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Revision 0

Data Requirements for Characterization Supporting Interim Measures in TX Farm

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LIST OF TERMS

Acronyms/Abbreviations

bgs	below ground surface
cps	counts per second
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
ft	feet
MW	metal waste
ORP	(DOE) Office of River Protection
PNNL	Pacific Northwest National Laboratory
RCRA	*Resource Conservation and Recovery Act of 1976*
SGE	surface geophysical exploration
SGLS	spectral gamma logging system
SST	single-shell tank
UPR	unplanned release
WMA	Waste Management Area
WRPS	Washington River Protection Solutions, LLC

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1.0 DIRECT PUSH INVESTIGATIONS TO SUPPORT POSSIBLE INTERIM MEASURES IN 241-TX TANK FARM

This report outlines the data requirements to continue characterization and evaluation efforts at the 241-TX Tank Farm (TX Farm). Figure 1-1 shows the layout of Waste Management Area (WMA) TX-TY. The overall objective of this effort is to gather data to support a determination regarding whether the application of an interim measure is merited to either curtail transport of the mobile contaminants or to remove them if possible. Note that the WMA boundary identified in Figure 1-1 is associated with groundwater monitoring and is essentially the perimeter fence, which is a security construct. The WMA for closure and corrective measures may include areas beyond the current perimeter fence(s) that have been affected by releases from single-shell tanks (SSTs) or ancillary equipment (e.g., pipeline breaks outside the fenceline).

1.1 STATE THE PROBLEM

The 241-TX Tank Farm has near-surface soil contamination of hazardous constituents from past waste releases. It is postulated that an interim measure would be implemented at TX Farm. The exact nature of the interim measure at this time is not known. However, it is postulated that either an interim barrier could be placed over TX Farm to reduce moisture infiltration rate into the soil, thereby reducing the migration of soluble contaminants to the groundwater, or a remedial technology could be deployed to remove contaminants from the subsurface. In either case, the lateral extent of the vadose contamination at TX Farm needs be determined in order to ensure the proper design of the interim measure.

Table 4-4 in RPP-ENV-41309, *Criteria for Prioritizing Hanford Site Tank Farm Interim Surface Barriers and for Evaluating Their Performance* indicated that a barrier placed over a grouped site consisting of tank 241-TX-107 (TX-107) and UPR-200-W-100 was ranked 7th of 15. The report also indicated that information and methodology in the report should be updated over time to include additional data (e.g., on released inventory). Hence this information has been reviewed and additional information has been presented.

Specifically regarding TX Farm, a meeting was held on September 6, 2012 with representatives from the Washington State Department of Ecology (Ecology), U.S. Department of Energy (DOE) Office of River Protection (ORP), Pacific Northwest National Laboratory (PNNL), and Washington River Protection Solutions, LLC (WRPS). During this meeting, waste release characterization information about TX Farm was presented to further the understanding on the need of an interim measure (refer to Appendix A for meeting minutes). Known sources of contamination identified in RPP-54073, *TX Tank Farm Leak Inventory Assessment Meeting Summaries* were discussed in this meeting. These sources include: TX-107 with leak estimate from 2,500 gal to 8,000 gal; category 4 tanks (241-TX-105 [TX-105], 241-TX-110 [TX-110], 241-TX-113 [TX-113], 241-TX-114 [TX-114], 241-TX-115 [TX-115], 241-TX-116 [TX-116], and 241-TX-117 [TX-117]); and unplanned releases (UPRs) (UPR-200-W-12, UPR-200-W-17, and UPR-200-W-100). Figure 1-1 shows tanks designated as leakers and Figure 1-2 shows the location of UPRs.

Figure 1-1. Waste Management Area TX-TY and Surrounding Facilities.

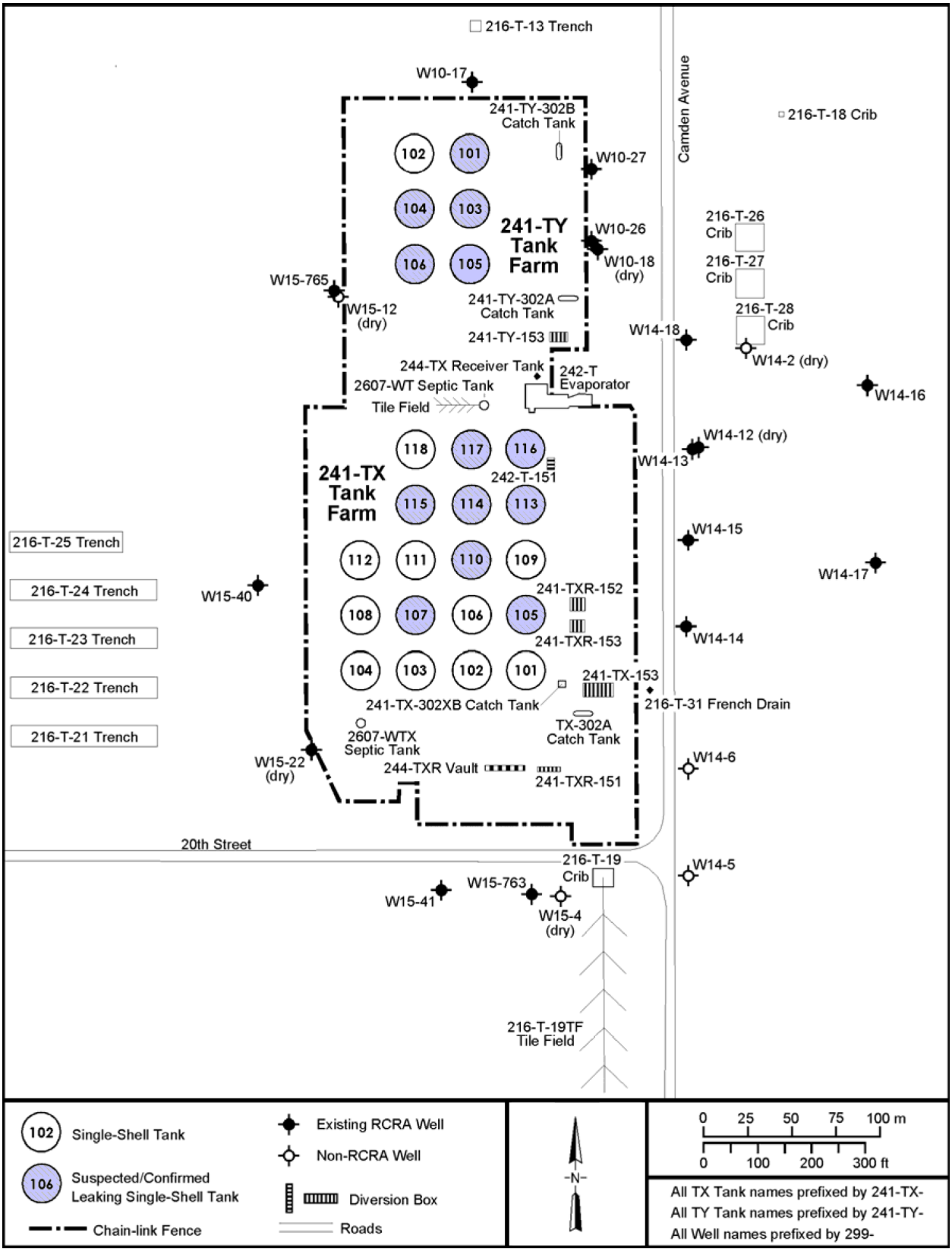
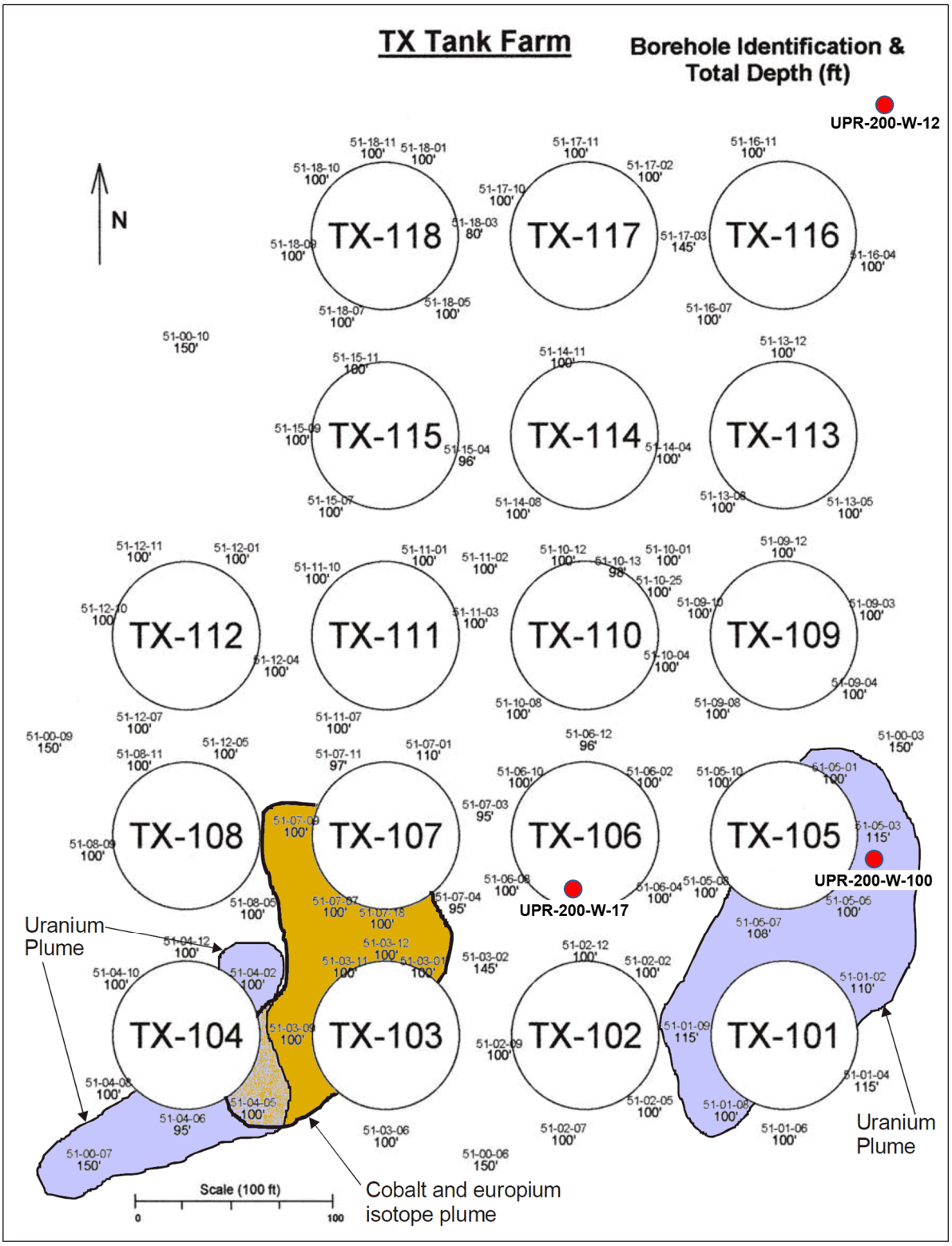


Figure 1-2. Waste Management Area TX-TY Elevated Gamma Data in Drywells Showing the Uranium, Cobalt-60, and Europium Plumes in Southern 241-TX Tank Farm.



Modified from RPP-6353, *Analysis and Summary Report of Historical Dry Well Gamma Logs for the 241-TX Tank Farm – 200 West*.

According to RPP-54073, the category 4 tanks had small levels of contamination observed in nearby drywells. The levels of contamination could come from either a leak in the tank, overfilling of the tank with loss out of the side inlet ports, or leaks from pipelines close to the tank. Little information is available for these tanks to support a leak volume estimate, and no previous leak inventory estimate has been developed. Also, no leak volume estimate has been developed for these tanks other than to assume an average value based on previous tank leaks from 18 other tanks. The average leak volume estimate in HNF-EP-0182, *Waste Tank Summary Report for Month Ending October 31, 2012* for these tanks was based on an assumption that their cumulative leakage is approximately the same as for 18 of the 24 tanks where leak volumes were determined by liquid-level decreases. The total liquid loss for the category 4 tanks is assumed to be 8,000 gal. Of the three UPRs, only UPR-200-W-100 released a significant volume (2,500 gal) of waste to the vadose zone; the other two were considered negligible (UPR-200-W-17) or of ~5 gal (UPR-200-W-12).

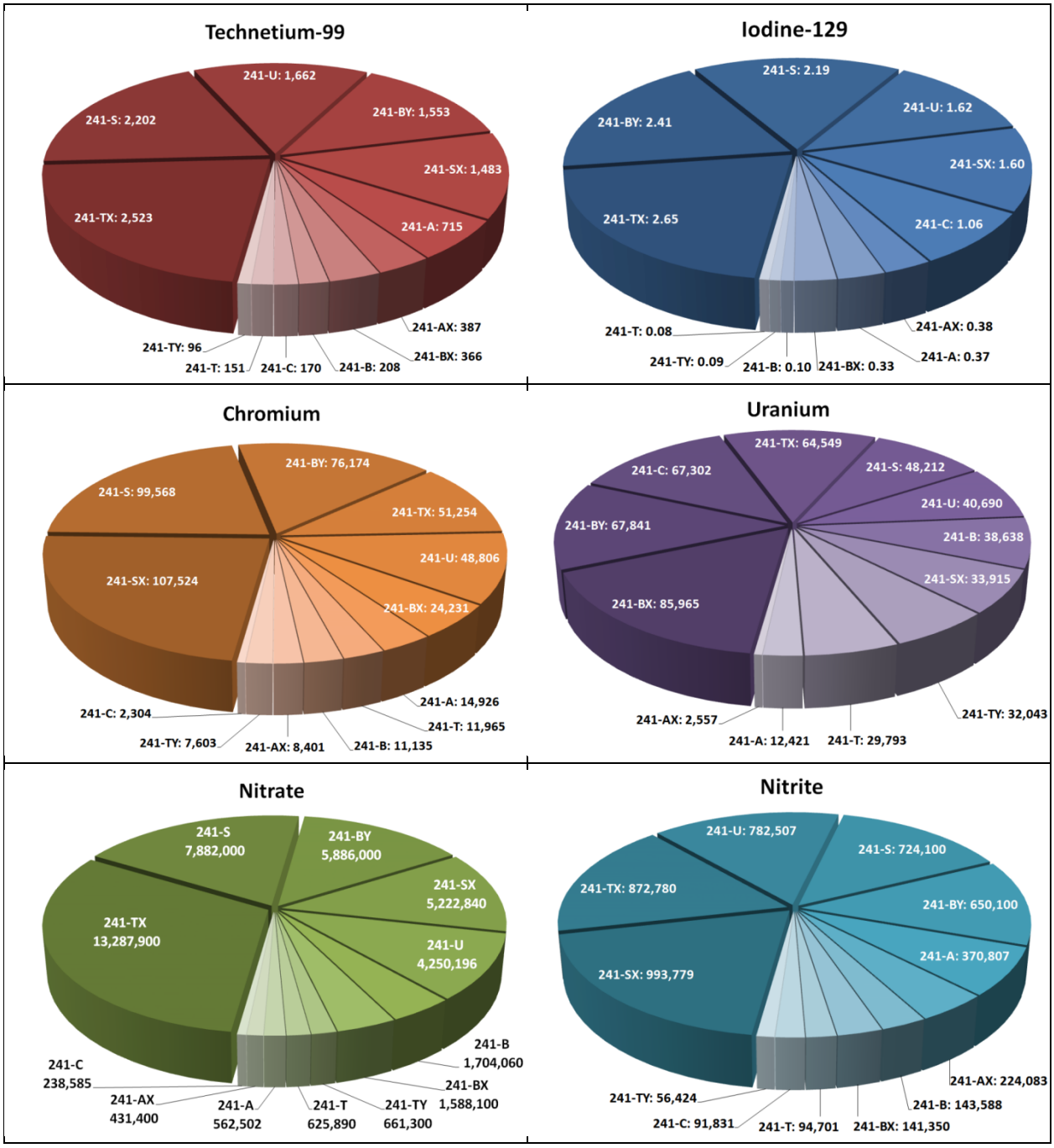
In addition to the information in RPP-54073, Revision 0-A of RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-TY* delineated two uranium plumes and a co-mingled ^{60}Co and europium plume in the southern half of TX Farm from drywell measurements (Figure 1-2, blue areas). The first plume is between tanks 241-TX-101 (TX-101) and TX-105 with ^{238}U values ranging from 1 to 100 pCi/g from 45 to 75 ft below ground surface (bgs). Note that 1 pCi/g of ^{238}U equals 3 µg/g of ^{238}U. The ^{235}U concentrations mirror the ^{238}U values, but about an order of magnitude lower. The highest uranium levels occur at shallow depths toward the northeast. The second uranium plume with similar concentrations is found in drywells around tank 241-TX-104 at a depth of 45 to 100 ft bgs, again with the higher contamination levels occurring at shallow depths toward the northeast. The presence of uranium contamination at these concentrations strongly indicates leakage of metal waste (MW) in the early 1950s. No other substantive information is available that describes the nature or cause of this leak. There is also a ^{60}Co/europium plume (Figure 1-2, brown area) in the drywells between tanks 241-TX-103 (TX-103), TX-105, and TX-107. The plume is located ~45 to 75 ft bgs and is related to the tank TX-107 leak event in the mid-1970s.

It should be noted that there has been extensive characterization work conducted in WMA TX-TY as part of *Resource Conservation and Recovery Act of 1976* (RCRA) Phase 1 characterization efforts and the installation of an interim barrier over 241-TY Tank Farm (TY Farm). Information gathered during those characterization efforts indicate that TX Farm contaminant transport could be reduced or removed by an interim measure. Gathering additional vadose zone characterization information at TX Farm would result in a better understanding of the benefits of an interim measure at TX Farm.

In addition to protecting groundwater from past UPRs, an interim measure such as an infiltration barrier placed over TX Farm may also protect groundwater by slowing and/or stopping a possible future leak from the SSTs. To understand the impacts of possible future UPRs from SSTs, the Best Basis Inventory database was queried through for those constituents that could impact groundwater (^{99}Tc, ^{129}I, chromium, nitrite, nitrate, and uranium) if a UPR were to occur. This inventory was downloaded from Tank Waste Information Network on April 10, 2012, with the radionuclides decayed to January 1, 2008. The inventory of groundwater-impacting constituents was summed to calculate a percentage of those contaminants for each tank farm over

the total inventory. The results are shown in Figure 1-3 as a series of pie charts. From these pie charts, it can be readily seen that TX Farm has the highest percentage of ^{99}Tc, ^{129}I, and nitrate. Installation of an interim measure such as an infiltration barrier would protect groundwater not only from past UPRs, but also from future releases if a UPR occurred before waste in these tanks is retrieved.

Figure 1-3. Inventory of Contaminants That May Impact Groundwater in Single-Shell Tank Waste.



1.2 IDENTIFY THE DECISION

The purpose of the field work in TX Farm is to gather data to help determine if the conditions are such that an interim measure will be beneficial (e.g., reduce the rate of migration of contaminants in soil to groundwater or remove the mobile contaminants [reduce groundwater risk] in the near term). In order to determine if an interim measure would be effective, the geographic extent of subsurface soluble contaminant plumes must be understood. It is also important to understand whether the soluble contaminants are too deep in the vadose zone or too close to the groundwater for an interim measure (such as a barrier) to effectively reduce the risk and therefore the release of contaminants to the groundwater. In simple terms, the effective depth of the interim barrier is defined as the maximum depth at which a barrier is expected to reduce the migration rate of contaminants through the soil.

The effective depth of a surface barrier is dependent upon a number of factors. PNNL-18661, *Technical Basis for Evaluating Surface Barriers to Protect Groundwater from Deep Vadose Zone Contamination* indicates that the effectiveness of surface barriers is highly dependent on the complex interaction of site conditions, surface barrier design and performance features, and vadose zone contaminant conditions. Factors such as barrier design, barrier size relative to contamination depth and extent, and the method used for disposition of collected water all impact a barrier's effective depth. It is also worth noting that RPP-33431, *Design Analysis for T-Farm Interim Surface Barrier (TISB)* examined the depth of barrier effectiveness with numerical simulations and concluded the maximum depth of impact for the 241-T Tank Farm interim surface barrier is about 50 m (164 ft) bgs.

In addition to determining the merit of an interim measure, it is anticipated that data collected for this effort will also be used to further characterize the vadose zone in TX Farm. The data should help determine the extent and nature of the plume contaminants and provide indications that a tank or pipe release of waste has migrated through the soil column. It is also possible that data collected may be used to formulate the basis for future RCRA Phase 2 characterization activities at TX Farm. Ultimately, characterization data is needed to determine how to prepare TX Farm for closure.

1.2.1 Identify Inputs to the Decision

Four main factors that could affect the effectiveness of an interim measure are:

- Soil properties
- Contaminant location
- Contaminant properties (i.e., mobility)
- Recharge rate.

In order to ascertain information on these factors, the following inputs must be considered:

- Leak assessment information (e.g., when and where have leaks occurred)
- Geology, stratigraphy, and hydrology of the area.

1.2.1.1 Leak Assessment Information. The following factors are crucial regarding barrier evaluations (e.g., choosing sampling locations) for tank farms (RPP-ENV-38696, *Data Requirements for Characterization Supporting Near-Term Interim Barriers*).

- When and where the leak or tank overfill occurred or could have occurred. Extensive measurements of gamma radiation show that in the Hanford formation, soluble (mobile) contaminants move downward ~2 to 3 ft per year after initial movement (i.e., after a leak event) and if it is determined that contaminant movement is greater, suggest that there might be potential impacts to the groundwater as a result of preferential pathways, impermeable formation, and other subsurface features if found or determined to be present.

- Sources of releases. Often there can be several sources of contamination. Knowledge of potential sources can aid in putting the pieces together.

- Type of waste stream involved in the leak. Over 50 waste types have been identified at Hanford. These waste types have different concentrations of key contaminants as well as different ratios between key contaminants. Such information can help determine how much of a contaminant may be present and how fast the contaminant may be moving (i.e., mobility).

- Numeric relationship of data at this location to data of the same type nearby. Comparing data at this location to a nearby location can provide trends (e.g., concentrations, geologic elevations) that can aid in developing an integrated and coherent understanding of the system.

- Nearby facilities and their event history (e.g., leaking waterlines, sinkholes, liquid discharge sites).

1.2.1.2 Tank Leak Summaries. Ecology, along with the tank farm contractor for DOE, developed a process to reassess selected tank leak estimates (volumes and inventories), and to update SST leak and UPR volumes and inventory estimates as emergent field data is obtained (RPP-32681, *Process to Assess Tank Farm Leaks in Support of Retrieval and Closure Planning*). This process was started for TX Farm in the Summer of 2011 when a number of meetings with Ecology took place. However, the final report documenting this process was not completed in time for this report. The final report is due in fiscal year 2013.

However, the meeting summaries which provide details about the known UPRs in TX Farm are available in RPP-54073. This section provides brief summaries of the known UPRs from TX Farm SSTs taken from RPP-54073. Information on other UPRs in TX Farm is taken from RPP-23752 and the Waste Information Data System, which is an electronic database of waste site information for the Hanford Site. Following the description of the UPRs is a brief summary of the Best Basis Inventory of contaminants that may impact groundwater if a UPR occurred at TX Farm.

Known sources of contamination discussed in in RPP-54073 and RPP-23752 include: tanks TX-105, TX-107, TX-110, TX-113, TX-114, TX-115, TX-116, and TX-117; and UPR-200-W-12, UPR-200-W-17, and UPR-200-W-100. Each of these occurrences is described below.

- Tank TX-105 was reviewed by the leak assessment team during the June 14, 2011 and July 12, 2011 meetings (RPP-54073). Tank TX-105 was classified as an "assumed leaker" based on gross gamma activity detected in drywells (51-05-01, 51-05-03 and 51-05-05) when the drywells were drilled. However, no estimate for the size of the leak is included in tank waste summary reports (HNF-EP-0182). Process data shows that the tank was overfilled in 1952 and between 1961 and 1964, and that waste may have been released from the spare inlets. Spectral gamma logging data show ^{235}U and ^{238}U activity in the drywells, suggesting MW may have been released in the early 1950s.

  The team concluded that the release near tank TX-105 appears to be a MW release from a transfer line and/or spare inlet, or may be from a tank leak, with an estimated 0.18 Ci of ^{238}U (i.e., 54 kg of ^{238}U) and a release volume of 150,000 gal, or larger if a dilute waste stream. Inventory estimates for other constituents released should use the RPP-19822, *Hanford Defined Waste Model – Revision 5.0* MW constituent concentrations multiplied by 150,000 gal. It was noted that the plume size estimates are based on a limited data set and additional direct push logging was recommended as part of future TX Farm investigations to better estimate the distribution and inventory of the plume.

- Tank TX-107 was categorized as "questionable integrity" in 1977 based on liquid level decreases and increasing drywell activity, and declared a confirmed leaker in 1984 with a leak volume estimate of 2,500 gal based on increasing activity in nearby drywells (HNF-EP-0182). Spectral gamma logging system (SGLS) measurements obtained in 1996 show ^{60}Co and ^{154}Eu gamma activity in the zones from 50 to 70 ft bgs in drywells 51-07-18 and 51-07-07 and in other drywells between SSTs TX-103 and TX-107, with a total estimated ^{60}Co activity of 0.075 Ci (using the ^{60}Co contaminated threshold values >1 pCi/g from GJO-97-13-TAR/ GJO-HAN-11, *Hanford Tank Farms Vadose Zone: TX Tank Farm Report*). Gamma activity near tank TX-103 was attributed to a leak from tank TX-107. Based on the 2,500-gal leak from HNF-EP-0182, the Hanford Soil Inventory Model (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*) estimates the nitrate inventory for this UPR to be ~6,500 kg (~14,330 lbs) with a maximum of ~17,750 kg (~39,132 lbs).

  However, the UPR at tank TX-107 was reviewed by the leak assessment team during the July 12, 2011 meeting (RPP-54073). The team concluded that a leak in the TX-107 tank liner released an estimated volume of 1,300 gal of strontium recovery waste, with an inventory of 300 Ci of ^{90}Sr (decayed to 1996). Based on the estimated ^{60}Co plume size (for >1 pCi/g) of 3,500 m^3 (124,000 ft^3) and assuming a 10% increase in moisture content as a result of the release, the diluted plume may be as large as 100,000 gal.

- Tank TX-110 information was presented and discussed by the assessment team on August 9, 2011 (RPP-54073). Tank TX-110 was declared "questionable integrity" in

1977 as a result of a low activity radiation peak detected at 54 ft bgs in drywell 51-10-01. The peak rapidly decayed between 1977 and 1985 following a ^{106}Ru decay line and 1996 SGLS data shows less than 1 pCi/g gamma activity in drywells near tank TX-110 except for small spikes to <10 pCi/g near surface and at the bottom of drywell 51-10-12. This indicates the historical gamma peak was likely due to waste migrating from another source, possibly in the area around tanks TX-107 or TX-114. The waste in tank TX-110 has not been sampled. No data or information was found indicating the presence of a liner leak and there is little data to suggest a release occurred near the tank.

- Tank TX-113 information was presented and discussed by the assessment team in the August 9, 2011 meeting (RPP-54073). Tank TX-113 was declared "questionable integrity" in 1974 as a result of increasing gamma activity in drywell 51-14-04. Historical transfer records show that the tank was filled above the cascade outlet as a result of cascade plugging of the cascade lines and in-tank photographs show the waste level was well above the cascade line, indicating the potential for releases from the cascade lines or spare inlet ports. Drywells around tank TX-113 show ~10 pCi/g of ^{137}Cs activity between the surface and 20 ft bgs. This activity is attributed to cascade line leaks, near-surface transfer line leaks or spills during operations. At ~45 ft bgs (below the tank base) in drywell 51-14-04, 1E5 pCi/g of ^{137}Cs activity was detected. Because there was a sharp ^{137}Cs spike at 45 ft with no path to it, the high ^{137}Cs activity has all indications to be from a liner leak from tank TX-114. Tank TX-114 appears to be the more likely source of the detected contamination. As a result, a waste inventory associated with this plume is assigned to tank TX-114.

- Tank TX-114 information was presented and discussed by the assessment team in the August 9, 2011 and August 23, 2011 meetings (RPP-54073). Tank TX-114 was declared "questionable integrity" in 1974, the same time as tank TX-113, as a result of increasing gamma activity in drywell 51-14-04, located only 2 ft from the east side of tank TX-114. Like tank TX-113, historical transfer records show that tank TX-114 was filled above the cascade outlet as a result of plugging of the cascade lines and in-tank photographs show the waste level was well above the cascade line, indicating the potential for releases from the cascade lines or spare inlets. The drywells show ~100 pCi/g of ^{137}Cs activity between the surface and 20 ft below surface in drywells 51-14-04 and 51-14-11. This activity was attributed to cascade line leaks, near-surface transfer line leaks and spills during operations.

  Drywell 51-14-04 shows a ^{137}Cs peak at ~45 ft bgs with nothing above it. Assuming the ^{137}Cs activity is from a leak near the bottom of the tank, based on the size and shape of the plume, if the drywell activity represents the edge of the plume and the entire plume is at ^{137}Cs sorption capacity [5 $(10)^7$ pCi/g], an estimated 6,000 Ci could have been released with a release volume of 7,000 gal based on 1974 tank samples (0.83 Ci/gal). This sample result is assumed to be representative of the waste leaked because the same waste type (Evaporator Bottoms) was in the tank from 1954 to 1974 and high gamma activity was present when drywell 51-14-04 was first installed in 1974. This estimate is based primarily on data from one drywell near the release location. The waste type and time of releases, the date and source of releases, the size and shape of releases, and the

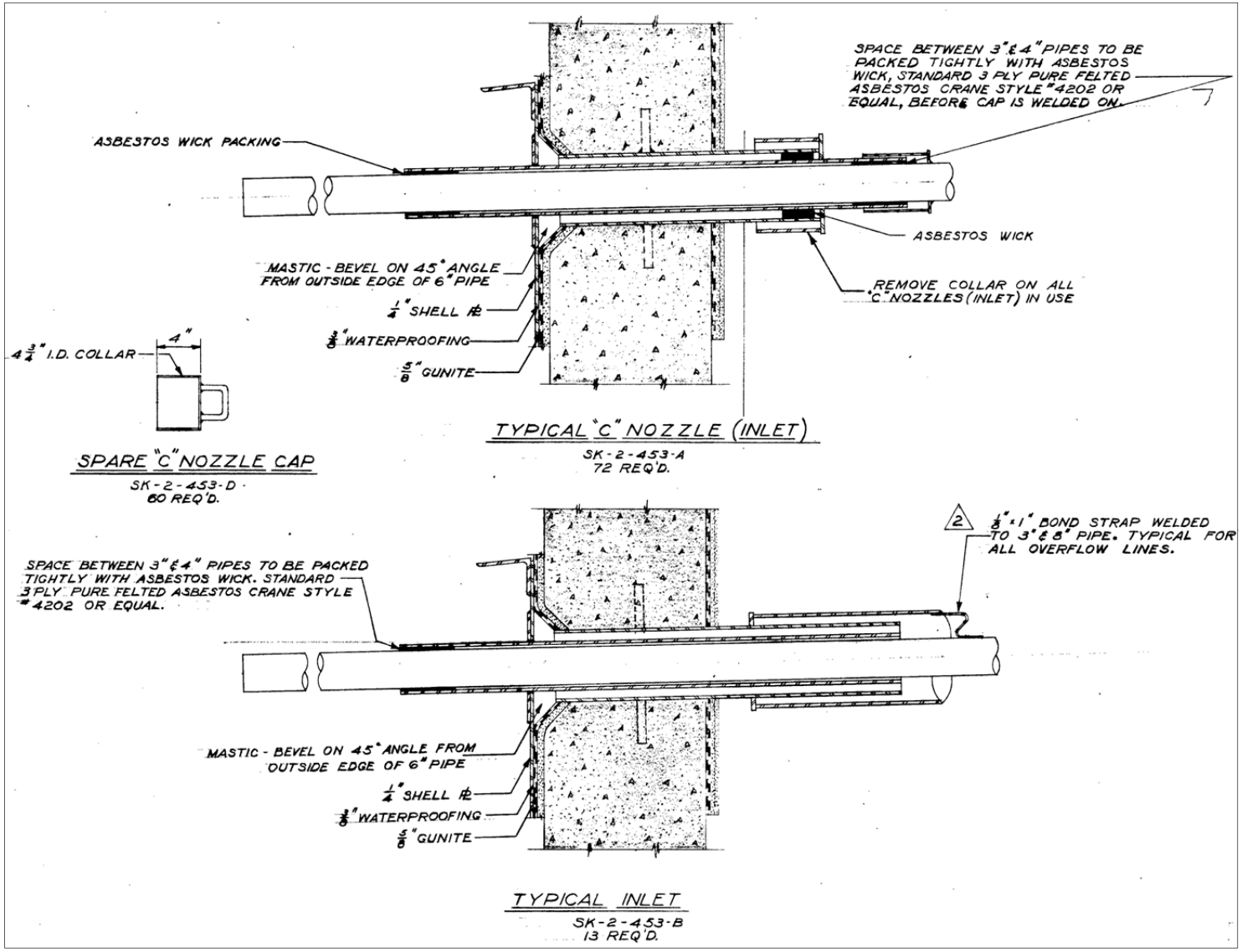
composition of waste released were assumed based on limited data. If better inventory estimates are required, additional data is needed.

- Tank TX-115 information was presented and discussed by the assessment team in the August 23, 2011 meeting (RPP-54073). Tank TX-115 was declared "questionable integrity" in 1977 as a result of gamma activity in drywell 51-15-04. Historical transfer records and photos show that tank TX-115 was filled above the cascade outlet in 1952, indicating the potential for releases from the cascade line. However, there is no evidence of a liquid level decrease until supernate was pumped in the first quarter of 1953. This suggests that little or no liquid was released when the tank was overfilled. The SGLS logs in drywells around the tank show low levels of ^{137}Cs activity (<10 pCi/g). Historical gamma peaks were observed in 1977 in drywells 51-15-04. The gamma peak started at ~20 ft bgs and migrated deeper and decayed away by 1994, indicating a mobile short-lived radionuclide such as ^{106}Ru that may have migrated from a cascade line leak or spare inlet overflow (spare inlets are near drywell 51-15-04). Because drywell data shows low activity and there is no occurrence report or indication of a liquid level decrease, no inventory for a release was estimated for this tank.

- Tanks TX-116 and TX-117 information was presented and discussed by the assessment team in the August 23, 2011 and September 13, 2011 meetings (RPP-54073). These tanks were both declared "questionable integrity" in 1977 as a result of gamma activity in drywells near the tanks. Historical transfer records and photos show that both tanks were filled above the cascade outlet, indicating the potential for releases from the cascade line or spare inlet overflow. The SGLS logs in drywells around the tank show low levels of ^{137}Cs activity (<100 pCi/g) below 20 ft bgs. The historical gamma peaks of 2,000 counts per second (cps) and 3,300 cps were discovered in drywells 51-16-04 and 51-16-11 at ~40 and 50 ft bgs respectively when the wells were first logged in 1973. The gamma activity quickly decayed away in drywell 51-16-04 and decayed then increased to 6,500 cps in drywell 51-16-11 before it decayed away. Except for low levels of near-surface ^{137}Cs activity (<50 pCi/g) and occasional hits <1 pCi lower in the drywell, gamma activity was not present in 1996 SGLS logs. This indicates the presence of mobile and/or quick-decaying radionuclides that may have migrated from another source such as tanks TX-110 or TX-114, or may be related to small releases from tank systems releases (overflows) or transfer lines. Because there was no indication of a release from the tank waste surface measurements and because SGLS gamma activity was low, no inventory was estimated for these tanks.

Potential Waste Losses from Spare Inlet Nozzles. The SSTs in TX Farm are each equipped with horizontal spare inlet nozzles (H-2-807, *18 Tank Farm General Layout 241 TX Proj. C-163*; H-2-817, *75 Foot Tank Nozzle, Piping and Riser Assemblies 241-TX Proj. C-163*), as shown in Figure 1-4. A nozzle consists of an inner 4-in.-diameter schedule 80 steel pipe with an outer 6-in-diameter schedule 40 steel pipe. The outer 6-in.-diameter steel pipe is imbedded in the concrete sidewall of the SST, attached to the exterior of the carbon steel sidewall using mastic, and protrudes ~8 in. from the exterior of the tank wall. The 4-in.-diameter steel pipe is inserted through the 6-in.-diameter steel pipe, protrudes ~12 in. inside the SST and ~18 in. beyond the exterior of the concrete sidewall of the SST. The 4-in.-diameter steel pipe is welded to the

Figure 1-4. Inlet Nozzle Detail.



Source: H-2-817, *75 Foot Tank Nozzle, Piping and Riser Assemblies 241-TX Proj. C-163.*

sidewall of the carbon steel tank. An 8-in.-diameter steel collar is tightly fitted around the 6-in.-diameter steel pipe where the 4-in.-diameter steel pipe exits this outer pipe. Process waste lines, which are 3-in.-inner-diameter, 11-gauge (stainless steel) tubing, are inserted through the 4-in.-diameter steel pipe and extend ~4 ft inside the SST.

The elevation of the spare inlet nozzles is ~24 ft from the center of the tank bottom. Inlet nozzles in TX Farm are located at approximately the 2 o'clock and 4 o'clock positions relative to north being 12 o'clock. The design for the SSTs identified that a 4.5-in.-diameter cover was to be placed over and welded to the 4-in.-diameter spare inlet nozzles (see Figure 1-4). It is known that at 241-BX Tank Farm, whose tanks are of a similar design to TX Farm, some of the spare inlet nozzles are poorly sealed, some have blanks which are welded tight, some have wooden plugs driven into the spare nozzle covered by a cap and sealed with waterproofing, and some have caps covered with waterproofing membrane and then sealed in cement (see HW-20742, *Loss of Depleted Metal Waste Supernatant to Soil*, page 5).

1.2.1.3 Unplanned Releases within 241-TX Tank Farm. Of the UPRs of waste within TX Farm, only UPR-W-200-100 lost a significant volume of waste (2,500 gal). This was a transfer line leak between tanks TX-105 and 241-TX-118. First cycle waste was discovered leaking from a waste transfer line in November 1954. Coordinates included in ARH-2757 Pt. 4, *Radioactive Contamination in Unplanned Releases to Ground within the Chemical Separations Area Control Zone through 1972 (Exclusive of Liquid Waste Storage Tank Farms)* place the release adjacent to the east side of tank TX-105, inside the tank farm fence. The maximum dose rate was 4.5 rad per hour at a distance of 1.2 meters (4 ft). The liquid release covered an area of ~30 by 38 meters (100 by 125 ft). The waste contained ~10 Ci of fission products. The nitrate inventory associated with UPR-200-W-100 has been estimated to be ~1,050 kg (~2,315 lbs) with a maximum of ~2,400 kg (~5,291 lbs) (RPP-26744). The contaminated area was surrounded with a chain and radiation zone signs and was covered with clean soil in 1954. RPP-26744 estimated a nitrate inventory of ~4 kg (~9 lbs) with a maximum of ~13 kg (~29 lbs) for UPR-200-W-12.

The other two UPRs are UPR-200-W-12 and UPR-200-W-17. According to the Waste Information Data System, UPR-200-W-12 occurred while jetting waste concentrate from the evaporator in the Spring of 1951, a few gallons of waste was forced up and out of an open (above ground) riser. A maximum dose rate of 2 rad per hour at a distance of 5 centimeters (2 in.) was observed. The Waste Information Data System report UPR-200-W-17 states that this release occurred on September 12, 1952; contamination spread in the TX Farm during the removal of a temporary process waste pump from tank 241-TX-106. Waste was being transferred from tank 241-TX-106 to tank TX-114 via an over ground line. The contamination on a pump seal was not sufficiently removed or packaged prior to moving the assembly, affecting the ground, personnel, and vehicles at the job site. Adverse wind conditions developed before the contamination could be totally removed or fixed, which caused the contamination spread to enlarge.

1.2.2 Geology, Stratigraphy, and Hydrology

The geology of the 241-T, TX, and TY Tank Farms and vicinity is well understood as a result of several decades of site characterization activities. It has been described in numerous reports

(ARH-LD-135, *Geology of the 241-T Tank Farm*; ARH-LD-136, *Geology of the 241-TX Tank Farm*; ARH-LD-137, *Geology of the 241-TY Tank Farm*; RHO-ST-23, *Geology of the Separation Areas, Hanford Site, South-Central Washington*; PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*, Volume 1; PNL-7336, *Geohydrology of the 218-W-5 Burial Ground, 200 West Area*; WHC-SD-EN-TI-019, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*; GJO-97-13-TAR/GJO-HAN-11; RPP-8531, *Vadose Zone Geology of Boreholes 299-W10-27 and 299-W11-39 T-TX-TY Waste Management Area Hanford Site, South-Central Washington*; RPP-7123, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*). The main source of information about geologic strata underlying the Hanford Site and the tank farms is data from the drilling of boreholes and the analyses of the sediments and contaminants within them.

Four major stratigraphic units underlie the 241-T, TX, and TY Tank Farms (in ascending order) include the following:

1) Igneous Columbia River Basalt Group

2) Miocene- to Pliocene-age Ringold Formation (including members of Taylor Flats [Rtf] and members of Wooded Island [R_{wi}])

3) Cold Creek unit (including subunits CCU_u and CCU_l)

4) Hanford formation (including subunits H1 and H2).

East-West and North-South cross sections are given in Figures 1-5 and 1-6, respectively, which show the general layout of the sedimentary units underlying the tank farms. Of these, the backfill, Hanford formation, Cold Creek unit, and the upper portion of the Ringold Formation make up the vadose zone. The unconfined aquifer is contained within the lower portion of the Ringold Formation. All major stratigraphic units are inferred to be essentially continuous in this area, although unit thicknesses vary and some subunits are not present at a few boreholes. Waste Management Area TX-TY was constructed within the Cold Creek syncline and sits on the northern limb of the syncline, the major units to dip gently west to southwest toward the axis of the Cold Creek syncline.

General characteristics of each unit descending from the surface down beneath WMA TX-TY are as follows.

- **Hanford formation**. The Hanford formation is a cataclysmic flood deposit that is between 75 and 100 ft thick and thickens slightly towards the south and west. It consists of two subunits (H1 and H2) that are distinguished by a distinct change in the dominant particle size distribution. The upper H1 unit, deposited in a high-energy environment, is gravel-dominated and composed of poorly sorted basaltic, sandy gravels to silty sandy gravels. It is between 25 and 70 ft thick in the area. The lower H2 unit, deposited in a lower-energy environment, is a sand-dominated sequence, composed of mostly horizontal to tabular cross-bedded sands to gravelly sands. Thin silt lenses are occasionally present that occur on a scale too small to correlate between boreholes. It is between 14 and 60 ft thick in the area.

- **Cold Creek Unit**. The Cold Creek unit (referred to in previous documents as the Plio-Pleistocene unit) is a calcite-rich paleosol generated by surficial weathering events in a semiarid environment that is between 20 and 35 ft thick. It consists of two subunits, CCU_u and CCU_l. The upper subunit (CCU_u) is a silty sequence, consisting of inter-stratified, well-sorted silts and fine sands, and contains a relatively high concentration of natural gamma-emitting isotopes. This subunit is sometimes difficult to distinguish from the overlying H2 subunit because of lithologic similarities. The lower subunit (CCU_l) consists of interbedded layers of pedogenically altered to unaltered gravel, sand silt, and/or clay cemented together with one or more layers of secondary calcium carbonate, often referred to as caliche. It is mostly between 10 and 25 ft thick in the area.

- **Ringold Formation**. The Ringold Formation was formed as fluvial-lacustrine deposits on top of the last basalt flow. The depth of the Ringold Formation is not well known locally because most nearby boreholes have not been drilled deeply enough to reach the basalt bedrock. However, regional data suggest a total thickness of ~375 ft.
Two subunits, member of Taylor Flats (R_{td}) and member of Wooded Island (R_{wi}), are present here. The upper subunit (R_{td}) ranges between 0 and 30 ft, thickens to the north, and is a fine-grained sequence consisting of interstratified, well-bedded fine to coarse sands to silts. The lower subunit (R_{wi}) is, for the most part, a coarse-grained sequence consisting of mostly moderately sorted, quartzitic sandy gravel to silty sandy gravel. Within this sequence of coarse sediments, a distinct high-silt rich layer, the lower mud unit, occurs ~275 ft below the top of the Ringold Formation. Although few local boreholes reach this depth, regional data suggest this unit is largely continuous in the area and is considered to be sufficiently impermeable to be the bottom boundary of the unconfined aquifer.

- **Columbia River Basalt Group**. The Columbia River Basalt Group forms the bedrock base of the aquifer beneath the WMA TX-TY. At least 50 basalt flows exist beneath the Hanford Site with a combined thickness of more than 3,000 m (10,000 ft) (DOE/RW-0164, *Consultation Draft Site Characterization Plan Reference Repository Location, Hanford Site, Washington*, Volume 1). The Elephant Mountain Member of the Saddle Mountains Basalt, the youngest flow in the area, lies ~150 m (500 ft) below land surface. The Elephant Mountain Member is ~25 to 27 m (80 to 90 ft) thick in the 200 West Area (RHO-BWI-ST-14, *Subsurface Geology of the Cold Creek Syncline*, "Chapter 3 – Wanapum and Saddle Mountains Basalts of the Cold Creek Syncline Area") and dated by the potassium/argon method to be 10.5 Ma ("Duration and Volume of Columbia River Basalt Volcanism: Washington, Oregon, Idaho" [McKee et al. 1977]). The Elephant Mountain Member consists of medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE/RW-0164). The top of basalt dips gently southwest ~0.7 degree toward the axis of the Cold Creek syncline. In general, lava flows of the Saddle Mountains Basalt and the overlying suprabasalt sediments thicken to the south toward the axis of the Cold Creek syncline. Only one borehole (299-W11-26, also referred to as DH-6) within 300 m (1,000 ft) of these WMAs extends to the basalt bedrock. Sandwiched between various basalt flows are sedimentary interbeds, collectively referred to as the Ellensburg Formation, which include fluvial and lacustrine sediments consisting of mud, sand, and gravel deposited between volcanic eruptions.

Figure 1-5. East-West Hydrogeologic Cross Section A-A' across the 241-TX Tank Farm.

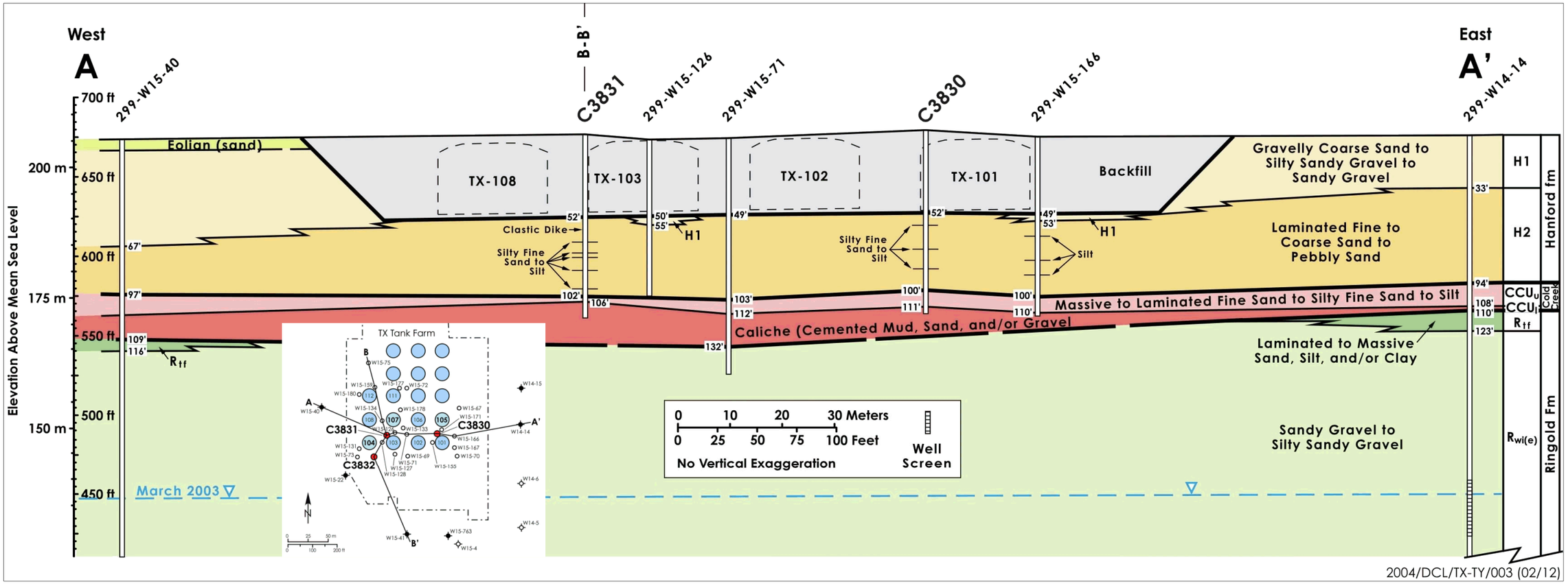
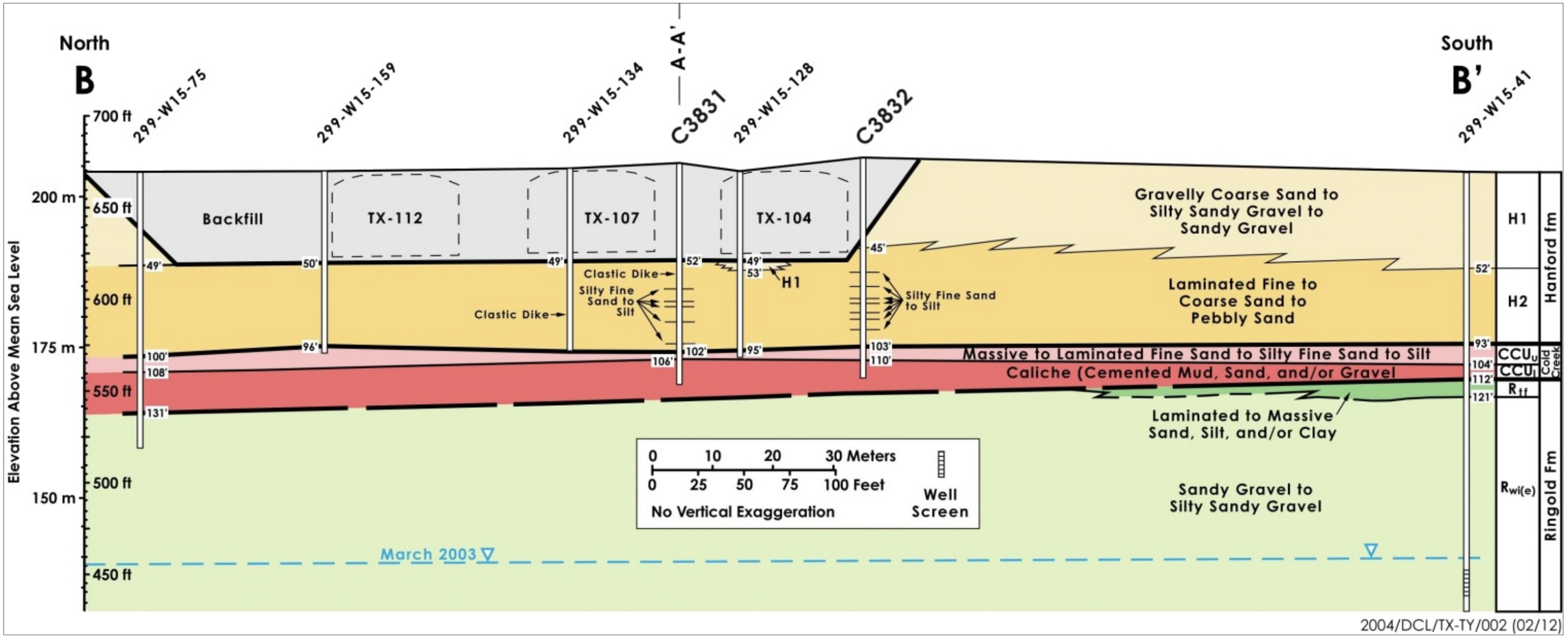


Figure 1-6. North-South Hydrogeologic Cross Section B-B' across the 241-TX Tank Farm.



Little evidence exists of significant erosion into the top of the Elephant Mountain member within the 200 West Area and no indication of erosional "windows" through the basalt into the underlying Rattlesnake Ridge interbed (WHC-SD-EN-TI-014, *Hydrogeologic Model for the 200 West Groundwater Aggregate Area*).

Given the nature and extent of tank waste contamination in the vadose zone underlying WMA TX-TY, the most significant geologic features that have influenced contaminant migration and distribution through the vadose zone are the highly-cemented CCU_l layer (and perhaps the underlying silt-rich member of Taylor Flats, Ringold Formation [R_{tf}]) and the slight dip of all layers toward the south. The CCU_l, because of its thickness and low permeability, appears to have largely prevented vertical migration of tank waste contaminants below the subunit and enhanced lateral migration. Because of the general stratigraphic dip to the south, a greater portion of the inventory has migrated in this direction.

The excavation for WMA TX-TY tanks was constructed entirely in the Hanford formation sediments. The backfill placed around the completed tanks was the excavated materials that were stockpiled next to the tank farm during tank construction. The base of the excavation is ~48 ft bgs.

At WMA TX-TY, the upper portion of the uppermost aquifer is contained in the Ringold Formation. In the vicinity of TX Farm, the top of the saturated zone is 235 ft bgs and the base (top of the Columbia River Basalt Group) is ~495 ft bgs. The direction of current groundwater flow is southeasterly (eventually turning east to the river) in the southern portion of the 200 West Area, while it is north and northeast (through Gable Gap) in the northern portion of the 200 West Area. However, at WMA TX-TY, DOE/RL-2011-118, *Hanford Site Groundwater Monitoring Report for 2011* reports that the groundwater flow direction and rate at WMA TX-TY is influenced by the 200-ZP-1 pump-and-treat system.

Vadose zone conditions across the Hanford Site show variations similar to those observed in the uppermost aquifer system. Sediments in the vadose zone vary from open-framework gravels of the gravel-dominated facies and interbedded sand and silt of the silt-dominated facies of the Hanford formation to calcium carbonate-rich deposits of the Cold Creek unit and cemented gravels of the Ringold Formation. These sediments are characterized by numerous lateral discontinuities, such as pinchouts, erosion truncations, and irregular flow patterns. If clastic dikes are present, they may enhance vertical flow patterns. Therefore, there are numerous possible avenues for contamination to migrate through the vadose zone (HNF-4936, *Subsurface Physical Conditions Description of the S-SX Waste Management Area*).

1.2.3 Information Input

The following is a list of documents and field efforts that provide information:

- DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*, Rev. 1

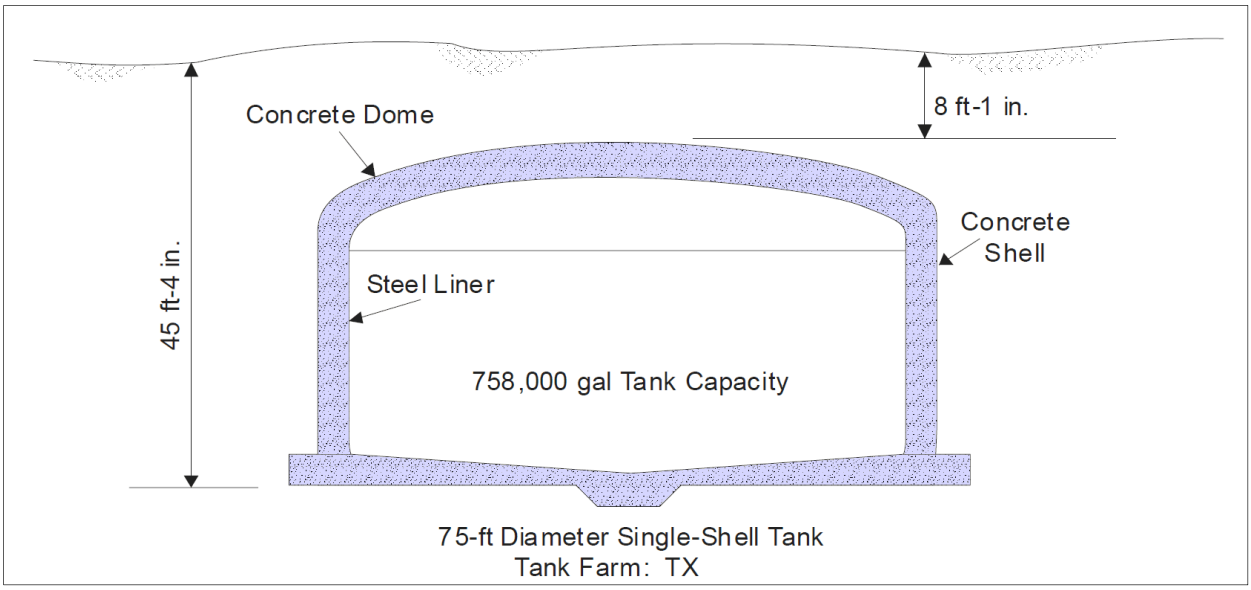
- DOE/RL-2011-118, *Hanford Site Groundwater Monitoring and Performance Report for 2011*

- GJO-97-13-TAR/GJO-HAN-11, *Hanford Tank Farms Vadose Zone: TX Tank Farm Report* and GJO-97-13-TARA/GJO-HAN-11, *Hanford Tank Farms Vadose Zone: Addendum to the TX Tank Farm Report*
- PNNL-14594, *Characterization of Vadose Zone Sediments Below the TX Tank Farm: Boreholes C3830, C3831, C3832 and RCRA Borehole 299-W10-27*
- PNNL-16005, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY*
- RPP-5957, *Historical Vadose Zone Contamination from T, TX, and TY Tank Farm Operations*
- RPP-6353, *Analysis and Summary Report of Historical Dry Well Gamma Logs for 241-TX Tank Farm – 200 West*
- RPP-7123, *Subsurface Conditions Description of the T and TX-TY Waste Management Areas*
- RPP-17393, *Modeling Data Package for WMAs T and TX-TY Field Investigation Report*
- RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-TY*
- RPP-43551, *Tank Farm Interim Barrier Data Quality Objectives*
- RPP-54073, *TX Tank Farm Leak Inventory Assessment Meeting Summaries*
- RPP-ENV-38696, *Data Requirements for Characterization Supporting Near-Term Interim Barriers*, Rev. 2
- RPP-RPT-38320, *Surface Geophysical Exploration of the TX and TY Tank Farms at the Hanford Site*
- RPP-RPT-47123, *Interim Surface Barrier Evaluation Report*
- WRPS-43539, *Environmental Monitoring of Leaks using Time Lapsed Long Electrode Electrical Resistivity* (Journal Article)
- Moisture and spectral gamma logs from the drywells in TX Farm
- Ground penetrating radar performed in TX Farm
- TX Farm topography and pipeline information
- Future Characterization Sites for Potential Interim Barriers Meeting Notes – January 13, 2001.

1.3 DEFINE THE STUDY BOUNDARIES

The 241-TX Tank Farm was constructed between 1947 and 1948 in the 200 West Area and consists of 18 100-series SSTs, diversion boxes, pipelines, and other ancillary equipment. The tanks have a capacity of 758,000 gal, a diameter of 75 ft, and an operating depth of 23 ft. The base of the farm excavation is ~45 ft below the ground surface, allowing space for footings and other construction requirements. The TX Farm tanks have a dished bottom with a 4-ft-radius knuckle. The tanks were designed with a primary mild steel liner and a concrete dome with various risers. They were set on a reinforced concrete foundation and covered with ~8 ft of backfill material (HNF-SD-WM-ER-321, *Supporting Document for the Historical Tank Content Estimate for TX Tank Farm*). Figure 1-7 shows a simple cross-sectional sketch of a TX Farm SST, while Figure 1-8 provides a plan view of tank TX-107 showing the location of inlet and outlet cascade lines, spare inlet nozzles, risers and other tank features.

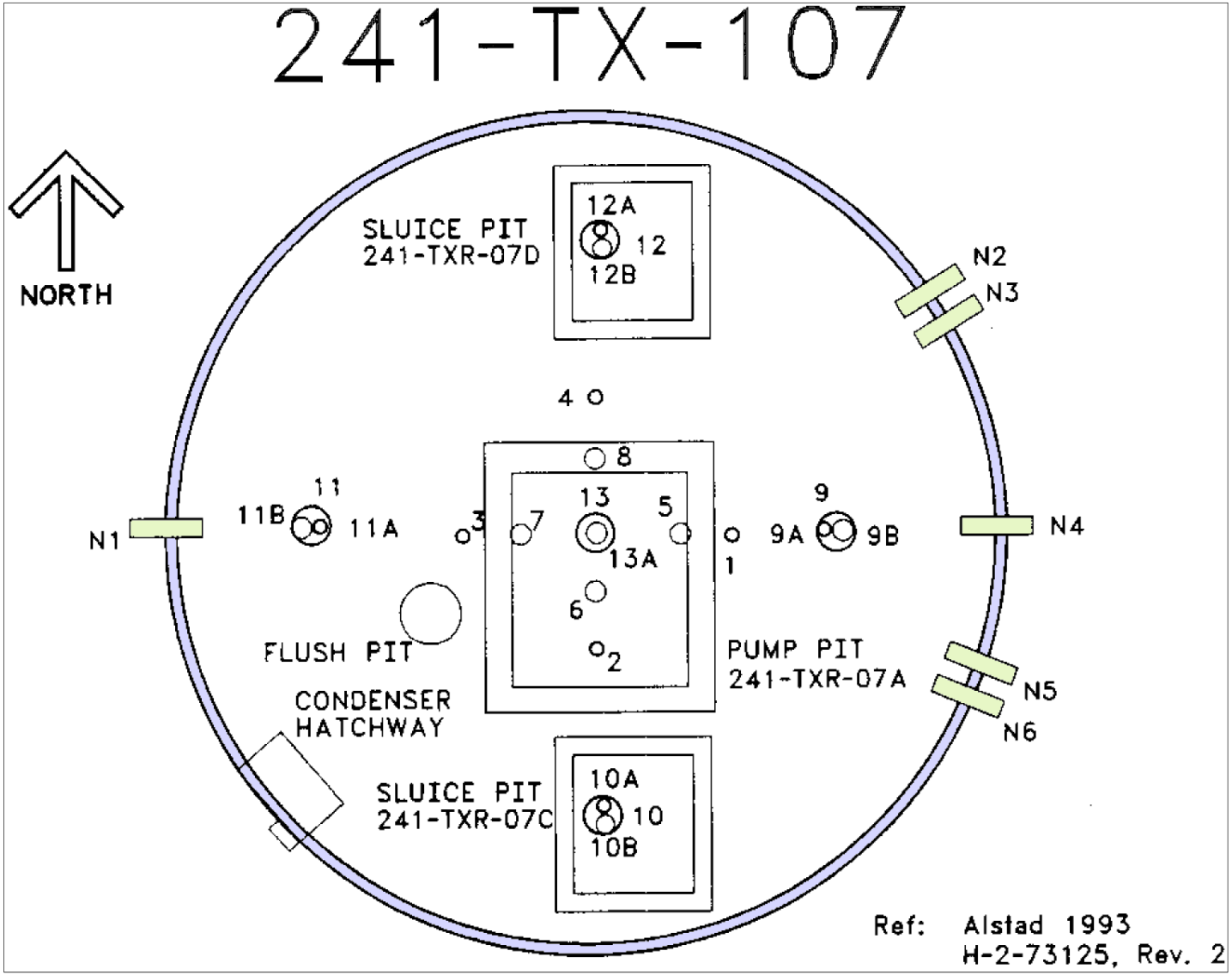
Figure 1-7. Simplified Sketch of 241-TX Farm Tank.



The 241-TX Tank Farm was designed for waste with a maximum fluid temperature of 220 °F. The 18 tanks were constructed at different elevations with connecting overflow lines that allowed waste to cascade from tank to tank. The tank farm has five cascades, three of four tanks each and two of three tanks each. A cascade overflow line 3 in. in diameter connects tank TX-101 as the first in a cascade series of three tanks finishing with tanks 241-TX-102 and TX-103. Each tank in the cascade series is set 1 ft lower in elevation from the preceding tank. The cascade outlet height is ~23.8 ft from the tank bottom. The spare inlet nozzles are ~4.5 in. higher in elevation than the cascade outlet.

The first two cascades (tanks TX-101 through 241-TX-108 [TX-108]) were filled with T Plant MW; during the 1950s, six of the tanks were sluiced until empty and started receiving Reduction Oxidation Plant waste. Tanks TX-103 and TX-108 were used for tributyl phosphate waste after sluicing. These tanks were used as bottoms and recycled for the 242-T Evaporator in later years.

Figure 1-8. 241-TX Farm Single-Shell Tank Plan View.



Source: H-2-73125, *Piping Waste Tank Isolation 241-TX-107*.

The 242-T Evaporator system was installed in 1952 to remove water from the waste. This unit operated for approximately four years, after which it was shut down. The 242-T Evaporator was reactivated at the end of 1965. Following capacity increasing modifications, the unit was later shut down in 1976. The third cascade (tanks 241-TX-109 through 241-TX-112) stored first-cycle decontamination waste before use with the 242-T Evaporator. The last six tanks were not used until the early 1950s, and were used in combination with the 242-T Evaporator, as feed, bottoms and recycle waste. The 241-TX Tank Farm has been completely interim stabilized and isolated (i.e., as much liquid as practical has been removed from SSTs and lines to the tanks have been terminated except for cascade lines). All raw water is cut off at the farm edge; however, minimal air and electrical supplies remain within the tank farm.

1.3.1 Spatial Boundaries

A total of 12 direct push sites have been allotted for TX Farm interim measure evaluation efforts. Eight locations are to be pushed first, with four additional sites to be located after information from the first pushes is reviewed. It is anticipated that depths up to 130 ft bgs will be reached; however, it is likely that the Cold Creek unit will be a barrier to the direct push and the direct push will stop at the Cold Creek unit (~100 to 132 ft bgs). On average, three depths were sampled in 241-BY Tank Farm, TY Farm and WMA S-SX, where previous direct pushes for an interim barrier evaluation were conducted. Three depths were chosen to assist in defining the extent of the vertical boundaries of contamination. Based on experience gained from sampling in other farms, it is anticipated that three depths will help define the vertical extent of contamination to support interim measures at TX Farm.

1.3.2 Temporal Boundaries

Temporal boundaries are associated with the following factors: availability of personnel to perform the work, the time to complete push probe holes and sampling efforts, the time to process samples and perform analysis, and the dates associated with milestones.

1.3.3 Parameters of Interest and Action Levels

The extent of a plume is defined by its most mobile constituents. In this case, the most mobile constituents are nitrate and ^{99}Tc. The conceptual model indicates that, once released, these constituents move down vertically with some horizontal spreading (unless diverted horizontally by capillary barriers or low conductivity layers). For this reason, nitrate and ^{99}Tc are the constituents primarily considered in interim measure evaluation. The established action limit with respect to past barrier evaluation was 10 parts per million for nitrate and 2.5 pCi/g for ^{99}Tc (RPP-43551). The action limit for nitrate is approximately three times the soil background concentration, and the action limit for ^{99}Tc was based on approximately three times the detection limit of ^{99}Tc (0.85 pCi/g) from analyses conducted by PNNL.

For interim measure evaluation, contaminants producing gamma radiation are unlikely to provide direct information (^{137}Cs is expected to be relatively immobile and mobile ^{60}Co is expected to be too low in concentration, based on past logging efforts). These constituents (^{137}Cs and ^{60}Co) and others will be analyzed (via the laboratory) to aid in vadose zone characterization efforts, which

are needed to determine how areas will be dispositioned for cleanup and closure (refer to Appendix B for the entire list of constituents to be analyzed).

1.3.4 Scale of Decision Making

Figure 1-9 is a flowchart from RPP-43551 that shows the logic for determining the presence of mobile waste contamination and evaluating the need for constructing an interim measure. The flowchart shows the activities and decisions required to determine if construction of an interim barrier would be beneficial.

1.4 DEVELOP A DECISION RULE

The following concentrations will be used in the barrier evaluation:

- Nitrate concentration greater than 10 parts per million (i.e., µg/g)
- ^{99}Tc concentration greater than 2.5 pCi/g.

The flowchart from RPP-43551 (Figure 1-9) also provides guidance for evaluating the analytical data (^{99}Tc and nitrate) and for the overall evaluation process.

1.5 SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Analytical sensitivity and reproducibility must be sufficient to compare to action levels. If data collected provide an unacceptable level of uncertainty in the interim barrier evaluation, then additional sampling/field efforts will take place to decrease the uncertainty. When deciding what additional data is needed, the costs of additional sampling and analysis must be weighed against the benefit of reduced uncertainty.

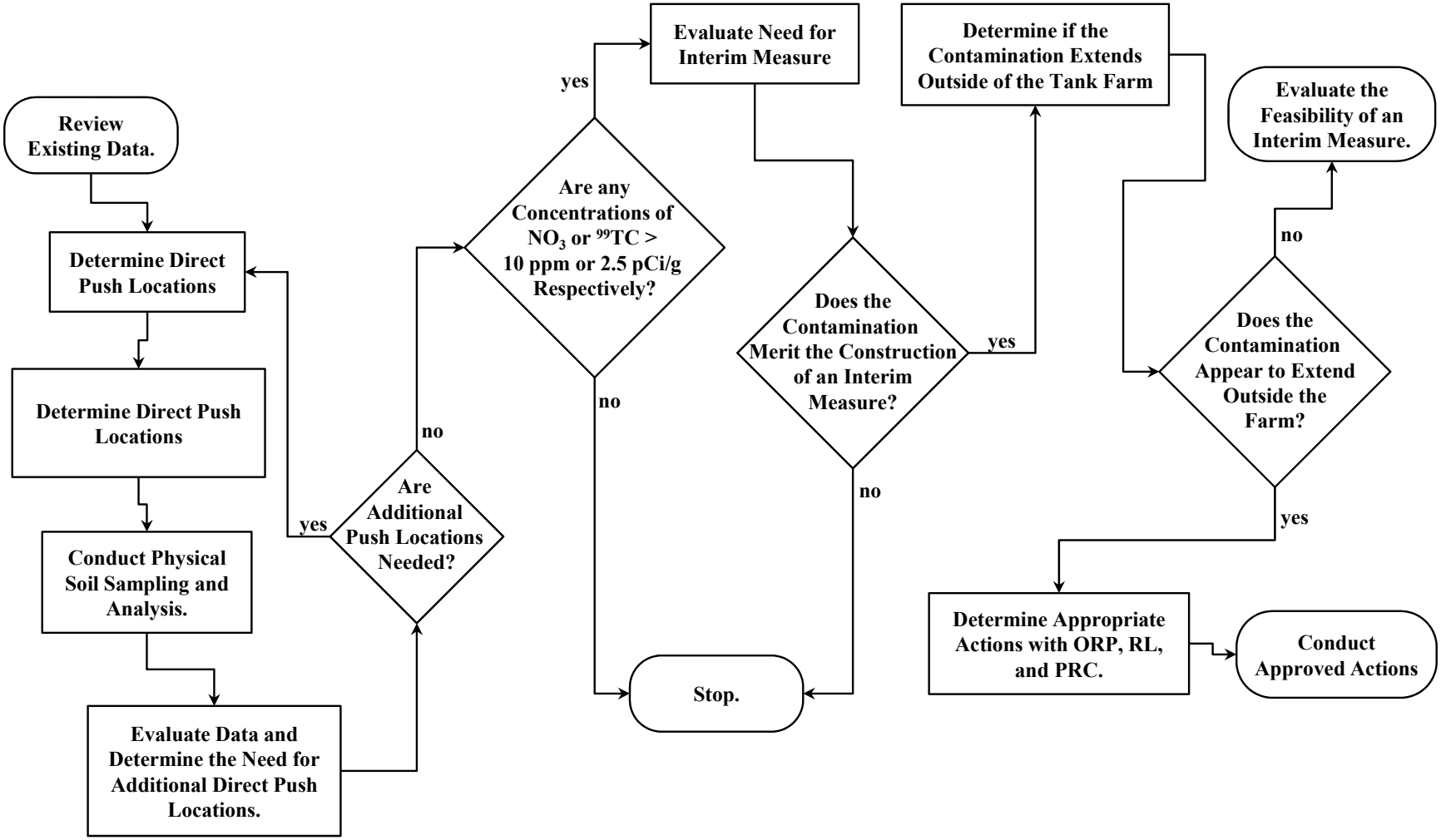
1.6 OPTIMIZE THE DESIGN FOR OBTAINING DATA

In order to optimally gather information for the interim measure evaluation efforts, field work was/is being conducted as follows:

1) Well-to-well surface geophysical exploration (SGE) was performed to obtain a two-dimensional (N-S/E-W) depiction of the subsurface plume(s) (completed, see RPP-RPT-38104, *Surface Geophysical Exploration of TX-TY Tank Farms at the Hanford Site: Results of Background Characterization with Ground Penetrating Radar*).

2) Decide and implement direct push characterization (including subsurface sediment sample and placement of deep electrodes) to optimize the area/extent of the interim surface measure.

Figure 1-9. Tank Farm Interim Measure Evaluation Flowchart.



Source: RPP-43551, *Tank Farm Interim Barrier Data Quality Objectives*.

Surface geophysical exploration is an application of high-resolution resistivity; however, rather than measuring resistivity over time and looking for changes in resistivity, SGE consists of one-time measurements to identify resistivity anomalies or low resistivity areas. Because tank waste is high in nitrate and sodium, areas of low resistivity indicate locations where waste may have been released to the soil. The selection of sampling locations was also guided by SGE, because of its ability to assess resistivity anomalies (potential waste releases) across large areas.

For TX Farm, SGE has been completed. Direct push characterization is the current focus effort. In order to optimize the placement of direct push locations, available field results have been reviewed. For TX Farm, this information is comprised of the following:

- Leak Assessment Information (Section 1.2.1.1)
- Geology, Stratigraphy, and Hydrology (Section 1.2.2)
- Drywell Information (Section 1.6.1)
- SGE Information (Section 1.6.2)
- Groundwater Contamination Summary (Section 1.6.3).

Section 1.6.4 presents direct push locations selected and Section 1.6.5 identifies the direct push sample selection process.

1.6.1 Drywell Information

There are a total of 96 drywells in TX Farm; 9 of these drywells were installed in 1949 with the rest in 1970 or later. Figure 1-10 shows the location of drywells in TX Farm and Table 1 provides the following information about the drywells: Tank Farm Name, Well ID, Well Name, date the drywell was drilled, and depth of the drywell.

All wells were spectral gamma logged in the late 1990s (GJO-97-13-TAR/GJO-HAN-11 and GJO-97-13-TARA/GJO-HAN-11). Of the 96 drywells in TX Farm, 43 of them had ^{137}Cs contamination greater than or equal to 10 pCi/g (Figure 1-11). Most of the ^{137}Cs contamination was found from 0 to 45 ft bgs, with only six drywells (Figure 1-12) having contamination above 100 pCi/g between ground surface and 45 ft bgs. Only drywell 51-14-04 had ^{137}Cs concentrations above 10 pCi/g at greater than 45 ft bgs; no ^{137}Cs values were above 10 pCi/g at depths lower than 50 ft bgs. The highest recorded ^{137}Cs was ~67,750 pCi/g at 46 ft bgs at drywell 51-14-04.

Drywells 51-03-01, 51-03-11, 51-03-12, 51-07-18, 51-07-07, 51-03-09, and 51-04-05 show commonality in current spectral gamma characteristics and historical migration patterns, suggesting leakage from tank TX-107 beginning about 1975. The primary gamma emitter is ^{60}Co, which is present from 45 to 70 ft bgs. Europium-154 also is present at 50 to 60 ft bgs in all but the two southernmost drywells, 51-03-09 and 51-04-05. Historical gamma data indicate migration of ^{60}Co from northeast to the southwest over time between 1977 and 1992. Interpreted historical gamma data (RPP-6353) suggest more than one migration event in drywells 51-03-11, 51-07-18, 51-07-07, and 51-04-05. Given the time of the leak and the tank waste history, waste lost from this tank was B-Plant waste, generated by ^{137}Cs recovery from Plutonium Uranium Extraction Plant supernatant liquid.

Figure 1-10. 241-TX Farm Single-Shell Tanks and Drywells.

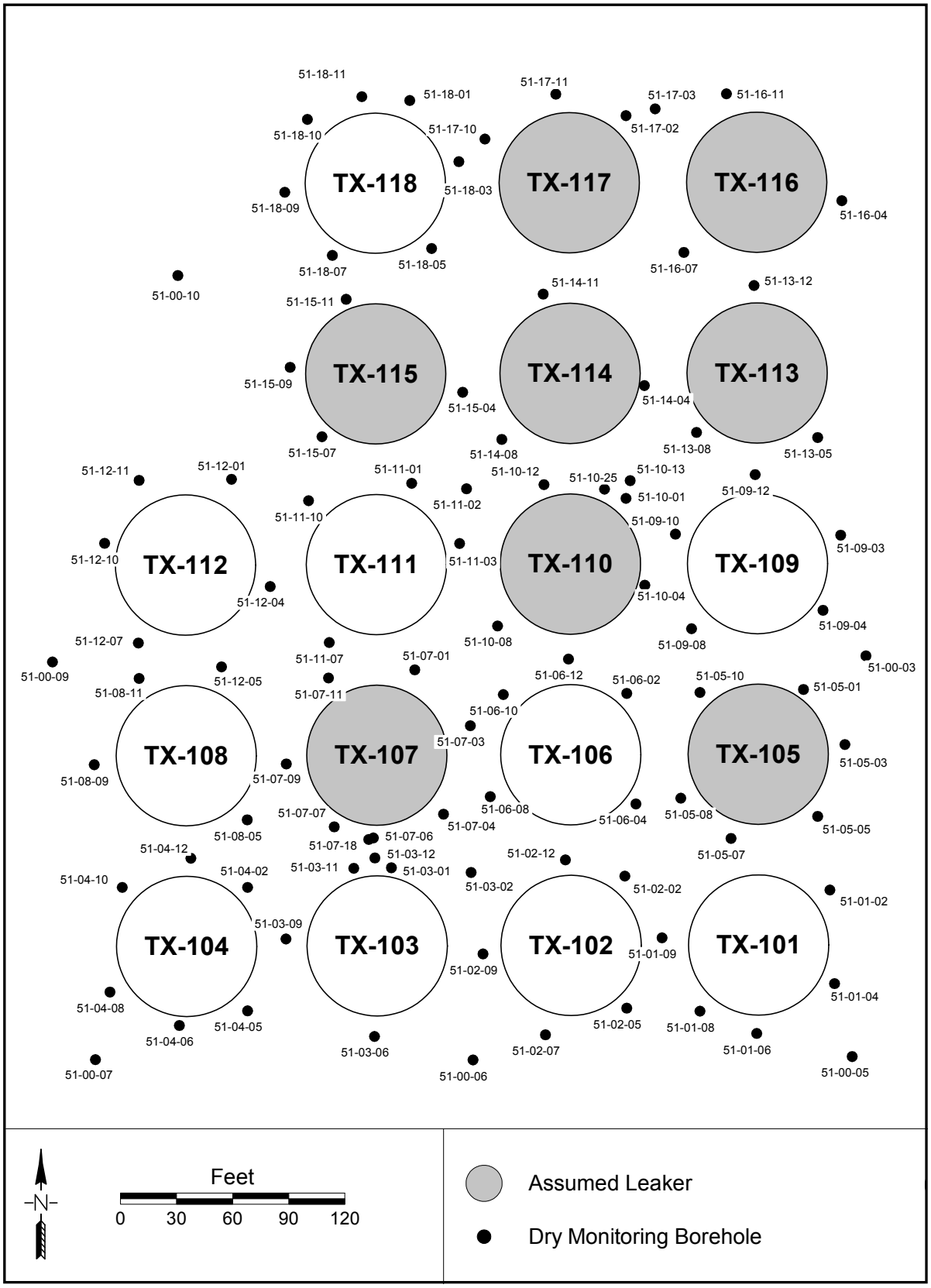


Table 1. 241-TX Tank Farm Drywell Names, Drill Date, and Depths. (3 sheets)

Tank Farm Name	Well ID	Well Name	Drill Date	Total Depth Drilled (ft)
51-00-03[a]	A7368	299-W15-67	1/31/1949	150
51-00-05	A7371	299-W15-70	2/28/1949	150
51-00-06[a]	A7370	299-W15-69	2/28/1949	150
51-00-07[a]	A7374	299-W15-73	3/31/1949	150
51-00-09[a]	A7375	299-W15-74	3/31/1949	150
51-00-10[a]	A7376	299-W15-75	3/31/1949	150
51-01-02	A7464	299-W15-166	1/31/1974	112
51-01-04	A7465	299-W15-167	12/31/1973	115
51-01-06	A7466	299-W15-168	4/30/1974	100
51-01-08	A7467	299-W15-169	4/30/1974	100
51-01-09	A7453	299-W15-155	12/31/1973	115
51-02-02	A7468	299-W15-170	4/30/1974	100
51-02-05	A7442	299-W15-143	7/31/1971	100
51-02-07	A7470	299-W15-172	4/30/1974	100
51-02-09	A7441	299-W15-142	7/31/1971	100
51-02-12	A7440	299-W15-141	7/31/1971	100
51-03-01[b]	A7490	299-W15-192	6/30/1977	105
51-03-02[a]	A7372	299-W15-71	2/28/1949	150
51-03-06	A7426	299-W15-127	11/30/1971	100
51-03-09	A7427	299-W15-128	11/30/1971	100
51-03-11	A7489	299-W15-191	5/31/1977	105
51-03-12	A7425	299-W15-126	11/30/1971	100
51-04-02	A7451	299-W15-153	4/30/1976	105
51-04-05	A7429	299-W15-130	11/30/1971	100
51-04-06	A7452	299-W15-154	4/30/1976	105
51-04-08	A7430	299-W15-131	11/30/1971	100
51-04-10	A7454	299-W15-156	4/30/1976	105
51-04-12	A7428	299-W15-129	11/30/1971	100
51-05-01	A7471	299-W15-173	3/31/1974	100
51-05-03	A7472	299-W15-174	1/31/1974	115
51-05-05	A7444	299-W15-145	6/30/1971	100
51-05-07	A7469	299-W15-171	1/31/1974	111
51-05-08	A7445	299-W15-146	6/30/1971	100

Table 1. 241-TX Tank Farm Drywell Names, Drill Date, and Depths. (3 sheets)

Tank Farm Name	Well ID	Well Name	Drill Date	Total Depth Drilled (ft)
51-05-10	A7443	299-W15-144	6/30/1971	100
51-06-02	A7447	299-W15-148	6/30/1971	100
51-06-04	A7448	299-W15-149	7/31/1971	100
51-06-08	A7473	299-W15-175	4/30/1974	100
51-06-10	A7446	299-W15-147	7/31/1971	100
51-06-12	A7456	299-W15-158	4/30/1976	105
51-07-01	A7476	299-W15-178	1/31/1974	110
51-07-03	A7485	299-W15-187	4/30/1976	100
51-07-04	A7432	299-W15-133	12/31/1971	100
51-07-06c	A7491	299-W15-193	7/31/1977	55
51-07-07	A7488	299-W15-190	5/31/1977	105
51-07-09	A7433	299-W15-134	11/30/1971	100
51-07-11	A7431	299-W15-132	11/30/1971	100
51-07-18	A7493	299-W15-195	7/31/1977	105
51-08-05	A7435	299-W15-136	11/30/1971	100
51-08-09	A7436	299-W15-137	11/30/1971	100
51-08-11	A7434	299-W15-135	11/30/1971	100
51-09-03	A7438	299-W15-139	10/31/1971	100
51-09-04	A7486	299-W15-188	4/30/1976	105
51-09-08	A7439	299-W15-140	10/31/1971	100
51-09-10	A7487	299-W15-189	4/30/1976	105
51-09-12	A7437	299-W15-138	10/31/1971	100
51-10-01	A7474	299-W15-176	4/30/1974	100
51-10-04	A7402	299-W15-103	9/30/1970	100
51-10-08	A7403	299-W15-104	9/30/1970	100
51-10-12	A7404	299-W15-105	9/30/1970	100
51-10-13	A7494	299-W15-196	9/30/1977	105
51-10-25	A7495	299-W15-197	3/31/1978	100
51-11-01	A7475	299-W15-177	4/30/1974	113
51-11-02[a]	A7373	299-W15-72	2/28/1949	150
51-11-03[a]	A7405	299-W15-106	9/30/1970	100
51-11-07	A7406	299-W15-107	9/30/1970	100
51-11-10	A7407	299-W15-108	9/30/1970	100

Table 1. 241-TX Tank Farm Drywell Names, Drill Date, and Depths. (3 sheets)

Tank Farm Name	Well ID	Well Name	Drill Date	Total Depth Drilled (ft)
51-12-01	A7457	299-W15-159	11/30/1973	100
51-12-04	A7408	299-W15-109	9/30/1970	100
51-12-05	A7477	299-W15-179	4/30/1974	100
51-12-07	A7409	299-W15-110	10/31/1970	100
51-12-10	A7478	299-W15-180	4/30/1974	100
51-12-11	A7410	299-W15-111	9/30/1970	100
51-13-05	A7411	299-W15-112	10/31/1970	100
51-13-08	A7412	299-W15-113	9/30/1970	100
51-13-12	A7413	299-W15-114	10/31/1970	100
51-14-04	A7414	299-W15-115	9/30/1970	100
51-14-08	A7415	299-W15-116	9/30/1970	100
51-14-11	A7416	299-W15-117	9/30/1970	100
51-15-04	A7417	299-W15-118	3/31/1970	100
51-15-07	A7418	299-W15-119	3/31/1970	100
51-15-09	A7458	299-W15-160	12/31/1973	100
51-15-11	A7419	299-W15-120	3/31/1970	100
51-16-04	A7459	299-W15-161	11/30/1973	100
51-16-07	A7461	299-W15-163	12/31/1973	100
51-16-11	A7460	299-W15-162	11/30/1973	100
51-17-02	A7420	299-W15-121	10/31/1970	100
51-17-03	A7369	299-W15-68	1/31/1949	150
51-17-10	A7421	299-W15-122	10/31/1970	100
51-17-11	A7462	299-W15-164	10/31/1973	100
51-18-01	A7479	299-W15-181	4/30/1974	100
51-18-03	A7422	299-W15-123	10/31/1970	100
51-18-05	A7480	299-W15-182	4/30/1974	100
51-18-07	A7423	299-W15-124	9/30/1970	100
51-18-09	A7481	299-W15-183	4/30/1974	100
51-18-10	A7424	299-W15-125	11/30/1970	100
51-18-11	A7463	299-W15-165	11/30/1973	100

[a] Eight-in. diameter steel casing.
[b] Not completed; grouted and abandoned.
[c] Eight-in. starter casing to 18 ft below ground surface and an inner 6-in. casing with grout between the casings.

References: GJO-97-13-TAR/GJO-HAN-11, *Hanford Tank Farms Vadose Zone: TX Tank Farm Report* and GJO-97-13-TARA/GJO-HAN-11, *Hanford Tank Farms Vadose Zone: Addendum to the TX Tank Farm Report*.

Figure 1-11. Gamma Contamination > 10 pCi/g and < 100 pCi/g between 0 and 35 feet below Ground Surface.

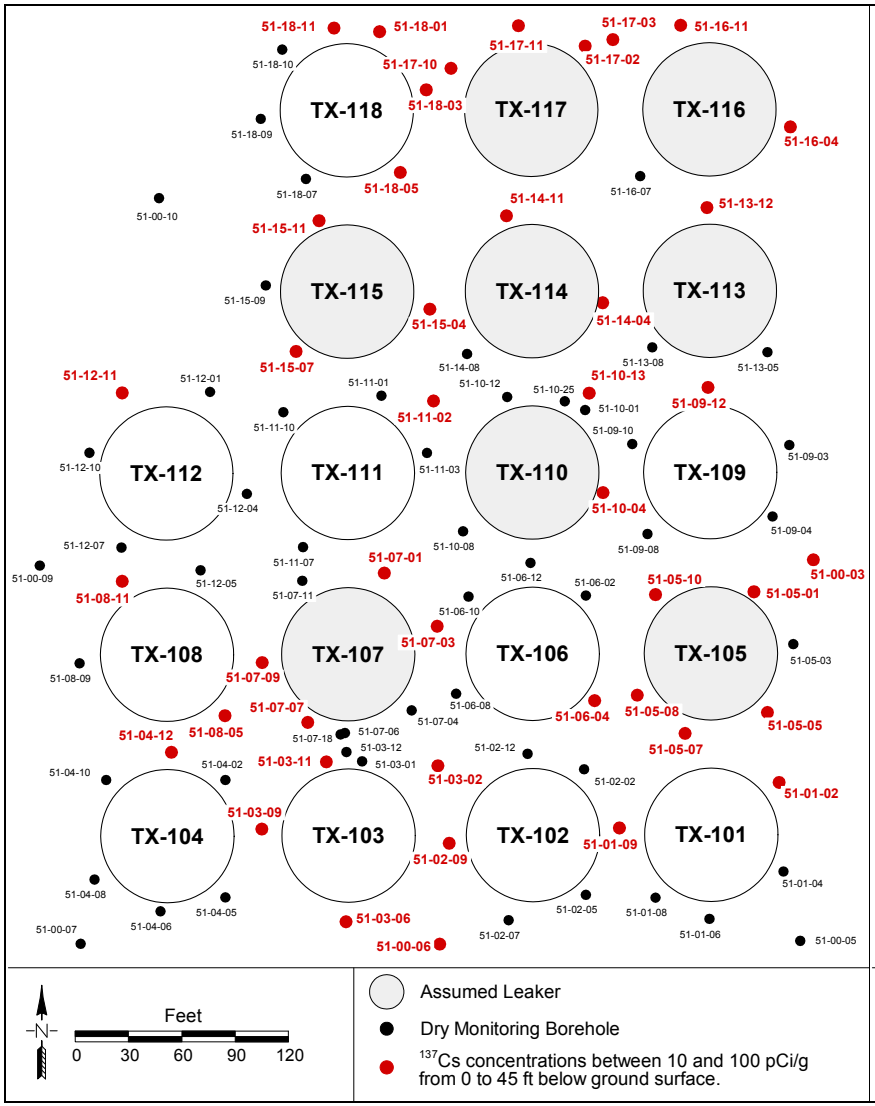
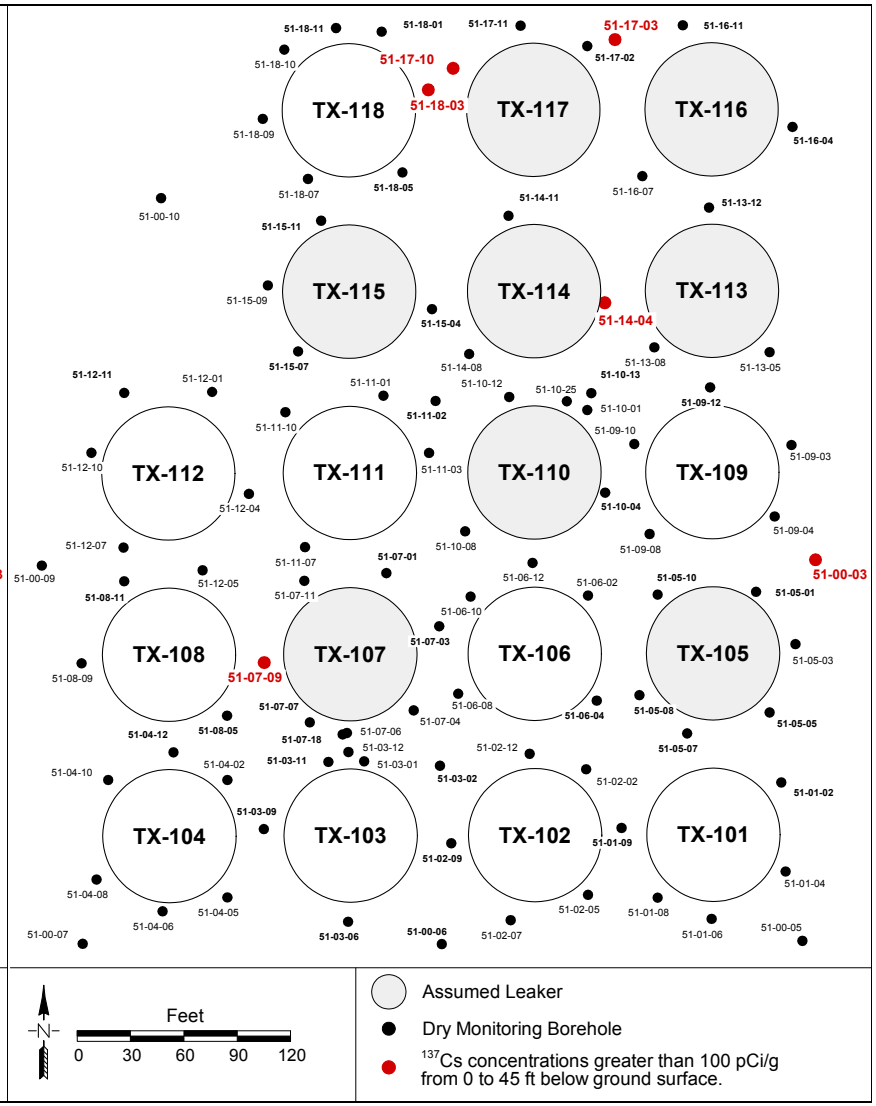


Figure 1-12. Gamma Contamination > 100 pCi/g between 0 and 35 feet below Ground Surface.



1.6.2 Surface Geophysical Exploration Information

Surface geophysical exploration techniques were used to investigate the subsurface of WMA TX-TY from September of 2007 to April of 2008. At this WMA, a full application of SGE, including well-to-well, surface-to-surface, and well-to-surface resistivity surveys were made. In addition, detailed ground penetrating radar surveys (RPP-RPT-38104) were conducted in the farms and both electromagnetic induction and differential magnetometry surveys (RPP-RPT-36893, *Surface Geophysical Exploration of TX and TY Tank Farms at the Hanford Site: Results of Background Characterization with Magnetics and Electromagnetics*) were run in those areas outside of the farms. For WMA TX-TY, the surveys covered the extensive waste sites adjacent to the tank farms, as well as the actual tank farms. The results are documented in RPP-RPT-38320 and RPP-ENV-38767, *Summary and Assessment of Surface Geophysical Exploration in the TX and TY Farms*.

A review of results of the TXTY-WTW8 inversion model domain (Figure 1-13) shows a primary low resistivity target of 0.1-5 ohm-m (red) and 5-10 ohm-m (green). The distribution of the primary and secondary targets in this model is more dispersed and irregular when compared to the TxTy_WTW6 domain, which covers TY Farm. This target dispersion may be influenced by the significantly higher number of buried pipes and other infrastructure shown within the TX Farm boundary. The clustering of low resistivity targets around tanks TX-107, TX-108, 241-TX-111 and 241-TX-112 and the more dispersed low resistivity targets in other parts of the domain do not strictly follow the paths of known buried infrastructure, but they appear to be influenced by them to some degree in this area.

1.6.3 Groundwater Contamination Summary

The groundwater sample data shows elevated levels of ^{99}Tc, nitrate, and chromium near TX Farm. However, ^{99}Tc, ^{129}I, nitrate, and chromium showed the same declining trend during the reporting period. This may indicate that all four contaminants shared a common source. Figures 1-14 and 1-15 show ^{99}Tc and nitrate concentrations, respectively, in the aquifer in the vicinity of TX Farm. Accelerated recharge from these sources may have contributed to driving mobile contaminants such as ^{99}Tc to the groundwater. Additional information on contaminants in the groundwater near WMA TX-TY can be found in DOE/RL-2011-118.

Figure 1-13. Well-to-Well Resistivity Inversion Model Results for the TXTY-WTW8 Domain.

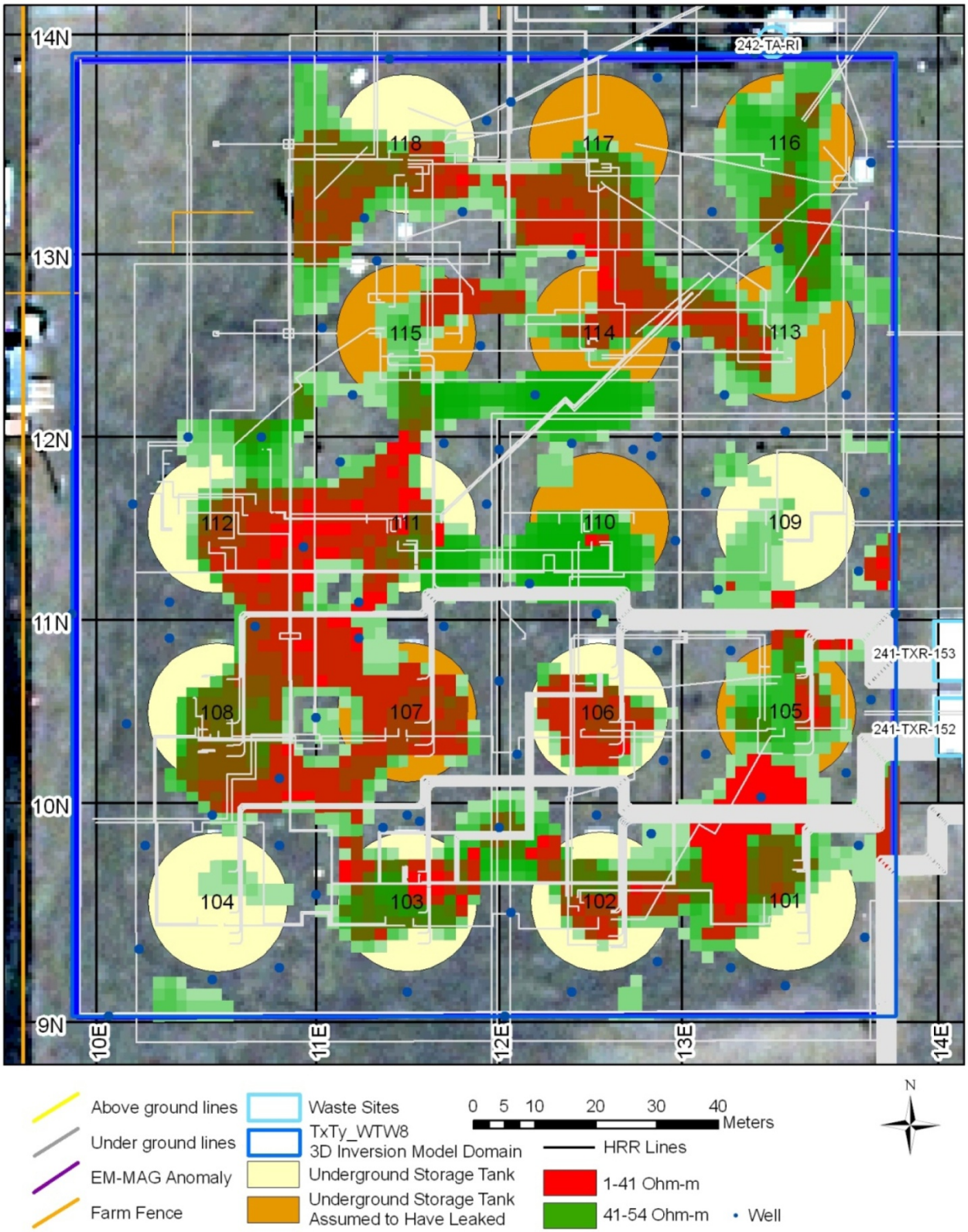


Figure 1-14. Technetium-99 in Upper Aquifer at Waste Management Area TX-TY.

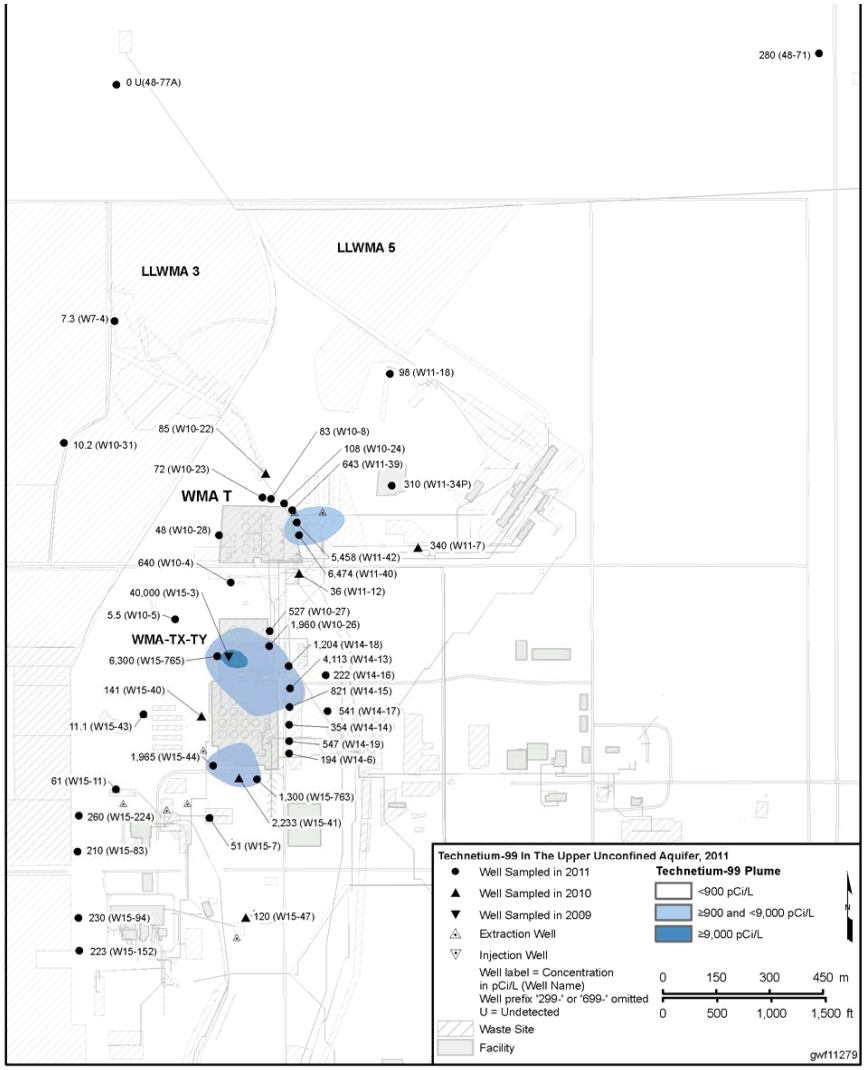
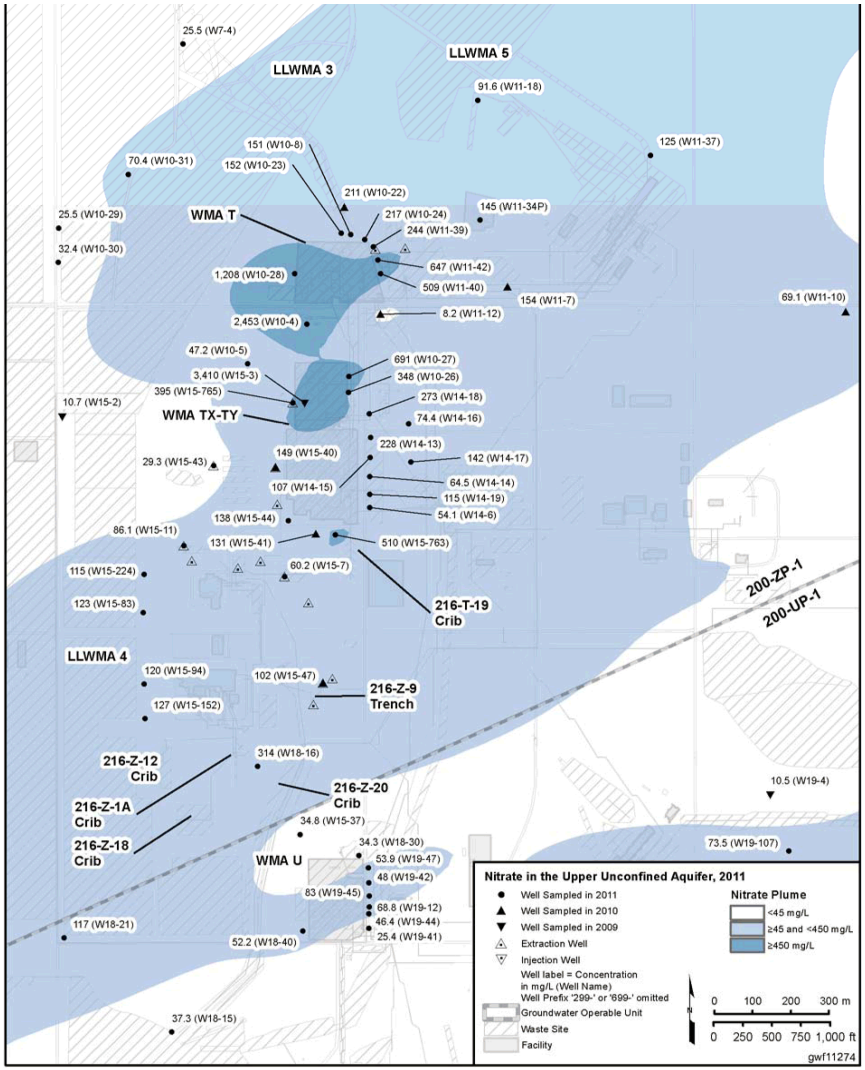


Figure 1-15. Nitrate in Upper Aquifer at Waste Management Area TX-TY.



1.6.4 Direct Push Sample Locations

With respect to direct push efforts in TX Farm, sample locations have been selected by targeting the following areas:

- Where there have been known and possible waste releases and leaks (i.e., tanks TX-105, TX-107, TX-117, and UPR-200-W-100) detected by drywell monitoring
- Suspected vadose zone plume areas southwest of tanks 241-TX-104 and TX-101
- SGE anomalies between tanks TX-108 and 241-TX-112 and between tanks TX-115 and 241-TX-118
- Along outer edge of tank locations to assist in identifying the boundary of contaminated vadose zone underneath TX Farm.

Direct push placement locations avoid contact and pushing through existing infrastructure (whether on the surface or in the subsurface; e.g., tanks, pipes, diversion boxes). Figure 1-16 shows the topography in and around WMA TX-TY and the recommended direct push locations for the TX Farm. These direct push locations are those that were recommend in a meeting held on September 6, 2012 in Ecology's offices. The personnel that attended the meeting consisted of staff from Ecology, DOE-ORP, WRPS, and PNNL. The meeting minutes are documented in Appendix A.

Since no staff attending that meeting had been to TX Farm in some time, a field trip was arranged with the same participants to visit the site to ensure that the recommended locations were accessible. That field trip occurred on the morning of September 18, 2012, with a follow-up meeting in the afternoon (refer to Appendix C for meeting minutes). At the field trip it was recognized that the direct push close to tank TX-105 and UPR-200-W-100 (Site #1) could not be located as recommended because of the topography; three alternative sites (1A, 1B, and 1C) were identified. All other sites appeared accessible from the surface; however, it was noted that the sites might not be accessible due to underground infrastructure.

In December 2012 and January 2013, ground penetrating radar was performed and evaluated. Ground penetrating radar results indicate that locations 2 through 8 are accessible. Ground penetrating radar results also indicate that location 1B is the most accessible of the 1 locations (i.e., 1A, 1B, 1C – Refer to Appendix D for a location map). This was identified in the January 16, 2013 meeting with WRPS, Ecology and DOE-ORP. In this meeting, it was also agreed that 1B would be referred to as 1 (refer to Appendix D for meeting minutes). Table 2 identifies the eight location numbers and the general logic for selecting these direct push locations. Figure 1-17 shows the results from ground penetrating radar and the general locations for the first eight pushes.

Note that in the January 16, 2013 meeting, it was also agreed upon that the locations of the additional four direct push boreholes will be determined following review of available results from the initial eight locations by WRPS, DOE and Ecology. The interagency agreement on the

final four borehole locations will be documented in meeting minutes that will be placed in the Administrative Record associated with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989). The methodologies to be used and the constituents to be analyzed will be the same for the final four boreholes as the first eight.

Figure 1-16. Topography and Proposed Direct Push Sites at 241-TX Tank Farm.

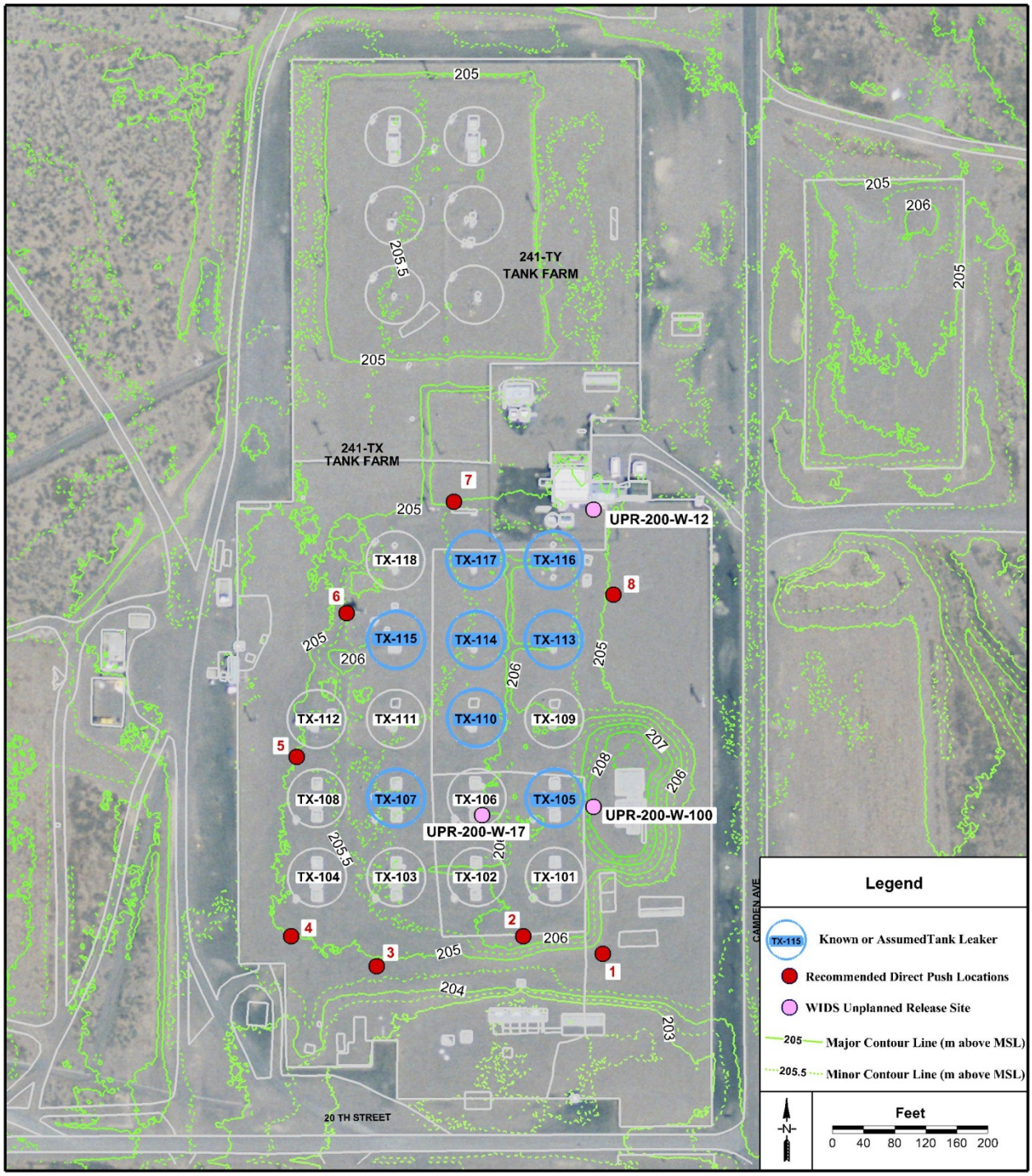


Table 2. Direct Push Location Strategy for 241-TX Tank Farm. (2 sheets)

Site #	Approximate Location	Input Factors Associated with Location[a] Reason for Sampling with Respect to Measure
1	Southeast of tank 241-TX-105 (TX-105)	• Tank TX-105 currently designated as a leaker (at least 150,000 gal) • Nearby diversion boxes and pipelines • Process records indicate it was overfilled in 1952 and between 1961 and 1964 • Gross gamma activity detected in drywells 51-05-01, 51-05-03, and 51-05-05 on East – Southeast side of tank • UPR-200-W-100 is also to the east of tank TX-105 **Further assess the path and inventory of tank TX-105 and UPR-200-W-100 Releases (see Figure 1-2 for uranium plume map)**
2	Southwest of tank 241-TX-101	• Releases associated with tank TX-105 and UPR-200-W-100 appear to be trending to the southwest (see Figure 1-2) • Tc-99 groundwater plume is to the south of 241-TX Tank Farm (TX Farm) (Figure 1-14) **Further assess the nature and depth of migration of releases near tank TX-105 and UPR-200-W-100; also to attempt to define a boundary for the migration**
3	South of tank 241-TX-103	• Tank 241-TX-107 currently designated as a leaker (1,300 gal) • Noted Co-60 and Eu-154 activity in drywells 51-07-07, 51-07-18 and in drywells between tanks 241-TX-107 and 241-TX-103 • Tc-99 groundwater plume is to the south of TX Farm (Figure 1-14) **Confirm Previous Results: Gather additional data to assist in determining nature and extent of contamination (i.e., Tc-99) south of the TX Farm tanks, also to attempt to define boundary to vadose zone contamination**
4	South of tank 241-TX-104	• Tank 241-TX-104 currently designated as sound pending further evaluation • Uranium vadose zone plume to the east and south of tank 241-TX-104, may be the result of a transfer line or cascade line leak • Tc-99 groundwater plume is to the south of TX Farm (Figure 1-14) **Confirm Previous Results: Gather additional data to assist in determining nature and extent of contamination (i.e., Tc-99) south of the TX Farm tanks, also to attempt to define boundary to vadose zone contamination**
5	In between tanks 241-TX-108 and 241-TX-112 and slightly to the west of the centerline between these tanks	• Higher conductivity area based on resistivity information in this area (Figure 1-13) **Explore surface geophysical exploration (SGE) anomaly close to tanks 241-TX-108 and 241-TX-112. Gather data to assist in determining nature and extent of contamination (i.e., Tc-99)**

Table 2. Direct Push Location Strategy for 241-TX Tank Farm. (2 sheets)

Site #	Approximate Location	Input Factors Associated with Location[a] Reason for Sampling with Respect to Measure
6	In between tanks 241-TX-115 (TX-115) and 241-TX-118 and to the NW of tank TX-115	• Tank TX-115 was declared "questionable integrity" in 1977 based on gamma activity in drywell 51-15-04 and arbitrarily assigned a leak volume of 8,000 gal • May have been overfilled in the early 1950s • SGE anomaly to the north and northwest of tank TX-115 **Explore SGE anomaly close to tanks TX-115 and 241-TX-118. Gather data to assist in determining nature and extent of contamination (i.e., Tc-99).**
7	North of tank 241-TX-117	• Tank 241-TX-117 was declared "questionable integrity" in 1977 based on gamma activity detected during scans of nearby vadose zone drywells and arbitrarily assigned a leak volume of 8,000 gal • Tc-99 in groundwater in this vicinity (Figure 1-14) **Gather data to assist in determining nature and extent of contamination (i.e., Tc-99) and to attempt to define boundary to vadose zone contamination**
8	East of tank 241-TX-113 and 241-TX-116	• Tank 241-TX-113 was declared "questionable integrity" in 1977 based on gamma activity detected during scans of nearby vadose zone drywells and arbitrarily assigned a leak volume of 8,000 gal • Historical transfer records show that tank 241-TX-113 was filled above the cascade outlet as a result of cascade plugging of the cascade lines and in-tank photographs show the waste level was well above the cascade line, indicating the potential for releases from the cascade lines or spare inlet ports • Tank 241-TX-116 was declared "questionable integrity" in 1977 based on gamma activity detected during scans of nearby vadose zone drywells and arbitrarily assigned a leak volume of 8,000 gal **Gather data to assist in determining nature and extent of contamination (i.e., Tc-99) and to attempt to define boundary to vadose zone contamination**

[a] Tank leak and pipeline failure information is provided in RPP-54073, *TX Tank Farm Leak Inventory Assessment Meeting Summaries* and HNF-EP-0182, *Waste Tank Summary Report for Month Ending October 31, 2012.*

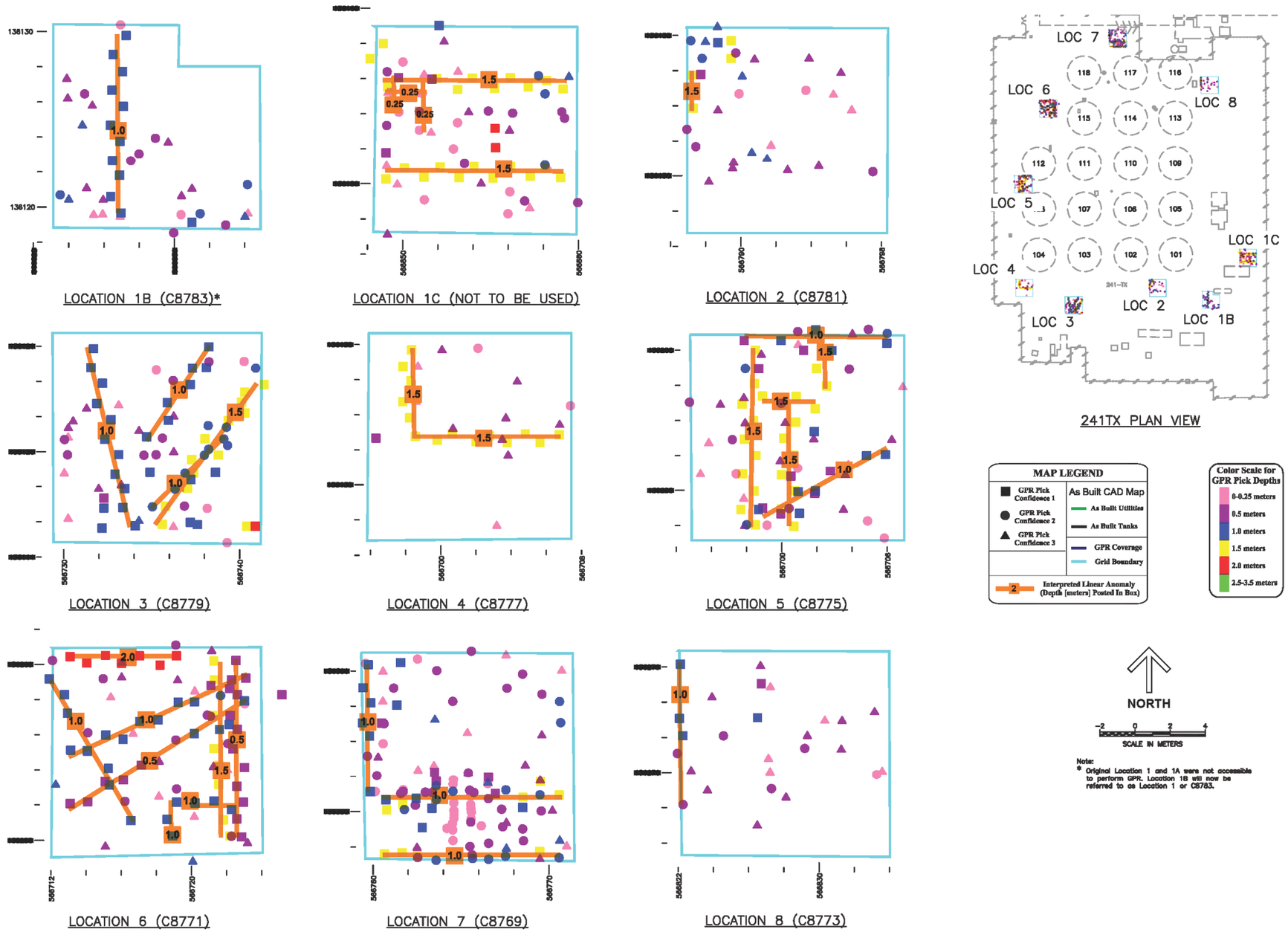
1.6.5 Direct Push Sample Intervals

Optimization efforts will also be instituted with regard to choosing sample depths. The following factors will be considered in order to efficiently and appropriately select sample depths.

Moisture logging

- Areas of saturated water content. Because the central plateau of the Hanford Site is in an arid region, subsurface saturated areas above the water table often indicate abnormal sources of water (e.g., water line leaks, high liquid discharges). These sources may be a source of contamination or of the water driving force.

Figure 1-17. 241-TX Tank Farm Ground Penetrating Radar and Eight Direct Push Locations.



- Areas of high moisture. As mobile contaminants move with water, high moisture content often indicates high amounts of key contaminants.

Gamma logging

- Areas of increased gamma radiation. These areas may indicate a change of geology, which is useful to determine the position of the general features mentioned in geology above; or such areas may indicate the presence of man-made gamma-emitting contaminants.

Geology/Stratigraphy

- Zones of interest.

- Sediment layers immediately above a layer with low hydraulic conductivity. In these cases, there may be lateral flow down the slope of the low-conductivity layer or ponding if the gradient is flat.

- Fine-grained sediment layers over coarse-grained layers. In such cases, there will likely be lateral flow within the fine-grained unit.

Analytical Information

- Available indicator parameters (^{99}Tc and nitrate). Direct push sample information from other locations already sampled may be used to help determine other borehole sample intervals. If a sample interval at one location has higher concentrations, then this sample interval may be of interest at other locations.

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APPENDIX A

MEETING MINUTES: FUTURE CHARACTERIZATION SITES FOR POTENTIAL INTERIM MEASURE AT TX TANK FARM SEPTEMBER 6, 2012

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Meeting Notes

Data Requirements for 241-TX Farm Direct Push Logging and Sampling

Meeting Date:	Thursday September 6, 2012
Location:	Ecology Building, room 3A
Purpose:	Discuss data requirements for the direct push logging and sampling that will be performed at 241-TX tank farm to evaluate potential interim measures
Attendees:	Joe Caggiano (Ecology), Maria Skorska (Ecology), Jared Mathey (Ecology) , Chris Kemp (ORP), Mark Triplett (PNNL), Mike Connelly (WRS), Susan Eberlein (WRPS), Harold Sydnor (WRPS)

Topics of Discussion:

- Mike Connelly discussed the general approach to defining data requirements for a direct push field activity (State the problem, Identify the decision, Identify inputs to the decision, Define study boundaries, Develop a decision rule, Optimize the direct push locations).
- It was noted that the purpose of this direct push campaign is to determine if an interim surface barrier or other interim measure would be beneficial at TX farm. Future characterization will be required for a complete Phase 2 RCRA Facility Investigation/Corrective Measures Study, beyond the scope of the current activity.
- Mike summarized the body of information that led to the conclusion that TX tank farm contains vadose zone contaminants (see attachment 1 for summary information from previous studies).
- Joe Caggiano noted that although many of the TX farm tanks are designated as "assumed leakers", the designation may be the result of an overfill or other loss, rather than a loss of tank integrity.
- Joe noted that the TX tanks served as feed and receiver tanks for the 242-T evaporator, with the result that there were many transfers of waste through pipelines, which could have resulted in undocumented losses.
- Mark Triplett raised a question about the soil inventory estimate used in the draft Tank Closure and Waste Management (TC&WM) Environmental Impact Statement (EIS). Mark subsequently confirmed that in the publicly available draft, TX farm has the highest estimated leak inventory for Tc-99 and Nitrate of all of the farms. (See Table D-26 in the draft.) They used an inventory of 107 Ci of Tc-99. T Farm was 2nd with 67 Ci and C farm 3rd with 56 Ci. The estimate may be revised in the final.

- Joe noted that the depth of plumes and the mobility of the contaminants will determine how effective an interim surface barrier would be.
- Joe recommended that we review history of any large liquid releases (e.g. water line leaks) in the area.
- The approach to direct push logging and sampling was briefly summarized:
    - A first direct push bore hole is pushed to refusal, and is logged for gamma and moisture.
    - The logging results are used to select appropriate sampling depths. Mobile contaminants are likely to accumulate in the same regions as the higher moisture.
    - The first probe hole is decommissioned, placing multiple electrodes for use in subsequent resistivity work if needed.
    - A second direct push probe hole is pushed adjacent to the first (a few feet away). Approximately 3 samples are taken during pushing of the second probe hole. Each sample is approximately 18 inches in length, and about 600-700 g of soil.
    - Sample analysis is performed on a "quick turnaround" basis (about 1 week) for a few key analytes. A more complete suite of analyses is performed over a longer time period.
- It was proposed that the direct push sites be selected in 2 phases. In the first phase, about 8 locations should be identified to get the approximate outline of the area of interest. Based on the results of logs and quick-turnaround samples from the first locations, an additional 4 locations should be chosen to better define the area of interest.
- The group selected 8 tentative locations for the first round of direct push (see page 17 of attachment 1 – red triangles indicate proposed locations). Each proposed location will have a logging probe hole and a sampling probe hole.
- The proposed locations will be subject to some adjustment once ground penetrating radar is completed, to avoid contact with sub-surface structures.
- The final 4 locations will be selected based on results from the first 8 locations. It was agreed that the details for the final 4 would not be included in the work plan, but only a general outline of potential areas (see attachment 1, page 17, areas noted as "Round 2").
- The group will meet again in approximately 2 weeks, following opportunities to review additional information and address questions. At that meeting, the proposed 8 locations will be reviewed again to determine if any changes are needed.
- Proposed analytes for the sample analysis were discussed. Pages 18 and 19 include tables of analytes that had been included for the interim surface barrier investigation at S farm. Attendees were asked to review the tables to identify if any changes were needed before the next meeting.

Actions:

1. Provide meeting notes with summary of proposed direct push locations (Eberlein)
2. Review historic records to determine if any large liquid releases (e.g. water line leaks) occurred in the area of TX farm (Connelly).
3. Review notes and background information (as needed) to determine if any changes should be proposed for the initial 8 locations, shown on attachment 1 page 17 (all attendees).
4. Review tables of proposed analytes (attachment 1, pages 18-19) to determine if any changes are warranted (all attendees).
5. Schedule field trip and follow-on meeting to finalize plans, tentatively the week of September 17 (Eberlein)

Concurrence:

CJ Kemp 10-23-12 | Mike W Barnes 10-30-12

C.J. Kemp, ORP Date | Jeff Lyon, Ecology Date

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ATTACHMENT 1

PROPOSED TX FARM INTERIM MEASURE DATA REQUIREMENTS OUTLINE

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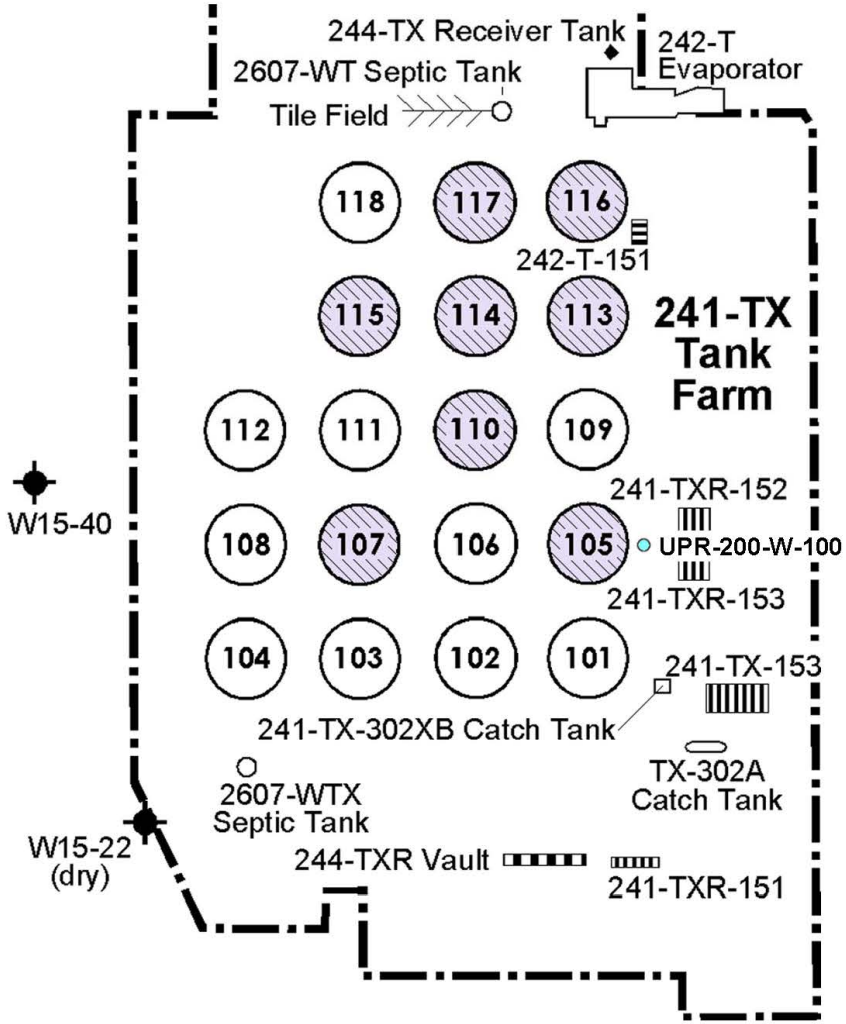
Proposed TX Farm Interim Measure Data Requirements Outline

- STATE THE PROBLEM
- IDENTIFY THE DECISION
- IDENTIFY INPUTS TO THE DECISION
  - Leak Assessment Information
  - Geology, Stratigraphy, and Hydrology
  - Existing Characterization Input
- DEFINE THE STUDY BOUNDARIES
  - Spatial Boundaries
  - Temporal Boundaries
  - Parameters of Interest and Action Levels
  - Scale of Decision Making
- DEVELOP A DECISION RULE
- OPTIMIZE DIRECT PUSH LOCATIONS
- ADDITIONAL ANALYTES

State the Problem



TX Tank Farm Contains Vadose Zone Contamination

- **Known Leaker TX-107 → 1975 – 1977; 8,000 gal**
- **All Other TX-Tanks identified as leakers**
  - RPP-23405 Category 4 Tanks →TX-105, TX-11O, TX-113, TX-114, TX-115, TX-116, and TX-117 Little information to support leak estimate; arbitrarily assigned 8,000 gal based on leaks at other tanks. Small levels of contamination are found by these tanks (is it a tank or pipeline?)
  - RPP-23752 Field Investigation identified uranium plumes around TX-104 and TX-105
- **Unplanned Releases**
  - UPR-200-W-12 → RPP-23405 estimate of 5 gal, near 242-T Evaporator
  - UPR-200-W- 17 → RPP-23405 no basis for volume estimate, appears negligible. Occurred during pump removal at TX-106
  - UPR-200-W-100 → RPP-23405 estimate of ~2,500 gal of 1C2 Waste

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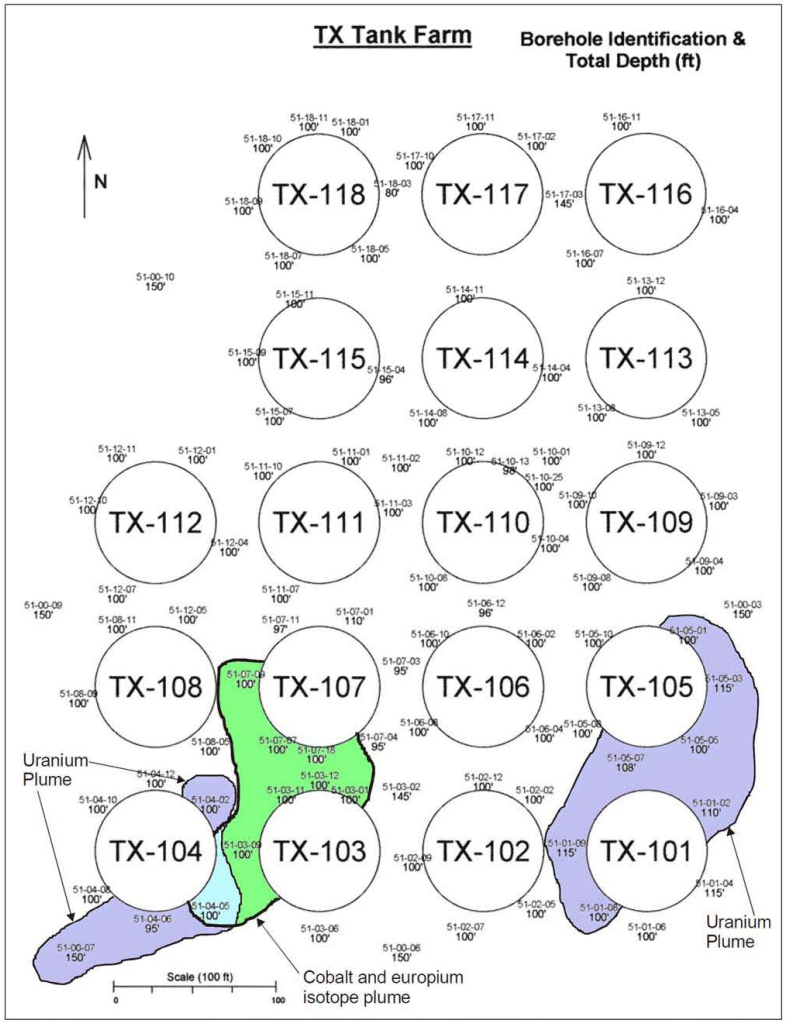
State the Problem (cont'd)



RPP-ENV-41309, *Criteria for Prioritizing Hanford Site Tank Farm Interim Surface Barriers and for Evaluating Their Performance* Ranked TX-107 + UPR-200-W-100 Seventh of Top 15 Barriers sites over groups of Tanks/UPRs

Modified from Randall et al. 2000b

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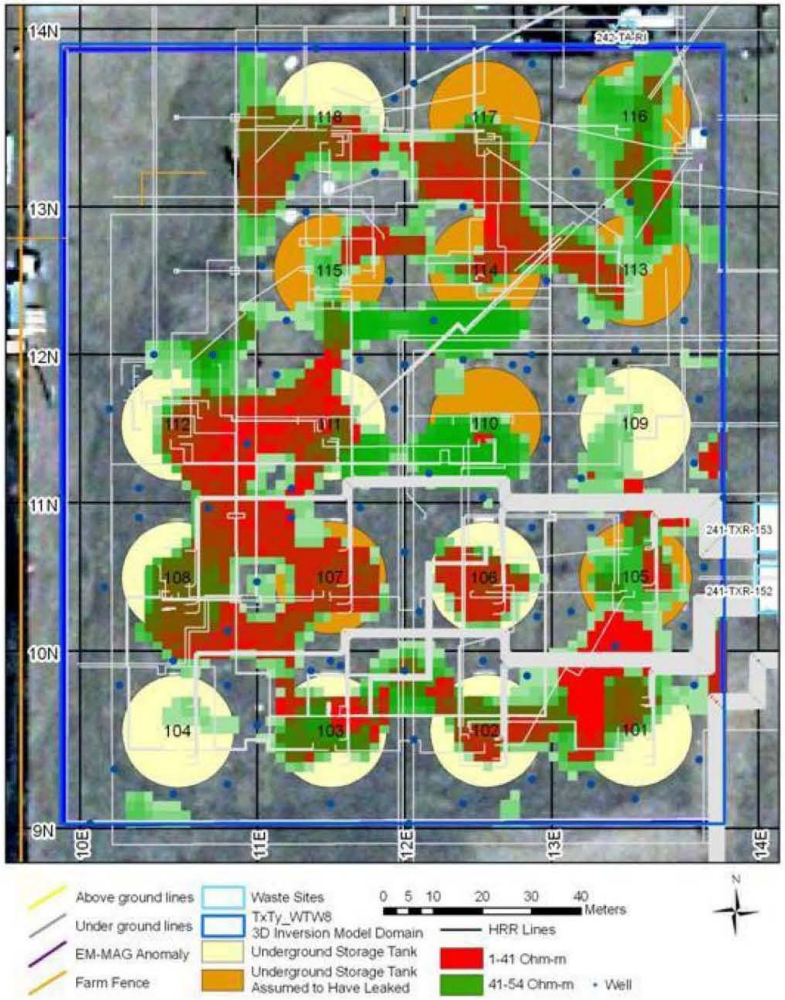
State the Problem (cont'd)



Subsurface Geophysical Exploration (SGE) may indicate more widespread vadose zone contamination

Identify the Decision

- Main purpose of the field work in TX Farm is to gather data to help determine if the conditions are such that an interim barrier will be beneficial
  - Areal extent of subsurface soluble contaminant
  - Vertical extent
  - Possible effective depth
- Secondary Purpose
  - Effort will be used to further characterize the vadose zone in TX Farm
  - May help to form the basis of Phase 2 characterization at TX Farm

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IDENTIFY INPUTS TO THE DECISION

- Leak Assessment Information
- Geology, stratigraphy, and hydrology of the area
- Previous Characterization Input

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Leak Assessment Information

- When and Where Leak occurred or could have occurred
- Type of waste stream (Metals, Redox, etc.)
- Inventories of mobile constituents
- Nearby Facilities and event histories
- Leak Assessment Documents for TX Tank Farm
  - Updated Leaks Assessment for TX has been started presently on hold due to funding
  - RPP-23405 → *Tank Farm Vadose Zone Contamination Volume Estimates*
  - *RPP-23752 Field Investigation Report for T and TX/TY WMAs*
  - RPP-7123 *Subsurface Conditions Report for T and TX/TY WMAs*

Geology, Stratigraphy, and Hydrology of the Area → Past Characterization Activities

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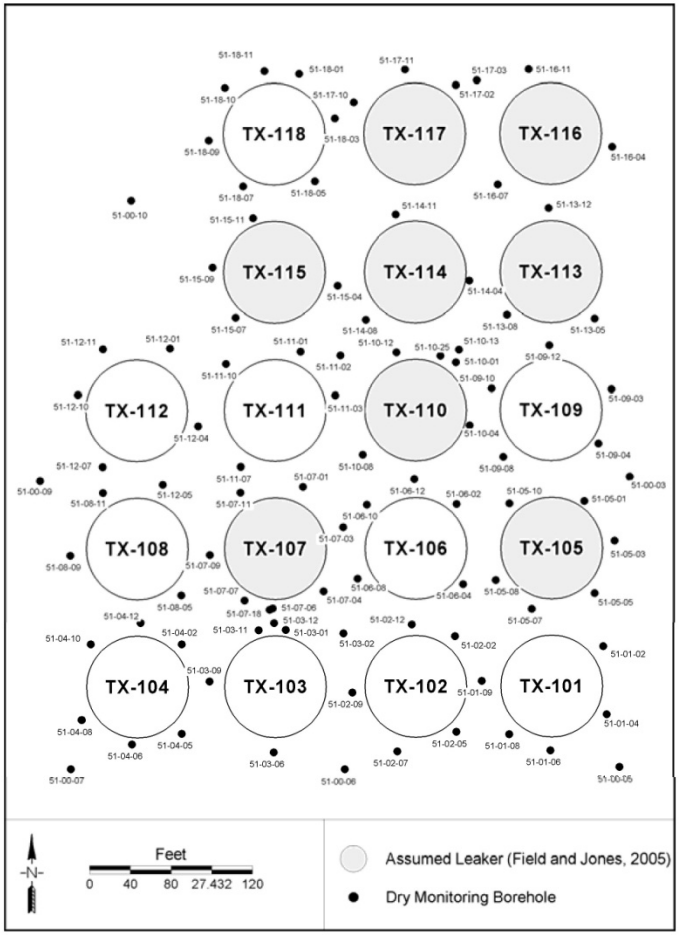
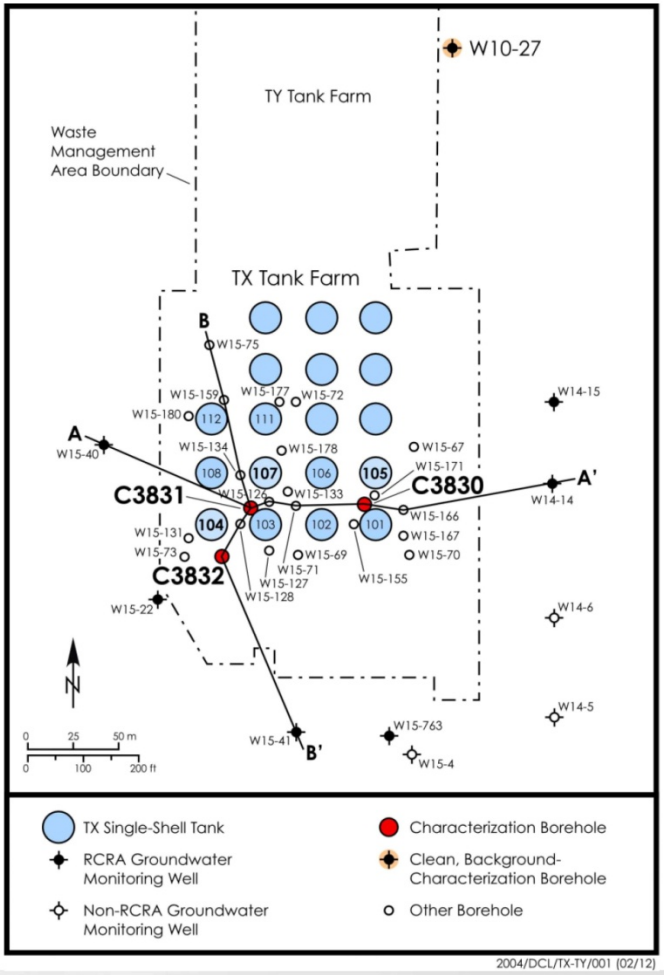
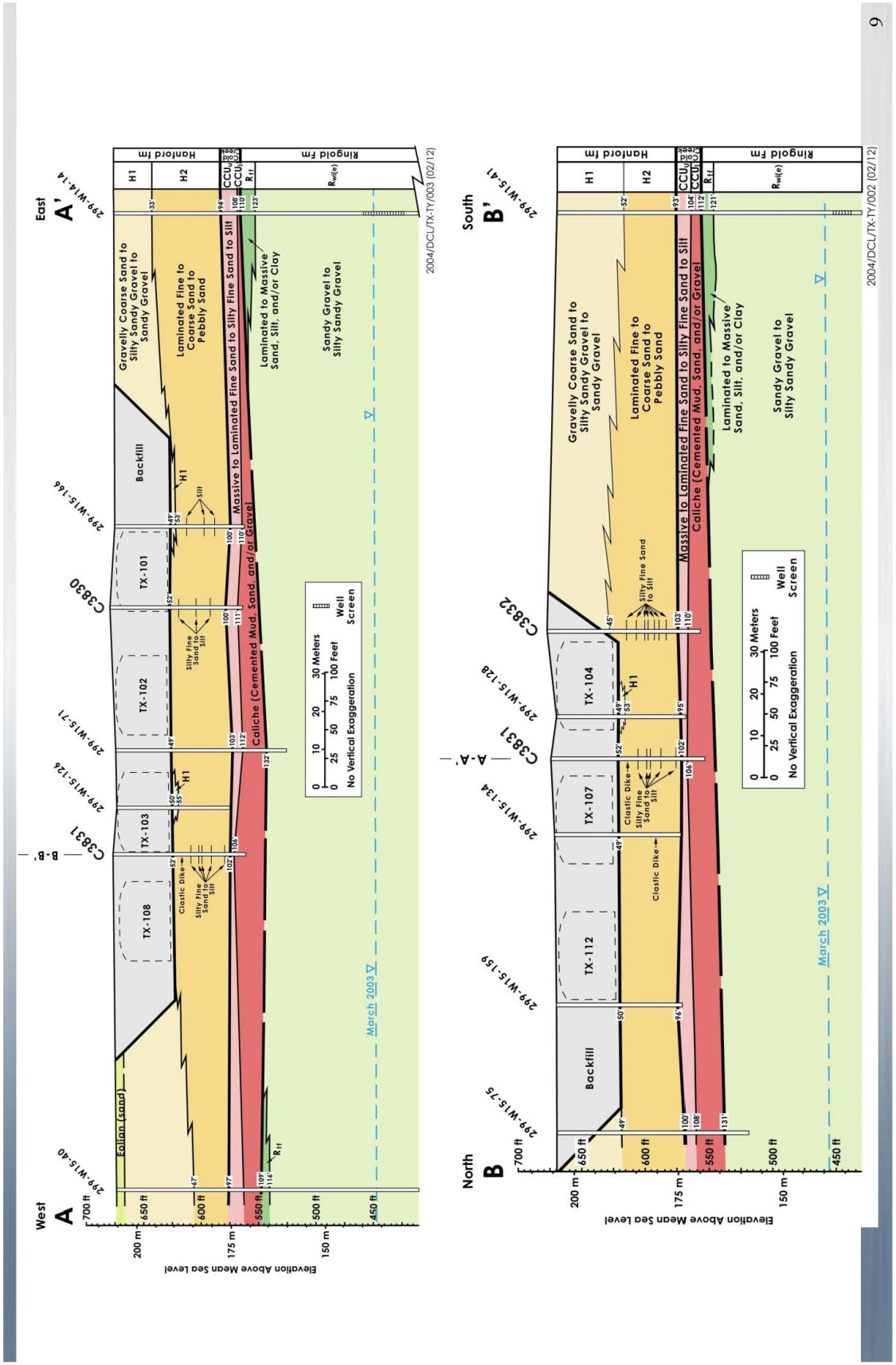
Geophysical Logging



Sampling




Stratigraphy, Geology, Hydrology
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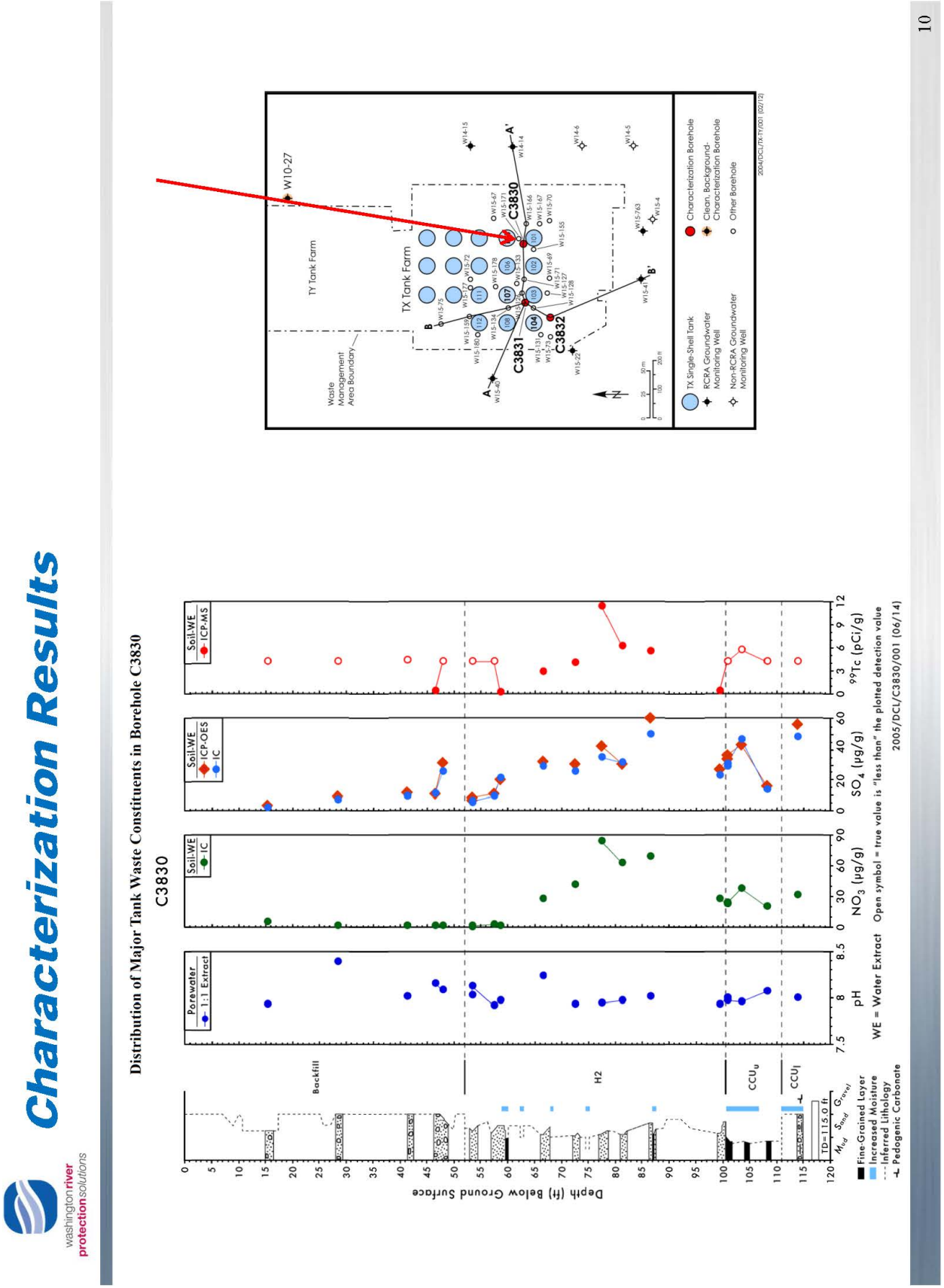
West
A
East
A'
Eolian (sand)
Gravelly Coarse Sand to Silty Sandy Gravel to Sandy Gravel
Laminated Fine to Coarse Sand to Pebbly Sand
Laminated to Massive Sand, Silt, and/or Clay
Sandy Gravel to Silty Sandy Gravel
Massive to Laminated Fine Sand to Silty Fine Sand to Silt
Caliche (Cemented Mud, Sand, and/or Gravel)
Backfill
Clastic Dike
Silty Fine Sand to Silt
Silt
TX-108
TX-103
TX-102
TX-101
C3831
C3830
B-B'
Hanford Fm
Ringold Fm
H1
H2
March 2003
No Vertical Exaggeration
Well Screen
Elevation Above Mean Sea Level
2004/DCL/TX-TY/003 (02/12)
North
B
South
B'
TX-112
TX-107
TX-104
C3832
C3831
A-A'
2004/DCL/TX-TY/002 (02/12)
9


Characterization Results
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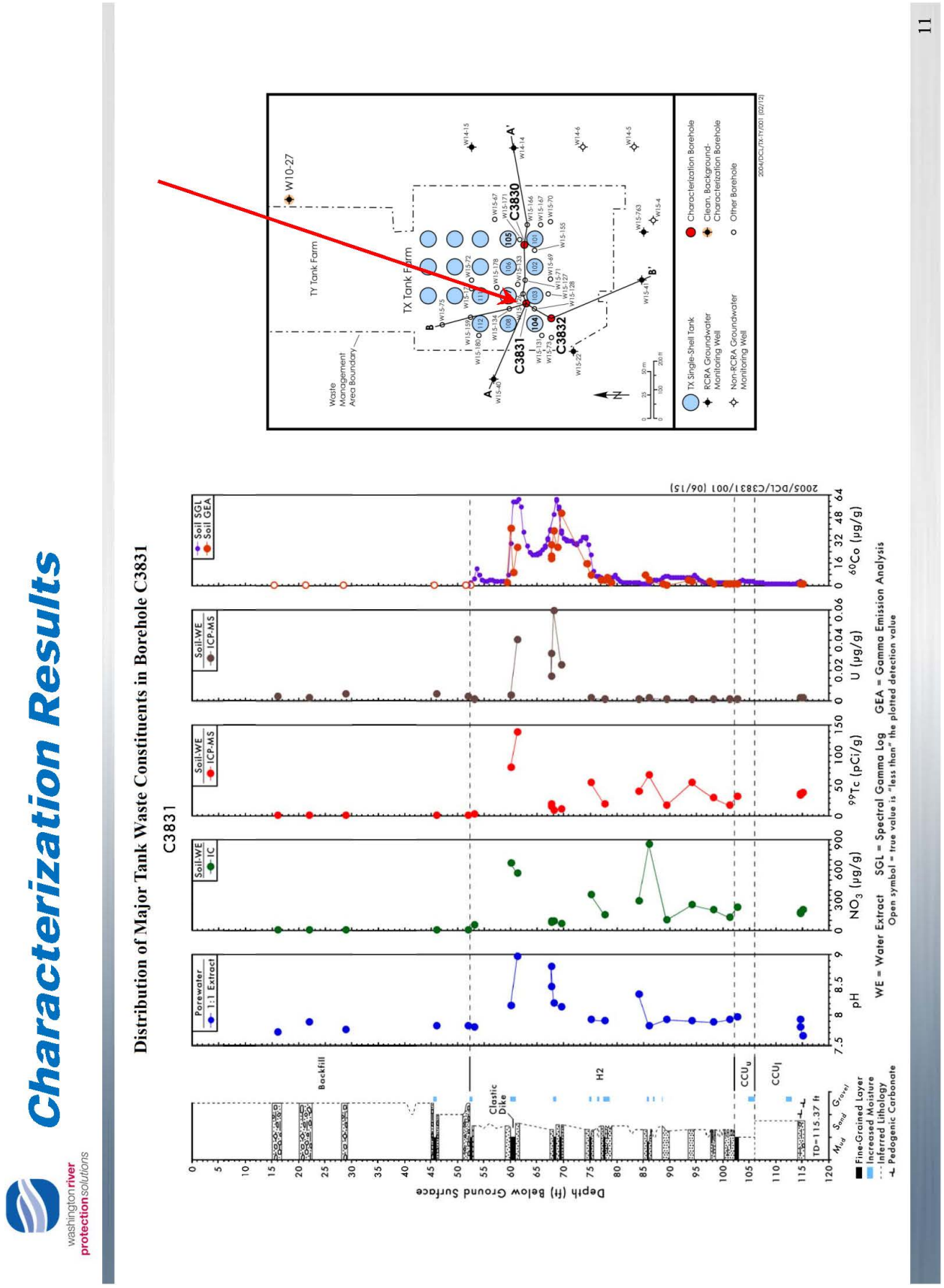
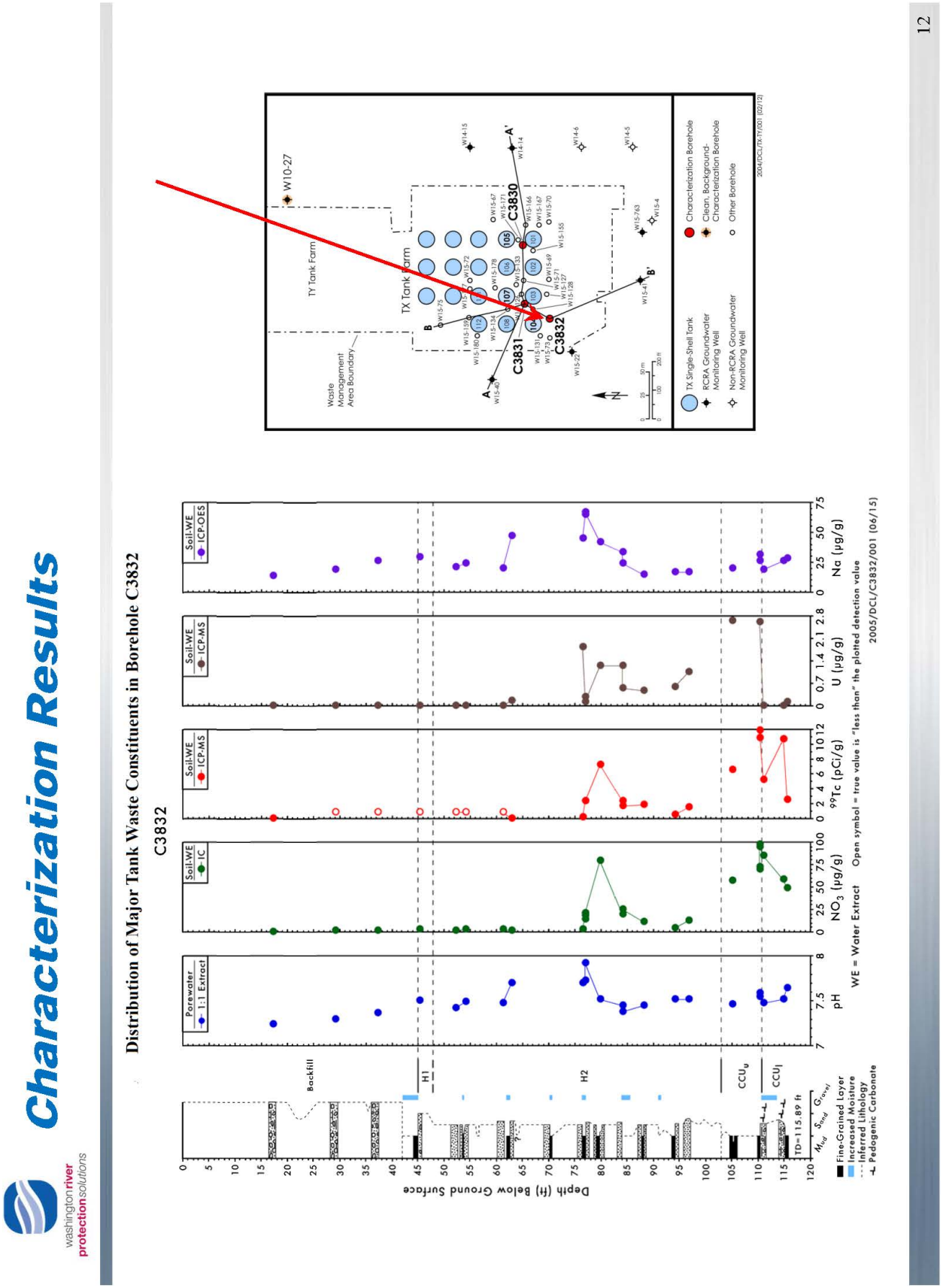
Distribution of Major Tank Waste Constituents in Borehole C3830
C3830
Porewater 1:1 Extract
Soil-WE IC
Soil-WE ICP-OES IC
Soil-WE ICP-MS
Depth (ft) below Ground Surface
Backfill
H2
CCU
pH
NO3 (µg/g)
SO4 (µg/g)
99Tc (pCi/g)
WE = Water Extract Open symbol = true value is "less than" the plotted detection value
2005/DCL/C3830/001 (06/14)
Fine-Grained Layer
Increased Moisture
Inferred Lithology
Pedogenic Carbonate
TD=115.0 ft
TY Tank Farm
TX Tank Farm
Waste Management Area Boundary
W10-27
C3830
C3831
C3832
TX Single-Shell Tank
RCRA Groundwater Monitoring Well
Non-RCRA Groundwater Monitoring Well
Characterization Borehole
Clean, Background-Characterization Borehole
Other Borehole
2004/DCL/TX-TY/001 (02/12)
10


Characterization Results
washington river protection solutions
Distribution of Major Tank Waste Constituents in Borehole C3831
C3831
Depth (ft) Below Ground Surface
Backfill
Clastic Dike
H2
CCU
Fine-Grained Layer
Increased Moisture
Inferred Lithology
Pedogenic Carbonate
Porewater 1:1 Extract
Soil:WE IC
Soil:WE ICP-MS
Soil SGL
Soil GEA
pH
NO3 (µg/g)
99Tc (pCi/g)
U (µg/g)
60Co (µg/g)
WE = Water Extract SGL = Spectral Gamma Log GEA = Gamma Emission Analysis
Open symbol = true value is "less than" the plotted detection value
2005/DCL/C3831/001 (06/15)
TY Tank Farm
TX Tank Farm
Waste Management Area Boundary
C3830
C3831
C3832
TX Single-Shell Tank
RCRA Groundwater Monitoring Well
Non-RCRA Groundwater Monitoring Well
Characterization Borehole
Clean, Background-Characterization Borehole
Other Borehole
2004/DCL/TX-TY/001 (02/12)
11


Characterization Results
washington river protection solutions
Distribution of Major Tank Waste Constituents in Borehole C3832
C3832
Depth (ft) below Ground Surface
Backfill
H1
H2
CCU
TD=115.89 ft
Fine-Grained Layer
Increased Moisture
Inferred Lithology
Pedogenic Carbonate
Porewater 1:1 Extract
Soil-WE IC
Soil-WE ICP-MS
Soil-WE ICP-OES
pH
NO3 (µg/g)
99Tc (pCi/g)
U (µg/g)
Na (µg/g)
WE = Water Extract
Open symbol = true value is "less than" the plotted detection value
2005/DCL/C3832/001 (06/15)
TX Tank Farm
TY Tank Farm
Waste Management Area Boundary
W10-27
C3830
C3831
C3832
Characterization Borehole
Clean, Background-Characterization Borehole
Other Borehole
TX Single-Shell Tank
RCRA Groundwater Monitoring Well
Non-RCRA Groundwater Monitoring Well
2004/DCL/TX-TY/001 (02/12)
12

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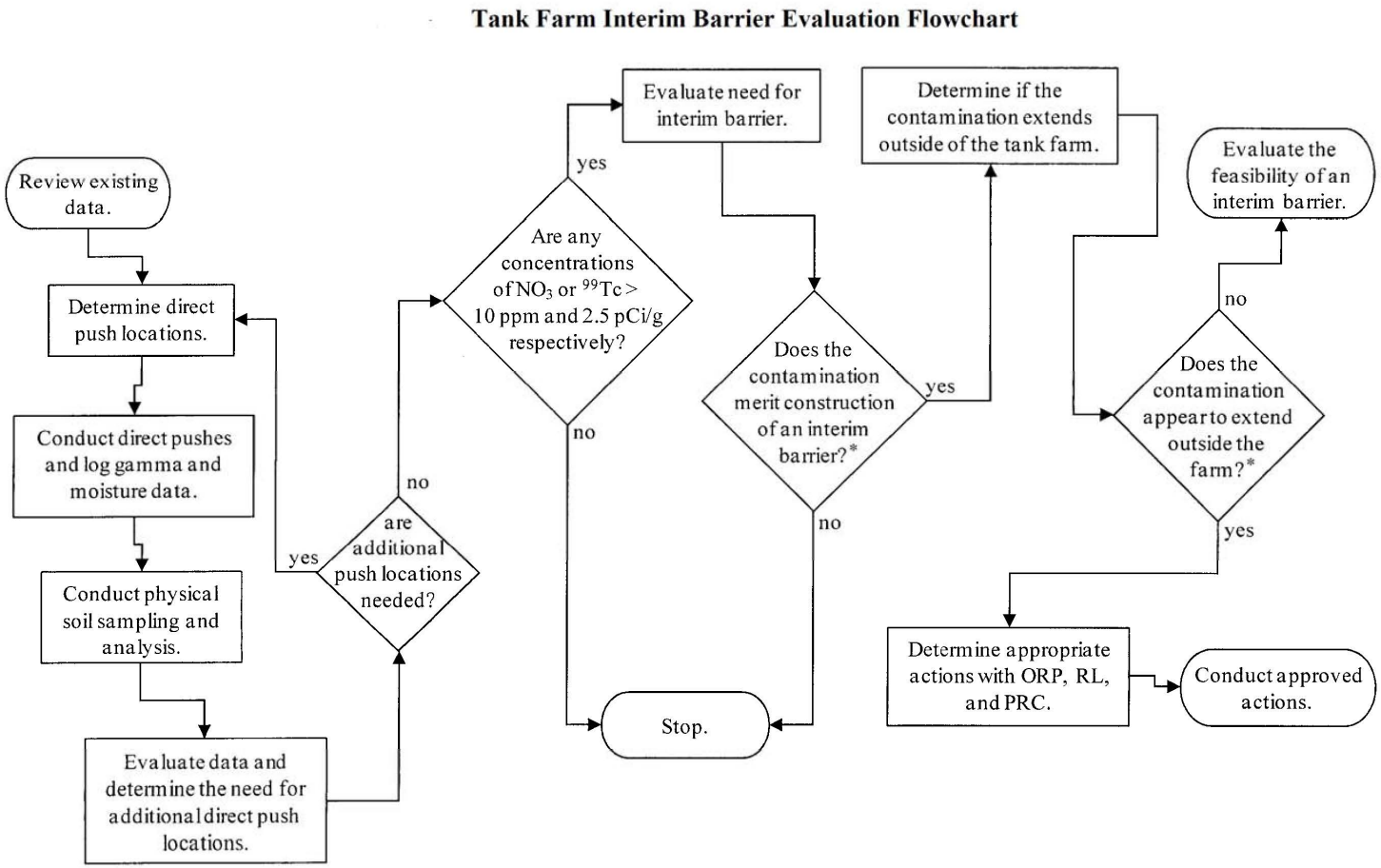
Boundaries

- Spatial Boundaries
  - Twelve Direct Push have been allotted for TX Farm interim barrier evaluation
  - Expected refusal at ~100 ft bgs
  - Past direct push for interim barriers selected three depth intervals were chosen to sample.
- Temporal Boundaries
  - Allow for the scheduling of sampling and analytical activities, collection of samples, and processing of analytical data when received
- Parameters of Interest and action levels
  - Past sampling for interim barriers selected nitrate at 10 ppm (i.e., µg/g) and Tc-99 at 2.5 pCi/g

Suggested Decision Rule for Interim Barrier



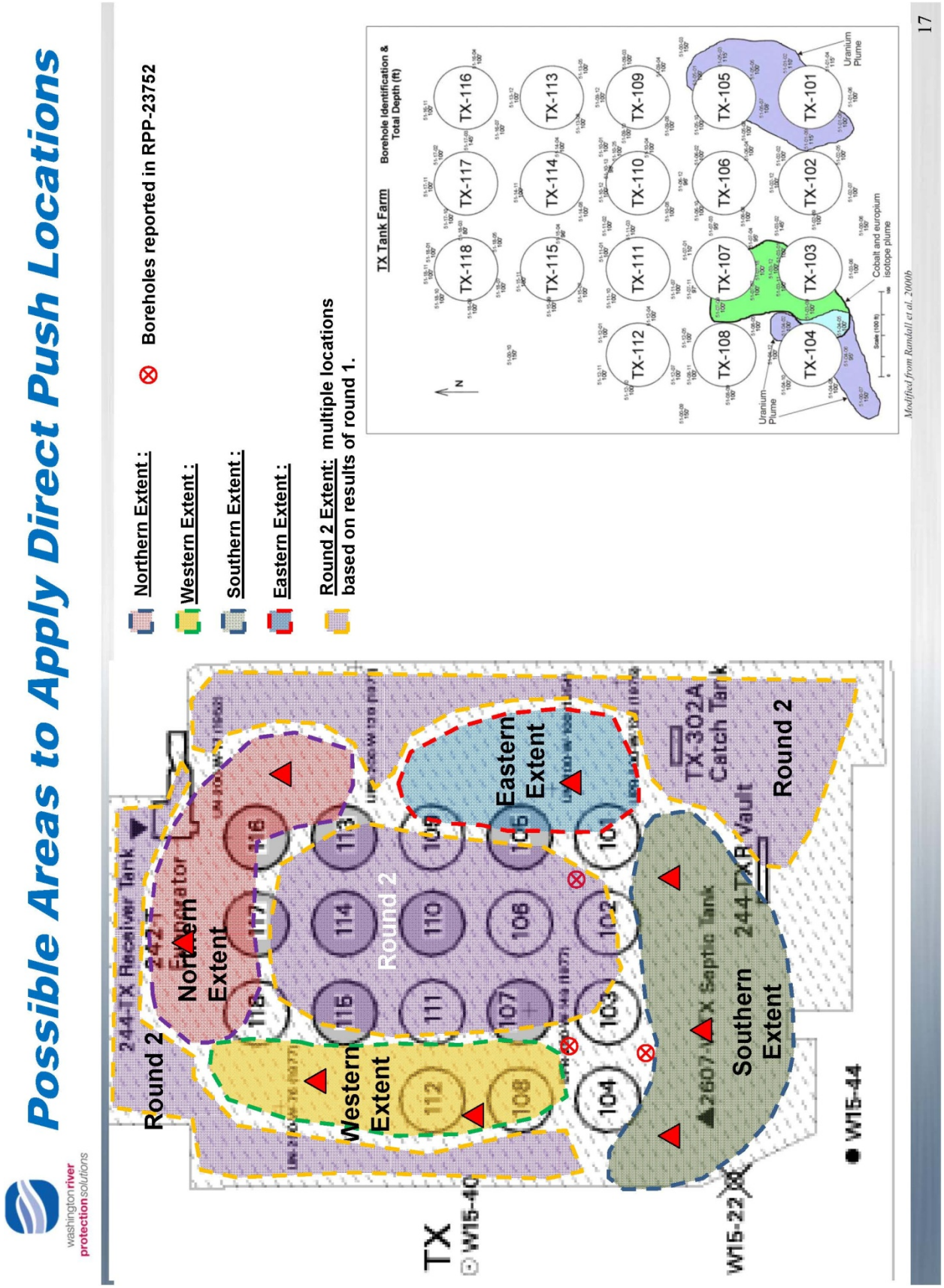
* Additionally: Is the contamination within the effective depth of a barrier?

How to Optimize Design of Direct Push Locations

- Select Direct Push Locations Based On
  - Known and possible waste releases (i.e TX-107 and UPR-200-W-100)?
  - Near suspected leaking tanks with minor contamination (i.e. TX-105, TX-110, TX-113 to TX-117)?
  - Near suspected overfill events (i.e. TX-105)?
  - Where there are higher gamma levels from spectral logging?
  - Near low SGE low resistivity areas?

How to Optimize Design of Direct Push Vertical Samples

- Optimization efforts will also be instituted with regard to choosing sample depths
  - Moisture Logging
    - Areas of high moisture content
    - Areas of saturated moisture content
  - Gamma Logging → Areas of increased gamma radiation
  - Geology/Stratigraphy
    - Zones of interest
    - Sediment layers immediately above a layer with low hydraulic conductivity
    - Fine-grained sediment layers over coarse-grained layers
  - Analytical Information
    - Quick-Turnaround analytes (Tc-99 and Nitrate) from nearby direct push holes may also help determine borehole sample intervals.


Possible Areas to Apply Direct Push Locations
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Northern Extent :
Western Extent :
Southern Extent :
Eastern Extent :
Round 2 Extent: multiple locations based on results of round 1.
Boreholes reported in RPP-23752
TX Tank Farm
Borehole Identification & Total Depth (ft)
TX-118
TX-117
TX-116
TX-115
TX-114
TX-113
TX-112
TX-111
TX-110
TX-109
TX-108
TX-107
TX-106
TX-105
TX-104
TX-103
TX-102
TX-101
Uranium Plume
Cobalt and europium isotope plume
Modified from Randall et al. 2000b
Round 2
Northern Extent
Western Extent
Eastern Extent
Southern Extent
TX-302A Catch Tank
244-TX Receiver Tank
242-T Evaporator
244-TXR Vault
2607-TX Septic Tank
W15-40
W15-22
W15-44
17

Analytes Select for the S Tank Farm Interim Barrier Direct Push (non-rads)

Analysis Type	Primary Analysis	Constituent	Holding Time
"Quick Turn"	ICP/MS	Technetium-99	6 months
	9056 Ion chromatography	Nitrate	28 days/48 hours after digestion
	9045	pH	As soon as possible
	9050	Conductivity	28 days
Standard	6010 ICP/AES	Aluminum, Barium, Beryllium, Calcium, Chromium, Copper, Iron, Lead, Lithium, Manganese, Magnesium, Molybdenum, Phosphorous, Potassium, Sodium, Strontium, Zinc, Boron, Bismuth, Cerium, Europium, Lanthanum, Neodymium, Niobium, Palladium, Praseodymium, Rubidium, Rhodium, Ruthenium, Samarium, Silicon, Tin, Sulfur, Tantalum, Tellurium, Thorium, Titanium, Tungsten, Yttrium, Zirconium	6 months
	6020 ICP/MS	Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Uranium[b], Vanadium	6 months
	7471 Cold vapor atomic absorption	Mercury	28 days
	9056 Ion chromatography	Fluoride, Nitrite, Nitrate, Chloride, Sulfate, Acetate, Formate, Glycolate, Oxalate, Bromide, Phosphate	28 days/48 hours
	Ion chromatography EPA 300.7	Ammonium	7 days to distillation/28 days for preserved distillate
	9215 Ion selective electrode	Sulfide	7 days
	9014 Spectrophotometric	Cyanide	14 days

Analytes Select for the S Tank Farm Interim Barrier Direct Push (Rads)

Analysis Type	Primary Analysis	Constituent	Holding Time
Standard	Gamma energy analysis	Cesium-137, Cobalt-60, Antimony-125, Europium-152, Europium-154, Europium-155, Thorium-228, Thorium-234	6 months
	Low energy gamma counting	Iodine-129	6 months
	ICP/MS	Techenetium-99, Tin-126, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238, Neptunium-237, Thorium-230, Thorium-232	6 months
	Liquid scintillation	Carbon-14, Tritium, Nickel-63, Selenium-79	6 months
	Alpha energy analysis	Plutonium-238, Plutonium-239/240, Americium-241, Curium-242, Curium-243/244	6 months
	Beta proportional counting	Strontium-90	6 months
	Gravimetric	Percent solids	None
	Gravimetric	Percent water	None
	Gravimetric	Bulk density	None

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APPENDIX B

SOIL SAMPLING REQUIREMENTS FOR 241-TX TANK FARM

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Table B-1. Soil Sampling Requirements for 241-S Tank Farm[a] (2 sheets)

Analysis Type	Primary Analysis	Constituent	Holding Time
"Quick Turn"	Inductively coupled plasma/Mass spectroscopy	Technetium-99	6 months
	9056 Ion chromatography	Nitrate	28 days/48 hours after digestion
	9045	pH	As soon as possible
	9050	Conductivity	28 days
Standard	6010 Inductively coupled plasma/ Atomic emission spectroscopy	Aluminum, Barium, Beryllium, Calcium, Chromium, Copper, Iron, Lead, Lithium, Manganese, Magnesium, Molybdenum, Phosphorous, Potassium, Sodium, Strontium, Zinc, Boron, Bismuth, Cerium, Europium, Lanthanum, Neodymium, Niobium, Palladium, Praseodymium, Rubidium, Rhodium, Ruthenium, Samarium, Silicon, Tin, Sulfur, Tantalum, Tellurium, Thorium, Titanium, Tungsten, Yttrium, Zirconium	6 months
	6020 Inductively coupled plasma/ Mass spectroscopy	Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Uranium[b], Vanadium	6 months
	7471 Cold vapor atomic absorption	Mercury	28 days
	9056 Ion chromatography	Fluoride, Nitrite, Nitrate, Chloride, Sulfate, Acetate, Formate, Glycolate, Oxalate, Bromide, Phosphate	28 days/48 hours
	Ion chromatography EPA 300.7	Ammonium	7 days to distillation/28 days for preserved distillate
	9215 Ion selective electrode	Sulfide	7 days
	9014 Spectrophotometric	Cyanide	14 days
	Gamma energy analysis	Cesium-137, Cobalt-60, Antimony-125, Europium-152, Europium-154, Europium-155, Thorium-228, Thorium-234	6 months

Table B-1. Soil Sampling Requirements for 241-S Tank Farm[a] (2 sheets)

Analysis Type	Primary Analysis	Constituent	Holding Time
Standard	Low energy gamma counting	Iodine-129	6 months
	Inductively coupled plasma/Mass spectroscopy	Technetium-99, Tin-126, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238, Neptunium-237, Thorium-230, Thorium-232	6 months
	Liquid scintillation	Carbon-14, Tritium, Nickel-63, Selenium-79	6 months
	Alpha energy analysis	Plutonium-238, Plutonium-239/240, Americium-241, Curium-242, Curium-243/244	6 months
	Beta proportional counting	Strontium-90	6 months
	Gravimetric	Percent solids	None
	Gravimetric	Percent water	None
	Gravimetric	Bulk density	None

[a] Samplers will place the shoe material in a 500-mL glass bottle. The samples will be cooled to ≤ 6 °C. Available material from the shoe and liners (A, B, and C) are composited by the laboratory and the composited material is used in the "quick turn" and standard analysis.

[b] Uranium analysis will be met through the uranium-238 analysis.

EPA = U.S. Environmental Protection Agency

Reference: EPA 600/S4-86/024, 1986, *Development of Standard Methods for the Collection and Analysis of Precipitation*, "Method 300.7, Dissolved Sodium, Ammonium, Potassium, Magnesium, and Calcium in Wet Deposition by Chemically Suppressed Ion Chromatography," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, Ohio.

APPENDIX C

MEETING MINUTES FROM S-FARM INTERIM BARRIER DIRECT PUSH SAMPLE LOCATIONS SEPTEMBER 18, 2012 MEETING

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Meeting Notes

TX Field Trip to Verify Direct Push Locations with Follow-On Confirmation Meeting

Meeting Date:	Tuesday September 18, 2012
Location:	TX Tank Farm in the Morning Ecology Building, room 3A in the Afternoon
Purpose:	Verify selected locations for the direct push logging and sampling that will be performed at 241-TX Tank Farm to evaluate potential interim measures
Attendees:	Field Trip: Joe Caggiano (Ecology), Jared Mathey (Ecology), Chris Kemp (ORP), Jim Lynch (ORP), Doug Hildebrand (RL), Harold Sydnor (WRPS), Mike Connelly (WRPS), Marcel Bergeron (WRPS), Dan Glaser (WRPS) Follow-On Meeting: Joe Caggiano (Ecology), Jared Mathey (Ecology), Jeff Lyon (Ecology), Marysia Skorska (Ecology), Mark Triplett (PNNL), Doug Hildebrand (RL), Harold Sydnor (WRPS), Mike Connelly (WRPS), Dan Glaser (WRPS)

Topics of Discussion:

- Mike Connelly provided the field trip participants with a topographic map of TX-Tank Farm. There were labeling errors on the map, and Mike said he would provide an updated map with the labeling errors corrected (attached with these meeting notes).

- Field trip participants met on the southeast side of TX tank farm. It was recognized by everyone that the suggested direct push location on the SE side of TX-105 would not work. It was located on top of a hill close to the 241-TXR-152 and 241-TXR-153 diversion boxes. Harold indicated that he would not be able to get the direct push rig up the hill because of the limited space on top of the hill. It was also noted that space south and below the hill was limited due to chained off WIDS sites and the location of diversion box 241-TX-153. The chained off areas were due to two underground miscellaneous storage tanks (241-TX-302A and 241-TX-302XB). Both of these are catch tanks which are connected to the 241-TX-153 diversion box. WIDS reports are attached to these meeting notes. Since, the location on top of the hill was not accessible; a new location approximately 60 ft SSE of the original location was selected. This location is just to the NW of diversion box 241-TX-153. Since, the underground infrastructure will not be known until ground penetrating radar is completed over the area, two alternative locations were identified; one approximately 140 ft south of the original location (preferred alternative) and one approximately 100 ft ESE of the original location. All locations are shown on the updated topographic map.

- The field participants then walked around the farm and surveyed all other proposed locations. It appears that all other locations would be accessible to the direct push with one caveat there is an overhead power line for the location close to 241-TX-115 and 241-TX-118 tanks. Harold will check with the appropriate people and if that location has to be modified, the participants of the field trip and follow-on meeting will be notified. All locations are subject to relocation pending the outcome of GPR surveys to detect and locate underground structures that must be avoided.

- The follow-on meeting at Ecology's offices. In that meeting, the participants reviewed the observations at the tank farm and concurred with the direct push locations (see map on the following page).

Actions:

1. Provide Meeting Notes for both the field trip and follow-on meeting (Connelly)
2. Provide update map showing the direct push locations and alternative sites if underground infrastructure interfered with the direct push location (Connelly). See following page for updated map.

Concurrence:

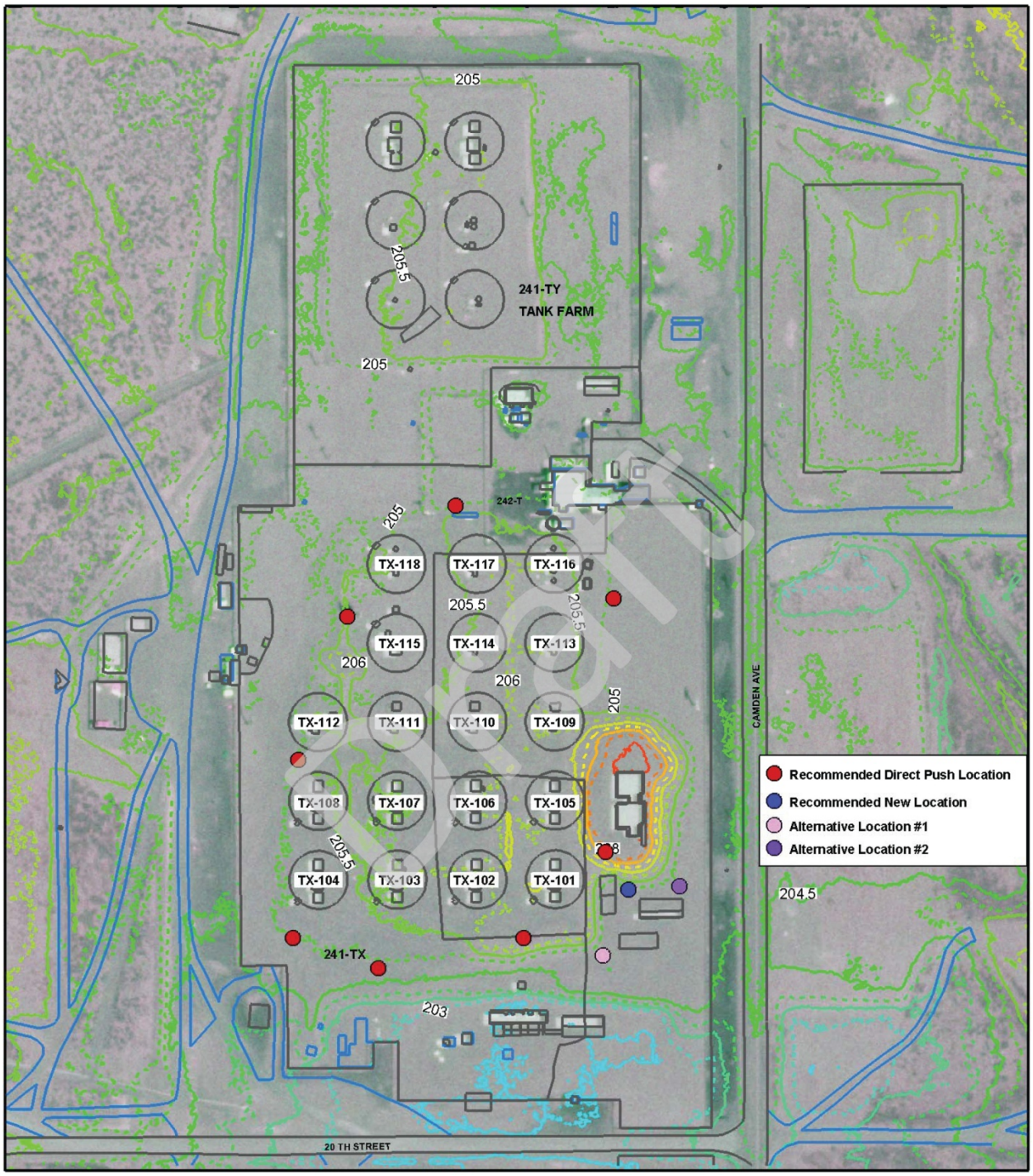
CJ Kemp 10-23-12

C.J. Kemp, ORP Date

Mike W Barn 10-30-12

Jeff Lyon, Ecology Date

Proposed Direct Push Locations Supporting Interim Measures at TX Tank Farm



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APPENDIX D

MEETING NOTES
200 WEST TANK FARMS INTERIM MEASURES INVESTIGATION WORK PLAN
AND
241-TX TANK FARM SAMPLING AND ANALYSIS PLAN

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MEETING NOTES

200 West Tank Farms Interim Measures Investigation Work Plan
and
241-TX Tank Farm Sampling and Analysis Plan

MEETING DATE: January 16, 2013

LOCATION: Washington State Department of Ecology, Richland Office

ATTENDEES:

Mike Barnes (Ecology)	R.D. Hildebrand (DOE)
Joe Caggiano (Ecology)	Dan Parker (WRPS)
Mike Connelly (WRPS)	Julie Robertson (Freestone Environmental Services)
Susan Eberlein (WRPS)	Maria Skorska (Ecology)
Les Fort (WRPS)	Harold Sydnor (WRPS)
Dan Glaser (WRPS)	Cindy Tabor (WRPS)
Erika Garcia (Freestone Environmental Services)	

PURPOSE: This meeting was scheduled to provide a forum to discuss Ecology comments on *200 West Area Tank Farms Interim Measures Investigation Work Plan* (RPP-PLAN-53808, Revision 0) and also to introduce Ecology to the *Sampling and Analysis Plan for Soil Samples in Support of Interim Measure Planning at the 241-TX Tank Farm* (draft in preparation). **NOTE**: Following the meeting of January 16, 2013, the participating agencies agreed to participate in follow-on meetings to occur on an approximately monthly basis. A list of open and unresolved issues and the status of those issues will be tracked and documented in the notes of these meetings in the form of action items and pending resolutions.

DISCUSSION:

TX Farm SAP

Ms. Tabor provided a presentation describing the contents of the draft TX SAP (Attachment 1). Key discussion points are summarized below.

- The SAP will reference RPP-54073, *TX Tank Farm Leak Inventory Assessment Meeting Summaries*, regarding leak assessment information.
- The outline and content of the TX Farm SAP closely follow the outline and content of RPP-PLAN-49132, *Field Sampling and Analysis Plan for Soil Samples in Support of an Interim Barrier at S Farm*.
- The direct push investigation will initially focus on eight locations as agreed during meetings held on September 6 and September 18, 2012. The locations of an additional four direct push boreholes will be determined following review by DOE and Ecology of available results from the initial eight locations. The interagency agreement on the final four borehole locations will be documented in meeting minutes that will be placed in the Administrative Record associated with the *Hanford Federal Facility Agreement and Consent Order* (HFFACO). The methodologies to be used and

analytes will be the same for the final four boreholes as the first eight, as documented in the TX Farm SAP.

- Ecology asked whether available results from three boreholes installed in 1982 near TX-104, TX-105, and TX-106 were considered when locations were selected for the first eight boreholes. WRPS confirmed that data from those boreholes was considered during the selection process.
- Mr. Sydnor noted that during recent driller walk downs at TX Farm, it was concluded that drilling equipment accessibility issues preclude installation of a borehole at alternative site 1A. Additionally, there is significant underground infrastructure at alternative site 1C that precludes use of that location. Therefore, the site previously identified as alternative site 1B will be selected for borehole installation. **ACTION**: The body of the TX Farm SAP will be written to eliminate discussion of 1A/1B/1C and will simply identify the former site 1B as "Site 1."
- Sample depth locations will be selected as described in the attached presentation. Sample depth agreement meetings will be signed by DOE and Ecology and placed in the Administrative Record.
- Soil samples will be analyzed for constituents as shown in the presentation. The list excludes sulfide and identifies four analytes for quick-turn analysis (bold text). Levels of constituents shown in italicized text will be reported if they are detected.
- WRPS and DOE stated an intent to provide Ecology with a copy of the draft SAP in mid-February for informal review in the hopes that any significant issues could be identified and worked before the document is issued formally.
- Ecology stated that HFFACO text regarding data validation appeared to have been modified recently and that those changes might necessitate modification of the data validation text used in the SAP. **ACTION**: Ms. Tabor will follow-up with Mr. Barnes and Jerry Yokel (Ecology) to prepare data validation text.

200 West Interim Measures Work Plan

- Ms. Eberlein noted that per HFFACO primary document review requirements, Ecology's comments on the work plan (RPP-PLAN-53808, Rev. 0) must be provided by January 24, 2013. The parties discussed several options that could be used to fulfill this requirement, including provision of a formal letter and inclusion of the comments in the meeting minutes for the HFFACO monthly project managers' meeting scheduled for January 22, 2013. **ACTION**: Ecology staff will relay options to the Ecology project manager for his consideration.
- Ms. Tabor handed out a table listing informally-provided Ecology comments on the Rev. 0 work plan, along with potential resolutions. The parties discussed a limited number of comments they deemed higher priority, as described below:
  - Comments requesting inclusion of text and a new figure regarding tank Tc-99 inventory – WRPS agreed to include the requested text and provided a new figure illustrating contaminant inventories in the single-shell tanks. Ecology agreed the figure should be added.
  - Comment requesting additional 3D resistivity information – WRPS agreed to incorporate the requested information.
  - Comment requesting the document be updated to incorporate the latest tank system descriptions and tank leak loss values – WRPS agreed to incorporate the requested information.

ACTION: Ms. Tabor will update the table handed out at the meeting to reflect the discussion and will email it to Ecology for their use as desired to meet the HFFACO timeline to formally provide comments on the work plan by January 24, 2013.

ACTIONS: Refer to the following table. A date-based numbering system is being used to track the actions to completion. Actions will be removed from the list after DOE and Ecology have agreed to their completion.

R Douglas H. Debrand	R [signature]	2-6-2013
DOE Project Manager (print)	DOE Project Manager (signature)	Date
Jeffery J Lyon	[signature]	2-11-2013
Ecology Project Manager (print)	Ecology Project Manager (signature)	Date

Item #	Topic/Title	Actionee	Description	Status
2013-01-16-1	Identification of TX Farm borehole site 1	Tabor	Update draft TX Farm SAP to eliminate discussion of 1A/1B/1C and simply identify the former site 1B as "Site 1."	(new)
2013-01-16-2	SAP data validation text	Tabor	Follow-up with Mike Barnes and Jerry Yokel to prepare SAP data validation text.	(new)
2013-01-16-3	Formal documentation of Ecology comments on work plan by 1/24/2013	Skorska	Discuss options for documenting Ecology comments with Jeff Lyon.	(new)
2013-01-16-4	Ecology comments on work plan	Tabor	Update table with Ecology comments on work plan and proposed resolutions.	(new)

Proposed TX Farm Interim Measure Sampling and Analysis Plan

- Purpose of SAP
- SAP Reference Materials
- Sample Locations
- Sample Depth Decision Process
- Analytical Constituents
- Schedule

Purpose of the TX SAP

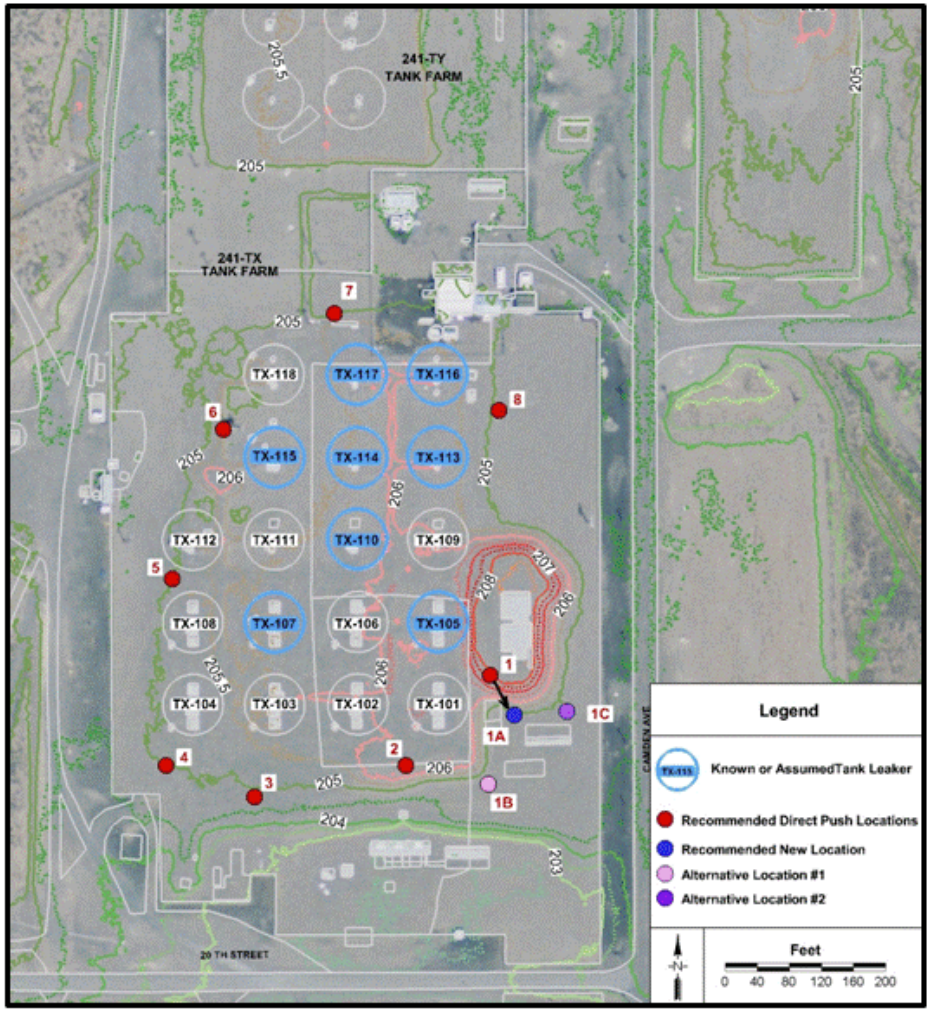
- Document sampling and analysis activities necessary to assist in determining
  - If an interim measure is merited at TX Farm
  - Geographic extent of vadose contamination at TX Farm
- Implement RPP-PLAN-53808, *200 West Area Tank Farms Interim Measures Investigation Work Plan*
- Fulfill Tri-Party Agreement Milestone M-045-21 (submit SAP) and gather data to support Target Date M-045-22-T01 (submit characterization report)
- Inform future RCRA Phase 2 characterization activities at TX Farm

TX Farm SAP Reference Documents

The following references are being used to develop the TX Farm SAP:

- RPP-43551, *Tank Farm Interim Barrier Data Quality Objectives*
- RPP-PLAN-53808, Interim Measures Investigation Work Plan
- RPP-23752, the T and TX-TY Field Investigation Report
- RPP 54073, *TX Tank Farm Leak Inventory Assessment Meeting Summaries*
- RPP-PLAN-49132, *Field Sampling and Analysis Plan for Soil Samples in Support of an Interim Barrier at S Farm*
- Minutes from September 6 and September 18, 2012 meetings regarding TX vadose zone sampling
- RPP-ENV-53773, *Data Requirements for Characterization Supporting Interim Measures in TX Farm*

Proposed Borehole Location Map



Hanford Site 200 West Area,
241-TX Tank Farm

Information based on September 18, 2012 field walk down.

Direct Push Location Strategy for TX Farm

- Push boreholes in 8 locations:
  1. SE of TX-105/E of TX-101 (further assess tank TX-105 and UPR-200-W-100 releases) – 1A
  2. SW of TX-101 (further assess releases near TX-105 and UPR-200-W-100)
  3. S of TX-103 (gather additional data on contamination south of the TX Farm tanks)
  4. S of TX-104 (gather additional data on contamination south of the TX Farm tanks)
  5. Between TX-108 and TX-112 (explore SGE anomaly)
  6. Between TX-115 and TX-118 (explore SGE anomaly)
  7. N of TX-117 (gather data near tank of questionable integrity)
  8. E of TX-113 and TX-116 (gather data near tanks of questionable integrity)
- Push boreholes in 4 additional locations TBD based on results from initial 8 locations

Sample Depth Decision Process

- Soil samples will be collected consistent with previous interim barrier support efforts
  - An average of three depths from each sample probe hole.
  - Geophysical logging and available quick turnaround analysis (^{99}Tc and nitrate) will be used to aid in determining sample depths.
  - Meetings will be held with, or e-mails will be sent to, representatives from WRPS, DOE, ORP, DOE-RL, and Ecology, to gain a consensus on sample depths.

Analytes Selected for the TX Farm Interim Measure Direct Push

Primary Analytical Method (prep)	Constituent
9045	**pH**
9050	**Conductivity**
6010 ICP/AES	Aluminum, Barium, Beryllium, Calcium, Chromium, Copper, Iron, Lead, Lithium, Manganese, Magnesium, Molybdenum, Phosphorous, Potassium, Sodium, Strontium, Zinc, *Boron, Bismuth, Cerium, Europium, Lanthanum, Neodymium, Niobium, Palladium, Praseodymium, Rubidium, Rhodium, Ruthenium, Samarium, Silicon, Tin, Sulfur, Tantalum, Tellurium, Thorium, Titanium, Tungsten, Yttrium, Zirconium*
6020 ICP/MS	Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Uranium, Vanadium
7471 Cold vapor atomic absorption	Mercury
9056 Ion chromatography	Fluoride, Nitrite, **Nitrate**, Chloride, Sulfate, Acetate, Formate, Glycolate, Oxalate, *Bromide, Phosphate*
Ion chromatography EPA 300.7	Ammonium
9014 Spectrophotometric	Cyanide
Gamma energy analysis	Cesium-137, Cobalt-60, Antimony-125, Europium-152, Europium-154, Europium-155, Thorium-228, Thorium-234
Low energy gamma counting	Iodine-129
ICP/MS	**Techenetium-99**, Tin-126, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238, Neptunium-237, Thorium-230, Thorium-232
Liquid scintillation	Carbon-14, Tritium, Nickel-63, Selenium-79
Alpha energy analysis	Plutonium-238, Plutonium-239/240, Americium-241, Curium-242, Curium-243/244
Beta proportional counting	Strontium-90
Gravimetric	Percent solids
Gravimetric	Percent water
Gravimetric	Bulk density

Analytes are as proposed in September 6, 2012 meeting, except that sulfide has been deleted.

Schedule for TX Farm Work

	Fiscal Year 2013	Fiscal Year 2014	Fiscal Year 2015
241-TX Tank Farm			
Submit TX Sampling and Analysis Plan (M-045-21)	March 31, 2013		
Provide Field Work Completion Summary		March 31, 2014	
Provide TX Farm Interim Action Recommendations		June 30, 2014	
Submit Characterization Report (M-045-22-T01)			Sept. 30, 2014
Complete M-045-22 Milestone			Sept. 30, 2014
Submit Change Package to Modify M-045-92 Milestone			Sept. 30, 2014

Direct Push Location Strategy for TX Farm

Site #	Approximate Location	Input Factors Associated with Location[a]	Reason for Sampling with Respect to Interim Measure
1A (Agreed Upon Location – Refer to the 6th bullet in third column of this row)	Southeast of tank 241-TX-105 (TX-105)	• Tank TX-105 designated as a leaker (at least 150,000 gal) • Nearby diversion boxes and pipelines • Process records indicate it was overfilled in 1952 and between 1961 and 1964 • Gross gamma activity detected in drywells 51-05-01, 51-05-03, and 51-05-05 on East – Southeast side of tank • UPR-200-W-100 is also to the east of tank TX-105 • Direct push initial location (1) cannot be reached due to topography; three alternative sites have been identified (1A, 1B, and 1C), all further to the south but in the vicinity of transfer lines and diversion boxes. Location 1A is the preferred alternative location based on site visit dated September 18, 2012. If 1A is not accessible, then 1B will be selected, and if 1B is not accessible, then 1C will be selected.	Further assess the path and inventory of tank TX-105 and UPR-200-W-100 Releases (see Figure 2-4 for uranium plume map[b])
2 (Agreed Upon Location)	Southwest of tank 241-TX-101	• Releases associated with tank TX-105 and UPR-200-W-100 appear to be trending to the southwest (see Figure 2-4[b]) • Tc-99 groundwater plume is to the south of 241-TX Tank Farm (TX Farm) (See Figure 2-10[b])	Further assess the nature and depth of migration of releases near tank TX-105 and UPR-200-W-100; also to attempt to define a boundary for the migration
3 (Agreed Upon Location)	South of tank 241-TX-103	• Tank 241-TX-107 is designated as a leaker (1,300 gal) • Noted Co-60 and Eu-154 activity in drywells 51-07-07, 51-07-18 and in drywells between tanks 241-TX-107 and 241-TX-103 • Tc-99 groundwater plume is to the south of TX Farm (Figure 2-10[b])	Confirm Previous Results: Gather additional data to assist in determining nature and extent of contamination (i.e., Tc-99) south of the TX Farm tanks, also to attempt to define boundary to vadose zone contamination
4 (Agreed Upon Location)	South of tank 241-TX-104	• Tank 241-TX-104 is not designated as a leaker • Uranium vadose zone plume to the east and south of tank 241-TX-104, may be the result of a transfer line or cascade line leak • Tc-99 groundwater plume is to the south of TX Farm (Figure 2-10[b])	Confirm Previous Results: Gather additional data to assist in determining nature and extent of contamination (i.e., Tc-99) south of the TX Farm tanks, also to attempt to define boundary to vadose zone contamination

[a] Tank leak and pipeline failure information is provided in RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates.*

[b] Reference figures are provided in RPP-PLAN-53808, *200 West Area Tank Farms Interim Measures Investigation Work Plan.*

Direct Push Location Strategy for TX Farm (Continued)

Site #	Approximate Location	Input Factors Associated with Location[a]	Reason for Sampling with Respect to Interim Measure
5 (Agreed Upon Location)	In between tanks 241-TX-108 and 241-TX-112 and slightly to the west of the centerline between these tanks	• Higher conductivity area based on resistivity information in this area (Figure 2-9[b])	Explore surface geophysical exploration (SGE) anomaly close to tanks 241-TX-108 and 241-TX-112. Gather data to assist in determining nature and extent of contamination (i.e., Tc-99).
6 (Agreed Upon Location)	In between tanks 241-TX-115 (TX-115) and 241-TX-118 and to the NW of tank TX-115	• Tank TX-115 was declared "questionably integrity" in 1977 based on gamma activity in drywell 51-15-04 and arbitrarily assigned a leak volume of 8,000 gal • May have been overfilled in the early 1950s • SGE anomaly to the north and northwest of tank TX-115	Explore SGE anomaly close to tanks TX-115 and 241-TX-118. Gather data to assist in determining nature and extent of contamination (i.e., Tc-99).
7 (Agreed Upon Location)	North of tank 241-TX-117	• Tank 241-TX-117 was declared "questionably integrity" in 1977 based on gamma activity nearby vadose zone drywells and arbitrarily assigned a leak volume of 8,000 gal • Tc-99 in groundwater in this vicinity (Figure 2-10[b])	Gather data to assist in determining nature and extent of contamination (i.e., Tc-99) and to attempt to define boundary to vadose zone contamination
8 (Agreed Upon Location)	East of tank 241-TX-113 and 241-TX-116	• Tank 241-TX-113 was declared "questionably integrity" in 1977 based on gamma activity nearby vadose zone drywells and arbitrarily assigned a leak volume of 8,000 gal • Historical transfer records show that the tank 241-TX-113 was filled above the cascade outlet as a result of cascade plugging of the cascade lines and in-tank photographs show the waste level was well above the cascade line, indicating the potential for releases from the cascade lines or spare inlet ports • Tank 241-TX-116 was declared "questionably integrity" in 1977 based on gamma activity nearby vadose zone drywells and arbitrarily assigned a leak volume of 8,000 gal	Gather data to assist in determining nature and extent of contamination (i.e., Tc-99) and to attempt to define boundary to vadose zone contamination

[a] Tank leak and pipeline failure information is provided in RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates.*

[b] Reference figures are provided in RPP-PLAN-53808, *200 West Area Tank Farms Interim Measures Investigation Work Plan.*

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INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

Title: Data Requirements for Characterization Supporting Interim Measures in TX Farm

Information Category:
- ☐ Abstract ☐ Journal Article ☐ Summary
- ☐ Internet ☐ Visual Aid ☐ Software
- ☐ Full Paper ☐ Report ☑ Other Data Requirements

Publish to OSTI? ☐ Yes ☑ No

Trademark/Copyright "Right to Use" Information or Permission Documentation	Yes	NA
	☐	☑

Document Number: RPP-ENV-53773 Revision 0 Date: February 2013

Author: Tabor, Cindy L

Part II: External/Public Presentation Information

Conference Name:

Sponsoring Organization(s): WRPS

Date of Conference: Conference Location:

Will Material be Handed Out? ☐ Yes ☑ No Will Information be Published? ☐ Yes ☑ No *(If Yes, attach copy of Conference format instructions/guidance.)*

Part III: WRPS Document Originator Checklist

Description	*Yes*	*N/A*	*Print/Sign/Date*
Information Product meets requirements in TFC-BSM-AD-C-01?	☐	☑	
Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist)	☐	☑	
If product contains pictures, safety review completed?	☑	☐	Roberts, Sheryl K IDMS workflow data attached

Part IV: WRPS Internal Review

Function	*Organization*	*Date*	*Print Name/Signature/Date*
Subject Matter Expert	WRPS	11/14/2019	Tabor, Cindy L workflow data attached
Responsible Manager	WRPS	11/05/2019	Rutland, Paul L workflow data attached
Other:			

Part V: IRM Clearance Services Review

Description	*Yes*	*No*	*Print Name/Signature*
Document Contains Classified Information?	☐	☒	If Answer is "Yes," ADC Approval Required Print Name/Signature/Date
Document Contains Information Restricted by DOE Operational Security Guidelines?	☐	☒	Reviewer Signature: Print Name/Signature/Date
Document is Subject to Release Restrictions? *If the answer is "Yes," please mark category at right and describe limitation or responsible organization below:*	☐	☒	Document contains: ☐ Applied Technology ☐ Protected CRADA ☐ Personal/Private ☐ Export Controlled ☐ Proprietary ☐ Procurement – Sensitive ☐ Patentable Info. ☐ OUO ☐ Predecisional Info. ☐ UCNI ☐ Restricted by Operational Security Guidelines ☐ Other (Specify)
Additional Comments from Information Clearance Specialist Review?	☐	☒	Information Clearance Specialist Approval APPROVED By Lynn M. Ayers at 7:30 am, Nov 14, 2019 Print Name/Signature/Date

When IRM Clearance Review is Complete – Return to WRPS Originator for Final Signature Routing (Part VI)

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part VI: Final Review and Approvals

Description	*Approved for Release*		*Print Name/Signature*
	Yes	*N/A*	
WRPS External Affairs	☒	☐	McCune, Hal C - IDMS workflow data attached
WRPS Office of Chief Counsel	☒	☐	Roden, Mari L - IDMS workflow data attached
DOE – ORP Public Affairs/Communications	☒	☐	Levardi, Yvonne & Tyree, Geoff - workflow data attached
Other:	☒	☐	Zelen, Ben J - IDMS workflow data attached
Other:	☒	☐	Lobos, Rodrigo A - IDMS workflow data attached

Comments Required for WRPS-Indicate Purpose of Document:

This report outlines the data requirements to continue characterization and evaluation efforts at the 241-TX Tank Farm. The overall objective of this effort is to gather data to support a determination regarding whether the application of an interim measure is merited to either curtail transport of the mobile contaminants or to remove them if possible. The exact nature of the interim measure at this time is not known. However, it is postulated that either an interim barrier could be placed over 241-TX Tank Farm to reduce moisture infiltration rate into the soil, thereby reducing the migration of soluble contaminants to the groundwater, or a remedial technology could be deployed to remove contaminants from the subsurface. In either case, the lateral extent of the vadose contamination at 241-TX Tank Farm needs be determined in order to ensure the proper design of the interim measure.

APPROVED
By Lynn M. Ayers at 7:30 am, Nov 14, 2019

Approved for Public Release; Further Dissemination Unlimited

Information Release Station

Was/Is Information Product Approved for Release? ☒ Yes ☐ No

If Yes, what is the Level of Releaser? ☑ Public/Unrestricted ☐ Other (Specify) _____

Date Information Product Stamped/Marked for Release: 11/14/2019

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