TEXAS NATURAL RESOURCES CONSERVATION COMMISSION (TNRCC) PROTOCOLS FOR CONDUCTING RISK-BASED ASSESSMENTS AT LEAKING PETROLEUM STORAGE TANK (LPST) SITES

Mahbub Hussain[1] and Timmi O. Osinowo[2]

1 - Department of Earth Sciences, KFUPM, Dhahran 31261
2 - Lexington Group International, Inc., Dallas, Texas 75231, U.S.A.

ABSTRACT

This study outlines the criteria followed by the Texas Natural Resources Commission (TNRCC) for conducting Site Assessment at leaking petroleum storage tank (LPST) sites to support Risk-Based Assessments (RBA). In addition, the study reports the preliminary findings and the status of a site investigation at a leaking underground petroleum storage tank site (abandoned truck filling and service station) in Texas following the TNRCC guidelines.

Keywords

UST, Petroleum, Site Assessment, TNRCC, Monitoring.

Introduction

An underground storage tank (UST) is any tank including underground piping connected to the tank, that has at least 10 percent of its volume underground (USEPA, 1988). According to the United States Environmental Protection Agency (USEPA) several million petroleum or hazardous chemical-containing underground storage tank systems in the United States alone, are currently leaking. Leaking petroleum storage tanks (LPST) can cause fire and explosion hazards that threaten human safety. In addition, leaking USTs often contaminate soil and ground water resources.

In order to respond to the growing problems with LPSTs, the United States Congress in 1984 enacted Subtitle I to the Resource Conservation and Recovery Act (RCRA). Subtitle I requires EPA to develop regulations to protect human health and the environment from leaking USTs. Over the last decade EPA has developed a set of guidelines for removal of USTs, but has allowed the states to develop their own regulations for sampling and analysis once a tank is removed. However, up to now, these regulations are not well documented for use by general public and consultants. UST regulations vary from state to state. In some states the regulations are so vague or misleading that these are difficult to interpret. The variations in the state laws regarding procedures for conducting site assessment at the LPST sites are dramatic. Often, procedures acceptable in one state may not meet the requirements of other states.

In response to the House Bill 2587 passed by the 74th Texas Legislature, the Texas Natu Resources Conservation Commission (TNRCC) developed rules to implement risk-based corrective action for LPST sites. The TNRCC requires that risk-based assessment process developed by the TNRCC must be followed to achieve the site assessment requirements oı Title 30 Texas Administrative Code (TAC) 334.78 (a)(5) and Chapter 26.3572 of the Tex: Water Code as amended by House Bill 2587.

The site assessment process developed by the TNRCC is goal-oriented which provides flexibility to collect the appropriate site information in most expeditious, valid and cost-effective manner. One very important aspect of this assessment process is its flexibility. The process is not rigidly controlled by prescriptive procedures, but rather encourages a flexible scope of work responsive to on-site conditions. The TNRCC allows the Correctiv Action Specialist (CAS) to make necessary field decisions to achieve the assessment goals

Objectives of the Site Assessment Process

The main objective of the site assessment process is to collect sufficient data to determine site priority and support the Plan A Risk Evaluation (*Risk-Based Corrective Action for Leaking Storage Tank Sites - RBCA; RG-36*). RBCA entails identifying and investigating critical pathways, establishing site priority, and determining target cleanup levels based on two alternatives, Plan A and Plan B. As outlined in the TNRCC guidance document RG-: Plan A is based on conservative default values, while Plan B requires a more comprehensi site assessment, and typically results in more achievable site-specific cleanup levels. The integration of the site assessment process in the overall framework of the RBCA program i illustrated in Figure 1.

More specifically, the TNRCC site assessment process aims at achieving the following goa

- identify all potential receptors, exposure pathways, and immediate and long-term hazards

- identify contaminant areas and maximum contaminant concentrations of all affect media

- delineate the vertical extent of affected media which exceeds health protective an cross-media protective concentrations

- provide permanent well points when ground water is affected, and

- identify site conditions which affect or limit contaminant movement.

The objectives of the risk-based site assessment are achieved in two main phases: ***prelimin planning***, which involves a thorough review of facility information and performance of a receptor survey to develop a conceptual model and scope of work prior to developing a model and work force mobilization to the site; and ***site investigation***, which utilizes

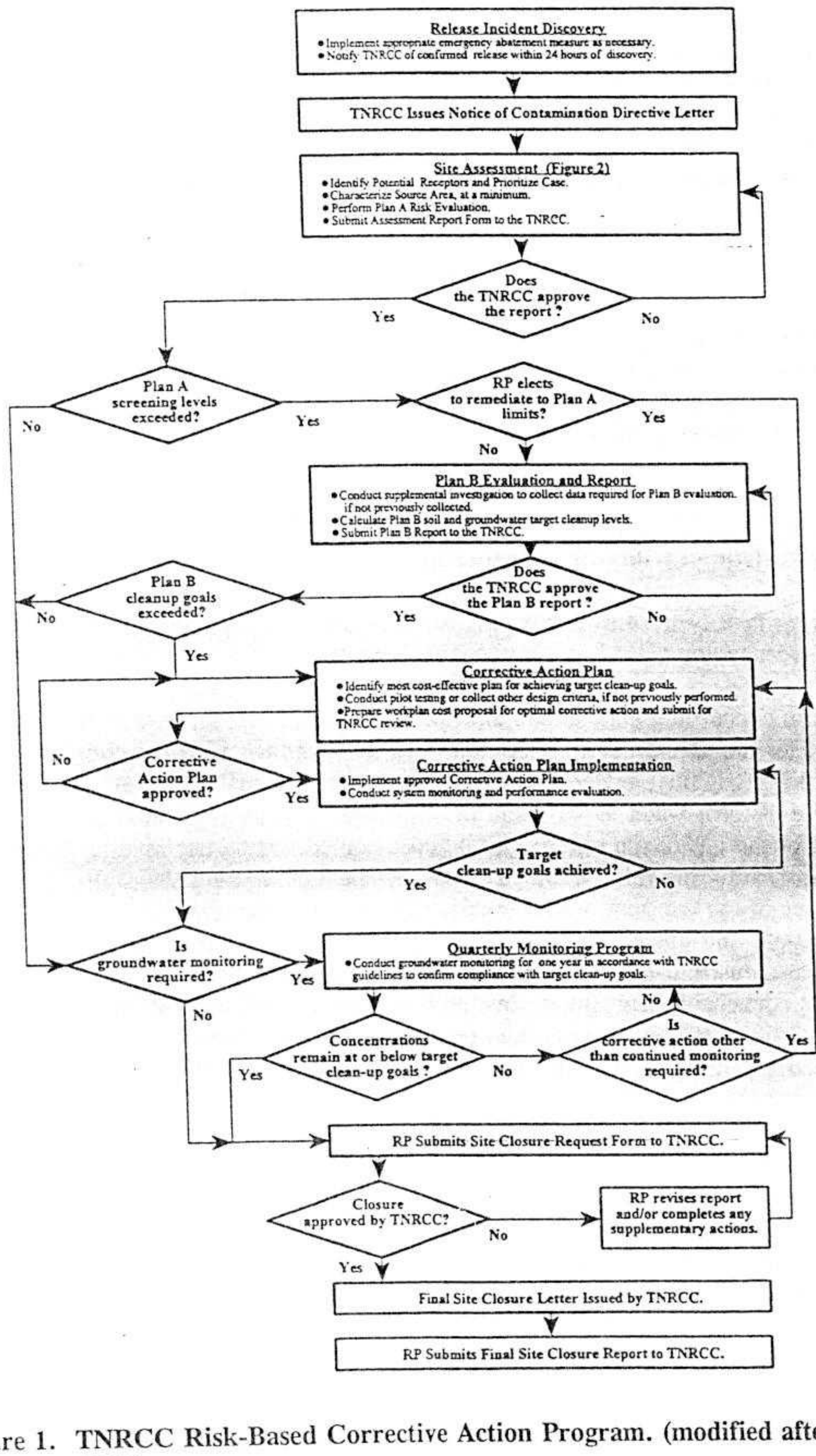

Figure 1. TNRCC Risk-Based Corrective Action Program. (modified after TNRCC, 1995)

rapid or conventional sampling tools and analytical techniques. The risk-based site assessment process encourages use of innovative technologies in site reconnaissance and allows changes to the initial scope of work based on field findings to best meet the goals the assessment. The findings of the site investigation including site prioritization, and Pla evaluation results are reported in the ***Assessment Report Form***. The integration of these components in the overall Site Assessment Process framework is illustrated in Figure 2.

Preliminary Planning

Preliminary planning includes review of all pertinent data to develop a conceptual model prior to site investigation. As indicated earlier, at a minimum, the preliminary planning process should include a review of existing facility information, performance of a receptor survey, development of a conceptual model, and designing a scope of work for site investigation.

Review of existing facility information

The existing facility information require a review of documents related to local and region geology/hydrogeology, land use, and source history.

Information concerning general soil and rock types, regional depth to bed rock, depth to ground water, aquifer properties, ground water gradient and flow direction may be compil from local and regional geologic and hydrogeologic maps and other relevant publications. The source of local water supply, and the uppermost aquifer (or water-bearing zone) withi 0.5 miles of the LPST site should also be documented. Land use investigation should be directed in finding information on past, current and future land uses of the site, past and current uses of the adjacent properties, identification of other possible sources of contamination, and documentation of the current land use of the area as either commercial/industrial, or residential. As a part of the site investigation review, all documents concerning tank system layout, tank performance records (inventory control and/or tank tightness test records) and records of any other potential sources of contamination at the site need to be reviewed and documented.

Receptor Survey

The receptor survey includes a field survey of potential receptors (schools, hospitals, residences, basements, day care, nursing homes, etc.) and migration pathways (subsurface utilities and structures) within a 500-foot radius of the facility and, a water well records (bo registered and unregistered) inventory. The data is used for site prioritization and determination of target cleanup levels.

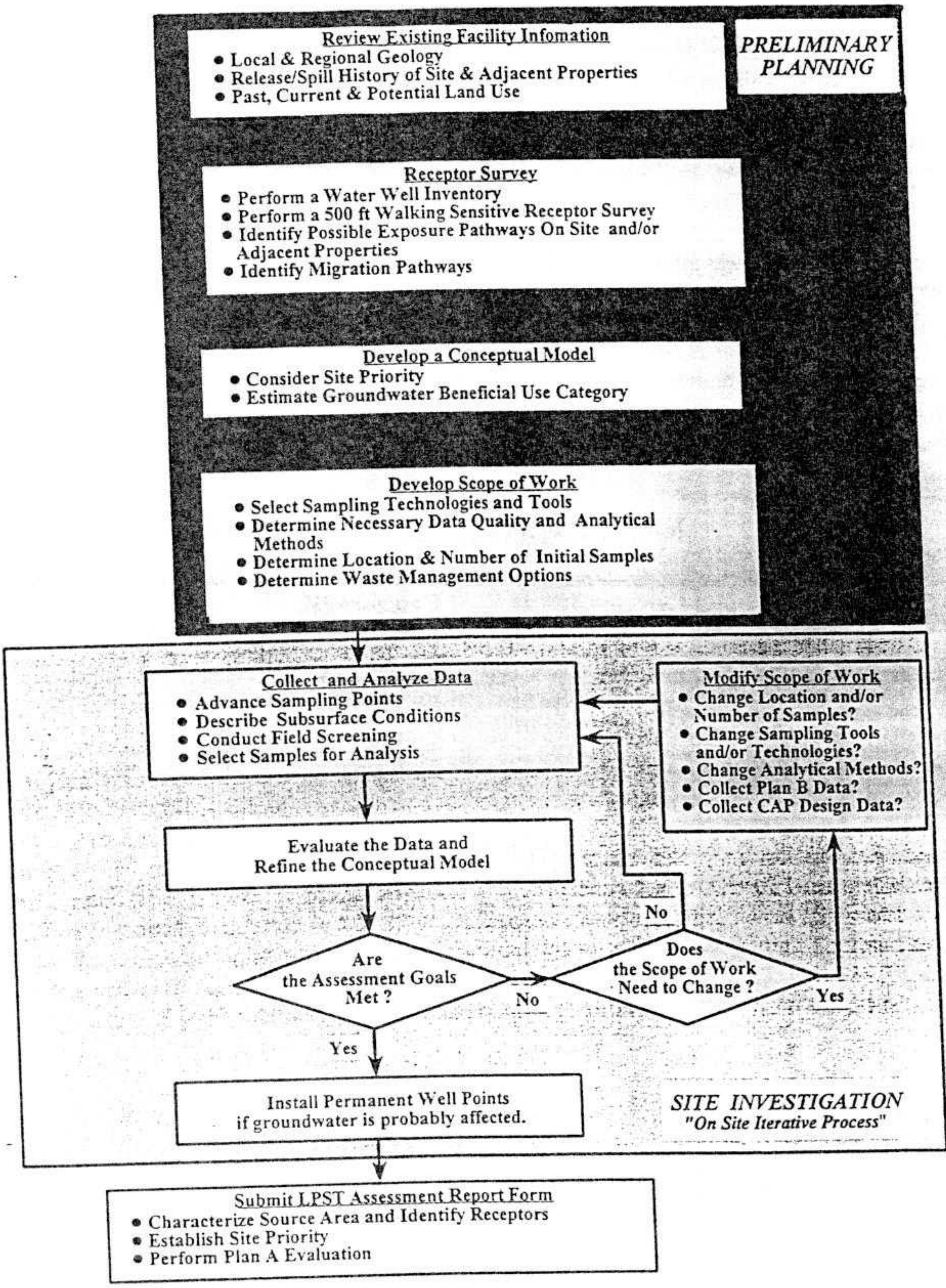

Figure 2. The components of the TNRCC Site Assessment Process. (modified after TNRCC, 1995)

Conceptual Model

A conceptual model is defined as a three-dimensional representation of the site conditions which provides a general understanding or working hypothesis of the relationship between the contaminant source areas, transport mechanisms (e.g., leaching, ground water transpoı receptors (e.g., residents, water users), and exposure routes (e.g., inhalation, ingestion, dermal contact, etc.). In brief, the conceptual model should be designed to provide a thorough understanding of the following:

- *the contaminant concentrations and distribution*
- *the factors affecting contaminant transport, and*
- *the potential for contaminants to reach a receptor.*

Assuming that the potential threat to ground water is the main driving factor in establishin risk-based target cleanup concentrations, TNRCC recommends cleanup concentrations base on the present and potential beneficial use (Table 1) of the threatened ground water.

Table 1. Beneficial Ground Water Use Categories

Category I	Category II	Category III	Category IV
Impacted or threatened water supply well(s)	Affected ground water zone TDS <3,000 ppm, <u>and</u> no beneficial use[2] is documented within 0.5 miles of the site	Affected ground water zone TDS 3,000 - 10,000 ppm, <u>and</u> no beneficial use is documented within 0.5 miles of the site	Affected ground water zone TDS >10,000 ppm, <u>and</u> no beneficia use is documented wit 0.5 miles of the site
OR	**OR**		**OR**
Affected ground water zone TDS <3,000 ppm, <u>and</u> water well (s)[1] or water supply spring located within 0.5 miles of site	TDS 3,000 - 10,000 ppm, <u>and</u> beneficial use is documented within 0.5 miles of the site		Well yield <150 gpd (i.e., affected zone is ı considered to have a beneficial use)

(modified after TNRCC, 1

1 - If construction details of water well(s) are unknown or can not be proven, the interval is assumed to be connected.

2 - Applies to a drinking water source producing from the same or connected interval as the affected ground wate zone.

Scope of Work

The scope of work is described as the plan, derived from the conceptual model, used to complete the site assessment, and is developed on a site-by-site basis by the CAS. TNRCC requires the following items to be considered and incorporated into the scope of work.

- determination of maximum concentrations of chemicals in each affected medium

- determination of one appropriate category of beneficial ground water use for the site

- evaluation of dermal exposure if ground water is determined to be Beneficial Use Category IV and depth is less than 15 feet, unless documentation can be provided that surface cover will be maintained and/or construction practices will not encroach upon ground water

- evaluation of inhalation exposure to vapor and particulates if the top two feet of soil are affected by the release and no impervious cover will be maintained

- evaluation of vapors to ensure total contaminant concentration does not exceed 25% lower explosive limit (LEL)

- determination of target surface water concentrations based on human ingestion of water and the potential Beneficial Use Category I exposure parameters

- evaluation of the contaminants of the target soil protecting the ground water when depth to ground water is greater than 15 feet below ground surface (bgs) and Beneficial Use Category is I, II, or III, or when soils only are affected and regional Beneficial Use can not be established

- evaluation of the acceptable level of total petroleum hydrocarbons (TPH) when no compounds with toxicity values are present based on the following factors:

  - presence of natural aqueous phase liquid (NAPL)
  - potential for explosive vapor
  - impact to food source vegetation
  - levels should not exceed 0.5 mg/l in affected water supply wells or water intakes,
  - potential odor nuisance.

Analytical Methods

The scope of work must outline the analytical methods to be used during the site investigation. While TNRCC encourages use of rapid, cost-effective field screening (qualitative) methods to assist in the assessment process, it requires use of quantitative analytical methods for comprehensive evaluation of field conditions. Field screening methods must be supported by EPA-approved quantitative analytical methods (Table 2). TNRCC recommends the following primary considerations in selecting the analytical metl and data quality level:

- *purpose of the sampling (e.g., prioritization, risk evaluation, regulatory requirements)*
- *contaminant(s) of concern*
- *media of concern*
- *analytical turnaround time, and*
- *detection limits.*

If TPH concentrations exceed TNRCC action levels, the soil and ground water should be further analyzed for specific indicator compounds (e.g., polycyclic aromatic hydrocarbons, PAH) for toxicity evaluation. TNRCC encourages analysis of oxygen and certain inorgani compounds including nitrates, and sulfates as an inexpensive screening tool for indirect measurement of hydrocarbon distribution.

Sample Location

The scope of work should be designed to identify the tentative, general locations for sampling. TNRCC recommends consideration of the following when selecting sampling point locations:

- *point of release(s) or suspected area of major sources of contaminants*
- *locations of potential receptors*
- *physical characteristics of the surface and subsurface as determined in the preliminary planning*
- *off-site access, and*
- *contingencies for additional sampling points.*

The TNRCC risk-based site plan allows modification of the scope of work while assessmen is in progress. Target risk-based concentrations and analytical results are compared to determine the placement of next sampling and/or permanent well point(s) and, refinement o the conceptual understanding of the contaminated site.

Site Investigation

The site investigation is guided by the scope of work prepared during the planning phase. However, as indicated earlier, the scope of work is not a rigid document and can be periodically modified based on the field data collected during site investigation. The CAS i charge of the project is authorized to evaluate site information in the field and dictate the course of the investigation.

Data collected during the site investigation need to be evaluated, and integrated to develop adequate site model. TNRCC recommends compilation of the site field investigation data onto simple graphics, such as maps and cross sections to facilitate the evaluation process and

Table 2. Analytical Requirements

Released Substance	Ground Water	Soil	Air	EPA Approved Methods[1]
Gasoline	BTEX TPH MTBE TDS	BTEX TPH	BTEX	EPA 8020 (GC/PID) EPA 418.1 (IR) EPA 8020 EPA 160.1
Diesel, Jet Fuels, No. 1,2, and 4 Fuel oils	BTEX PAH TPH TDS	BTEX PAH TPH	BTEX	EPA 8020 (GC/PID) EPA 8100 or 8310 EPA 418.1 (IR) EPA 160.1
Hydraulic Fluid, Lubricating Oils, No. 6 Fuel oil	PAH TPH TDS	PAH TPH		EPA 8100 or 8310 EPA 418.1 EPA 160.1
Waste Oil, Other Unknown Petroleum Products	BTEX PAH VOC TPH TDS Total metals[2]	BTEX PAH VOC TPH	BTEX VOC	EPA 8020 (GC/PID) EPA 8100 or 8310 EPA 8240 (GC/MS) EPA 418.1 EPA 160.1

(modified after TNRCC, 1995)

1 - For analysis listed without recommended EPA standard methods, consult EPA Publication SW-846. Detection limits should not exceed the risk-based target concentrations.

2 - Total metal analyses include arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. The EPA Toxicity Characteristics Leachate Procedure (TCLP) is required when any analysis exceeds 20 times the EPA regulatory limit for that metal as defined in 40 CFR 261.24.

refinement of the conceptual model. Data collected during the site assessment and/or other previous assessment should be adequate to perform a Plan A risk evaluation and prioritize the site. The site investigation should aim at achieving the following objectives to support a Plan A evaluation:

- determination of all potential receptors, exposures pathways, immediate and long-term hazards

- identification of contaminant source area(s) and maximum contaminant concentrations of all affected areas

- delineation of vertical extent of the affected media exceeding health-based and cross-media contaminations

- identification of site conditions which affect or limit contaminant movement

The following sections highlight TNRCC's site assessment data collection and analysis protocols.

Geologic Description/Conditions

In order to get a better understanding of the subsurface soil conditions of the site, continuous profiling of the subsurface should be conducted while advancing the sampling points. TNRCC recommends preparation of a continuous lithologic log following the Unif Soil Classification System. All subsurface characteristics and features which control contaminant migration and distribution should be recorded.

Sample Selection - Chemicals of Concern

Samples should be collected to define the vertical and horizontal extents of contaminant distribution. TNRCC requires, at a minimum, collection of discrete soil samples from the following intervals:

- *zone of highest contamination based upon field screening results*
- *immediately above the saturated zone, and*
- *total depth.*

TNRCC Plan A risk evaluation requires collection of discrete soil samples from the following intervals:

- *0 to 2 feet (inhalation, ingestion, and dermal considerations)*
- *2 to 15 feet (inhalation, ingestion, and dermal considerations, and*
- *15 to total depth (ground water protective considerations).*

Sample Selection - Physical Soil Properties

The physical properties of the soils affect fate and transport of the chemical(s) of concern. Site specific physical properties may be utilized in TNRCC Plan B as input parameters for contaminant fate and transport models. Soil parameters need to be determined include,

- *soil bulk density*
- *porosity*
- *water content*
- *fraction organic carbon, and*
- *hydraulic conductivity.*

Sample Collection - Vapors

TNRCC recommends determination of vapor concentrations when Natural Aqueous Phase Liquid (NAPL) and/or contaminant-saturated soils, or any other suspected hazardous vapor conditions are present. Vapor sampling is needed to evaluate actual vapor hazard, if the level exceeds 25% of the Lowest Explosive Limit (LEL).

Sample Selection - Surface Water

When surface water contamination is suspected, sample selection should consist of sediment and/or water up and downstream, and/or radially from the discharge point(s). The extent of contamination should be defined by levels established in Title 30 TAC 307, to the MCL, or to health-risk based concentrations.

Sample Selection - Ground Water

TNRCC encourages use of temporary sampling points for rapid screening of the levels of ground water contamination. The field generated data obtained from the screening dictate placement of permanent wells to document contaminant migration and ground water flow. If ground water is affected, the permanent well points should remain in place. TNRCC recommends consideration of the following for well placement and design:

- *concentration of contaminant(s) in the source area*
- *proximity to potential or impacted receptor(s)*
- *hydrogeologic conditions, and*
- *beneficial ground water use.*

A layout of the placement of sampling points at a LPST site as recommended by the TNRCC is illustrated in Figure 3.

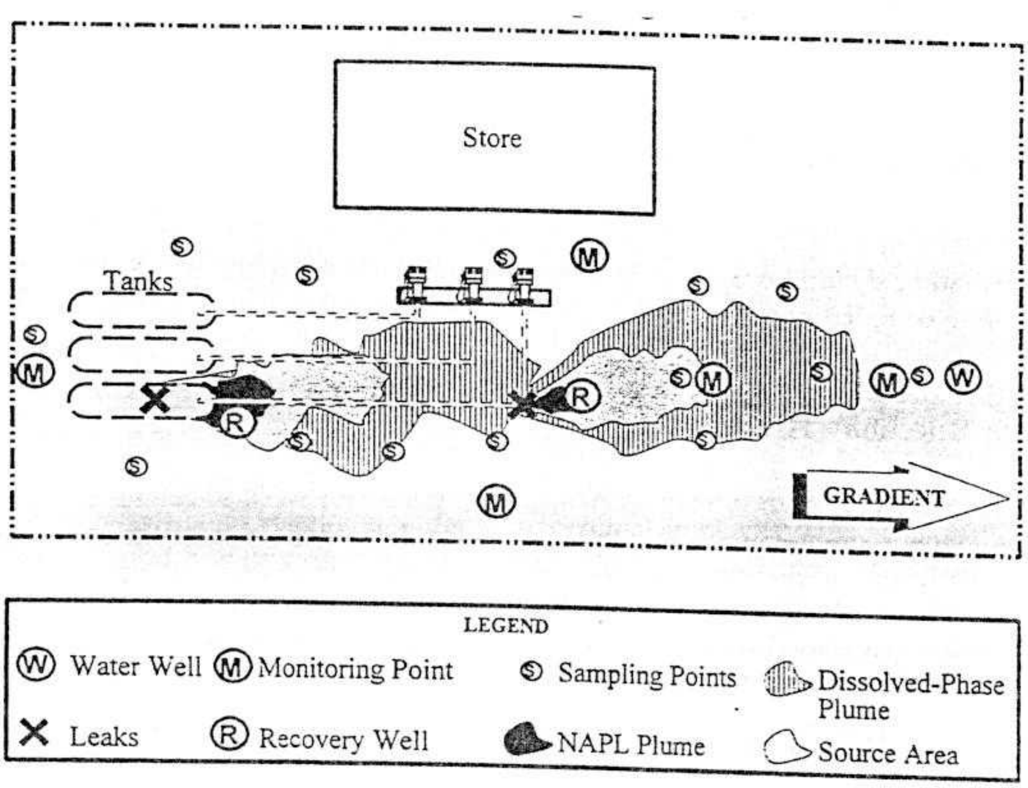

Figure 3. Placement of sampling points. (modified after TNRCC, 1995)

Case History: Colorado City, Texas

The study site is an abandoned truck-filling and service station located in Colorado City, West Texas. A preliminary investigation conducted at the site indicated soil and ground water contamination. Subsequent activities at the site involved removal of all four storage tanks and associated delivery pipelines. In addition, four shallow (up to 20 feet) ground water monitoring wells were also installed. Laboratory analysis of soil and ground water samples collected from the site showed elevated levels of total petroleum hydrocarbons (TPH) and BTEX (up to 26 ppm of BTEX and 6400 ppm of TPH in soil and, up to 264 ppm of BTEX and 27 ppm of TPH for ground water, respectively).

A Risk-Based Site Assessment which incorporates TNRCC Plan A Risk Evaluation is now being conducted. Goals are set and attempts being made to achieve the following: identification of all potential receptors, exposure pathways, and immediate and long-term hazards; identification of the areas showing maximum contaminant concentrations; delineation of the vertical extent of the affected media which exceed health protective and cross media protective concentrations; place permanent monitoring well points for the affected ground water; and identification of site conditions which affect or limit contaminant movement.

Conclusions

The site assessment guidelines developed by the TNRCC to conduct risk-based assessments at LPST site is a goal-oriented protocol which offer the flexibility to collect the appropriate site information in most expeditious, valid and cost-effective manner. One unique feature of this protocol is that it delegates authority to the CAS to modify the scope of work based on actual findings in the field. The process is not rigidly controlled by prescriptive procedures devised by the regulatory agency, but rather encourages a flexible scope of work responsive to on-site conditions.

Acknowledgement

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