

The TCEQ LPST Cleanup Process

From Release Reporting to Case Closure



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Program Director – P2/Mitigation

EnviroPhase Overview

- Founded 2005 in Dallas
- Environmental consulting services for property acquisition/development, commercial/industrial, financial, and private sectors
- Phase I/II/III + PCAs
- Closure via Regulatory Programs
- PST/UST Tank Removal
- Asbestos/Mold/Lead/Radon Consulting

The LPST Cleanup

- LPST stands for “Leaking Petroleum Storage Tank”.
- LPST Cleanups are regulated by the TCEQ Petroleum Storage Tank (PST) Program under Texas Administrative Code (TAC) Chapter 334 rules.
- Once a fuel release from an underground fuel storage tank is suspected or confirmed, release reporting to the TCEQ PST Program is required.
 - The TCEQ issues a leaker letter (opens LPST Pollution Case) requiring the Owner/Operator of the USTs to immediately abate any releases and conduct soil and groundwater cleanup per Texas Water Code (TWC) Section 26.351(b) and TAC Section 334.71-334.85.

The LPST Cleanup

- The TCEQ requires the tank owner/operator to conduct a comprehensive site assessment and submit an Assessment Report Form (ARF).
- Assessment performed at the source area(s) to investigate the magnitude and vertical and horizontal extent of the fuel release(s).
- Soil and Groundwater samples collected from source areas to evaluate hot spots.
 - Tank Pull or Soil Borings/Temporary Monitoring Wells (Site Check or Phase II ESA)
 - If LNAPL encountered, remove LNAPL to maximum extent practical.

The LPST Cleanup

- Remove soils exceeding Health Based and Construction Worker exposure concentrations at depths less than 5' feet bgs.
- Additional monitoring wells installed for horizontal delineation or to demonstrate decreasing concentration trends with distance from the source area(s).
- Document Plume Stability and Decreasing Concentration Trends with distance from the source area(s). Typically requires at least four (4) quarterly groundwater sampling events.
- Submit Site Closure Request.
- Final Site Closure

What Triggers Issuance of an LPST Pollution Case

- Suspected or Confirmed Release
 - Failed Tightness Testing Results
 - Fuel in Containment Sumps (STP and Dispenser)
 - Fuel in Tank Pit Observation Wells
 - Water in tanks
 - Inventory Records
 - UST Removal
 - Site Check (Temporarily out of Service UST Systems)
 - Phase II ESA Sample Results
 - Odors





Date	Start Stick Inventory (Gallons)	Gas Delivered	Gallons Pumped	Mid Grade	Mid Grade 67%	Book Inventory (Gallons)	End Stick Inventory		Daily Over or Short	Initials
							Inches	Gallons		
1	6161		724	85.44	57.24	5379.76	0	5387	7.24	BT
2	5387		317.25	88.35	59.19	5010.56	0	4980	-30.56	BT
3	4980		1.9	0	0.00	4978.10	0	4979	0.90	BT
4	4979		252.99	52.5	35.18	4690.84	0	4685	-5.84	BT
5	4685	4508	875.31	58.8	39.40	8278.29	0	8244	-34.29	BT
6	8244		1199.1	124.19	83.21	6961.69	0	6845	-116.69	BT
7	6845		822.08	66.64	44.65	5978.27	0	5676	-302.27	BT
8	5676		731.99	115.87	77.63	4866.38	0	4535	-331.38	BT
9	4535		1021.69	21.69	14.53	3498.78	0	3053	-445.78	BT
10	3053		791.2	56.48	37.84	2223.96	0	1888	-335.96	BT
11	1888	6988	829.16	123.69	82.87	7963.97	0	7468	-495.97	BT
12	7468		1125.26	121.44	81.36	6261.38	0	5693	-568.38	BT
13	5693		1046.28	93.72	62.79	4583.93	0	3967	-616.93	BT
14	3967		893.59	29.92	20.05	3053.36	0	2700	-353.36	BT
15	2700		823.74	43.15	28.91	1847.35	0	1578	-269.35	BT
16	1578	6966	936.16	76.05	50.95	7556.89	0	7143	-413.89	BT
17	7143		1016.37	85.07	57.00	6069.63	0	5626	-443.63	BT
18	5626		954.34	55.71	37.33	4634.33	0	4272	-362.33	BT
19	4272		1079.54	131.87	88.35	3104.11	0	2744	-360.11	BT
20	2744	7042	1174.35	108.1	72.43	8538.62	0	8038	-500.62	BT
21	8038		1304.49	127.1	85.16	6648.35	0	6121	-527.35	BT
22	6121		954.39	53.65	35.95	5130.66	0	4706	-424.66	BT
23	4706		966.19	114.68	76.84	3662.97	0	3242	-420.97	BT
24	3242		727.09	100.87	67.58	2447.33	0	2123	-324.33	BT
25	2123	7511	617.72	29.71	19.91	8996.37	0	8726	-270.37	BT
26	8726		748.02	52.04	34.87	7943.11	0	7554	-389.11	BT
27	7554		1072.97	65.3	43.75	6437.28	0	6015	-422.28	BT
28	6015		1177.8	76.55	51.29	4785.91	0	4265	-520.91	BT
29	4265		918.9	36.24	24.28	3321.82	0	2852	-469.82	BT
30	2852	7492	1138.79	46.2	30.95	9174.26	0	8555	-619.26	BT
31	8555		745.33	66.14	44.31	7765.36		7206	-559.36	

26988.59

-10927.61 This g

Date	Start Stick Inventory (Gallons)	Gas Delivered	Gallons Pumped	Mid Grade	Mid Grade 67%	Book Inventory (Gallons)	End Stick Inventory		Daily Over or Short	Initials
							Inches	Gallons		
1	6161									df
2	0									df
3	0									df
4	0									df
5	4685		875.31	58.8	39.40	3770.29	0	8244	4473.71	df
6	8244		1199.1	124.19	83.21	6961.69	0	6845	-116.69	df
7	6845		822.08	66.64	44.65	5978.27	0	5676	-302.27	df
8	5676		731.99	115.87	77.63	4866.38	0	4535	-331.38	df
9	4535		1021.69	21.69	14.53	3498.78	0	3053	-445.78	df
10	3053		791.2	56.48	37.84	2223.96	0	1888	-335.96	df
11	1888	6388	829.16	123.69	82.87	7963.97	0	7468	-495.97	df
12	7468		1125.26	121.44	81.36	6261.38	0	5693	-568.38	df
13	5693		1046.28	93.72	62.79	4583.93	0	3967	-616.93	df
14	3967		893.59	29.92	20.05	3053.36	0	2700	-353.36	df
15	2700		823.74	43.15	28.91	1847.35	0	1578	-269.35	df
16	1578	6966	936.16	76.05	50.95	7556.89	0	7143	-413.89	df
17	7143		1016.37	85.07	57.00	6069.63	0	5626	-443.63	df
18	5626		954.34	55.71	37.33	4634.33	0	4272	-362.33	df
19	4272		1079.54	131.87	88.35	3104.11	0	2744	-360.11	df
20	2744	7042	1174.95	108.1	72.43	8538.62	0	8038	-500.62	df
21	8038		1304.49	127.1	85.16	6648.35	0	6121	-527.35	df
22	6121		954.39	53.65	35.95	5130.66	0	4706	-424.66	df
23	4706		966.19	114.68	76.84	3662.97	0	3242	-420.97	df
24	3242		727.09	100.87	67.58	2447.33	0	2123	-324.33	df
25	2123	7511	617.72	29.71	19.91	8996.37	0	8726	-270.37	df
26	8726		748.02	52.04	34.87	7943.11	0	7554	-389.11	df
27	7554		1072.97	65.3	43.75	6437.28	0	6015	-422.28	df
28	6015		1177.8	76.55	51.29	4785.91	0	4265	-520.91	df
29	4265		918.9	36.24	24.28	3321.82	0	2852	-469.82	df
30	2852	7492	1138.79	46.2	30.95	9174.26	0	8555	-619.26	df
31	8555		745.33	66.14	44.31	7765.36		7206	-559.36	
1	3901		60.49	72.79	24.02	3816.49	0	3816	-0.49	df
2	3816		13.79	55.61	18.35	3783.86	0	3766	-17.86	df
		35999	25766.73	10232.27		3784	6448.27			



Site Check Requirements for Temporarily Out-of-Service Underground Storage Tank (UST) Systems to be Released from Financial Assurance Requirements

In accordance with 30 Texas Administrative Code (TAC) §334.54(e)(5)(b), an owner/operator who intends to place a UST system temporarily out-of-service (TOOS) must empty the UST system in accordance with 30 TAC §334.54(d)(2) and perform a “site check” as defined by 30 TAC §334.74(2) to be released from financial assurance requirements. The purpose of a site check is to determine if a release has occurred from the portion of the UST system that is to be placed TOOS. Site checks are to conform to the American Society for Testing and Materials (ASTM) guidance ASTM E1903, *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process* and be conducted by qualified personnel following recognized industry practices. The TCEQ recommends contacting an environmental consulting firm registered as a Corrective Action Specialist (RCAS) to conduct these activities. A list of these companies is available on the TCEQ website at https://www.tceq.texas.gov/remediation/pst_rp/license.html.

Site checks performed in accordance with §334.74(2) must be capable of detecting and measuring the presence of a release where contamination is most likely to be present. This must include the inspection of any existing tank hold observation wells for the presence of non-aqueous phase liquid (NAPL) and sampling where releases are most likely to occur from the UST system. The minimum requirements for assessing releases at the UST system are described below:

Tank Hold

- Advance at least two soil borings as close to the tank hold as possible, to a depth of at least 1 foot lower than the bottom of the tank hold. One of the borings must be placed close to the fill port; the other boring(s) may be placed on other side(s) of the tank hold.
- If the tank hold has more than 2 tanks or if any of the tanks in the tank hold are greater than 2,000 gallons in capacity, additional borings may be needed with at least one along each side of the tank hold.
- Collect two soil samples from each boring:
 - one at the interval with the highest indication of contamination (staining, odors, field instrument reading); or between the midpoint of the maximum tank diameter and total depth (TD) (if no obvious contamination is present); and
 - a second sample at the bottom of the boring.
- If groundwater is encountered before reaching the bottom of the boring, collect a groundwater sample by installing a temporary monitor well.

Dispenser(s)

- Advance one soil boring adjacent to each dispenser, at least one foot into the native soil below the depth of dispenser sump and collect one sample from the bottom of each boring.
- Separate dispenser samples are not required if the dispensers are located directly above the tank hold.

Release Reporting

- Incident Report Form Submittal
- Release Determination Report (RDR) Submittal (required for LPST issuance)

Risk Based Corrective Action

- Guidance provided in RG-523 (Revised January 2012) – Risk Based Corrective Action for LPST Sites
- Primary Cleanup Levels (Plan A Target Concentrations) are based on the presence or absence of water wells or other sensitive receptors (such as surface waters) within a 1/2 mile radius of the affected area.
 - Can typically obtain Plan A Category II Target Concentrations if no water wells present (water wells drawing water from affected zone) or surface water potentially threatened.
 - Can use Plan A Category III Target Concentrations if TDS > 10,000 mg/L
- Delineate to Plan A Category I Target Concentrations in direction of water wells using groundwater from affected zone.
- Delineate to Plan A Category III Target Concentrations at property boundaries.

Risk Based Corrective Action

- Remove NAPL to maximum extent practical
 - Removal by pumping or sorbents or both
 - Mobile Dual Phase Extraction (MDPE)
- Alternate Cleanup Levels can be established for a Class 3 Groundwater Resource (well yields less than 150 gallons per day).
 - Plan A Target Concentrations for Construction Worker Exposure
- Sampling Approach – Well Placement and Number of Samples Collected and Sample Depths (not a Phase II)
- Document Plume Stability and Decreasing Concentration Trends with distance from the source area(s). Typically requires at least four (4) quarterly groundwater sampling events.









TCEQ REGULATORY GUIDANCE

Remediation Division

RG-523/PST-03 • Revised January 2017

Risk-based Corrective Action for LPST Sites

Table 2. Categories of Affected Groundwater.

Category I	Category II	Category III	Category IV
One or more affected or threatened drinking-water wells	Affected groundwater zone with TDS < 3,000 mg/L, and no drinking-water wells documented within 1/2 mile of the site	Affected groundwater zone with TDS 3,000–10,000 mg/L, and no drinking-water wells documented within 1/2 mile of the site	Affected groundwater zone with TDS > 10,000 mg/L
Affected groundwater zone TDS < 3,000 mg/L, <u>and</u> one or more drinking-water wells or water-supply springs located within 1/2 mile of site	TDS 3,000–10,000 mg/L, and one or more drinking-water wells are documented within 1/2 mile of the site		Well yield < 150 gpd (i.e., the affected zone is not productive)

Plan A Target Concentrations

Chemicals of Concern (COCs)	Groundwater (mg/L)			Groundwater Protective Soil (mg/kg)			Health-Based Soil (mg/kg)		Construction Worker		Irrigation Well (mg/L)		Hypothetical POE (mg/L)
	Beneficial Groundwater Use Category						Resident	Com/Ind	Soil (mg/kg)	Ground-water (mg/L)	Resident	Com/Ind	Groundwater
	I	II	III	I	II	III							
Benzene	0.005	0.0568	0.27	0.12	1.34	6.40	7.14	9.62	21.9	61.2	0.408	2.06	4.03
<i>Ethylbenzene</i>	0.7	3.65	5.21	36.8	88.8*	88.8*	3,270	22,400	525	32.3	9.22	28.2	7.77
<i>Toluene</i>	1.0	2.92	4.17	39.1	114	163	3,850	35,200	907	51.7	10.1	43.5	6.21
<i>Xylenes (total)</i>	10.0	10.0	10.4	117*	117*	117*	1,870	9,280	202	46.6	17.5	51.7	15.5
<i>Acenaphthene</i>	2.19	2.19	3.13	34.1	34.1	34.1	4,690	123,000	11,500	3.04	2.06	4.21	4.66
<i>Acenaphthylene</i>	2.19	2.19	3.13	54.7*	54.7*	54.7*	4,690	123,000	11,500	3.77	2.66	5.77	4.66
<i>Anthracene</i>	11.0	11.0	15.6	2.04	2.04	2.04	23,500	613,000	57,700	12.6	9.14	18.3	23.3
<i>Benz-a-anthracene</i>	0.000852	0.00852	0.0406	7.1	7.1	7.1	6.37	55.3	486	0.0512	0.0034	0.00395	0.604
<i>Benzo-a-pyrene</i>	0.0002	0.000852	0.00406	3.09*	3.09*	3.09*	0.639	5.66	53.4	0.00233	0.0002	0.0002	0.0604
<i>Benzo-b-fluoranthene</i>	0.000852	0.00852	0.0406	3.61*	3.61*	3.61*	6.38	55.9	507	0.0262	0.00166	0.00189	0.604
<i>Benzo-g,h,i-perylene</i>	1.1	1.1	1.56	0.824*	0.824*	0.824*	2,350	61,300	5,770	0.028	0.056	0.0967	2.33
<i>Benzo-k-fluoranthene</i>	0.00852	0.0852	0.406	1.35*	1.35*	1.35*	64	572	5,590	0.228	0.0166	0.0189	6.04
<i>Chrysene</i>	0.0852	0.852	4.06	1.24*	1.24*	1.24*	639	5,630	52,500	4.84	0.34	0.395	60.4
<i>Dibenz-a,h-anthracene</i>	0.0002	0.000852	0.00406	1.91*	1.91*	1.91*	0.64	5.72	55.9	0.0011	0.0002	0.0002	0.0604
<i>Fluoranthene</i>	1.46	1.46	2.09	25.5*	25.5*	25.5*	3,130	81,800	7,690	0.387	0.631	1.17	3.11
<i>Fluorene</i>	1.46	1.46	2.09	30.2*	30.2*	30.2*	3,130	81,800	7,690	2.12	1.73	3.73	3.11
<i>Indeno-1,2,3-cd-pyrene</i>	0.000852	0.00852	0.0406	26.0*	26.0*	26.0*	6.4	57.2	558	0.0109	0.000804	0.000902	0.604
Methyl tert-butyl ether (MTBE) (see footnote)	0.24	0.365	0.521	2.56	3.90	5.57	87.3	128	294	83.5	1.86	28.7	0.777
<i>Naphthalene</i>	0.73	0.73	1.04	99.7*	99.7*	99.7*	112	531	11.5	0.668	1.77	5.24	1.55
<i>Phenanthrene</i>	1.10	1.10	1.56	28.2*	28.2*	28.2*	2,350	61,300	6,390	1.33	0.914	1.83	2.33
<i>Pyrene</i>	1.10	1.10	1.56	10.3*	10.3*	10.3*	2,350	61,300	5,770	0.294	0.473	0.875	2.33

Normal font: Carcinogenic COC

Italic font: Non-carcinogenic COC

Bold font: Maximum Contaminant Level (MCL)

*: The saturated soil concentration is substituted for the calculated value.

MTBE: Groundwater is non-carcinogenic, soil is carcinogenic.



SUBJECT: **Soil Boring and Monitor Well Installation**

When the Texas Natural Resource Conservation Commission (TNRCC) is notified of a release from a storage tank, the TNRCC may request that the owner or operator of the leaking storage tank(s) conduct an environmental site assessment to determine the extent of the effect of the release upon the environment. The requested environmental site assessment generally requires the installation of soil borings to investigate the effect of the release upon the soils and in some cases the installation of monitor wells to investigate the effect of the release upon the groundwater.

- **The TNRCC requires that the services of a registered Corrective Action Specialist (and a Project Manager as of February 4, 1994) be employed to conduct the requested assessment and to oversee the installation of the soil borings and monitor wells.**

This pamphlet details the minimum requirements for the installation of the requested soil borings and monitor wells. Monitor wells must be installed in compliance with Title 30, Texas Administrative Code, Chapter 338 which contains the specific Texas regulations regarding the installation of water wells and monitor wells. Of particular importance is the requirement that monitor wells must be installed within the State of Texas by a driller licensed by the State of Texas.

This pamphlet also provides some recommendations for soil boring/monitor well design and placement.

Soil Boring Installation

Soil borings are utilized to collect soil and/or rock samples from below the ground surface. The collected samples are used to determine:

- the type of soil and/or rock present beneath the site, and
- the amount of and the limits of any contamination in the soil resulting from the release from the storage tank. Contaminant levels are determined through laboratory analysis of soil samples.

The TNRCC recommends that three soil borings be initially installed during the first phase of an environmental site assessment in order to determine:

- the degree or amount of contamination in the soil,
- the lateral or horizontal extent of contamination in the soil, and
- the vertical extent or depth of contamination in the soil.

When possible, the soil borings should be installed using the hollow-stem auger method in order to avoid the use of drilling fluids and to make it easier to collect representative soil samples. The use of the hollow-stem auger method also makes the subsequent installation of monitor wells easier.

In order to prevent the spread of contamination from one boring to another (cross-contamination), all down-hole drilling equipment should be decontaminated between each boring. Sampling equipment should be decontaminated using tri-sodium phosphate or a similar detergent after the collection of each sample.

Soil samples should be collected continuously to the bottom of each boring. Less frequent sampling may be allowable when deep borings (greater than 50 feet) are drilled.

Samples should be collected with a decontaminated split-spoon sampler, Shelby tube, or similar sampling device. All collected soil samples should be viewed and described to document subsurface soil and rock types utilizing the Unified Soil Classification System.

Discreet, duplicate soil samples should be collected from the sampler referenced above. One sample should be field screened using an automated screening device to check for the presence of vapors from the contaminants released from the storage tank. The second sample should be immediately preserved for potential shipment to the laboratory for analysis.

Soil borings should be drilled to a depth of at least five feet below the base of contamination. While drilling, the presence of contaminants should be determined by field screening the collected soil samples.

If a groundwater producing zone is encountered during the drilling of a boring, consideration should be given to converting the boring to a monitor well. Monitor wells are needed to investigate groundwater contamination. Please refer to the subsequent Monitor Well Installation section.

The purpose of submitting soil samples for laboratory analysis is to determine the maximum level of soil contamination at a particular location and to determine the maximum depth of soil contamination at a particular location. Therefore, soil samples selected for laboratory analysis should be collected from the zone of highest contamination as determined from the field screen, and from one or more of the following:

- immediately above the water table or bedrock,
- the base of each borehole (if groundwater is not encountered), or
- below the water table if groundwater is encountered.

Generally, it is adequate that only two or three soil samples per boring are submitted for laboratory analysis. However, in certain instances more soil sample analyses may be needed. In such cases, contact the TNRCC case coordinator for approval.

Soil samples should be collected immediately after the sampling device is retrieved from the borehole to limit exposure of the sample to effects of wind and heat.

- Each sample should be collected using clean disposable gloves and other clean sampling utensils.
- Samples which are to be sent to the laboratory for analysis should be placed in sterile sample jars provided by the laboratory. Completely fill each sample jar so that no air space (headspace) exists, wipe soil from the jar threads, and seal the jar using a cap lined with Teflon. The jar should be labeled and placed on ice in a covered, insulated cooler and chilled to 40°F (4°C).

Please refer to the TNRCC pamphlet entitled *Soil and Groundwater Sampling and Analysis* for the determination of which constituents to analyze for and which laboratory methods to use.

Monitor Well Installation

Monitor wells should be installed when groundwater is determined to be affected or thought to be affected by the release from the storage tank. Monitor wells are necessary to:

- determine the depth to groundwater at the site,
- determine the direction of groundwater flow, and
- collect representative groundwater samples for laboratory analysis to determine the degree of groundwater contamination and the quality of the groundwater.

If there is no evidence or threat of a groundwater impact, monitor wells are generally unnecessary. Evidence of groundwater impact may include:

- groundwater is present at a very shallow depth,
- groundwater is encountered while installing borings prior to reaching the base of soil contamination, or
- a neighboring water well is contaminated with the substance released from the storage tank in question.

In all cases, preparations should be made in advance so that monitor wells can be installed immediately after drilling the borings described in the Soil Boring Installation section of this pamphlet if wells become necessary.

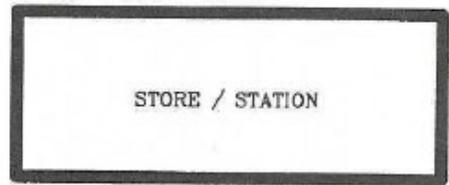
⊗ MW

Apparent or Known
Ground-water Gradient



Suspected
Leak Point ⊗ MW

Product Lines



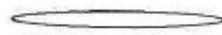
STORE / STATION

Product Lines

Dispenser Island

⊗ MW

Product Lines



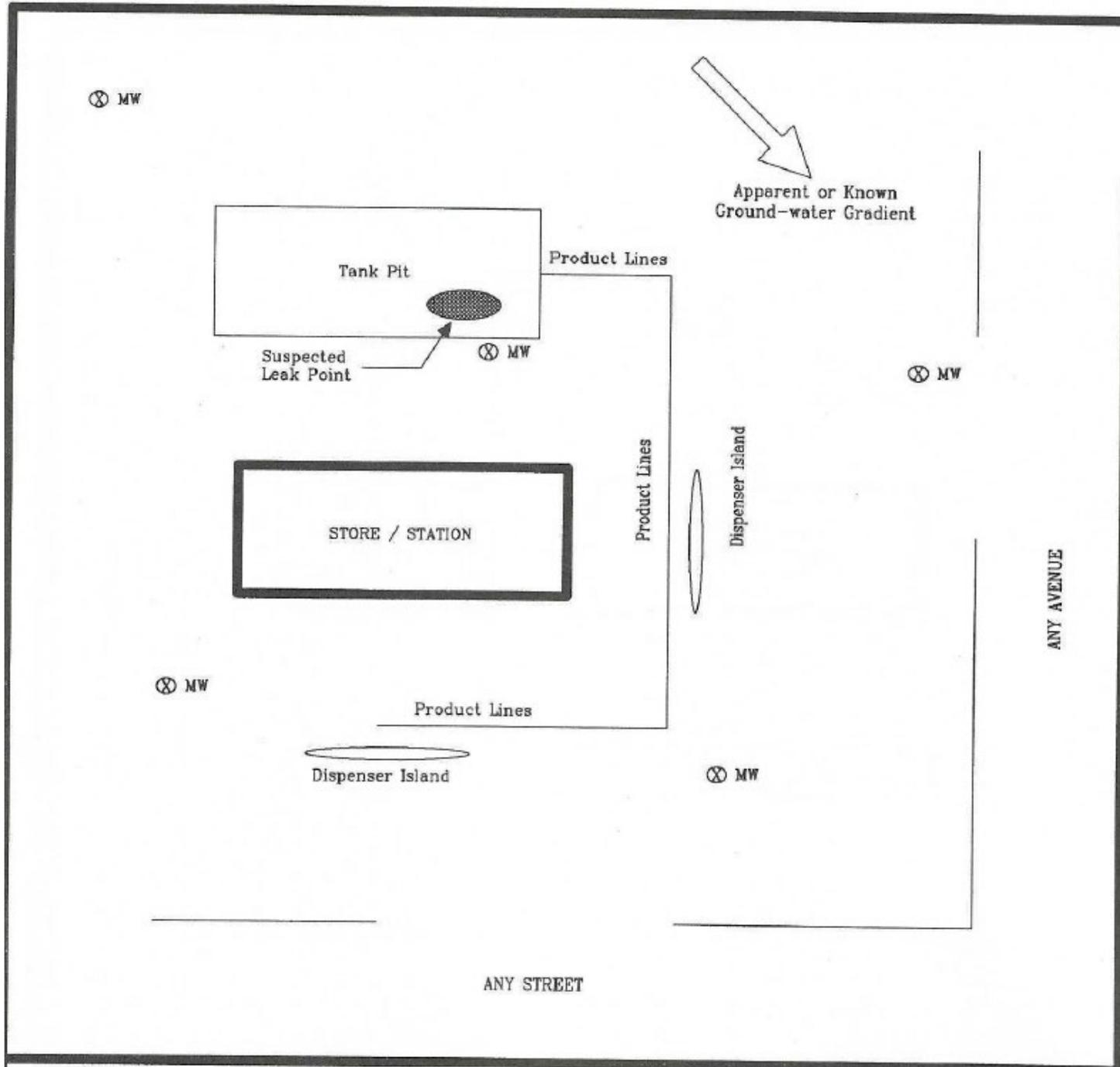
Dispenser Island

⊗ MW

⊗ MW

ANY AVENUE

ANY STREET



COC concentrations in soils and groundwater should not be capable of generating vapors in the pore spaces of the soil, utilities, or in the atmosphere which could cause an explosive environment at any surface or subsurface structure. In instances where there is a reasonable potential for explosive vapors to collect in surface or subsurface structures (e.g., utility vaults, storm sewers, basements, poorly vented surface structures), target soil-air concentrations should be based on 25 percent LEL value for that constituent. Vapor accumulations in excess of 10 percent of the LEL should be vented, monitored, and further assessed for possible remediation. Vapor concentrations must not exceed 25 percent of the LEL. The LEL and upper explosive limit (UEL) for some common compounds are provided in Table 6. Monitoring for explosive atmosphere levels should be performed by a properly trained environmental or fire professional using a properly calibrated and operating explosimeter. If emergency or hazardous situations exist, such as the presence of explosive conditions, immediately contact the local fire authority or State Fire Marshal and notify the local TCEQ Regional Office. Take all actions necessary to prevent such situations from occurring and immediately abate the hazardous conditions.

Table 6. Maximum Allowable Vapor Concentrations.

Compound	LEL %	UEL %	25% LEL Action Levels, %
Gasoline	1.2	7.6	0.30 (3,000 ppm _v)
JP-4	1.3	8.0	0.32 (3,200 ppm _v)
Diesel Fuel	1.3	7.5	0.32 (3,200 ppm _v)
Fuel Oils	0.6	7.5	0.15 (1,500 ppm _v)
Kerosene	0.7	5.0	0.18 (1,800 ppm _v)
Benzene	1.3	7.9	0.32 (3,200 ppm _v)
Ethylbenzene	1.0	6.7	0.25 (2,500 ppm _v)
Toluene	1.2	7.1	0.30 (3,000 ppm _v)
Xylenes	1.0	7.0	0.25 (2,500 ppm _v)
<i>n</i> -hexane	1.2	7.5	0.28 (2,800 ppm _v)

If direct measurement is not feasible and NAPL is not present at the site, use the following equilibrium-partitioning equation to determine the theoretical maximum vapor concentration in the soil (Thomas, 1982). The calculated soil vapor concentrations can be compared to the 25 percent LEL action level in Table 6 to determine if the potential to create vapor levels of concern exists. The default values provided below are conservative. Hence, if calculated concentrations are less than 25 percent of the LEL, then soil concentrations should be adequately protective. Use site-specific data if available.

$$C_a = \frac{C_T H' \beta}{K_d \beta + \Phi_w + \Phi_a H'}, \text{ where}$$

C_T = bulk soil concentration (mg/kg dry weight) (see field sampling data)

C_a = soil vapor concentration (mg/L)

K_d = soil-water partition coefficient ($K_{oc} \times f_{oc}$)

K_{oc} = organic carbon partition coefficient (kg adsorbed chemical/kg soil organic carbon)/ (kg dissolved chemical/L water) (chemical specific)

f_{oc} = soil organic carbon fraction (default: 0.2% or .002)

β = dry-soil bulk density (kg/L) (default: 1.72 kg/L)

Φ = total soil porosity [$\Phi = 1 - \beta/P_b$; P_b = particle density (default particle density = 2.65 kg/L)]

Φ_a = air filled soil porosity ($\Phi - \Phi_w$)

Φ_w = water content (cm^3/cm^3) (default: 13% or .13)

H' = Henry's Law constant (unitless). $H' = H / (RT)$ where H = the dimensional form of Henry's Law Constant, atm-m³/mol; R = universal gas constant, 0.0000821 atm-m³/mole-°K; T = absolute temperature, 273°K + °C. $H' = H \times 41.57$.

[Note: mg/L \times (1×10^3 L/m³) = mg/m³]

Note the following conversion of Threshold Limit Values (TLV) in ppm to mg/m³ assuming 760 torr barometric pressure at 25°C (77°F), and where 24.45 = molar volume in liters (ACGIH, 1991):

$$\text{TLV (mg/m}^3\text{)} = \frac{\text{TLV in ppm (gram molecular weight of substance)}}{24.45}$$

This same conversion, rearranged to solve for ppm, can be used to convert concentrations derived from the previous equation for comparison to concentrations presented in Table 5.

TARGET VAPOR CALCULATIONS - BACKWARD CALCULATIONS

$$3,200 \text{ ppm}_v = \text{TLV}_{\text{ppmv}}$$

$$\text{TLV}_{\text{ppmv}} = \frac{(X)_{\text{mg/m}^3} (24.45)}{78}$$

$$\begin{aligned} X_{\text{mg/m}^3} &= \frac{(\text{TLV}_{\text{ppmv}})(78)}{24.45} = \frac{(3,200 \text{ ppm}_v)(78)}{24.45} \\ &= 10208.59 \text{ mg/m}^3 \end{aligned}$$

$$\frac{10208.59 \text{ mg/m}^3}{1e-10^3 \text{ L/m}^3} = 10.209 = 10.21$$

$$C_a = 10.21 \text{ mg/l}$$

$$C_a = \frac{C_T H' \beta}{k_d \beta + \phi_w + \phi_a H'}$$

$$C_T = \frac{C_a (k_d \beta + \phi_w + \phi_a H')}{H' \beta}$$

$$C_T = \frac{10.21 \text{ mg/l} (0.45)}{(0.233)(1.8 \text{ kg/l})}$$

$$= \frac{4.5945 \text{ mg/l}}{0.4194 \text{ kg/l}} = 10.95 \text{ mg/kg}$$



Site Closure Request

- Site Closure Request Form - TCEQ-0028
 - Remove NAPL to maximum extent practical
 - Waste Disposed
 - Contaminant Concentrations show Consistent or Low Static Trend at Source Area
 - Contaminant Concentrations show Decreasing Concentration Trends with Distance from Source Area
 - Receptor Survey Completed
 - Affected surface soils exceed Health Based Target Concentrations present at depths <2 and <15 feet bgs
 - Affected groundwater concentrations exceed Construction Worker Target Concentrations at depth <15 bgs (or within known utility depths).
 - Flow Chart Pathways direct Site towards Closure

Figure 1
Groundwater Pathways (wells, aquifers, surface water, etc)

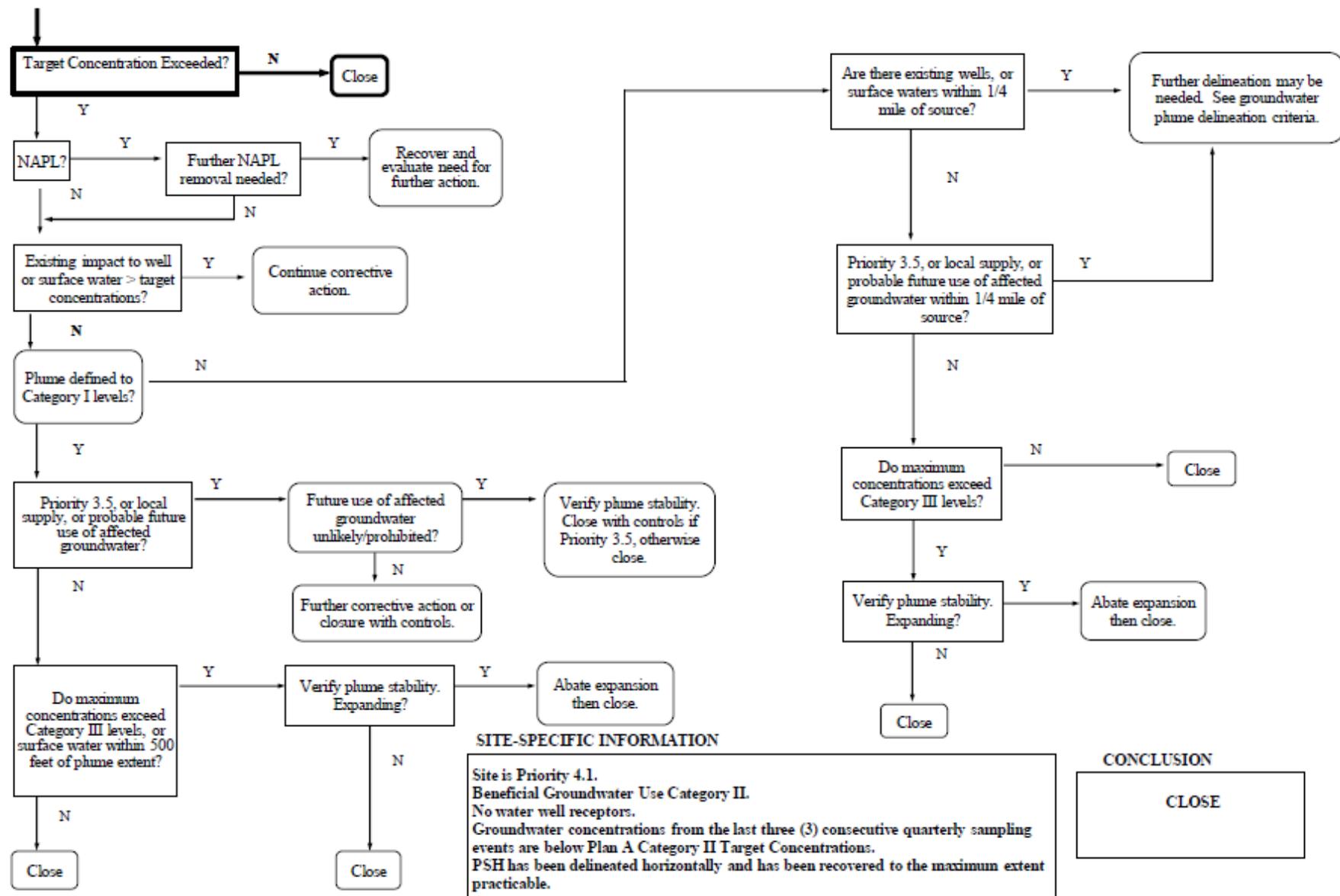


Figure 2

Groundwater Pathway (construction workers)

Groundwater depth < 15 Feet, or Within Typical Construction Depth

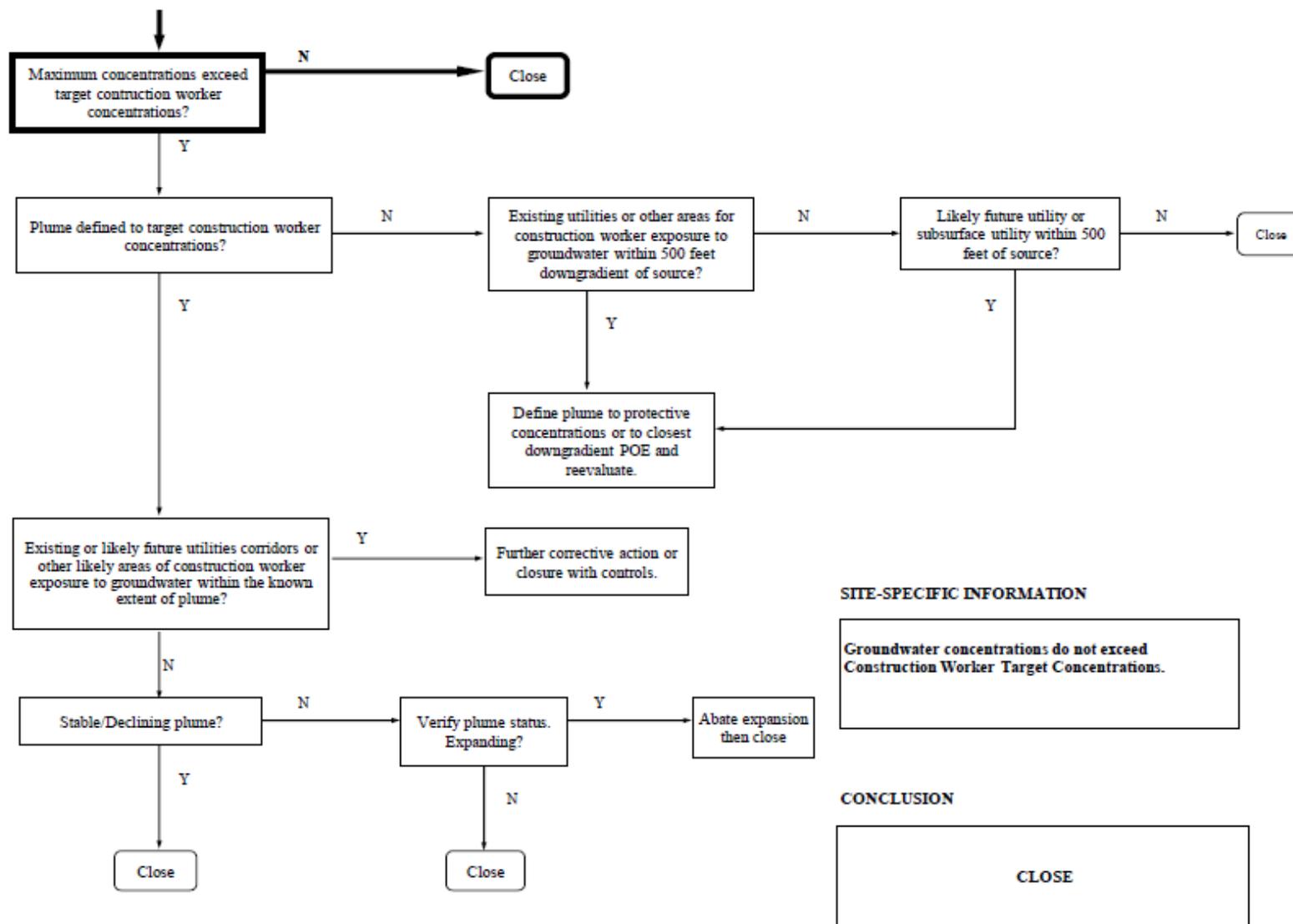
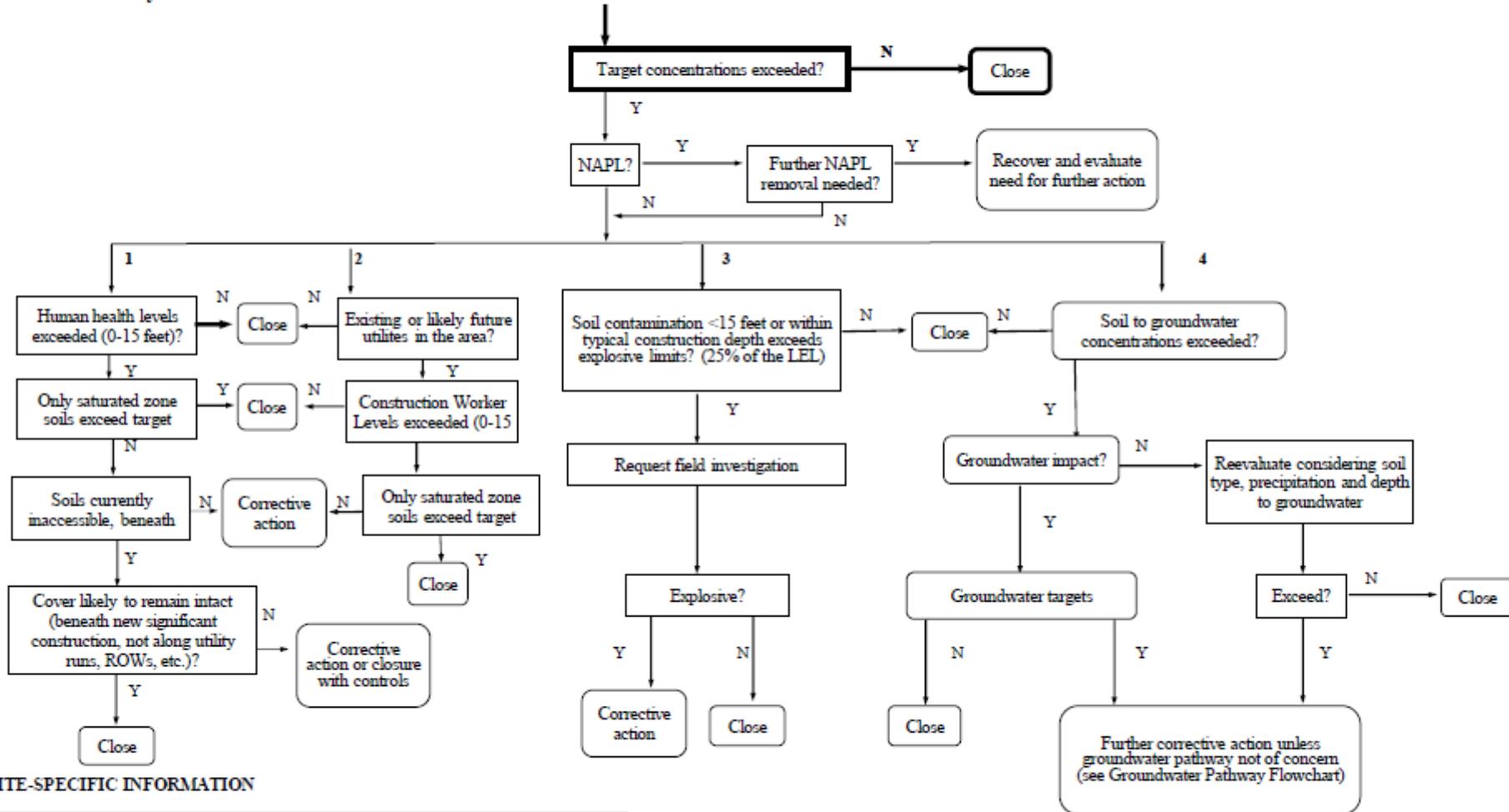


Figure 3

Soils Pathways

Evaluate all four pathways



SITE-SPECIFIC INFORMATION

Soil sample results do not exceed Plan A Category II Target Concentrations.

CONCLUSION

CLOSE

Key Take Aways for Case Closure

- Affected soil >Health Based and Construction Worker Exposure Concentrations less than 15' bgs or typical utility depths removed
- Remove PSH to max extent possible
- Stable to decreasing concentrations at source area and decreasing concentration trends with distance from source area.
- Plume delineation to Category III Target Concentrations at Property Boundary

Questions

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