the best day for the work. Busiest hours: 9:30 to 13:00 and 16:00 to 19:00.
They work from 5 to 22:00. According to the owner, there's been a car wash for 15 years. .
There's a 15000L oil tank. They sell the oil. They have no drawing with the electrical lines
Electricity comes from the street (Pedroso de Moraes). The oil tank is not identified in the map, it's on the west side of it.
The tanks are filled on Mondays, Wednesdays, Thursdays and Fridays from 6 to 10AM.
At the car wash, the pavement has been damaged (at least for 3 years)
Soil Vapor samples were taken manually.
The property limit is on the yellow line.
From the tanks, there are wiring going to the Veeder Root.
The location of the tanks does not correspond to the maps.
The used oil is taken manually to the tank (in the car wash area). The station is going to be rebuilt in February.
Pictures: Taken at 17:35

1- Carwash
2- Station
3- Pedroso
4- Pedroso 2
5- Station 2
6- Cardeal
7- Cardeal 2
8- Station 3
9- Carwash 2
10- Car dryer
11- Station (Back)
12- Carwash-Pedroso
13- Carwash 3
14- Cardeal

12-06-2001

Site 2
Posto de Servico Mundo Novo
Address: Av. Marginal Direita do Tiete, 201
Phone number: 69540464
Owner: Manuel Lourenço Simão and Francisco Pereira Simao
They have been there for 27 years. The stations functions since 1968. They bought it on 1972. The station is different from its original version, but it's been as it is now for 10 years.There were 10 tanks 10 years ago, with a total of 150,000L capacity with diesel, gasoline and alcohol. In 1991, seven tanks were removed and replaced with six new tanks for gasoline and alcohol. Now their capacity is 130,000L.
There has never been a confirmed spill of gasoline, diesel or alcohol. The station was monitored two years ago, when SABESP was digging an interceptor.
There have been ten superficial leaks every year, when the car is being filled or when the tanks are being filled.
When removing the tanks, there were leakages of the residue that remained in the tanks, after they were emptied. They use TELEMED (Rua Fabia, 789 SP/ Brasil phone: 38727799) as an inventory control. There is no alarm and no control of water.
They sell 130,000L/month of regular gasoline, 60,000L/month of gasoline with additives, 15,000L/month of alcohol and 120,000L/month of diesel.
The busiest hours are on Monday (8 to 9AM) and Friday (8-9AM ad 5-6PM)
The tanks are filled on Tuesday, Thursday and Saturday.

Venturi is the company that does a weekly monitoring.
The oil is stored in a tank(5,000L) and sold.
Tiete River runs in front of the station.
Drawing on page 5 of the field book. Pictures.
Legend:
1- Lubrification
2- Pumps
3- Marginal/Corinthians
4- Diesel/Serafim
5- Station 1
6- Station 2
7- Marginal
8- Oil
9- Station
10- Marginal
11- Station
12- Pumps
13- Station
14- Manobra
15- Pumps
16- Pumps
17- Pumps
18- Service

Monitoring wells

Number	O2 %	LEL%
1	Deficiency at 0.5m	0
2		100 at 0.2 meters
3	Deficiency	100 on surface
4		100% at 1m and 10% at 0.5m

Site 1
Auto Posto Monterey
Rua Carlos Petit, 36
Vila Mariana
Phone: 55498544

Page 17: Pictures – Legend:
1- Oil
2- Station
3- Vergueiro / Carlos Petit
4- Vergueiro
5- Oil
6- Pumps
7- Station
8- Vergueiro
9- SABESP
10- Car wash
11- Pumps
12- Station
13- Borracheiro (where tires are changed/fixed)
14- Air
15- Carlos Petit
16- Station/pump
17- Station/pump

Owner: Carla Patricia de Souza
Severino or Claudio know the station history (6 years)
The station was opened in 1972
They don't know if the tanks have been replaced.
In December 2000, the station was rebuilt.
The tanks were replaced
They have inventory control with alarm for water. The tank leaking was the one on south. It was detected by the subway on August 2000.
They sell 70,000L/month of gasoline, 40,000L/month and 10,000L/month of alcohol.
The busiest days are Thursday (2-10PM), Friday (6-10AM) and Saturday (8am to 2pm)
The tanks are loaded on Wednesday.
The used oil is sold.
They have a sand separating bex.
There is no knowledge of any leakage in other stations near the site.
Samples are collected every Friday.
Monitoring wells:

Number	O2 %	LEL%
1	Deficiency at 0.25m	0
2	Deficiency at 0.1m	0

3	Deficiency at 1m	80
4	Deficiency at 1m	0
5	Deficiency at 0.5m	4

Site 9
Dakota Auto Posto
Av. Robert Kennedy, 4695
Phone: 56668796
Manager: Amauri Lopes Bertolotti
Auxiliar: Emerson Pureza da Silva
Shouldn't come on Monday and Saturday.

Pictures (Drawing on page 23):
1- Diesel pump
2- Station passage
3- View to the Guarapiranga Reservoir
4- Passage
5- Pumps
6- Robert Kennedy entrance/ Shell sign
7- Entrance
8- Pumps / oil change
9- Patio
10- Borracharia (where tires are fixed/changed)
11- Sailing school
12- Pumps
13- Pumps
14- Oil drums
15- Well hose
16- Well hose
17- Monitoring well hose

Behind the diesel pump there was a well. It may be an old monitoring well. 0%LEL

Monitoring Wells:
(Drawing on page 25)

Number	O2 %	LEL%	Other
1			No keys
2			No keys
3	18	200 at surface	
4	18	30 at surface	
5			No keys
6			
7	19	50 at surface	
8			No keys
9			No keys

12-07-2001

Site 7
AD Servicos Automotivos
Rua dos Tamoios, 620 (corner with Rua Carlos Pinto Alves)
Arrived at 10:00.
Leakage in 1997. Source not identified. There is a tank from an airline company (VASP) with products for airplane painting.
Present on the site: Brandi, Mike Munsil, Beatriz Gil and Marcos (CETESB).
We received copies from the underground facilities of the station.
The owner asked about damages in his equipment. Marcos (CETESB) is verifying .
We started looking at the electric lines map.

Monitoring Wells:

Number	O2 %	LEL%
1	Deficiency	0
2	Deficiency	0
3	Deficiency	0

We marked the tanks, pumps, isles and the station's inventory control system.
If someone has any question (customer from the station, person passing by), the phone number to be given is 30307000. (CETESB)
We informed the owner the intention of starting the work on Monday. He said he was available and we told him that we would not impact his commercial activities.

Pictures taken at 13:17
1- Oil change
2- Station 1
3- Tamoios 1
4- Tamoios 2
5- Station 2
6- Carlos Pinto Alves 1
7- Carlos Pinto Alves 2
8- Station 3
9- Station back
10- Inside the station 1
11- Inside the station 2
12- Inside the station 3

12-08-2001

Site 5
Posto Terceiro Millenium
Av. Corifeu de Azevedo Marques, 3480 (corner with Sebastião Eugênio de Camargo)
We received maps from Ambiterra.

There are three tanks of 30,000L each. Two of them are divided in two tanks of 15,000L each. So there are 5 tanks. At the car wash, a cistern was found. There is a water well.
There was a bank on the right side of the pumps.
In the sanitary, the measure of LEL was 0%.
There is no electric power. Have to bring a generator.
Beside the store, there is a passage to a cellar.
Fabio's (driver) phone number: 98602472
Health and Safety Meeting:
Risks at the place:

- Negative impact on the skin;
- Exposed electric wiring;
- Rout to the cearest hospital
- No risks with traffic.

Signed by Mike Munsil, Brandi, Beatriz and Ivandra.
At the basement: O2% is 20.7 outside, on the entrance, 1.5meters and 3.0 meters below.
Left at 13:45.

Site 8
Auto Posto 45
Arrived at 15:15. The owner and the manager were not there. The person responsible for the station didn't authorize us to visit the place. Ivandra (Ambiterra) contacted Shell (Cesar) and they let us take a look at the station.
We made a drawing of the station, marking the tanks.

12-10-2001

Site 7

AD Servicos Automotivos (Airport)

Arrived at 10:00.

We were late because of the driver.

10:10 – meeting with everybody from this project and the station owner to explain about the health and safety plan prepared by CDM. Received copies: the owner, Claudio from American Drilling, Cetesb (Jorge) and Cobrape. The possible risks were explained, as the risk of being run over and the explosivity risks. The owner agreed with all the SV points. The points SV 4, 5 and 6 had their positions changed to meet the owner's requirements. Were present at the site:

Name	Company
Vicente de Aquino Neto	CETESB
Edson Hongo	Petrobrás
Cristian Santori Santarosa	Petrobrás
Mike Munsil	EC Americas
Beatriz Gil	Cobrape
Brandi	Cobrape
Jorge Luiz Gouveia	CETESB
Cláudio de Souza	American Drilling
Fabio Souza	American Drilling
Roberto Carlos Souza	American Drilling

American Drilling started cutting through the concrete. Near the pump the concentration was measured with the PID and the reading was 0,1ppm. When monitoring the breathing zone, one must remain measuring for 5 minutes and take the average. The first spot to be cut through the concrete took place at 11:15a.m.. The breathing zone at the mini-market was measured with the PID as 0.6ppm, while a car was being filled up.

Position	Method	Reading (ppm / %)	Time	Level
SV-5	PID	6,5	11:45	Breathing Zone
SV-1	LEL	0	11:30	Breathing Zone
SV-1	LEL	0	11:30	Ground
SV-2	LEL	1	11:45	Breathing Zone
SV-2	LEL	1	11:45	Ground
SV-4	LEL	1	12:00	Breathing Zone
SV-4	LEL	0	12:00	Ground
SV-4	PID	4,5	12:00	Breathing Zone
SV-3	LEL	0	12:10	Breathing Zone
SV-3	LEL	0	12:15	Ground
SV-7	LEL	0	12:30	Ground
SV-7	LEL	0	12:30	Breathing Zone
SV-8	LEL	0	12:35	Breathing Zone

SV-8	LEL	0	12:40	Ground
SV-9	LEL	0	15:00	Breathing Zone
SV-1	LEL	0	16:00	Breathing Zone/ Ground

Pictures – taken at 12:30

1. SV-7
2. SV-8 (12:40)
3. SV-8 (12:40)
4. SV-1: Verifying the soil (14:40)
5. Água Espraiada
6. VASP (Station is located next to the truck)
7. Profa. Heloisa Carneiro
8. Profa. Heloisa Carneiro
9. Rua Tapes
10. Rua Capiberibe
11. Tamoios
12. Tamoios
13. SV-1 Perfuration up to 1 meter.
14. SV-1 – Geoprobe

Around 13:30 we went to have lunch.
We've scheduled with Joao Batista, from Aster, a visit to their station tomorrow. (Station San Martin Phone Number: 38255357)

Luiz Eduardo and me took a walk around the station to investigate the area. The rain water flows from the street to the river Agua Espraiada. The area is mostly residential and the highest movement is at Rua dos Tamoios (because of the airport and a bank). The work was delaid because of the difficulty to calibrate the GC. It is possible that the problem with the calibration comes from the engine at Vasp (Airline Company), because of the release of fuel in atmospheric air (16:00).

At 16:00 the drilling at SV-1 started. Is was necessary to use the Geoprobe because the regular probe couldn't go down to 1 meter.
At 16:20 it started raining.

Readings:

Location	PID (ppm)	LEL (%)	O2 (%)	Time	Other
SV-1	2,1	0		16:20	
SV-2	2,8	1		16:55	PID average: 2,1ppm
SV-3	3,1			17:40	PID average: 1,8ppm
SV-4	4,2	0		17:10	PID average: 2,1ppm
SV-7	6,1	16,1	0		Sample taken whem PID

					reading was 5,8ppm
SV-8	193,8	17,3	0	18:15	
SV-9	54,7	18,9	0		

After SV-1, the tubing connecting the equipment to the probe was changed and the T fitting with the septum was maintained.
Claudio from American Drilling said that he would look for a T fitting that could be adapted to seal the probe and connect to the tubing that goes to the PID and to the Explosimeter. We have to check the size of the probe to make this adaptation.
All the points were drilled 1 meter with the Geoprobe.
The samples were taken up to 18:50. American Drilling had to cover the points with concrete. Some cones will be left at the station to protect the holes, since we are coming back to this station tomorrow. The owner (Mr. Antonio) will be responsible for the cones.

12-11-2001

Station San Martin
The station has 7 tanks of 15.000L each, every one divided into two tanks. So the 14 tanks are divided into:

- 7 with addicted gasoline
- 4 with normal gasoline
- 3 with alcohol

On a building nearby it was detected gasoline odor underground. It appears that the garage next to the station was using product to wash car pieces and t hen letting them go down the drain.
Aster architect (Cecilia) phone number: 38463300
The station sells 1,100,000L of gasoline/month and 300,000L of alcohol/month.

12-12-2001

Arrived at the station at 9:00. Joao Batista (responsible for the station), Mr. Amaro (electrition while the station was rebuilt) and Mr. Pinheiro (former manager) agreed with all the points to be drilled.
We waited until the tanks where filled by the truck to start probing. After the healt h and safety meeting American Drilling started cutting through the concrete. The average concentration read with the PID in the station area was around 3ppm for about 5 minutes.
We called Cobrape, so that they could have Peter to call us at the station.

13:06- SV-12: The reading with the PID was overrange. In the screen the value showed was 889ppm. The explosimeter readings were over 200%LEL, 2%O2 and the alarm from the H2S rang. We monitored the monitoring wells to see if we could go on with the drilling. The hole was sealed immediately with cement.

Readings:

Location	O2 (%)	LEL (%)	H2S (ppm)	Time	Level
SV-7		0		10:50	Breathing Zone
SV-8		0		11:00	Breathing Zone
SV-12		0		11:10	Breathing Zone
SV-6		0		11:30	Breathing Zone
MW-4	2,3	90	8	13:15	1m
Access to tank 10		100		13:17	Ground
MW-6	2,6	84	2	13:18	1m
MW-7	1	95	3	13:19	1m
MW-3	12,6	6	0	13:20	1m
MW-2	3,2	120	1	13:22	1m
MW-1	0,2	86	1	13:23	
MW-8	12	5	0	13:30	1m

SV-8: (13:35) It was not possible to drill this location with the Bosch.
SV-7: (13:40) Only the Bosch hammer was used. The Geoprobe was used only to take the probe out.

Mike talked to Peter, explained what happened and we continued the work.

Location	PID (ppm)	LEL (%)	O2 (%)	H2S (ppm)	Time	Other
SV-7	164	5	20,1	0	13:40	
SV-8	527	41	16	0	14:45	Used the Geoprobe
SV-6	146	29	15,3	0		
SV-2	8	0	20,4		15:50	Breathing zone: 20,6%O2 0%LEL

SV-1	2	0	6,3	0	16:50	PID average: 1ppm No sample was taken from this point for the GC
SV-3	658	17,7	17	0	17:40	Breathing Zone: 20,6%O2 0%LEL
SV-4	158	55	14	0	18:05	
SV-5	1039 over range	40	13,4	0	18:45	No sample was taken from this point for the GC
SV-15	Abandoned					

The explosimeter is around 7%LEL out of calibration, so we are subtracting this value from all the readings (the table shows the values after subtracting).
Things to be resolved with Shell:

- ART (Technical responsibility certificate)
- Insurance
- Confidentiality term

Shell wants a meeting to sign the confidentiality term with CETESB, Cobrape and CDM (have to check the possibility of Mike, Jobelino or Pena signing the document).

PID calibration: 103ppm
New Calibration was made. We saw many superficial leakages at the site. Change of GCs.

SV-15: Used the Bosch until it was too hard. Then tried the Geoprobe (it seems that they hit a rock). Next to the point there is a monitoring well. Apparently there was an attempt of drilling two other places before they succeeded. Stopped the work at 19:45.

19:40- Spoke to Claudio (worker at the station, responsible for the place when the manager is out) and he agreed that American Drilling could close the holes on the next day. We offered leaving the cones but he preferred not to use them, because it could affect the traffic at the station.
Calibration check: PID #1: Ambient air: 5ppm
Calibration Gas: 111ppm

12-13-2001

PID #2: Calibration: 100ppm
Arrived at the station at 8:20.
Attended the health and Safety Meeting:

Name	Company
Beatriz	Cobrape

André	Cobrape
Mike Munsil	ECAmericas
Fabio	American Drilling
Roberto Carlos	American Drilling

Spoke to Cecília (Aster Architect) about SV-15, that was not drilled.
Ambient air: around 5ppm with the PID.

Location	O2 (%)	LEL (%)	Time	Level
SV-9		0	10:50	Breathing Zone
SV-10		0	11:10	Breathing Zone
SV-14		0	11:30	Breathing Zone
SV-11	20,6	0	11:37	Breathing Zone
SV-19		0	13:20	Breathing Zone
SV-18		0	13:40	Breathing Zone
SV-17		0	14:00	Breathing Zone
SV-22		0	14:20	Breathing Zone
SV-16		0	14:30	Breathing Zone
SV-20		0	14:45	Breathing Zone
SV-21		0	15:15	Breathing Zone
SV-13		0	15:30	Breathing Zone

Location	PID (ppm)	LEL (%)	O2 (%)	H2S (ppm)	Time	Other
SV-9	104	2	17	0	10:50	
SV-10	830	60	5,9	0	11:10	
SV-14	407	1	20,3		11:30	No sample was collected from this point to the GC
SV-11	33	20,3	1	0	11:37	No sample was collected from this point to the GC
SV-19	8	0	20,6		13:20	Changed the T fitting
SV-18	1470 over range	120	6,5	0	13:40	
SV-17	31,5	0	20,3	0	14:00	
SV-22	Hit paving blocks – no reading was taken at this point – 14:20 Bosch couldn't cut through					
SV-16	20	0	4,5		14:30	
SV-21	3	1	17,7		15:15	Used the Geoprobe to cut through the paving blocks
SV-20	540	4	20,1		14:45	Calibration check (PID#2): 160ppm – from now on PID#1

						will be used (87,6ppm)
SV-13	85	3	18,6		16:00	

Pictures:
17. GC
18. Operating the Bosch (Roberto Carlos) at SV-21
19. Geoprobe (SV-17)
20. Fabio operating the Geoprobe (SV-16)

End of the day.

12-14-2001

9:35 – Ambiterra on site
American Drilling not on site
Marking proposed locations, setting up GC2. Beatriz of Cobrape will operate it. We will maintain GC logs in the other field book.
9:55 – Security on site to verify if all is OK.
Checking PID 1 calibration against 98 ppm isobutylene standard. Rading is 98.1 acceptable.
10:14 – ambient air: 0.4ppm (PID)
Checked out LEL/O2 meter. OK. Drillers still not on site. Bia is calibrating GC-2.
10:45 – Drillers on site.
Walking site with Everaldo of Ambiterra to get agreement.
11:00 – Walked every point with Everaldo of Ambiterra and obtained agreement on each point.
11:07 – Completed H&S briefing. Starting to break concrete.
11:39 – Humid, breezy 10-15mph
Breaking concrete.

Location	PID (ppm)	LEL (%)	O2 (%)	H2S (ppm)	Time	Other
SV-8	0,0	0	5,9		11:50	
SV-3	5,8	3	17,8		12:25	Ambient air: 0ppm w/ PID
SV-9	0	0	6,9		12:56	
SV-12	3,1	0	20,7		13:16	13:25 – break for lunch 14:00 – on site Recalibrating GC2 Breaking concrete
SV-16	0	0	20,7		14:54	Raining heavily
Checked calibration PID1 – 101 v 98 GC-2 not calibrating. Trying GC-1 (15:21)						
SV-1	0	0	20,7		16:03	16:15 – Cesar on site
SV-2	0	0	20,7		16:24	GC-1 won't work, switching back to GC-2. Establishing calibration but air charge is low

SV-4	0	0	20,7		16:57	
SV-5	0	0	20,7		17:07	
SV-10	0	1	12,9		17:13	
SV-19	0	0	20,7		17:27	
GC-2 won't calibrate, move ahead on all points with PID and LEL. Cesar off-site.						
SV-22	0	0	18,9		17:35	
Checked PID 1 calibration 66 vs98. Recalibration: 101 vs 98						
SV-18	3	0	20,7		17:46	
SV-17	6	0	20,7		18:02	
SV-7	5	21	9,7		17:58	
SV-21	2,7	0	20,7		18:02	
SV-15	2	0	20,7		18:24	
SV-13	0,4	0	20,7		18:40	
SV-11	0	0	16,9		18:52	
SV-6	1,8	0	20,7		19:09	

Too dark to continue. Shutting down.
19:23 – PID calibration check: 104 vs 98.
19:35 – off-site

12-15-2001

Site 5 – Terceiro Millenium (Shell)

Summary

Location	PID (ppm)	LEL (%)	O2 (%)	GC	Date
SV-1	0	0	20,7	-	12-14-01
SV-2	0	0	20,7	-	12-14-01
SV-3	5,8	3	17,8	Y	12-14-01
SV-4	0	0	20,7	-	12-14-01
SV-5	0	0	20,7	-	12-14-01
SV-6	1,8	0	20,7	-	12-14-01
SV-7	5,0	21	9,7	-	12-14-01
SV-8	0	0	5,9	-	12-14-01
SV-9	0	0	6,9	Y	12-14-01
SV-10	0	1	12,9	-	12-14-01
SV-11	0	0	16,9	-	12-14-01
SV-12	3,1	0	20,7	Y	12-14-01
SV-13	0,4	0	20,7	Y	12-14-01
SV-14	2,5	0	20,7	-	15-12-01
SV-15	2	0	20,7	-	12-14-01
SV-16	0	0	20,7	Y	12-14-01

SV-17	6,0	0	20,7	-	12-14-01
SV-18	3,0	0	20,7	-	12-14-01
SV-19	0	0	20,7	-	12-14-01
SV-20	0,0	0	11,5	-	15-12-01
SV-21	2,7	0	20,7	-	12-14-01
SV-22	0	0	18,9	-	12-14-01
SV-23	4,2	0	20,7	-	15-12-01
SV-24	0,3	0	20,7	-	15-12-01
SV-25	2,8	0	20,7	-	15-12-01

We waited for Everaldo Rodrigo Julio of Ambiterra until 9:30 (The time scheduled was 8:30).
Calibration check of PID 1: 90,7ppm.

12-17-2001

Site 4: Shell AP Fernao Dias
Arrived at 10:15. Present at the site:

Name	Company
Salvador	Station manager
Everaldo	Ambiterra
Fabio	American Drilling
Roberto Carlos	American Drilling
Beatriz	Cobrape
Brandi	Cobrape
Andre	Cobrape
Mike Munsil	ECAmericas

Made H&S briefing. Marked the points. Waited for the truck to fill the tanks and for Everaldo (Ambiterra) to arrive.
Data from this site is found in the other logbook (#1).
Engefuro: Phone number: 69542404
R$40/hole
R$60/ mobilization tax
engefuro@engefuro.com.br

12-19-2001
Station Mundo Novo (Site 2)
Arrived at 9:00 (Engefuro had no arrived yet).
Spoke to Manuel, the station owner.

Field Study Soil Vapor Data

Site # 5 SHELL AP 3r Milenio

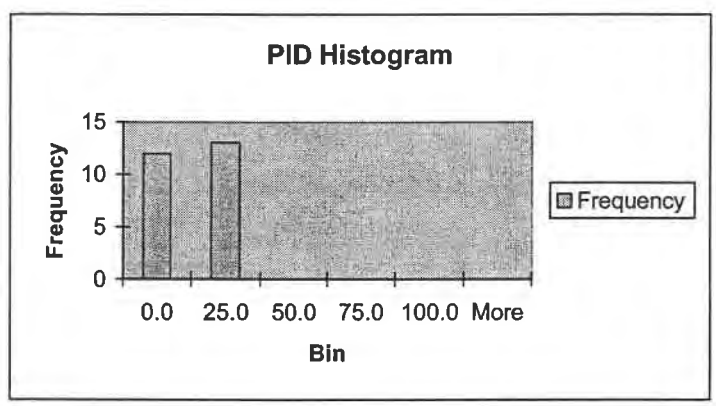
Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comment	Range PID (ppm)
SV-1	0.0	0.0	-	20.7	No reason to believe this site is contaminated	0.0
SV-2	0.0	0.0	-	20.7	results are consistent with site inspection	0.0
SV-3	5.8	3.0	-	17.8		0.0
SV-4	0.0	0.0	-	20.7		0.0
SV-5	0.0	0.0	-	20.7		0.0
SV-6	1.8	0.0	-	20.7		0.0
SV-7	5.0	21.0	-	9.7		0.0
SV-8	0.0	0.0	-	5.9		0.0
SV-9	0.0	0.0	-	6.9		0.0
SV-10	0.0	1.0	-	12.9		0.0
SV-11	0.0	0.0	-	16.9		0.0
SV-12	3.1	0.0	-	20.7		0.0
SV-13	0.4	0.0	-	20.7		0.3
SV-14	2.5	0.0	-	20.7		0.4
SV-15	2.0	0.0	-	20.7		1.8
SV-16	0.0	0.0	-	20.7		2.0
SV-17	6.0	0.0	-	20.7		2.5
SV-18	3.0	0.0	-	20.7		2.7
SV-19	0.0	0.0	-	20.7		2.8
SV-20	0.0	0.0	-	11.5		3.0
SV-21	2.7	0.0	-	20.7		3.1
SV-22	0.0	0.0	-	18.9		4.2
SV-23	4.2	0.0	-	20.7		5.0
SV-24	0.3	0.0	-	20.7		5.8
SV-25	2.8	0.0	-	20.7		6.0

PID
0.0
0.0
5.8
0.0
0.0
1.8
5.0
0.0
0.0
0.0
0.0
3.1
0.4
2.5
2.0
0.0
6.0
3.0
0.0
0.0
2.7
0.0
4.2
0.3
2.8

Column1	
Mean	1.584
Median	0.3
Mode	0
Range	6
Minimum	0
Maximum	6
Count	25

0.0	
25.0	
50.0	
75.0	
100.0	

Bin	*Frequency*
0.0	12
25.0	13
50.0	0
75.0	0
100.0	0
More	0

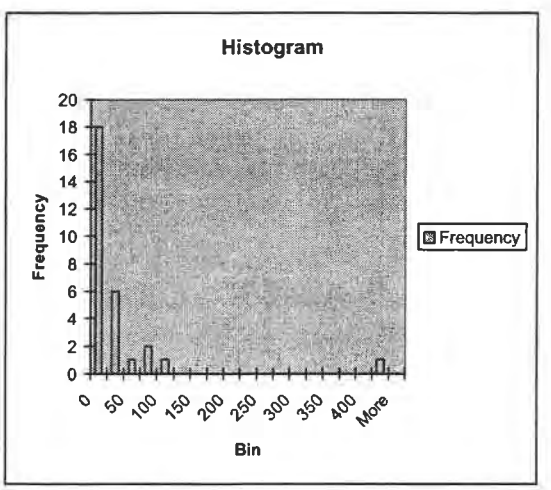


Site # 8 SHELL AP 45

Measurement Point	Date	Time	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	PID (ppm)
SV-1	1/14/02	-	-				-
SV-2	1/15/02	11:55	0.0				0.0
SV-3	1/15/02	11:23	0.0				0.0
SV-4	1/15/02	11:30	0.0				0.0
SV-5	1/15/02	14:20	0.0				0.0
SV-6	1/14/02	-					0.0
SV-7	1/15/02	10:36	410.8				0.0
SV-8	1/15/02	14:08	0.0				0.0
SV-9	1/14/02	13:50	85.4				0.0
SV-10	1/14/02	-	-				0.0
SV-11	1/15/02	-	-				0.0
SV-12	1/14/02	-	-				0.0
SV-13	1/14/02	-	-				0.0
SV-14	1/14/02	-	-				0.0
SV-15	1/14/02	15:12	10.3				0.0
SV-16	1/14/02	15:17	2.9				0.0
SV-17	1/14/02	-	-				0.0
SV-18	1/14/02	13:36	0.0				0.0
SV-19	1/14/02	15:25	0.0				0.0
SV-20	1/15/02	10:57	1.4				0.9
SV-21	1/14/02	13:14	73.2				1.4
SV-22	1/14/02	-	-				2.8
SV-23	1/14/02	13:27	0.0				2.9
SV-24	1/14/02	13:00	65.5				4.8
SV-25	1/15/02	11:17	0.0				10.3
SV-26	1/14/02	12:44	25.3				25.3
SV-27	1/14/02	13:06	0.0				65.5
SV-28	1/14/02	15:33	0.0				73.2
SV-29	1/14/02	15:41	0.9				85.4
SV-30	1/14/02	-	-				410.8
SV-31	1/14/02	12:08	0.0				-
SV-32	1/14/02	16:03	0.0				-
SV-33	1/14/02	-	-				-
SV-34	1/14/02	12:36	0.0				-
SV-35	1/14/02	12:52	0.0				-
SV-36	1/14/02	16:15	2.8				-
SV-37	1/14/02	16:26	0.0				-
SV-38	1/14/02	12:26	4.8				-
SV-39	1/14/02	13:51	0.0				-
SV-40	1/14/02	-	-				-
SV-41	1/15/02	13:52	0.0				-
SV-42	1/14/02	-	-				

PID
0.0
0.0
0.0
0.0
410.8
0.0
85.4
10.3
2.9
0.0
0.0
1.4
73.2
0.0
65.5
0.0
25.3
0.0
0.0
0.9
0.0
0.0
0.0
0.0
2.8
0.0
4.8
0.0
0.0

Column1		*Bin*	*Frequency*
Mean	23.56034	0	18
Median	0	25	6
Mode	0	50	1
Range	410.8	75	2
Minimum	0	100	1
Maximum	410.8	125	0
Count	29	150	0
		175	0
		200	0
		225	0
		250	0
		275	0
		300	0
		325	0
		350	0
		375	0
		400	0
		425	1
		More	0

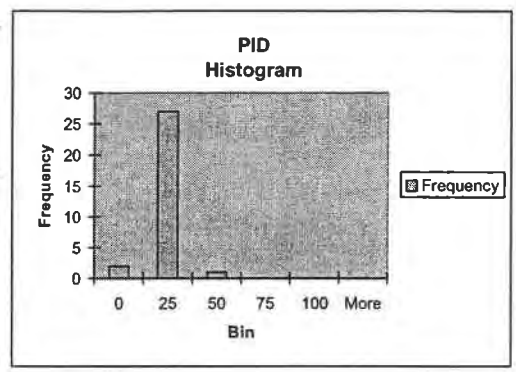


Site # 4 SHELL AP Fernao Dias

Measurement Point	PID (ppm)	GasTech (ppm, with methane elimination)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comment	Ranges PID (ppm)
SV-1	-	-	-	-	-	Could not complete, refusal at some sort of foundation or pavement	0.0
SV-2	-	-	-	-	-	Could not complete, refusal at some sort of foundation or pavement	0.0
SV-3	-	-	-	-	-	Could not complete, refusal at some sort of foundation or pavement	0.4
SV-4	3.6	50	0.0	0	20.7		2.0
SV-5	5.3	25	0.0	0	20.7		2.1
SV-6	-	-	-	-	-	Could not complete, refusal at underground vault	2.3
SV-7	0.0	150	0.0	0	19.5	Anomalous, changed over to dual tube measurement	2.7
SV-8	2.3	25	0.0	0	17.2		2.8
SV-9	0.0	25	0.0	0	19.0		3.3
SV-10	15.9	0	0.0	0	19.3		3 4
SV-11	2.8	0	0.0	0	20.5		3.6
SV-12	20.0	25	4.0	0	20.7		4.6
SV-13	2.0	0	0.0	0	20.7		4.8
SV-14	2.1	10	-	-	-	MSA failed	5.3
SV-15	-	-	-	-	-	Could not complete, refusal at some sort of foundation or pavement	6.0
SV-16	0.4	0	0.0	0	19.6		7.3
SV-17	7.8	12	-	-	-	MSA failed	7.8
SV-18	10.0	150	-	-	-		10.0
SV-19	4.6	10	-	-	-	MSA failed	11.2
SV-20	39.3	20	-	-	-	MSA failed	15.4
SV-21	21.4	25	-	-	-	MSA failed	15.9
SV-22	17.2	0	0.0	0	20.7		17.2
SV-23	-	-	-	-	-	Could not complete, refusal at some sort of foundation or pavement	18.2
SV-24	3.3	3	0.0	0	20.5		19.4
SV-25	19.4	-	-	-	-	MSA failed	20.0
SV-26	6.0	0	0.0	0	20.7		20.0
SV-27	2.7	-	0.0	0	21.1		21.4
SV-28	23.6	-	6.0	0	7.8		22.3
SV-29	22.3	0	0.0	0	20.8		23.6
SV-30	7.3	0	0.0	0	20.6		39.3
SV-31	3.4	-	2.0	0	19.0		-
SV-32	4.8	10	-	-	-	MSA failed	-
SV-33	11.2	8	-	-	-	MSA failed	-
SV-34	15.4	0	0.0	0	20.5		-
SV-35	18.2	25	0.0	0	20.7		-
SV-36	20.0	23	0.0	0	20.6		-

3.6
5.3
0.0
2.3
0.0
15.9
2.8
20.0
2.0
2.1
0.4
7.8
10.0
4.6
39.3
21.4
17.2
3.3
19.4
6.0
2.7
23.6
22.3
7.3
3.4
4.8
11.2
15.4
18.2
20.0

PID		*Bin*	*Frequency*
Mean	10	0	2
Median	7	25	27
Mode	0	50	1
Range	39	75	0
Minimum	0	100	0
Maximum	39	More	0
Count	30		



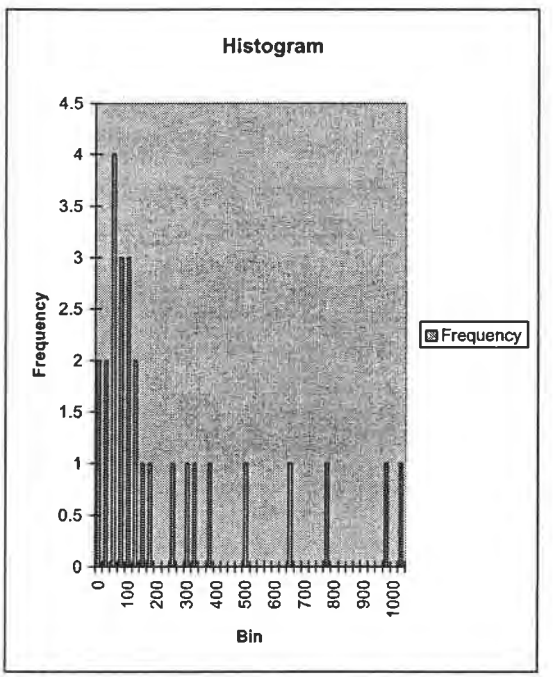
Site # 9 Shell AP Dakota

Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comments	Range PID
SV-1	0	0	0	20.4		0
SV-2	319.0	0	0	20.5		0.0
SV-3	298.0	0	0	20.5		1.3
SV-4	50.0	0	0	20.5		7.6
SV-5	0.0	0	0	20.3		43.0
SV-6	971.5	0	0	20.6		47.5
SV-7	2345.0	0	0	20.6		49.5
SV-8	7.6	0	0	20.5		50.0
SV-9	111.0	0	0	20.3		51
SV-10	760.0	0	0	20.5		51.0
SV-11	-	-	-	-	MSA Failed, Could not core concrete	53.4
SV-12	632.5	-	-	-	MSA Failed	80.0
SV-13	1.3	0	0	20.5		82.0
SV-14	150.0	-	-	-	MSA Failed	98.0
SV-15	488.5	-	-	-	MSA Failed	105.5
SV-16	362.0	-	-	-	MSA Failed	111.0
SV-17	172.5	-	-	-	MSA Failed	150.0
SV-18	43.0	-	-	-	MSA Failed	172.5
SV-19	47.5	-	-	-	MSA Failed	237.5
SV-20	51	-	-	-	MSA Failed	298.0
SV-21	105.5	-	-	-	MSA Failed	319.0
SV-22	80.0	-	-	-	MSA Failed	362.0
SV-23	53.4	-	-	-	MSA Failed	488.5
SV-24	98.0	-	-	-	MSA Failed	632.5
SV-25	49.5	-	-	-	MSA Failed	760.0
SV-26	82.0	-	-	-	MSA Failed	971.5
SV-27	237.5	-	-	-	MSA Failed	2345.0
SV-28	51.0	-	-	-	MSA Failed	-

0
319.0
298.0
50.0
0.0
971.5
2345.0
7.6
111.0
760.0
632.5
1.3
150.0
488.5
362.0
172.5
43.0
47.5
51
105.5
80.0
53.4
98.0
49.5
82.0
237.5
51.0

	Column1
Mean	280.2704
Median	98
Mode	0
Range	2345
Minimum	0
Maximum	2345
Count	27

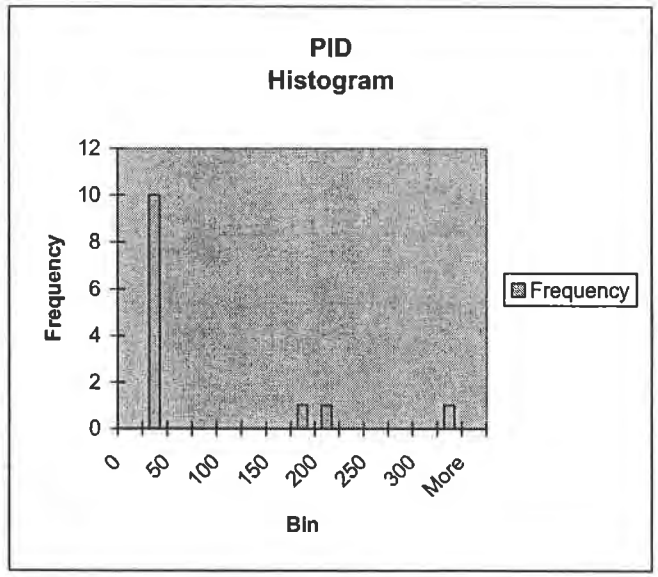
Bin	*Frequency*
0	2
25	2
50	4
75	3
100	3
125	2
150	1
175	1
200	0
225	0
250	1
275	0
300	1
325	1
350	0
375	1
400	0
425	0
450	0
475	0
500	1
525	0
550	0
575	0
600	0
625	0
650	1
675	0
700	0
725	0
750	0
775	1
800	0
825	0
850	0
875	0
900	0
925	0
950	0
975	1
1000	0
More	1



Site # 1 SHELL AP Monterey

Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comments	Ranges PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)
SV-1	14.4	179.0	2.0	2.9		2.0	0.0	0.0	2.9
SV-2	6.7	0.0	0.0	20.6		5.0	0.0	0.0	3.0
SV-3	172.2	158.0	0.0	16.5		6.7	0.0	0.0	6.9
SV-4	6.7	0.0	0.0	20.6		6.7	0.0	0.0	7.9
SV-5	2.0	44.0	5.0	7.9		9.8	0.0	0.0	16.5
SV-6	5.0	0.0	0.0	20.6		11.1	0.0	0.0	20.2
SV-7	12.4	0.0	0.0	20.5		12.4	0.0	0.0	20.4
SV-8	11.1	0.0	0.0	20.2		13.1	0.0	0.0	20.5
SV-9	315.0	32.0	11.0	6.9		14.4	0.0	0.0	20.5
SV-10	13.1	0.0	0.0	20.5		22.3	32.0	2.0	20.5
SV-11	22.3	0.0	0.0	20.5		172.2	44.0	3.0	20.6
SV-12	186.8	0.0	3.0	3.0		186.8	158.0	5.0	20.6
SV-13	9.8	0.0	0.0	20.4		315.0	179.0	11.0	20.6

PID	
Mean	60
Median	12
Mode	7
Range	313
Minimum	2
Maximum	315
Count	13
Bin	*Frequency*
0	0
25	10
50	0
75	0
100	0
125	0
150	0
175	1
200	1
225	0
250	0
275	0
300	0
325	1
More	0

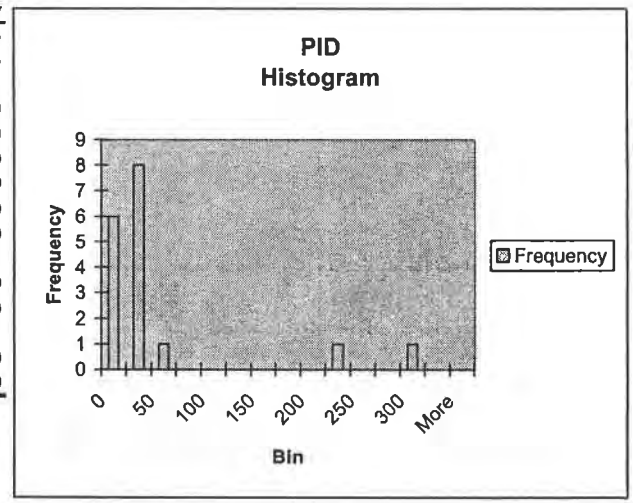


Site # 2 SHELL AP Mundo Novo

Measurement Point	PID (ppm)	GasTech (ppm, methane elimination)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)		Ranges PID (ppm)	GasTech (ppm, methane elimination)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)
SV-1	20.9	10000.0	20.0	0.0	4.1	GasTech Overrange, 100%LEL=10000ppm	0.0	0.0	0.0	0.0	4.1
SV-2	0.0	0.0	0.0	0.0	20.3		0.0	0.0	0.0	0.0	9.0
SV-3	0.0	0.0	0.0	0.0	20.3		0.0	0.0	0.0	0.0	15.3
SV-4	0.0	0.0	0.0	0.0	20.4		0.0	0.0	0.0	0.0	16.4
SV-5	5.0	10000.0	144.0	0.0	15.3	GasTech Overrange	0.0	0.0	0.0	0.0	20.2
SV-6	36.0	0.0	0.0	0.0	20.3		0.0	0.0	0.0	0.0	20.3
SV-7	0.0	0.0	0.0	0.0	20.4		4.0	0.0	0.0	0.0	20.3
SV-8	16.0	25.0	0.0	0.0	20.5		4.9	0.0	0.0	0.0	20.3
SV-9	17.0	25.0	0.0	0.0	20.2		5.0	0.0	0.0	0.0	20.4
SV-10	0.0	25.0	0.0	0.0	20.5		7.0	20.0	0.0	0.0	20.4
SV-11	4.9	20.0	2.0	0.0	20.4		10.0	25.0	0.0	0.0	20.4
SV-12	202.0	1000.0	11.0	0.0	16.4	GasTech Overrange	16.0	25.0	0.0	0.0	20.4
SV-13	300.0	1000.0	127.0	6.0	9.0	GasTech Overrange	17.0	25.0	2.0	0.0	20.5
SV-14	-	-	-	-	-	Abandoned due to refusal	20.9	1000.0	11.0	0.0	20.5
SV-15	4.0	0.0	0.0	0.0	20.5		36.0	1000.0	20.0	0.0	20.5
SV-16	10.0	0.0	0.0	0.0	20.5		202.0	10000.0	127.0	0.0	20.5
SV-17	0.0	0.0	0.0	0.0	20.4		300.0	10000.0	144.0	6.0	20.5
SV-18	-	-	-	-	-	Abandoned, encountered stormwater lines	-	-	-	-	-
SV-19	7.0	0.0	0.0	0.0	20.5		-	-	-	-	-

PID
20.9
0.0
0.0
0.0
5.0
36.0
0.0
16.0
17.0
0.0
4.9
202.0
300.0
4.0
10.0
0.0
7.0

PID		*Bin*	*Frequency*
Mean	37	0	6
Median	5	25	8
Mode	0	50	1
Range	300	75	0
Minimum	0	100	0
Maximum	300	125	0
Count	17	150	0
		175	0
		200	0
		225	1
		250	0
		275	0
		300	1
		325	0
		More	0



Site # 3 ASTER San Martin

Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comments
SV-1	1.0	0	0	6.3	
SV-2	8.0	0	-	20.4	
SV-3	658.0	17	0	17.7	
SV-4	188.0	55	0	14	
SV-5	1039.0	40	0	13.4	
SV-6	146.0	37	0	15.3	
SV-7	164.0	6	0	20.1	
SV-8	527.0	41	0	16	
SV-9	104.0	2	0	17	
SV-10	830.0	60	0	5.9	
SV-11	33.0	1	0	20.3	
SV-12	2000.0	-	-	-	PID overrange
SV-13	85.0	3	-	18.6	
SV-14	407.0	1	-	20.3	
SV-15	-	-	-	-	encountered refusal
SV-16	20.0	0	-	4.5	
SV-17	31.5	0	0	20.3	
SV-18	1470.0	120	0	6.5	
SV-19	8.0	0	-	20.6	
SV-20	540	4	-	20.1	
SV-21	3	1	-	17.7	
SV-22	-	-	-	-	encountered refusal

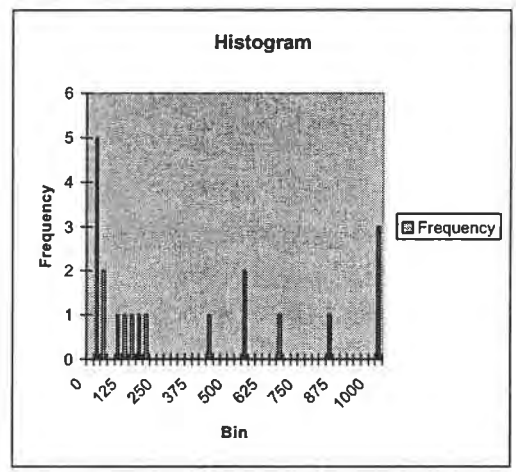
Ranges

PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)
1.0	0	0	4.5
3	0	0	5.9
8.0	0	0	6.3
8.0	0	0	6.5
20.0	0	0	13.4
31.5	1	0	14
33.0	1	0	15.3
85.0	1	0	16
104.0	2	0	17
146.0	3	0	17.7
164.0	4	0	17.7
188.0	6	0	18.6
407.0	17	-	20.1
527.0	37	-	20.1
540	40	-	20.3
658.0	41	-	20.3
830.0	55	-	20.3
1039.0	60	-	20.4
1470.0	120	-	20.6
2000.0	-	-	-
-	-	-	-
-	-	-	-

PID
1.0
8.0
658.0
188.0
1039.0
146.0
164.0
527.0
104.0
830.0
33.0
2000.0
85.0
407.0
20.0
31.5
1470.0
8.0
540
3

PID	
Mean	413
Median	155
Mode	8
Range	1999
Minimum	1
Maximum	2000
Count	20

Bin	*Frequency*
0	0
25	5
50	2
75	0
100	1
125	1
150	1
175	1
200	1
225	0
250	0
275	0
300	0
325	0
350	0
375	0
400	0
425	1
450	0
475	0
500	0
525	0
550	2
575	0
600	0
625	0
650	0
675	1
700	0
725	0
750	0
775	0
800	0
825	0
850	1
875	0
900	0
925	0
950	0
975	0
1000	0
More	3



Site # 7 BR AD Servicios

Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comments
SV-1	2.8	0.0		22.7	
SV-2	2.8	0.0		5.0	
SV-3	3.1	-	-	-	MSA Failed
SV-4	4.2	-	-	-	MSA Failed
SV-5	1.0	-	-	-	MSA Failed
SV-6	2.1	-	-	-	MSA Failed
SV-7	6.5	-	-	-	MSA Failed
SV-8	193.8	-	-	-	MSA Failed
SV-9	54.6	-	-	-	MSA Failed
SV-10	12.2	-	-	-	MSA Failed
SV-11	1.8	-	-	-	MSA Failed

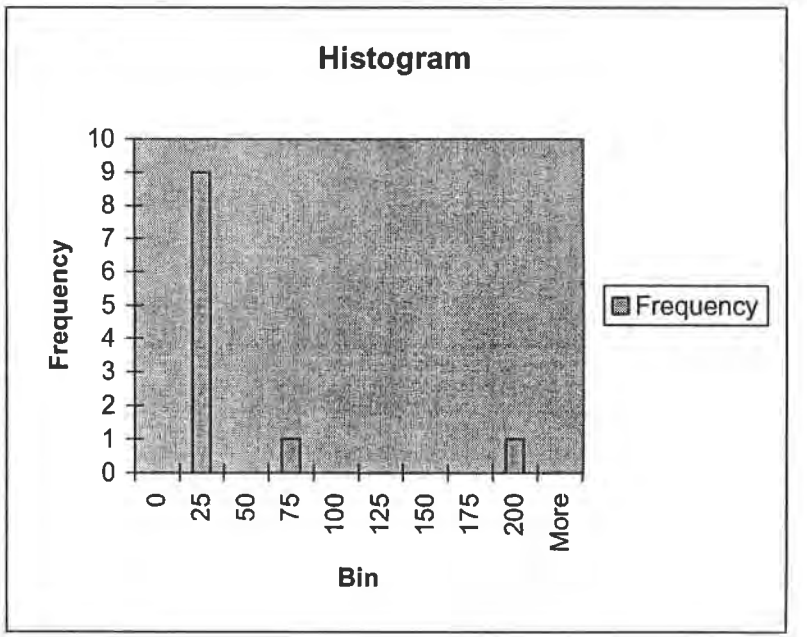
Range

PID (ppm)
1.0
1.8
2.1
2.8
2.8
3.1
4.2
6.5
12.2
54.6
193.8

PID

2.8
2.8
3.1
4.2
1.0
2.1
6.5
193.8
54.6
12.2
1.8

Column1		*Bin*	*Frequency*
Mean	25.9	0	0
Median	3.1	25	9
Mode	2.8	50	0
Range	192.8	75	1
Minimum	1	100	0
Maximum	193.8	125	0
Count	11	150	0
		175	0
		200	1
		More	0



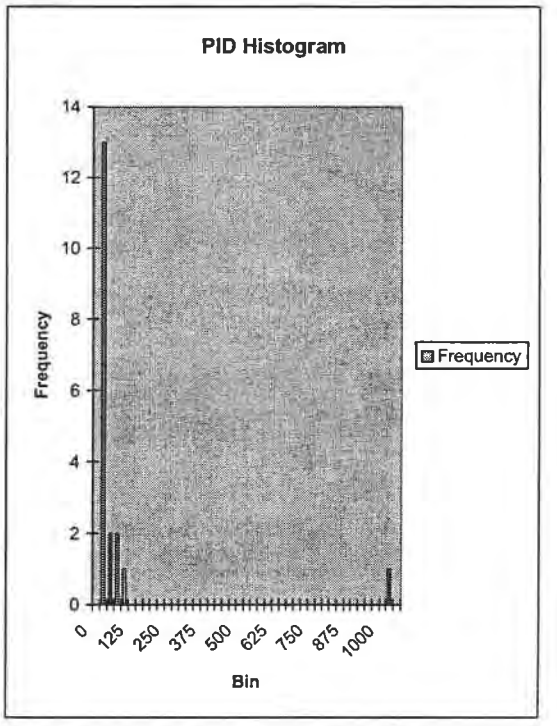
Site # 6 SHELL AP Super

Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comment	Range PID (ppm)
SV-1	19.1	0.0	0.0	20.6		4.5
SV-2	11.9	0.0	0.0	20.6		5.1
SV-3	21.4	0.0	0.0	20.6		5.7
SV-4	11.9	70.0	0.0	20.6	This is real, possibly Ethanol	7.0
SV-5	56.1	7.0	0.0	19.6		7.5
SV-6	53.5	9.3	0.0	19.9		9.3
SV-7	11.9	0.0	0.0	20.6		10.5
SV-8	7.5	0.0	0.0	20.6		11.9
SV-9	5.1	0.0	0.0	20.4		11.9
SV-10	14.1	2.0	0.0	20.4		11.9
SV-11	-	-	0.0	-	Could not complete, refusal at some sort of foundation or pavement	14.1
SV-12	26.0	0.0	0.0	20.4		19.1
SV-13	5.7	0.0	0.0	20.4		21.4
SV-14	1013.0	184.0	0.0	16.4	This is real, possibly gasoline	26.0
SV-15	4.5	0.0	0.0	12.3		45.6
SV-16	7.0	0.0	0.0	20.6		53.5
SV-17	45.6	0.0	0.0	12.7		56.1
SV-18	9.3	0.0	0.0	16.8		77.3
SV-19	-	-	0.0	-	Could not complete, refusal at some sort of foundation or pavement	1013.0
SV-20	10.5	0.0	0.0	20.4		-
SV-21	77.3	0.0	0.0	20.5		-

PID
19.1
11.9
21.4
11.9
56.1
53.5
11.9
7.5
5.1
14.1
26.0
5.7
1013.0
4.5
7.0
45.6
9.3
10.5
77.3

	PID
Mean	74.28421
Median	11.9
Mode	11.9
Range	1008.5
Minimum	4.5
Maximum	1013
Count	19

Bin	*Frequency*
0	0
25	13
50	2
75	2
100	1
125	0
150	0
175	0
200	0
225	0
250	0
275	0
300	0
325	0
350	0
375	0
400	0
425	0
450	0
475	0
500	0
525	0
550	0
575	0
600	0
625	0
650	0
675	0
700	0
725	0
750	0
775	0
800	0
825	0
850	0
875	0
900	0
925	0
950	0
975	0
1000	0
1025	1
More	0



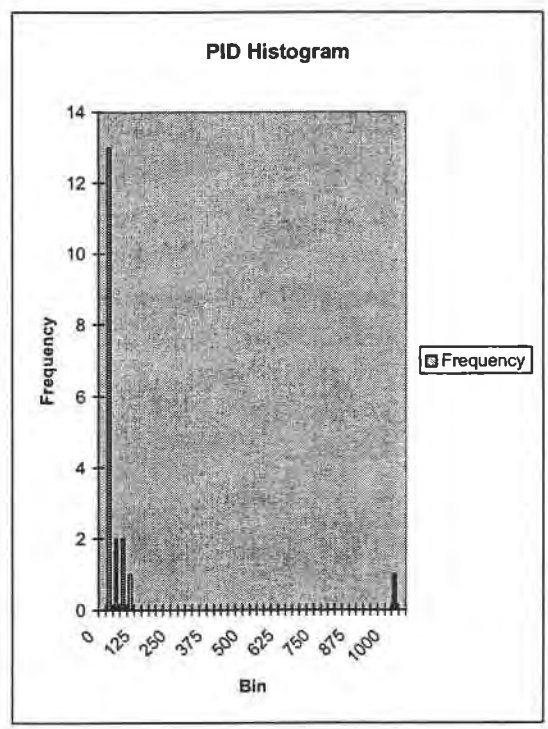
Site # 6 SHELL AP Super

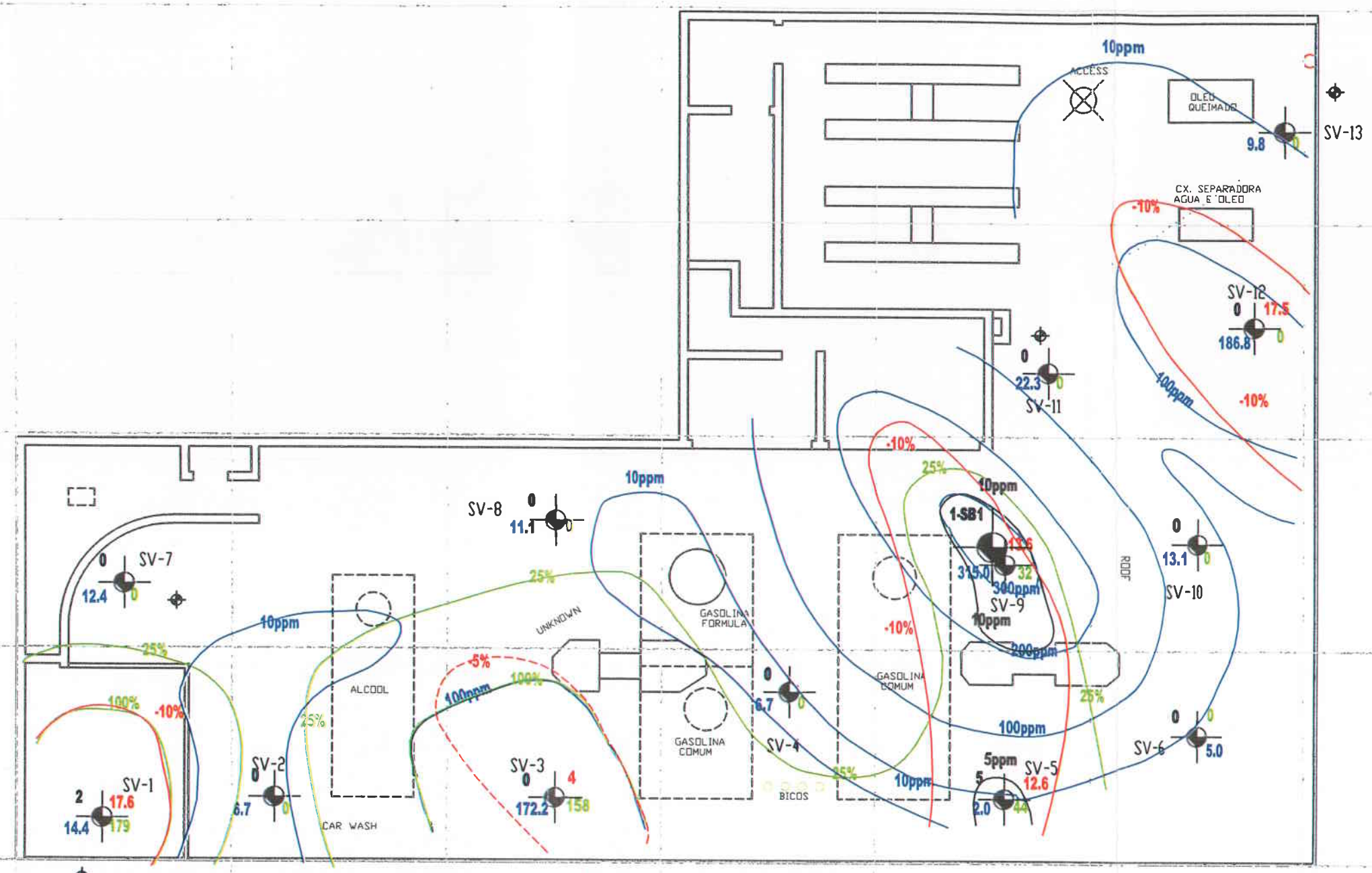
Measurement Point	PID (ppm)	MSA LEL (%)	MSA H2S (ppm)	MSA O2 (%)	Comment	Range PID (ppm)
SV-1	19.1	0.0	0.0	20.6		4.5
SV-2	11.9	0.0	0.0	20.6		5.1
SV-3	21.4	0.0	0.0	20.6		5.7
SV-4	11.9	70.0	0.0	20.6	This is real, possibly Ethanol	7.0
SV-5	56.1	7.0	0.0	19.6		7.5
SV-6	53.5	9.3	0.0	19.9		9.3
SV-7	11.9	0.0	0.0	20.6		10.5
SV-8	7.5	0.0	0.0	20.6		11.9
SV-9	5.1	0.0	0.0	20.4		11.9
SV-10	14.1	2.0	0.0	20.4		11.9
SV-11	-	-	0.0	-	Could not complete, refusal at some sort of foundation or pavement	14.1
SV-12	26.0	0.0	0.0	20.4		19.1
SV-13	5.7	0.0	0.0	20.4		21.4
SV-14	1013.0	184.0	0.0	16.4	This is real, possibly gasoline	26.0
SV-15	4.5	0.0	0.0	12.3		45.6
SV-16	7.0	0.0	0.0	20.6		53.5
SV-17	45.6	0.0	0.0	12.7		56.1
SV-18	9.3	0.0	0.0	16.8		77.3
SV-19	-	-	0.0	-	Could not complete, refusal at some sort of foundation or pavement	1013.0
SV-20	10.5	0.0	0.0	20.4		-
SV-21	77.3	0.0	0.0	20.5		-

PID
19.1
11.9
21.4
11.9
56.1
53.5
11.9
7.5
5.1
14.1
26.0
5.7
1013.0
4.5
7.0
45.6
9.3
10.5
77.3

	PID
Mean	74.28421
Median	11.9
Mode	11.9
Range	1008.5
Minimum	4.5
Maximum	1013
Count	19

Bin	*Frequency*
0	0
25	13
50	2
75	2
100	1
125	0
150	0
175	0
200	0
225	0
250	0
275	0
300	0
325	0
350	0
375	0
400	0
425	0
450	0
475	0
500	0
525	0
550	0
575	0
600	0
625	0
650	0
675	0
700	0
725	0
750	0
775	0
800	0
825	0
850	0
875	0
900	0
925	0
950	0
975	0
1000	0
1025	1
More	0





LEGENDA:

- PONTOS DE MONITORAMENTO
- PID ppm
- LEL%
- H2Sppm
- 02% Deficiency

RUA VERGUEIRO

Site 1 - SHELL, AP MONTEREY
SCALE 1:5K

Note:

5 apparent features

PID ppm indicated 4
LEL % indicated 4
H2S ppm indicated 2
O2 % deficiency indicated 5

Based upon raw PID data

CETESB UST PROJECT
SAO PAULO, BRAZIL

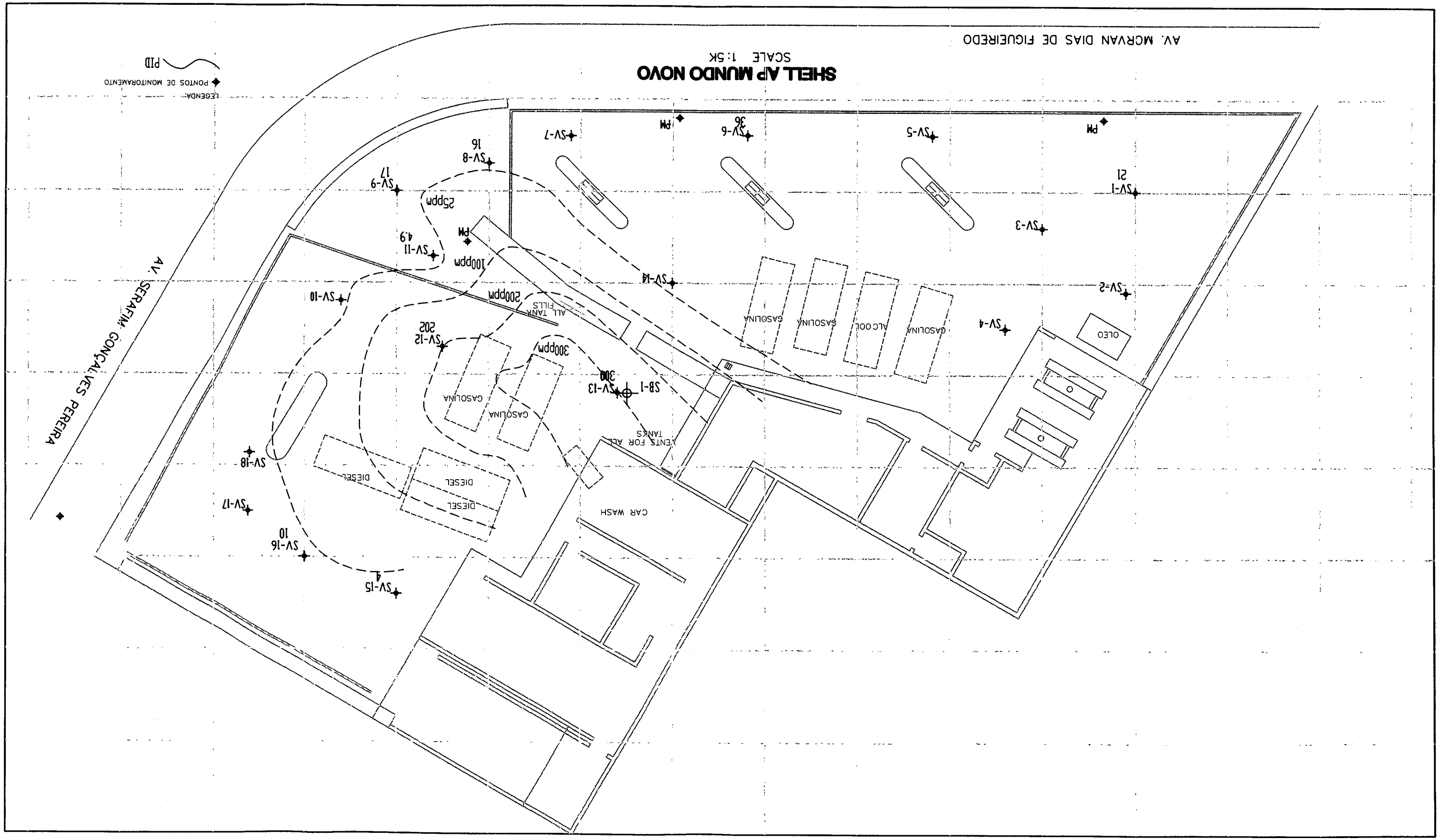
CDM

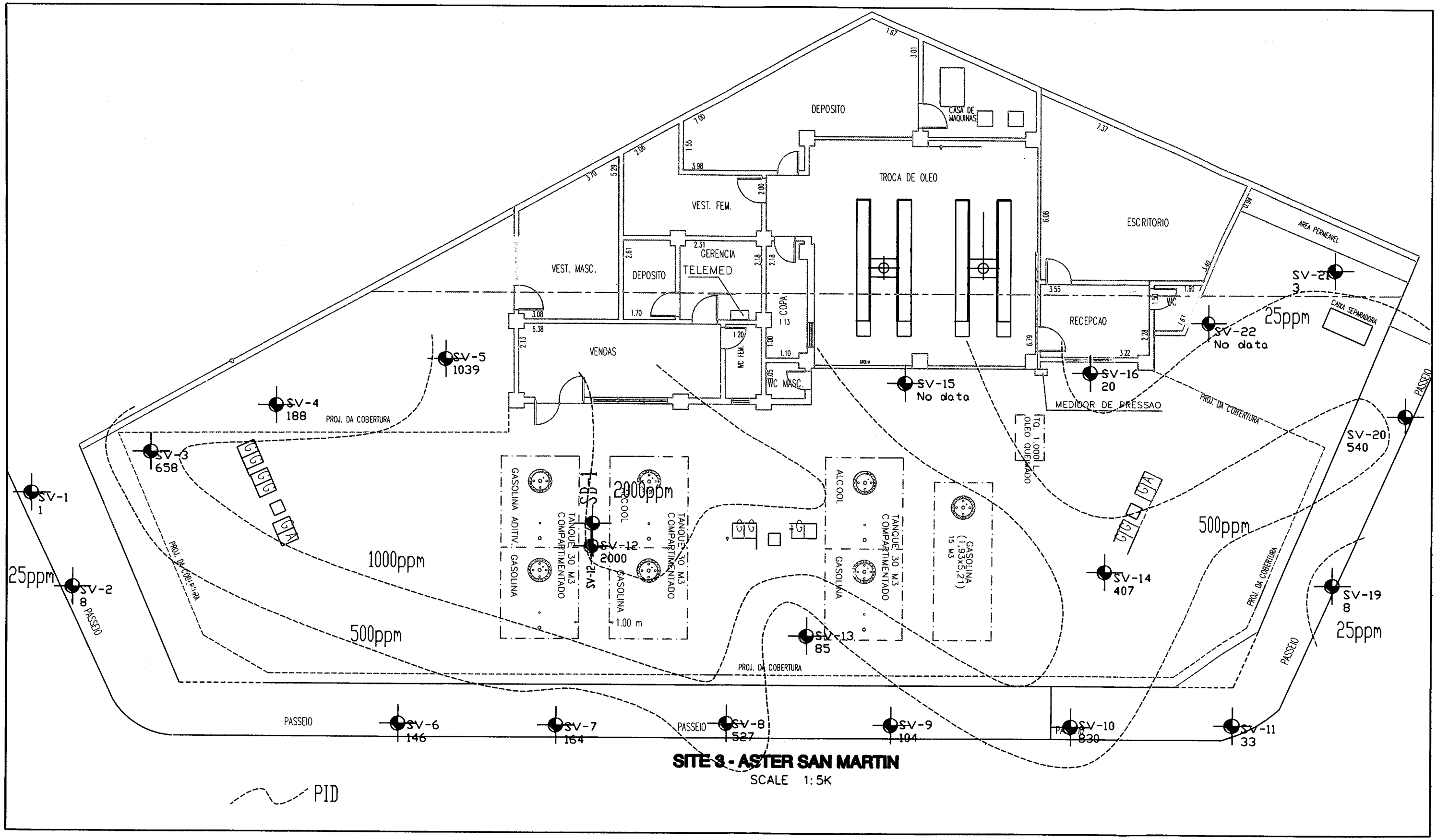
SITE 1
SHELL AP MONTEREY

CDM

CETESB UST PROJECT
SAO PAULO, BRAZIL

SITE 2
SHELL AP MUNDO NOVO





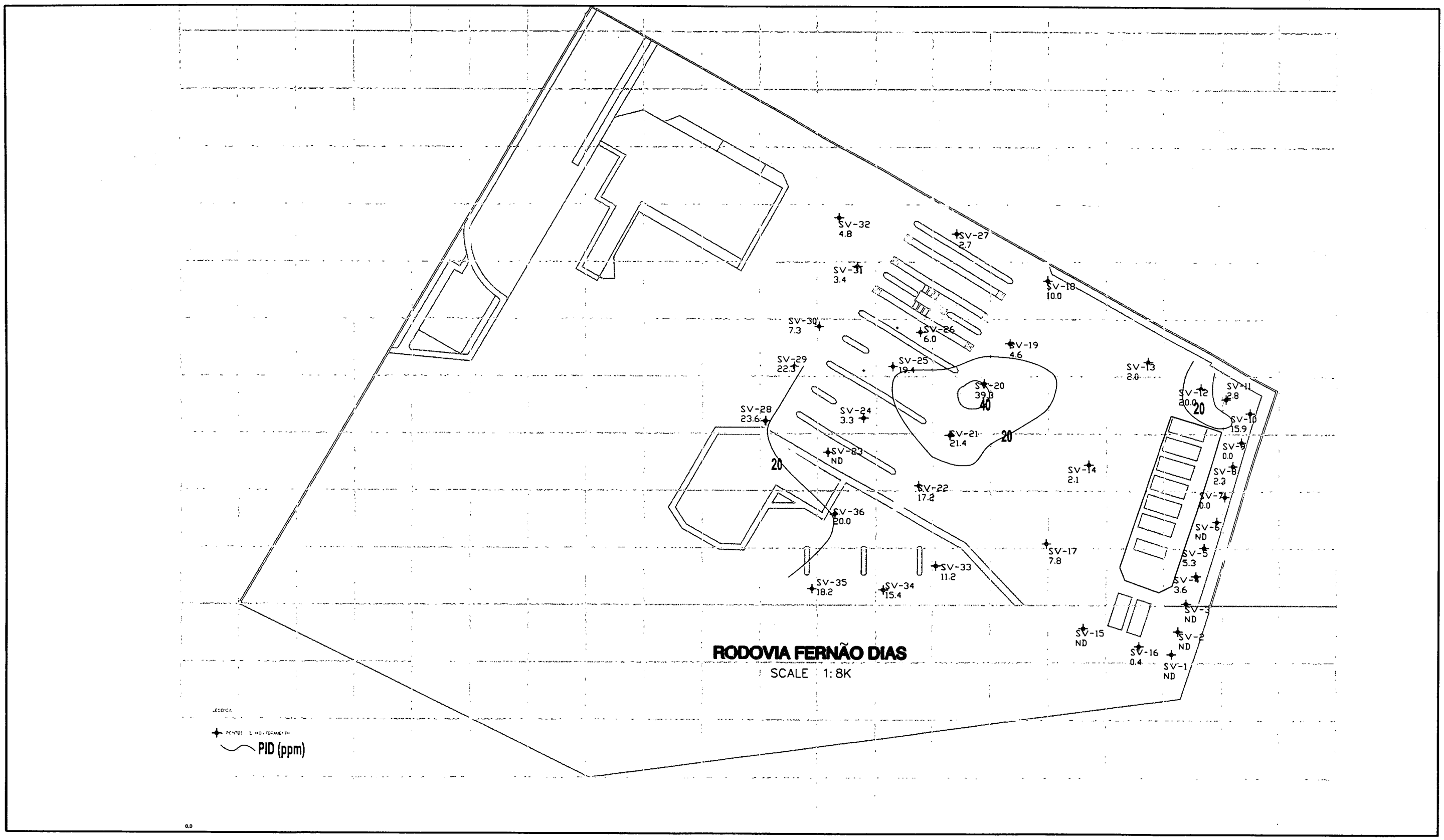
SITE 3 - ASTER SAN MARTIN

SCALE 1:5K

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

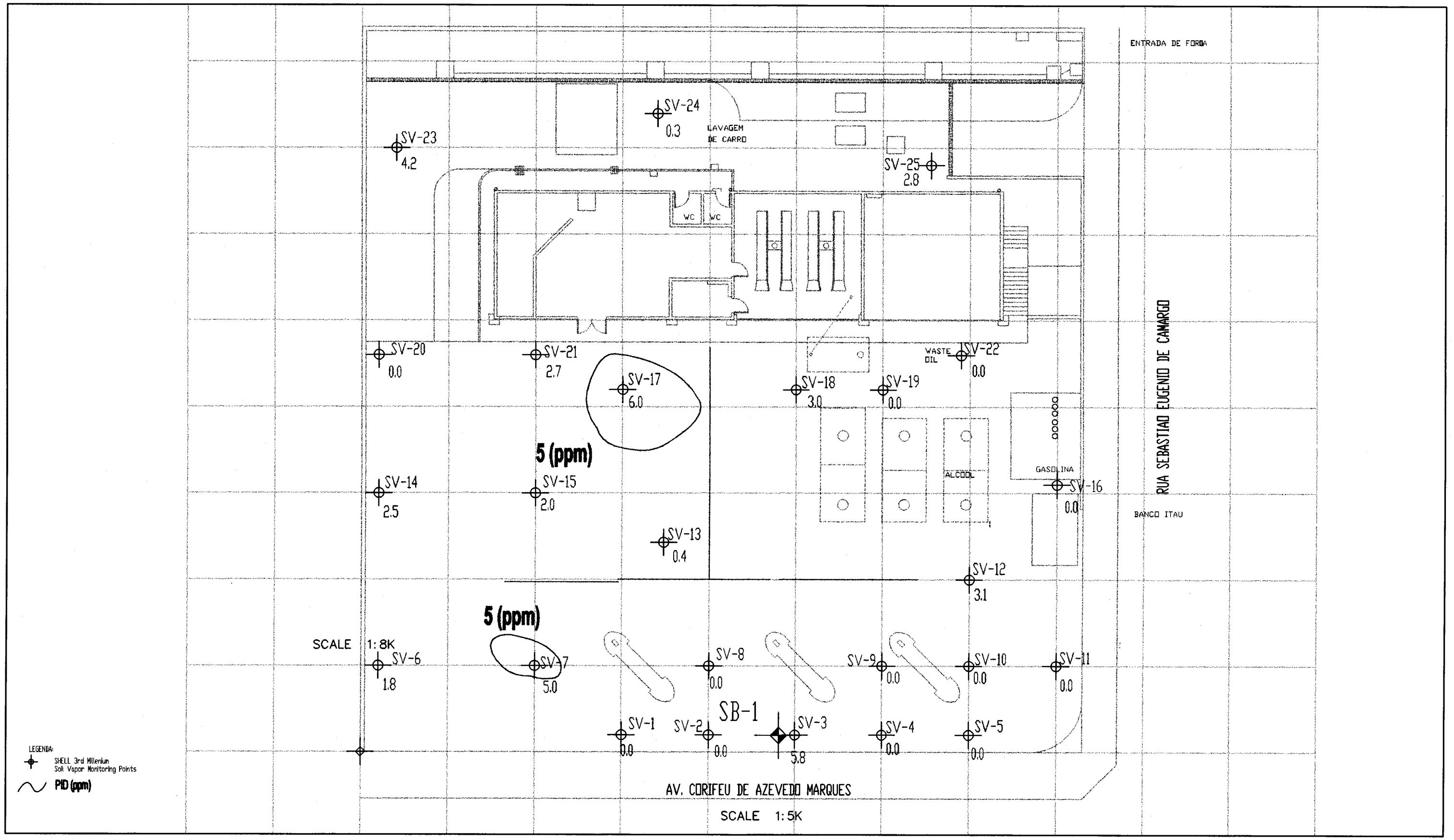
SITE 3
ASTER SAN MARTIN



CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

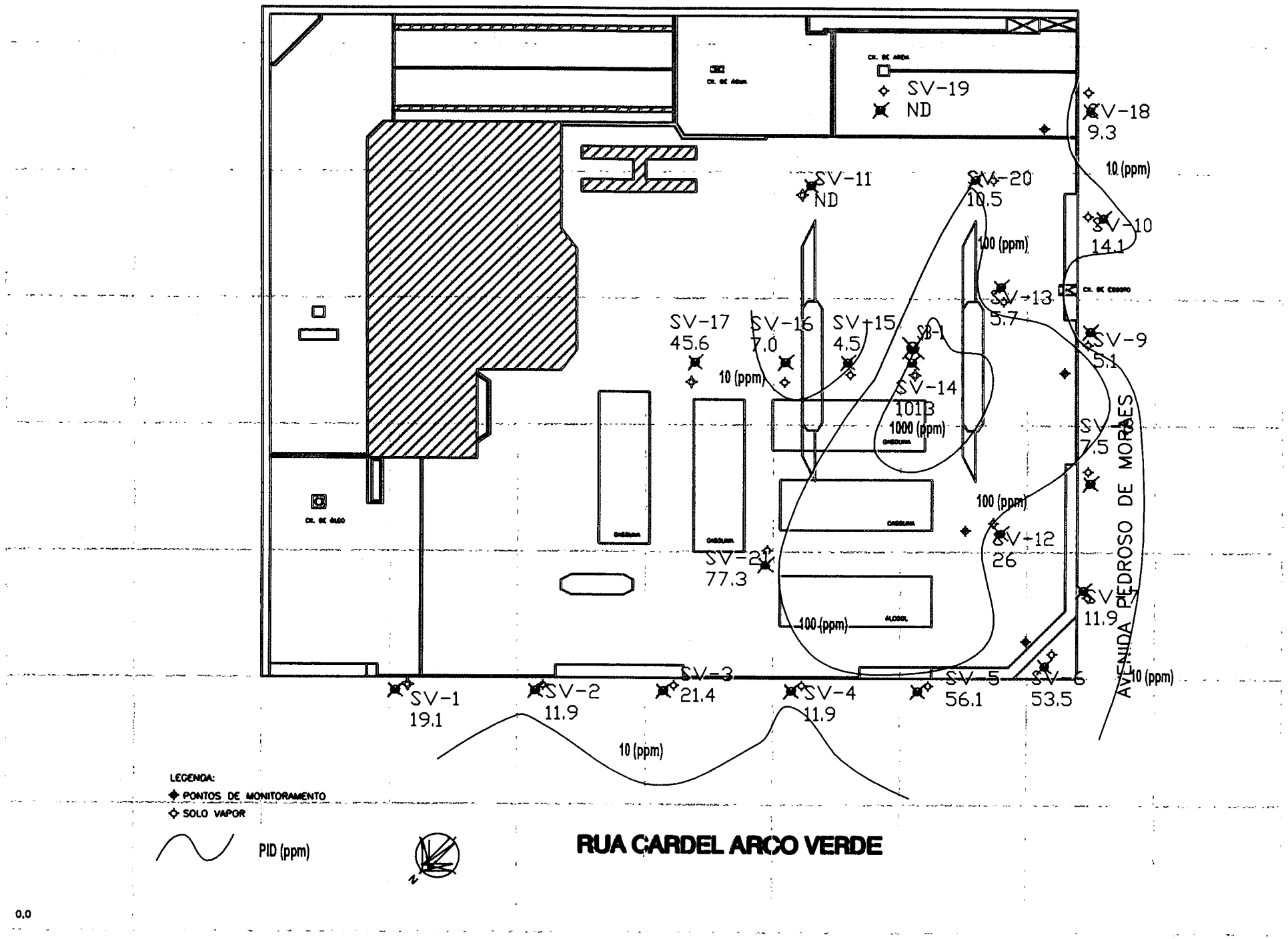
SITE 4
SHELL AP FERNÃO DIAS



CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 5
SHELL AP 3rd MILENIUM

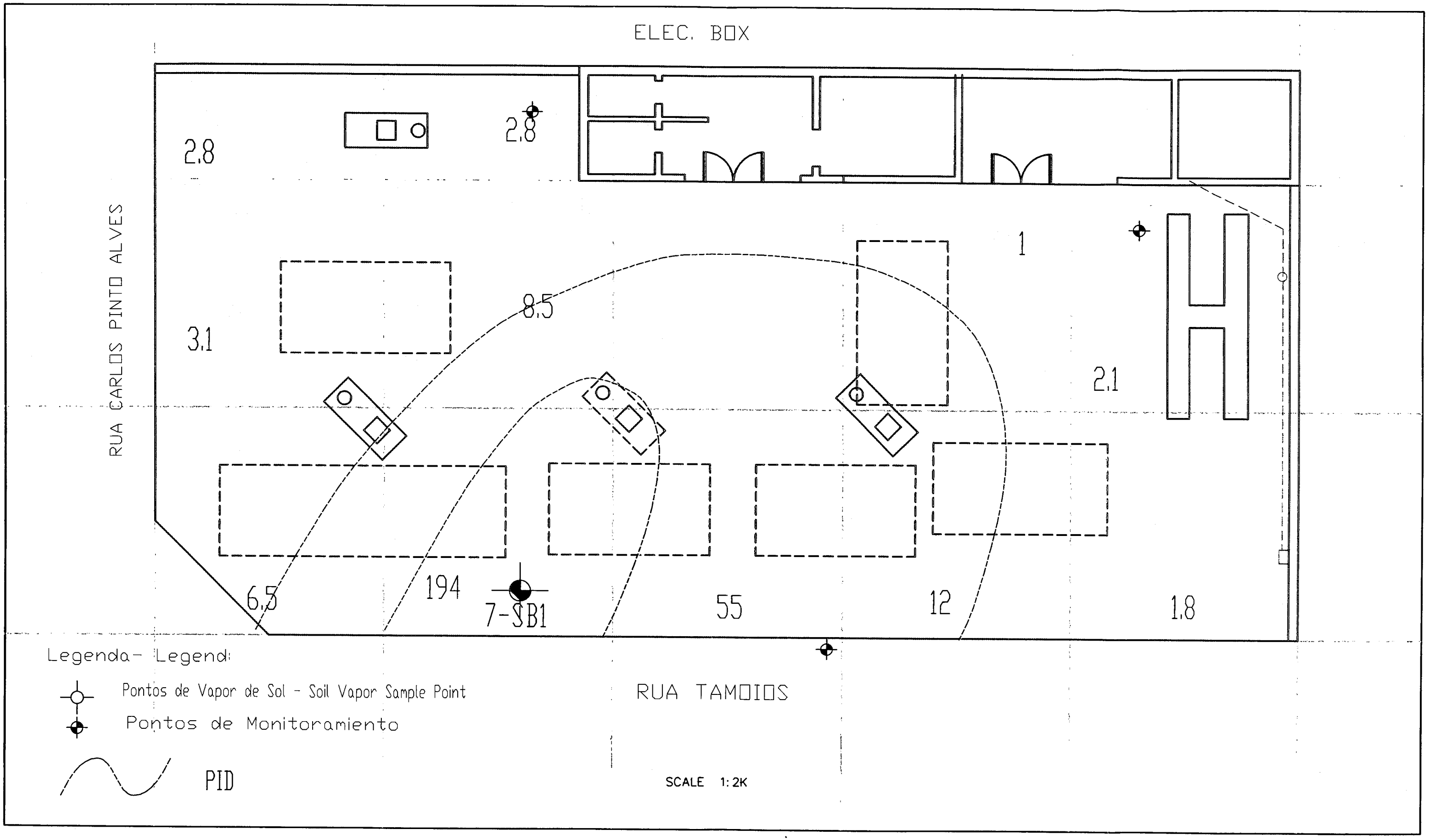


SCALE 1:5K

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

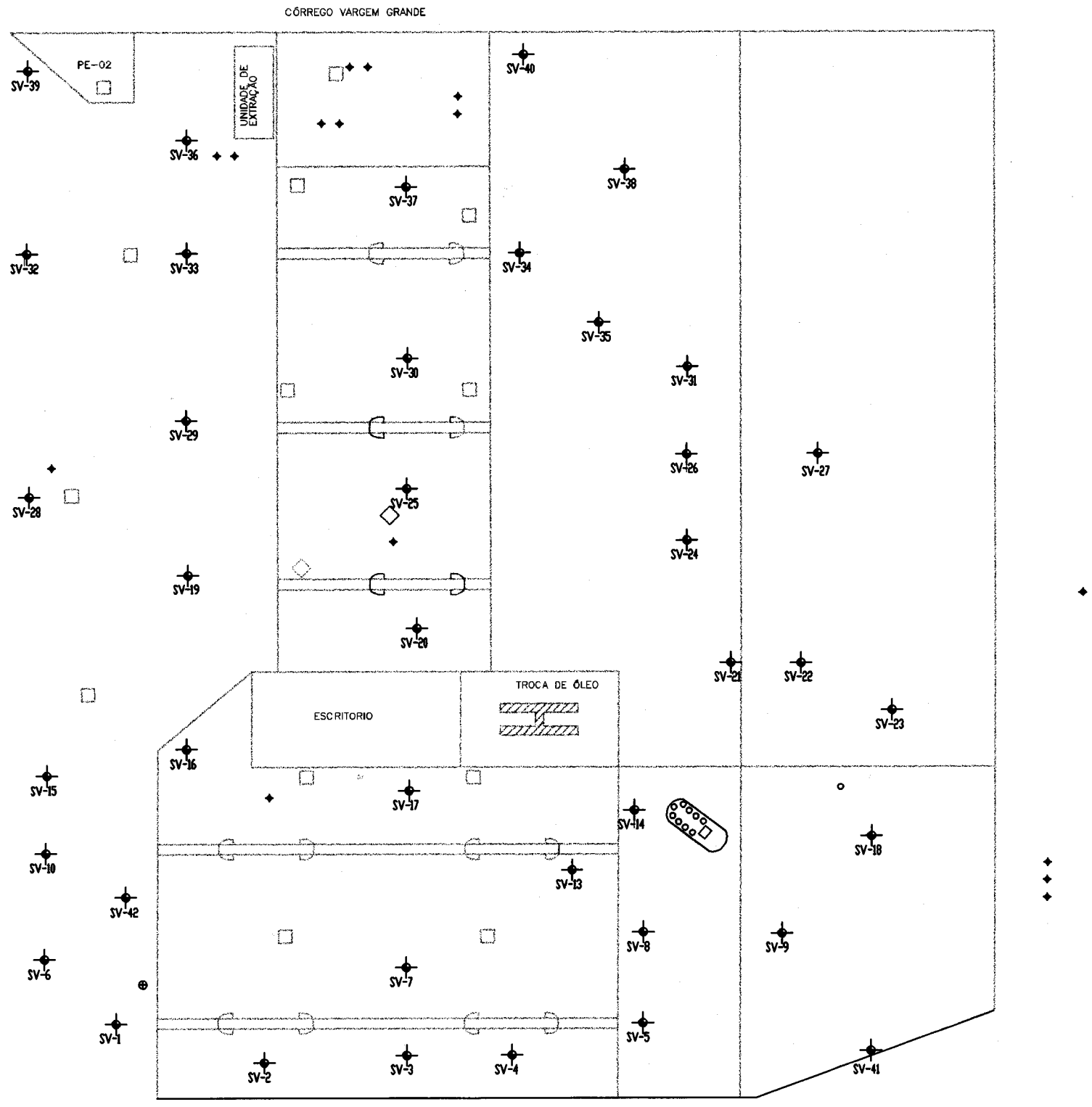
SITE 6
SHELL AP SUPER LTDA



CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 7
BR A. D. SERVICOS AUTOMOTIVOS LTDA.



LEGENDA:

PONTOS DE MONITORAMENTO

Soil Vapor Point

SV-23

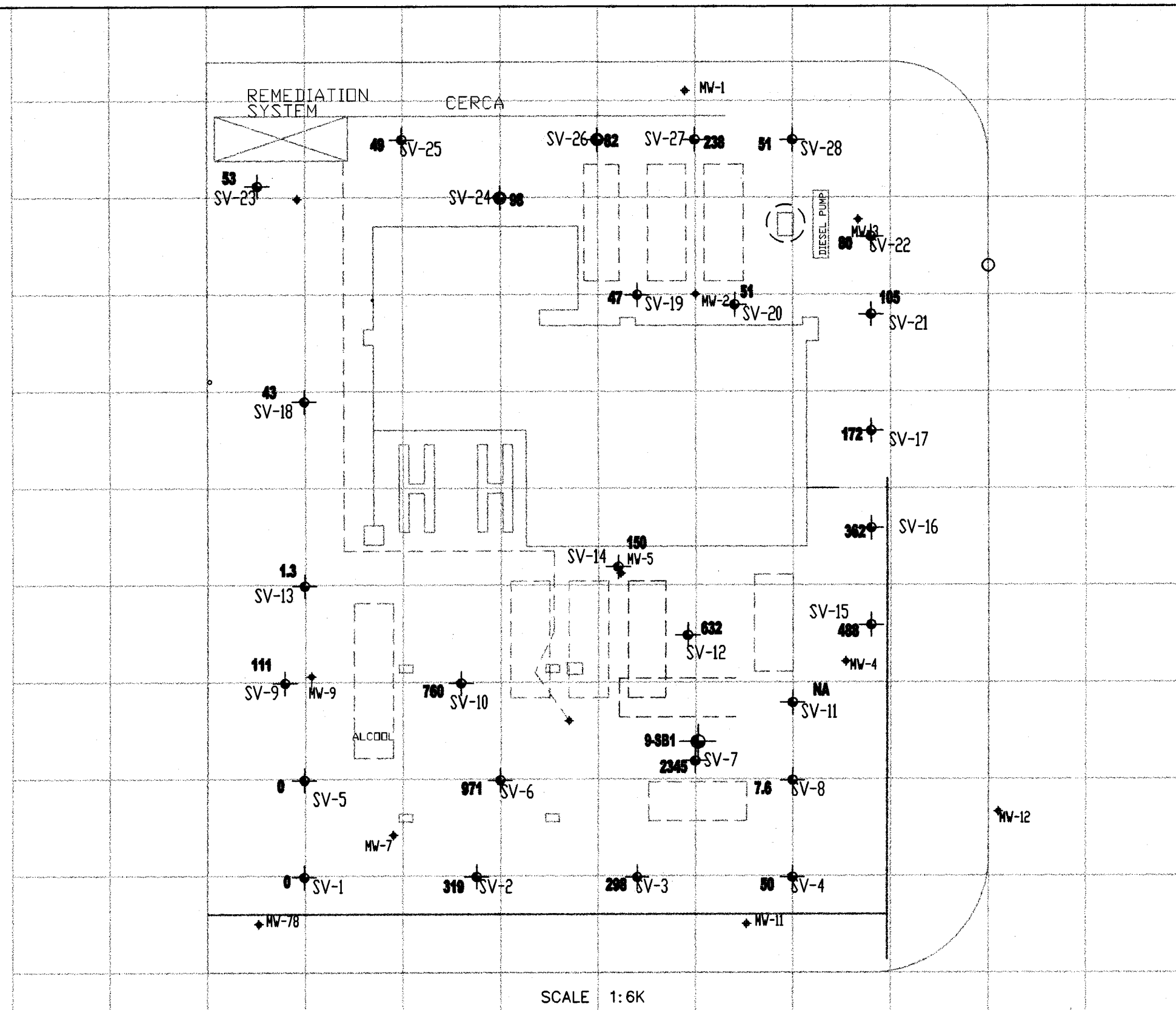
10.0000 m

SCALE 1:8K

CETESB UST PROJECT
SAO PAULO, BRAZIL

SITE 8
SHELL AP 45

CDM



LEGENDA:

PONTOS DE MONITORAMENTO

CETESB UST PROJECT
SAO PAULO, BRAZIL

CDM

SITE 9
SHELL AP PRAIA HAWAI LTDA.

Field Study Soil Boring Logs and Analytical Data Summary

CDM

Appendix B

Site 1 – SHELL, AP Monterrey

Overview

AP Monterrey is a small filling station that also offers oil changing services. There were 1 alcohol tank, 2 gasoline tanks and 1 waste oil tank on site. Past impact to the site was known.

Methods

The OVM and MSA LEL meters were used on site. Thirteen sample points were advanced, sampled and measured. See following table and chart

Existing Subsurface Conditions

Four soil gas anomalies were identified, see following site sketch.

Soil sample 1-SB1 was collected at 15-75 cm below grade near SV-9. Headspace for this sample was 311 ppm by OVM. Soil gas for a nearby soil vapor location was 315 ppm by OVM.

Boring log – 1-SB1

0-15 cm	Cement and subgrade
15-75 cm	100% recovery, silty brown clay 5yr4/4 – 5yr3/4, low plasticity, no odor, dry, 315ppm
75-135 cm	75% recovery, silty brown clay 5yr4/4 – 5yr3/4, low plasticity, no odor, dry, grading down to slightly moist at 100cm, CL-CH, 91.5 ppm
135-195 cm	75% recovery, plastic silty red-brown clay 5yr5/6-10r4/6, slightly moist, CH, 143 ppm
195-255 cm	75% recovery, plastic silty red-brown clay 5yr5/6-10r4/6, slightly moist, CH, 100 ppm
255-315 cm	75% recovery, plastic slightly silty red-brown clay 5yr5/6-10r4/6, slightly moist, CH, 118 ppm

TD 315 cm bg

Laboratory Analysis of Sample 1-SB1 15-75 cm bg

B	<13 ug/kg
E	<13 ug/kg
T	<13 ug/kg
X	6 ug/kg *J
TPH Fingerprint	DRO (C8-C30) 90 mg/kg No match
PAH	ND at 45 ug/kg LQL all parameters
Ethanol	2200 ug/kg *J

Site 2 – SHELL, AP Mundo Novo

Overview

AP Mundo Novo is a moderately sized filling station that also offers oil changing services. There are 10 USTs (alcohol, gasoline, diesel and waste oil tanks) on site. Past impact to the site was known.

Methods

The OVM, GASTECH and MSA LEL meters were used on site. Nineteen sample points were advanced. Seventeen were sampled and measured. See following table and chart

Existing Subsurface Conditions

One soil gas anomalies were identified, see following site sketch.

Soil sample 2-SB1 was collected at 140-260 cm below grade near SV-13. Headspace for this sample was 764 ppm by OVM. Soil gas for a nearby soil vapor location was 300 ppm by OVM.

Boring log – 1-SB2

0-20 cm	Cement and subgrade
20-140 cm	20% recovery, clay and gravel fill, strong hydrocarbon odor, dry, 252 ppm
140-260 cm	90% recovery, silty sandy soft clay 5r2/2, very plastic, moist to wet, strong hydrocarbon odor, 764 ppm.
260-380 cm	80% recovery, silty sandy soft clay 5r2/2, very plastic, moist to wet, strong hydrocarbon odor, abrupt change at 360 cm bg to coarse, subangular sand, 5y6/1, wet, strong hydrocarbon odor, 511 ppm.

TD 380 cm bg

Laboratory Analysis of Sample 2-SB1 140-260 cm bg

B	<14 ug/kg
E	11 ug/kg
T	20 ug/kg
X	14 ug/kg
TPH Fingerprint	DRO (C8-C30) 230 mg/kg Diesel match
PAH	ND at 45 ug/kg LQL all parameters
Ethanol	<5500 ug/kg

Site 3 – ASTER, AP San Martin Ltda.

Overview

AP San Martin is a moderately sized filling station that also offers car washing and oil changing services. There were 6 USTs (alcohol, gasoline, and waste oil) on site. Past impact to the site was known.

Methods

The OVM and MSA LEL meters were used on site. Twenty two sample points were advanced. Twenty were sampled and measured. See following table and chart

Existing Subsurface Conditions

One wide-spread soil gas anomaly was identified, see following site sketch.

Soil sample 3-SB1 was collected at 120-240 cm below grade near SV-12. Headspace for this sample was 265 ppm by OVM. Soil gas for a nearby soil vapor location was 2000 ppm by OVM.

Boring log – 3-SB1

0-50 cm	Cement and subgrade
80-120 cm	25% recovery, red-brown silty clay, probably tank backfill, dry, 106 ppm
120-240 cm	25% recovery, red-brown silty clay, probably tank backfill, dry, 265 ppm
240-360 cm	75% recovery, red-brown sand and gray clay, probably tank backfill, hydrocarbon odor, slightly moist to slightly wet, 64 ppm.
360-480 cm	75% recovery, gray gravel, sand and clay, tank hold fill, slight hydrocarbon odor, wet, 14 ppm.
TD 480 cm bg	

Laboratory Analysis of Sample 3-SB1 120-240 cm bg

B	<11 ug/kg
E	<11 ug/kg
T	<11 ug/kg
X	<11 ug/kg
TPH Fingerprint	DRO (C8-C30) 60 mg/kg No match
PAH	ND at 36 ug/kg LQL all parameters
Ethanol	<5500 ug/kg

Site 4 – SHELL, AP Fernao Dias

Overview

AP Fernao Dias is a large sized truck stop that also offers oil changing services. There were at least 9 USTs on site. Past impact to the site was known.

Methods

The OVM, GASTECH and MSA LEL meters were used on site. Thirty six sample points were advanced. Thirty were sampled and measured. See following table and chart

Existing Subsurface Conditions

No significant soil gas anomalies were identified.

Soil sample 4-SB1 was collected at 140-260 cm below grade near SV-20. Headspace for this sample was 8.8 ppm by OVM. Soil gas for a nearby soil vapor location was 39.3 ppm by OVM.

Boring log – 1-SB4

0-30 cm	Cement and subgrade
30-140 cm	80% recovery, fill and sandy silty clay, 5yr4/4-5yr5/6, slightly plastic, CL-CH, no odor, dry, 8.2 ppm
140-260 cm	90% recovery, clay, mottled 5yr5/6 – 5r4/6, plastic, CH, no odor, wet, 8.8 ppm
TD 260 cm bg	

Laboratory Analysis of Sample 4-SB1 140-260 cm bg

B	<13 ug/kg
E	<13 ug/kg
T	<13 ug/kg
X	<13 ug/kg
TPH Fingerprint	DRO (C8-C30) 30 mg/kg No match
PAH	ND at 42 ug/kg LQL all parameters
Ethanol	<6500 ug/kg

Site 5 – SHELL, AP 3° Milenio

Overview

AP 3° Milenio is a closed moderately sized filling station that also offered car washing and oil changing services. There were 7 USTs (alcohol, gasoline, diesel, and waste oil) on site. Past impact to the site was not known.

Methods

The OVM and MSA LEL meters were used on site. Twenty five sample points were advanced, sampled and measured. See following table and chart.

Existing Subsurface Conditions

No soil gas anomalies were identified, see following site sketch. Soil sample 5-SB1 was collected at 258-378 cm below grade near SV-3. Headspace for this sample was 8 ppm by OVM. Soil gas for a nearby soil vapor location was 5.8 ppm by OVM.

Boring log – 5-SB1

0-18 cm	Cement and subgrade
18-138 cm	90% recovery, clayey silt fill, 5yr5/6, moderate to low plasticity, soft, no odor, moist, ML, 4 ppm
138-258 cm	90% recovery, clayey sandy silt, 5yr5/6-10R4/6,low plasticity, no odor, dry, ML, 8 ppm
258-378 cm	90% recovery, clayey sandy silt with more fine grained sand and less silt than above, 5yr5/6-10R4/6,low plasticity, no odor, dry, ML-CL, 8 ppm
378-498 cm	90% recovery, clayey sandy silt with more fine grained sand and less silt than above, 5yr5/6-10R4/6,low plasticity, no odor, dry, ML-CL, grading down to variegated with 5yr7/2 sandy silt, slightly moist to dry, 5ppm
498-618 cm	90% recovery, clayey sandy silt 5yr7/2 grading down to 10r/6/6 with 25% 10yr8/6 mottles at common root casts, plastic silty clay, slightly moist, 4.3ppm

TD 618 cm bg

Laboratory Analysis of Sample 5-SB1 258-378 cm bg

B	<11 ug/kg
E	<11 ug/kg
T	<11 ug/kg
X	<11 ug/kg
TPH Fingerprint	DRO (C8-C30) 40 mg/kg No match
PAH	ND at 39 ug/kg LQL all parameters
Ethanol	<5500 ug/kg

Site 6 – SHELL, AP Super, Ltda.

Overview

AP Super is a very small filling station that also offers car washing services. There were 5 USTs on site (gasoline and alcohol). Past impact to the site was known. This is a strongly sloping site.

Methods

The OVM and MSA LEL meters were used on site. Twenty sample points were advanced. Nineteen were sampled and measured. See following table and chart

Existing Subsurface Conditions

One soil gas anomaly was identified, see following site sketch. Soil sample 6-SB1 was collected at 270-390 cm below grade near SV-14. Headspace for this sample was 25 ppm by OVM. Soil gas for a nearby soil vapor location was 1013 ppm by OVM.

Boring log – 6-SB1

0-30 cm	Cement and subgrade
30-150 cm	50% recovery, sandy carbonaceous silty clay, mottled 10yr5/4 – 10yr2/2, slightly moist, CL, no odor, rare gravel, 11 ppm
150-270 cm	90% recovery, clayey sandy silt, 5yr5/6, low plasticity, dry, native soil, no odor, 24 ppm.
270-390 cm	100% recovery, clayey sandy silt, 5yr5/6, low plasticity, dry, native soil, no odor, 25 ppm.
390-510 cm	90% recovery, clayey sandy silt, grading 5yr5/6 top to 10yr6/6 bottom, ML with 10% granules, moist to wet, no odor, 21 ppm.
510-630 cm	90% recovery, clayey sandy silt, grading 5yr5/6 top to 10yr6/6 bottom, ML with 10% granules, moist to wet, no odor graded down to clayey silty medium grained to coarse angular quartz sand with rare gravel at 550 cm, wet, 3 ppm

TD 630 cm bg

Laboratory Analysis of Sample 6-SB1 270-390 cm bg

B	<13 ug/kg
E	<13 ug/kg
T	<13 ug/kg
X	<13 ug/kg
TPH Fingerprint	DRO (C8-C30) 20 mg/kg No match
PAH	ND at 42 ug/kg LQL all parameters
Ethanol	<6500 ug/kg

Site 7 – BR, A.D. Servicios Automotivos, Ltda.

Overview

A.D. Servicios Autmotivos is a very small filling station that also offers oil changing services. There are 6 USTS (alcohol, gasoline, waste oil) on site. Past impact to the site was known.

Methods

The OVM and MSA LEL meters were used on site. Gas chromatography was performed. Eleven sample points were advanced, sampled and measured. See following table and chart

Existing Subsurface Conditions

One soil gas anomaly was identified, see following site sketch. Soil sample 7-SB1 was collected at 335-395 cm below grade near SV-8. Headspace for this sample was 224 ppm by OVM. Soil gas for a nearby soil vapor location was 193.8 ppm by OVM.

Boring log – 7-SB1

0-35 cm	Cement and subgrade
35-95 cm	90% recovery, dark yellow brown silty clay, 5yr3/4-10y44/2, moderate to low plasticity, dry, no odor, 27 ppm
95-155 cm	90% recovery, yellow brown silty clay with less than 10% sand and granules, 10yr5/4, very soft, plastic, slightly moist, no odor, 147 ppm
155-215 cm	100% recovery, dark red brown clay, 10yr5/4 grading to 10r3/4 at 165 cm, soft , plastic slightly moist, no odor, 98 ppm
215-275 cm	50% recovery, dark red brown clay, 10r3/4, soft , very plastic slightly moist, no odor, 63 ppm
275-335 cm	90% recovery, dark red brown clay, 10r3/4, soft , very plastic slightly moist to wet in rare silty seams, no odor, 152 ppm
335-395 cm	95% recovery, dark red brown clay, 10r3/4, soft , very plastic slightly moist to dry, no odor, 224
395-455 cm	90% recovery, dark red brown clay, 10r3/4, soft , plastic slightly moist to dry, chemical odor, 197 ppm
455-515 cm	0% recovery, equipment malfunction

TD 515 cm bg

Laboratory Analysis of Sample 7-SB1 140-260 cm bg

B <13 ug/kg	TPH Fingerprint, DRO (C8-C30) 20 mg/kg No match
E <13 ug/kg	PAH ND at 43 ug/kg LQL all parameters
T <13 ug/kg	Ethanol 1730000 ug/kg
X <13 ug/kg	

Site 8 – SHELL, AP # 45

Overview

AP #45 is a large truck stop that also offers oil changing services. There are 9 USTs (alcohol, gasoline, diesel tank, waste oil) on site. Past impact to the site was known.

Methods

The OVM meter was used on site. Forty two sample points were advanced. Forty were sampled and measured. See following table and chart

Existing Subsurface Conditions

One soil gas anomaly was identified, see following site sketch.

Soil sample 8-SB1 was collected at 220-280 cm below grade near SV-7. Headspace for this sample was 872 ppm by OVM. Soil gas for a nearby soil vapor location was 410.8 ppm by OVM.

Boring log – 8-SB1

0-20 cm	Cement and subgrade
20-100 cm	100% recovery, clayey sandy silt to silty sandy clay, orange brown, 10yr5/4, no odor, low plasticity, ML-CL, 104 ppm
100-160 cm	100% recovery, clayey silt, orange, 5yr5/6, no odor, slightly plastic, dry, ML, 73 ppm
160-220 cm	100% recovery, clayey gravelly silt, hydrocarbon odor, slightly moist, lot to moderate plasticity, grading down from clayey silt, orange, 5yr5/6, no odor, slightly plastic, dry, ML, 88 ppm
220-280 cm	100% recovery, 5yr5/6, clayey gravelly silt, hydrocarbon odor, slightly moist to wet in seams, ML, 872 ppm.

TD 280 cm bg

Laboratory Analysis of Sample 8-SB1 220-280 cm bg

B	<13 ug/kg
E	<13 ug/kg
T	<13 ug/kg
X	25 ug/kg
TPH Fingerprint	DRO (C8-C30) 90 mg/kg No match
PAH	ND at 43 ug/kg LQL all parameters
Ethanol	<6500 ug/kg

Site 9 – SHELL, AP Praia do Hawai, Ltda

Overview

AP Praia do Hawai is a moderately sized filling station that also offers oil changing services. There are # USTs (alcohol, gasoline, diesel and waste oil) on site. Past impact to the site was known.

Methods

The OVM and MSA LEL meters and Photovac Field Gas Chromatograph were used on site. Twenty eight sample points were advanced. Twenty seven were sampled and measured. See following table and chart

Existing Subsurface Conditions

Two soil gas anomalies were identified, see following site sketch.

Soil sample 9-SB1 was collected at 15-135 cm below grade near SV-7. Headspace for this sample was 864 ppm by OVM. Soil gas for a nearby soil vapor location was 2345 ppm by OVM.

Boring log – 9-SB1

0-15 cm	Cement and subgrade
15-135 cm	90% recovery, fat clay with rare silt and sand, plastic, no odor, 864 ppm
135-255 cm	25% recovery, black, diesel saturated clay, strong hydrocarbon odor, 176 ppm
255-375 cm	75% recovery, black, diesel saturated clay, strong hydrocarbon odor, sharp change at 300 cm to 10yr6/2 clayey sandy silt, ML, dry, stopped to not carry contamination down, 719 ppm

TD 375 cm bg

Laboratory Analysis of Sample 9-SB1 15-135 cm bg

B	<12 ug/kg
E	<12 ug/kg
T	<12 ug/kg
X	6 ug/kg *J
TPH Fingerprint	DRO (C8-C30) 30 mg/kg No match
PAH	ND at 41 ug/kg LQL all parameters
Ethanol	2160 ug/kg *J

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.
"Química Analítica no Gerenciamento Ambiental"

São Paulo, 08 de Fevereiro de 2002.

Sr. José Antônio de Jesus
COBRAPE – Companhia Brasileira de Projetos e Empreendimentos
Rua Capitão Antonio Rosa, 406 – Jardim Paulistano
São Paulo - SP

Prezado Sr. José Antônio

Em anexo se encontram os resultados originais das análises químicas de 03 amostras de solo - **Projeto 20535-32720** - recebidas em nosso laboratório em 17 de Janeiro de 2002.

As amostras são identificadas como Projeto Ceimic Nº 2201032 que pode ser utilizado como referência quando necessitar de maiores informações sobre este projeto.

Permanecemos a disposição para quaisquer informações que considere necessárias.

Atenciosamente,

Adriana D' Agostinho
Gerente do Laboratório
CRQ no 04233242

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Sample Cross Reference

Client : **Cobrape**
Project# :
Project Name : 20535-32720
Ceimic I.D. : 201032

Smp#	Sample ID	Matrix	Date Sampled
01	8-SB1(220-280cm)	Soil	01/15/02
02	1-SB1(1.5-75cm)	Soil	01/15/02
03	7-SB1(335-395cm)	Soil	01/15/02

Analytical Schedule

Analysis/Method	Technique/Description
EPA 8260 BTEX + ETHANOL	GC/MS
EPA 8270 Polynuclear Aromatic Hydrocarbons	GC/MS
EPA 8015 B TOTAL PETROLEUM HYDROCARBONS	GC/FID

CEIMIC STANDARD DISPOSAL PRACTICE

The sample (s) from this project will be disposed of thirty (30) days from the date of this report. If an extended storage period is required, please contact our laboratory prior to scheduled disposal date. In addition, if the sample(s) need to be returned to the client please notify the laboratory prior to disposal date.

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

BTEX RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535-32720
Ceimic I.D. : 2201032
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
01	8-SB1(220-280cm)	01/15/02	01/17/02	02/04/02	V20204-B1	76

Compound	Results
Benzene	<13
Toluene	<13
Ethylbenzene	<13
Xylenes (TOTAL)	25

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	92
Toluene-d8	65-135	96
Bromofluorobenzene	65-135	98

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535-32720
Ceimic I.D. : 2201032
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
02	1-SB1(15-75cm)	01/16/02	01/17/02	02/04/02	V20204-B1	74

Compound	Results
Benzene	<13
Toluene	<13
Ethylbenzene	<13
Xylenes (TOTAL)	6*J

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	90
Toluene-d8	65-135	98
Bromofluorobenzene	65-135	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535-32720
Ceimic I.D. : 2201032
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
03	7-SB1(335-395cm)	01/16/02	01/17/02	02/04/02	V20204-B1	76

Compound	Results
Benzene	<13
Toluene	<13
Ethylbenzene	<13
Xylenes (TOTAL)	<13

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	88
Toluene-d8	65-135	94
Bromofluorobenzene	65-135	106

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

METHOD BLANK

Test : EPA METHOD 8260(BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535-32720
Ceimic I.D. : 2201032
Blank I.D. : V20204-B1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Results
Benzene	<10
Toluene	<10
Ethylbenzene	<10
Xylenes (TOTAL)	<10

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	116
Toluene-d8	75-125	94
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

LABORATORY CONTROL SUMMARY

Test : EPA METHOD 8260(BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535-32720
Ceimic I.D. : 2201032
Blank spike ID : V20204-LCS1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)	QC Limits (%)
1,1-Dichloroethene	50	40	80	62-148
Trichloroethene	50	48	96	63-125
Benzene	50	48	96	67-132
Toluene	50	51	102	69-131
Chlorobenzene	50	48	96	63-136

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	114
Toluene-d8	75-125	92
Bromofluorobenzene	75-125	98

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

VOLATILE RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201032
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
01	8 - SB1 (220-280CM)	01/15/02	01/17/02	02/04/02	V20204-B1	76

Compound	Results
Ethanol	<6500

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	96
Toluene-d8	75-125	96
Bromofluorobenzene	75-125	96

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201032
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
02	1 - SB1 (15 - 75CM)	01/16/02	01/17/02	02/04/02	V20204-B1	74

Compound	Results
Ethanol	2200*J

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	94
Toluene-d8	75-125	98
Bromofluorobenzene	75-125	100

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201032
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
03	7 - SB1 (335 - 395 CM)	01/16/02	01/17/02	02/04/02	V20204-B1	76

Compound	Results
Ethanol	1730000

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	94
Toluene-d8	75-125	94
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

METHOD BLANK

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201032
Blank I.D. : V20204-B1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Results
Ethanol	<5000

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	116
Toluene-d8	75-125	94
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

LABORATORY CONTROL SUMMARY

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201032
Blank spike ID : V20204-LCS1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)
Ethanol	50000	56000	112

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	106
Toluene-d8	75-125	90
Bromofluorobenzene	75-125	96

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

TPH - FINGERPRINT RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201032
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
01	8-SB1(220-280cm)	01/15/02	01/17/02	01/24/02	F0121-B1	76

Target Analyte	Results
Diesel Range Organics (C8 - C30)	90

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	110

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201032
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
02	1-SB1(1.5-75cm)	01/16/02	01/17/02	01/30/02	F0121-B1	74

Target Analyte	Results
Diesel Range Organics (C8 - C30)	30

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	118

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201032
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
03	7-SB1(335-395cm)	01/16/02	01/17/02	01/30/02	F0121-B1	74

Target Analyte	Results
Diesel Range Organics (C8 - C30)	20

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	150*H

*H Result outside of limits due to sample matrix interference.

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

METHOD BLANK

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Coprave**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201032
Blank I.D. : F0121-B1
Date analysed : 01/30/02
Matriz : Soil
Concentrações units : mg/Kg (ppm)

Target Analyte	Results
Diesel Range Organics (C8 - C30)	<20

The TPH detected in the sample matches: N.A.

N.A.= Not applicable.

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	124

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

LABORATORY CONTROL SUMMARY

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Coprave**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201032
Blank spike ID : F0121-LCS1
Date analysed : 01/24/02
Matrix : Soil
Concentration units : mg/Kg (ppm)

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)	QC Limits
Diesel Range Organics	133	88	66	48-128

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	126

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

PAH´S - EPA 8100
RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201032-01

Client Sample ID: 8-SB1(220-280cm)

Date Sampled: 01/15/02

Sample wt: 15.02g

Date Received: 01/17/02

% Moisture: 24

Date Extracted: 01/18/02

Dilution Factor: 1.0

Date Analysed: 01/28/02

Associated Method Blank: V0118-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	43
Acenaphthylene	ND	43
Acenaphthene	ND	43
Fluorene	ND	43
Phenanthrene	ND	43
Fluoranthene	ND	43
Pyrene	ND	43
Benzo(a)anthracene	ND	43
Chrysene	ND	43
Di-n-octylphthalate	ND	43
Benzo(b)fluoranthene	ND	43
Benzo(k)fluoranthene	ND	43
Benzo(a)pyrene	ND	43
Indeno(1,2,3-cd)pyrene	ND	43
Dibenzo(a,h)anthracene	ND	43
Benzo(g,h,i)perylene	ND	43

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201032-02

Client Sample ID: 1-SB1(15-75cm)

Date Sampled: 01/15/02

Sample wt: 15.03g

Date Received: 01/17/02

% Moisture: 26

Date Extracted: 01/18/02

Dilution Factor: 1.0

Date Analysed: 01/28/02

Associated Method Blank: V0118-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	45
Acenaphthylene	ND	45
Acenaphthene	ND	45
Fluorene	ND	45
Phenanthrene	ND	45
Fluoranthene	ND	45
Pyrene	ND	45
Benzo(a)anthracene	ND	45
Chrysene	ND	45
Di-n-octylphthalate	ND	45
Benzo(b)fluoranthene	ND	45
Benzo(k)fluoranthene	ND	45
Benzo(a)pyrene	ND	45
Indeno(1,2,3-cd)pyrene	ND	45
Dibenzo(a,h)anthracene	ND	45
Benzo(g,h,i)perylene	ND	45

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201032-03

Client Sample ID: 7-SB1(335-395cm)

Date Sampled: 01/15/02

Sample wt: 15.02g

Date Received: 01/17/02

% Moisture: 24

Date Extracted: 01/18/02

Dilution Factor: 1.0

Date Analysed: 01/28/02

Associated Method Blank: V0118-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	43
Acenaphthylene	ND	43
Acenaphthene	ND	43
Fluorene	ND	43
Phenanthrene	ND	43
Fluoranthene	ND	43
Pyrene	ND	43
Benzo(a)anthracene	ND	43
Chrysene	ND	43
Di-n-octylphthalate	ND	43
Benzo(b)fluoranthene	ND	43
Benzo(k)fluoranthene	ND	43
Benzo(a)pyrene	ND	43
Indeno(1,2,3-cd)pyrene	ND	43
Dibenzo(a,h)anthracene	ND	43
Benzo(g,h,i)perylene	ND	43

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED
METHOD BLANK

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: SOIL

Sample wt/vol: 15.0 g

Blank ID: V0118-B1

Date Extracted: 01/18/02

Date Analysed: 01/28/02

Dilution Factor: 1.0

COMPOUND	Sample concentration ug/Kg (ppb)	Quantitation limit ug/Kg (ppb)
Naphthalene	ND	33
Acenaphthylene	ND	33
Acenaphthene	ND	33
Fluorene	ND	33
Phenanthrene	ND	33
Fluoranthene	ND	33
Pyrene	ND	33
Benzo(a)anthracene	ND	33
Chrysene	MD	33
Di-n-octylphthalate	ND	33
Benzo(b)fluoranthene	ND	33
Benzo(k)fluoranthene	ND	33
Benzo(a)pyrene	ND	33
Indeno(1,2,3-cd)pyrene	ND	33
Dibenzo(a,h)anthracene	ND	33
Benzo(g,h,i)perylene	ND	33

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODOFIED
LABORATORY CONTROL SAMPLE

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: SOIL

Sample wt/vol: 15.0 g

Blank Spike ID: V0118-LCS1

Date Extracted: 01/18/02

Date Analysed: 01/28/02

Dilution Factor: 1.0

COMPOUND	Spike Added (ug/Kg)	Blank spike result (ug/Kg)	Blank spike recovery (%)	QC Limits (%)
Naphthalene	333	176	53	48-98
Acenaphthylene	333	183	55	40-112
Acenaphthene	333	176	53	44-113
Fluorene	333	213	64	36-126
Phenanthrene	333	209	63	30-129

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED
SURROGATE RECOVERY

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

	CLIENT SAMPLE ID	SURROGATE SPIKE RECOVERY (%) NAPHTHALENE - d8
01	8-SB1(220-280cm)	90
02	1-SB1(15-75cm)	85
03	7-SB1(335-395cm)	88
	V0118-B1	82
	V0118-LCS1	86

* Values outside of contract required QC limits
D Surrogate diluted out

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CHAIN OF CUSTODY

CHAIN OF CUSTODY

Original Chain of Custody goes to Laboratory

Page 1 of 1

Cokrapl.

Proj. #	Project. name 20535-32720
Samplers (Please print) J. M. Munsil, ecamericas	

	DATE	Time	Comp. / Grab.	Sample Identification	Sample Matrix	Number of containers	TPH	FP	BTEX	PAH	ETANOL				Remarks
01	15-1-2	1635	G	8-SB1 (220-280cm)	Soil	1	X	X	X	X	X				High TPH Diesel?
02	16-1-2	1015	G	1-SB1 (15-75cm)	Soil	1	X	X	X	X	X				
03	16-1-2	[illegible]	G	1-SB1 ([illegible]cm)	Soil	1	X	X	X	X	X				solvent?

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
[signature]	16-1-2 20:15	① [signature]	
② [signature]		③	
		Thalyta Soares	17/01/02 10:25hs

Remarks: Standard turn-around report to Peter Shilland, CDM

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA. - Rua Brigadeiro Galvão, 535-A - São Paulo - SP - Brasil
TEL.: (11) 3667-0126 - FAX: (11) 826-1429 - e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS
CHECAGEM DO RECEBIMENTO DE AMOSTRAS

CLIENTE:	Cubrape	NUMERO DO PROJETO:	201032

Envio das Amostras	UPS	FEDEX	OUTROS
	CLIENTE X	CEIMIC	

	SIM	NÃO	COMENTÁRIOS
1. As amostras foram recebidas em caixa térmica?	X		
2. A caixa térmica estava lacrada?		X	
2. Data da abertura da caixa térmica: 17-1-02			
4. Chain of Custody estava presente?	X		
5. Temperatura da caixa térmica: 2°C			
6. As amostras foram recebidas intactas (nenhum frasco quebrado) ?	X		
7. Quantidade de amostra suficiente ?	X		
8. Os frascos utilizados eram corretos para os parâmetros de análise?		X	*
9. As amostras estavam preservadas corretamente?	X		
10. As amostras foram recebidas dentro do tempo de validade de análise?	X		
11. A identificação dos frascos coincidiam com o COC ?	X		
12. Frascos para VOC estavam isentos de bolhas de ar ?	X		
13. O gerente responsável pelo projeto foi comunicado ?	X		
14. O cliente foi comunicado ?	X		
COMENTÁRIOS ADICIONAIS:			* transferi para frasco de BTXE

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.
"Química Analítica no Gerenciamento Ambiental"

São Paulo, 13 de Fevereiro de 2002.

Sr. José Antônio de Jesus
COBRAPE – Companhia Brasileira de Projetos e Empreendimentos
Rua Capitão Antonio Rosa, 406 – Jardim Paulistano
São Paulo - SP

Prezado Sr. José Antônio

Em anexo se encontram os resultados originais das análises químicas de 06 amostras de solo - **Projeto 20535-32720** - recebidas em nosso laboratório em 18 de Janeiro de 2002.

As amostras são identificadas como Projeto Ceimic Nº 2201043 que pode ser utilizado como referência quando necessitar de maiores informações sobre este projeto.

Permanecemos a disposição para quaisquer informações que considere necessárias.

Atenciosamente,

Adriana D'Agostinho
Gerente do Laboratório
CRQ nº 04233242

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Sample Cross Reference

Client : **Cobrape**
Project# :
Project Name : 20535-32720
Ceimic I.D. : 201043

Smp#	Sample ID	Matrix	Date Sampled
01	3-SB1	Soil	01/17/02
02	6-SB1	Soil	01/17/02
03	5-SB1	Soil	01/17/02
04	9-SB1	Soil	01/17/02
05	2-SB1	Soil	01/18/02
06	4-SB1	Soil	01/18/02

Analytical Schedule

Analysis/Method	Technique/Description
EPA 8021 (BTEX)	GC/PHOTOIONIZATION DETECTOR
EPA 8100 Polynuclear Aromatic Hydrocarbons	GC/FLAME IONIZATION DETECTOR
EPA 8015 B TOTAL PETROLEUM HYDROCARBONS	GC/FLAME IONIZATION DETECTOR

CEIMIC STANDARD DISPOSAL PRACTICE

The sample (s) from this project will be disposed of thirty (30) days from the date of this report. If an extended storage period is required, please contact our laboratory prior to scheduled disposal date. In addition, if the sample(s) need to be returned to the client please notify the laboratory prior to disposal date.

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

BTEX RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
01	3 - SB1	01/17/02	01/18/02	01/29/02	V20129-B1	92

Compound	Results
Benzene	<11
Toluene	<11
Ethylbenzene	<11
Xylenes (TOTAL)	<11

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	110
Toluene-d8	65-135	106
Bromofluorobenzene	65-135	120

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
02	6 - SB1 (SUPER)	01/17/02	01/18/02	01/29/02	V20129-B1	79

Compound	Results
Benzene	<13
Toluene	<13
Ethylbenzene	<13
Xylenes (TOTAL)	<13

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	112
Toluene-d8	65-135	106
Bromofluorobenzene	65-135	120

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
03	5 - SB1	01/17/02	01/18/02	01/29/02	V20129-B1	85

Compound	Results
Benzene	<11
Toluene	<11
Ethylbenzene	<11
Xylenes (TOTAL)	<11

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	114
Toluene-d8	65-135	106
Bromofluorobenzene	65-135	120

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
04	9 - SB1	01/17/02	01/18/02	02/04/02	V20204-B1	80

Compound	Results
Benzene	<12
Toluene	<12
Ethylbenzene	<12
Xylenes (TOTAL)	6*J

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	114
Toluene-d8	65-135	96
Bromofluorobenzene	65-135	96

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
05	2 - SB1	01/18/02	01/18/02	02/04/02	V20204-B1	72

Compound	Results
Benzene	<14
Toluene	11
Ethylbenzene	20
Xylenes (TOTAL)	14

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	118
Toluene-d8	65-135	100
Bromofluorobenzene	65-135	96

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Matrix : soil
Concentration units : ug/Kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
06	4 - SB1	01/18/02	01/18/02	02/04/02	V20204-B1	79

Compound	Results
Benzene	<13
Toluene	<13
Ethylbenzene	<13
Xylenes (TOTAL)	<13

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	52-149	112
Toluene-d8	65-135	94
Bromofluorobenzene	65-135	92

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

METHOD BLANK

Test : EPA METHOD 8260(BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Blank I.D. : V20129-B1
Date analysed : 01/29/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Results
Benzene	<10
Toluene	<10
Ethylbenzene	<10
Xylenes (TOTAL)	<10

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	102
Toluene-d8	75-125	98
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

LABORATORY CONTROL SUMMARY

Test : EPA METHOD 8260(BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Blank spike ID : V20129-LCS1
Date analysed : 01/29/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)	QC Limits (%)
1,1-Dichloroethene	50	40	80	62-148
Trichloroethene	50	49	98	63-125
Benzene	50	50	100	67-132
Toluene	50	52	104	69-131
Chlorobenzene	50	49	98	63-136

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	108
Toluene-d8	75-125	96
Bromofluorobenzene	75-125	100

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

METHOD BLANK

Test : EPA METHOD 8260(BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Blank I.D. : V20204-B1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Results
Benzene	<10
Toluene	<10
Ethylbenzene	<10
Xylenes (TOTAL)	<10

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	116
Toluene-d8	75-125	94
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

LABORATORY CONTROL SUMMARY

Test : EPA METHOD 8260(BENZENE, TOLUENE, ETHYLBENZENE, XYLENES BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 -32720
Ceimic I.D. : 2201043
Blank spike ID : V20204-LCS1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)	QC Limits (%)
1,1-Dichloroethene	50	40	80	62-148
Trichloroethene	50	48	96	63-125
Benzene	50	48	96	67-132
Toluene	50	51	102	69-131
Chlorobenzene	50	48	96	63-136

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	114
Toluene-d8	75-125	92
Bromofluorobenzene	75-125	98

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

VOLATILE RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
01	3 - SB1	01/17/02	01/18/02	01/29/02	V20129-B1	92

Compound	Results
Ethanol	<5500

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	116
Toluene-d8	75-125	106
Bromofluorobenzene	75-125	120

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
02	6 - SB1 (SUPER)	01/17/02	01/18/02	01/29/02	V20129-B1	79

Compound	Results
Ethanol	<6500

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	116
Toluene-d8	75-125	106
Bromofluorobenzene	75-125	120

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
03	5 - SB1	01/17/02	01/18/02	01/29/02	V20129-B1	85

Compound	Results
Ethanol	<5500

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	120
Toluene-d8	75-125	106
Bromofluorobenzene	75-125	120

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
04	9 - SB1	01/17/02	01/18/02	02/04/02	V20204-B1	80

Compound	Results
Ethanol	2160*J

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	118
Toluene-d8	75-125	96
Bromofluorobenzene	75-125	94

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
05	2 - SB1	01/18/02	01/18/02	02/04/02	V20204-B1	72

Compound	Results
Ethanol	<7000

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	120
Toluene-d8	75-125	100
Bromofluorobenzene	75-125	94

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY RESULTS

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Matrix : Soil
Concentration units : ug/kg

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
06	4 - SB1	01/18/02	01/18/02	02/04/02	V20204-B1	79

Compound	Results
Ethanol	<6500

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	118
Toluene-d8	75-125	94
Bromofluorobenzene	75-125	90

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

METHOD BLANK

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Blank I.D. : V20129-B1
Date analysed : 01/29/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Results
Etanol	<5000

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	102
Toluene-d8	75-125	98
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

LABORATORY CONTROL SUMMARY

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Blank spike ID : V20129-LCS1
Date analysed : 01/29/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)
Ethanol	50000	48000	96

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	112
Toluene-d8	75-125	92
Bromofluorobenzene	75-125	92

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

METHOD BLANK

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Blank I.D. : V20204-B1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Results
Ethanol	<5000

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	116
Toluene-d8	75-125	94
Bromofluorobenzene	75-125	102

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

GAS CHROMATOGRAPHY/MASS SPECTROSCOPY - QUALITY CONTROL

LABORATORY CONTROL SUMMARY

Test : EPA METHOD 8260 (ETHANOL BY GC/MS)
Client : **COBRAPE Companhia Brasileira de Empreendimentos**
Project name : 20535 - 32720
Ceimic I.D. : 2201043
Blank spike ID : V20204-LCS1
Date analysed : 02/04/02
Dil. Factor : 1
Matrix : Soil
Concentration units : ug/Kg

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)
Ethanol	50000	56000	112

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC limits	
1,2-Dichloroethane-d4	62-139	106
Toluene-d8	75-125	90
Bromofluorobenzene	75-125	96

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

TPH - FINGERPRINT RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
01	3-SB1	01/17/02	01/21/02	01/31/02	F0128-B1	92

Target Analyte	Results
Diesel Range Organics (C8 - C30)	60

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	*H

*H Result outside of limits due to sample matrix interference.

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
02	6-SB1	01/17/02	01/21/02	02/06/02	F0128-B1	79

Target Analyte	Results
Diesel Range Organics (C8 - C30)	20

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	75

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
03	5-SB1	01/17/02	01/21/02	02/05/02	F0128-B1	85

Target Analyte	Results
Diesel Range Organics (C8 - C30)	40

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	75

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
04	9-SB1	01/17/02	01/21/02	02/05/02	F0128-B1	80

Target Analyte	Results
Diesel Range Organics (C8 - C30)	30

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	63

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
05	2-SB1	01/18/02	01/21/02	02/05/02	F0128-B1	72

Target Analyte	Results
Diesel Range Organics (C8 - C30)	230

The TPH detected in the sample matches: Diesel

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	90

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Matrix : Soil
Concentration units : mg/Kg (ppm)

#	Sample I.D.	Date Sampled	Date Received	Date Analysed	Associated Blank	% Solids
06	4-SB1	01/18/02	01/21/02	02/05/02	F0128-B1	79

Target Analyte	Results
Diesel Range Organics (C8 - C30)	30

The TPH detected in the sample matches: No match

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	76

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

METHOD BLANK

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Blank I.D. : F0128-B1
Date analysed : 01/30/02
Matriz : Soil
Concentrações units : mg/Kg (ppm)

Target Analyte	Results
Diesel Range Organics (C8 - C30)	<20

The TPH detected in the sample matches: N.A.

N.A.= Not applicable.

The sample was screened for the following products:

Gasoline	Jet Fuel A	Diesel Fuel	Bunker Oil
Kerosene	Motor Oil	Fuel Oil # 2	Naphtha
JP-4 Jet Fuel	Hydraulic Jack Oil	Fuel Oil # 4	Creosote
JP-5 Jet Fuel	Transmission Fluid	Fuel Oil # 5	Mineral Spirits
JP-8 Jet Fuel	Lubrificating Oil	Fuel Oil # 6	Mineral Oil

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	82

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

LABORATORY CONTROL SUMMARY

Test : TOTAL PETROLEUM HYDROCARBONS (TPH) - by Modified Method 8015B
Client : **Cobrape**
Project # :
Project name : 20535-32720
Ceimic I.D. : 201043
Blank spike ID : F0128-LCS1
Date analysed : 01/30/02
Matrix : Soil
Concentration units : mg/Kg (ppm)

Compound	Spike Added	Blank Spike Result	Blank Spike Recovery(%)	QC Limits
Diesel Range Organics	133	84	63	48-128

SURROGATE SPIKE RECOVERY (%)

Surrogate compound	QC Limits	
n-eicosane	40-132	112

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

PAH´S - EPA 8100
RESULTS

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201043-01

Client Sample ID: 3-SB1

Date Sampled: 01/17/02

Sample wt: 15.01g

Date Received: 01/21/01

% Moisture: 8

Date Extracted: 01/29/02

Dilution Factor: 1.0

Date Analysed: 02/02/02

Associated Method Blank: V0129-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	36
Acenaphthylene	ND	36
Acenaphthene	ND	36
Fluorene	ND	36
Phenanthrene	ND	36
Fluoranthene	ND	36
Pyrene	ND	36
Benzo(a)anthracene	ND	36
Chrysene	ND	36
Anthracene	ND	36
Benzo(b)fluoranthene	ND	36
Benzo(k)fluoranthene	ND	36
Benzo(a)pyrene	ND	36
Indeno(1,2,3-cd)pyrene	ND	36
Dibenzo(a,h)anthracene	ND	36
Benzo(g,h,i)perylene	ND	36

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201043-02

Client Sample ID: 6-SB1

Date Sampled: 01/17/02

Sample wt: 15.03g

Date Received: 01/21/01

% Moisture: 21

Date Extracted: 01/29/02

Dilution Factor: 1.0

Date Analysed: 02/02/02

Associated Method Blank: V0129-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	42
Acenaphthylene	ND	42
Acenaphthene	ND	42
Fluorene	ND	42
Phenanthrene	ND	42
Fluoranthene	ND	42
Pyrene	ND	42
Benzo(a)anthracene	ND	42
Chrysene	ND	42
Anthracene	ND	42
Benzo(b)fluoranthene	ND	42
Benzo(k)fluoranthene	ND	42
Benzo(a)pyrene	ND	42
Indeno(1,2,3-cd)pyrene	ND	42
Dibenzo(a,h)anthracene	ND	42
Benzo(g,h,i)perylene	ND	42

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201043-03

Client Sample ID: 5-SB1

Date Sampled: 01/17/02

Sample wt: 15.05g

Date Received: 01/21/01

% Moisture: 15

Date Extracted: 01/29/02

Dilution Factor: 1.0

Date Analysed: 02/02/02

Associated Method Blank: V0129-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	39
Acenaphthylene	ND	39
Acenaphthene	ND	39
Fluorene	ND	39
Phenanthrene	ND	39
Fluoranthene	ND	39
Pyrene	ND	39
Benzo(a)anthracene	ND	39
Chrysene	ND	39
Anthracene	ND	39
Benzo(b)fluoranthene	ND	39
Benzo(k)fluoranthene	ND	39
Benzo(a)pyrene	ND	39
Indeno(1,2,3-cd)pyrene	ND	39
Dibenzo(a,h)anthracene	ND	39
Benzo(g,h,i)perylene	ND	39

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201043-04

Client Sample ID: 9-SB1

Date Sampled: 01/17/02

Sample wt: 15.07g

Date Received: 01/21/01

% Moisture: 20

Date Extracted: 01/29/02

Dilution Factor: 1.0

Date Analysed: 02/02/02

Associated Method Blank: V0129-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	41
Acenaphthylene	ND	41
Acenaphthene	ND	41
Fluorene	ND	41
Phenanthrene	ND	41
Fluoranthene	ND	41
Pyrene	ND	41
Benzo(a)anthracene	ND	41
Chrysene	ND	41
Anthracene	ND	41
Benzo(b)fluoranthene	ND	41
Benzo(k)fluoranthene	ND	41
Benzo(a)pyrene	ND	41
Indeno(1,2,3-cd)pyrene	ND	41
Dibenzo(a,h)anthracene	ND	41
Benzo(g,h,i)perylene	ND	41

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201043-05

Client Sample ID: 2-SB1

Date Sampled: 01/18/02

Sample wt: 15.10g

Date Received: 01/21/01

% Moisture: 28

Date Extracted: 01/29/02

Dilution Factor: 2

Date Analysed: 02/02/02

Associated Method Blank: V0129-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	92
Acenaphthylene	ND	92
Acenaphthene	ND	92
Fluorene	ND	92
Phenanthrene	ND	92
Fluoranthene	ND	92
Pyrene	ND	92
Benzo(a)anthracene	ND	92
Chrysene	ND	92
Anthracene	ND	92
Benzo(b)fluoranthene	ND	92
Benzo(k)fluoranthene	ND	92
Benzo(a)pyrene	ND	92
Indeno(1,2,3-cd)pyrene	ND	92
Dibenzo(a,h)anthracene	ND	92
Benzo(g,h,i)perylene	ND	92

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: Soil

Lab Sample ID: 2201043-06

Client Sample ID: 4-SB1

Date Sampled: 01/18/02

Sample wt: 16.06g

Date Received: 01/21/01

% Moisture: 21

Date Extracted: 01/29/02

Dilution Factor: 1.0

Date Analysed: 02/02/02

Associated Method Blank: V0129-B1

COMPOUND	Sample Concentration ug/Kg (ppb)	Quantitation Limit ug/Kg (ppb)
Naphthalene	ND	42
Acenaphthylene	ND	42
Acenaphthene	ND	42
Fluorene	ND	42
Phenanthrene	ND	42
Fluoranthene	ND	42
Pyrene	ND	42
Benzo(a)anthracene	ND	42
Chrysene	ND	42
Anthracene	ND	42
Benzo(b)fluoranthene	ND	42
Benzo(k)fluoranthene	ND	42
Benzo(a)pyrene	ND	42
Indeno(1,2,3-cd)pyrene	ND	42
Dibenzo(a,h)anthracene	ND	42
Benzo(g,h,i)perylene	ND	42

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED
METHOD BLANK

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: SOIL

Sample wt/vol: 15.0 g

Blank ID: V0129-B1

Date Extracted: 01/20/02

Date Analysed: 02/02/02

Dilution Factor: 1.0

COMPOUND	Sample concentration ug/Kg (ppb)	Quantitation limit ug/Kg (ppb)
Naphthalene	ND	33
Acenaphthylene	ND	33
Acenaphthene	ND	33
Fluorene	ND	33
Phenanthrene	ND	33
Fluoranthene	ND	33
Pyrene	ND	33
Benzo(a)anthracene	ND	33
Chrysene	MD	33
Anthracene	ND	33
Benzo(b)fluoranthene	ND	33
Benzo(k)fluoranthene	ND	33
Benzo(a)pyrene	ND	33
Indeno(1,2,3-cd)pyrene	ND	33
Dibenzo(a,h)anthracene	ND	33
Benzo(g,h,i)perylene	ND	33

Rua Guaipá, 203 - Vila Leopoldina · CEP 05089-001 · São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 · e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODOFIED
LABORATORY CONTROL SAMPLE

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

Matrix: SOIL

Sample wt/vol: 15.0 g

Blank Spike ID: V0129-LCS1

Date Extracted: 01/29/02

Date Analysed: 02/02/02

Dilution Factor: 1.0

COMPOUND	Spike Added (ug/Kg)	Blank spike result (ug/Kg)	Blank spike recovery (%)	QC Limits (%)
Naphthalene	333	199	60	48-98
Acenaphthylene	333	176	53	40-112
Acenaphthene	333	176	53	44-113
Fluorene	333	203	61	36-126
Phenanthrene	333	133	40	30-129

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA.

"Química Analítica no Gerenciamento Ambiental"

SEMIVOLATILE ORGANICS ANALYSIS by GC/MS SW846 METHOD 8270 - MODIFIED
SURROGATE RECOVERY

Client: **COBRAPE Companhia Brasileira de Empreendimentos**

Project Name:

	CLIENT SAMPLE ID	SURROGATE SPIKE RECOVERY (%) NAPHTHALENE - d8
01	3-SB1	96
02	6-SB1	95
03	5-SB1	88
04	9-SB1	80
05	2-SB1	D
06	4-SB1	82
	V0129-B1	91
	V0129-LCS1	90

* Values outside of contract required QC limits
D Surrogate diluted out

Rua Guaipá, 203 - Vila Leopoldina . CEP 05089-001 . São Paulo - SP - Brasil
Tel./Fax: (11) 3832-2234 . e-mail: ceimic@8415.com.br

CHAIN OF CUSTODY

CHAIN OF CUSTODY

Original Chain of Custody goes to Laboratory

Page 1 of 1

Cobrop

Proj. #	Project. name 20535-32720
Samplers (Please print) J.M. Munsil, ec americasille	

	DATE	Time	Comp. / Grab.	Sample Identification	Sample Matrix	Number of containers	TPH	FP	BTEX	PAH	ETANOL				Remarks
01	17-1-2	1050	G	3-SB1	Soil	1	X	X	X	X	X				
02	17-1-2	1335	G	6-SB1 (Super)	Soil	1	X	X	X	X	X				
03	17-1-2	1650	G	5-SB1	Soil	1	X	X	X	X	X				
04	17-1-2	1928	G	9-SB1	Soil	1	X	X	X	X	X				
05	18-1-2	1030	G	2-SB1	Soil	1	X	X	X	X	X				
06	18-1-2	1220	G	4-SB1	Soil	1	X	X	X	X	X				

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time 18-1-2 1519	Received by (Signature)	Date/Time 18.1.02

Remarks:
9-SB1 - alta concentração Diesel
2-SB1 - " "
4-SB1 - " Gasolina

15:15

CEIMIC ANÁLISES AMBIENTAIS S/C LTDA. - Rua Brigadeiro Galvão, 535-A - São Paulo - SP - Brasil
TEL.: (11) 3667-0126 - FAX: (11) 826-1429 - e-mail: ceimic@8415.com.br

CEIMIC ANÁLISES AMBIENTAIS
CHECAGEM DO RECEBIMENTO DE AMOSTRAS

CLIENTE:	Cobrape	NUMERO DO PROJETO:	201043

Envio das Amostras	UPS	FEDEX	OUTROS
	CLIENTE X	CEIMIC	

	SIM	NÃO	COMENTÁRIOS
1. As amostras foram recebidas em caixa térmica?	X		
2. A caixa térmica estava lacrada?		X	
2. Data da abertura da caixa térmica: 18-1-02			
4. Chain of Custody estava presente?	X		
5. Temperatura da caixa térmica: 1°C			
6. As amostras foram recebidas intactas (nenhum frasco quebrado) ?	X		
7. Quantidade de amostra suficiente ?	X		
8. Os frascos utilizados eram corretos para os* parâmetros de análise?		X	* os frascos de BTEX deve ser separado
9. As amostras estavam preservadas corretamente?	X		
10. As amostras foram recebidas dentro do tempo de validade de análise?	X		
11. A identificação dos frascos coincidiam com o COC ?	X		
12. Frascos para VOC estavam isentos de bolhas de ar ?	–		
13. O gerente responsável pelo projeto foi comunicado ?	–		
14. O cliente foi comunicado ?	–		
COMENTÁRIOS ADICIONAIS:			

Appendix C

Site Assessment Methodology

Sampling Program Parameters Matrix

Sampling Program Parameters		UST System Condition [1]										
		Good				Fair				Poor		
Soil Vapor Points		A_1	A_2	A_3		A_1	A_2	A_3		A_1	A_2	A_3
	T_1	16-20	16-22	20-30	T_1	10-14	16-22	20-30	T_1	Not Needed [2]		
	T_2	18-22	24-30	28-38	T_2	10-14	16-22	20-30	T_2			
	T_3	20-24	26-34	30-40	T_3	10-14	16-22	20-30	T_3			
Soil Samples		A_1	A_2	A_3		A_1	A_2	A_3		A_1	A_2	A_3
	T_1	1	1	1	T_1	6-8	9-11	12-14	T_1	4	4	4
	T_2	1	1	1	T_2	8-10	11-13	13-15	T_2	6	6	6
	T_3	1	1	1	T_3	10-12	13-15	16-18	T_3	8	8	8
Groundwater Samples		A_1	A_2	A_3		A_1	A_2	A_3		A_1	A_2	A_3
	T_1	N/A			T_1	N/A			T_1	6-8	8-10	10-12
	T_2				T_2				T_2	9-11	11-13	13-15
	T_3				T_3				T_3	12-14	14-16	16-18

Key:			**System Condition [1]**
A_1=<2,000 m^2 A_2=2,000–10,000 m^2 A3=>10,000 m^2 **SITE AREA**		T_1=1-4 tanks T_2=5-9 tanks T_3=10-15 tanks **No. OF TANKS**	Good: • In compliance with the standards and specifications that CETESB intends to require everywhere after 12 years, **OR** • System newer than 5 years old with leak detection equipment or inventory control procedures in place since installation.
Color:		See note 3.	Fair: • Systems between 5 and 15 years old in good operating condition with leak detection equipment or inventory control procedures in place, **AND** • No known or suspected release incidents.
		See note 4.	
			Poor: All others.

Notes:

(1) Classifications and classification criteria shown are used for purposes of example only.
(2) Groundwater and soil samples supercede soil vapor samples for reliability.
(3) Mandatory sampling procedure to apply for license.
(4) Sampling that may be prudent and cost effective to sufficiently characterize sub-surface condition of contaminated sites prior to remedial action. Not required for licensing process

Proposed Methods
Soil Gas Survey: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo

CDM

Appendix C

Contents

Introduction 1
1.0 Collect and Review Background Site Data 2
1.1 Interviews 2
1.2 Data Search and Review 2

2.0 Safe Work Preparation
2.1 Reviewing Previously Gathered Data 3
2.2 Creating a Preliminary Site Clearance Plan 3
2.2.1 Site Clearance Visit 3
2.2.2 Plotting Underground Features 4
2.3 Creating the Final Site Clearance Plan 7
2.4 Preparing a Health and Safety Plan 7

3.0 Quality Assurance/Quality Control Procedures 8

4.0 Prepare a Conceptual Model 9

5.0 Sampling Locations Identification 11

6.0 Soil Gas Collection and Analysis 12

7.0 Mapping the Results 14

8.0 Soil Sample Location and Analysis 15

9.0 Soil Gas Survey Report 15

10.0 Reading List and Sources 16

Soil Gas Survey: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo

This document presents a method to identify potential fuel releases from underground storage tanks (UST) by means of a Soil Gas Survey.

Typically, soil gas sampling involves the collection of vapors occupying the pore spaces of soils. The vapors are composed of air and water vapor, naturally occurring organic compounds, human-induced organic compounds, organic compounds migrating from deep fossil fuel reserves, and other constituents capable of partitioning from liquid and solid materials into the vapor phase under ambient conditions. Soil gas samples are collected and analyzed to determine the composition of the vapors, and gain an understanding of their distribution spatially. The results are interpreted in terms of soil moisture content, environmental contamination, fossil fuel presence, biological breakdown, etc., depending on the application and question(s) of interest or concern. Soil gas surveying is an effective, efficient, relatively non-disruptive method of delineating the nature and spatial extent of materials emitting volatile and semi-volatile organic compounds.

Two general methods of soil gas sampling exist -- active and passive. Conventional or active approaches involve inserting a hollow-stemmed probe into the subsurface and "actively" removing a sample of soil gas from the pore spaces. This sample is moved to a container for later analysis, or analyzed at the site using field analytical equipment. That is the approach presented here.

The proposed method consists of eleven tasks, to be executed in order, as follows:

- Collect and Review Background Site Data
- Safe Work Preparation
- Quality Analysis /Quality Control
- Prepare a Conceptual Model
- Identify Sampling Locations
- Penetrate Surfaces
- Collect and Analyze Soil Gas
- Map the Results
- Determine Follow-up Soil and Groundwater Analytical Scope
- Prepare and Submit Report

1.0 Collect and Review Background Site Data

1.1 Interviews

Interviews should be conducted of knowledgeable parties at each site. Information requested may include:

- A Site Construction and Improvements History
- Site Construction and Improvements Photographs
- Aerial Photographs
- UST System Installation Photographs
- A Site Fueling History
- Major Improvements, Demolitions And Renovations
- Site Drainage
- Current Fueling Schedules
- Current Tanks And Lines Status
- An Overview Of The Fueling System
- Any Release Episodes And Responses And Reports
- Health And Safety Requirements And Suggestions
- Site Construction And Layout Plans
- Fueling System Schematics

1.2 Data Search and Review

A data search and review should be conducted to determine the gross geologic and hydrogeologic characteristics of the site. Data reviewed may include:

- Topographic And Floodplain Maps
- Hydrologic Basin Maps
- Geologic Maps

- Surface Hydrology Maps
- Aquifer Maps
- Water Supply Well Data
- Previous Investigation Reports
- Municipal Stormwater And Sanitary System Plans

2.0 Safe Work Preparation

The intent of this section is to provide a method, which if followed rigorously, should result in safe site investigation work. The steps to be followed include:

- Reviewing previously gathered data
- Performing site clearance
- Creating a site health and safety plan for invasive sampling

2.1 Reviewing Previously Gathered Data

The information previously gathered should be reviewed with specific regard to site safety and to preparing a list of questions to be answered during the site clearance visits.

2.2 Creating a Preliminary Site Clearance Plan

Site utility clearance should be performed. The intent of the clearance is to:

- Identify safe areas to perform invasive sampling
- Prepare a plan to deal with potentially hazardous situations encountered while performing the work
- Educating Site staff and investigators about the potential hazards specific to the site

2.2.1 Site Clearance Visit

The site clearance visit can be performed in conjunction with the Site Interviews noted in section 1.1 above. However, information derived from site interviews should be reviewed before inspecting the site for utility clearance. Also, before inspecting the site, the inspector should request that federal, state, county and municipal authorities, and electrical,

telephone and pipeline service companies mark their underground features at the property boundaries and where the features enter the property.

Site personnel with the greatest experience on site should accompany the inspector during the site visit. It may be necessary to ask that site management and third party service providers also be present during the site inspection.

The site clearance visit should concentrate upon creating a site plan, to scale, which identifies all current and historic underground features that could be encountered during invasive sampling. This means that the inspector should be prepared with the equipment and expertise necessary to create a scaled site plan from measurements taken on site in the absence of an existing and accurate site plan. Most existing site plans are neither accurate nor up to date.

If site plans are available, they may be used as the base for the site clearance map if they are at an acceptable scale (generally no greater than 1:50) and only after they are determined to be accurate. Most sites do not have "as-built" site plans available. Thus, it is often necessary to verify that major features are accurately plotted on the site map before plotting the underground features. It may also be necessary to survey the site boundaries and major cultural features to provide adequate quality and accurate points from which to measure observed site features.

2.2.2 *Plotting Underground Features*

All active and historical underground features on and immediately adjacent to the site should be identified and plotted on a site plan, to scale, at a scale of 1:25. All identified features should be accurately measured and plotted with accuracy of at least plus or minus 25 cm. The site plan should include a north arrow and a scale identifier.

Underground features encountered at fueling stations may include (but are not limited to):

- Underground Storage Tank (UST) Systems
- UST telemetry lines
- UST electrical power lines

- UST pressurized or suction fuel lines
- UST vent lines
- UST inventory control lines
- UST vapor recovery lines
- Other UST devices
- Waste Oil UST
- Waste Oil UST fill tubing and monitoring lines
- Waste Oil UST vent lines
- Waste Oil UST manifold lines
- Stormwater drainage channels, tubing and ducting
- Sanitary sewage drainage channels, tubing and ducting
- Car wash effluent lines, drainage channels, tubing and ducting
- Oil/water separator
- Oil/water separator fill and effluent lines, drainage channels, tubing and ducting
- Active and inactive groundwater remediation systems
- Groundwater Monitoring Wells
- Soil Vapor Monitoring Wells
- Sanitary sewage tanks
- Sanitary sewage tank influent and effluent lines, drainage channels, tubing and ducting
- Electrical and Optical Telephone cables
- Electrical service cables
- Water supply lines
- Water wells

- Hand-dug water wells
- Historic pavements and roadways
- Historic foundations and stormwater control systems
- Water supply wells
- Historic sumps
- Municipal and/or state utilities, including stormwater control, sanitary sewage control, water supply, natural gas supply and other utilities
- Natural gas and oil pipelines
- Liquid chemical or pressurized gas pipelines
- Basements
- Underground Parking
- Underground Storage
- Other underground manmade features such as archeological features

Cut marks in the paved surfaces, differences in paving materials and any other indications of repaired pavement should be noted and identified on the site plan. It may be necessary to use additional measures such as geophysics to identify major features that could be significantly dangerous to encounter during invasive sampling, but that are not otherwise identifiable on site. For example, this may include historic underground storage tanks that are presumed to be present based upon site interviews or review of historic plans, but which cannot be otherwise identified during the site clearance visit.

It is particularly difficult to identify and plot UST system piping and service lines and especially so for newer installations. Many of these lines, and particularly most new plastic or fiber-reinforced plastic lines are flexible and are placed in arcs rather than in straight lines. There is often no direct observable evidence of the underground path of these lines because pavements were typically later placed over them following installation and "as-built" drawings are seldom generated.

Thus, it is best to identify their locations from construction and installation photographs or by interviews of the persons who constructed the system. When these resources are not available then it is best to ensure that a person who has observed or managed UST system installations be the person who marks their probable location on the clearance plan. In the absence of any of these resources, it is best to mark their probable paths within a 1-meter radius envelope rather than as a single straight line. Where the paths of lines can only be inferred, it is necessary to indicate multiple potential placements upon the site plan, each within its own 1-meter radius envelope. Thus, it is common to create a site plan with many overlapping features.

Before leaving the site the inspector should walk the entire site with senior site management staff to present the findings of the site clearance visit, to request comments and insights and to obtain recommendations for traffic control and site safety.

2.3 Creating the Final Site Clearance Plan

The inspector who performed the site clearance should be the person who prepares or otherwise is responsible for the creation of the final site clearance plan.

The final plan should include:

- An underground features map at a 1:25 scale, with property boundaries and exterior utilities marked, a scale indicator, a north arrow and a date
- A list of all probable underground features that could be encountered during invasive sampling
- Photographs to indicate key site features and potentially hazardous situations

The plan should be created before invasive sampling is performed.

2.4 Preparing a Health and Safety Plan

A health and safety plan (HASP) should be prepared before invasive sampling is performed. The intent of preparing the HASP is to provide a method, which if followed rigorously, should result in safe site investigation work. The steps to be followed include:

- Perform Site Clearance

- Identify Chemicals of Concern (COCs) and their potential health effects
- Identify means to monitor the potential for exposure to COCs
- Identify Potential Physical Hazards
- Identify means to mitigate potential physical hazards
- Identify Personnel Protective Equipment per task
- Identify exposure levels that indicate a change in PPE is necessary
- Identify reasonably available emergency response equipment for onsite use
- Identify emergency response routes to the nearest emergency treatment center, their name, address and directions
- Forms for Daily Health and Safety Briefings

An example Health and Safety Plan is attached.

3.0 Quality Assurance/Quality Control Procedures

Numerous QA/QC procedures must be undertaken during an active soil-gas survey to ensure that the samples are representative of subsurface conditions. The following list is not comprehensive for all site conditions or equipment; rather, it contains the primary issues that investigators check when they evaluate active soil-gas survey reports. QA/QC procedures include:

- All soil-gas surveys should be collected following the same procedures.
- Sampling should be completed in a relatively short period of time (e.g., hours, days) because temporal variations such as temperature, humidity, barometric pressure, and rain can affect contaminant concentrations.
- Decontamination procedures should be practiced to prevent contaminant gain or loss that results from adsorption onto sampling equipment.
- The insides of the sample train components should be as dry as possible because water can raise or lower contamination values.
- Ambient air present in the sample train must be purged prior to sample collection.

- When sampling directly through probe rods, the sample train connections should be checked prior to collecting each sample to ensure they are airtight.

- Annular space between the side of the borehole and the installation device (e.g., probe rod) should be sealed at the ground surface with a bentonite paste or similar material.

- Blank samples should be tested regularly to ensure that decontamination procedures are adequate and to determine background VOC levels.

- Duplicate soil-gas samples should be collected each day (generally 1 for every 10 samples) to assess the reproducibility of the data.

- A permanent monitoring point provides consistent results for multiple measurement episodes.

- Consistent sampling method within a site, with a minimum of operator error is more important than type of probe used.

- Identical measurement instruments can pump soil gas at very different rates. When possible the same instrument must be used to minimize equipment variation.

4.0 Prepare a Conceptual Model

The intent of this section is to provide guidance to prepare a conceptual model of site conditions for use to guide the field screening and to understand the site screening results. The conceptual model is used to define potential exposure pathways for investigation and evaluation and to refine the selection of investigation points.

An essential component of informed decision-making is the conceptual site model (CSM) of the chemical release and the site setting. A CSM is an inventory of the actual and potential sources, pathways, and receptors related to the chemical release. Sources include the primary release of the chemical into the environment (e.g., surface spill or UST system leak). Sources also include the regions of affected soil or groundwater adjacent to the original release, which act as secondary sources of chemical to the surrounding environment. Pathways include the mechanisms by which a chemical may migrate from the source to a point of potential exposure (e.g., groundwater migration, vapor migration). Pathways also include the route by which a receptor is exposed to the chemical (e.g., ingestion, inhalation, and dermal contact). Receptors may include any organism (human or other ecological species) or habitat that may be adversely affected by exposure to the chemical.

A conceptual site model can be summarized in a variety of ways, such as a written summary, a table or matrix, a flowchart, or a schematic figure. A conceptual model may distinguish between current (actual) exposures, and future (potential) exposures.

At the initial stages of an investigation, the conceptual model may be no more than a set of simplified, conservative assumptions about site conditions (sources, pathways, and receptors). As additional knowledge of the site is obtained, the conceptual model is verified or refined. The conceptual site model is the basis for all investigation tasks, whereby data needs regarding sources, pathways, or receptors are identified, and then fulfilled, as the field investigation proceeds. After some subsurface data is collected, the conceptual model would also include a written or graphical summary of the subsurface conditions at the site. This would include a summary of the extent of affected soil and groundwater, and any significant geologic and hydraulic influences on the potential migration of chemicals in the subsurface.

In the early stages of many site assessments, very little may be known about the releases, migration and exposure pathways, or potential receptors. Consequently, the CSM may be generalized at the beginning of the assessment, but it will become more representative of actual site conditions as more site information is obtained. The initial site assessment may include only limited information about potential sources, pathways, and receptors, and so conservative assumptions are commonly used in the initial conceptual site model. For example, if a receptor is found to exist near the site and no other information is known about sources or pathways, then the conceptual model would typically make the conservative assumption that the pathway exists. Further site characterization data would be used to evaluate this assumption and refine it accordingly. The development of the conceptual site model is further discussed in ASTM, 1995b and ASTM, 1998a.

The Conceptual Model should be based on a review of existing information on past and current land uses, potential sources of contamination, and potential migration pathways and receptors. Much of the required data may already be available as part of the previous steps (Sections 1.0 and 2.0) a previous Phase I Environmental Site Assessment; otherwise standard Phase I sources and techniques may be used (ASTM, 1997). In addition, the regional hydrogeology, including local water-supply systems, must be considered. Relevant hydrogeologic data can often be obtained from federal and state geological surveys, state or local environmental and water agencies, private water companies, and university geology and civil engineering departments. The initial Conceptual Model is typically summarized on large-scale maps of the site area, showing geologic and hydrogeologic features, cross sections, groundwater flow directions and velocities, anticipated sources, plume location and extent, receptors, and other relevant factors. Data gaps can then be readily identified.

Specific features to include are:

- Man-made features
    - UST and Fueling System
    - Current and Historical
    - Historical Setting
- Hydrology
    - Geology and Hydrogeology
- Release Indications
- Potential Receptors
- Potential Gas Sources
- Potential Gas Movement Pathways
- Potential Gas Receptors

5.0 Sampling Locations Identification

The intent of this section is to provide guidance to select safe sampling locations that meet the objectives of the site screening process. It is not possible to safely perform soil vapor sampling on a standard 5-meter grid spacing at one meter below grade (1 mbg) at fueling sites unless the grid is totally included in one contiguous cleared area. Safe sampling can be performed if sample locations are selected from "cleared areas" identified by site clearance methods. Cleared area is defined as areas where (based upon site clearance performed as in Section 2.0) no underground manmade features exist and that are at least 1 meter laterally distant from an identified subsurface manmade feature.

The average site encountered in this work can be adequately characterized by 20 to 25 sample locations. Very small sites may be adequately characterized by no more than 10 to 15 sample points. Larger sites, such as fleet fueling stations and "truck stops" may require 30 to 50 locations or more. Adequate characterization is herein defined as the ability to detect that a release(s) exists, but not necessarily the point source of the release. Definitive detection of a release also requires characterization of the soil gas as deriving from a fuel component.

Locate sample points within cleared areas of the site. When possible, place samples locations on a grid within cleared areas. Grid spacing near or flanking underground fueling system components should be no greater than 5 meters. Grid spacing in areas not clearly suspect as potential sources or migration pathways should be no less than 10 meters. This allows more resources to be expended in areas more likely to contain contamination if it exists. Locate sample points near any point where 2 or more elements of the fuel system join together, such as:

- Fill port to tank
- Distribution line to distribution line at corners
- Pump to fuel line at base of pump
- Tank wall to tank wall

Sample points should be located no more than 5 meters from a potential underground source (or contaminant migration pathway such as pipe chases) to adequately identify the potential for a release from that source. In fine-grained soils, a lesser spacing may be necessary. However, sample points should be located no closer than 1 meter to any underground feature identified during site clearance to allow for safe penetration, given the inherent uncertainty of the clearance process and the variation in installations.

6.0 Soil Gas Collection and Analysis

It is necessary and common to penetrate paving surfaces in order to place the sampling device in the ground. Concrete, brick and pavement coring using a local cement coring service may be the most cost-effective, safe and least obtrusive method available. Jackhammer and other impact hammer drill methods are most likely to damage utilities immediately below a paved surface before the operator understands that there is a problem. In unpaved areas, it may be possible to penetrate surfaces by manual labor.

A wide variety of soil gas sampling tools exists. Some use an expendable tip to seal the rods as they are advanced to the target depth. Others use a retractable tip. Still others use an expendable or retractable tip equipped with flexible tubing through which the sample is extracted.

Soil gas samples are typically extracted using a vacuum pump and are collected in stainless steel Summa® canisters, Tedlar® bags, or syringes. Soil gas samples should be analyzed as soon as possible (ideally on site) to prevent diffusive losses or biodegradation of the samples.

Direct push (DP) tools are used for subsurface investigations by driving, pushing, and/or vibrating small-diameter hollow steel rods into the ground.

By attaching sampling tools to the end of the steel rods, they can be used to collect soil, soil gas, and groundwater samples. DP rods can also be equipped with probes that provide continuous in situ measurements of subsurface properties (e.g., stratigraphy, contaminant distribution). DP equipment can be advanced with various methods ranging from 30-pound manual hammers to trucks weighing 40 tons. DP technologies are most applicable in unconsolidated sediments, typically to depths less than 30 meters. In addition, they are increasingly being used to install small-diameter (i.e., less than 2 inches) temporary or permanent monitoring wells, and small-diameter piezometers. Penetration is limited.

The average of three repeated measurements over time helps provide reliable identification of potential releases. This is because:

- There is significant potential for variation in measurements due to variations in operation, wind, and organic vapors in air, variations in instrument response with changes in humidity, variations in sewer gases, and changes in barometric pressure

- Most of the variations noted above will result in a lower measurement than the true value. Some can result in error by indicating an anomaly where none exists.

A small diameter (2.5 centimeters or less) open tube soil vapor probe may provide better results than a large diameter probe. This is because:

- There is less soil displacement and compaction immediately around the probe

- A small diameter probe is more likely to be successfully placed at the target depth than a larger diameter probe

- An open tube probe is partially retrieved (approximately 0.25 meter) before exhausting soil gas and the open hole provides a larger surface area for soil gas transfer than surfaces exposed in perforations of a perforated probe

- The open tube probe can be adapted to carry perforated teflon or nylon tubing, which can be left in place as a permanent soil vapor monitoring well

Soil gases can be a mix of components from fuel system and non-fuel system sources. Hydrogen sulfide and methane (perhaps from nearby sewers) were commonly encountered. No one instrument can identify all gases potentially encountered. Thus, it is clearly possible to assign a sewer gas anomaly to a fuel system source if gas components are not identified. A reduction in oxygen percentage in soil gas may be as indicative of a fuel-related anomaly as an

increase in fuel-derived soil gas, especially if soil gas components are not discriminated by the measurement method.

Non-fuel system derived methane and hydrogen sulfide are commonly encountered during the fieldwork and result in soil gas anomalies when analyzed by iso-concentration mapping. If these gases are not discriminated during measurement, it is not only possible but also easy to wrongly conclude that an observed soil gas anomaly indicates a fuel release.

When possible, set permanent monitoring points. The equipment and supplies needed to do this can be acquired locally. Perform at least 3 monitoring episodes using the same equipment each time, recording site conditions during each measurement episode. Identify the concentrations at each sampling point of the following parameters and soil gas components:

- Percent oxygen
- Percent Lower Explosive Limit
- Volatile Organic Carbon (VOC)
- Hydrogen sulfide

Use an integrated oxygen, hydrogen sulfide and LEL meter such as an MSA LEL to identify anomalies and a photo-ionization detector to measure VOC concentrations. These instruments are available locally.

Always use the same instrument for every sample point measurement at a given site. Do not mix instruments or methods across a single site, for a single parameter. Do not use analog meter instruments. Do not use an interpretation of an LEL% response (such as 25% as used in the state of Texas, USA) as an indication of a fuel release. This method will result in false positives. Only use the LEL% response in combination with a means to identify fuel indicator compounds such as VOC.

7.0 Mapping the Results

Calculate the average of measurement results per parameter, per sample location. Plot the average results as iso-concentration contour lines on the site clearance map prepared during execution of Section 2.0. Compare the resulting anomalies to site and nearby municipal utilities and determine the potential for sewer gas impact to the site. Verify that any apparently significant anomalies also demonstrate a reduction in percent oxygen in air. Closely review site documentation for any organic compound anomalies that do not coincide with oxygen anomalies. Resample or discard areas that contain anomalies not clearly containing soil gas clearly derived from fuel components.

8.0 Soil Sample Location and Analysis

Using the VOC concentration contour map developed using the soil vapor survey, locate one soil boring in the center of the area with highest VOC concentration. See "Soil Sampling: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo" in this appendix for details regarding soil sampling. While drilling the boring, perform a vertical soil gas profile (see Section 5.0 of "Groundwater Sampling: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo" in this appendix).

9.0 Soil Gas Survey Report

A concise report should be issued, presenting sufficient data to allow a third party to assess the quality of the work.

Elements of the report can include:

Executive Summary

Statement of Qualifications of Assessor

Site Description

Site Clearance Map

Conceptual Model

Field Measurement Episodes Summary

Sampling Point Map

Soil Gas Results Tables

Anomalies Identification Summary

Soil Gas Maps. Iso-concentration Maps. A site map that accurately shows iso-concentration contour lines, per measured parameter and their relation to the location of the monitoring points and past and present fueling systems. It is best presented on the Site Clearance Map.

Supporting Documents

Photographic Record. Photographic record of work, depicting the procedures used in the field.

Log of field conditions.

10.0 Reading List and Sources: Soil Gas Surveys

ASTM. 1993. Standard guide for soil gas monitoring in the vadose zone, D5314-93, Annual Book of ASTM Standards, Philadelphia.

API. 1991. Chemical Fate and Impact of Oxygenates in Groundwater: Solubility of BTEX from Gasoline-Oxygenate Mixtures. API Publication No. 4531. American Petroleum Institute. Washington, D.C.

API. 1996a. A Guide to the Assessment and Remediation of Underground Petroleum Releases. API Publication No. 1628. American Petroleum Institute. Washington, D.C. Third Edition, July.

API. 1996b. Natural Attenuation Processes. API Publication No. 1628A. American Petroleum Institute. Washington, D.C. First Edition, July.

API. 1996c. Risk-Based Decision-Making. API Publication No. 1628B. American Petroleum Institute. Washington, D.C. First Edition, July.

API. 1997a. Field Evaluation of Biological and Non-Biological Treatment Technologies to Remove MTBE/Oxygenates from Petroleum Product Terminal Wastewaters. API Publication No. 4655. American Petroleum Institute. Washington, D.C.

API. 1997b. Field Studies of BTEX and MTBE Intrinsic Bioremediation. API Publication No. 4654. American Petroleum Institute. Washington, D.C.

Arulanantham R., and T. Buscheck. 1999. Assessment and Management of MTBE Impacted Sites. Course notes. Sponsored by the California Environmental Protection Agency, State Water Resources Control Board. 1999.

ASTM. 1995a. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites, E 1739-95 1 . American Society for Testing and Materials, West Conshohocken, PA.

ASTM. 1995b. Standard Guide for Developing Conceptual Site Models for Contaminated Sites, E 1689-95. American Society for Testing and Materials, West Conshohocken, PA.

ASTM, 1997. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, E1527-97. American Society for Testing and Materials, West Conshohocken, PA.

ASTM. 1998a. Provisional Standard Guide for Risk-Based Corrective Action, PS 104-98. American Society for Testing and Materials, West Conshohocken, PA.

ASTM. 1998b. Standard Guide for Remediation of Ground Water by Natural Attenuation at Petroleum Release Sites, E 1943-98. American Society for Testing and Materials, West Conshohocken, PA.

ASTM. 1999a. Standard Guide for Accelerated Site Characterization for Confirmed or Suspected Petroleum Releases, E 1912-98. American Society for Testing and Materials, West Conshohocken, PA.

Baehr A.L. 1987. Selective Transport of Hydrocarbons in the Unsaturated Zone Due to Aqueous and Vapor Phase Partitioning. Water Resources Research. 23(10): 1926-1938.

Chamberlin, T.C. 1897. The Method of Multiple Working Hypotheses. Journal of Geology. 5(6).

Cordry, K.E. 1986. Ground water sampling without wells. In Proceedings of the Sixth National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, May 11-13, 1992. National Water Well Association, Columbus, OH.

Corey, A.T. 1986. Air permeability. In Methods of soil analysis, Part 1, 2nd edition, A. Klute, ed., Am. Soc. of Agron. Monograph No. 9: 1121-36. Madison:Univ. of Wisconsin Press.

Crum, J., Przybysz, R. (1998), Michigan's approach for evaluating vapor migration of contamination from ground- water and soil to indoor air at UST release sites, Proceedings of the 1998 Petroleum Hydrocarbons and Organic Chemicals in Groundwater: National Groundwater Water Association, Houston Texas, pp. 230-250.

Devitt, D.A., R.B. Evans, W.A. Jury, T.H. Starks, B. Eklund, and A. Gholson. 1987. Soil gas sensing for detection and mapping of volatile organics, EPA/600/8-87/036. (NTIS PB87-228516).

Devitt D.A., et al., Soil Gas Sensing for Detection and Mapping of Volatile Organics, National Ground Water Association, Dublin, OH, 1987.

Deyo, B.G., G.A. Robbins, and G.B. Binkhorst. 1993. Use of portable oxygen and carbon dioxide detectors to screen soil gas for subsurface gasoline contamination. Gr. Water, vol. 31, no. 4.

Einarson, M.D., M. S. Schirmer, D.M. Mackay, R.A. Wilson. 1999. Comparison of Eight Innovative Site Characterization Tools Used to Investigate and MTBE Plume at Site 60, Vandenberg Air Force Base, California. in Proceedings of the API/NGWA Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, Houston, Tex., Nov. 17-19, 1999, p., 147-157.

Feenstra, S. 1990. Evaluation of Multi-Component DNAPL Sources by Monitoring of Dissolved-Phase Concentrations. In Proceedings of the Conference On Subsurface Contamination by Immiscible Fluids, International Association of Hydrogeologists, Calgary, Alberta, April 18- 20, 1990.

Feenstra, S., D.M. Mackay, and J.A. Cherry. 1991. A Method for Assessing Residual NAPL Based on Organic Chemical Concentrations in Soil Samples. Ground Water Monitoring Review 11(2):128-136.

Gibbs, L. 1990. Gasoline Additives - When and Why. SAE Tech. Paper 902104, Int'l Fuels and Lubricants Meeting, Soc. Auto. Eng., Warrendale PA.

Gustafson, J.B., Tell, J.G., and Orem, D. (1997), Selection of representative TPH fractions based on fate and trans- port considerations, TPH National Criteria Working Group, Vol. 3, Amherst Scientific Publisher.

Hers, I., Zapf-Gilj, R. (1998), Canadian Consortium Research Project - field validation of soil gas transport to indoor air pathway, Proceedings of the 1998 Petroleum Hydrocarbons and Organic Chemicals in Groundwater: National Groundwater Water Association, Houston Texas, pp. 251-266.

Happel, A.M., E.H. Beckenbach, R.U. Halden. 1998. An Evaluation of MTBE Impacts to California Groundwater Resources. Lawrence Livermore National Laboratory, UCRL-AR-130897; Lawrence Livermore National Laboratory: Livermore, CA, 77 pp.

Hubbard, C.E., J.F. Barker, S.F. O'Hannesin, M. Vandegriendt, and R.W. Gillham. 1994. Transport and fate of dissolved methanol, methyl-tertiary-butyl-ether, and monoaromatic hydrocarbons in a shallow sand aquifer. API Publication No. 4601. American Petroleum Institute. Washington, D.C.

Integrated Science and Technology, Inc. 1996. Example report of soil vapor contaminant assessment. 1349 Old Highway 41, Suite 225. Marrietta, GA.

Johnson, P.C., Ettinger, R.A. (1991), Heuristic model for predicting the intrusion rate of contaminant vapors into buildings, Environ. Sci. Technology, 25, 1445-1452.

Kerfoot, H.B. and L.J. Barrows. 1987. Soil gas measurements for detection of subsurface organic contaminants, EPA/600/2-87/027 (NTIS PB87-174884).

Kerfoot, H.B. and P.B. Durgin. 1987. Soil-gas surveying for subsurface organic contamination: Active and passive techniques. In Superfund '87: Proceedings of the 8th national conference. Washington, D.C: The Hazardous Materials Control Research Institute.

Mace, R.E., R.S. Fisher, D.M. Welch, and S.P. Parra. 1997. Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank Sites in Texas; Bureau of Economic Geology, University of Texas at Austin, Austin, Texas.

Marrin, D.L. 1991. Subsurface biogenic gas ratios associated with hydrocarbon contamination, eds. R.E. Hinchee and R.F. Ofenbuttle. In In-Situ Bioreclamation, Stoneham: Butterworth-Heinemann.

Marrin, D.L. and H.B. Kerfoot. 1988. Soil gas surveying techniques. Environ. Sci. Tech. vol. 22, no.7: 740-45.

Marrin, D.L. and G.M. Thompson. 1987. Gaseous behavior of TCE overlying a contaminated aquifer. Groundwater, vol. 25, no. 1: 740-45.

NESCAUM. 1999. "The Health Effects of Gasoline Constituents." In: RFG/MTBE Recommendations and Findings. Northeast States for Coordinated Air Use Management. Attachment 1. August 1999. National Toxicology Program. 1999. http://ntp-server.niehs.nih.gov/NewHomeRoc/9thConsideration.html OFA. 1998. Taste and Odor Properties of Methyl Tertiary-Butyl Ether and Implications for Setting a Secondary Maximum Contaminant Level. Oxygenated Fuels Association Technical Memorandum. June 26. http://www.ofa.net/111.pdf.

OSTP 1997. Interagency Assessment of Oxygenated Fuels. Office of Science and Technology Policy. National Science and Technology Council. June.

Pankow, J.F., and J.A. Cherry. 1996. Dense chlorinated solvents and other DNAPLs in groundwater. Waterloo Press. Portland, Oregon.

Pankow, J.F., N.R. Thompson, R.L. Johnson, A.L. Baehr, and J.S. Zogorski. 1997. The Urban Atmosphere as a Non-Point Source for the Transport of MTBE and Other Volatile Organic Compounds (VOCs) to Shallow Groundwater. Environmental Science & Technology, 31: 2821-2828.

Pitchford, A.M., A.T. Mazzella, and K.R. Scarbrough. 1988. Soil-gas and geophysical techniques for detection of subsurface organic contamination, EPA/600/4-88/019 (NTIS PB88-208194). 81 p.

Reid, J.B, H.J. Reisenger, P.G. Bartholomae, J.C. Gray, and A.S. Hullman, 1999. Comparative MtBE Versus Benzene Plume Behavior, BP Oil Company Florida Facilities. Integrated Science & Technology, Inc., Marietta, Georgia. 58 pp.

Rice, D.W., R.D. Grose, J.C. Michaelson, B.P. Dooher, D.H. MacQueen, S.J. Cullen, W.E. Kastenberg, L.G. Everett, M.A. Marino. 1995. California Leaking Underground Fuel Tank (LUFT) Historical Case Analyses. UCRL-AR-122207. Lawrence Livermore National Laboratory. Livermore, CA.

Rice, D.W., W.W. McNab, P.C. Johnson, L.G. Everett, W.E. Kastenberg, M.C. Cavanaugh, S. Pelmulder, M.C Small, and R.C Ragaini. 1998. Department of Defense Petroleum Hydrocarbon Cleanup Demonstration Program Final Report: Risk-Informed Decision Making as Petroleum Contaminated Sites. UCRL-AR-131771. Lawrence Livermore National Laboratory. Livermore, CA.

Rivett, M. O., 1995. Soil Gas Signatures from Volatile Chlorinated Solvents: Borden Field Experiments. Ground Water, 33(1): 84-98.

Rixey, W.G., and S. Joshi. 1999. Dissolution Characteristics of MTBE, BTEX and 1,2,4-Trimethylbenzene from a Residually Trapped Gasoline Source, in Proceedings of the API/NGWA Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, Houston, Tex., Nov. 17-19, 1999, p., 107- 122.

Robbins, G.A., B.G. Deyo, M.R. Temple, J.D. Stuart, and M.J. Lacy. 1990a. Soil-gas surveying for subsurface gasoline contamination using total organic vapor detection instruments: Part I. Theory and laboratory experimentation. Gr. Water Mon. Rev. vol. 10, no. 3: 122-31.

Robbins, G.A., B.G. Deyo, M.R. Temple, J.D. Stuart, and M.J. Lacy. 1990b. Soil-gas surveying for subsurface gasoline contamination using total organic vapor detection instruments: Part II. Field experimentation. Gr. Water Mon. Rev., vol. 10, no. 4: 110-17.

Robbins, G.A. 1995. Accelerated field site characterization employing 'push' technologies (II) (With supplement gas chromatography section by B. Hartman). Short Course Notes, 4M Center, Univ. of Tennessee/Chattanooga.

Robbins, G.A., B. E. McAninch, F.M. Gavas, and P.M. Ellis. 1995. An evaluation of soil-gas surveying for H2 S for locating subsurface hydrocarbon contamination. Gr. Water Mon. Rev., vol. 15, no. 1: 124-32.

Roberts, N., M.E. Billa, and G.E. Furst. 1992. A phased approach to remediation of a complex site. In Proceedings of the National Ground Water Association focus conference on eastern regional ground-water issues, Columbus, OH.

Schirmer, M. and J.F. Barker. 1998. A Study of Long-term MTBE Attenuation in the Borden Aquifer, Ontario, Canada. Ground Water Monitoring & Remediation. 18(2): 113-122.

SCVWD, 1999. Summary Report, Investigation of MtBE Occurrence Associated with Operating Underground Storage Tanks, Santa Clara Valley Water District Groundwater Vulnerability Pilot Study, Santa Clara Valley Water District, Santa Clara, California, July 16, 1999. http://www.scvwd.dst.ca.us/wtrqual/factmtbe.htm.

Staudinger, J., Robers, P. (1996), A critical review of Henry's law constants for environmental applications Critical Reviews in Environmental Sci. and Tech., 26, 205-297.

Scoenleber, J.R., and Morton, P.S., New Jersey Department of Environmental Protection and Energy Field Sampling Procedures Manual, Maps and Publications Sales Office Bureau of Revenue, Trenton, NJ, 1992.

Small, M.C., and J. Weaver, 1999. An updated conceptual model for subsurface fate and transport of MTBE and benzene, in Proceedings of the NGWA/API Conference

on Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, Houston, Texas, Nov. 17-19, 1999, p. 209-220.

Stocking, A., S. McDonald, B. Woll, and M. Kavanaugh. 1999. Evaluation of Fate and Transport of Methyl Tertiary Butyl Ether (MTBE) in Gasoline Following a Small Spill, in Proceedings of the NGWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, Houston, Texas, Nov. 17-19, 1999, p. 229-244.

Suflita, J.M. and M.R. Mormile. 1993. Anaerobic biodegradation of known and potential gasoline oxygenates in the terrestrial subsurface. Environmental Science & Technology, 27(5): 976-978.

Thompson, G.M. and D.L. Marrin. 1987. Soil gas contaminant investigations: A dynamic approach. Gr. Water Mon. Rev., vol. 7, no. 2: 88-93.

Todd, D.K. 1980. Groundwater Hydrology, Second Edition, John Wiley & Sons, New York. U.S. EPA. 1993. Assessment of Potential Health Risks of Gasoline Oxygenated with Methyl Tertiary Butyl Ether. EPA/600/R-93/206, November. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C., 50 p.

Ullom, W.L. 1995. Soil gas sampling. In Handbook of vadose zone characterization and monitoring, eds.L.G. Wilson, L.G. Everett, S.J. Cullen, pp.555-67. Lewis Publishers.

U.S. EPA. 1997b. Expedited Site Assessment Tools for Underground Storage Tanks Sites. EPA 510-B-97-001. March. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. EPA. 1999a. MTBE Groundwater Clean-up Levels for LUST Sites: Current & Future. http://www.epa.gov/swerust1/mtbe/mtbemap.htm

U.S. EPA. 1999b. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Office of Solid Waste and Emergency Response Directive Number: 9200.4-17P, April 21. U.S. Environmental Protection Agency, Washington. D.C.

U.S. EPA. 1993. Subsurface characterization and monitoring techniques: A desk reference guide. Volume 2: The vadose zone, field screening and analytical methods, EPA/625/R-93/003b. Office of Research and Development, Washington, DC.

U.S. EPA. 1995. How to evaluate alternative cleanup technologies for underground storage tank sites: A guide for corrective action plan reviewers, EPA 510-B-95-007. Office of Underground Storage Tanks, Washington, DC.

Weaver, J.W., R.J. Charbeneau, J.D. Tauxe, B.K. Lien, and J.B. Provost. 1994. The Hydrocarbon Spill Screening Model (HSSM) Volume 1: User's Guide. EPA/600/R-

94/039a Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Ada, Oklahoma.

Wiedemeier, T.H., J.T. Wilson, D.H. Kampbell, R.N. Miller, and J.E. Hansen. 1995. Technical protocol for implementing intrinsic remediation with long-term monitoring for natural attenuation of fuel contamination dissolved in groundwater. U.S. Air Force Center for Environmental Excellence, San Antonio, TX.

WDOE (1997), Interim interpretive and policy statement: Cleanup of total petroleum hydrocarbons, Washington Department of Ecology, ECY97-600.

Werner, M.D. 1985. The effects of relative humidity on the vapor phase adsorption of trichloroethylene by activated carbon. Amer. Indus. Hygien. Ass. J., vol. 46, no. 10: 585-90.

Proposed Methods
Soil Samples: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo

CDM

Contents

Introduction 1
1.0 Sampling Location Identification 1

2.0 Collect and Analyze Soil Samples 3
2.1 Preparation 3
2.2 Subsurface Soil Sample Collection 4
2.3 Sample Preservation 5
2.4 Sample Handling, Storage and Transport 6
2.5 Soil Classification 6

3.0 Vertical Soil Gas Measurement 7

4.0 Recommended Analyses 8

5.0 Quality Assurance/Quality Control 9
5.1 Quality Assurance Samples 9
5.2 Equipment Decontamination 10

6.0 Reporting 10

7.0 Reading List and Sources 11

Soil Sampling: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo

This document presents a proposed method to identify potential fuel releases from underground storage tanks (USTs) by means of soil sampling and analysis.

Two general methods of analyzing soil samples exist; at the field location and at a fixed laboratory. Conventional approaches involve inserting a hollow-stemmed probe into the subsurface and "actively" removing a sample of soil. This sample is moved to a container for later analysis, or analyzed at the site using field analytical equipment. That is the approach presented here.

The proposed method consists of the following elements:

- Safe Work Preparation
- Preparing a Conceptual Model
- Identify Locations and Depths to Collect Samples
- Penetrate Surfaces
- Collect and Analyze Soil Samples
- Quality Analysis /Quality Control
- Prepare and Submit Report

For instruction about Safe Work Preparation and Preparing a Conceptual Model, see Sections 2 and 4 of "Soil Gas Survey: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo."

1.0 Sampling Locations Identification

The intent of this section is to provide guidance to select safe sampling locations that meet the objectives of the investigation process. It is not possible to safely perform soil sampling on standard grid spacing at fueling sites unless the grid is totally included in one contiguous cleared area. Safe sampling can be performed if sample locations are selected from "cleared areas" identified by site clearance methods. A cleared area is defined as an area where no underground manmade features exist and that are at least 1 meter laterally distant from an identified subsurface manmade feature.

Very small sites may be adequately characterized by no more than 6 to 14 sample points. Larger sites, such as fleet fueling stations and "truck stops" may require 15 to 18 locations or more. Adequate characterization is herein defined as the ability to detect that a release(s) exists, but not necessarily the

point source of the release. Definitive detection of a release also requires characterization of the soil contaminant as deriving from a fuel component.

Locate sample points within cleared areas of the site. Locations near or flanking underground fueling system components should be no greater than 5 meters distant. Where possible, locate down gradient sample points near any point where 2 or more elements of the fuel system join together, such as:

- Fill port to tank
- Distribution line to distribution line at corners
- Pump to fuel line at base of pump
- Tank wall to tank wall

Sample points should be located no more than 5 meters from a potential underground source (or contaminant migration pathway such as pipe chases) to adequately identify the potential for a release from that source. In fine-grained soils, a lesser spacing may be necessary. However, sample points should be located no closer than 1 meter to any underground feature identified during site clearance to allow for safe penetration, given the inherent uncertainty of the clearance process and the variation in installations.

For the purposes of this document a UST system is defined as a set of tanks and all associated equipment that contain and serve one (1) fuel type, as long as the USTs are located adjacent to one another.

Before planning the locations of contaminant detection sampling points in soils, it is necessary to at least estimate the direction(s) of groundwater flow across the site. Once the direction(s) is (are) known or estimated, then the probable direction of contaminant transport can used to update the conceptual model for more informed planning.

Once all points have been identified, it is best to start sampling at the least likely location to exhibit contamination and to move then to the next most likely, and so on.

If a soil gas survey has been performed, then it can be used as a basis (at least in part) to locate the soil sampling points. This location should be placed at the center of the greatest soil vapor anomaly that has been identified as derived from fuels. If no such anomaly exists, then the sampling point should be placed immediately down hydraulic gradient (within 5 meters and in a cleared area) of either the pump area or tank hold that has the greatest potential for a release.

At least one sampling location should be placed immediately down hydraulic gradient of each UST system on the site and as close to the UST system as safely possible (within cleared areas). Further, since UST system components may be widely dispersed across a site (for example, pumps located near one property boundary and a set of tanks located at the other end of the property) at least one sampling location should also be placed down gradient of each element of widely dispersed UST systems that are suspect for fuel releases. Such elements include (but are not limited to), pump stations and piping elbows where underground piping turns a corner. Finally, if the review of site information acquired during site clearance indicates the potential for a historical release, at least one sampling location should also be placed in the area of the suspect release.

2.0 Collect and Analyze Soil Samples

Soil sample selection process and collection procedures are covered herein. There are many types of soil sample equipment available, and only the most common method (hollow stem auger and tube sampling) is presented here.

It is necessary and common to penetrate paving surfaces in order to place the sampling device in the ground. Concrete, brick and pavement coring using a local cement coring service may be the most cost-effective, safe and least obtrusive method available. Jackhammer and other impact hammer drill methods are most likely to damage utilities immediately below a paved surface before the operator understands that there is a problem. In unpaved areas, it may be possible to penetrate surfaces by manual labor.

2.1 Preparation

Before commencement of a boring installation, the following equipment should be assembled: ice chests, labeled sample jars with lids, Teflon liners for jar lids, personal protective equipment, soil screening instrumentation, chain-of-custody forms, field log book, boring log sheet, first aid kit, and sample spatulas.

The ice chests should be checked to see that they contain a chain-of-custody form, the proper sample bottles, and ice packs. The screening instrument should be checked to see that it is calibrated and operational. A background reading should be obtained and the instrument should be zeroed each time the instrument is used.

Health and safety personnel protective equipment specified in the Health and Safety Plan should be donned before proceeding to the sample point.

Organic vapor readings taken in the breathing zone at intervals specified by the Site Manager should be used to determine if respirators are needed throughout the boring procedures, as specified by the Health and Safety Plan.

2.2 Subsurface Soil Sample Collection

Soil samples should be collected continuously from the surface to total depth, generally at the top of first ground water, the top of the groundwater table or at the top of the capillary fringe of a water table aquifer. Under most circumstances the boring should not cross the groundwater interface. It may be necessary to make an informed decision of the benefit to the project of the additional data to be acquired versus the potential risk of carrying contamination from a higher section into ground water.

All samples should be collected into glass jars (or other container as required by the analytical method), labeled and temporarily placed on ice until one sample is identified for retention and laboratory analysis. A sub-sample from each interval should be screened for volatile organic soil vapor as per the method noted below. The sample exhibiting the greatest concentration of soil gas should be retained and delivered to the laboratory for analysis. If no one subsample stands out then the sample located immediately above groundwater (or the capillary fringe if it has been identified) should be retained for analysis. All others should be disposed with other site wastes.

Sampling should be performed in advance of the drill or probe stem to reduce potential cross contamination. Samples should be taken with 3-inch diameter tubes in cohesive soils and with a 2-inch diameter split barrel sampler in non-cohesive soils. Sampling equipment should be cleaned prior to each sample collection.

Upon retrieval of the sampler, the sample should be extruded from the tube, or removed from the split barrel sampler and placed on clean aluminum foil or plastic film. The exterior portion, approximately 1/4 inch, should be trimmed off tube samples. Non-cohesive split-spoon samples should not be trimmed unless there is evidence of smear, in which case it should be trimmed. Visually contaminated or the most coarse-grained portion of each sample should be collected for analysis.

Soil samples collected for purgeable organic compound analyses should be placed into their corresponding container such that headspace left in the closed container is minimized.

The drill rig and all soil sampling tools should be steam cleaned with a high-pressure-hot water washer prior to each boring location. All steam cleaning activities should occur at a location specified by the client

Soil Samplers/Soil Sample Preparation Tools

- All soil sample barrels and soil sample preparation tools should be cleaned between samples as follows:
- Wash equipment thoroughly with laboratory detergent (Liquinox) and tap water to remove any particulate matter or surface film.
- Rinse equipment thoroughly with tap water.
- Rinse equipment thoroughly with de-ionized water.
- Rinse equipment with solvent (methanol) and allow to air dry as long as possible.

Documentation of Sample Acquisition

A key piece of information is the data on the sample acquisition. All information pertinent to field observation, surveys, and sampling will be recorded in a bound logbook. Entries in the logbook will include at least the following:

- Site location of sampling activity;
- Type of material (soil, groundwater, etc.);
- Number and approximate volume of samples taken;
- Location of sampling point;
- Date and time of collection;
- Collector's sample identification number(s);
- Field observations;
- Any field measurements made such as headspace, odor or other field parameters; and
- Weather conditions

2.3 Sample Preservation

Take care to ensure that sample containers do not adsorb contaminants onto the container, leach contaminants from the container into the sample, or otherwise change the chemical composition of the sample. Check with the laboratory that is analyzing your samples.

Sample containers may require special cleaning before use. In most circumstances, the laboratory will do this or will purchase containers that have

undergone this rigorous cleaning procedure. Either way, check with your laboratory to see if any special pre-cleaning procedures are necessary.

Preserving samples retards biodegradation reactions, hydrolysis reactions, precipitation and co-precipitation reactions and sorption reactions. Sample preservation usually involves reducing or increasing pH by adding an acid or base preservative. Non-alcohol volatile organic compounds may best be preserved by adding methanol to the container (don't do this if you suspect a fuel alcohol or "gasohol" release!). Samples are also preserved by cooling them to 4°C. Add preservatives to the container before or immediately after collecting the sample.

2.4 Sample Handling, Storage and Transport

After collecting, preserving and labeling, place the sample immediately on ice in a cooler. Samples must remain at or below 4°C throughout handling, storage and shipping. Add sufficient ice or use another cooling method to keep the samples at or below 4°C. Avoid using frozen cold packs because they rarely keep samples sufficiently cool. If you must use frozen packs, pre-cool the samples to 4°C and add a temperature blank before shipping. The laboratory will use the temperature blank to document the temperatures of the samples upon arrival.

Separate breakable sample containers (e.g., glass jars) with bubble wrap, foam, ice, etc. At least a portion of each container must contact the ice, otherwise the protective layer (e.g., bubble wrap) may insulate the sample from the cooling effects of the ice. Placing samples in a plastic bag can help minimize the chance of cross-contamination among samples should a container break.

Be conscious of analytical holding times and minimize the time between sampling and delivery to the laboratory. Results for samples analyzed after holding times have expired are questionable at best. Laboratories are required to honor holding times. When samples arrive near the end of the holding time, the risk increases that holding times will not be met and you may incur additional costs to expedite sample analyses. If the laboratory exceeds holding times, results should be flagged.

2.5 Soil Classification

A detailed geological log of the boring should be generated. This log should include information including:

- the location of the boring
- penetration rate or standard penetration resistance
- sampled intervals and percent recovery

- stratigraphic and lithologic information
- aquifers
- water-bearing zones and zones of high permeability or fracture encountered
- contamination observed
- any other drilling observations including lost circulation zones or other difficulties encountered during drilling.

Classify unconsolidated deposits on the log according to ASTM D-2487 or similar standard, and describe in detail by texture, color, mineralogy, moisture content, degree of weathering, geologic origin, and other relevant characteristics. Include a description of the classification system used with the log. Describe rock on the log according the lithology, mineralogy, color, grain size, degree of cementation, degree of weathering, density and orientation of fractures, other primary and secondary features and physical characteristics of the rock, and the rock quality designation. Descriptions should conform to ASTM C-294, or another standard system of nomenclature for rock classification. Include a description of the classification system used with the log. Submit a clear, labeled, photographic record of all rock cores if rock cores were recovered during drilling.

3.0 Vertical Soil Gas Analysis

VOC concentration in soil gas should be measured at least every 0.5 meters of penetration into the subsurface. Use the polyethylene bag headspace method described below to characterize soil contamination at potential fuel release sites. The collapse of the polyethylene bag during analysis allows uniform flow of contaminant vapors into the field instrument, giving accurate readings.

1. Use photo-ionization detectors (PID) with a 10.2 eV (+/-) or greater lamp source, oxide semiconductor total hydrocarbon detectors, or flame ionization detectors (FID). Perform PID or FID instrument calibration on site and at least daily to yield "total organic vapors" in volume parts per million (ppm) of a benzene equivalent. Follow the manufacturer's instructions for operation, maintenance, and calibration of the instrument. Keep calibration records in a bound book.

2. Use a self-sealing liter-size polyethylene freezer bag. Half-fill the bag with sample (the volume ratio of soil to air is equal), then immediately seal it. Manually break up the soil clumps within the bag.

3. Allow headspace development for at least 10 minutes at approximate room temperature. Vigorously shake bags for 15 seconds at the

beginning and end of the headspace development period. Headspace development decreases with temperature. When temperatures are below the operating range of the instrument, perform headspace development and analysis in a heated vehicle or building. Record the ambient temperature during headspace screening. Complete headspace analysis within approximately minutes of sample collection.

4. After headspace development, introduce the instrument sampling probe through a small opening in the bag to a point about one-half of the headspace depth. Keep the probe free of water droplets and soil particles. (Syringe withdrawal of a headspace sample and injection to an instrument probe or septum-fitted inlet is acceptable, provided the method accuracy is proven by means of a test gas standard.)

5. Record the highest meter response on a sampling form. Maximum response usually occurs within about two seconds. Erratic meter response may occur if high organic vapor concentrations or moisture is present. Watch for a bounce in the needle if using an older variety, since very high contaminant concentrations may read zero after a bounce in the needle. Note any erratic headspace data in the sampling form. Do not collect analytical samples from the polyethylene bag.

An alternative method for vertical soil gas collection follows:

Samples for headspace analysis should be placed in a glass jar with a Teflon-lined lid. Uniform sized jars should be used to provide for consistent headspace volumes for each sample. Approximately half of the jar should be filled with sample material. Samples should be kept out of direct sunlight. Approximate ambient temperatures should be maintained for the headspace samples. Samples should be allowed to equilibrate for at least 30 minutes and not more than 24 hours prior to headspace screening. Withdraw soil gas and analyze as described above.

4.0 Recommended Analyses

The basis of the following recommendations is that the analytical regime be sufficient to determine that impact from fuel-derived compounds exists, but not to monitor a specific compound.

Gasoline and BTEX Components
Gasoline Range organics (GRO, C1-C10) by a gas chromatography method such as EPA 8015 or international equivalent.

Diesel
Diesel Range organics (DRO, C10-C28) by a gas chromatography method such as EPA 8015 or international equivalent.

Waste Oil
C24+ range organics by a gas chromatography method such as EPA 8015 or international equivalent.

Polyaromatic Hydrocarbons (PAH) by EPA method 8270 or international equivalent.

Methanol
Methanol discrimination by direct-injection gas chromatography modified EPA 8015 method or international equivalent.

5.0 Quality Assurance/Quality Control

5.1 Quality Assurance Samples

Trip Blank
The purpose of the trip blank is to determine if any volatile samples have become contaminated with extraneous substances during storage and transport.

Trip blanks are only necessary when collecting VOC, gasoline range organics (GRO), and petroleum volatile organic compound (PVOC) samples. Trip blanks should be prepared and provided by the laboratory analyzing the VOC, GRO or PVOC samples.

Include one trip blank per sample batch, that is, at least one per sampling event and one per cooler. If you use more than one vehicle to transport the samples, or if samples are not shipped together, include one trip blank per vehicle or one trip blank per cooler. The easiest way to minimize the number of trip blanks necessary is to store, transport and ship all VOC, GRO and PVOC samples in one cooler.

Field Duplicate
A field duplicate sample is collected to determine the variability of analytical results caused by the sampling equipment and procedures used. Collect field duplicates for sensitive parameters such as VOCs, sorptive organics and trace metals.

Collect one field duplicate for every 10 or fewer samples collected. This frequency can be reduced if it is demonstrated to the satisfaction of the regulatory authority that variability in duplicate samples has been consistently low. Collect and handle the original sample and field duplicate using the same procedures; however, label them differently so the laboratory cannot tell they are duplicates; thus minimizing any potential bias. If possible, collect the duplicate and original sample from the same grab sampler.

5.2 Equipment Decontamination

Follow proper equipment decontamination procedures to minimize the potential for cross-contamination between wells and maintain data quality, refer to Section 7 of "Groundwater Samples: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo" in this appendix.

6.0 Reporting

A concise report should be issued, presenting sufficient data to allow a third party to assess the quality of the work. See Section 9.0 of "Soil Gas Survey: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo" in this appendix.

7.0 Reading List and Sources: Soil Investigations

- API. 1996a. A Guide to the Assessment and Remediation of Underground Petroleum Releases. API Publication No. 1628. American Petroleum Institute. Washington, D.C. Third Edition, July.

- API. 1996b. Natural Attenuation Processes. API Publication No. 1628A. American Petroleum Institute. Washington, D.C. First Edition, July.

- API. 1996c. Risk-Based Decision-Making. API Publication No. 1628B. American Petroleum Institute. Washington, D.C. First Edition, July.

- API. 1997b. Field Studies of BTEX and MTBE Intrinsic Bioremediation. API Publication No. 4654. American Petroleum Institute. Washington, D.C.

- ASTM. 1995b. Standard Guide for Developing Conceptual Site Models for Contaminated Sites, E 1689-95. American Society for Testing and Materials, West Conshohocken, PA.

- ASTM, 1997. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process, E1527-97. American Society for Testing and Materials, West Conshohocken, PA.

- ASTM. 1999a. Standard Guide for Accelerated Site Characterization for Confirmed or Suspected Petroleum Releases, E 1912-98. American Society for Testing and Materials, West Conshohocken, PA.

- Chamberlin, T.C. 1897. The Method of Multiple Working Hypotheses. Journal of Geology. 5(6).

- 60, Vandenberg Air Force Base, California. in Proceedings of the API/NGWA Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention, Detection, and Remediation, Houston, Tex., Nov. 17-19, 1999, p., 147-157.

- Feenstra, S., D.M. Mackay, and J.A. Cherry. 1991. A Method for Assessing Residual NAPL Based on Organic Chemical Concentrations in Soil Samples. Ground Water Monitoring Review 11(2):128-136.

- Hubbard, C.E., J.F. Barker, S.F. O'Hannesin, M. Vandegriendt, and R.W. Gillham. 1994. Transport and fate of dissolved methanol, methyl-tertiary-butyl-ether, and monoaromatic hydrocarbons in a shallow sand aquifer. API Publication No. 4601. American Petroleum Institute. Washington, D.C.

- Mace, R.E., R.S. Fisher, D.M. Welch, and S.P. Parra. 1997. Extent, Mass, and Duration of Hydrocarbon Plumes from Leaking Petroleum Storage Tank Sites in Texas; Bureau of Economic Geology, University of Texas at Austin, Austin, Texas.

- Marrin, D.L. 1991. Subsurface biogenic gas ratios associated with hydrocarbon contamination, eds. R.E. Hinchee and R.F. Ofenbuttle. In In-Situ Bioreclamation, Stoneham: Butterworth-Heinemann.

- Marrin, D.L. and H.B. Kerfoot. 1988. Soil gas surveying techniques. Environ. Sci. Tech. vol. 22, no.7: 740-45.

- Marrin, D.L. and G.M. Thompson. 1987. Gaseous behavior of TCE overlying a contaminated aquifer. Groundwater, vol. 25, no. 1: 740-45.

- NESCAUM. 1999. "The Health Effects of Gasoline Constituents." In: RFG/MTBE Recommendations and Findings. Northeast States for Coordinated Air Use

- Robbins, G.A. 1995. Accelerated field site characterization employing 'push' technologies (II) (With supplement gas chromatography section by B. Hartman). Short Course Notes, 4M Center, Univ. of Tennessee/Chattanooga.

- Scoenleber, J.R., and Morton, P.S., New Jersey Department of Environmental Protection and Energy Field Sampling Procedures Manual, Maps and Publications Sales Office Bureau of Revenue, Trenton, NJ, 1992.

- Small, M.C., and J. Weaver, 1999. An updated conceptual model for subsurface fate and transport of MTBE and benzene, in Proceedings of the NGWA/API Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water--Prevention,

- Ullom, W.L. 1995. Soil gas sampling. In Handbook of vadose zone characterization and monitoring, eds.L.G. Wilson, L.G. Everett, S.J. Cullen, pp.555-67. Lewis Publishers.

- U.S. EPA. 1997b. Expedited Site Assessment Tools for Underground Storage Tanks Sites. EPA 510-B-97-001. March. Office of Solid Waste and Emergency Response, U.S.

- U.S. EPA. 1993. Subsurface characterization and monitoring techniques: A desk reference guide. Volume 2: The vadose zone, field screening and analytical methods,

- Weaver, J.W., R.J. Charbeneau, J.D. Tauxe, B.K. Lien, and J.B. Provost. 1994. The Hydrocarbon Spill Screening Model (HSSM) Volume 1: User's Guide. EPA/600/R-94/039a Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Ada, Oklahoma.

Proposed Methods
Groundwater Samples: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo

CDM

Appendix C

Contents

1.0 Scope **1**

2.0 Task 1—Collecting Background Data **1**

3.0 Task 2—Clearing the Site for Safe Work **2**

4.0 Task 3—Determining Sample Points **2**
- 4.1 Characterizing Groundwater Flow Gradient 3
  - 4.1.1 Equipment and Procedures 5
- 4.2 Locating Sampling Points 6

5.0 Task 4—Advancing and Sampling Borings **7**
- 5.1 Geologic Log 7
- 5.2 Vertical Soil Gas Measurement 8

6.0 Task 5—Monitoring Well Construction **8**
- 6.1 Assembly and Installation 11
- 6.2 Well Development 13
- 6.3 Well Surveying 14

7.0 Task 6—Groundwater Sample Collection and Analysis **14**
- 7.1 Sampling Equipment for Constructed Monitoring Wells 14
- 7.2 Sample Collection 18
  - 7.2.1 Filling Sample Containers 18
  - 7.2.2 Sample Preservation and Handling 20
  - 7.2.3 Quality Assurance/Quality Control 21
  - 7.2.4 Decontamination Procedures 23

8.0 Direct Push Techniques for Sampling Groundwater **24**
- 8.1 Introduction to Direct Push 25
- 8.2 Collecting Groundwater by Direct Push Methods 26
- 8.3 Quality Assurance/Quality Control 30

9.0 Recommended Laboratory Analysis to Detect Fuel-Derived Contamination **31**

10.0 Task 7--Reporting **34**

11.0 Reading Guide for Groundwater Sampling and Analysis **37**

Groundwater Sampling: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo

This document presents a method to identify potential fuel releases from underground storage tanks (UST) through groundwater sampling. Under this method, monitoring wells shall be constructed at appropriate locations. Both conventional and direct-push alternatives to standard monitoring wells are presented, and sample collection and preservation are discussed. Finally, methods are proposed to identify the presence of fuel-derived components in groundwater.

1.0 Scope

The proposed method consists of the following tasks, to be executed in order, as follows:

- Collecting Background Site Data
- Clearing the Site for Safe Work
- Determining Sampling Points and Penetrating Surfaces
- Advancing and Sampling Borings
- Constructing and Purging Monitoring WellsCollecting and Analyzing Groundwater Samples
- Reporting

2.0 Task 1 - Collecting Background Site Data

Interviews should be conducted of knowledgeable parties at each site. Information requested may include:

- A site construction history
- A site fueling history
- Major improvements, demolitions and renovations
- Site drainage
- Current fueling schedules
- Current tanks and lines status
- An overview of the fueling system
- Any release episodes and responses and reports

- Health and safety requirements and suggestions
- Site construction and layout plans
- Fueling system schematics

A data search and review should be conducted to determine the gross geologic and hydrogeologic characteristics of the site. Data reviewed may include:

- Topographic And Floodplain Maps
- Hydrologic Basin Maps
- Geologic Maps
- Surface Hydrology Maps
- Aquifer Maps
- Water Supply Well Data
- Previous Investigation Reports

3.0 Task 2 – Clearing the Site for Safe Work

Site utility clearance should be performed. It consists of:

- Reviewing the data gathered in the site interviews
- Constructing or modifying site plans
- Physically inspecting the site and identifying all underground manmade features
- Plotting the underground features on the site plan
- Reviewing the site plan with knowledgeable site personnel and correcting, supplementing as necessary

4.0 Task 3 – Determining Sampling Points

Determination of the number and locations of sample points should be based upon 1) characterizing the gross direction and gradient of groundwater flow, and 2) making a reasonable effort to determine that on-site fuel releases have impacted first groundwater. Groundwater gradient estimates at very small sites may be made using no more than 3 measurement points. Larger sites, such as fleet fueling stations and "truck stops" may require 3 to 5 locations. Reasonably determining the presence or absence of fuel-derived compounds in groundwater requires additional characterization points, ranging from a minimum of three locations for small sites, to as many as 15 for large sites. The duration of work on site should range from 2 to 14

days, depending upon the size and complexity of the site and other site conditions. In general, normal site operations may proceed with minimal interference.

Background wells should be installed to allow determination of the quality of groundwater that has not been affected by leakage from a UST system. A determination of background quality may include sampling of wells that are not hydraulically up gradient of the UST system if hydrogeologic conditions do not allow the owner or operator to determine which wells are hydraulically up gradient or if sampling at other wells will provide a better indication of background groundwater quality than is possible from up gradient wells.

The down-gradient monitoring system should be installed to ensure the detection of groundwater contamination in the uppermost aquifer. When physical obstacles preclude installation of the groundwater monitoring wells at existing units, the wells may be installed at the closest practicable distance hydraulically down gradient that will ensure detection of groundwater contamination of the uppermost aquifer.

Do not install monitoring wells in locations where they are subject to periodic or seasonal inundation by onsite operations, severe rainfall, or floodwaters, unless the top terminal casing height is at least 0.6 meters above the expected level of highest surface runoff (for example, 100-year flood elevation) or special watertight construction is used.

4.1 Characterizing Groundwater Flow

For all sites, the general stratigraphy of the site and the depth to first groundwater should be known before establishing measurement points. This means that it may be necessary to perform a boring or excavation to record site stratigraphy, hydrostratigraphy and lithologies before characterizing groundwater.

For small sites (<=2,000 m^2) three measurement points should be located within cleared areas of the site. They should be as widely separated as possible, should be located in areas where there is no floating product, and should be well protected from casual contact. For smaller sites that are flat, it is extremely important that 1) the wells are at least 20 meters apart (so that a change in potentiometric surface can actually be observed and recorded), 2) the well screens cross the potentiometric surface, and 3) the well screens do <u>not</u> cross aquitards, however thin. These requirements imply that in some cases the consultant will have to set a well outside a property boundary, and the consultant may have to perform aquifer testing at one point to establish the hydrostratigraphy before planning the groundwater monitoring network.

For larger sites (>2,000 m^2) it is first necessary to perform a review of the site geology, hydrology, surface topography, drainage systems, the conceptual model and any other applicable information to make an estimate of the expected topography of the first groundwater surface. If it can reasonably be expected that groundwater is planar throughout the site, then 3 locations are sufficient. However, if there is any indication that a groundwater divide (no matter how small) exists, then three measurement

points are necessary per planar surface. For example, if the site is bounded by two parallel drainage ditches that intercept first groundwater, there may be a groundwater divide under the site. The consultant should make an estimate of the probable location and direction of the divide and establish monitoring points that will allow at least three measurements per expected planar surface.

The procedure for collecting accurate water level measurements includes:

1. Measure the static water level for a well before purging, sampling or inserting any instrument or device into a well. If a well is purged, sampled, or a device is inserted into a well before measuring the static water level in the well, the measurement will not represent the static "undisturbed" water level or hydraulic head existing in the well.

2. Collect measurements from all wells on the site as quickly as possible. The best method is to collect measurements from all of the site's wells before doing any other tasks on the wells. This may be impractical and too time consuming for some sites. Typically, a water level measurement is taken and then the well is sampled. This method is acceptable if you collect all water level measurements at a site on the same day and the barometric pressure for that day does not change significantly (e.g., changing high or low pressure, advancing storm, etc.,). If the barometric pressure does change significantly during collection, a second round of measurements may be appropriate.

3. Collect measurements in the order of least-to-most contaminated wells. Decontaminate the measuring device between each well to prevent cross-contamination. Do not let any parts of the instrument or tape touch the ground or any contaminated surface.

4. Read measurements from the top of the casing or a reference elevation on the well. This is usually a permanently and clearly marked spot located at the highest point on the top of the well casing. All top-of-casing or reference elevations must be surveyed to a common point of known elevation so that the water level measurements can be converted to groundwater level elevations, usually expressed as meters above mean sea level (MSL) or as compared to a datum. Water level measurements must be accurate and precise to 0.25 cm (0.01 ft).

5. Whenever possible, use one measuring device and one person operating it for all wells at a site during each sampling event. Better yet, use the same measuring device and same person for all wells at a site over the life of a project. This will help ensure that water level data are accurate and comparable. If more than one measuring device is used, check both instruments against a calibrated standard, the same well, and against each other to ensure that they provide the same water level measurements. If necessary, use a correction factor to equalize the readings. Do this after checking each device to determine which tape length is correct.

6. After removing a water/air-tight well cap, allow the pressure within the well to stabilize. This is necessary because water/air-tight well caps do not allow the water level in the well to equalize with the ground surface atmospheric pressure as long as the well cap is in place. This is especially important for wells screened in silt and clay (low permeability) formations. Take several measurements spaced several minutes apart to confirm that the water level in the well has stabilized.

4.1.1 Equipment and Procedures

Equipment and procedures used for taking water level measurements vary substantially. Choose water level measuring devices based on their accuracy, precision, ease of use, reliability, durability, ease of decontamination and cost. Under most circumstances water level measurements should be read to the nearest 0.01 ft (0.25 cm) to be of any real use.

Water level measuring devices typically are either manual, non-recording devices or continuous measuring devices that provide a paper or electronic record of changing water levels over time. Although not exhaustive, the following discussion describes equipment and methods frequently used by groundwater professionals.

Electronic Methods
These devices commonly operate by completing a circuit between two electrodes housed in a probe. When the electric probe contacts a water surface, a light, amperage gauge, or buzzer signals the operator that the probe has intersected a water surface. Most of these devices are manually operated, non-recording devices. The operation of other electrical methods relies on such physical characteristics as resistance, capacitance or self-potential to produce a signal (Dalton et al., 1991).

Probably the most commonly used electrical method is the electronic water level indicator. This device may be subject to measurement errors due to the probe contacting condensation on the inside wall of a well's casing or electrical problems with the device. If there is a substantial layer of floating hydrocarbons (i.e., immiscible layer) in a well, you cannot reliably make a water level measurement. Other potential sources of measurement errors include kinks in the cable, inaccurate gradation, or the banded measuring marks on the cable becoming loose and sliding. Check the measuring cable for proper length and gradation at least quarterly against a steel tape or some other accurate means of length calibration. Also, regularly check batteries and electrical connections. You may want to bring along another device (e.g., popper) as backup in case the electric method malfunctions.

Poppers
A simple device known as a "popper" is a quick, inexpensive and commonly-used method for measuring the water level in a well. This device is also a manually-operated, non-recording method.

To take water level measurements with this device, you lower the popper into the well until you hear a "pop" sound. This indicates that you've reached the water

surface. By repeatedly raising and lowering the popper onto the water surface and listening for the "pop" sound, you determine the depth to water. Some practice is required to determine at what point the popper contacts the water surface. The precision and accuracy of this technique highly depend on the user's skill and the well's depth (more accurate for shallow wells). You may also use the popper for measuring well depth by lowering it through the water column until the tape slackens. Slowly pull the tape up until it just becomes taut again; this is the well depth.

When a popper is connected to a tape, no length corrections should be necessary (i.e., depth to water measurements can be measured directly without adding or subtracting the length of the popper). Steel tape is recommended over flexible tape. Flexible tape can stretch and therefore should be calibrated quarterly against a known length standard. A high-quality steel tape or metallic monuments anchored in concrete are acceptable calibration methods.

Although simple and inexpensive, the popper method is prone to errors and measurement difficulties. If the water table intersects the well screen, if the well has high gas content, or if the well is near a noisy area, the "pop" may be difficult to hear. Wet tape, especially wet flexible (non-steel) tape, may stick to the well casing making it difficult, if not impossible, to collect accurate measurements. Floating hydrocarbons in a well may also interfere with collecting accurate measurements.

4.2 Locating Sampling Points to Detect Groundwater Contamination

For the purposes of this document a UST system is defined as a set of tanks and all associated equipment that contain and serve one fuel type, as long as the UST are located adjacent to one another.

Once the direction of groundwater flow across the site has been established, at least one monitoring well should be located at a point that allows background water quality to be determined. Background wells should be installed to allow determination of the quality of background groundwater that has not been affected by leakage from a UST system. This location is often the most up gradient point where a monitoring well can safely located on the property. However, in the event that it is known or suspected that there is no suitable point on the property it may be necessary to place a monitoring well outside property boundaries. A determination of background quality may include sampling of wells that are not hydraulically up gradient of the UST system if hydrogeologic conditions do not allow the owner or operator to determine which wells are hydraulically up gradient or if sampling at other wells will provide a better indication of background groundwater quality than is possible from up gradient wells.

At least one monitoring well should be placed down gradient of each UST system on the site. Thus a site that serves diesel, gasoline and methanol should be characterized by at least one background well and no less than three down gradient monitoring

wells. Further, since UST system components may be widely dispersed across a site (for example, pumps located near one property boundary and a set of tanks located at the other end of the property) at least one monitoring well should also be placed down gradient of each element of widely dispersed UST systems that are suspect for fuel releases. Such elements include (but are not limited to), pump stations and piping elbows where underground piping turns a corner. Finally, if the review of site information acquired during site clearance indicates the potential for a historical release, at least one monitoring well should also be placed in the area of the suspect release.

The down gradient monitoring system should be installed to ensure the detection of groundwater contamination in the uppermost aquifer. When physical obstacles preclude installation of the groundwater monitoring wells at existing units, the wells may be installed at the closest practicable distance hydraulically down gradient that will ensure detection of groundwater contamination of the uppermost aquifer. Given the density of underground features at most sites, care should be taken to locate the monitoring well in a cleared portion of the site, no closer than one meter to a potential source, and within five meters if possible.

5.0 Task 4 – Advancing and Sampling Borings

Monitoring wells are constructed in borings advanced from the ground surface to a depth at which the water table can be intercepted within the well screen. As borings advance and soil is removed, a person experienced in the practice of geology should describe the soil. Vertical soil gas contaminant concentrations should be measured, described, and plotted on the geologic log of the boring. Concrete and other pavement surfaces should be penetrated by coring, jackhammer, and rotary hammer or impact hammer methods. A cement coring service may be the most cost-effective, safe and least obtrusive method available.

5.1 Geologic Log

A detailed geological log of the monitoring well should be generated which includes information on the location of the well, penetration rate or standard penetration resistance, sampled intervals and percent recovery, stratigraphic and lithologic information, aquifers, water-bearing zones and zones of high permeability or fracture encountered, contamination observed, and any other drilling observations including lost circulation zones or other difficulties encountered during drilling.

Classify unconsolidated deposits on the log according to ASTM D-2487 or similar standard, and describe in detail by texture, color, mineralogy, moisture content, degree of weathering, geologic origin, and other relevant characteristics. Include a description of the classification system used with the log. Describe rock on the log according the lithology, mineralogy, color, grain size, degree of cementation, degree of weathering, density and orientation of fractures, other primary and secondary features and physical characteristics of the rock, and the rock quality designation. Descriptions should conform to ASTM C-294, or another standard system of

nomenclature for rock classification. Include a description of the classification system used with the log. Submit a clear, labeled, photographic record of all rock cores if rock cores were recovered during drilling.

5.2 Vertical Soil Gas Analysis

Soil gas should be analyzed for potential contaminants at least every 0.5 meters of penetration into the subsurface. For instruction on vertical soil gas analysis, see Section 3.0 of "Soil Samples: Collection Methods and Potential Release Determination for Underground Storage Tank Systems in São Paulo" in this appendix.

6.0 Task 5 - Monitoring Well Construction

Monitoring wells are constructed in borings. The construction methods used can strongly influence the results of any measurement or sampling episodes. Thus, great care should be taken to properly construct a monitoring well for the task.

The primary materials commonly used in monitoring well construction are the drilling tools and equipment, casing, riser pipe, well screen, centralizers, annular sealant, filter pack, and drilling fluids or additives. 2- or 4-inch diameter schedule 40 PVC is standard in construction of well screens and risers. All PVC pipes should be threaded due to the volatile organic compounds contained in PVC glues, which could contaminate the system. In cases of monitoring for non-aqueous-phase liquids (NAPL) or contaminants of high concentration that react with PVC, stainless steel should be used in place of PVC. The integrity of these materials should be of sufficient size and strength in order to meet the objectives of the monitoring point. All materials used in the construction of a monitoring well must be free of any contaminants during storage, assembly, and installation that could affect the monitoring of the groundwater system.

6.1 Assembly and Installation

Construct monitoring wells in such a manner as to protect against loss of integrity by soil erosion, soil settlement, shrink-swell soil conditions, damage by vehicles or heavy equipment, and/or other site-specific hazards. Secure monitoring wells against unauthorized entry with appropriate locking devices.

The equipment and technique to construct a monitoring well borehole must be able to provide a stable environment in which to insert the well. The borehole must be open and vertical, while still maintaining the integrity of the surrounding zone to be monitored. To insure proper installation, a professional should be consulted or used. The two major drilling procedures used in monitoring well installation are hollow stem augers or rotary-drills. The well screen and riser are lowered directly within the hollow stem during a hollow stem auger installation. During a rotary-drilled well installation, potable water must be employed to dilute drilling mud to ensure ease of installation. When feasible, drilling procedures that do not introduce water or other liquids into the borehole should be used. If the introduction of drilling fluids such as

air, water, or gas cannot be avoided safety precautions must be used to avoid contamination of the zone to be monitored.

Boreholes, hollow-stem auger flights, or permanent or temporary surface casing should have a minimum inside working diameter at least four (4) inches larger than the outside diameter of the well casing and screen, to ensure that (1) casing and screen can be properly centered in the borehole, (2) the filter pack and annular seal are of sufficient thickness, (3) there is sufficient working room for a Tremie pipe to be properly used in the well, and/or (4) filter pack and annular seal materials can be poured into the well without causing bridging in the annulus or binding of the well casing or screen when auger flights or temporary casing are withdrawn from the well. Therefore, for 2-inch and 4-inch nominal diameter well casings, the borehole, auger or casing used should have a nominal inside diameter of 6 and 8 inches, respectively. Level the drilling machine prior to drilling, to ensure that the borehole is plumb with respect to the vertical. Recheck leveling frequently during drilling. Employ drilling practices that produce the straightest possible borehole during drilling. For rotary drilling, for example, this requires selection of the appropriate drill bit, drill collars, rotating speed, and weight on the drill bit for the materials being penetrated. For cable tool drilling, this requires selection of the appropriate drill bit, drill stem, stroke length and stroke rate for the materials being penetrated.

After the screen and riser have been positioned, the filter pack is placed from the base of the well to between 1-2 feet above the top of the well screen. The filter pack should consist if well rounded silica sand. Filter pack grain size should be decided upon based on the distribution of the surrounding aquifer's grain size. After the filter pack is set, the well must be sealed to the ground surface to prevent contamination from the surface or water-bearing zones above the well screen down the borehole. bentonite is placed on top of the filter pack 1-2 feet thick to protect the filter pack from invasion of grout. The grout completes the seal from the top of the bentonite to the top of the ground surface. Finally, protective casing and locking well caps must be installed to insure that the monitoring well is protected from vandalism and accidental damage.

Decontaminate all equipment that will be placed in the borehole on-site prior to use, and again between boreholes. Decontamination methods include steam cleaning, high-pressure hot water washing, detergent washing followed by thorough rinsing with potable water, and/or other appropriate methods. Include decontamination of internal plumbing of the drilling equipment, and any other items, that will contact potentially contaminated materials. To the extent possible, plan drilling activities to proceed in order from the least to the most potentially contaminated locations; therefore, drill up gradient wells first.

Use permanent or temporary casing during well drilling and construction in cases where contaminated groundwater could migrate through the borehole into uncontaminated water-bearing zones, or where the formations penetrated have a

tendency to slough or cave into the borehole and affect filter pack and annular seal placement or integrity.

In cases where monitoring wells are to be installed in a deeper water-bearing zone separated from a shallow contaminated zone by a low permeability confining layer, set and grout permanent or temporary surface casing into the confining layer prior to drilling into the deeper zone.

Take every appropriate precaution during drilling to avoid introducing contaminants related to drilling into the borehole. Do not use drilling mud or gel, synthetic drilling fluids, petroleum-or metal-based pipe joint compounds, or other potential contaminants unless necessary. Equip air-drilling systems with in-line air filters in good working order to remove compressor oils entrained in the air stream. Use only potable water if it is necessary to add water to the borehole during drilling. Identify the source of the water in the drilling report. Provide a chemical analysis of the drilling water, if requested.

High-yield powdered sodium bentonite clay gel, free of organic polymers, mixed with potable water, is the preferred drilling fluid if it is necessary to add drilling fluid to the borehole during drilling to stabilize the hole or control downhole fluid losses. Air drilling systems may require the use of alternative drilling fluid additives, such as foaming agents.

Properly manage and dispose of any contaminated drill cuttings or water removed from the borehole during drilling. Document the method of cuttings and water management and disposal in the well construction report

Seal casings with caps. Vent casing caps to allow for pressure equalization, unless watertight construction is required. Install well screen in all monitoring wells. Use factory-fabricated screen (i.e. machine slotted or wire-wrapped). Do not use hand cut screen (i.e. hack saw or torch slotted). Select a screen slot size that is compatible with the grain size of the filter pack (e.g. the screen should be capable of retaining at least ninety (90) percent of the filter pack). Consider site stratigraphy, water table variations, saturated thickness of the water-bearing zone, groundwater flow patterns and velocity, expected contaminant behavior, and monitoring objectives when selecting the screen composition, length, and position.

Use bottom caps or end plugs on all monitoring well casing and screen assemblies. Use of a bottom cap with a bail handle may make retrieval of the casing and screen assembly easier when the well is decommissioned. In some instances, use of a tail pipe or sediment sump at the base of the well may be appropriate. Joints, caps, and end plugs must be watertight and secured by welds, threads, or force fittings. Do not use solvents, glues or adhesives for casing or screen assembly.

Clean all well screen and casing thoroughly on-site before installation in the well by steam cleaning, high-pressure hot water washing, detergent washing followed by

thorough rinsing with potable water, and/or other appropriate methods, unless delivered to the site in sealed packaging with documentation from the manufacturer that appropriate decontamination was performed prior to shipping. Center all well screen and casing in the borehole. Use casing centralizers as necessary to center the well assembly in the borehole. At a minimum, use one casing centralizer at the bottom of the screened interval in each well to ensure proper positioning of the screen and filter pack with respect to the borehole wall. In most cases, a second casing centralizer should also be installed at the top of the screened interval, unless use of a centralizer in this location significantly increases the potential for bridging of the filter pack during placement.

Suspend the casing and screen in the borehole under slight tension during placement of the filter pack and annular sealing materials to improve plumbness and centering of the casing in the borehole.

The filter pack is the primary barrier preventing particulate matter such as fine-grained sands and silt from the screened formation from entering the well; therefore, extreme care must be taken in the selection of materials for the filter pack, and in filter pack installation and development. Use clean, chemically inert, well-rounded, siliceous material for the filter pack surrounding the well screen. Do not use filter fabrics in conjunction with, or in place of, filter packs. Choose a filter pack material that will (1) minimize the amount of fine-grained sediment entering the well, (2) allow for proper well development, (3) not inhibit the inflow of water to the well, and (4) not affect the chemistry of water samples taken from the well. Do not extend the filter pack more than three (3) feet above the top, or one (1) foot below the bottom of the well screen. Prior to filter pack placement, calculate the volume of filter pack material required. Record calculated and actual volumes used, and report these volumes in the Well Construction

Base the grain size of the filter pack placed in wells screened in water-bearing zones composed of non-cohesive granular materials upon a representative sieve analysis of the formation materials opposite the well screen. Choose a filter pack material with a d-30 grain size (30 percent passing) 4 to 6 times larger than the d-30 grain size of the finest formation materials screened, and a uniformity coefficient of 2.5 or less. Use a multiplier of 4 for fine-grained, uniform, poorly graded or well sorted formation materials, and a multiplier of 6 for non-uniform well graded or poorly sorted materials. Alternatively, choose a filter pack material with a d-50 grain size two (2) times larger than the d-50 grain size of the finest formation sample. Selection of filter packs is discussed in more detail in (Aller, et al.,1989) and (Driscoll, 1986).

Alternative methods of selecting filter pack materials may be necessary if the well is screened in consolidated rock or in very fine-grained sands or silty formations. Place the filter pack material through a Tremie pipe in order to ensure positive placement opposite the well screen without bridging or size segregation of the filter pack material. If the fluid level in the well is within about 10 feet of the top of the well

screen, set the Tremie pipe above the fluid level, to avoid plugging of the Tremie pipe during filter pack placement.

If the fluid level in the well is greater than about 10 feet above the top of the well screen, the Tremie pipe may need to be set deeper than the fluid level, and placement of the filter pack through the Tremie pipe may require the use of water to wash the filter pack through the pipe.

If water is used for filter pack placement, use only potable water, and record the source and volume of water used. Identify the source of the water in the drilling report. Provide a chemical analysis of the water if requested. Recover a volume of water at least equivalent to the volume of water used to place the filter pack by pumping or bailing the well during filter pack placement and/or subsequent well development.

If augers or temporary casing are used and the well is less than 15 meters deep, the filter pack may also be installed by slowly and carefully pouring the filter pack material into the annular space. Slowly withdraw the augers or casing as the filter pack rises in the well annulus. Sound the top of the filter pack frequently during placement and following installation, to ensure that the filter pack is not bridging in the annulus, and to document final placement depth. Develop the well by surging, bailing or pumping during placement of the filter pack, to improve initial settlement of the filter-pack and reduce the possibility of creating a void space in the annulus between the filter pack and the annular seal during subsequent well development.

The filter pack seal prevents infiltration of grout slurry into the filter pack. The filter pack seal consists of a two-foot thick fine-grained sand cushion overlain by a three-(3) foot thick bentonite seal, placed in the annulus above the filter pack. For the sand cushion, use sand with a d-50 grain size two to three times finer than the d-50 grain size of the filter pack material, but no coarser than 20 mesh (0.833 millimeters). Sound the top of both the sand cushion and the bentonite seal following installation to check for proper placement. If grout slurry will be used to seal the annular space, and bentonite chips or pellets are used for the bentonite seal, allow the bentonite seal to hydrate for at least two hours prior to placing the annular seal, to prevent invasion of the filter pack by the grout slurry.

The annular seal is the primary safeguard against movement of water or contaminants from the surface into a monitoring well, or movement of water or contaminants between water-bearing zones penetrated during drilling of the well; therefore, extreme care must be taken in the selection of materials for the seal, and in seal installation. Seal the entire annular space from the top of the bentonite seal to the bottom of the surface seal. Leave temporary casings or auger flights in the hole prior to grouting to prevent caving of the borehole or vertical migration of contaminants within the borehole. Withdraw temporary casing or augers slowly as the well is backfilled with grout.

Allow the annular seal to set for at least 24 hours prior to installing the security casing and surface seal. Any settlement of the annular seal should be topped off before installing the security casing and surface seal.

Install locking, watertight, unvented caps on the well casings in flush-mounted installations. Flush mounted security casings must be installed through an impervious surface such as asphalt or concrete. If an impervious surface does not exist, one must be constructed, with a recompacted subgrade that will support the maximum traffic loads in the area, and sloped to allow water to drain away from the well in all directions.

6.2 Well Development

Well development removes the fine-grained material to improve the hydraulic efficiency of the well. Hydrologic efficiency is achieved when a large fraction of the fine materials from both the filter pack and aquifer material adjacent to the borehole no longer clog the pump or well screen.

There are several different methods of well development that include mechanical surging with bailing or pumping, over pumping, airlift pumping, and jetting. This procedure should be slow and systematic in order to prevent the movement of more material than the development method can effectively remove. In most cases, well development is site specific and can vary based on soil property, well location, and well type. In general, once the pH is stabilized the well can be used for monitoring the site.

Develop wells as soon as possible after construction, but no sooner than 24 hours after placing the annular seal. Develop the entire vertical screened interval using surge blocks, bailers, pumps, or other equipment that frequently reverses the flow of water through the well screen and prevents bridging of formation or filter pack particles. Do not introduce non-formation water into the well during development. If air-lift pumping techniques are use for well development, the preferred air lift pumping method contains the air within an eductor line and thus prevents air from entering the well screen or filter pack. If air is introduced into the screened zone of the well, air development should be followed by a period of pumping or bailing of sufficient duration that all oxygenated water near the well bore is removed as documented by measurements of dissolved oxygen and/or related geochemical measurements. Development should not disturb the annular seal or the formations above the water-bearing zone, or damage the well. Special development techniques that minimize agitation and disturbance of the formation materials may be required in monitoring wells which screen very fine-grained sands or silty formations.

Development is considered complete only when all water introduced during drilling plus a minimum of 5 to 10 well bore volumes have been removed from the well, or the water is chemically stable, and is as free of sediment as possible. During development, remove at least 5 well bore volumes from wells completed in fine-grained strata such as silty or clayey sands, or silts (ASTM Groups SM, SC, ML) with

estimated hydraulic conductivities less than 10-3 centimeters per second (cm/sec). Remove at least 10 well bore volumes from wells completed in coarse-grained strata such as sands, gravels, or mixtures of sand and gravel (ASTM Groups SP, SW, GP, GW) with estimated hydraulic conductivities greater than 10-3 cm/sec.

Water produced from the well is considered chemically stable when field parameters (pH, temperature, specific conductance, Eh or dissolved oxygen) remain within 5 percent of the previous measurement for at least 3 successive borehole volumes. Water produced from the well is considered free of sediment when water produced is clear and/or has a total suspended solids content of less than 100 milligrams per liter (mg/L) for at least 3 successive borehole volumes.

6.3 Well Surveying

Survey the location, elevation of the land surface, and the elevation of the top of the casing of each well. The location survey should have a horizontal accuracy of 15 cm, the land surface elevation should have a vertical accuracy of 3 cm, and the top of well casing elevation should have a vertical accuracy of 0.3 cm. Provide latitude-longitude coordinates for the well, accurate to the nearest one-tenth of a second. Mark the well casing with a permanent reference point for water level measurements, such as a notch filed in the top of the casing or other similar recognizable and labeled mark.

7.0 Task 6 – Groundwater Sample Collection and Analysis

Several water quality parameters are subject to rapid alteration (caused by aeration, oxidation and the loss or gain of dissolved gasses) when groundwater is removed from a well and exposed to oxygen and atmospheric pressure. Water quality measurements that may be subject to rapid change include, but are not limited to, specific conductance, pH, dissolved oxygen, Eh and alkalinity.

Take water quality measurements while purging, using a closed flow-through cell and parameter-specific monitoring probes. Using a down-well measuring probe is also recommended; however, well water must be flowing past the probe during measuring (i.e., the probe is near pump inlet during purging or you lower and raise it in the water column as you measure). These two methods minimize any contact between groundwater and atmospheric conditions (air and pressure), thus limiting any alteration while you are measuring. If you cannot use either of these methods, take water quality measurements immediately after collecting a sample.

7.1 Groundwater Sampling Equipment for Constructed Monitoring Wells

Sampling equipment for drawing groundwater from constructed monitoring wells includes, but is not limited to, bailers, syringes, and hand pumps.

Bailers

Two common styles of bailers include the single check valve or "standard" bailer and the dual or double check valve bailer, also known as the point-source bailer. Point-source bailers may reduce mixing of the sample with the water column as the bailer is removed from the well.

We recommended: 1) using a bailer equipped with a bottom-emptying device or a low-flow pump for collecting VOC samples from monitoring wells; 2) using a bailer at sites where wells are not easily accessed; 3) using a bailer for sampling on days below freezing; and 4) using a dedicated system if a low-flow pump is used to collect samples. On average, it took four times longer to collect samples with the portable low-flow pump than with the portable bailer: The portable low-flow pump is heavier and bulkier; includes more equipment and accessories (e.g., power source, pump and sample tubing, flow-through cell, etc.), and takes longer to set up, decontaminate and dismantle.

A bailer is essentially a hollow rigid tube that fills from the bottom up as you lower it into the water column. A bailer is attached to a line or cable and slowly lowered into the water column. Slowly lowering and raising the bailer is essential to minimize sample turbulence, agitation, degassing, aeration and turbidity. NEVER let a bailer free-fall into the water and NEVER rapidly raise the bailer out of the water column! These activities severely agitate the samples collected from the well. In addition, these activities may over-develop the well or damage the well's filter pack.

After slowly raising the bailer out of the water column, lift it straight up and avoid banging it against the casing wall. To accomplish this, you can place a tripod and pulley over the well or use vertical hand-over-hand lifting. The bailer lifting method known as "helicoptering," or grabbing the rope with alternating horizontal hands, causes the bailer to bounce from side to side within the well casing. This can cause sample agitation, the gain or loss of dissolved gasses in the sample, and loss of VOCs by volatilization.

To avoid sample aeration, use a bottom emptying device when decanting samples from a bailer. Pouring the sample from the top of a bailer is unacceptable under most circumstances due to excessive sample agitation and aeration.

Advantages of bailers

- Can be constructed of almost any material.
- Relatively inexpensive to purchase or construct.
- Simple to operate and durable with few parts to break.
- No depth or well diameter limitations.
- Light, portable and easy to disassemble and decontaminate in the field.
- Requires no power source or controller box.
- Ideal for collecting samples on days when the temperature is below freezing.

Limitations of bailers

- May lose VOCs or alter redox-sensitive samples.
- May artificially mobilize colloids and particulates near the well screen during its operation.
- Sample quality highly depends on the skill and care of the bailer's operator.
- Time consuming and labor intensive, especially for deep wells and wells requiring purging of many well volumes.
- Check valve ball may leak when collecting silt- or sand-laden samples.
- Direct, in-line filtration is possible but may be time consuming.
- Heavy use of a bailer may cause the bailer's surface materials to become rough and scratched, which makes it difficult to properly decontaminate the bailer.

Syringe Samplers

A variety of designs for syringe samplers are available on the market. Most work with a moveable plunger, piston, or float mechanism operated mechanically, pneumatically or by hydrostatic pressure. Common materials used in the construction of syringe samplers include flexible tubing, stainless steel ballasts and tubes and PVC or polyethylene syringe chambers. As with any other sampling device, make sure that the design, operation and material of the device do not adversely affect the samples being collected.

Syringe samplers function much like a medical syringe. After you lower the device into a well's water column, a plunger or piston is pulled up either mechanically or pneumatically, thus allowing water to enter the lower sample chamber. After the piston rises to the top and the sample chamber is full of water, pull the device to the surface and decant it into sample containers.

Modifications to the syringe sampler allow it to become a simple syringe pump. It is, therefore, no longer a grab sampler. Alternating vacuum and pressure drive the piston or plunger up and down. The intake port may be faced upward to ensure that any gas in the sample chamber is released before sample collection. A pair of check valves, one below the sample intake and one on the sample line, allows the sample to be drawn in under vacuum and then flow to the surface through a separate line after pressure is applied to the piston. The main advantage of the syringe pump over the syringe sampler is that the pump allows you to collect unlimited sample volume without pulling the device from the well.

Advantages of syringe samplers

- Can be made of a wide variety of readily available materials.
- Relatively inexpensive to purchase or construct.
- Usually simple to operate and requires little operator training.
- Most have no depth limitations.
- Effective at collecting depth-discrete samples.

- Light and portable and usually easy to decontaminate in the field.
- Typically requires no power source (some syringe pumps may require an air compressor or electrical power source).

Limitations of syringe samplers

- Plungers may be prone to bind and leak, especially when collecting silt-laden samples.
- Operation may be difficult if the device is lowered into a deep well.
- Plungers are typically made of non-inert materials (rubber) unsuitable for VOCs and other sorptive contaminants.
- Sample transfer can be difficult.
- Degassing can occur while samples are being decanted.
- Syringe chambers usually have limited sample volume.
- Not widely available through commercial markets.

Hand Pumps

Hand pumps are mechanical piston pumps that, in the simplest form, consist of a piston that moves inside a cylinder, which is submerged below the water table. When the piston moves up, a one-way check valve at the bottom of the cylinder allows water to enter; when the piston moves down, the check valve closes and the piston forces water up to the surface. The pump assembly is attached to the wellhead by a fixture, and a rod extending from the surface to the sampling depth and connected to the piston is moved by hand to actuate pumping. The pump plus rod assembly must be as long as the sampling depth, although the rod assembly is commonly broken into 5-ft lengths for transport. The pump diameter is generally less than 2-in., suitable for insertion into 2-in. diameter monitoring wells. Pumping rates up to 5 gal/min can be achieved.

The sample is exposed to the atmosphere during pumping and during transfer to a container; consequently, loss of volatiles is likely to occur, and the solubility of inorganic contaminants may be affected when using hand pumps. Since the sample comes into contact with the internal parts of the pump, care must be taken that pump materials are inert to the contaminant being sampled. Currently, the most readily available hand pumps are made of polyvinyl chloride (PVC), which may not be suitable for high-quality samples for organic analytes.

The pump must be decontaminated between sampling one well and the next by completely flushing it with required decontamination fluids. Alternatively, if a well is to be sampled repeatedly, the pump can be dedicated to that well. Since the pumping rod must be extended to the sampling depth, sampling at deep levels requires additional setup time as well as labor to operate the pump.

Advantages of Hand Pumps

Hand pumps are readily available, relatively inexpensive, easy to use, and achieve reasonable pumping rates. They are completely portable, requiring no power source. They may be used to sample depths up to about 100 ft; however, setup is time consuming, and pumping is laborious for deep wells. Hand pumps may be decontaminated between uses, but the procedure requires a moderate amount of time.

Limitations of Hand Pumps

Loss of volatile contaminants and the alteration of the solubility properties of inorganic contaminants are problems in using hand pumps for sampling. Compatibility of construction materials with contaminants is an additional consideration. Hand pumps may require more sample handling than other methods, which presents potential safety hazards with some contaminants, especially radionuclides.

7.2 Sample Collection

The primary objective of sampling is to collect an unaltered groundwater sample that represents the physical and chemical composition of the groundwater. Because groundwater is almost always under different temperature, pressure, dissolved gas content and oxidation-reduction (redox) state than conditions above ground, precautions must be taken to ensure that samples undergo minimal alteration during the sample withdrawal and collection process.

Sampling equipment must not react with any contaminants you are collecting. Operate your equipment to cause the least disturbance to the samples. Equipment must deliver samples to the surface with minimal agitation and aeration. Once you collect your samples, it is imperative to maintain their physical and chemical composition and quality until they can be measured or analyzed. During sampling, primary objectives and considerations include minimizing sample disturbance, avoiding sample exposure to air and extraneous contamination, and preserving sample integrity throughout collection.

7.2.1 Filling Sample Containers

Although the procedures used to fill sample containers may seem a minor consideration, filling them improperly can jeopardize all the careful work that went into collecting minimally-disturbed, representative samples. Filling sample containers exposes the samples to air, agitates the samples, may change their composition, may cause the loss of contaminants by volatilization or degassing, and may expose the samples to extraneous contamination.

Collect sample parameters in the following order:

1. Unfiltered samples for in-field water quality measurements (not necessary if down well or flow-through cell measurements are taken).

2. Volatile organic compounds (VOCs).
3. Non-filtered, non-preserved (e.g., sulfate, chromium VI, mercury, semi- and non-volatiles, pesticides, PCBs).
4. Non-filtered, preserved (e.g., nitrogen series [ammonia, nitrates, nitrites, etc.], phenolics, total phosphorous, total metals, cyanide, total organic carbon).
5. Filtered, non-preserved (e.g., dissolved chromium VI).
6. Filtered, preserved immediately (e.g., dissolved metals).
7. Miscellaneous parameters.

Collect sulfate samples before sulfuric acid preserved samples (e.g., nitrogen series). Collect nitrogen series samples before nitric acid preserved samples (e.g., boron, dissolved metals). This will prevent accidental contamination of a sample with a preservative intended for another sample (e.g., sulfuric acid preservation contaminating an unpreserved sulfate sample).

Before opening and filling sample containers, check the sampling area for potential sources of extraneous contamination. Make sure the area around the well is clean and that contaminated equipment is kept away from the well. Protect the samples from airborne contaminants such as engine exhaust, blowing dust and organic fumes (e.g., gas cans); sample upwind of these contaminants or remove them before sampling. Choose gloves appropriate for the contaminants you encounter. Change into new, clean gloves every time you sample a new well or suspect your gloves have become contaminated. Do not attempt to decontaminate or reuse gloves; use disposables.

Do not open sample containers until it is time to fill them. Immediately after filling a sample container, if you haven't already done so, add any required preservative - filter first, if required - replace the cap, label the container and place the sample on ice in a cooler. Following these procedures will help minimize sample turbulence, agitation, volatilization, degassing, atmospheric exposure, biodegradation, exposure to extraneous contamination and heating of samples.

Filling VOC Containers
When practical, store empty VOC containers on ice until you use them. This will minimize the loss of VOCs when you fill the sample containers. Open only one VOC container or one set of containers at a time. This will minimize exposure of the VOC sample to extraneous VOC contamination. After you open an empty container, add preservative. Acid preservative inhibits biodegradation of VOCs in a sample.

When filling a VOC container, tip it at a slight angle and allow a slow steady stream of water to run down its inner wall. This will minimize agitation, aeration and volatilization of the VOCs. Fill the container until a positive meniscus forms at the top. No air space (i.e., head space) should remain in the container. If any airspace remains, VOCs in the sample can volatilize to this space and may be lost before analysis.

After filling a VOC container and replacing the cap, invert the sample and tap it lightly to check for bubbles. If bubbles are present, discard this sample and fill additional VOC containers. If bubbles are unavoidable, collect numerous samples and save the ones with the fewest bubbles. Do not try to reopen and add more water to samples that have bubbles.

Semi- and non-volatile organics are also susceptible to extraneous background contamination and cross-contamination. These compounds are also susceptible to sorption and desorption reactions with the purging and sampling equipment. Equipment should be made of relatively inert material. Good decontamination procedures are necessary to avoid any cross-contamination between wells. These samples are not usually preserved or filtered; however, you should cool them to 4° C immediately after collection.

7.2.2 Sample Preservation And Handling

Take care to ensure that sample containers do not adsorb contaminants onto the container, leach contaminants from the container into the sample, or otherwise change the chemical composition of the sample. Sample containers may require special cleaning before use. Check with your laboratory to see if any special pre-cleaning procedures are necessary.

Preserving samples retards biodegradation reactions, hydrolysis reactions, precipitation and co-precipitation reactions and sorption reactions. Sample preservation usually involves reducing or increasing pH by adding an acid or base preservative. Samples are also preserved by cooling them to 4° C. Add preservatives to the container before or immediately after collecting the sample. If you add preservative before collection, take care to minimize sample overflow, which may dilute the preservative. If a sample requires filtration, add preservative after filtration, not before.

After collecting, filtering (if required), preserving and labeling, place the sample immediately on ice in a cooler. Samples must remain at or below 4° C throughout handling, storage and shipping. Add sufficient ice or use another cooling method to keep the samples at or below 4° C. Avoid using frozen cold packs because they rarely keep samples sufficiently cool. If you must use frozen packs, pre-cool the samples to 4° C and add a temperature blank before shipping. The laboratory will use the temperature blank to document the temperatures of the samples upon arrival.

Separate breakable sample containers (e.g., glass VOC vials) with bubble wrap, foam, ice, etc. At least a portion of each container must contact the ice, otherwise the protective layer (e.g., bubble wrap) may insulate the sample from the cooling effects of the ice. Placing samples in a plastic bag can help minimize the chance of cross-contamination among samples should a container break.

Be conscious of analytical holding times and minimize the time between sampling and delivery to the laboratory. Results for samples analyzed after holding times have

expired are questionable at best. Laboratories are required to honor holding times. When samples arrive near the end of the holding time, the risk increases that holding times will not be met and you may incur additional costs to expedite sample analyses. If the laboratory exceeds holding times, results should be flagged.

7.2.3 Quality Assurance/Quality Control

Following proper QA/QC procedures when collecting samples in the field will help minimize error, variability and bias in results attributable to sampling and handling. Both the equipment and procedures used in collecting and handling groundwater samples have limitations that introduce a certain level of error, variability and bias into the final analytical results.

Quality assurance (QA) procedures for collecting groundwater samples are the checks, such as documentation and quality assurance samples, that establish the type and quality of collected data. For example, a trip blank verifies whether samples were exposed to extraneous contamination during storage and transport, while a field blank verifies whether equipment decontamination procedures were adequate.

Quality control (QC) refers to the plans, equipment and procedures used to verify and maintain the quality of collected data. One important QC procedure - if dedicated or disposable equipment is not used - is to sample wells from least to most contaminated. Do this to avoid cross-contamination between wells and samples.

Chain of Custody, Sample Tracking and Security
Following proper chain of custody, tracking and security procedures is essential to maintain the integrity and legal validity of your samples. Sample and shipper security measures ensure that the samples were not tampered with before analysis. This can be very important if sample analytical results come under legal scrutiny. Remember, any project and its data can face legal challenge.

Trip Blank
The purpose of the trip blank is to determine if any volatile samples have become contaminated with extraneous substances during storage and transport.

Trip blanks are only necessary when collecting VOC, gasoline range organics (GRO), and petroleum volatile organic compound (PVOC) samples. Trip blanks should be prepared and provided by the laboratory analyzing the VOC, GRO or PVOC samples. Trip blanks must be prepared with laboratory reagent grade water and analyzed by the same laboratory that is analyzing the volatile samples. Do not prepare trip blanks with water (even if distilled or de-ionized) purchased at a store; there is no guarantee that store-bought water is contamination-free. The trip blank should remain in the same cooler in which the groundwater samples are stored and shipped.

Note: If trip blank holding times permit, trip blanks do not need to be analyzed if VOC, GRO and PVOC compounds are not detected in any of the groundwater samples. Trip blanks have the same holding time as samples.

Include one trip blank per sample batch, that is, at least one per sampling event and one per cooler. If you use more than one vehicle to transport the samples, or if samples are not shipped together, include one trip blank per vehicle or one trip blank per cooler. The easiest way to minimize the number of trip blanks necessary is to store, transport and ship all VOC, GRO and PVOC samples in one cooler.

Field Blank
Field blanks are also commonly called field rinsate blanks, decontamination blanks and equipment blanks. A field blank evaluates the effectiveness of decontamination procedures when equipment is not dedicated to a well or disposed of after one use. If decontamination procedures are effective, there should be no contamination in the field blanks. Field blanks are not required if dedicated sampling equipment or disposable sampling equipment is used.

A field blank consists of a sample of the reagent grade water supplied by the laboratory and used in the final rinse step of the equipment decontamination procedure. Process the field blank water through the equipment the same way you process any other final rinse water.

Collect one field blank for every 10 or fewer samples collected. Analyze the field blank for the same parameters as the samples. If possible, collect the field blank after sampling the most contaminated well.

Field Duplicate
A field duplicate sample is collected to determine the variability of analytical results caused by the sampling equipment and procedures used. Collect field duplicates for sensitive parameters such as VOCs, sorptive organics and trace metals. Try to choose wells in which the contaminant concentrations have been relatively stable over time and wells that are screened in relatively homogeneous material. This will minimize analytical variability caused by contaminant concentration gradients that may exist in the groundwater system.

Collect one field duplicate for every 10 or fewer samples collected. Collect and handle the original sample and field duplicate using the same procedures; however, label them differently so the laboratory cannot tell they are duplicates; thus minimizing any potential bias. If possible, collect the duplicate and original sample from the same grab sampler, from a water discharge splitter if pumping, or immediately after each other if you do not use a discharge splitter.

Equipment Decontamination
Follow proper equipment decontamination procedures to minimize the potential for cross-contamination between wells and maintain data quality. According to Nielsen (1991), without effective decontamination procedures, any data generated by an investigation or remediation are subject to critical scrutiny.

The level of rigor and stringency required for equipment decontamination will depend on 1) the type, concentration, sorption and limits of detection of analytes

being sampled; 2) the risk of equipment coming into contact with contamination during storage and transport; 3) regulatory objectives and requirements; and 4) the level of QA/QC procedures required.

All equipment contacting well water or any unclean surface should be properly decontaminated after contact. Examples of equipment that require decontamination include: water level instruments; well purging and sampling devices and accessories; filtration apparatus; and instruments used for field water quality measurements (e.g., conductivity, pH, turbidity and dissolved oxygen probes and meters).

Address any health and safety issues related to decontamination chemicals, equipment and procedures in the site-specific health and safety plan.

7.2.4 Decontamination Procedures

The American Society for Testing and Materials (ASTM) Method D 5088-90 provides basic guidelines for the "Decontamination of Field Equipment Used at Non-radioactive Waste Sites." The ASTM Method D 5088-90 procedures recommend the following for decontaminating equipment that comes into contact with sample water:

Minimum Decontamination Procedures

1. Wash sample contact equipment with a non-phosphate detergent solution (e.g., Alquinox®, Liquinox®).
2. Thoroughly rinse the equipment with organic-free tap water.

Rigorous Decontamination Procedures

1. Wash equipment with a non-phosphate detergent solution and scrub with an inert brush. For internal mechanisms and tubing, circulate the detergent solution through the equipment.
2. Thoroughly rinse the equipment with organic-free tap water.
3. For organic sampling, rinse equipment with an organic desorbing agent (e.g., pesticide grade isopropanol, acetone, methanol or hexane). For inorganic sampling, rinse with inorganic desorbing agent (e.g., dilute [0.1 Normal] reagent grade hydrochloric acid or nitric acid solution). For stainless and low-carbon steel, a more dilute hydrochloric acid solution (1 percent) is recommended. Note: If organic or inorganic desorbing agents are to be used, check with your laboratory regarding potential analytical interferences or contamination potential and proper use of these desorbing agents.
4. Rinse with organic-free tap water (only if inorganic desorbing agent used).
5. Rinse with de-ionized (reagent grade organic free) water. Allow the equipment to air dry before next use.
6. Place equipment in an inert container or wrap in clean plastic or aluminum foil for storage and transport.

In addition, disassemble the equipment as much as possible and wash/scrub it with a non-phosphate detergent during decontamination. Because disassembling equipment

can take time and be hard on the equipment, use your professional judgment to determine when this is necessary.

Decontamination Documentation
At a minimum, decontamination documentation should include: 1) the location where decontamination occurred; 2) the individuals performing the decontamination; 3) the decontamination procedures, including the wash solution and rinse water used (e.g., tap water and reagent grade water); 4) equipment storage and transport procedures; and 5) the handling and disposal of decontamination wastewater. If you have already included this information in your site sampling plan, re-documentation is not necessary.

Disposal of Decontamination Wastewater
If decontamination wastewater is classified as hazardous, the cost and time to properly treat and dispose of it can be substantial. A couple of methods for avoiding the generation of hazardous waste is to use dedicated equipment left in the well, thus minimizing or eliminating decontamination wastewater, or to use dedicated equipment not stored in the well but taken back to a laboratory after sampling to conduct proper decontamination procedures.

If the decontamination wastewater is not classified as hazardous waste, you may be able to dispose of it into a sanitary sewer, not a storm sewer. You should get approval from the receiving wastewater treatment plant (WWTP) beforehand. WWTP personnel will usually want to know the type and concentration of contaminants and the volume of wastewater in question. If approval is granted, make sure you don't pour silt-laden water into the sanitary sewer because silt may clog the sewer. Allow the silt to settle out and then decant the clear wastewater into the sanitary sewer. Non-hazardous wastewater may also be treated at an on-site groundwater treatment system, if appropriate.

Equipment Storage and Transport
Properly storing and transporting equipment protects it from a variety of extraneous solid, liquid and airborne contaminants including oils, greases, fuels, solvents, paints and other VOCs.

Examples of appropriate storage include wrapping the equipment in clean aluminum foil, placing it in plastic bags, or placing it in a PVC carrying tube outfitted with end caps. The storage/transport device should be made of relatively inert materials that will not contaminate the equipment. For example, if you use a PVC tube to transport bailers, do not fasten the end caps to the PVC tube with glues that contain VOCs.

8.0 Direct Push Techniques for Sampling Groundwater

Direct push methods can be used as alternatives to constructing and sampling a monitoring well. For most sites the direct push methods can only provide a subset of the information obtained by hollow-stem auger/coring methods. Further, and especially in fine-grained sediments, if great care is not taken to purge and develop

the well then volatile constituents of fuel contaminants will be under-represented. Thus, great care should be taken to a) understand the methods, b) understand when a direct push method is applicable to a particular site, c) properly apply the selected method, and d) apply quality control/quality assurance to the sampling episodes and interpretation.

Selecting Direct Push as an Appropriate Method for a Site
Direct push techniques are acceptable for sampling groundwater if:

- site sediments containing groundwater:
    - are characteristically silts, sands or pebbles (<25%) with few gravelly or cobbly zones
    - are not commonly interlaminated or interbedded with soft clay laminae and beds
    - are not interlaminated or interbedded with indurated zones such as welded tuffs or caliche
    - can release a sufficient yield of groundwater within 30 minutes to allow capture of sufficient sample volume to meet the laboratory analysis requirements

- the inner diameter of the sampling device is 2.0 inches or greater

- the sample collection method
    - minimizes the loss of volatile constituents
    - captures sufficient volume in <u>one sampling episode</u> to meet the laboratory analysis requirements
    - there is an overwhelming reason not to use conventional drilling and monitoring well construction methods

8.1 Introduction to Direct Push

Also known as "direct-drive," drive-point" or "push-driven", direct push technology refers to pushing and/or vibrating small-diameter hollow steel rods into the ground. Sampling tools can be attached to the end of the steel rods to collect soil, soil-gas and groundwater samples. This technology can be a useful and cost-effective technology, which yields representative soil and groundwater samples <u>when used properly</u>.

Direct-push platforms have gained widespread acceptance in the environmental industry over the past decade because of their versatility, relatively low cost, and mobility. As opposed to drilling techniques in which soil is removed and a borehole is produced, direct-push units use hydraulic pressure to advance sampling devices and geotechnical and analytical sensors into the subsurface. The weight of the truck in combination with a hydraulic ram or hammer is used to "push" the tool string into the ground. With this no soil is removed, and only a very small borehole is created.

The three major classes of direct-push platforms are cone penetrometer (CPT) , rotary hammer and hand-held systems. While "CPT" technically refers only to the geotechnical cone penetrometer instruments advanced by these large vehicles, the vehicles themselves have come to be known by this designation. The distinction between these methods is that CPTs advance the tool string by applying a hydraulic ram against the weight or mass of the vehicle alone, rotary hammer units add a hydraulic hammer to the hydraulic ram to compensate for their lower mass, and hand-held units use only the inertia of a weight (slide hammer) or a percussion hammer (rotary hammer) attached to a bar to advance a probe. These platforms share the same principle of operation, similar tools, and a number of advantages and limitations. They differ in scale, application, and to the types of instruments and tools that have been developed for each. For these reasons, CPT, rotary hammer and hand-held platforms tend to fill different niches in the environmental field. For the purposes of this document CPT units are not appropriate to the characterization goals at most Brazilian fueling stations and are not further considered. Rotary hammer and hand-held platforms are commonly in use in the Americas and are further characterized below.

Rotary Hammer
Rotary hammer systems are usually mounted on pick-up trucks, tracks or small trailers. A rotary hammer system uses a combined force generated by the static weight of the vehicle on which it is mounted and a percussion hammer to advance steel rods and either a sampler or analytical device. A variety of samplers for retrieving soil, soil gas, and groundwater samples are available. Geoprobe™™ is an example of a brand of trailer-mounted rotary hammer system that is available (but not common) in Brazil.

Hand-held Slide Hammers and Hammer Drills
Hand-held slide hammers (also known as hammer samplers or inertial samplers) are capable of being easily transported and used by one person. The sampler depends on the inertial force of a 20 pound (or greater) hammer raised and lowered along a slide attached to the top of a probe rod. AMS™ manufactures a slide hammer and sampling kits commonly used in the Americas. An electrically-driven hammer drill (rotary impact hammer) such as that manufactured by Bosch™ is a viable alternative to the slide hammer and can easily be adapted to use with a sampling kit purchased for a slide-hammer.

8.2 Collecting Groundwater by Direct Push Methods

Once groundwater is reached by the direct push device, there are 2 methods available to collect a sample; 1) by pumping from within the device using an external pump system (examples are peristaltic pumps and bailers) and 2) by sampling from within the device by using a mechanism that is integral to the direct push device (examples include BAT samplers and HydroPunch™) .

Well Points and Direct Push Wells

Well points and direct push wells are either temporary or permanent installations that are used to access ground water for sampling or waterlevel measurements. They can be used to obtain samples for all analyte groups; however, samples taken from well points are generally suitable only for screening-level applications. Driven well points and direct push wells cannot be used in hard rock, and they are very difficult or impossible to install in material with significant boulder content or in dense silts and clays. They can be driven or pushed to depths of about 50 ft.

A well point consists of a forged steel point that is attached to a screened section (well point) that is in turn attached to the bottom of a casing. Many types of screen can be used, but the most hydraulically efficient and commonly used type is continuous-slot, wire-wound screen. The screen is usually made of stainless steel or steel, and the casing is made of steel to withstand driving forces. Both the well point and the casing are most commonly 1.25 in. to 2 in. in diameter. Well points are available in a variety of lengths from 2 ft to longer than 15 ft. The well point is attached to the casing by welding or by a drive coupling that is specifically designed to withstand the force of the blows that drive the casing.

The well is constructed by driving the casing and the screen into the ground either by hand, with hammer drills, or with drive heads attached to a hoisting device. New sections of casing are attached in 4 ft or 5 ft sections as the well is driven deeper. Crude stratigraphic information can be obtained by counting the number of blows per foot necessary to drive the well point. Well points can also be installed inside driven casing from which the soil has been removed, but this type of installation is uncommon. Water in the completed well point is sampled by standard, small-diameter sampling devices, such as bailers and pumps.

In addition to standard well points, a number of devices that can be classified as direct push wells have been used in ground-water investigations. These devices are hydraulically pushed into the subsurface rather than driven. Pushing causes less formation damage than driving and less damage to sampling tools. The hydraulic pushing device can be mounted on a truck. The well, which is essentially a hollow tube with ports attached to a drive point, is generally an inch or less in diameter and is constructed of steel or stainless steel. Sampling can be accomplished using tubing and a peristaltic pump. Multiport designs for sampling different levels are possible. These devices can be pulled after sampling or left in place. Other direct push technology employs specially designed samplers similar to BAT or HydroPunch™ type samplers.

Well points can be driven by hand to depths up to about 30 ft in sands or sands and gravel. Depths of about 50 ft can be obtained in these materials using a drive head. Probes can be pushed up to about 50 ft, but are more effective for sampling shallower depths. Driving or pushing through boulders or dense silts and clays can be difficult or impossible either because penetration cannot be achieved or because the device is damaged or destroyed. In addition, silts and clays may clog screens or openings and

be extremely difficult to remove, especially if the well is completed in a low permeability formation.

Driven well points and pushed probes do not allow completion techniques such as installation of filter packs or seals. Thus, sample quality may suffer, and there is no way to ensure that cross-connection between water-bearing zones does not occur. Because the point and the casing may be made of steel, well points may affect the sample quality by leaching or adsorption. Use of stainless steel in direct push devices alleviates sample quality problems. Sample quality can also be improved by purging the well point before sampling. Obtaining adequate sample volume can be a problem, especially in low-permeability formations.

Use of well points and direct push wells is a relatively low-cost way to provide locations for water level monitoring and to obtain screening-level samples of ground water from shallow, unconsolidated formations. Well points and probes are available from environmental products companies, and they can be installed easily and rapidly to shallow depths. They can be left in place to provide ongoing monitoring capability at a location. Driving or pushing wells does not generate significant soil for possible disposal as hazardous waste.

Well points generally produce sample quality suitable only for screening-level analyses. Direct push wells may be acceptable for characterization-level sampling. The use of these devices is limited to depths of about 50 ft, and they are most cost effective at much shallower depths. Well points and probes cannot be driven or pushed into hard rock and are very difficult to drive into material with cobbles or into dense silts and clays. Only very crude stratigraphic data are obtainable while driving well points.

Internal Devices
(Cone Penetrometer, HydroPunch™ , BAT Samplers, Geoprobe™, Cone Sipper, HydroSparge)

Direct push samplers are used to sample ground water without having to drill a bore hole or install a monitoring well. Because they allow rapid sampling of a large number of locations, they are often used in screening-level investigations. However, they can be used to take high-quality samples for analyses for all contaminant groups. Because these tools are pushed or driven into the ground, they cannot be used in hard rock, and they are difficult or impossible to use in formations with significant gravel or cobble content. Under favorable conditions, maximum depths of penetration exceed 100 ft but are more typically about 50 ft or less.

Several systems are currently available that use hydraulic technology to push or drive small-diameter water samplers into the subsurface (e.g., cone penetrometer rigs and Geoprobe™ systems). Most of these systems are also capable of sampling soil gas and soil, and cone penetrometer testing provides additional information on subsurface conditions. These applications are discussed in other sections of this guide. Water

samples are taken with a sampling tool or probe that is attached to rods and pushed or driven into the ground by a hydraulic system. The hydraulic system used for this type of application is substantial (e.g., capable of applying up to about 40 tons of force) and is mounted on a special cone penetrometer rig or a heavy-duty truck.

Several types of sampling tools are available. The HydroPunch™ tool is basically a double cylinder that is specially designed so that it is sealed until the desired sampling depth is reached. When the desired depth is reached, the outer cylinder is pulled back, exposing a perforated, stainless steel sampling barrel covered with filter material. The water sample enters the barrel and is then retrieved by pulling the assembly out on the rods. Other manufacturers make similar tools.

The BAT sampler is a specially designed sampling probe with a filter mounted inside a stainless steel shaft. The filter allows water to enter the shaft. A septum at the top of the shaft keeps the sampling probe sealed. This probe can either be used in a permanent installation or pushed into the ground on cone penetrometer rods and subsequently retrieved. In the push sampling application, the probe is pushed into the subsurface to the desired sampling depth and allowed to fill. Samples are collected in a sample vial that is sealed on its lower end with a septum. A double-pointed hypodermic needle followed by the sample vial is lowered down the rods. When the sample vial reaches the probe, the needle pierces both of the septa on both the probe and the vial, connecting the two and allowing water from the probe to enter the vial. The sample vial and needle are then pulled up the rods to retrieve the sample, and the probe septum reseals. Multiple samples can be collected from the same point.

Various other types of sampling probes can be attached to cone penetrometer rods or to other hydraulic systems and pushed or driven into the subsurface. These probes rely on a variety of mechanisms for keeping the probe sealed until the sampling depth is reached and have a variety of intake designs. Unlike HydroPunch™ -type samplers and BAT samplers, the sample is usually retrieved from these probes by a suction lift pump, commonly a peristaltic pump. The probes may be left in the ground for repeated sampling or pulled.

Samples taken with HydroPunch™ -type samplers and BAT samplers are suitable for high-quality analyses for all analyte groups. These sampling tools are small in diameter, generally less than an inch in inside diameter, and obtaining adequate sample volume if several types of analyses are desired can require repeated sampling. HydroPunch™ -type samplers are capable of collecting sample volumes of 500 to 1000 mL. BAT samplers collect volumes of 150 mL. Sample volume is not limited if samples are retrieved by pumps. In low-permeability formations, probe fill times may be very long (e.g., up to 2 h), making sampling time consuming.

Probes cannot be pushed into hard rock, and significant gravel or cobble content in the formation may impede or preclude penetration of the probes. The depth of penetration achievable depends on the type of formation, the type of sampling probe, and the size of the hydraulic equipment used. Maximum depths of penetration can

exceed 100 ft under favorable conditions but are more typically about 50 ft. If peristaltic pumps are used to retrieve sample, sampling depths are limited to about 25 ft. Site access may be a problem for cone penetrometer rigs and large truck-mounted systems.

The Cone Sipper and HydroSparge are examples of two more innovative sampling devices under development. Both devices are designed to be lowered down cone penetration rods. The Cone Sipper is a miniature gas lift pump, which uses alternating vacuum and pressure with a miniature valve to move liquid or gas samples to the surface. The HydroSparge is an in situ technique for sparging VOCs in ground water. Once converted to a gaseous state the VOCs are transported to the surface for near-real-time analysis.

Sampling tools must be decontaminated between holes. If the tool leaves an open hole, the hole is usually grouted when sampling is complete.

Cone penetrometer-type water sampling is a rapid way to obtain samples from a large number of locations and, consequently, is often used in screening-level investigations. However, high quality samples for all analyte groups can be obtained with appropriate sampling tools. Cone penetrometer-type sampling does not generate significant quantities of waste.

Cone penetrometer-type sampling cannot be done in hard rock or in formations with significant cobble or boulder content. Although maximum depths of penetration may exceed 100 ft, they are more likely to be about 50 ft. Obtaining adequate sample volume may be time consuming.

8.3 Quality Assurance /Quality Control for Direct Push Methods

Initial quality control consists of verifying with reasonable certainty that the site is appropriate for the method. That is, that site sediments containing groundwater:

- are characteristically silts, sands or pebbles with few gravelly or cobbly zones
- are not commonly interlaminated or interbedded with soft clay laminae and beds
- are not interlaminated or interbedded with indurated zones such as welded tuffs or caliche
- can release a sufficient yield of groundwater within 30 minutes to allow capture of sufficient sample volume to meet the laboratory analysis requirements

Having determined that the site is suitable, the consultant should then verify:

- that the direct push tool has an inner diameter of 2.0 inches or greater
- that the sample collection method minimizes the loss of volatile constituents
- that the sample collector is capable of capturing sufficient volume in <u>one sampling episode</u> to meet the laboratory analysis requirements

When setting a permanent well using a direct push method the consultant should attempt to develop the well to the extent possible by following the procedures described in Task 5 above.

When interpreting the results the consultant should realize that samples derived from direct push methods are most likely to under-represent actual conditions. Thus, when reporting an analytical result at or near the lower acceptable level as required by the State, the consultant should 1) identify in the report that the sample result may under-report the actual conditions and 2) recommend (also in the report) verification of the low result by a means acceptable to the relevant regulatory authority.

9.0 Recommended Laboratory Analyses to Detect Fuel-Derived Contamination

The basis of the following recommendations is that the analytical regime be sufficient to determine that impact from fuel-derived compounds exists, but not to monitor a specific compound.

Gasoline and BTEX Components
Gasoline Range organics (GRO, C1-C10) by a gas chromatography method such as EPA 8015 or international equivalent.

Diesel
Diesel Range organics (DRO, C10-C28) by a gas chromatography method such as EPA 8015 or international equivalent.

Waste Oil
C24+ range organics by a gas chromatography method such as EPA 8015 or international equivalent.

Polyaromatic Hydrocarbons (PAH) by EPA method 8270 or international equivalent.

Methanol
Methanol discrimination by direct-injection gas chromatography modified EPA 8015 method or international equivalent.

10.0 Task 7 – Reporting

A concise report should be issued, presenting sufficient data to allow a third party to assess the quality of the work. The report should be supported by appendices presenting the following:

Well Location Map. A site map which accurately shows the as-built location of the monitoring well or direct push sampling location.

Geologic Log. A detailed geological log of the monitoring well which includes information on the location of the well, penetration rate or standard penetration resistance, sampled intervals and percent recovery, stratigraphic and lithologic information, aquifers, water-bearing zones and zones of high permeability or fracture encountered, contamination observed, and any other drilling observations including lost circulation zones or other difficulties encountered during drilling. Include a description of the classification system used with the log.

Photographic Record. Photographic record of all rock or sediment cores if cores were recovered during drilling.

Chain of Custody records for groundwater samples.

Sampling Record for Direct Push Samples (as applicable). Include the following information:

1. Detailed discussion of the applicability of the direct push method to the site stratigraphy and lithology

2. Time and date of sampling, contractor's name and affiliation;

3. Type of direct push equipment used, method of pushing, sample collection method;

4. The size (diameter) and total depth of the borehole, and depth of the sampled zone;

5. Method of disposal of wastes;

6. Volume of water sampled and duration necessary to collect that volume;

7. Development method(s), time spent on development, pumping rate and volume of water produced during development, clarity of water before and after development, record of field measurements of water quality made during development, method of disposal of development water;

8. Results of location and elevation survey;

9. Static water level measured to the nearest 0.3 cm, with the date of measurement;

10. Copies of geophysical logs (if any)

11. Results of hydraulic conductivity tests, including raw data, test methods, analytical procedures, and data plots;

As-Built Construction Record for Monitoring Wells (as applicable). Include the following information with the as-built:

1. Construction record of the monitoring well:

2. Date of drilling and well installation, driller's name and affiliation, site geologist's name and affiliation;

3. Type of drilling equipment used, method of drilling, volume of water used, and type and volume of drilling fluids or additives used;

4. The size (diameter) and total depth of the borehole, and depth of the completed well;

5. Method of disposal of drill cuttings;

6. Screened interval; screen composition, diameter, slot size and percent open area; and installation procedure;

7. Casing composition, diameter and installation procedure;

8. Method of joining used to assemble screen and casing; type and location of all casing centralizers used;

9. Type of filter pack material, placement interval and method of placement of filter pack, volume of filter pack material used, sieve analysis of filter pack material;

10. Type of annular sealant, placement interval and method of placement of annular sealant, calculated and actual volume of sealant used, mud weight of sealant (if grout slurry was used);

11. Surface seal and security casing design and construction;

12. Well construction diagram;

13. Development method(s), time spent on development, pumping rate and volume of water produced during development, clarity of water before and after development, record of field measurements of water quality made during development, method of disposal of development water;

14. Results of location and elevation survey;

15. Static water level measured to the nearest 0.3 cm, with the date of measurement;

16. Copies of geophysical logs (if any)

17. Results of hydraulic conductivity tests, including raw data, test methods, analytical procedures, and data plots;

Laboratory sample receipt records and analytical reports.

Sampling Record for Water Sampling (by location). Include the following information:

WELL SPECIFIC FIELD SHEET - MONITORING WELLS (Sheet ___ of ___)

Facility/Project Name: **Date:**
Section/Grid or Address:
License or Permit#:
Weather today and past weeks(precipitation):
Persons Sampling:
Well Name **Well ID No.**
Damage to Well? (Y/N)
Top of Casing or Reference Elevation (MSL) **Depth to Water (to 0.01 ft)**
Groundwater Elevation (MSL) **Depth to Well Bottom (ft)**
4-5 Well Volumes (gal. or liters)
Purging Device ; dedicated (D) or portable (PT)
Purging Device Intake Depth (ft)
Purging Time (start - stop)
Average Purging Flow Rate (gpm or L/min)
Volume Purged (gal. or liters)
Purged Dry? (Y/N)
Problem Purging? (Y/N)
Sampling Device (D or PT)
Sampler Intake Depth (ft)
Average Sampling Flow Rate (gpm or L/min)
Time Sample Collected
Preservative (e.g, HCL)
Field Temperature (oC)
Field Specific Conductance @25oC (uMhos/cm) **Time Measured**
Field pH (standard units) **Time Measured**
Turbidity (NTUs or describe) (e.g. slight, moderate) **Time Measured**
Dissolved Oxygen (mg/l) **Time Measured**
Eh - redox potential (mv) **Time Measured**
Color (describe - gray, ect)
Odor (describe - pungent, ect)
Sample Field Filtered? (Y/N)
Time Samples Filtered
Well Capped & Locked? (Y/N)

Comments (Discuss well damage, purging or sampling problems, deviations from sampling plan, etc.): _____

_____

_____

Sheet Completed by_____**Date**_____

GROUNDWATER SAMPLING FIELD PROCEDURES DOCUMENTATION

Facility/Project Name:_____Date:_____
Section/Grid Location or Address:_____
Facility Type: License/Permit :_____
Weather (temp., cloudiness, bar. pres., wind):_____
Persons Sampling and Title:_____
Water Level Equipment (type, model):_____
Purging Equipment (type, model, material):_____
Purging Method (4 well vol. or stabilization):_____
How Purge Volume Measured? (eg., calibrated bucket):_____
Sample Collection Equipment (type, model, material):_____
Method of Sample Withdrawal (bottom emptying device, low flow):_____
Type of Transfer Containers:_____
Filtering Equipment (type, material):_____
Filter Membrane (type, pore size):_____
When Were Samples Sent to Lab?_____
What Lab Were the Samples Sent to?_____
Were Enforcement Samples Sent?_____
How Were Samples Kept Cool (ice, other)?_____
Equipment Decontamination Procedures?_____
Decontamination Water Disposal?_____
pH Meter (type, model):_____ Person calibrating:_____
Frequency calibrated:_____
Calibration procedures (buffers used):_____
Problems with meter:_____
Conductivity Meter (type, model):_____ Person calibrating:_____
Frequency calibrated:_____
Calibration procedures:_____
Problems with meter:_____
Turbidity Equipment (type,model):_____Person calibrating/set-up:_____
Frequency calibrated:_____
Calibration procedures:_____
Problems with meter:_____
Dissolved Oxygen Meter (type,model):_____Person calibrating/set-up:_____
Frequency calibrated:_____
Calibration procedures:_____
Problems with meter:_____
When Were In-field Measurements Taken (immediately after collection or XX minutes after collection)?:_____
Comments (difficulties, questionable data, deviations from sampling plan, etc):_____
_____
_____

11.0 Reading Guide for Ground Water Sampling and Direct Push Techniques

- Allen, D.C. and S.E. Walker. 1984. Background Ground Water Quality Monitoring: Temporal Variation. In: Proc. 4th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Dublin, OH, pp. 226-231.

- Aller, L. et al. 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. Dublin: National Water Well Association.

- Aller, Linda, T.W. Bennett, Glen Hackett, R.J. Petty, J.H. Lehr, et al, 1989, Handbook of Suggested Practices for the Design and Installation of Ground Water Monitoring Wells: National Water Well Association, Dublin, OH, 398 p.

- API Publication Number 4599: "Interlaboratory Study of Three Methods for Analyzing Petroleum Hydrocarbons in Soils: Diesel-Range Organics (DRO), Gasoline-Range Organics (GRO), Petroleum Hydrocarbons (PHC)", **June 1994.**

- American Society for Testing and Materials (ASTM). 1992. Standard Guide for Pore-Liquid Sampling from the Vadose Zone, D4696-92. ASTM, Philadelphia, PA, pp. 809-839.

- American Society for Testing and Materials (ASTM).) Method D 5088-90 provides basic guidelines for the "Decontamination of Field Equipment Used at Nonradioactive Waste Sites."ASTM, Philadelphia, PA.

- American Society for Testing and Materials (ASTM). 1994. Standard Guide for Sampling Groundwater Monitoring Wells, D4448-85a (reapproved 1992). In: ASTM Standards on Ground Water and Vadose Zone Investigations. ASTM, Philadelphia, PA, pp. 193-206.

- American Society for Testing and Materials, Annual Book of ASTM Standards, Section 4, Volume 04.01: Cement; Lime; Gypsum: American Society for Testing and Materials, Philadelphia, PA.

- American Society for Testing and Materials, Annual Book of ASTM Standards, Section 4, Volume 04.08: Soil and Rock; Building Stones; Geotextiles: American Society for Testing and Materials, Philadelphia, PA.

- American Society for Testing and Materials, ASTM D-5092-90, Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers: American Society for Testing and Materials, Philadelphia, PA., Volume 04.08, pp. 1 1721 183.

- American Society for Testing and Materials, ASTM F-480, Standard Specifications for Thermoplastic Water Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR): American Society for Testing and Materials, Philadelphia, PA.

- ASTM. 1995. Provisional standard guide for accelerated site characterization for confirmed or suspected petroleum releases, PS3-95. Annual Book of ASTM Standards, Philadelphia.

- Baerg, D.F., R.C. Starr, J.A. Cherry and D.J.A. Smyth. 1992. Performance Testing of Conventional and Innovative Downhole Samplers and Pumps for VOCs in a Laboratory Monitoring Well. In: Nat. Groundwater Sampling Symp. Proc. (Washington DC), Grundfos Pumps Corp., Clovis, CA, pp. 71-75.

- Bangsund, W.J., C.G. Peng and W.R. Mattsfield. 1994. Investigation of Contaminant Migration By Low-Flow Rate Sampling Techniques. In: Proc. 8th Nat. Outdoor Action Conference and Exposition, National Groundwater Association, Minneapolis, MN, pp. 311-321.

- Barber, C. and G.B. Davis. 1987. Representative Sampling of Ground Water from Short-Screened Boreholes. Groundwater 25(5):581-588.

- Barcelona, M.J. 1988. Overview of the Sampling Process. In: Principles of Environmental Sampling, L.H. Keith (ed.), ACS Professional Reference Book, American Chemical Society, Washington, DC, pp. 3-23.

- Barcelona, M.J. and J.A. Helfrich. 1986. Well Construction and Purging Effects on Ground-Water Samples. Environmental Science and Technology 20(11):1179-1184.

- Barcelona, M.J. and J.A. Helfrich. 1992. Realistic Expectations for Ground-Water Investigations in the 1990's. In: Current Practice in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Neilsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 3-23.

- Barcelona, M.J. and J.P. Gibb. 1988. Development of Effective Ground-Water Sampling Protocols. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society for Testing and Materials, Philadelphia, PA, pp. 17-26.

- Barcelona, M.J., H.A. Wehrmann and M.D. Varljen. 1994. Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground-Water Sampling. Groundwater 32(1):12-22.

- Barcelona, M.J., H.A. Wehrmann, and M.D. Varljen. 1994. Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground-Water Sampling. Groundwater 32(1):12-22.

- Barcelona, M.J., J.A. Helfrich and E.E. Garske. 1985b. Sampling Tubing Effects on Groundwater Samples. Analytical Chemistry. 57:460-464.

- Barcelona, M.J., J.A. Helfrich and E.E. Garske. 1988. Verification of Sampling Methods and Selection of Materials for Ground Water Contamination Studies. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society of Testing and Materials, Philadelphia, PA, pp. 221-231.

- Barcelona, M.J., J.A. Helfrich, E.E. Garske, and J.P. Gibb. 1984. A Laboratory Evaluation of Ground Water Sampling Mechanisms. Ground Water Monitoring Review 4(2):32-41.

- Barcelona, M.J., J.P. Gibb, and R.A. Miller, 1983, A Guide to the Selection of Materials for Monitoring Well Construction and Ground Water Sampling: Illinois State Water Survey, Department of Energy and Natural Resources, Champaign, Illinois, Contract Report 327, 78 p.

- Barcelona, M.J., J.P. Gibb, J.A. Helfrich, and E.E. Garske. 1985a. Practical Guide for Ground-Water Sampling. EPA/600/2-85/104 (NTIS PB86-137304), pp. 90-160.

- Barker, J.F. and R. Dickhout. 1988. An Evaluation of Some Systems for Sampling Gas-Charged Ground Water for Volatile Organic Analysis. Ground Water Monitoring Review 8(4):112-120.

- Barker, J.F., G.C. Patrick, L. Lemon, and G.M. Travis. 1987. Some Biases in Sampling Multilevel Piezometers for Volatile Organics. Ground Water Monitoring Review 7(2):48-54.

- Bedient, P. B., H. S. Riafi, and C. J. Newell, Ground Water Contamination: Remediation and Transport, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1994.

- Bergen, C.L., R.C. Tuckfield and N.M. Park. 1990. Suitability of the HydroPunch™ TM for Assessing Groundwater Contaminated by Volatile Organics. Ground Water Management 2:387-399 (4th NOAC).

- Braids, O.C. 1986. The Rationale for Filtration of Ground Water Samples. In: Proc. 6th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Dublin, OH, pp. 292-294.

- Braids, O.C., R.M. Burger and J.J. Trela. 1987. Should Ground Water Samples from Monitoring Wells be Filtered Before Laboratory Analysis? Ground Water Monitoring Review 7(3):58-67.

- Braids, O.C., R.M. Burger, and J.J. Trela. 1987. Should Ground Water Samples from Monitoring Wells be Filtered Before Laboratory Analysis? Ground Water Monitoring Review 7(3):58-67.

- Bryden, G.W., W.R. Mabey and K.M. Robine. 1986. Sampling for Toxic Contaminants in Ground Water. Ground Water Monitoring Review 6(2):67-72.

- Bumb, A.C., McKee, C.R., Evans, R.B. and Eccles, L.A. 1988. Design of Lysimeter Leak Detector Networks for Surface Impoundments and Landfills. Ground Water Monitoring Review 8(2):102-114.

- Burger, R.M. 1986. Positive Aspects of Sample Filtration. In: Proc. 6th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Dublin, OH, pp. 301-314.

- Butler, J., Franseen, E. , Jianghai X., Schulmeister, M., Zheng , L, Weis, T, Bynes, A, Healey, J., and Miller, R. (2000). Experimental assessment of the utility of direct-push profiling and ground-penetrating radar for hydrostratigraphic investigations. Soc. Econ. Pet. Min/Int. Assc. Sed., Prog. and Absts., p. 26.

- Butler, J.J., Jr. 1997. The Design, Performance, and Analysis of Slug Tests. Boca Raton, Lewis Publishers.

- Butler, J.J., Jr., C.D. McElwee, and G.C. Bohling. 1999b. Pumping tests in networks of multilevel sampling wells: Motivation and methodology. Water Resour. Res. 35, no. 11: 3553-3560.

- Butler, J.J., Jr., C.D. McElwee, and W.Z. Liu. 1996. Improving the reliability of parameter estimates obtained from slug tests. Ground Water 34, no. 3: 480-490.

- Butler, J.J., Jr., Franseen, E.K., Xia, J., Schulmeister, M.K., Zheng, L., Weiss, T., Byrnes, A.P., Healey, J.M., and Miller, R., 2000, Experimental assessments of the utility of direct-push profiling and ground-penetrating radar for hydrostratigraphic investigations (abs.): Program and Abstracts, SEPM/IAS Research Conf. Environmental Sedimentology--Hydrogeology of Sedimentary Aquifers, p. 27

- Butler, J.J., Jr., Healey, J.M., McCall, W., Loheide, S.P., and Garnett, E., 2000, Hydraulic tests with direct-push equipment (abs.): EOS, v. 81, no. 19, p. S239

- Butler, J.J., Jr., Healey, J.M., Schulmeister, M.K., and Zheng, L. (2001) A field assessment of direct-push technology for site characterization investigations (abs.), Proc. 18th Annual Water and the Future of Kansas Conf., p. 21. (abstract available at: http://www.kgs.ukans.edu/Hydro/DirectPush/Abstracts/future_2001.html)

- Butler, J.J., Jr., J.M. Healey, L. Zheng, W. McCall, and M.K. Schulmeister. 1999a. Hydrostratigraphic characterization of unconsolidated alluvium with direct-push sensor technology (abstract). GSA 1999 Annual Meeting Abstracts with Program. v. 31, no. 7: A350 (full report (Kansas Geological Survey Open-File Rept. 99-40) available at www.kgs.ukans.edu/Hydro/Publications/OFR99_40/index.html).

- Butler, J.J., Jr., J.M. Healey, V.A. Zlotnik, and B.R. Zurbuchen. 1998. The dipole flow test for site characterization: Some practical considerations (abstract). EOS 79, no. 17: S153 (full report (Kansas Geological Survey Open-File Rept. 98-20) available at www.kgs.ukans.edu/Hydro/Publications/OFR98_20/index.html).

- Butler, J.J., Jr., J.M. Healey, W. McCall, E.J. Garnett, and S.P. Loheide, II. Hydraulic tests with direct-push equipment. Ground Water: in review.

- Byrnes, M.E. 1994. Field Sampling Methods for Remedial Investigations. Lewis Publishers. Ann Arbor, Michigan.

- Campbell, J.A. and W.R. Mabey. 1985. A Systematic Approach for Evaluating the Quality of Ground Water Monitoring Data. Ground Water Monitoring Review 5(4):58-62.

- Canova, J.L. and M.G. Muthig. 1991. The Effect of Latex Gloves and Nylon Cord on Ground Water Sample Quality. Ground Water Monitoring Review 11(2):98-103.

- Cheremisinoff, Paul N., Groundwater-leachate: modeling, monitoring, sampling, Technomic Pub. Co., Lancaster, Pa., 1984.

- Cherry, J.A. 1994. Groundwater monitoring: some current deficiencies and alternative approaches. Hazardous waste site investigations: Toward better decisions. Lewis Publishers.

- Clark, S.B., N.M. Park and R.C. Tuckfield. 1992. Effects of Sample Collection Device and Filter Pore Size on Concentration of Metals in Groundwater Samples (U). In: Nat. Groundwater Sampling Symp. Proc. (Washington, DC), Grundfos Pumps Corp., Clovis, CA, pp. 13-19.

- Clausen, J.L. and D.K. Solomon. 1994. Characterization of Ground Water Plumes and DNAPL Source Zones Using a Driven Discrete-Depth Sampling System. Martin Marietta Energy Systems.

- Cullen, S.J. 1995. Vadose Zone Monitoring: Experiences and Trends in the United States. Ground Water Monitoring Review 15(3):136-143.

- Cullen, S.J., J.H. Dramer, L.G. Everett and L.A. Eccles. 1992. Is Our Ground Water Monitoring Strategy Illogical? Ground Water Monitoring Review 12(3):103-107.

- Dalton, M.G., B.E. Huntsman, and K. Bradbury. 1991. Acquisition and Interpretation of Water level Data. In: Practical Handbook of Ground-Water Monitoring, Lewis Publishers, Chelsa, MI, pp. 367-395.

- Devlin, J.F. 1987. Recommendations Concerning Materials and Pumping Systems used in the Sampling of Grounwater Contaminated with Volatile Organics. Water Pollution Research Journal of Canada 22(1):65-72.

- Domenico, P.A. and F.W. Schwartz. 1990. Physical and Chemical Hydrogeology. John Wiley & Sons, Inc., New York, New York.

- Driscoll, F. G. 1987. Ground-Water and Wells. St. Paul: Johnson Filtration Systems, Inc.

- Durham, G.N. and T.G. Bumala. 1992. Using Vibration Strip Transducers for Measuring Water Levels in Monitoring Wells. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 273-280.

- Durham, G.N. and T.G. Bumala. 1992. Using Vibration Strip Transducers for Measuring Water Levels in Monitoring Wells. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 273-280.

- Edil, T.B., July 8, 1988, Sealing Characteristics of Selected Grouts for Water Wells, Report of the Third Phase Experiment: Wisconsin Department of Natural Resources, 30 p.

- Edil, T.B., M.M.K. Chang, L.T. Lan and T.V. Riewe, 1992, Sealing Characteristics of Selected Grouts for Water Wells: Groundwater Journal, V. 30, No. 3, pp. 351-361.

- Ehrenzeller, J.L., F.G. Bader, and V.E. Keys. 1991. Using the Cone Penetrometer and HydroPunch™ Method to Collect Reconnaissance Ground Water Samples. Ground Water Management 5:733-746 (5th National Outdoor Action Conference).

- Einarson, M.D. 1995. Enviro-CoreTM -- A new vibratory direct-push technology for collecting continuous soil cores. In Proceedings of the 9th national outdoor action conference. National Ground Water Association, Columbus, OH.

- EnviroTech. 1996. EnviroTech Product Catalog 1995-1996. Martinez: EnviroTech.

- EnviroTech. 1996. Product Catalog. Martinez: EnviroTech.

- Everett, L.G., E. W. Hoylman, L. Graham, and L. G., McMillion. 1984. Constraints and Categories of Vadose Zone Monitoring Devices. Ground Water Monitoring Review, Winter 1984, pp. 26-32.

- Everett, L.G., L.G. Wilson and L. G. McMillion. 1982. Vadose Zone Monitoring Concepts for Hazardous Waste Sites. Ground Water, Vol 20, May/June 1982, pp. 312-324.

- Everett, Lorne G., Groundwater Monitoring: guidelines and methodology for developing and implementing a groundwater quality monitoring program, General Electric Company, Technology Marketing, Schenectady, N.Y. 1986.

- Feld, J., J.P. Connelly and D.E. Lindorff. 1984. Ground Water Sampling - Addressing the Turbulent Inconsistencies. Wisc. Dept. Nat. Resources (WDNR), WDNR, Madison, WI, 15 pp. unpubl.

- Fetter, C.W. 1993. Contaminant Hydrogeology. Macmillan Publishing Co., New York, New York.

- Freeze, R. A. & Cherry, J. A., Groundwater, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.

- Gaber, M.S., and B.O. Fisher, 1988, Michigan Water Well Grouting Manual: Ground Water Quality Control Section, Division of Water Supply, Bureau of Environmental and Occupational Health, Michigan Department of Public Health, Lansing, Michigan, Report GW-3-302.

- Garner, S. 1988. Making the Most of Field-Measurable Ground Water Quality Parameters. Ground Water Monitoring Review 8(3):60-65.

- Garnett, E., McCall, W., Butler, J.J., Jr., and Healey, J.M., 2000, Determination of hydraulic conductivity with slug tests in direct push tools (abs.): Proc. of the 2000 Petroleum Hydrocarbons and Organic Chemicals in Ground Water Conf., p. 158

- Gass, T.E. 1991. Test Results of the Grundfos Ground-Water Sampling Pump. Ground Water Management 5:553-565 (5th National Outdoor Action Conference).

- Gass, T.E., 1988, Monitoring Well Filter Pack and Screen Slot Selection: A Reassessment of Design Parameters: Water Well Journal, v. 42, no. 5, pp. 30-32.

- Gass, T.E., 1989, Monitoring Wells in Non-Aquifer Formations: Water Well Journal, v. 43, no. 2, pp. 27-28.

- Gerba, C.P. 1988. Methods for Virus Sampling and Analysis of Ground Water. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society for Testing and Materials, Philadelphia, PA, pp. 343-348.

- Gibs, J. and T.E. Imbrigiotta. 1990. Well-Purging Criteria for Sampling Organic Compounds. Ground Water 28(1):68-78.

- Gibs, J., T.E. Imbrigiotta, J.H. Ficken, J.F. Pankow and M.E. Rosen. 1994. Effects of Sample Isolation and Handling on the Recovery of Purgeable Organic Compounds. Ground Water Monitoring Review 14(2):142-152.

- Greenberg, A.E., L.S. Clesceri and A.D. Eaton (eds.). 1992. Standard Methods for the Examination of Water and Wastewater, 18th Edition, American Public Health Association, Washington DC.

- Halliburton Services, 1975, Halliburton Cementing Tables: Halliburton Company, Duncan, Oklahoma.

- HAZCO. 1996. Instrument Rental and Environmental Products Catalog. Dayton: HAZCO Services, Inc.

- Hergoz, B.L., J.D. Pennino and G.L. Nielsen. 1991. Ground-Water Sampling. In: Practical Handbook of Ground-Water Monitoring, Lewis Publishers, Chelsa, MI, pp. 449-499.

- Hergoz, B.L., J.D. Pennino, and G.L. Nielsen. 1991. Ground-Water Sampling. In: Practical Handbook of Ground-Water Monitoring, Lewis Publishers, Chelsa, MI, pp. 449-499.

- Hergoz, B.L., S.J. Chou, J.R. Valkenburg and R.A. Griffin. 1988. Changes in Volatile Organic Chemical Concentrations After Purging Slowly Recovering Wells. Ground Water Monitoring Review 8(4):93-99.

- Hewitt, A.D. 1992. Potential of Common Well Casing Materials to Influence Aqueous Metal Concentrations. Ground Water Monitoring Review 12(2):131-136.

- Hinsby, K., P.L. Bjerg, L.J. Andersen, B. Skov, and E.V. Clausen. 1992. A mini slug test method for determination of a local hydraulic conductivity of an unconfined sandy aquifer. Jour. of Hydrology 136: 87-106.

- Holm, T.R., G.K. George and M.J. Barcelona. 1988. Oxygen Transfer through Flexible Tubing and Its Effects on Ground Water Sampling Results. Ground Water Monitoring Review 8(3):83-89.

- Hvorslev, M.J. 1951. Time lag and soil permeability in ground-water observations. Bull no. 36. Waterways Exper. Sta., Corps of Engrs., U.S. Army.

- Iles, D.L., P.D. Hammond, and L.D. Schulz. 1992. Effects of Sampling Methods on Inorganic Water Chemistry Results. In: Nat. Groundwater Sampling Symp. Proc. (Washington DC), Grundfos Pumps Corp., Clovis, CA, pp. 41-68.

- Imbrigiotta, T.E., J. Gibbs, T.V. Fusillo, G.R. Kish and J.J. Hochreiter. 1988. Field Evaluation of Seven Sampling Devices for Purgeable Organic Compounds in Ground Water. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society of Testing and Materials, Philadelphia, PA, pp. 258-273.

- Jammallo, J.M. 1990. Field Filtering of Water Samples - A Device for Consideration. Ground Water Management 2:347-351 (4th National Outdoor Action Conference).

- Kaback, D.S., C.L. Bergren, C.A. Carlson and C.L. Carlson. 1990. Testing a Ground Water Sampling Tool: Are the Samples Representative? Ground Water Management 2:403-417 (4th NOAC).

- Kaback, D.S., C.L. Bergren, C.A. Carlson, and C.L. Carlson. 1990. Testing a Ground Water Sampling Tool: Are the Samples Representative? Ground Water Management 2:403-417 (4th NOAC).

- Karklins, S., Lenon, J.. 1996. Groundwater Sampling Field Manual PUBL-DG-038 96. Wisconsin Department of Natural Resources. Bureau of Drinking Water and Groundwater

- Kaminski, D.B. 1994. Guidelines For Choosing Sampling Equipment. Ground Water Age 28(10):10- 11.

- Kearl, P.M., N.E. Korte and T.A. Cronk. 1992. Suggested Modifications to Ground Water Sampling Procedures Based on Observations From the Colloidal Borescope. Ground Water Monitoring Review 12(2):155-160.

- Keely, J.F., and Kwasi Boateng, 1987, Monitoring Well Installation, Purging, and Sampling Techniques-Part I: Conceptualizations: Groundwater, v. 25, no. 3, pp. 300-313.

- Keith, L.H. (editor) 1992. Environmental Sampling and Analysis: A Practical Guide. Lewis Publishers, Chelsea, MI.

- Kent, R.T. and D.E. Payne. 1988. Sampling Groundwater Monitoring Wells - Special Quality Assurance and Quality Control Considerations. In: Principles of Environmental Sampling, L.H. Keith (ed.), ACS Professional Reference Book, American Chemical Society, Washington, DC, pp. 230-246.

- Knobel, L.L. and L.J. Mann. 1993. Sampling for Purgeable Organic Compounds Using Positive- Displacement Piston and Centrifugal Submersible Pumps: A Comparative Study. Ground Water Monitoring and Remediation 13(2):142-148.

- Langenheim R. L. and M. K. Schulmeister (1987) Virgin River Gorge: Boundary between the Colorado Plateau and the Great Basin in Northwestern Arizona. In Geological Society of America Centennial Field Guide 8 Cordilleran Section (M.L. Hill, ed.) p 43-47.

- Lanier, A.A., Sellwood, S.M., Butler, J.J., Jr., Healey, J.M., McCall, W., and Garnett, E., 2000, Direct-push hydraulic profiling in an unconsolidated alluvial aquifer (abs.): Geological Society of America, 2000 Annual Meeting, Abstracts with Program, v. 32, no.7, p. A271

- Liikala, T.L., D.S. Daly and A.P. Toste. 1988. An Evaluation of the Effects of Well Construction Materials and Ground-water Sampling Equipment on Concentrations of Volatile Organic Compounds. PNL-6585 UC-11, Pacific Northwest Laboratory, Richland, Washington.

- Lindorff et al. 1987. Groundwater Sampling Procedures Guidelines. Madison: Wisconsin Department of Natural Resources.

- Lutenegger, A.J. and D.J. DeGroot. 1995. Techniques for sealing cone penetrometer holes. Canadian Geotech. J. October.

- MacFarlane, I.D., J.L. Kocornik, F.T. Barranco and A.R. Bonas. 1992. The Application of Slow Pumping at a Manufactured Gas Plant. Ground Water Management 11:413-425 (6th National Outdoor Action Conference).

- Mackiewicz, M.C. 1990. A Simple 11-Step Procedure to Document the Accuracy, Precision and Significance of Measurements by Field Instrumentation. Ground Water Management 2:373-383 (4th National Outdoor Action Conference).

- Macpherson G. L. and M. K. Schulmeister (1994) Sources, fate and residence time of nitrate at two sites in Kansas: A comparison of carbonate and alluvial Aquifers. Kansas Water Resources Research Institute, Rpt# G2020-08, 81 p.

- MacPherson, J.M and J.F. Pankow. 1988. A Discrete Point Sampler for Ground Water Monitoring Wells. Ground Water Monitoring Review 8(3):161-164.

- Maltby, V. and J.P. Unwin. 1988. A Field Investigation of Ground-Water Monitoring Well Purging Techniques. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 281-299.

- Maslansky, S.P. and C.J. Maslansky. 1991. Health and Safety Considerations in Ground-Water Monitoring Investigations. In: Practical Handbook of Ground-Water Monitoring, Lewis Publishers, Chelsa, MI, pp. 589-623.

- McAlary, T.A. and J.F. Barker. 1987. Volatilization Losses of Organics During Ground Water Sampling from Low Permeability Materials. Ground Water Monitoring Review 7(4):63-68.

- McCall, W., Butler, J.J., Jr., Healey, J.M., and E. Garnett, E., 2000, A dual-tube direct push method for vertical profiling of hydraulic conductivity in unconsolidated aquifers (abs.): Geological Society of America, 2000 Annual Meeting, Abstracts with Program, v. 32, no.7, p. A522

- McElwee, C.D., J.J. Butler, Jr., and J.M. Healey. 1991. A new sampling system for obtaining relatively undisturbed cores of unconsolidated coarse sand and gravel. Ground Water Monitoring Review 11, no. 3: 182-191.

- McGuire, P.E. and Lowery, B. 1992. Evaluation of Several Vacuum Solution Samplers in Sand and Silt Loam at Several Water Potentials. Ground Water Monitoring Review 12(4):151-160.

- McGuire, P.E., Lowery, B. and Helmke, P.A. 1992. Potential Sampling Error: Trace Metal Adsorption on Vacuum Porous Cup Samplers. Soil Science Society of America 56(1):74-81.

- Means, R. S. 1996b. Environmental Restoration Assemblies Cost Book. Kingston: R. S. Means Company, Inc., and Delta Technologies Group, Inc.

- Meredith, D.V. and D.A. Brice. 1992. Limitations on the Collection of Representative Samples for Small Diameter Monitoring Wells. Ground Water Management II:429-439 (6th National Outdoor Action Conference).

- Merry, W. M., and C. M. Palmer. 1986. Installation and Performance of a Vadose Monitoring System. Proceedings of the NWWA Conference on Characterization and Monitoring of the Vadose Zone, NWWA, pp. 107-125.

- Meyer, Jr., K.A. 1990. Dedicated Ground Water Sampling Systems--A Technical and Economic Evaluation. Ground Water Management 2:341-346 (4th National Outdoor Action Conference).

- Mickam, J.T., R. Bellandi and E.C. Tifft Jr. 1989. Equipment Decontamination Procedures for Groundwater and Vadose Zone Monitoring Programs: Status and Prospects. Ground Water Monitoring Review 9(2):100-121.

- Miller, G.P. 1993. Representative Groundwater Samples Call For Proper Protocols. Hazmat World. November, 1993. pp. 42-46.

- Mines, B.S., J.L. Davidson, D. Bloomqyuist, and T.B. Stauffer. 1993. Sampling of VOCs with the BAT Ground Water Sampling System. Ground Water Monitoring and Remediation 13(1):115-120.

- Minnesota Pollution Control Agency, Leaking Petroleum Storage Tanks, Soil Sample Collection and Analysis Procedures, Fact Sheet #3.22

- Morley, D.P. 1995. Direct push: Proceed with caution. In Proceedings of the 9th national outdoor action conference. National Ground Water Association, Columbus, OH.

- Muska, C.F., W.P. Colven, V.D. Jones, J.T. Scogin, B.B. Looney and V. Price. 1986. Field Evaluation of Ground Water Sampling Devices for Volatile Organic Compounds. In: Proc. 6th Nat. Symp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Worthington, OH, pp. 235-246.

- Nevada Division of Environmental Protection, Guidance Document For Design Of Groundwater Monitoring Wells, Wts - 4, (Revised 1996)

- New York State Department of Environmental Conservation, December 31, 1988, 6 NYCRR Part 360: Solid Waste Management Facilities: New York State Department of Environmental Conservation Division of Solid Waste, Albany, New York.

- Nielsen, D.M. and G.L. Yeates. 1985. A Comparison of Sampling Mechanisms Available for Small- Diameter Ground Water Monitoring Wells. Ground Water Monitoring Review 5(2):83-99.

- Nielsen, G.L. 1991. Decontamination Program Design for Ground-Water Quality Investigations. In: Practical Handbook of Ground-Water Monitoring, Lewis Publishers, Chelsa, MI, pp. 625-636.

- Occupation Safety and Health Administration, U.S. Department of Labor, 1989, 29 CFR Part 1910, Hazardous Waste Operation and Emergency Response: 54 FR 9294, March 6, 1989.

- Olson, C.M. 1991. The Development and Implementation of a Remedial Investigation Work Plan and Data Management System. Ground Water Monitoring Review 11(3):145-152.

- Oregon Department of Environmental Quality, DEQ Guidance Document, Groundwater Monitoring Well Drilling, Construction, and Decommissioning, August 24, 1992.

- Oregon Water Resources Department, 1990, OAR Chapter 690, Division 200, Rules and Regulations Prescribing General Standards for the Construction and Maintenance of Wells in Oregon: Oregon Water Resources Department, Salem, Oregon.

- Oregon Water Resources Department, 1990, OAR Chapter 690, Division 240, Construction and Maintenance of Monitoring Wells and Other Holes in Oregon: Oregon Water Resources Department, Salem, Oregon.

- Ostergren, C., and J.P. Connelly. 1994. Slow Pumping versus Field Filtering Analysis with Respect to Implementation. Wisc. Dept. Natural Resources (WDNR), WDNR, Madison, WI, unpubl.

- Palmer, C.D., J.F. Keely, and W. Fish. 1987. Potential for Solute Retardation on Monitoring Well Sand Packs and Its Effect on Purging Requirements for Ground Water Sampling. Ground Water Monitoring Review 7(2):40-47.

- Panko, A.W. and P. Barth. 1988. Chemical Stability Prior to Ground-Water Sampling: A Review of Current Well Purging Methods. In: Ground-Water

Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society of Testing and Materials, Philadelphia, PA, pp. 232-239.

- Parker, L.V. 1992. Suggested Guidelines for the Use of PTFE, PVC and Stainless Steel in Samplers and Well Casings. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, pp. 217-229.

- Parker, L.V. 1994. The Effects of Ground Water Sampling Devices on Water Quality: A Literature Review. Ground Water Monitoring Review 14(2):130-141.

- Parker, T.K., M.F. Eisen, A.A. Kopania, A. Robertson, R.L. Eades and G. Thomas. 1992. Selection, Design, Installation and Evaluation of Dedicated Groundwater Sampling Systems; A Case Study. In: Nat. Groundwater Sampling Symp. Proc. (Washington DC), Grundfos Pumps Corp., Clovis, CA, pp. 89-106.

- Pastor, E.F. and D.R. Frick. 1992. Considerations in Selecting Indicator Parameters for the Statistical Evaluation of Ground-Water Quality. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 411-425.

- Patterson, B.M., T.R. Power and C. Barber. 1993. Comparison of Two Integrated Methods for the Collection and Analysis of Volatile Organic Compounds in Ground Water. Ground Water Monitoring Review 13(3):118-123.

- Paul, C.J. and R.W. Puls. 1992. Comparison of Ground-Water Sampling Devices Based On Equilibration of Water Quality Indicator Parameters. In: Nat. Groundwater Sampling Symp. Proc. (Washington, DC), Grundfos Pumps Corp., Clovis, CA, pp. 21-39.

- Pearsall, K.A. and D.A.V. Eckhardt. 1987. Effects of Selected Sampling Equipment and Procedures on the Concentrations of Trichloroethylene and Related Compounds in Ground Water Samples. Ground Water Monitoring Review 7(2):64-73.

- Pennino, J.D. 1988. There's No Such Things as a Representative Ground Water Sample. Ground Water Monitoring Review 8(3):4-9.

- Pennino, J.D. 1990. Total Versus Dissolved Metals: Implications for Preservation and Filtration. In: Ground Water and Vadose Zone Monitoring, D.M. Nielsen and A.I. Johnson (eds.), ASTM STP 1053, American Society for Testing and Materials, Philadelphia, PA, pp. 238-246.

- Pennino, J.D. 1990. Total Versus Dissolved Metals: Implications for Preservation and Filtration. In: Ground Water and Vadose Zone Monitoring, D.M. Nielsen and

A.I. Johnson (eds.), ASTM STP 1053, American Society for Testing and Materials, Philadelphia, PA, pp. 238-246.

- Peters, C.A. and Healy, R.W. 1988. The Representativeness of Pore Water Samples Collected from the Unsaturated Zone Using Presure-vacuum Lysimeters. Ground Water Monitoring Review 8(2):96-101.

- Pettyjohn, W.A. 1982. Cause and Effect of Cyclic Changes in Ground-Water Quality. Ground Water Monitoring Review 2(1):43-49.

- Pionke, H.B. and J.B. Urban. 1987. Sampling the Chemistry of Shallow Aquifer Systems -- A Case Study. Ground Water Monitoring Review 7(2):79-88.

- Pitkin, S., R.A. Ingleton, and J.A. Cherry. 1994. Use of a drive point sampling device for detailed characterization of a PCDE plume in a sand aquifer at a dry cleaning facility. In Proceedings of the 8th national outdoor action conference. National Ground Water Association, Columbus, OH.

- Pohlmann, K.F. and J.W. Hess. 1988. Generalized Ground Water Sampling Device Matrix. Ground Water Monitoring Review 8(4):82-83.

- Pohlmann, K.F., R.P. Blegen and J.W. Hess. 1990. Field Comparisons of Ground-Water Sampling Devices for Hazardous Waste Sites: An Evaluation Using Volatile Organic Compounds. U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nevada. National Technical Information Service, Springfield, Virginia. EPA/600/4-90-028 (NTIS PB91-181776).

- Puls, R.W. 1994. A New Approach to Purging Monitoring Wells. Ground Water Age 28(5):18-19.

- Puls, R.W. and J.H. Eychaner. 1990. Sampling of Ground Water for Inorganics--Pumping Rate, Filtration and Oxidation Effects. Ground-Water Management 2:313-327 (4th National Outdoor Action Conference).

- Puls, R.W. and M.J. Barcelona. 1989b. Filtration of Ground Water Samples for Metal Analysis. Hazardous Wastes and Hazardous Materials 6(4):385-393.

- Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Ground Water Quality Samples for Metals. Ground Water Monitoring Review 12(3):167-176.

- Puls, R.W. and R.M. Powell. 1992. Acquisition of Representative Ground Water Quality Samples for Metals. Ground Water Monitoring Review 12(3):167-176.

- Rajagopal, R. 1986. The Effect of Sampling Frequency on Ground Water Quality Characterization. Ground Water Monitoring Review 6(4):65-73.

- Rannie, E.H. and R.L. Nadon. 1988. An Inexpensive, Multi-Use, Dedicated Pump for Ground Water Monitoring Wells. Ground Water Monitoring Review 8(4):100-107.

- Regan, P.T., J.A Conte and M.M. Mitchel. 1992. The Need for Improved Use of Geologic Data in Ground Water Investigations. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 24-37.

- Riggs, C.O. and Hathewaty A.W. 1988. Ground-Water Monitoring Field Practice-An Overview. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society for Testing and Materials, Philadelphia, PA, pp. 121-136.

- Robin, M.J.L. and R.W. Gillham. 1987. Field Evaluation of Well Purging Procedures. Ground Water Monitoring Review 7(4):85-93.

- Ronen, D., M. Magaritz and I. Levy. 1987. An In Situ Multilevel Sampler for Preventive Monitoring and Study of Hydrochemical Profiles in Aquifers. Ground Water Monitoring Review 7(4):69-73

- Rose, S. and A. Long. 1988. Monitoring Dissolved Oxygen in Ground Water: Some Basic Considerations. Ground Water Monitoring Review 8(1):93-97.

- Ross, C.G.A., R.A. Niemeyer, and T.D. Blackman. 1992. A Method for Reducing Purge Volumes in Deep Monitoring Wells, A Purging Experiment. Ground Water Management 11:45-58 (6th National Outdoor Action Conference).

- Sabel, G.V., and T.P. Clark, April 1985, Procedures for Ground Water Monitoring: Minnesota Pollution Control Agency Guidelines: Minnesota Pollution Control Agency, Solid and Hazardous Waste Division Program Development Section.

- Saunders, R.D. 1995. Direct Push Technology: Concept Comes of Age. Environmental Protection 6(1):37-39.

- Schaal, W. 1992. Is Well Purging with Vacuum a Reliable Cost-Saving Technique when Testing for Volatile Organic Compounds? Ground Water Management 11:401-412 (6th National Outdoor Action Conference).

- Schalla, R. 1992. Deployment and Purging for In Situ Sensors in Monitoring Wells. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 300-309.

- Schalla, R., D.A. Myers, M.A. Simmons, J.M. Thomas and A.P. Toste. 1988. The Sensitivity of Four Monitoring Well Sampling Systems to Low Concentrations of Three Volatile Organics. Ground Water Monitoring Review 8(3):90-96.

- Schulmeister M. K. (1994) The Origin of naturally occurring nitrate in soil and ground water--A preliminary report. Proc. 6th Ann. Konza Prairie Workshop, Manhattan, Ks. 33 p.

- Schulmeister M. K. (1996) Nitrate reduction, hydrology, and chemical evolution of groundwater in fine-grained alluvial sediments. Proc. Geol. Soc. of Am. Ann. meeting, 28 (7) p 258.

- Schulmeister M. K. and G. L. Macpherson (1994) Spatial and temporal variations in *15N of NO3- N-preliminary evaluation of an alluvial aquifer in Kansas, USA. Proc. Geol. Soc. of Am. Ann. meeting, 26, (6) p 23.

- Schulmeister, M. K, L. Zheng, J. J. Butler, J. M. Healey, W. A. McCall, and D. Wysocki (2000) Detailed hydrostratigraphic characterization with direct-push electrical conductivity (EC) profiling AGU Eos, Suppl., 81 (19) p S238.

- Schulmeister, M.K., J.J. Butler, Jr., D.O. Whittemore, S. Birk, J.M. Healey, G.W. McCall., S.M. Sellwood and M.A. Townsend (2001) A new direct-pushed-based approach for the chemical investigation of stream-aquifer interactions. Geol. Soc. of Am. Abst. with Prog. v. 33, no. 6, p 426.

- Schulmeister, M.K., S.M. Birk, J.M. Healey, J.J. Butler, Jr. , D.O. Whittemore,and H. Weiss (2001) Direct-push-installed, gas-driven mini-pumps for discrete-point groundwater sampling: A new in-situ approach to long-term monitoring. Eos v. 82, no. 47, p. 402.

- Schulmeister, M.K., Zheng, L., Butler, J.J., Jr., Healey, J.M., McCall, W., and Wysocki, D.A., 2000, Detailed hydrostratigraphic characterization with direct-push electrical conductivity profiling (abs.): EOS, v. 81, no. 19, p. S238

- Shafer J. M., H. A. Wehrmann, M. K. Schulmeister, and S. Schock (1988) A Plan for the comprehensive evaluation of the occurrence, transport and fate of groundwater contaminants in the Lake Calumet area of southeast Chicago. Illinois Hazardous Waste Research and Information Center, Technical Notes #88-101.

- Shaver, R.B. 1993. Field vs. Lab Alkalinity and pH: Effects on Ion Balance and Calcite Saturation Index. Ground Water Monitoring Review 13(2):104-112.

- Siegrist, R.L. and P.D. Jenssen. 1990. Evaluation of sampling method effects on volatile organic compound measurements in contaminated soils, Environ. Sci. and Technology. Vol. 24: 1387-92.

- Singogo W., W. K. Dodds, C. W. Rice, M. K. Schulmeister and G. L. Macpherson (1995) Ground water physical and chemical patterns in an agricultural and a prairie Ecosystem. Proc. 12th. Ann. Water and the Future of Kansas Conf., Manhattan, Ks.

- Smith, J.S., D.P. Steele, M.J. Malley and M.A. Bryant. 1988. Groundwater Sampling. In: Principles of Environmental Sampling, L.H. Keith (ed.), ACS Professional Reference Book, American Chemical Society, Washington, DC, pp. 255-262.

- Snow D.D., M.E. Burbach and R.F. Spalding. 1992. GroundWater Sampler Comparison Pesticide and Nitrate Concentrations. In: Nat. Groundwater Sampling Symp. Proc. (Washington DC), Grundfos Pumps Corp., Clovis, CA, pp. 77-87.

- Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992, American Public Health Association, Washington DC.

- Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995, American Public Health Association, Washington DC.

- Stolzenburg, T.R. and D.G. Nichols. 1985. Preserving the Chemical Integrity of a Ground Water Sample. In: Proc. 4th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Worthington, OH, pp. 221-225.

- Stolzenburg, T.R. and D.G. Nichols. 1986. Effects of Filtration Method and Sampling Devices on Inorganic Chemistry of Sampled Well Water. In: Proc. 6th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Dublin, OH, pp. 216-234.

- Strutynsky, A.I. and T.J. Sainey. 1992. Use of Piezometric Cone Penetration Testing and Penetrometer Ground Water Sampling for Volatile Organic Contaminant Plume Detection. In: Current Practices in Ground Water and Vadose Zone Investigations, ASTM STP 1118, D.M. Nielsen and M.N. Sara (eds.), American Society for Testing and Materials, Philadelphia, PA, pp. 199-213.

- Summers, K.V. and S.A. Gherini. 1987. Sampling Guidelines for Groundwater Quality. EPRI EA- 4952, Electric Power Research Institute, Palo Alto, CA.

- Svavarsson, G., J.P. Connelly, and H. Kuehling. 1995. A Comparison of Low Flow Pumping and Bailing for VOC Groundwater Sampling at Landfills. Wisc. Dept. Natural Resources (WDNR), WDNR, Madison, WI, unpubl.

- Tai, D.Y., K.S. Turner and L.A. Garcia. 1991. The Use of a Standpipe to Evaluate Ground Water Samplers. Ground Water Monitoring Review 11(1):125-132.

- Texas Natural Resource Conservation Commission, Texas Administrative Code, Title 30, Environmental Quality, Part 1, Chapter 330, Municipal Solid Waste,

Subchapter I, Groundwater Monitoring And Corrective Action Rule §330.242 - Monitor-Well Construction Specifications.

- Thomey, N., R. Ogle and J. Jackson. 1991. A Comparison of Results for Samples Collected with Bailers Constructed of Different Materials. Ground Water Management 5:577-582 (5th National Outdoor Action Conference).

- Trela, J.J. 1986. Should Ground Water Samples from Monitoring Wells Be Filtered Before Laboratory Analysis? Yes and No. In: Proc. 6th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Dublin OH, pp. 295-300.

- U. S. Environmental Protection Agency. 1993a. Subsurface Characterization and Monitoring Techniques: a Desk Reference Guide, Vol. 1 (EPA/625/R-93/003a). Cincinnati: Center for Environmental Research Information, U.S. Environmental Protection Agency.

- U.S. Environmental Protection Agency (EPA). 1986a. RCRA Ground Water Monitoring Technical Enforcement Guidance Document. EPA/530/SW-86/055. Published in NWWA/EPA Series, National Water Well Association, Dublin, OH. pp. 24-127.

- U.S. Environmental Protection Agency (EPA). 1986b. Permit Guidance Manual on Unsaturated Zone Monitoring for Hazardous Waste Land Treatment Units. Environmental Monitoring Systems Laboratory, Office of Solid and Emergency Response, EPA/530-SW-86-040.

- U.S. Environmental Protection Agency (EPA). 1987. Data Quality Objectives for Remedial Response Activities. U.S. Environmental Protection Agency, Washington, D.C. EPA/540/G-87/003.

- U.S. Environmental Protection Agency (EPA). 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance. U.S. Environmental Protection Agency, Washington, D.C. EPA/530/R-93/001.

- U.S. Environmental Protection Agency (EPA). 1993. Subsurface Characterization and Monitoring Techniques; A Desk Reference Guide. Volume 1: Solids and Ground Water. U.S. Environmental Protection Agency, Washington, D.C. EPA/625/R-93/003a.

- U.S. Environmental Protection Agency (EPA). 1994. Evaluation of Sampling and Field-Filtration Methods for the Analysis of Trace Metals in Ground Water. Environmental Monitoring Systems Laboratory, Office of Research and Development, EPA/600/R-94/119.

- U.S. Environmental Protection Agency (EPA). 1995. Ground Water Sampling - A Workshop Summary. U.S. Environmental Protection Agency, Washington, D.C. EPA/600/R-94/205.

- U.S. Environmental Protection Agency EPA/625/R-93\/003a 1993.

- U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response, OSWER9950.1. Subsurface Characterization and Monitoring Techniques.

- U.S. Environmental Protection Agency, September 1986, RCRA Ground Water Monitoring Technical Enforcement Guidance Document.

- U.S. Environmental Protection Agency. 1993a. Subsurface Characterization and Monitoring Techniques: a Desk Reference Guide, Vol. 1 (EPA/625/R-93/003a). Cincinnati: Center for Environmental Research Information, U.S. Environmental Protection Agency.

- U.S. EPA, 1997. Expedited Site Assessment Tools for Underground Storage Tank Sites: A Guide for Regulators, EPA 510-B-97-001.

- USEPA Test Method for the Evaluation of Solid Waste (SW-846), 3rd Edition, **1996**.

- Unwin, J. and V. Maltby. 1988. Investigations of Techniques for Purging Ground-Water Monitoring Wells and Sampling Ground Water for Volatile Organic Compounds. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society for Testing and Materials, Philadelphia, PA, pp. 240-252.

- Unwin. J.P. 1984. Sampling Ground Water for Volatile Organic Compounds: The Effects of Sampling Method, Compound Volatility and Concentration. In: Proc. 4th Nat. Symp. and Exp. on Aquifer Restoration and Ground Water Monitoring, National Water Well Association, Worthington, OH, pp. 214-220.

- Van Ee, J.J. and Mcmillion, L.G. 1988. Quality Assurance Guidelines for Ground-Water Investigations: The Requirements. In: Ground-Water Contamination: Field Methods, A.G. Collins and A.I. Johnson (eds.), ASTM STP 963, American Society for Testing and Materials, Philadelphia, PA, pp. 27-34.

- Visocky A. P. and M. K. Schulmeister (1988) Groundwater nvestigations for siting the Superconducting, Super Collider in northeastern Illinois. Illinois State Water Survey Circular #170, 80 p.

- Walton-Day, K., D.L. Macalady, M.H. Brooks and V.T. Tate. 1990. Field Methods for Measurement of Ground Water Redox Chemical Parameters. Ground Water Monitoring Review 10(4):81-89.

- Wilson , L.G. 1980. Monitoring in the Vadose Zone: A Review of Technical Elements and Methods, U. S. Environmental Protection Agency, EPA-600/7-80-134.

- Wilson, L.G. 1981. Monitoring in the Vadose Zone. Ground Water Monitoring Review, Summer 1981, pp. 44-51.

- Wilson, L.G. 1981. The Fate of Pollutants in the Vadose Zone, Monitoring Methods and Case Studies. Thirteenth Biennial Conference on Ground Water.

- Wilson, L.G. 1982. Monitoring in the Vadose Zone: Part II. Ground Water Monitoring Review, Winter 1982, pp. 31-42.

- Wilson, L.G. 1983. Monitoring in the Vadose Zone: Part III. Ground Water Monitoring Review, Winter 1983, pp. 155-165.

- Wilson, L.G. 1990. Methods for Sampling Fluids in the Vadose Zone. Ground Water and Vadose Zone Monitoring, ASTM STP 1053, pp. 7-24.

- Wilson, L.G., L.G. Everett, S.J. Cullen. 1995. Handbook of Vadose Zone Characterization and Monitoring, Lewis Publishers, Boca Raton, FL.

- Wilson, N. 1995. Soil Water Monitoring Devices. In: Soil Water and Ground Water Sampling, Lewis Publishers, Boca Raton, FL, pp. 15-29.

- Wisconsin Department of Natural Resources, 1987, Chapter NR 141, Groundwater Monitoring Well Requirements: Wisconsin Department of Natural Resources, Madison, Wisconsin.

- Wisconsin Department of Natural Resources, April 1985, Guidelines for Monitoring Well Installation, Wisconsin Department of Natural Resources, Madison, Wisconsin.

- Wisconsin Department of Natural Resources, January 1988, Chapter NR 508, Landfill Monitoring, Remedial Actions and In-Field Conditions Reports: Wisconsin Department of Natural Resources, Madison, Wisconsin.

- Yeskis, D., K. Chiu, S. Meyers, J. Weiss and T. Bloom. 1988. A Field Study of Various Sampling Devices and Their Effects on Volatile Organic Contaminants. Proceedings, Second National Outdoor Action Conference, National Water Well Association, pp. 471-479.

- Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker, and L.R. Hilpert. 1992. Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers: BAT Enviroprobe and QED HydroPunch™ . Ground Water Management 11:341-355 (6th National Outdoor Action Conference).

- Zlotnik, V.A., and B.R. Zurbuchen. 1998. Dipole probe: Design and field applications of a single-borehole device for measurements of vertical variations in hydraulic conductivity. Ground Water 36, no. 6: 884-893.

Appendix D

Excerpts of EPA OSWER 9355.4-24 Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites Peer Draft Review

The entire document is available for free download as an Adobe Acrobat® file at http://www.epa.gov/superfund/resources/soil/ssgmarch01.pdf

United States
Environmental Protection
Agency

Solid Waste and
Emergency Response

OSWER 9355.4-24
March 2001

Superfund

EPA

SUPPLEMENTAL GUIDANCE FOR DEVELOPING SOIL SCREENING LEVELS FOR SUPERFUND SITES

Peer Review Draft

2.0 OVERVIEW OF SOIL SCREENING

This chapter of the guidance document provides a brief overview of soil screening evaluations for sites on the NPL. It begins with a definition of the soil screening concept and a discussion of its applicability and limitations, then describes three approaches to conducting soil screening evaluations, and concludes with a review of EPA's seven-step soil screening process. For a more in-depth and comprehensive discussion of these topics, please refer to Chapter 1.0 of EPA's 1996 *SSG*.

2.1 The Screening Concept

As used in this guidance, screening refers to the process of identifying and defining areas, contaminants, and conditions at a site that do not require further federal attention under CERCLA. Site managers make these determinations by comparing measured soil contaminant concentrations to soil screening levels (SSLs). SSLs are soil contaminant concentrations below which no further action or study regarding the soil at a site is warranted under CERCLA, provided that conditions associated with the SSLs are met. In general, areas with measured concentrations of contaminants below SSLs may be screened from further federal attention; if actual concentrations in the soil are at or above SSLs, further study, though not necessarily cleanup action, is required.[4] Exhibit 2-1 summarizes the definition and the applicability of the soil screening process and the associated SSLs.

SSLs are risk-based soil concentrations derived for individual chemicals of concern from standardized sets of equations. These equations combine EPA chemical toxicity data with parameters defined by assumed future land uses and exposure scenarios, including receptor characteristics and potential exposure pathways. Residential SSLs, initially described in the 1996 *SSG* and updated in this document, are based on exposure scenarios associated with residential activities, while non-residential SSLs are based on scenarios associated with non-residential activities.

For each chemical, SSLs are back-calculated from target risk levels. For the inhalation pathway and for the combined direct ingestion/dermal absorption pathway (see Section 3.2), target risk levels for soil exposures are a one-in-a-million ($1x10^{-6}$) excess lifetime cancer risk for carcinogens and a hazard quotient (HQ) of one for non-carcinogens. SSLs for the migration to ground water pathway are back-calculated from the following ground water concentration limits (in order of preference): non-zero maximum contaminant level goals (MCLGs); maximum contaminant levels (MCLs); or health-based limits (based on a cancer risk of $1x10^{-6}$ or an HQ of one).

---

[4] Areas meeting federal SSLs may still require further study. Some EPA Regional Offices and states have developed separate soil screening levels and/or preliminary remediation goals (PRGs) that may be more stringent than those presented in this guidance (though these alternative levels are based on the same general methodology described in this guidance). It is important that site managers confer with regional and state risk assessors when conducting soil screening evaluations to ensure that any SSLs developed will be consistent with their accepted soil levels. To help site managers with this task, EPA has convened a work group to identify differences in approaches to evaluating soil screening or PRGs across regions.

Exhibit 2-1 A GENERAL GUIDE TO THE SCREENING AND SSL CONCEPTS	
Screening **Is:**	Screening **Is Not:**
• A method for identifying and defining areas, contaminants, and conditions at a site that generally do not require further federal attention; • A means of focusing the Remedial Investigation/ Feasibility Study (RI/FS) and site risk assessment; • A means for gathering data for later phases of the Superfund site remediation process.	• Mandatory; • A substitute for an RI/FS or risk assessment; • Valid unless conditions associated with SSLs (e.g., assumed future land use and site activities) are met.
SSLs **Are:**	SSLs **Are Not:**
• Risk-based concentrations; • Levels below which no further action or study is warranted under CERCLA, provided conditions concerning potential exposures and receptors (e.g., future land use) are met; • Specific to assumed exposures and site conditions.	• National cleanup standards; • Uniform across all sites; • Applicable to radioactive contaminants.

Although SSLs are "risk-based," the soil screening process does not eliminate the need to conduct site-specific risk assessments as part of the Superfund cleanup process. However, the screening process can help focus the risk assessment for a site on specific areas, contaminants, and pathways, and data collected during the screening process can be used in the risk assessment. Similarly, SSLs are not national cleanup standards, and exceedances of SSLs do not trigger the need for response actions at NPL sites.

In addition, because SSLs are based on a set of assumptions about likely future land use and site activities, they are only pertinent to the extent that future activities are consistent with these assumptions. Institutional controls may serve to limit future land uses and associated exposures to those assumed in a non-residential screening analysis, helping to ensure that the non-residential SSLs (which may be based on less conservative exposure assumptions than residential SSLs) are adequately protective. Institutional controls are not generally necessary for sites screened using residential SSLs because the conservative assumptions incorporated in the residential exposure scenario yield SSLs that are protective of non-residential uses as well.

The use of SSLs for screening purposes during site investigation at CERCLA sites is not mandatory. However, it is recommended by EPA as a tool to focus the RI/FS and site risk assessment by identifying the contaminants and areas of concern, and to gather necessary information for later phases of the RI/FS process.[5]

---

[5] SSLs developed in accordance with this guidance can also be applied to Resource Conservation and Recovery Act (RCRA) corrective action sites as "action levels," where appropriate, since the RCRA corrective action program currently views the role of action levels as generally serving the same purpose as soil screening levels. For more information, see 61 *Federal Register* 19432, 19439, and 19446 (May 1, 1996).

SSLs also can be used as Preliminary Remediation Goals (PRGs) provided conditions found during subsequent investigations at a specific site are the same as the conditions assumed in developing the SSLs. PRGs can be used as the basis for developing final cleanup levels for remediation. Thus, although SSLs are not national cleanup standards and exceedances of SSLs alone do not trigger the need for response actions at NPL sites, they could be used as the basis for developing cleanup levels if a site-specific nine-criteria evaluation of remedial alternatives indicates that alternatives achieving the SSLs are protective, comply with Applicable or Relevant and Appropriate Requirements (ARARs), and appropriately balance the other criteria, including cost.

2.2 The Tiered Screening Framework /Selecting a Screening Approach

EPA's framework for soil screening assessment provides site managers with three approaches to establish SSLs for comparison to soil contaminant concentrations:

- Apply **generic** SSLs developed by EPA;
- Develop SSLs using a **simple site-specific** methodology; or
- Develop SSLs using a more **detailed site-specific** modeling approach.

These approaches involve using increasingly detailed site-specific information to replace generic assumptions, thereby tailoring the screening model to more accurately reflect site conditions, potential exposure pathways, and receptor characteristics. Additionally, progression from generic to detailed site-specific methods generally results in less stringent screening levels because conservative assumptions are often replaced with site-specific information while maintaining a constant target risk level.

The first approach for developing screening levels is the simplest and least site-specific. This approach assumes a generic exposure scenario, intended to be broadly protective under a wide array of site conditions. The site manager simply compares measured soil concentrations to chemical-specific SSLs derived by EPA based on the conservative generic scenario and provided in a look-up table. (These tables, together with additional guidance on applying the generic SSLs to individual sites, are presented in Appendix A of this document.) While this approach offers the benefits of simplicity and ease of use, the generic SSLs are calculated using conservative assumptions about site conditions and are thus likely to be more stringent than SSLs developed using more site-specific approaches. Where site conditions differ substantially from the scenario used to derive the generic SSLs, generic levels may not be appropriate for identifying areas that can be "screened out." The specific assumptions underlying the generic SSLs are identified in the equations presented in Section 4.2.3 (non-residential exposure scenario) and in Appendix B (residential exposure scenario).

The second approach, the simple site-specific methodology, allows site managers to calculate SSLs using the same equations used to derive the generic SSLs. Unlike the generic approach, the simple site-specific methodology offers some flexibility in the use of site-specific data

Exhibit A-2

GENERIC SSLs FOR COMMERCIAL/INDUSTRIAL SCENARIO: OUTDOOR WORKER RECEPTOR[a]

Compound	CAS No.	Ingestion-Dermal (mg/kg)	Inhalation of Volatiles (mg/kg)	Inhalation of Fugitive Particulates (mg/kg)	Migration to Ground Water	
					DAF=20 (mg/kg)	DAF=1 (mg/kg)
Organics						
Acenaphthene	83-32-9	37,000 [b]	— [c]	—	570 [b]	29 [b]
Acetone (2-Propanone)	67-64-1	110,000 [b,c]	— [c]	—	16 [b]	0.8 [b]
Aldrin	309-00-2	0.2 [c,e]	6 [e]	—	0.5 [e]	0.02 [e]
Anthracene	120-12-7	180,000 [b]	— [c]	—	12,000 [b]	590 [b]
Benz(a)anthracene	56-55-3	2 [e]	— [c]	—	2 [e]	0.08 [e,f]
Benzene	71-43-2	58 [c,e]	1 [e]	—	0.03	0.002 [f]
Benzo(b)fluoranthene	205-99-2	2 [e]	— [c]	—	5 [e]	0.2 [e,f]
Benzo(k)fluoranthene	207-08-9	23 [e]	— [c]	—	49 [e]	2 [e]
Benzoic acid	65-85-0	1,000,000 [b,c]	— [c]	—	400 [b,i]	20 [b,i]
Benzo(a)pyrene	50-32-8	0.2 [e]	— [c]	—	8	0.4
Bis(2-chloroethyl)ether	111-44-4	2 [e]	0.4 [e]	—	0.0004 [e,f]	0.00002 [e,f]
Bis(2-ethylhexyl)phthalate	117-81-7	140 [e]	— [c]	—	3,600	180
Bromodichloromethane	75-27-4	51 [c,e]	— [c]	—	0.6	0.03
Bromoform (tribromomethane)	75-25-2	400 [c,e]	88 [e]	—	0.8	0.04
Butanol	71-36-3	110,000 [b,c]	— [c]	—	17 [b]	0.9 [b]
Butyl benzyl phthalate	85-68-7	140,000 [b]	— [c]	—	930 [d]	810 [b]
Carbazole	86-74-8	96 [e]	— [c]	—	0.6 [e]	0.03 [e,f]
Carbon disulfide	75-15-0	110,000 [b,c]	720 [d]	—	32 [b]	2 [b]
Carbon tetrachloride	56-23-5	24 [c,e]	0.6 [e]	—	0.07	0.003 [f]
Chlordane	57-74-9	7 [e]	120 [e]	—	10	0.5
p-Chloroaniline	106-47-8	2,700 [b]	— [c]	—	0.7 [b]	0.03 [b,f]
Chlorobenzene	108-90-7	23,000 [b,c]	180 [b]	—	1	0.07
Chlorodibromomethane	124-48-1	38 [c,e]	— [c]	—	0.4	0.02
Chloroform	67-66-3	520 [c,e]	0.5 [e]	—	0.6	0.03
2-Chlorophenol	95-57-8	3,400 [b]	— [c]	—	4 [b,i]	0.2 [b,f,i]
Chrysene	218-01-9	230 [e]	— [c]	—	160 [e]	8 [e]
DDD	72-54-8	13 [c,e]	— [c]	—	16 [e]	0.8 [e]
DDE	72-55-9	9 [c,e]	— [c]	—	54 [e]	3 [e]
DDT	50-29-3	8 [e]	— [g]	—	32 [e]	2 [e]
Dibenz(a,h)anthracene	53-70-3	0.2 [e]	— [c]	—	2 [e]	0.08 [e,f]
Di-n-butyl phthalate	84-74-2	68,000 [b]	— [c]	—	2,300 [d]	270 [b]
1,2-Dichlorobenzene	95-50-1	62,000 [b]	600 [d]	—	17	0.9
1,4-Dichlorobenzene	106-46-7	80 [e]	— [g]	—	2	0.1 [f]
3,3-Dichlorobenzidine	91-94-1	4 [e]	— [c]	—	0.007 [e,f]	0.0003 [e,f]
1,1-Dichloroethane	75-34-3	110,000 [b,c]	1,700 [d]	—	23 [b]	1 [b]
1,2-Dichloroethane	107-06-2	35 [c,e]	0.6 [e]	—	0.02	0.001 [f]
1,1-Dichloroethylene	75-35-4	5 [c,e]	0.1 [e]	—	0.06	0.003 [f]
cis-1,2-Dichloroethylene	156-59-2	11,000 [b,c]	— [c]	—	0.4	0.02
trans-1,2-Dichloroethylene	156-60-5	23,000 [b,c]	— [c]	—	0.7	0.03
2,4-Dichlorophenol	120-83-2	2,100 [b]	— [c]	—	1 [b,i]	0.05 [b,f,i]
1,2-Dichloropropane	78-87-5	47 [c,e]	21 [b]	—	0.03	0.001 [f]
1,3-Dichloropropene	542-75-6	32 [c,e]	2 [e]	—	0.004 [e]	0.0002 [e]

Exhibit A-2 (continued)

GENERIC SSLs FOR COMMERCIAL/INDUSTRIAL SCENARIO: OUTDOOR WORKER RECEPTOR[a]

Compound	CAS No.	Ingestion-Dermal (mg/kg)	Inhalation of Volatiles (mg/kg)	Inhalation of Fugitive Particulates (mg/kg)	Migration to Ground Water	
					DAF=20 (mg/kg)	DAF=1 (mg/kg)
***Organics* (continued)**						
Dieldrin	60-57-1	0.2 [c,e]	2 [e]	—	0.004 [e]	0.0002 [e,f]
Diethylphthalate	84-66-2	550,000 [b]	— [c]	—	470 [b]	23 [b]
2,4-Dimethylphenol	105-67-9	14,000 [b]	— [c]	—	9 [b]	0.4 [b]
2,4-Dinitrophenol	51-28-5	1,400 [b]	— [c]	—	0.2 [b,f,i]	0.008 [b,f,i]
2,4-Dinitrotoluene	121-14-2	3 [e]	— [c]	—	0.0008 [e,f]	0.00004 [e,f]
2,6-Dinitrotoluene	606-20-2	3 [e]	— [c]	—	0.0007 [e,f]	0.00003 [e,f]
Di-n-octyl phthalate	117-84-0	14,000 [b]	— [c]	—	10,000 [d]	10,000 [d]
Endosulfan	115-29-7	6,800 [b,c]	— [c]	—	18 [b]	0.9 [b]
Endrin	72-20-8	340 [b,c]	— [c]	—	1	0.05
Ethylbenzene	100-41-4	110,000 [b,c]	400 [d]	—	13	0.7
Fluoranthene	206-44-0	24,000 [b]	— [c]	—	4,300 [b]	210 [b]
Fluorene	86-73-7	24,000 [b]	— [c]	—	560 [b]	28 [b]
Heptachlor	76-44-8	0.7 [c,e]	7 [e]	—	23	1
Heptachlor Epoxide	1024-57-3	0.3 [c,e]	8 [e]	—	0.7	0.03
Hexachlorobenzene	118-74-1	1 [e]	2 [e]	—	2	0.1 [f]
Hexachloro-1,3-butadiene	87-68-3	25 [e]	13 [e]	—	2	0.1 [f]
α-HCH (α-BHC)	319-84-6	0.5 [c,e]	1 [e]	—	0.0005 [e,f]	0.00003 [e,f]
β-HCH(β-BHC)	319-85-7	2 [c,e]	— [g]	—	0.003 [e]	0.0001 [e,f]
γ-HCH(Lindane)	58-89-9	2 [e]	— [c]	—	0.009	0.0005 [f]
Hexachlorocyclopentadiene	77-47-4	4,800 [b]	14 [b]	—	400	20
Hexachloroethane	67-72-1	140 [e]	92 [e]	—	0.5 [e]	0.02 [e,f]
Indeno(1,2,3-cd)pyrene	193-39-5	2 [e]	— [c]	—	14 [e]	0.7 [e]
Isophorone	78-59-1	2,000 [e]	— [c]	—	0.5 [e]	0.03 [e,f]
Methoxychlor	72-43-5	5,700 [b,c]	— [c]	—	160	8
Methyl bromide	74-83-9	1,600 [b,c]	13 [b]	—	0.2 [b]	0.01 [b,f]
Methylene chloride	75-09-2	420 [c,e]	22 [e]	—	0.02 [e]	0.001 [e,f]
2-Methylphenol (o-cresol)	95-48-7	34,000 [b]	— [c]	—	15 [b]	0.8 [b]
Naphthalene	91-20-3	12,000 [b]	240 [b]	—	84 [b]	4 [b]
Nitrobenzene	98-95-3	340 [b]	130 [b]	—	0.1 [b,f]	0.007 [b,f]
N-Nitrosodiphenylamine	86-30-6	390 [e]	— [c]	—	1 [e]	0.06 [e,f]
N-Nitrosodi-n-propylamine	621-64-7	0.3 [e]	— [c]	—	0.00005 [e,f]	0.000002 [e,f]
Pentachlorophenol	87-86-5	10 [e]	— [c]	—	0.03 [f,i]	0.001 [f,i]
Phenol	108-95-2	410,000 [b]	— [c]	—	100 [b]	5 [b]
Pyrene	129-00-0	18,000 [b]	— [c]	—	4,200 [b]	210 [b]
Styrene	100-42-5	230,000 [b,c]	1,500 [d]	—	4	0.2
1,1,2,2-Tetrachloroethane	79-34-5	16 [c,e]	1 [e]	—	0.003 [e,f]	0.0002 [e,f]
Tetrachloroethylene	127-18-4	61 [c,e]	18 [e]	—	0.06	0.003 [f]
Toluene	108-88-3	230,000 [b,c]	650 [d]	—	12	0.6
Toxaphene	8001-35-2	3 [c,e]	150 [e]	—	31	2
1,2,4-Trichlorobenzene	120-82-1	6,800 [b]	3,200 [d]	—	5	0.3 [f]
1,1,1-Trichloroethane	71-55-6	— [c]	1,200 [d]	—	2	0.1
1,1,2-Trichloroethane	79-00-5	56 [c,e]	2 [e]	—	0.02	0.0009 [f]
Trichloroethylene	79-01-6	290 [c,e]	8 [e]	—	0.06	0.003 [f]
2,4,5-Trichlorophenol	95-95-4	68,000 [b]	— [c]	—	270 [b,i]	14 [b,i]

Exhibit A-2 (continued)

GENERIC SSLs FOR COMMERCIAL/INDUSTRIAL SCENARIO: OUTDOOR WORKER RECEPTOR[a]

Compound	CAS No.	Ingestion-Dermal (mg/kg)	Inhalation of Volatiles (mg/kg)	Inhalation of Fugitive Particulates (mg/kg)	Migration to Ground Water	
					DAF=20 (mg/kg)	DAF=1 (mg/kg)
***Organics* (continued)**						
2,4,6-Trichlorophenol	88-06-2	170 [e]	340 [e]	—	0.2 [e,f,i]	0.008 [e,f,i]
Vinyl acetate	108-05-4	— [c]	1,400 [b]	—	170 [b]	8 [b]
Vinyl chloride (chloroethene)	75-01-4	4 [c,e]	1 [e]	—	0.01 [f,j]	0.0007 [f]
m-Xylene	108-38-3	1,000,000 [b,c]	— [c]	—	210	10
o-Xylene	95-47-6	1,000,000 [b,c]	— [c]	—	190	9
p-Xylene	106-42-3	1,000,000 [b,c]	— [c]	—	200	10
Inorganics						
Antimony	7440-36-0	450 [b,c]	—	— [c]	5	0.3
Arsenic	7440-38-2	2 [e]	—	1,400 [e]	29 [i]	1 [i]
Barium	7440-39-3	79,000 [b,c]	—	1,000,000 [b]	1,600 [i]	82 [i]
Beryllium	7440-41-7	2,300 [c,e]	—	2,600 [e]	63 [i]	3 [i]
Cadmium	7440-43-9	900 [b,h]	—	3,400 [e]	8 [i]	0.4 [i]
Chromium (total)	7440-47-3	3,400 [b,c]	—	510 [e]	38 [i]	2 [i]
Chromium (III)	16065-83-1	1,000,000 [b,c]	—	— [c]	— [g]	— [g]
Chromium (VI)	18540-29-9	3,400 [b,c]	—	510 [e]	38 [i]	2 [i]
Cyanide (amenable)	57-12-5	23,000 [b,c]	—	— [c]	40	2
Lead	7439-92-1	750 [j]	—	— [j]	— [j]	— [j]
Mercury	7439-97-6	340 [b,c,k]	14 [b,i]	—	2 [i]	0.1 [i]
Nickel	7440-02-0	23,000 [b,c]	—	26,000 [e]	130 [i]	7 [i]
Selenium	7782-49-2	5,700 [b,c]	—	— [c]	5 [i]	0.3 [i]
Silver	7440-22-4	5,700 [b,c]	—	— [c]	34 [b,i]	2 [b,i]
Thallium	7440-28-0	91 [b,c,l]	—	— [c]	0.7 [i]	0.04 [i]
Vanadium	7440-62-2	7,900 [b,c]	—	— [c]	6,000 [b]	300 [b]
Zinc	7440-66-6	340,000 [b,c]	—	— [c]	12,000 [b,i]	620 [b,i]

DAF = Dilution Attenuation Factor

[a] Screening level based on human health criteria only

[b] Calculated values correspond to a noncancer hazard quotient of 1

[c] Ingestion-Dermal pathway: no dermal absorption data available; calculated based on ingestion data only. Inhalation of volatiles pathway: no toxicity criteria available

[d] Soil Saturation Limit (Csat)

[e] Calculated values correspond to a cancer risk of 1 in 1,000,000

[f] Level is at or below Contract Laboratory Program required quantification limit for Regular Analytical Services (RAS)

[g] Chemical-specific properties are such that this pathway is not of concern at any soil contaminant concentration

[h] SSL is based on dietary RfD

[i] SSL for pH of 6.8

[j] A screening level of 750 mg/kg has been set for lead based on conservative inputs to the Technical Review Workgroup for Lead's Adult Pb model (http://www.epa.gov/oerrpage/superfund/programs/lead/adfaqs.htm)

[k] SSL is based on RfD for mercuric chloride (CAS No. 007847-94-7)

[l] SSL is based on Rfd for thallium chloride (CAS No. 7791-12-0)

Exhibit A-3

GENERIC SSLs FOR COMMERCIAL/INDUSTRIAL SCENARIO: INDOOR WORKER RECEPTOR[a]

Compound	CAS No.	Ingestion-Dermal* (mg/kg)	Migration to Ground Water	
			DAF=20 (mg/kg)	DAF=1 (mg/kg)
Organics				
Acenaphthene	83-32-9	120,000 [b]	570 [b]	29 [b]
Acetone (2-Propanone)	67-64-1	200,000 [b]	16 [b]	0.8 [b]
Aldrin	309-00-2	0.3 [e]	0.5 [e]	0.02 [e]
Anthracene	120-12-7	610,000 [b]	12,000 [b]	590 [b]
Benz(a)anthracene	56-55-3	8 [e]	2 [e]	0.08 [e,f]
Benzene	71-43-2	100 [e]	0.03	0.002 [f]
Benzo(b)fluoranthene	205-99-2	8 [e]	5 [e]	0.2 [e,f]
Benzo(k)fluoranthene	207-08-9	78 [e]	49 [e]	2 [e]
Benzoic acid	65-85-0	1,000,000 [b]	400 [b,i]	20 [b,i]
Benzo(a)pyrene	50-32-8	0.8 [e]	8	0.4
Bis(2-chloroethyl)ether	111-44-4	5 [e]	0.0004 [e,f]	0.00002 [e,f]
Bis(2-ethylhexyl)phthalate	117-81-7	410 [e]	3,600	180
Bromodichloromethane	75-27-4	92 [e]	0.6	0.03
Bromoform (tribromomethane)	75-25-2	720 [e]	0.8	0.04
Butanol	71-36-3	200,000 [b]	17 [b]	0.9 [b]
Butyl benzyl phthalate	85-68-7	410,000 [b]	930 [d]	810 [b]
Carbazole	86-74-8	290 [e]	0.6 [e]	0.03 [e,f]
Carbon disulfide	75-15-0	200,000 [b]	32 [b]	2 [b]
Carbon tetrachloride	56-23-5	44 [e]	0.07	0.003 [f]
Chlordane	57-74-9	16 [e]	10	0.5
p-Chloroaniline	106-47-8	8,200 [b]	0.7 [b]	0.03 [b,f]
Chlorobenzene	108-90-7	41,000 [b]	1	0.07
Chlorodibromomethane	124-48-1	68 [e]	0.4	0.02
Chloroform	67-66-3	940 [e]	0.6	0.03
2-Chlorophenol	95-57-8	10,000 [b]	4 [b,i]	0.2 [b,f,i]
Chrysene	218-01-9	780 [e]	160 [e]	8 [e]
DDD	72-54-8	24 [e]	16 [e]	0.8 [e]
DDE	72-55-9	17 [e]	54 [e]	3 [e]
DDT	50-29-3	17 [e]	32 [e]	2 [e]
Dibenz(a,h)anthracene	53-70-3	0.8 [e]	2 [e]	0.08 [e,f]
Di-n-butyl phthalate	84-74-2	200,000 [b]	2,300 [d]	270 [b]
1,2-Dichlorobenzene	95-50-1	180,000 [b]	17	0.9
1,4-Dichlorobenzene	106-46-7	240 [e]	2	0.1 [f]
3,3-Dichlorobenzidine	91-94-1	13 [e]	0.007 [e,f]	0.0003 [e,f]
1,1-Dichloroethane	75-34-3	200,000 [b]	23 [b]	1 [b]
1,2-Dichloroethane	107-06-2	63 [e]	0.02	0.001 [f]
1,1-Dichloroethylene	75-35-4	10 [e]	0.06	0.003 [f]
cis-1,2-Dichloroethylene	156-59-2	20,000 [b]	0.4	0.02
trans-1,2-Dichloroethylene	156-60-5	41,000 [b]	0.7	0.03
2,4-Dichlorophenol	120-83-2	6,100 [b]	1 [b,i]	0.05 [b,f,i]

Exhibit A-3 (continued)

GENERIC SSLs FOR COMMERCIAL/INDUSTRIAL SCENARIO: INDOOR WORKER RECEPTOR[a]

Compound	CAS No.	Ingestion-Dermal* (mg/kg)	Migration to Ground Water	
			DAF=20 (mg/kg)	DAF=1 (mg/kg)
Organics(continued)				
1,2-Dichloropropane	78-87-5	84 [e]	0.03	0.001 [f]
1,3-Dichloropropene	542-75-6	57 [e]	0.004 [e]	0.0002 [e]
Dieldrin	60-57-1	0.4 [e]	0.004 [e]	0.0002 [e,f]
Diethylphthalate	84-66-2	1,000,000 [b]	470 [b]	23 [b]
2,4-Dimethylphenol	105-67-9	41,000 [b]	9 [b]	0.4 [b]
2,4-Dinitrophenol	51-28-5	4,100 [b]	0.2 [b,f,i]	0.008 [b,f,i]
2,4-Dinitrotoluene	121-14-2	8 [e]	0.0008 [e,f]	0.00004 [e,f]
2,6-Dinitrotoluene	606-20-2	8 [e]	0.0007 [e,f]	0.00003 [e,f]
Di-n-octyl phthalate	117-84-0	41,000 [b]	10,000 [d]	10,000 [d]
Endosulfan	115-29-7	12,000 [b]	18 [b]	0.9 [b]
Endrin	72-20-8	610 [b]	1	0.05
Ethylbenzene	100-41-4	200,000 [b]	13	0.7
Fluoranthene	206-44-0	82,000 [b]	4,300 [b]	210 [b]
Fluorene	86-73-7	82,000 [b]	560 [b]	28 [b]
Heptachlor	76-44-8	1 [e]	23	1
Heptachlor Epoxide	1024-57-3	0.6 [e]	0.7	0.03
Hexachlorobenzene	118-74-1	4 [e]	2	0.1 [f]
Hexachloro-1,3-butadiene	87-68-3	73 [e]	2	0.1 [f]
α-HCH (α-BHC)	319-84-6	0.9 [e]	0.0005 [e,f]	0.00003 [e,f]
β-HCH(β-BHC)	319-85-7	3 [e]	0.003 [e]	0.0001 [e,f]
γ-HCH(Lindane)	58-89-9	4 [e]	0.009	0.0005 [f]
Hexachlorocyclopentadiene	77-47-4	14,000 [b]	400	20
Hexachloroethane	67-72-1	410 [e]	0.5 [e]	0.02 [e,f]
Indeno(1,2,3-cd)pyrene	193-39-5	8 [e]	14 [e]	0.7 [e]
Isophorone	78-59-1	6,000 [e]	0.5 [e]	0.03 [e,f]
Methoxychlor	72-43-5	10,000 [b]	160	8
Methyl bromide	74-83-9	2,900 [b]	0.2 [b]	0.01 [b,f]
Methylene chloride	75-09-2	760 [e]	0.02 [e]	0.001 [e,f]
2-Methylphenol (o-cresol)	95-48-7	100,000 [b]	15 [b]	0.8 [b]
Naphthalene	91-20-3	41,000 [b]	84 [b]	4 [b]
Nitrobenzene	98-95-3	1,000 [b]	0.1 [b,f]	0.007 [b,f]
N-Nitrosodiphenylamine	86-30-6	1,200 [e]	1 [e]	0.06 [e,f]
N-Nitrosodi-n-propylamine	621-64-7	0.8 [e]	0.00005 [e,f]	0.000002 [e,f]
Pentachlorophenol	87-86-5	48 [e]	0.03 [f,i]	0.001 [f,i]
Phenol	108-95-2	1,000,000 [b]	100 [b]	5 [b]
Pyrene	129-00-0	61,000 [b]	4,200 [b]	210 [b]
Styrene	100-42-5	410,000 [b]	4	0.2
1,1,2,2-Tetrachloroethane	79-34-5	29 [e]	0.003 [e,f]	0.0002 [e,f]
Tetrachloroethylene	127-18-4	110 [e]	0.06	0.003 [f]
Toluene	108-88-3	410,000 [b]	12	0.6
Toxaphene	8001-35-2	5 [e]	31	2
1,2,4-Trichlorobenzene	120-82-1	20,000 [b]	5	0.3 [f]
1,1,1-Trichloroethane	71-55-6	— [c]	2	0.1

Exhibit A-3 (continued)

GENERIC SSLs FOR COMMERCIAL/INDUSTRIAL SCENARIO: INDOOR WORKER RECEPTOR[a]

Compound	CAS No.	Ingestion-Dermal* (mg/kg)	Migration to Ground Water	
			DAF=20 (mg/kg)	DAF=1 (mg/kg)
Organics(continued)				
1,1,2-Trichloroethane	79-00-5	100 [e]	0.02	0.0009 [f]
Trichloroethylene	79-01-6	520 [e]	0.06	0.003 [f]
2,4,5-Trichlorophenol	95-95-4	200,000 [b]	270 [b,l]	14 [b,l]
2,4,6-Trichlorophenol	88-06-2	520 [e]	0.2 [e,f,l]	0.008 [e,f,l]
Vinyl acetate	108-05-4	— [c]	170 [b]	8 [b]
Vinyl chloride (chloroethene)	75-01-4	8 [e]	0.01 [f,l]	0.0007 [f]
m-Xylene	108-38-3	1,000,000 [b]	210	10
o-Xylene	95-47-6	1,000,000 [b]	190	9
p-Xylene	106-42-3	1,000,000 [b]	200	10
Inorganics				
Antimony	7440-36-0	820 [b]	5	0.3
Arsenic	7440-38-2	4 [e]	29 [i]	1 [i]
Barium	7440-39-3	140,000 [b]	1,600 [i]	82 [i]
Beryllium	7440-41-7	4,100 [b]	63 [i]	3 [i]
Cadmium	7440-43-9	2,000 [b,h]	8 [i]	0.4 [i]
Chromium (total)	7440-47-3	6,100 [b]	38 [i]	2 [i]
Chromium (III)	16065-83-1	1,000,000 [b]	--- [g]	--- [g]
Chromium (VI)	18540-29-9	6,100 [b]	38 [i]	2 [i]
Cyanide (amenable)	57-12-5	41,000 [b]	40	2
Lead	7439-92-1	750 [j]	--- [j]	--- [j]
Mercury	7439-97-6	610 [b,k]	2 [i]	0.1 [i]
Nickel	7440-02-0	41,000 [b]	130 [i]	7 [i]
Selenium	7782-49-2	10,000 [b]	5 [i]	0.3 [i]
Silver	7440-22-4	10,000 [b]	34 [b,l]	2 [b,l]
Thallium	7440-28-0	160 [b,l]	0.7 [i]	0.04 [i]
Vanadium	7440-62-2	14,000 [b]	6,000 [b]	300 [b]
Zinc	7440-66-6	610,000 [b]	12,000 [b,i]	620 [b,i]

DAF = Dilution Attenuation Factor

* No dermal absorption data available for indoor worker receptor; calculated based on ingestion data only

[a] Screening level based on human health criteria only

[b] Calculated values correspond to a noncancer hazard quotient of 1

[c] Ingestion-Dermal pathway: no dermal absorption data available; calculated based on ingestion data only. Inhalation of volatiles pathway: no toxicity criteria available

[d] Soil Saturation Limit (Csat)

[e] Calculated values correspond to a cancer risk of 1 in 1,000,000

[f] Level is at or below Contract Laboratory Program required quantification limit for Regular Analytical Services (RAS)

[g] Chemical-specific properties are such that this pathway is not of concern at any soil contaminant concentration

[h] SSL is based on dietary RfD

[i] SSL for pH of 6.8

[j] A screening level of 750 mg/kg has been set for lead based on conservative inputs to the Technical Review Workgroup for Lead's Adult Pb model (http://www.epa.gov/oerrpage/superfund/programs/lead/adfaqs.htm)

[k] SSL is based on RfD for mercuric chloride (CAS No. 007847-94-7)

[l] SSL is based on Rfd for thallium chloride (CAS No. 7791-12-0)

Attachment D

Regulatory and Human Health Benchmarks Used for SSL Development

Attachment D. Regulatory and Human Health Benchmarks Used for SSL Development

		Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
CAS Number	Chemical Name	MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
83-32-9	Acenaphthene					2E+00	RfD							6.0E-02	1		
67-64-1	Acetone (2-Propanone)					4E+00	RfD	D			D			1.0E-01	1		
309-00-2	Aldrin					5E-06	SF_o	B2	1.7E+01	1	B2	4.9E-03	1	3.0E-05	1		
120-12-7	Anthracene					1E+01	RfD	D			D			3.0E-01	1		
7440-36-0	Antimony	6.0E-03	3	6.0E-03	3									4.0E-04	1		
7440-38-2	Arsenic			5.0E-02	3			A	1.5E+00	1	A	4.3E-03	1	3.0E-04	1		
7440-39-3	Barium	2.0E+00	3	2.0E+00	3									7.0E-02	1	5.0E-04	2
56-55-3	Benz(*a*)anthracene					1E-04	SF_o	B2	7.3E-01	4	B2						
71-43-2	Benzene			5.0E-03	3			A	2.9E-02	1	A	8.3E-06	1				
205-99-2	Benzo(*b*)fluoranthene					1E-04	SF_o	B2	7.3E-01	4	B2						
207-08-9	Benzo(*k*)fluoranthene					1E-03	SF_o	B2	7.3E-02	4	B2						
65-85-0	Benzoic acid					1E+02	RfD							4.0E+00	1		
50-32-8	Benzo(*a*)pyrene			2.0E-04	3			B2	7.3E+00	1	B2						
7440-41-7	Beryllium	4.0E-03	3	4.0E-03	3			B2	4.3E+00	1	B2	2.4E-03	1	5.0E-03	1		
111-44-4	Bis(2-chloroethyl)ether					8E-05	SF_o	B2	1.1E+00	1	B2	3.3E-04	1				
117-81-7	Bis(2-ethylhexyl)phthalate			6.0E-03	3			B2	1.4E-02	1	B2			2.0E-02	1		
75-27-4	Bromodichloromethane			1.0E-01 *	3			B2	6.2E-02	1	B2			2.0E-02	1		
75-25-2	Bromoform (tribromomethane)			1.0E-01 *	3			B2	7.9E-03	1	B2	1.1E-06	1	2.0E-02	1		
71-36-3	Butanol					4E+00	RfD	D			D			1.0E-01	1		
85-68-7	Butyl benzyl phthalate					7E+00	RfD	C			C			2.0E-01	1		
7440-43-9	Cadmium	5.0E-03	3	5.0E-03	3						B1	1.8E-03	1	1.0E-03**	1		
86-74-8	Carbazole					4E-03	SF_o	B2	2.0E-02	2							
75-15-0	Carbon disulfide					4E+00	RfD							1.0E-01	1	7.0E-01	1
56-23-5	Carbon tetrachloride			5.0E-03	3			B2	1.3E-01	1	B2	1.5E-05	1	7.0E-04	1		
57-74-9	Chlordane			2.0E-03	3			B2	1.3E+00	1	B2	3.7E-04	1	6.0E-05	1		
106-47-8	*p* -Chloroaniline					1E-01	RfD							4.0E-03	1		
108-90-7	Chlorobenzene	1.0E-01	3	1.0E-01	3			D			D			2.0E-02	1	2.0E-02	2
124-48-1	Chlorodibromomethane	6.0E-02	3	1.0E-01 *	3			C	8.4E-02	1	C			2.0E-02	1		
67-66-3	Chloroform			1.0E-01 *	3			B2	6.1E-03	1	B2	2.3E-05	1	1.0E-02	1		
95-57-8	2-Chlorophenol					2E-01	RfD							5.0E-03	1		

* Proposed MCL = 0.08 mg/L, *Drinking Water Regulations and Health Advisories* , U.S. EPA (1995).

** Cadmium RfD is based on dietary exposure.

Attachment D (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
7440-47-3	Chromium	1.0E-01	3	1.0E-01	3			A			A	1.2E-02	1	5.0E-03	1		
16065-83-1	Chromium (III)					4E+01	RfD							1.0E+00	1		
18540-29-9	Chromium (VI)			1.0E-01	3 *			A			A	1.2E-02	1	5.0E-03	1		
218-01-9	Chrysene					1E-02	SF_o	B2	7.3E-03	4							
57-12-5	Cyanide (amenable)	(2.0E-01)	3	(2.0E-01)	3			D			D			2.0E-02	1		
72-54-8	DDD					4E-04	SF_o	B2	2.4E-01	1	B2						
72-55-9	DDE					3E-04	SF_o	B2	3.4E-01	1	B2						
50-29-3	DDT					3E-04	SF_o	B2	3.4E-01	1	B2	9.7E-05	1	5.0E-04	1		
53-70-3	Dibenz(*a,h*)anthracene					1E-05	SF_o	B2	7.3E+00	4	B2						
84-74-2	Di-*n* -butyl phthalate					4E+00	RfD	D			D			1.0E-01	1		
95-50-1	1,2-Dichlorobenzene	6.0E-01	3	6.0E-01	3			D			D			9.0E-02	1	2.0E-01	2
106-46-7	1,4-Dichlorobenzene	7.5E-02	3	7.5E-02	3			B2	2.4E-02	2	B2					8.0E-01	1
91-94-1	3,3-Dichlorobenzidine					2E-04	SF_o	B2	4.5E-01	1	B2						
75-34-3	1,1-Dichloroethane					4E+00	RfD	C			C			1.0E-01	7	5.0E-01	2
107-06-2	1,2-Dichloroethane			5.0E-03	3			B2	9.1E-02	1	B2	2.6E-05	1				
75-35-4	1,1-Dichloroethylene	7.0E-03	3	7.0E-03	3			C	6.0E-01	1	C	5.0E-05	1	9.0E-03	1		
156-59-2	*cis* -1,2-Dichloroethylene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	2		
156-60-5	*trans* -1,2-Dichloroethylene	1.0E-01	3	1.0E-01	3									2.0E-02	1		
120-83-2	2,4-Dichlorophenol					1E-01	RfD							3.0E-03	1		
78-87-5	1,2-Dichloropropane			5.0E-03	3			B2	6.8E-02	2	B2					4.0E-03	1
542-75-6	1,3-Dichloropropene					5E-04	SF_o	B2	1.8E-01	2	B2	3.7E-05	2	3.0E-04	1	2.0E-02	1
60-57-1	Dieldrin					5E-06	SF_o	B2	1.6E+01	1	B2	4.6E-03	1	5.0E-05	1		
84-66-2	Diethylphthalate					3E+01	RfD	D			D			8.0E-01	1		
105-67-9	2,4-Dimethylphenol					7E-01	RfD							2.0E-02	1		
51-28-5	2,4-Dinitrophenol					4E-02	RfD							2.0E-03	1		
121-14-2	2,4-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				2.0E-03	1		
606-20-2	2,6-Dinitrotoluene**					1E-04	SF_o	B2	6.8E-01	1				1.0E-03	2		
117-84-0	Di-*n* -octyl phthalate					7E-01	RfD							2.0E-02	2		
115-29-7	Endosulfan					2E-01	RfD							6.0E-03	2		
72-20-8	Endrin	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	1		

* MCL for total chromium is based on Cr (VI) toxicity.

** Cancer Slope Factor is for 2,4-, 2,6-Dinitrotoluene mixture.

Attachment D (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
100-41-4	Ethylbenzene	7.0E-01	3	7.0E-01	3			D			D			1.0E-01	1	1.0E+00	1
206-44-0	Fluoranthene					1E+00	RfD	D			D			4.0E-02	1		
86-73-7	Fluorene					1E+00	RfD	D						4.0E-02	1		
76-44-8	Heptachlor			4.0E-04	3			B2	4.5E+00	1	B2	1.3E-03	1	5.0E-04	1		
1024-57-3	Heptachlor epoxide			2.0E-04	3			B2	9.1E+00	1	B2	2.6E-03	1	1.3E-05	1		
118-74-1	Hexachlorobenzene			1.0E-03	3			B2	1.6E+00	1	B2	4.6E-04	1	8.0E-04	1		
87-68-3	Hexachloro-1,3-butadiene	1.0E-03	3			1E-03	SF_o	C	7.8E-02	1	C	2.2E-05	1	2.0E-04	2		
319-84-6	α-HCH (α-BHC)					1E-05	SF_o	B2	6.3E+00	1	B2	1.8E-03	1				
319-85-7	β-HCH (β-BHC)					5E-05	SF_o	C	1.8E+00	1	C	5.3E-04	1				
58-89-9	γ-HCH (Lindane)	2.0E-04	3	2.0E-04	3			B2	1.3E+00	2	C			3.0E-04	1		
77-47-4	Hexachlorocyclopentadiene	5.0E-02	3	5.0E-02	3			D			D			7.0E-03	1	7.0E-05	2
67-72-1	Hexachloroethane					6E-03	SF_o	C	1.4E-02	1	C	4.0E-06	1	1.0E-03	1		
193-39-5	Indeno(1,2,3-*cd*)pyrene					1E-04	SF_o	B2	7.3E-01	4	B2						
78-59-1	Isophorone					9E-02	SF_o	C	9.5E-04	1	C			2.0E-01	1		
7439-97-6	Mercury	2.0E-03	3	2.0E-03	3			D			D			3.0E-04	2	3.0E-04	2
72-43-5	Methoxychlor	4.0E-02	3	4.0E-02	3			D			D			5.0E-03	1		
74-83-9	Methyl bromide					5E-02	RfD	D			D			1.4E-03	1	5.0E-03	1
75-09-2	Methylene chloride			5.0E-03	3			B2	7.5E-03	1	B2	4.7E-07	1	6.0E-02	1	3.0E+00	2
95-48-7	2-Methylphenol (o -cresol)					2E+00	RfD	C			C			5.0E-02	1		
91-20-3	Naphthalene					1E+00	RfD	D			D			4.0E-02	6		
7440-02-0	Nickel					1E-01	HA *	A			A	2.4E-04	1	2.0E-02	1		
98-95-3	Nitrobenzene					2E-02	RfD	D			D			5.0E-04	1	2.0E-03	2
86-30-6	*N* -Nitrosodiphenylamine					2E-02	SF_o	B2	4.9E-03	1	B2						
621-64-7	*N* -Nitrosodi-*n* -propylamine					1E-05	SF_o	B2	7.0E+00	1	B2						
87-86-5	Pentachlorophenol			1.0E-03	3			B2	1.2E-01	1	B2			3.0E-02	1		
108-95-2	Phenol					2E+01	RfD	D			D			6.0E-01	1		
129-00-0	Pyrene					1E+00	RfD	D			D			3.0E-02	1		
7782-49-2	Selenium	5.0E-02	3	5.0E-02	3			D			D			5.0E-03	1		
7440-22-4	Silver					2E-01	RfD	D			D			5.0E-03	1		
100-42-5	Styrene	1.0E-01	3	1.0E-01	3									2.0E-01	1	1.0E+00	1
79-34-5	1,1,2,2-Tetrachloroethane					4E-04	SF_o	C	2.0E-01	1	C	5.8E-05	1				

* Health advisory for nickel (MCL is currently remanded); EPA Office of Science and Technology, 7/10/95.

Attachment D

Regulatory and Human Health Benchmarks for SSL Development

This attachment provides regulatory and human health benchmarks necessary to calculate SSLs for 110 chemicals commonly found at National Priority List (NPL) sites. The sources of these values (shown in the following table) are regularly updated by EPA. Prior to calculating SSLs at a site, check all relevant chemical-specific values in this attachment against the most recent version of their sources to ensure that they are up-to-date.

Attachment D (continued)

CAS Number	Chemical Name	Maximum Contaminant Level Goal (mg/L)		Maximum Contaminant Level (mg/L)		Water Health Based Limits (mg/L)		Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$			Unit Risk Factor $(\mu g/m^3)^{-1}$			Reference Dose (mg/kg-d)		Reference Concentration (mg/m^3)	
		MCLG (PMCLG)	Ref. [a]	MCL (PMCL)	Ref. [a]	HBL [b]	Basis	Carc. Class [c]	SF_o	Ref. [a]	Carc. Class [c]	URF	Ref. [a]	RfD	Ref. [a]	RfC	Ref. [a]
127-18-4	Tetrachloroethylene			5.0E-03	3				5.2E-02	5		5.8E-07	5	1.0E-02	1		
7440-28-0	Thallium	5.0E-04	3	2.0E-03	3												
108-88-3	Toluene	1.0E+00	3	1.0E+00	3			D			D			2.0E-01	1	4.0E-01	1
8001-35-2	Toxaphene			3.0E-03	3			B2	1.1E+00	1	B2	3.2E-04	1				
120-82-1	1,2,4-Trichlorobenzene	7.0E-02	3	7.0E-02	3			D			D			1.0E-02	1	2.0E-01	2
71-55-6	1,1,1-Trichloroethane	2.0E-01	3	2.0E-01	3			D			D					1.0E+00	5
79-00-5	1,1,2-Trichloroethane	3.0E-03	3	5.0E-03	3			C	5.7E-02	1	C	1.6E-05	1	4.0E-03	1		
79-01-6	Trichloroethylene	zero	3	5.0E-03	3				1.1E-02	5		1.7E-06	5				
95-95-4	2,4,5-Trichlorophenol					4E+00	RfD							1.0E-01	1		
88-06-2	2,4,6-Trichlorophenol					8E-03	SF_o	B2	1.1E-02	1	B2	3.1E-06	1				
7440-62-2	Vanadium					3E-01	RfD							7.0E-03	2		
108-05-4	Vinyl acetate					4E+01	RfD							1.0E+00	1	2.0E-01	1
75-01-4	Vinyl chloride (chloroethene)			2.0E-03	3			A	1.9E+00	2	A	8.4E-05	2				
108-38-3	*m* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
95-47-6	*o* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	2		
106-42-3	*p* -Xylene	1.0E+01	3 *	1.0E+01	3 *			D			D			2.0E+00	1 **		
7440-66-6	Zinc					1E+01	RfD	D			D			3.0E-01	1		

* MCL for total xylenes [1330-20-7] is 10 mg/L.

** RfD for total xylenes is 2 mg/kg-day.

[a] References:
- 1 = IRIS, U.S. EPA (1995)
- 2 = HEAST, U.S. EPA (1995)
- 3 = U.S. EPA (1995)
- 4 = OHEA, U.S. EPA (1993)
- 5 = Interim toxicity criteria provided by Superfund Health Risk Techincal Support Center, Environmental Criteria Assessment Office (ECAO), Cincinnati, OH (1994)
- 6 = ECAO, U.S. EPA (1994i)
- 7 = ECAO, U.S. EPA (1994h)

[b] Health Based Limits calculated for 30-year exposure duration, 10^{-6} risk or hazard quotient = 1.

[c] Categorization of overall weight of evidence for human carcinogenicity:
- Group A: human carcinogen
- Group B: probable human carcinogen
  - B1: limited evidence from epidemiologic studies
  - B2: "sufficient" evidence from animal studies and "inadequate" evidence or "no data" from epidemiologic studies
- Group C: possible human carcinogen
- Group D: not classifiable as to health carcinogenicity
- Group E: evidence of noncarcinogenicity for humans

Appendix E

Summary of ASTM E1739-95e1 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites

This copyright document is available for download as an Adobe Acrobat® file from ASTM's website (http://www.astm.org) at a cost of US$45.00.

Referenced Documents | Standards Search | Other Standards Products

Document Summary

** To order the full text, see ordering options at left.*

Order Now:
Credit Card Only

Download Delivery:
Full Text (PDF)

Mail Delivery
Select Location:
- North America
- International

Price: $ 45.00

Pages: 51

Developed by
Subcommittee: E50.04

Book of Standards
Volume: 11.04

Help Desk

E1739-95e1 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites

Copyright 2002 ASTM International,
West Conshohocken, PA. All rights reserved.

1. Scope

1.1 This is a guide to risk-based corrective action (RBCA), which is a consistent decision-making process for the assessment and response to a petroleum release, based on the protection of human health and the environment. Sites with petroleum release vary greatly in terms of complexity, physical and chemical characteristics, and in the risk that they may pose to human health and the environment. The RBCA process recognizes this diversity, and uses a tiered approach where corrective action activities are tailored to site-specific conditions and risks. While the RBCA process is not limited to a particular class of compounds, this guide emphasizes the application of RBCA to petroleum product releases through the use of the examples. Ecological risk assessment, as discussed in this guide, is a qualitative evaluation of the actual or potential impacts to environmental (nonhuman) receptors. There may be circumstances under which a more detailed ecological risk assessment is necessary (see Ref (1).

1.2 The decision process described in this guide integrates risk and exposure assessment practices, as suggested by the United States Environmental Protection Agency (USEPA), with site assessment activities and remedial measure selection to ensure that the chosen action is protective of human health and the environment. The following general sequence of events is prescribed in RBCA, once the process is triggered by the suspicion or confirmation of petroleum release:

1.2.1 Performance of a site assessment;

1.2.2 Classification of the site by the urgency of initial response;

1.2.3 Implementation of an initial response action appropriate for the selected site classification;

1.2.4 Comparison of concentrations of chemical(s) of concern at the site with Tier 1 Risk Based Screening Levels (RBSLs) given in a look-up table;

1.2.5 Deciding whether further tier evaluation is warranted, if implementation of interim remedial action is warranted or if RBSLs may be applied as remediation target levels;

1.2.6 Collection of additional site-specific information as necessary, if

Other us also do

D6008: S for Cond Environ Surveys

E408: St Methods Emittanc Using In Techniq

E903: St for Solar Reflecta Transmit Using Int

E1527: S for Envir Assess Environ Assess

E1528: S for Envir Assess Screen

further tier evaluation is warranted;

1.2.7 Development of site-specific target levels (SSTLs) and point(s) of compliance (Tier 2 evaluation);

1.2.8 Comparison of the concentrations of chemical(s) of concern at the site with the Tier 2 evaluation SSTL at the determined point(s) of compliance or source area(s);

1.2.9 Deciding whether further tier evaluation is warranted, if implementation of interim remedial action is warranted, or if Tier 2 SSTLs may be applied as remediation target levels;

1.2.10 Collection of additional site-specific information as necessary, if further tier evaluation is warranted;

1.2.11 Development of SSTL and point(s) of compliance (Tier 3 evaluation);

1.2.12 Comparison of the concentrations of chemical(s) of concern at the site at the determined point(s) of compliance or source area(s) with the Tier 3 evaluation SSTL; and

1.2.13 Development of a remedial action plan to achieve the SSTL, as applicable.

1.3 The guide is organized as follows:

1.3.1 Section 2 lists referenced documents,

1.3.2 Section 3 defines terminology used in this guide,

1.3.3 Section 4 describes the significance and use of this guide,

1.3.4 Section 5 is a summary of the tiered approach,

1.3.5 Section 6 presents the RBCA procedures in a step-by-step process,

1.3.6 Appendix X1 details physical/chemical and toxicological characteristics of petroleum products,

1.3.7 Appendix X2 discusses the derivation of a Tier 1 RBSL Look-Up Table and provides an example,

1.3.8 Appendix X3 describes the uses of predictive modeling relative to the RBCA process,

1.3.9 Appendix X4 discusses considerations for institutional controls, and

1.3.10 Appendix X5 provides examples of RBCA applications.

1.4 This guide describes an approach for RBCA. It is intended to compliment but not supersede federal, state, and local regulations. Federal, state, or local agency approval may be required to implement the processes outlined in this guide.

1.5 The values stated in either inch-pound or SI units are to be regarded as the standard. The values given in parentheses are for

information only.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Index Terms

Contamination-environmental; Corrective action; Petroleum/petroleum products; Qualitative chemical spot test; RBCA process; Risk analysis-environmental; Subservice contamination; risk-based corrective action (RBCA)-applied at petroleum release sites; Environmental control/fate; risk-based corrective action (RBCA)-appliedat petroleum release sites; Petroleum release sites

[Back to Top]

E1739 E1739