Appendix A

Sampling and Analysis Plan for the 200-SW-2 Operable Unit Landfills

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Signature Page

Title: *200-SW-2 Radioactive Landfills Group Operable Unit RCRA Facility Investigation/ Corrective Measures Study/Remedial Investigation/Feasibility Study Work Plan*

Appendix A
Sampling and Analysis Plan for the 200-SW-2 Operable Unit Landfills

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Terms

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
BTR	Buyer's Technical Representative
CAS	Chemical Abstracts Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPEC	contaminant of potential ecological concern
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DOE-RL	DOE Richland Operations Office
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DUP	field duplicate
EB	equipment blank
ECO	Environmental Compliance Officer
Ecology	Washington State Department of Ecology
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
ERT	electrical resistivity tomography
FS	feasibility study
FSO	Field Sampling Operations
FSP	field sampling plan
FTB	full trip blank
FWS	Field Work Supervisor
FXR	field transfer blank
GEA	gamma energy analysis
GFPC	gas flow proportional counting

GPR	ground-penetrating radar
GPS	global positioning system
HEIS	Hanford Environmental Information System
ICP	inductively coupled plasma
INL	Idaho National Laboratory
LSC	liquid scintillation counter
MASW	multi-channel analysis of surface waves
MDL	method detection limit
MS	mass spectrometer
MSA	Mission Support Alliance
N/A	not applicable
NIOSH	National Institute for Occupational Safety and Health
OU	operable unit
PLM	polarized light microscopy
POC	point of contact
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	radiological control technician
RFI/CMS	RCRA facility investigation/corrective measures study
RI	remedial investigation
ROD	record of decision
RPD	relative percent difference
RSW	remotely stored waste
S&GRP	Soil and Groundwater Remediation Project
SAF	sampling authorization form
SAP	sampling and analysis plan
SMR	Sample Management and Reporting
SPLIT	field split sample

STS	surface-to-surface
SVOC	semivolatile organic compound
SWITS	Solid Waste Information Tracking System
TBD	to be determined
TDR	time domain reflectometry
TMF	total magnetic field
TPA	Tri-Party Agreement (*Hanford Federal Facility Agreement and Consent Order*) (Ecology et al., 1989a)
TPH	total petroleum hydrocarbon
Tri-Parties	DOE, EPA, and Ecology
TRU	Transuranic
TSD	treatment, storage, and/or disposal
UPR	unplanned release
VOA	volatile organic analysis
VOC	volatile organic compound
WSP	Washington State Plane

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A1 Introduction

The activities described in this sampling and analysis plan (SAP) support corrective actions under the *Resource Conservation and Recovery Act of 1976* (RCRA) and remedial actions under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The SAP and work plan activities fulfill the requirements for a RCRA facility investigation/corrective measures study (RFI/CMS) as well as a CERCLA remedial investigation (RI)/feasibility study (FS), comprising a combined RFI/CMS/RI/FS process for the 200-SW-2 Radioactive Landfills Operable Unit (OU). Figure A-1 shows the location of 200-SW-2 OU within the Hanford Site.

This SAP provides detail on the further RI of landfills to support characterization of risk and development of remedial action alternatives. This SAP describes the data to be collected that will be used to refine conceptual site models, support baseline risk assessments, and evaluate remediation technology performance in support of the FS, proposed plan, and eventual record of decision (ROD) for 200-SW-2 OU landfills and associated waste sites. A significant aspect of this effort is to fill data gaps by the collection of additional data, such as geophysical, soil gas, soil, and waste characteristic information. The work plan provides an analysis of existing information about the landfills and a subsequent evaluation of data gaps.

Both intrusive and nonintrusive characterization methods will be employed. The objective is to use the best method or suite of methods to assemble information to define the risk pathway elements. Nonintrusive methods will provide wide-area coverage of the landfill footprint, while intrusive methods provide in situ information on potential releases to the vadose zone beneath the landfills. The advantage of nonintrusive methods is that they are intrinsically safe and cost effective, and they provide for wide area coverage. The disadvantages of nonintrusive methods are that data can be difficult to interpret in terms of conventional parameters, smaller hot spots can be easy to miss, the data may not be amenable to standard statistical analysis, and the quality of the data may be difficult to ascertain. To help remedy these disadvantages, intrusive investigations will also be performed. Limited intrusive investigations will consist of test pit excavations, direct-push probes, and horizontal drilling underneath trenches. The intrusive techniques will support nonintrusive method results by providing quantitative analytical data for discrete locations throughout the landfills.

When used in combination, these two methods provide a comprehensive characterization approach. For example, direct-push data will be collected to calibrate and complement geophysical data to provide better understanding of the lateral continuity of geologic layers, including the deployment of downhole geophones for the collection of check shot or vertical seismic profiling information. Lithologic logs from surrounding groundwater monitoring wells and directional wells will supplement this calibration. This combination of methods is targeted to find contamination in the vadose zone, including preferential pathways or fine-grained sediment layers that may be controlling downward movement of moisture and the potential migration of mobile contaminants through the vadose zone.

This chapter provides general background information about the 200-SW-2 OU, contaminants of potential concern (COPCs), and a summary of data quality objectives (DQOs) identified for the landfills. Subsequent chapters of this SAP present the quality assurance project plan (QAPjP), the field sampling plan (FSP), and the health and safety and waste management requirements.

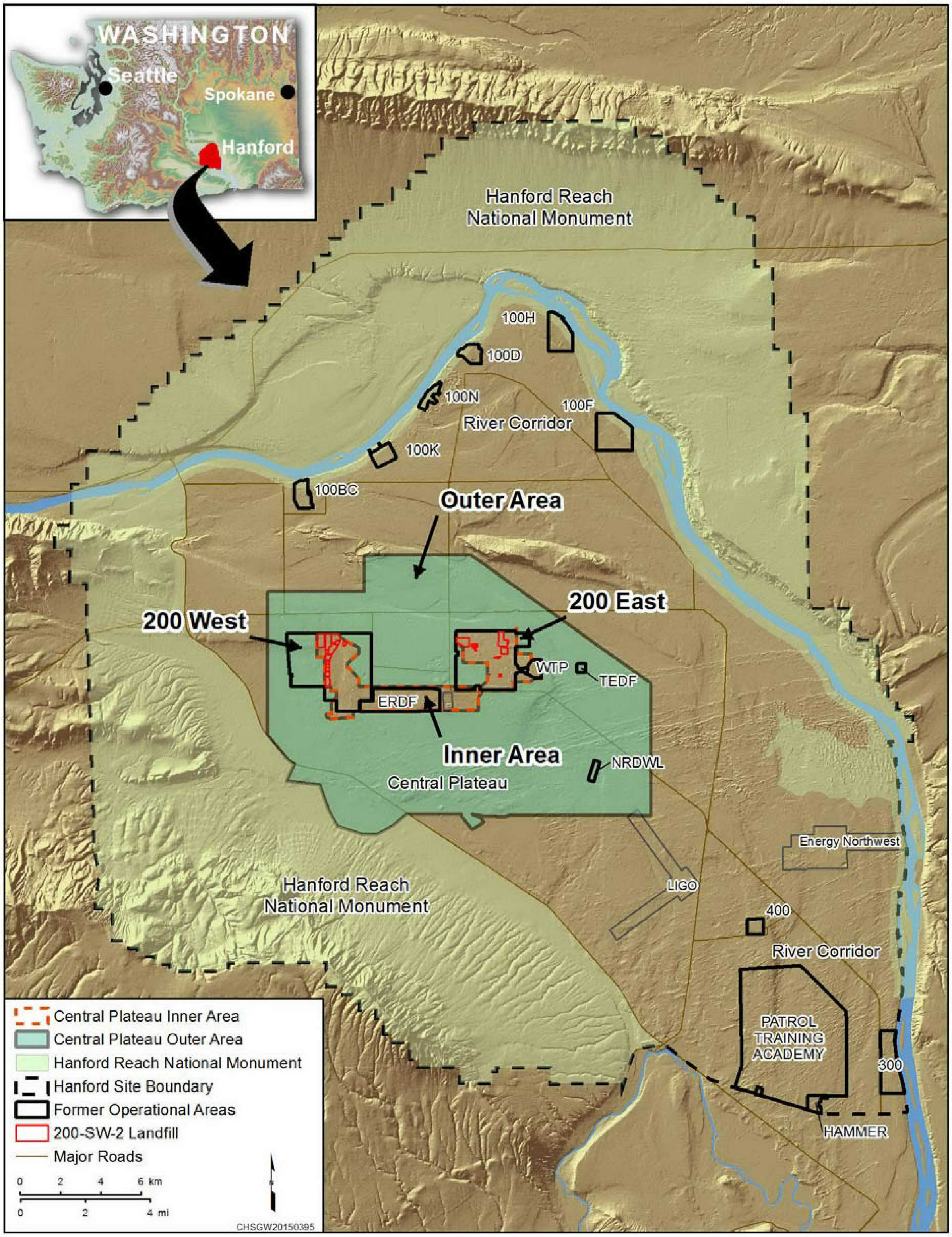

Figure A-1. Location of the 200-SW-2 OU Landfills and the Hanford Site

A1.1 Background

Because of the complexity of the 200-SW-2 OU landfills, characterization has proceeded in an iterative process, with the results from each phase supporting further refinement in data needs that are addressed during the next phase of the RI process. The initial investigation, which began in 2004, included a comprehensive review of existing documentation associated with the 200-SW-1 and 200-SW-2 OU waste sites. A large quantity of records was compiled and reviewed to focus future field characterization activities. In 2005, a collaborative negotiations process was held with the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology) (also known as the Tri-Parties). The negotiation is documented in CCN 0073214, "Path Forward 200-SW-1/2 RI/FS Work Plan Development." This process eventually rescoped the focus of the work plan from 127 waste sites in the 200-SW-1 and 200-SW-2 OUs to 24 landfills in the 200-SW-2 OU. The first DQO process (Phase I-A) for these landfills focused on nonintrusive investigations, including geophysical, radiological, and passive soil vapor samples.

After the Phase I-A field characterization activities were performed in mid-2006, a Phase I-B DQO process was performed to support development of an RFI/CMS/RI/FS work plan. The Phase I-B DQO and SAP focused on additional nonintrusive characterization as well as intrusive characterization techniques to complete the RI. The current proposed investigation described in this SAP builds on the previous Phase I-B DQO and SAP; however, this SAP more specifically addresses data gaps related to the risk pathway. This SAP also focuses on collecting data related to constituent mobility and investigating potential releases and their associated risks. The information gathered will be used to support risk assessments, further the refinement of the preliminary conceptual contaminant distribution models, and assist development and evaluation of remedial action alternatives.

A2 Waste Site Organization for SAP Implementation

The 200-SW-2 OU consists of 24 landfills located in the eastern inner and western inner Area of the Hanford Site. The OU also includes former ponds and ditches whose locations are collocated with the landfills. These are the 216-C-9 Pond, the 216-T-4A and 216-T-4B Ponds, and the 216-T-4-1 and 216-T-4-2 Ditches. All of these liquid disposal sites had dried and were stabilized before solid waste disposal took place.

The 200 Area is located near the center of the Hanford Site in south-central Washington State and is within one of three areas on the Hanford Site that are on the EPA National Priorities List under CERCLA (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List"). Chapter 2 of this 200-SW-2 OU RFI/CMS/RI/FS work plan provides additional details concerning each of these landfills.

The majority of waste disposed to the 200-SW-2 OU landfills originated from the processing facilities located in the eastern inner and western inner Areas. The 200-SW-2 OU landfills also contain some waste that originated from the Hanford Site 100 and 300 Areas, as well as from offsite sources.

A3 Project/Task Description

Characterization relies substantially upon nonintrusive characterization techniques, calibrated and augmented by intrusive techniques. This includes the application of historical records, borehole logging (nearby groundwater wells), nonintrusive assessment of caissons, and nonintrusive soil vapor and geophysical survey techniques. Intrusive methods include limited test pit excavations and sampling with direct push and/or directional drill rigs. The approach to COPCs and contaminants of potential ecological concern (COPECs) is described in Chapter 3 of this work plan. COPCs/COPECs include metals, volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs), and radionuclides. The COPC/COPEC list consists of contaminants that are readily detectable via standard soil sampling methods and analytical methods.

The overall 200-SW-2 OU project description is to complete the RFI/CMS/RI/FS and RCRA closure process for the 24 landfills and 5 ponds/ditches in the 200-SW-2 OU. As described in Chapter 4 of this work plan, a combination of intrusive and nonintrusive data collection techniques will be used. Nonintrusive activities, such as geophysical surveys, existing well logging, soil vapor samples, and remote inspection of caissons, will be accompanied by intrusive data collection.

A4 Data Quality Objective Summary

For this investigation, the basic statement of the problem remains the same as stated in SGW-33253, *Data Quality Objectives Summary Report for Phase I-B Characterization of the 200-SW-2 Operable Unit Landfills*; however, DQOs have been refined to address the objectives of the current investigation. The refined DQOs are summarized in Appendix J of this work plan.

A4.1 Statement of the Problem

The following is a list of problem statements from the DQO summary report (Appendix J):

1. Is there an unacceptable risk to human health and the environment posed by the waste in the 200-SW-2 OU landfills?
2. Are there complete pathways to human health and the environment?
3. Collect data to support the RFI/CMS/RI/FS and eventual selection of a remedial action alternative(s).
4. Collect sufficient data to support evaluation of the long-term effects of leaving the waste in place.

A4.2 Project Task and Problem Definition

The problem being addressed by this SAP is the need for investigation data for the 200-SW-2 OU landfills. These data will augment existing RI data compiled during past characterization activities, leading to completion of the RFI/CMS/RI/FS process for the 200-SW-2 OU landfills addressed in this work plan.

Chapter 1 of this work plan provides additional details on the problem definition and background.

A4.3 Decision Statements

The following is a list of decision statements from the DQO summary report (Appendix J):

1. Collect additional data to evaluate risk, pathways, and remedial alternatives.
2. Develop and select alternatives to break the complete pathways that create excess risk.
3. Develop and select alternatives that minimize or reduce long-term effects on human health and the environment above acceptable risk levels.

A4.4 Decision Rules

Table A-1 lists the decision rules from the DQO summary report (Appendix J).

Table A-1. 200-SW-2 OU Landfill Decision Rules

Principal Study Question	Decision Rule
1 What data are required to support evaluation of risk, pathways, and development of remedial action alternatives?	If the design of the RFI/CMS/RI/FS characterization approach was sufficient to support evaluation of risk, pathways, and development of remedial action alternatives, then perform the evaluation of risk and select the appropriate alternative; otherwise, additional data will need to be collected.
2 Was enough data collected to support the RFI/CMS/RI/FS and selection of remedial action alternatives?	If enough data were collected to support the RFI/CMS/RI/FS and select remedial action alternatives, then select the appropriate alternative; otherwise, additional data will need to be collected.
3 Was enough data collected to evaluate whether buried waste presents a long-term effect on human health and the environment?	If enough data were collected to evaluate whether buried waste presents a long-term effect on human health and the environment, then select the appropriate alternative; otherwise, additional data will need to be collected.

A5 Contaminants of Potential Concern

A set of radiological and organic COPCs that may be present in the 200-SW-2 OU landfills was developed based on the following information:

- 200 Area plant operations as identified in various DQO documents for the 200 Area OUs, including the 200-CW-1, 200-CS-1, 200-CW-5, 200-LW-1, 200-LW-2, 200-MW-1, 200-PW-1, 200-PW-2, 200-PW-4, 200-TW-1, and 200-TW-2 OUs
- The ecological risk assessment DQOs for the 200 Areas (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*; WMP-25493, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report-Phase II*); WMP-29253, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase III*)
- As discussed in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*

In order to ensure that contaminants from waste from other Hanford areas (e.g., 100 and 300 Areas) and offsite are represented, the COPC input list also included potential contaminants listed in the following information sources:

- Nonradiological constituents in containers with a "dangerous waste" flag set in the Solid Waste Information Tracking System (SWITS) for landfills that are within scope
- Radiological constituents listed in all containers in SWITS for in-scope landfills

- Nonradiological constituents listed in WAC 173-340-900, "Model Toxics Control Act—Cleanup," "Tables," Table 749-3 ("Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals")

The COPC input list consisted of over 800 potential contaminants. Radionuclides were eliminated from the list if they had short half-lives, were naturally occurring, or were produced only in minute quantities. Chemicals were eliminated if they were used in minute quantities, were nonhazardous, or are unable to exist in conditions in the landfills (i.e., exist in a gaseous state or naturally degrade very quickly). The final list of COPCs is presented in Table A-2.

Table A-2. 200-SW-2 OU Landfills COPC List

Radionuclides

Am-241	Cm-243	Eu-154	Ni-63	Pu-239-240	Tc-99	Th-232	U-233/234
C-14	Cm-244	Eu-155	Np-237	Pu-241	T-228	Th-234	U-235
Cs-137	Eu-152	I-129	Pu-238	Se-79	Th-230	H-3	U-238
Co-60				Sr-90			

Metals

Aluminum - Al	Bismuth – Bi	Copper – Cu	Molybdenum – Mo	Thallium – Tl
Antimony – Sb	Boron – B	Lead – Pb	Nickel – Ni	Uranium – U
Arsenic – As	Cadmium – Cd	Lithium – Li	Selenium – Se	Vanadium – V
Barium – Ba	Chromium – Cr	Manganese – Mn	Silver – Ag	Zinc – Zn
Beryllium – Be	Cobalt – Co	Mercury – Hg	Strontium – Sr	

Anions

Fluoride – F^-	Nitrate – NO_3^-	Sulfate – SO_4^{2-}	Phosphate – PO_4^{3-}
Nitrite – NO_2^-	Chloride – Cl^-	Bromide – Br^-	

Other

Ammonium – NH^{4+} (pH also to be measured)	Asbestos	Kerosene	Cyanide – CN^-

Volatile Organics

1,1,1-Trichloroethane	Acetonitrile	Methylene chloride
1,1,2,2-Tetrachloroethane	Benzene	n-Butyl alcohol (1-butanol)
1,1,1,2-Tetrachloroethane	Carbon disulfide	Tetrachloroethene
1,1,2-Trichloro-1,2,2- trifluoroethane	Carbon tetrachloride	Toluene
1,1,2-Trichloroethane	Chlorobenzene	trans-1,2-Dichloroethene
1,1-Dichloroethene	Chloroform	trans-1,3-Dichloropropene
1,1-Dichloroethane	cis-1,2-Dichloroethene	Trichloroethene
1,2-Dichloroethane	Diethyl ether	Trichlorofluoromethane
2-Butanone	Ethyl acetate	Vinyl chloride
2-Nitropropane	Ethylbenzene	Xylenes (total)

Table A-2. 200-SW-2 OU Landfills COPC List

4-Methyl-2-pentanone	Isobutanol		
Acetone	Methanol		
Semivolatile Organics			
1,2,4-Trichlorobenzene	Benzo(b)fluoranthene	Hexachloroethane	
2,4,5-Trichlorophenol	Benzo(k)fluoranthene	Indeno(1,2,3-d)pyrene	
2,4,6-Trichlorophenol	Bis(2-ethylhexyl)phthalate	Nitrobenzene	
2,4-Dinitrotoluene	Butylbenzylphthalate	N-nitroso-di-n-propylamine	
2-Chlorophenol	Chrysene	Naphthalene	
2-Ethoxyethanol	Cyclohexanone	n-Nitrosomorpholine	
2-Methylphenol (o-cresol)	Di-n-octylphthalate	o-Dichlorobenzene	
3+4-Methylphenol (m+p-cresol)	Fluoranthene	o-Nitrophenol	
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	Hexachlorobenzene	Pentachlorophenol	
Acenaphthene	Hexachlorobutadiene	Pyrene	
Benzo(a) anthracene	Di-n-butylphthalate	Pyridine	
Benzo(a)pyrene	Dibenz(a,h)anthracene	Tributyl phosphate	
Pesticides			
4-4'-DDD	Alpha-BHC	Gamma-BHC (Lindane)	Endrin
4-4'-DDE	Beta-BHC	Chlordane	Heptachlor
4-4'-DDT	Delta-BHC	Dieldrin	Heptachlor epoxide
Aldrin			
Aroclors (Polychlorinated Biphenyls)			
Aroclor 1016	Aroclor 1232	Aroclor 1248	Aroclor 1260
Aroclor 1221	Aroclor 1242	Aroclor 1254	

A5.1 Project Schedule

Submittal to Ecology of the RFI/CMS/RI/FS work plan for the 200-SW-2 OU landfills by March 31, 2015, will comply with the Tri-Party Agreement (TPA) (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*) Milestone M-015-93A. The proposed plan for the Solid Waste Landfills will be submitted to Ecology 5½ years after receiving the notice to proceed (Milestone M-015-93B) on landfill characterization. Further information regarding the project schedule can be found in Chapter 6 of this work plan.

A6 Quality Assurance Project Plan

A QAPjP establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis and data review. This QAPjP complies with requirements from the following documents:

- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5)
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD)

This chapter describes the applicable quality requirements and controls. Sections 6.5 and 7.8 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan* (hereafter referred to as the TPA Action Plan) require the quality assurance (QA)/quality control (QC) and sampling and analysis activities to specify the QA requirements for treatment, storage, and disposal units, as well as for past-practice processes. Therefore, this QAPjP follows the QA elements of EPA/240/B-01/003. This QAPjP also demonstrates conformance to Ecology Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies*; and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans* (EPA QA/G-5). This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to Hanford Site OU groundwater monitoring activities: project management, data generation and acquisition, assessment and oversight, and data review and usability.

A6.1 Project Management

This section addresses the basic aspects of project management, to ensure that project roles and responsibilities are understood, and describes the quality specifications, training, and management of project documents.

A6.1.1 Project/Task Organization

The contractor, or its approved subcontractor, is responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The project organization (in regard to sampling and characterization) is described in the following sections and is shown graphically in Figure A-2.

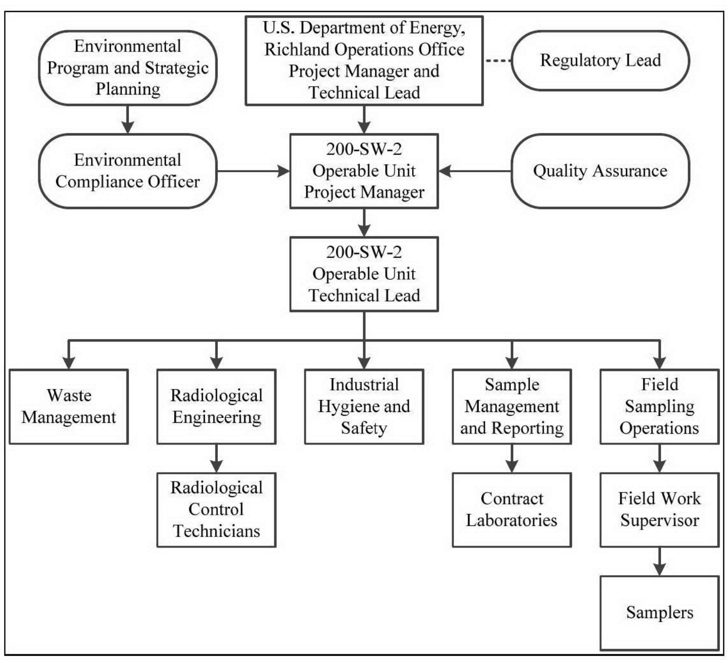

Figure A-2. 200-SW-2 OU Project Organization

A6.1.1.1 Regulatory Lead

Ecology is responsible for regulatory oversight of cleanup projects and activities. Ecology, as lead regulatory agency for the 200-SW-2 OU, has approval authority for work being performed under this SAP. The lead regulatory agency will work with the DOE Richland Operations Office (DOE-RL) to resolve concerns over the work described in this SAP in accordance with the TPA (Ecology et al., 1989a).

A6.1.1.2 DOE-RL Project Manager

DOE is responsible for Hanford Site cleanup. The DOE-RL Project Manager is responsible for monitoring the contractor's performance of activities under CERCLA, RCRA, the *Atomic Energy Act of 1954*, and the TPA (Ecology et al., 1989a) for the Hanford Site. The DOE-RL Project Manager is also responsible for obtaining lead regulatory agency approval of the SAP authorizing the field sampling activities.

A6.1.1.3 DOE-RL Technical Lead

The DOE-RL Technical Lead is responsible for providing day-to-day oversight of the contractor's work scope performance, working with the contractor and regulatory agencies to identify and resolve technical issues, and providing technical input to the DOE-RL Project Manager.

A6.1.1.4 200-SW-2 Operable Unit Project Manager

The 200-SW-2 OU Project Manager is responsible and accountable for project-related activities and coordinates with DOE-RL, regulators, and contractor management in support of sampling activities. Support is provided to the 200-SW-2 OU Technical Lead to ensure that work is performed safely and cost effectively. The 200-SW-2 OU Project Manager (or designee) is responsible for managing sampling documents and requirements, field activities, and subcontracted tasks and ensuring that the project file is properly maintained. The 200-SW-2 OU Project Manager is responsible for ensuring that project personnel are working to the current version of the SAP. The 200-SW-2 OU Project Manager ensures that sampling design requirements are converted into field instructions providing specific direction for all field activities. The 200-SW-2 OU Project Manager works closely with the Environmental Compliance Officer (ECO), QA, Health and Safety, the Field Work Supervisor (FWS), and the Sample Management and Reporting (SMR) organization to integrate these and other lead disciplines in planning and implementing the work scope. The 200-SW-2 OU Project Manager maintains a list of individuals or organizations filling each of the functional elements of the project organization.

A6.1.1.5 200-SW-2 Operable Unit Technical Lead

The 200-SW-2 OU Technical Lead is responsible for the development of specific sampling design, analytical requirements, and QC requirement, either independently or as defined through a systematic planning process. The 200-SW-2 OU Technical Lead ensures that sampling and analysis activities, as delegated by 200-SW2 OU Project Manager, are carried out in accordance with the SAP.

A6.1.1.6 Environmental Compliance Officer

The ECO, from the Environmental Program and Strategic Planning organization, provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The ECO also reviews plans, protocols, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues that affect operations and develops cost effective solutions; and responds to environmental/regulatory issues or concerns raised by DOE-RL and/or regulatory agencies. The ECO also oversees project implementation for compliance with applicable internal and external environmental requirements.

A6.1.1.7 Quality Assurance

The QA point of contact (POC) is matrixed from the QA organization to the 200-SW-2 OU Project Manager and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements, reviewing project documents (including DQO summary report, QAPjP, and SAP), reviewing data validation reports from third-party data validation contractors, and participating in QA assessments on sample collection and analysis activities, as appropriate.

A6.1.1.8 Industrial Hygiene and Safety

The Health and Safety organization responsibilities include coordinating industrial safety and health (industrial hygiene) support within the project, in accordance with the health and safety program, job hazard analyses, and other pertinent federal regulations. Health and Safety also assists project personnel in complying with the applicable health and safety program. The Health and Safety organization coordinates with Radiological Engineering to determine personal protective clothing requirements.

A6.1.1.9 Radiological Engineering

The Radiological Engineering organization is responsible for radiological engineering and health physics support within the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization. Radiological hazards are identified, and appropriate controls are implemented, to maintain worker exposures to hazards at ALARA levels. The Radiological Engineering interfaces with the project Health and Safety representative and other appropriate personnel, as needed, to plan and direct radiological control technician (RCT) support for activities.

A6.1.1.10 Sample Management and Reporting Organization

The SMR organization is responsible for interfacing between the project, the Field Sampling Operations (FSO), the Drilling and Well Maintenance Organization, and the analytical laboratories. The SMR organization generates field sampling documents, labels, and instructions for field sampling personnel; monitors the entire sample and data process; coordinates laboratory analytical work; and ensures that the laboratories conform to Hanford Site internal laboratory QA requirements (or their equivalent), as approved by the Tri-Parties. SMR resolves sample documentation deficiencies or issues associated with the FSO, laboratories, or other entities to ensure that project needs are met; receives the analytical data from the laboratories; performs data entry into the Hanford Environmental Information System (HEIS) database; and arranges for and oversees data validation. SMR is responsible for informing the 200-SW-2 OU Project Manager of any issues reported by the analytical laboratory. The SMR organization develops the sample authorization form (SAF), which provides information and instruction to the analytical laboratories, oversees data validation, and works with the 200-SW-2 OU Project Manager to prepare a characterization report on the sampling and analysis results. SMR also provides instructions to FSO samplers on the collection of samples, as specified in a SAP or monitoring plan.

A6.1.1.11 Analytical Laboratories

Onsite analytical laboratories and offsite contract laboratories analyze samples in accordance with established methods, provide data packages containing analytical and quality control results, and provide explanations in response to resolution of analytical issues. The laboratories must meet HASQARD (DOE/RL-96-68) QA requirements, must be on the Mission Support Alliance (MSA) Evaluated Suppliers List, and must be accredited by Ecology for the analyses performed for the Soil and Groundwater Remediation Project (S&GRP).

A6.1.1.12 Waste Management

Waste Management communicates policies and protocols and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost effective manner. Waste Management is also responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance; interpreting the characterization data to generate waste designations and profiles; and preparing and maintaining other documents confirming compliance with waste acceptance criteria.

A6.1.1.13 Field Work Supervisor

The FSO FWS is responsible for planning and coordinating field sampling resources. The FWS ensures that samplers are appropriately trained and available. Additional related responsibilities include ensuring that the sampling design is understood and can be performed as specified by directing training, performing mock-ups, and holding practice sessions with field personnel.

The FWS directs the samplers, who are nuclear chemical operators. The samplers collect groundwater, soil, vapor, and multimedia samples, including replicates/duplicates; collect field parameters; and prepare QC samples in accordance with the SAP, corresponding standard methods, and field and sample instructions. The samplers complete field logbook entries, chain-of-custody forms, and shipping paperwork and ensure delivery of the samples to the analytical laboratory.

The FWS acts as a technical interface between the 200-SW-2 OU Project Manager and the field crew supervisors (such as the Drilling Buyer's Technical Representative [BTR], and Geologist-BTR) and ensures that technical aspects of the field work will be met. The FWS reviews the SAP for field sample collection concerns, analytical requirements, and special sampling requirements. The FWS, in consultation with the 200-SW-2 OU Project Manager and SMR, resolves issues arising from translation of technical requirements to field operations and coordinates resolution of sampling issues.

A6.1.1.14 Well Drilling and Well Maintenance

The Well Drilling and Well Maintenance Manager has overall responsibility for planning, coordinating, and executing drilling construction and well maintenance activities. The Well Drilling and Well Maintenance Manager coordinates with the 200-SW-2 OU Project Manager to identify field constraints that could affect sampling design. The Well Activities Lead provides direction to the Geologist-BTR, who oversees the field geologist, and the Drilling BTR who oversees field construction activities and is responsible for daily interface with drilling and remediation subcontractors.

A6.1.2 Quality Objectives and Criteria

The QA objective of this plan is to ensure the generation of analytical data of known and appropriate quality that are acceptable and useful for decision making. In support of this objective, statistics and data descriptors, known as data quality indicators (DQIs), are used to determine the acceptability and utility of data to the user. The principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity and are defined for the purposes of this document in Table A-3.

Data quality is defined by the degree of stringency in the acceptance criteria assigned to these parameters. Typically, the acceptance criteria are set by the analytical method itself; however, project-specific requirements, as indicated by DQOs, may result in more stringent acceptance criteria. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during the data quality assessment (DQA) process.

Table A-3. Data Quality Indicators

DQI	Definition[a]	Determination Methodologies	Corrective Actions
Precision	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the relative percent difference.	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity). • Request reanalysis or remeasurement. • Qualify the data before use.
Accuracy	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. Quality control analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample).	If recovery does not meet objective: • Qualify the data before use. • Request reanalysis or remeasurement.
Representativeness	Sample representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring the approved plans were followed during sampling and analysis.	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	If results are not representative of the system sampled: • Identify the reason for them not being representative. • Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent. • Redefine sampling and measurement requirements and protocols • Resample and reanalyze.

Table A-3. Data Quality Indicators

DQI	Definition[a]	Determination Methodologies	Corrective Actions
Comparability	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and quality assurance protocols.	If data are not comparable to other data sets: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.
Completeness	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/acceptance criteria).	If data set does not meet completeness objective: • Identify appropriate changes to data collection and/or analysis methods. • Identify quantifiable bias, if applicable. • Qualify the data as appropriate. • Resample and/or reanalyze if needed. • Revise sampling/analysis protocols to ensure future comparability.

Table A-3. Data Quality Indicators

DQI	Definition[a]	Determination Methodologies	Corrective Actions
Bias	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling pools. • Institute correct sampling and subsampling procedures to limit preferential selection or loss of sample media. • Use random sampling designs. • Use sample handling procedures, including proper sample preservation, that limit the loss or gain of constituents to the sample media. Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other labs for analysis.
Sensitivity	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: • Request reanalysis or re-measurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*.

A6.1.3 Special Training/Certification

A graded approach is used to ensure that workers receive a level of training that is commensurate with responsibilities and complies with applicable DOE orders and government regulations. The FWS, in coordination with line management, will ensure that special training requirements for field personnel are met.

Typical training requirements or qualifications have been instituted by the contractor management team to meet training and qualification programs to satisfy multiple training drivers imposed by the applicable *Code of Federal Regulations* and *Washington Administrative Code* requirements. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. Field personnel typically have completed the following training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and supervised 24-hour hazardous waste site experience
- 8-Hour Hazardous Waste Worker Refresher Training (as required)
- Hanford General Employee Radiation Training
- Hanford General Employee Training
- Radiological Worker Training

Project-specific safety training, geared specifically to the project and the day's activity, will be provided. Project-specific training includes the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and required certifications for the type of sampling that is being performed in the field.
- Qualification requirements for RCTs are established by the Radiation Protection Program. The RCTs assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.
- Project personnel deploying passive or active soil vapor sampling devices will receive training in accordance with manufacturer's recommendations and methods for proper use of the equipment:
  - Geophysical methods (e.g., ground-penetrating radar [GPR], electromagnetic induction [EMI], total magnetic field [TMF], and borehole logging) will be subcontracted work. Subcontractors will be required to operate equipment in accordance with manufacturer recommendations and instructions, using or under the supervision of properly trained and qualified geologists or geophysicists. Documentation of training, qualifications, or other certifications will be maintained in the project files.
  - Direct-push activities will be subcontracted work. Subcontractors will be required to operate equipment in accordance with manufacturer's recommendations and instructions using properly trained and qualified personnel. Documentation of training, qualifications, or other certifications will be maintained in the project files.

- Horizontal boring activities will be subcontracted work. Subcontractors will be required to operate equipment in accordance with their standard operating methods using properly trained and qualified personnel. Documentation of training, qualifications, or other certifications will be maintained in the project files.
- Appropriately qualified onsite staff will perform excavation activities. Work will proceed in accordance with manufacturer's recommendations and instructions for proper use of equipment, using trained and qualified personnel. Documentation of training, qualifications, or other certifications will be maintained in the project files.

Pre-job briefings will be performed in accordance with work management and work release documents to evaluate an activity and associated hazards by considering the following various factors:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety protocols applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management will be used to confirm that an individual employee's training is appropriate and up-to-date prior to performing any field work.

A6.1.4 Documents and Records

The 200-SW-2 OU Project Manager is responsible for ensuring that the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Changes to the SAP are handled consistent with HASQARD (DOE/RL-96-68) and the TPA Action Plan (Ecology et al., 1989b). Table A-4 summarizes the changes that may be made and their documentation requirements.

The 200-SW-2 OU Project Manager is responsible for tracking all changes and obtaining appropriate reviews by contractor staff. The 200-SW-2 OU Project Manager will discuss the change with DOE-RL. DOE-RL will then discuss with the lead regulatory agency significant and fundamental changes, as described in Sections 9.3 and 12.4 of the TPA Action Plan (Ecology et al., 1989b). Appropriate documentation will follow in accordance with the requirements for the type of change.

Table A-4. Change Control for Sampling Projects

Type of Change[a]	Type of Change (TPA Action Plan[b])	Action	Documentation
Minor change: Change has no impact on the sample or field analytical result, and little or no impact on performance or cost. Further, the change does not affect the DQOs specified in the sampling and analysis plan.	**Minor field change:** Changes that have no adverse effect on the technical adequacy of the job or the work schedule.	The field personnel recognizing the need for a field change will consult with the 200-SW-2 OU Project Manager prior to implementing the field change.	Minor field changes will be documented in the field logbook. The logbook entry will include the field change, the reason for the field change, and the names and titles of those approving the field change.
Significant change: Change has a considerable effect on performance or cost, but still allow for meeting the DQOs specified in the sampling and analysis plan.	**Minor change:** Changes to approved plans that do not affect the overall intent of the plan or schedule.	The 200-SW-2 OU Project Manager will inform the DOE-RL Project Manager and the regulatory lead of the change and seek concurrence at a unit manager's meeting or comparable forum. The lead regulatory agency determines there is no need to revise the document.	Documentation of this change approval would be in the unit manager's meeting minutes or comparable record such as a change notice.[c]
Fundamental change: Change has significant effect on the sample or the field analytical result, performance, or cost, and the change does not meet the requirements specified in the DQOs in the sampling document.	**Revision necessary:** Lead regulatory agency determines changes to approved plans require revision to document.	If it is anticipated that a fundamental change will require the approval of the Regulatory Lead, the applicable DOE-RL Project Manager will be notified by the 200-SW-2 OU Project Manager and will be involved in the decision prior to implementation of a fundamental change The lead regulatory agency determines the change requires a revision to the document.	Formal revision of the sampling document.

a. Consistent with DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD).

b. Consistent with Sections 9.3 and 12.4 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*.

c. The TPA Action Plan, Section 9.3, defines the minimum elements of a change notice.

DOE-RL = U.S. Department of Energy-Richland Operations Office

DQO = data quality objective

OU = operable unit

TPA = Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*)

SMR, the FWS, and the appropriate BTR are responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. SMR will ensure that any deviations from the SAP are reflected in revised paperwork as applicable for the samplers and the analytical laboratory. The FWS or appropriate BTR will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective action protocols.

The 200-SW-2 OU Project Manager, FWS, or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

The 200-SW-2 OU Project Manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The project file will include the following items, as appropriate:

- Operational records and logbooks
- Data forms
- Global positioning system (GPS) data (a copy will be provided to SMR)
- Inspection or assessment reports and corrective action reports
- Borehole summary reports
- Interim progress reports
- Final reports
- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract
- The following records are managed and maintained by SMR personnel:
  - Field sampling logbooks
  - Groundwater sample reports and field sample reports
  - Chain-of-custody forms
  - Sample receipt records
  - Laboratory data packages
  - Analytical data verification and validation reports
  - Analytical data "case file purges" (i.e., raw data purged from laboratory files) provided by offsite analytical laboratories

The laboratory is responsible for maintaining, and having available upon request, the following items:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

A6.2 Data Generation and Acquisition

The following subsections present the requirements for analytical methods, measurement and analysis, data collection or generation, data handling, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed. The sampling design is presented in the FSP of this SAP.

A6.2.1 Analytical Methods Requirements

Analytical performance requirements for passive soil vapor samples are included in Table A-5. Analytical performance requirements for active soil vapor samples are shown in Table A-6. Analytical method performance requirements for samples collected are presented in Table A-7. Laboratory operations and analytical services will comply with HASQARD (DOE/RL-96-68). Project-specific criteria identified in Table A-7 may be more stringent than criteria specified in the HASQARD, in which case Table A-7 takes precedence over similar criteria in HASQARD. In consultation with the laboratory and the 200-SW-2 OU Project Manager, SMR can approve changes to analytical methods as long as the new method is based upon a nationally recognized standard method (e.g., EPA and American Society for Testing and Materials [ASTM]) and as long as the new method delivers analytical data that are comparable to those provided by the old method. The new method will achieve project DQOs, as well as or better than the replaced method, and is required due to the nature of the sample (e.g., high radioactivity). The laboratory using the new method must be accredited by Ecology to perform that method.

The laboratory using nonstandard methods, if any, must provide method validation data to confirm that the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Approval of the SAP by a regulatory agency constitutes approval of the nonstandard method.

Deviations from the analytical methods noted in Table A-7 must be approved in accordance with Table A-4 and in accordance with HASQARD (DOE/RL-96-68). The SMR organization, in consultation with the 200-SW-2 OU Project Manager, will take the lead in ensuring that deviations from the analytical methods noted in Table A-7 are properly approved.

Issues that may affect analytical results are to be resolved by SMR in coordination with the 200-SW-2 OU Project Manager.

A6.2.2 Field Analytical Methods

Chemical field screening and radiological field survey data used for site characteristics will be performed in accordance with approved methods and with applicable HASQARD (DOE/RL-96-68). Field analytical methods may also be performed in accordance with the manufacturer manuals.

A6.2.3 Quality Control

QC requirements specified in the SAP must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC sample requirements are summarized in Table A-8.

Failure of a QC measure will be determined and evaluated during data validation and DQA processes. Data will be qualified and flagged in HEIS, as appropriate.

Table A-5. Analytical Performance Requirements for Passive Soil Vapor Samples

Analytical Parameter	Collection Device and Method	Target Detection Limit	Accuracy (%)	Precision (%)
Laboratory Analysis				
Organic vapors (VOCs per manufacturers' specifications)	Passive soil vapor (BESURE or GORE-SORBER)[a], EPA Method 8260B[b]	10 ng/sample	+/-25	70 – 130

a. BESURE® is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland. GORE-SORBER™ is a trademark of W.L. Gore and Associates, San Francisco, California.

b. EPA Method 8260B (uses gas chromatography/mass spectrometry) is found in SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*.

EPA = U.S. Environmental Protection Agency

ng = nanogram

VOC = volatile organic compound

Table A-6. Analytical Performance Requirements for Active Soil Vapor Samples (EPA Method TO-15)

CAS Number	Analyte	Estimated Quantitation Limit	Accuracy (%)	Precision (%)
71-55-6	1,1,1-Trichloroethane	0.2 ppb (v/v)	+/-25	70 to 130
75-35-4	1,1-Dichloroethene	0.2 ppb (v/v)	+/-25	70 to 130
107-06-2	1,2-Dichloroethane	0.2 ppb (v/v)	+/-25	70 to 130
67-64-1	Acetone	0.2 ppb (v/v)	+/-25	70 to 130
71-43-2	Benzene	0.2 ppb (v/v)	+/-25	70 to 130
56-23-5	Carbon tetrachloride	0.2 ppb (v/v)	+/-25	70 to 130
67-66-3	Chloroform	0.2 ppb (v/v)	+/-25	70 to 130
124-48-1	Dibromochloromethane	0.2 ppb (v/v)	+/-25	70 to 130
75-09-2	Methylene chloride	0.2 ppb (v/v)	+/-25	70 to 130
79-01-6	Trichloroethene	0.2 ppb (v/v)	+/-25	70 to 130
75-01-4	Vinyl chloride	0.2 ppb (v/v)	+/-25	70 to 130

Note: EPA Compendium Method TO-15 is found in EPA/625/R-96/010b, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air*.

CAS = Chemical Abstracts Service

EPA = U.S. Environmental Protection Agency

ppb (v/v) = parts per billion, volume to volume

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

			Preliminary Screening Levels[a]						
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Field Measurements									
—	Gross gamma	pCi/g	10	—	—	—	Portable sodium iodide detector	≤50	—[c]
12587-46-1	Gross alpha	dpm/ 100 cm^2	100	—	—	—	Portable contamination detector	≤50	—[c]
12587-47-2	Gross beta	dpm/ 100 cm^2	5,000	—	—	—	Portable contamination detector	≤50	—[c]
Performance Requirements for Laboratory Measurements (Radiological)									
14596-10-2	Americium-241	pCi/g	1	942	—	3,890	AEA	≤30	70-130
14762-75-5	Carbon-14	pCi/g	2	1,600,000	—	4,760	LSC	≤30	70-130
10045-97-3	Cesium-137[d]	pCi/g	0.1	18	—	20.8	GEA	≤30	70-130
10198-40-0	Cobalt-60[d]	pCi/g	0.05	9.4	—	692	GEA	≤30	70-130
15757-87-6	Curium-243	pCi/g	—	105	—	--	AEA	≤30[d]	70-130[d]
13981-15-2	Curium-244	pCi/g	1	7,200	—	4,060	AEA	≤30[d]	70-130[d]
14683-23-9	Europium-152	pCi/g	0.1	12	—	1,520	GEA	≤30	70-130
15585-10-1	Europium-154	pCi/g	0.1	13	—	1,290	GEA	≤30	70-130
14391-16-3	Europium-155	pCi/g	0.1	966	—	15,800	GEA	≤30	70-130
15046-84-1	Iodine-129	pCi/g	2	1,943	—	—	GEA	≤30	70-130
13994-20-2	Neptunium-237	pCi/g	1	42	—	3,860	AEA	≤30[d]	70-130[d]

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

			Preliminary Screening Levels[a]						
CAS Number	**Analyte**	**Units**	**Estimated Quantitation Limit**	**Direct Exposure***	**Groundwater Protection****	**Ecological Protection*****	**Analytical Method[b]**	**Precision Requirement (%)**	**Accuracy Requirement (%)**
13981-37-8	Nickel-63	pCi/g	10	1,100,000	—	--	LSC	≤30[d]	70-130[d]
13981-16-3	Plutonium-238	pCi/g	1	3,370	—	5,270	AEA	≤30	70-130
PU-239/240	Plutonium-239/240	pCi/g	1	2,906	—	6,110	AEA	≤30	70-130
14119-32-5	Plutonium-241	pCi/g	15	31,100	—	—	LSC	≤30	70-130
15758-45-9	Selenium-79	pCi/g	10	—	—	—	GEA	≤30[d]	70-130[d]
10098-97-2	Strontium-90[d]	pCi/g	1	1,968	—	22.5	GFPC	≤30	70-130
14133-76-7	Technetium-99[d]	pCi/g	1.5	165,700	—	4,490	LSC	≤30[d]	70-130[d]
14274-82-9	Thorium-228	pCi/g	1	40	—	—	GEA	≤30[d]	70-130[d]
14269-63-7	Thorium-230	pCi/g	1	12	—	—	GEA	≤30d	70-130[d]
TH-232	Thorium-232	pCi/g	0.43	2.7	—	1,150	GEA	≤30[d]	70-130[d]
15065-10-8	Thorium-234	pCi/g	1	—	—	--	GEA	≤30[d]	70-130[d]
10028-17-8	Tritium	pCi/g	30	49,800	—	174,000	LSC	≤30[d]	70-130[d]
U-233/234	Uranium-233/234	pCi/g	1	1,757	—	5,130	AEA	≤30[d]	70-130[d]
15117-96-1	Uranium-235	pCi/g	1	61	—	2,770	AEA	≤30[d]	70-130
U-238	Uranium-238	pCi/g	1	283	—	1,580	AEA	≤30[d]	70-130
Performance Requirements for Laboratory Measurements (Nonradiological)									
24959-67-9	Bromide	mg/kg	12.5	—	—	—	EPA 300.0 (anions by IC)	≤30[e]	70-130[e]

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

Preliminary Screening Levels[a]									
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
16887-00-6	Chloride	mg/kg	55	—	1,000	100	—	—	—
16984-48-8	Fluoride[h]	mg/kg	25	210,000	2,880	2.8	—	—	—
NO3-N	Nitrate (as N)	mg/kg	12.5	5,600,000	40	52	—	—	—
NO2-N	Nitrite (as N)[h]	mg/kg	12.5	350,000	4.0	52	—	—	—
14265-44-2	Phosphate[h]	mg/kg	25	—	—	0.79	—	—	—
14808-79-8	Sulfate	mg/kg	27.5	—	1,000	237	—	—	—
6684-80-6	Ammonium	mg/kg	0.5	—	—	9.23	Ammonia method	≤30[e]	70-130[e]
57-12-5	Cyanide	mg/kg	1	2,100	0.97	—	EPA 9010 or 9012	≤30[e]	70-130[e]
—	Asbestos	—	—	—	—	—	PLM – NIOSH 9002	—	—
TPHKERO SENE	Kerosene	mg/kg	5	—	—	—	TPH-diesel	≤30	70-130
7429-90-5	Aluminum	mg/kg	5	3.5E+06	480,000	11,800	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30[e]	70-130[e]
7440-36-0	Antimony	mg/kg	1.2	1,400	5.4	5	—	—	—
7440-38-2	Arsenic[h]	mg/kg	10	88	0.034	10	—	—	—
7440-39-3	Barium	mg/kg	2	700,000	1,650	132	—	—	—
7440-41-7	Beryllium	mg/kg	0.5	7,000	63	10	—	—	—
7440-69-9	Bismuth	mg/kg	10	—	—	—	—	—	—

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

CAS Number	Analyte	Units	Preliminary Screening Levels[a] Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7440-42-8	Boron	mg/kg	0.5	700,000	205	3.62	—	—	—
7440-43-9	Cadmium	mg/kg	0.5	3,500	0.69	0.81	—	—	—
7440-47-3	Chromium (total)	mg/kg	1	5.25E+06	2,000	18.5	—	—	—
7440-48-4	Cobalt	mg/kg	2	1,050	4.3	15.7	—	—	—
7440-50-8	Copper	mg/kg	0.8	140,000	284	28	—	—	—
7439-92-1	Lead[f]	mg/kg	5	1,000	3,000	11	—	—	—
7439-93-2	Lithium	mg/kg	2.5	7,000	192	33.5	—	—	—
7439-96-5	Manganese	mg/kg	5	490,000	501	512	—	—	—
7439-98-7	Molybdenum	mg/kg	2	17,500	32	6	—	—	—
7440-02-0	Nickel	mg/kg	4	70,000	130	30	—	—	—
7782-49-2	Selenium[g]	mg/kg	10	17,500	5.2	0.78	—	—	—
7440-22-4	Silver	mg/kg	1	17,500	14	2	—	—	—
7440-24-6	Strontium	mg/kg	1	2.1E+06	6,760	—	—	—	—
7440-28-0	Thallium[g]	mg/kg	5	—	0.71	1	—	—	—
7440-61-1	Uranium	mg/kg	1.5	10,500	270	100	—	—	—
7440-62-2	Vanadium	mg/kg	2.5	17,500	1,600	85.1	—	—	—
7440-66-6	Zinc	mg/kg	1	1.05E+06	5,970	67.8	—	—	—

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

			Preliminary Screening Levels[a]						
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
7439-97-6	Mercury	mg/kg	0.2	1,050	2.1	0.33	EPA 7471 (Mercury by Cold Vapor) or 200.8 (ICP/MS)	≤30[e]	70-130[e]
72-54-8	4,4'-DDD	mg/kg	0.0033	547	0.34	—	EPA 8081 (Pesticides)	≤30[i]	70-130[i]
72-55-9	4,4'-DDE	mg/kg	0.0033	386	0.45	0.021	—	—	—
50-29-3	4,4'-DDT	mg/kg	0.0033	386	3.5	0.021	—	—	—
309-00-2	Aldrin	mg/kg	0.00165	7.7	0.0025	0.1	—	—	—
319-84-6	Alpha-BHC[h]	mg/kg	0.00165	21	5.4E-04	—	—	—	—
319-85-7	Beta-BHC	mg/kg	0.00165	73	0.0023	6	—	—	—
57-74-9	Chlordane	mg/kg	0.0165	375	0.26	1.0	—	—	—
319-86-8	Delta-BHC	mg/kg	0.00165	—	—	—	—	—	—
60-57-1	Dieldrin[h]	mg/kg	0.0033	8.2	0.0028	0.0049	—	—	—
1024-57-3	Heptachlor epoxide	mg/kg	0.00165	14	0.0080	—	—	—	—
11141-16-5	Aroclor 1232[h]	mg/kg	0.008	66	0.0038	0.65	EPA 8082 (Polychlorinated Biphenyls)	≤30[i]	70-130[i]
53469-21-9	Aroclor 1242	mg/kg	0.008	66	0.069	0.65	—	—	—
12672-29-6	Aroclor 1248	mg/kg	0.008	66	0.067	0.65	—	—	—
71-55-6	1,1,1-Trichloroethane	mg/kg	0.005	7.00E+06	1.6	—	EPA 8260 (Volatile Organic Compounds)	≤30[i]	70-130[i]

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

CAS Number	Analyte	Units	Estimated Quantitation Limit	Preliminary Screening Levels[a] Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
630-20-6	1,1,1,2-Tetrachloroethane	mg/kg	0.005	5,048	—	—	—	—	—
79-34-5	1,1,2,2-Tetrachloroethane[h]	mg/kg	0.005	656	0.0012	—	—	—	—
76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	mg/kg	0.01	—	—	—	—	—	—
79-00-5	1,1,2-Trichloroethane[h]	mg/kg	0.005	2,303	0.0043	—	—	—	—
75-34-3	1,1-Dichloroethane	mg/kg	0.01	23,026	0.042	—	—	—	—
75-35-4	1,1-Dichloroethene	mg/kg	0.01	175,000	0.050	—	—	—	—
107-06-2	1,2-Dichloroethane[h]	mg/kg	0.005	1,442	0.0023	—	—	—	—
78-93-3	2-Butanone	mg/kg	0.01	2.10E+06	20	—	—	—	—
79-46-9	2-Nitropropane	mg/kg	0.005	—	—	—	—	—	—
108-10-1	4-Methyl-2-pentanone	mg/kg	0.01	280,000	2.7	—	—	—	—
67-64-1	Acetone	mg/kg	0.02	3.15E+06	29	—	—	—	—
75-05-8	Acetonitrile	mg/kg	0.1	—	—	—	—	—	—
71-43-2	Benzene	mg/kg	0.005	2,386	0.0045	—	—	—	—
75-15-0	Carbon disulfide	mg/kg	0.005	350,000	5.7	—	—	—	—
56-23-5	Carbon tetrachloride	mg/kg	0.005	1,875	0.0058	—	—	—	—
108-90-7	Chlorobenzene	mg/kg	0.005	70,000	0.87	40	—	—	—
67-66-3	Chloroform	mg/kg	0.005	4,234	0.0075	—	—	—	—

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

Preliminary Screening Levels[a]									
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
159-59-2	cis-1,2-Dichloroethene	mg/kg	—	7,000	0.080	—	—	—	—
60-29-7	Diethyl ether	mg/kg	0.005	700,000	6.8	—	—	—	—
141-78-6	Ethyl acetate	mg/kg	5	3.15E+06	30	—	—	—	—
100-41-4	Ethylbenzene	mg/kg	0.005	11,932	0.034	—	—	—	—
78-83-1	Isobutanol	mg/kg	0.5	1,050,000	—	—	—	—	—
67-56-1	Methanol	mg/kg	1	1,750,000	16	—	—	—	—
75-09-2	Methylene chloride	mg/kg	0.005	21,000	0.022	—	—	—	—
71-36-3	n-Butyl alcohol (1-butanol)	mg/kg	0.1	350,000	—	—	—	—	—
127-18-4	Tetrachloroethene	mg/kg	0.005	21,000	0.053	—	—	—	—
108-88-3	Toluene	mg/kg	0.005	280,000	4.7	200	—	—	—
156-60-5	trans-1,2-Dichloroethene	mg/kg	0.005	70,000	0.54	—	—	—	—
10061-02-6	trans-1,3-Dichloropropene[h]	mg/kg	0.005	1,313	0.0025	—	—	—	—
79-01-6	Trichloroethene[h]	mg/kg	0.005	1,750	0.0036	—	—	—	—
75-69-4	Trichlorofluoromethane	mg/kg	0.01	1,050,000	28	—	—	—	—
75-01-4	Vinyl chloride[h]	mg/kg	0.01	182	3.80E-04	—	—	—	—
1330-20-7	Xylenes (total)	mg/kg	0.01	700,000	15	—	—	—	—
120-82-1	1,2,4-Trichlorobenzene[h]	mg/kg	0.33	4,526	0.056	—	EPA 8270 (Semivolatile Organic Compounds)	≤30[i]	70-130[i]

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

Preliminary Screening Levels[a]									
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
95-95-4	2,4,5-Trichlorophenol	mg/kg	0.33	350,000	29	—	—	—	—
88-06-2	2,4,6-Trichlorophenol	mg/kg	0.33	3,500	0.046	—	—	—	—
121-14-2	2,4-Dinitrotoluene[h]	mg/kg	0.33	423	0.0017	—	—	—	—
95-57-8	2-Chlorophenol	mg/kg	0.33	17,500	0.47	—	—	—	—
110-80-5	2-Ethoxyethanol	µg/kg	—	—	—	—	—	—	—
95-48-7	2-Methylphenol (o-cresol)	mg/kg	0.33	175,000	2.3	—	—	—	—
65794-96-9	3+4 Methylphenol (m+p-cresol)	mg/kg	0.33	—	—	—	—	—	—
59-50-7	4-Chloro-3-methylphenol	mg/kg	0.33	350,000	22	—	—	—	—
83-32-9	Acenaphthene	mg/kg	0.33	210,000	98	20	—	—	—
56-55-3	Benzo(a)anthracene	mg/kg	0.33	180	0.86	1.1	—	—	—
50-32-8	Benzo(a)pyrene[h]	mg/kg	0.33	18	0.23	1.1	—	—	—
205-99-2	Benzo(b)fluoranthene	mg/kg	0.33	180	2.9	1.1	—	—	—
207-08-9	Benzo(k)fluoranthene	mg/kg	0.33	180	2.9	1.1	—	—	—
117-81-7	Bis(2-ethylhexyl)phthalate	mg/kg	0.33	9,375	13	100	—	—	—
85-68-7	Butylbenzyl phthalate	mg/kg	0.33	69,079	13	—	—	—	—
218-01-9	Chrysene	mg/kg	0.33	1,798	9.5	1.1	—	—	—
108-94-1	Cyclohexanone	mg/kg	0.33	1.75E+07	—	—	—	—	—

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

Preliminary Screening Levels[a]									
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
53-70-3	Dibenz[a,h]anthracene	mg/kg	0.33	180	4.3	1.1	—	—	—
84-74-2	Di-n-butylphthalate	mg/kg	0.33	350,000	57	—	—	—	—
117-84-0	Di-n-octylphthalate	mg/kg	0.33	42,000	319,000	—	—	—	—
206-44-0	Fluoranthene	mg/kg	0.33	140,000	631	1.1	—	—	—
118-74-1	Hexachlorobenzeneh	mg/kg	0.33	82	0.088	—	—	—	—
87-68-3	Hexachlorobutadiene	mg/kg	0.33	1,683	0.60	—	—	—	—
67-72-1	Hexachloroethane	mg/kg	0.005	2,450	0.044	—	—	—	—
193-39-5	Indeno(1,2,3-cd)pyrene	mg/kg	0.33	180	8.3	1.1	—	—	—
91-20-3	Naphthalene	mg/kg	0.33	70,000	4.5	29	—	—	—
98-95-3	Nitrobenzene[h]	mg/kg	0.33	7,000	0.10	—	—	—	—
621-64-7	N-Nitroso-di-n-dipropylamine[h]	mg/kg	0.33	19	5.60E-05	—	—	—	—
59-89-2	n-Nitrosomorpholine	mg/kg	0.33	20	—	—	—	—	—
95-50-1	o-Dichlorobenzene	mg/kg	0.33	3.15E+05	7.0	—	—	—	—
88-75--5	o-Nitrophenol	mg/kg	—	—	—	—	—	—	—
87-86-5	Pentachlorophenol[h]	mg/kg	0.33	328	0.0035	—	—	—	—
129-00-0	Pyrene	mg/kg	0.04	105,000	655	1.1	—	—	—
110-86-1	Pyridine	mg/kg	0.005	3,500	—	—	—	—	—

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

			Preliminary Screening Levels[a]						
CAS Number	**Analyte**	**Units**	**Estimated Quantitation Limit**	**Direct Exposure***	**Groundwater Protection****	**Ecological Protection*****	**Analytical Method[b]**	**Precision Requirement (%)**	**Accuracy Requirement (%)**
126-73-8	Tributyl phosphate[h]	mg/kg	3.3	14,583	0.50	—	—	—	—

Sources:

* ECF-HANFORD-10-0453, *Calculation of Standard Method C Direct Contact Soil Cleanup Levels for Industrial Land Use for the 100 Areas and 300 Area Remedial Investigation/Feasibility Study Reports* (Table 7-1, "Summary of WAC 173-340-745 Standard Method C Industrial Soil Direct Contact Cleanup Levels"), and ECF-HANFORD-10-0452, *Calculation of Radiological Preliminary Remediation Goals in Soil for an Industrial Worker Exposure Scenario for the 100 Areas and 300 Area Remedial Investigation/Feasibility Study Reports* (Table 7-1, "Summary of Preliminary Remediation Goals for the 100 Areas and 300 Area Industrial Worker Exposure Scenario").

** ECF-HANFORD-10-0442, *Calculation of Nonradiological Soil Concentrations Protective of Groundwater Using the Fixed Parameter 3-Phase Equilibrium Partitioning Equation for the 100 Areas and 300 Area* (Table 7-1, "Soil Concentrations Protective of Groundwater Calculated Using the Fixed Parameter 3-Phase Partitioning Model").

*** CHPRC-00784, *Tier 1 Risk-Based Soil Concentrations Protective of Ecological Receptors at the Hanford Site* (Table 6-1, "Summary of Generic Screening Levels in Soil").

a. Unless otherwise noted, preliminary cleanup goals are established in WAC 173-340, "Model Toxics Control Act—Cleanup."

b. Equivalent methods may be substituted. For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA-600/R-94/111, *Methods for the Determination of Metals in Environmental Samples Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*.

c. Field measurements have no specific quality control requirement for accuracy except to perform checks to verify manufacturer's expected performance.

d. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis methods, additional accuracy criteria include analysis-specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

e. Accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. Based on Method A Soil Cleanup Levels for Industrial Properties from WAC 173-340-900, "Tables," Table 745-1, amended October 12, 2007.

g. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.

h. Calculated preliminary cleanup goal values are less than the established analytical methodology capabilities. The analytical detection limits will be used as working levels and will be periodically reviewed to establish whether lower detection limit capabilities have become available.

Table A-7. Analytical Performance Requirements for 200-SW-2 OU Landfill Sampling

			Preliminary Screening Levels[a]						
CAS Number	Analyte	Units	Estimated Quantitation Limit	Direct Exposure*	Groundwater Protection**	Ecological Protection***	Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)

i. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846, Method 8260.

-- = not available

CAS = Chemical Abstracts Service

EPA = U.S. Environmental Protection Agency

GEA = gamma energy analysis

GFPC = gas flow proportional counting

ICP = inductively coupled plasma

LSC = liquid scintillation counter

MS = mass spectrometer

NIOSH = National Institute for Occupational Safety and Health

TPH = total petroleum hydrocarbon (determination method in Washington and Oregon)

PLM = polarized light microscopy

Table A-8. 200-SW-2 OU Project Quality Control Requirements

Sample Type	Frequency	Characteristics Evaluated
Field Quality Control		
Field duplicates	One for every 20 samples maximum of each media sampled (well trips or soil samples[a]).	Precision, including sampling and analytical variability.
Field splits	As needed. When needed, the minimum is one for every analytical method, for each media sampled, for analyses performed where detection limit and precision and accuracy criteria have been defined in the analytical performance requirements table.	Precision, including sampling, analytical, and interlaboratory.
Full trip blanks	One for every 20 samples for each media sampled.	Contamination from containers or transportation.
Field transfer blanks	One each day VOCs sampled for each media sampled (wells or boreholes).	Contamination from sampling site.
Equipment blanks	As needed. If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment blank is not required. Otherwise, 1 for every 20 samples for each media.[b,c]	Adequacy of sampling equipment decontamination and contamination from nondedicated equipment.
Laboratory Quality Control[d]		
Method blanks	[e]	Laboratory contamination
Laboratory duplicates	[e]	Laboratory precision
Matrix spikes	[e]	Matrix effect/laboratory accuracy
Matrix spike duplicates	[e]	Laboratory accuracy and precision
Surrogates	[e]	Recovery/yield
Tracers	[e]	Recovery/yield
Laboratory control samples	One for every batch[d]	Evaluate laboratory accuracy
Performance evaluation programs[f]	Annual	Evaluate laboratory accuracy
Double-blind standards	Quarterly[g]	Evaluate laboratory accuracy
Assessment	Annually[h] or every 3 years[i]	Evaluate overall laboratory performance and operations

Table A-8. 200-SW-2 OU Project Quality Control Requirements

Sample Type	Frequency	Characteristics Evaluated

a. Soil grab samples that are not representative of a specific depth interval or location may be exempted from duplicate sampling.

b. For portable Grundfos pumps, equipment blanks are collected 1 for every 10 well trips. Whenever a new type of nondedicated equipment is used, an equipment blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination methods for the nondedicated equipment.

c. Vendor provided borehole equipment is considered dedicated equipment and equipment blanks are not typically performed.

d. Batching across projects is allowed for similar matrices (e.g., all Hanford groundwater).

e. As defined in laboratory analysis methods.

f. Nationally recognized program, such as DOE Mixed Analyte Performance Evaluation Program or Environmental Resource Associates.

g. Water matrix double-blind standards are submitted quarterly. Soil matrix double-blind standards are submitted by request of Analytical Services.

h. DOE, 2011, *Quality Systems for Analytical Services*, requires annual assessment of commercial laboratories.

i. DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document*, does not define a frequency for assessment of onsite laboratories. Three-year evaluated supplier list requirement is typically applied.

DOE = U.S. Department of Energy

QA = quality assurance

QC = quality control

VOC = volatile organic compound

A6.2.3.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure that reliable data are obtained. Field QC samples include field duplicates, split samples, and three types of field blanks: full trip blanks (FTBs), field transfer blanks (FXRs), and equipment blanks (EBs). Field blanks are typically prepared using high-purity reagent water. QC samples and the required frequency for collection are described in this section.

Field Duplicates

Field duplicates (DUPs) are independent samples collected as close as possible to the same time and same location and are intended to be identical. DUPs are placed in separate sample containers, and analyzed independently. The DUPs are collected at a frequency of 1 in 20 samples, and should be collected generally from an area expected to have some contamination so valid comparisons between the samples can be made (i.e., some constituents that will likely be greater than their detection limit).

Soil DUPs will be collected and homogenized before dividing into two separate samples in the field. Volatile organic analysis (VOA) soil DUPs will be sampled as collocated samples, as described. DUPs will be stored and transported together and analyzed for the same constituents by the same laboratory. DUPs will be used to determine precision for both sampling and laboratory measurements.

- Collocated samples are two samples collected as close as possible to the same time and location, which are not homogenized. This sampling protocol is used when homogenizing samples for split or duplicate samples could affect the quality of data.

- DUPs must agree within 20 percent (for water samples) and 30 percent (for soil samples), as measured by the relative percent difference (RPD), to be acceptable. Only those DUPs with at least one result greater than five times the appropriate detection limit are evaluated. Large RPDs can be an indication of potential laboratory performance problems, filed sampling problems, or sample heterogeneity and should be investigated. DUP results not satisfying evaluation criteria will be qualified and flagged in HEIS, as appropriate.

A minimum of one soil field duplicate will be collected for each day of sampling. The duplicate should be collected generally from an area that is expected to have some contamination, so that valid comparisons between the samples can be made (i.e., at least some of the constituents will be above detection limit). When sampling is performed from a split-spoon, volatile organic samples and volatile organic duplicate samples are collected directly from the sampler. The remaining soil is then composited in a stainless steel mixing bowl. The soil sample and duplicate sample are collected from this composited material.

Field Splits

Field split samples (SPLITs) are two samples collected as close as possible to the same time and same location and are intended to be identical. Soil SPLITs for VOA will be sampled as collocated samples, as described earlier. SPLITs will be stored in separate containers and analyzed by different laboratories for the same or similar analytes. SPLITs are interlaboratory comparison samples used to evaluate comparability between laboratories. Large RPDs can be an indication of potential laboratory performance problems and should be investigated.

Full Trip Blanks

FTBs are prepared by the sampling team prior to traveling to the sampling site. The preserved bottle set is either for VOA only or identical to the set that will be collected in the field. It is filled with reagent water or silica sand, as appropriate, to the primary sample media. The bottles are sealed and will be transported, unopened, to the field in the same storage containers used for samples collected the same day. FTBs are typically analyzed for the same constituents as the samples from the associated sampling event. FTBs are used to evaluate potential contamination of the samples attributable to the sample bottles, preservative, handling, storage, and transportation.

Field Transfer Blanks

FXRs are preserved VOA sample vials filled at the sample collection site with reagent water or silica sand (as appropriate to the primary sample media) that has been transported to the field. The samples will be prepared during sampling to evaluate potential contamination attributable to field conditions. After collection, FXR sample vials will be sealed and placed in the same storage containers with the samples collected the same day for the associated sampling event. FXR samples will be analyzed for VOCs only.

A minimum of one field blank will be collected at each borehole where the samples will undergo VOA. FXR will consist of reagent water added to clean sample containers at the location where the VOC sample was collected.

Equipment Blanks

EBs consist of reagent water or silica sand (as appropriate to the primary sample media) passed through or poured over the decontaminated sampling equipment identical to the sample set that will be collected and placed in sample containers, as identified on the project SAF. EB sample bottles will be placed in the same storage containers with the samples from the associated sampling event. EB samples will be analyzed for the same constituents as the samples from the associated sampling event. EBs will be used to evaluate the effectiveness of the decontamination process.

EBs are collected from reusable sampling devices on a 1-in-20 basis and are not required for disposable sampling equipment.

For the field blanks (i.e., FTBs, FXRs, and EBs), results greater than two times the method detection limit (MDL) are identified as containing suspected contamination. However, for common laboratory contaminants, such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the MDL. For radiological analytical data, blank results are flagged if they are greater than two times the total minimum detectable activity.

A6.2.3.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks, matrix spikes, and laboratory control samples) are defined for the three-digit EPA methods (EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*) and for the four-digit EPA methods (SW-846), and will be run at the frequency specified in the respective reference unless superseded by agreement. Laboratory QC requirements are also specified in HASQARD (DOE/RL-96-68).

QC checks outside of control limits will be reflected in the narrative of the analytical report and during the DQA, if performed.

For inorganic, metals, and radiochemical analyses, QC acceptance criteria for laboratory duplicate samples, matrix spike samples, matrix spike duplicate samples, surrogate recoveries, and laboratory control samples are given in HASQARD (DOE/RL-96-68). For organic analyses, QC acceptance criteria are typically statistically derived from historical data at the laboratories in accordance with SW-846.

A6.2.4 Measurement Equipment

Each user of the measuring equipment is responsible to ensure that equipment is functioning as expected, properly handled, and properly calibrated at required frequencies in accordance with methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance will be recorded in accordance with approved methods. Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved methods.

A6.2.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM) or have been evaluated as acceptable and valid in accordance with the methods, requirements, and specifications. Software applications will be acceptance tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory directly affecting the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with maintenance requirements specified in HASQARD (DOE/RL-96-68) and with applicable Hanford Site requirements.

A6.2.6 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section A10.11 Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan and in accordance with HASQARD (DOE/RL-96-68).

A6.2.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured or acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

A6.2.8 Nondirect Measurements

Nondirect measurements include data obtained from sources, such as computer databases, programs, literature files, and historical databases. If evaluation includes use of such data, whenever possible, such data will be technically reviewed to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

Historical waste records and inventories of solid waste disposal that were used to focus characterization efforts for the 200-SW-2 OU landfills is discussed in Appendix K of this work plan.

A6.2.9 Data Management

Environmental data will be managed to ensure that integrity and quality of the data are preserved. Data processing activities will be controlled to ensure that the introduction of errors is minimized while environmental data are being collected, transferred, stored, analyzed, and reviewed. The SMR organization, in coordination with the 200-SW-2 OU Project Manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management methods. S&GRP data processing practices will include some or all of the following controls to avoid errors during data handling and manipulation:

- Perform periodic checks/reviews to ensure that data are not lost or incorrectly transcribed when transferred from one format to another.
- Minimize the number of data transfer steps and the number of personnel handling the data.
- Institute access control and accountability measures to protect hardcopy and electronic database files.

Electronic data access, when appropriate, will be through a Hanford Site database (e.g., HEIS) or a project-specific database, whichever is applicable for the data being stored. Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the TPA Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR organization on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and establish their resolution with the 200-SW-2 OU Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Further details on documentation of field activities are provided in Section A9.9 and will be prepared, reviewed, approved, and maintained according to prescribed processes.

A6.3 Assessment and Oversight

The elements in assessment and oversight address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

A6.3.1 Assessments and Response Actions

Random surveillances and assessments verify compliance with the requirements outlined in this SAP, project field instructions, project quality management plan, methods, and regulatory requirements. Assessments include, but are not limited to, surveillances, management systems reviews, readiness reviews, technical systems audits, performance evaluations, audits of data quality, and DQAs. Assessment processes, roles, and responsibilities will be in accordance with existing QA program methods and as directed jointly by the 200-SW-2 OU Project Manager and the QA POC. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies resolutions in accordance with the QA program, corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the 200-SW-2 OU Project Manager (or designee).

The 200-SW-2 OU Project Manager will determine whether a DQA will be performed for the activities identified in this SAP. The DQA process, if performed, is discussed in Section A6.4.3. The results of the DQA will be provided to the 200-SW-2 OU Project Manager. No other planned assessments have been identified. If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments would be performed.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor oversees offsite analytical laboratories and verifies the laboratories are qualified for performing Hanford Site analytical work.

A6.3.2 Reports to Management

Management will be made aware of deficiencies identified by self-assessments, corrective actions from ECOs, and findings from QA assessments and surveillances. Issues reported by the laboratories are communicated to the SMR organization, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and to establish resolution with the 200-SW-2 OU Project Manager.

A6.4 Data Review and Usability

This section addresses the QA activities that occur after the data collection phase of the project is completed. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives.

A6.4.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review will include linking sample numbers to specific sampling locations, reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times have been met, and reviewing QC data to determine whether analysis have met the data quality requirements specified in this SAP.

The criteria for verification include, but are not limited to, review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors.

Errors identified by the laboratories are reported to the SMR organization's project coordinator, who initiates a sample issue resolution form. This process is used to document analytical errors and establish resolution with the 200-SW-2 OU Project Manager.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance in making inferences regarding risk. Physical data and field QA/QC results will be reviewed to ensure that physical property data and/or field screening results are usable.

A6.4.2 Data Validation

Data validation activities will be based on EPA functional guidelines. Data validation is typically subcontracted to a party independent of the contractor. Data validation qualifiers must be compatible with the HEIS database.

Data validation is an independent assessment to ensure that the reliability of data is known. Analytical data validation provides a level of assurance that an analyte is present or absent. Validation might also include verification of instrument calibrations, evaluation of analytical results based upon method blanks, recovery of various internal standards, correctness of uncertainty calculations, correctness of identification and quantification of analytes, and the effect of quality deficiencies on the reliability of the data. Data validation will be in accordance with internal methods. The criteria for data validation are based on a graded approach, using five levels of validation; Levels A through E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data and calculations of representative samples from the data set). Data validation will be performed to Level C, which consists of a review of the QC data and specifically requires verification of deliverables, requested versus reported analytes, and qualification of the results based on evaluation of analytical holding times, method blank results, matrix spike/matrix spike duplicate results, surrogate recoveries, and duplicate sample results. Level C data validation will be performed on at least five percent of the data by matrix and analyte group. Analyte group refers to categories, such as radionuclides, volatile chemicals, semivolatiles, polychlorinated biphenyls, metals, and anions. The goal is to include each of the various analyte groups and matrices during the data validation process.

A6.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of DQA is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met.

- **Step 1 – Review Data Quality Objectives and Sampling Design:** This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO summary report and this SAP:
  - List any deviations from the planned sampling design.
  - Determine the potential effect of any deviations.

- **Step 2 – Conduct a Preliminary Data Review:** Identify, locate, and compile all information related to the sampling and analysis data being assessed including sample summary sheets, logbooks, chain-of-custody forms, field measurement data, laboratory analysis, field and laboratory QC samples and analysis results, flagged data, laboratory standards results, data validation reports, and various discrepancy or data reviewer reports. Perform basic statistical calculations (percentage of flagged data, percent of various QC parameters not meeting acceptance criteria, and percent of nondetects).

- **Step 3 – Conduct a Data Usability Assessment:** Summarize the usability of the data set as a whole and the quality of individual results as appropriate. Describe the usability in terms of the following DQIs:

  - **Precision**: Primarily from field duplicate data but also from laboratory QC.

  - **Accuracy/Bias:** Discuss evidence of field contamination and laboratory QC.

  - **Representativeness:** Discuss the extent to which the sampling design was accomplished and the representativeness of the samples and the design as a whole. Identify any specific measurements that are not representative of the target condition, explain why they are nonrepresentative, and discuss the impact to the data set.

  - **Comparability:** If multiple laboratories were used, or if this data set is intended to be combined with others, discuss the nature of differences that may limit the comparability.

  - **Completeness:** Discuss the accomplishment of all SAP-required data generating activities. This must include a comparison of samples actually collected versus those identified in the original sampling design. Comment on the impact to data set usability of any planned samples that were not taken. Although the third-party data validation report typically includes a completeness metric that relates to the percent of data that is not rejected, the third-party data validation report generally relates only to the fraction of the data set that was actually validated. Thus, it cannot be the only completeness evaluation of the data set in total.

  - **Sensitivity:** Discuss any laboratory data that do not meet the SAP-required reporting limits, and compare the results to any applicable decision thresholds, such as maximum contaminant levels and action levels.

    For radiochemical determinations, discuss the magnitude of the total propagated uncertainty to the reported activity value and to applicable decision thresholds. Discuss uses of data where total propagated uncertainty calculations are warranted.

    Describe the impacts of any deviations of the DQIs, as noted by data flags in terms of limitation of the use of the data set, or individual analytical results for the specific question to be answered.

- **Step 4 – Formulate Overall Conclusion as to Usability of Data Set:** Based upon the usability assessments in Step 3, develop an overall conclusion as to the usability of the entire data set for their intended purpose.

The DQA will be performed in accordance with the EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide* (EPA QA/G-9R), and EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners* (EPA QA/G-9S). The five steps identified for evaluating data generated from this project are summarized as follows:

- **Step 1 – Review Data Quality Objectives and Sampling Design:** This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO summary report and this SAP.

  As appropriate, complete the following actions:

  - Verify that the hypothesis or estimate chosen is consistent with the project's objective and meets project performance and acceptance criteria.
  - Translate study objectives into statistical terms.
  - List any deviations from the planned sampling design.
  - Determine the potential effect of any deviations.

- **Step 2 – Conduct a Preliminary Data Review:** Compare the actual QA/QC achieved (e.g., precision, accuracy, and completeness) and the requirements identified in this SAP. Document significant deviations in the final DQA report. Calculate the basic statistics from the analytical data and include an evaluation of the distribution of the data.

  As appropriate, make the following determinations:

  - Central tendency of the data (e.g., mean, median, and mode)
  - Relative standing of individual datum (e.g., percentiles and quantities)
  - Dispersion of the data (e.g., range, variance, and standard deviation)
  - Association, i.e., relationship between two or more variables, of the data (e.g., correlation coefficients)

  If appropriate, this information can be determined and/or displayed graphically.

- **Step 3 – Select the Data Analyses:** Select the appropriate statistical hypothesis tests or graphical data analyses and justify this selection.

  As appropriate, make the following determinations:

  - Null hypothesis
  - Alternative hypothesis
  - Statistic test (one sample t-test)
  - Critical value (regulatory threshold)
  - Conclusion

- **Step 4 – Verify the Assumptions:** Assess the validity of the data analyses (Step 3) by determining whether the data support the underlying assumptions necessary for the data analyses or the data set must be modified (e.g., transposed or augmented with additional data) before further analysis. This step is necessary because the validity of the selected method depends on the validity of key assumptions underlying the test.

As appropriate, make the following determinations:

- Assumptions required for data analyses test (e.g., independent data and approximate normal distribution)
- Whether data meet the assumptions

Assumptions might be determined qualitatively by reviewing the sampling plan, qualitatively inspecting the shape of a histogram, and quantitatively applying an appropriate test for distributions assumptions. If it is determined that one or more of the assumptions is not met, then an alternate plan is needed (selection of a different statistical method or collections of additional data).

- **Step 5 – Draw Conclusions from the Data:** Apply the statistical method selected in Step 3. Clearly document any calculations used.

  As appropriate, make the following determinations:

  - If the data reject the null hypothesis
  - If the data fail to reject the null hypothesis
  - Confidence interval (qualitatively or quantitatively)
  - Tolerance interval

A7 Field Sampling Plan

The FSP describes the field activities that will be used to collect data from field observations, surveys, laboratory analysis of samples, and other measurements. This section contains detail on the field placement and location of those data collection activities. Because a primary objective of this investigation is to fill specific gaps identified for individual waste sites, not all data collection techniques will be necessary at each or every landfill, and the execution of the field program can be altered as new information is obtained.

Tables and figures in this section propose site-specific sample locations wherever possible (see specific landfill plates for proposed sampling locations). Some locations in the 200-SW-2 OU landfills may not be accessible for sampling due to access restrictions (e.g., no-walk/no-drive zones) or conflicts with other related field operations. The approach and rationale for the data collection and this FSP are identified in Chapter 4 of this work plan. Applicable sampling and data collection techniques are identified in the following sections of this FSP.

A7.1 Sampling Design

The 200-SW-2 OU sampling design describes the data collection design for the project, including types and numbers of samples required, sampling locations and frequency, sample matrices, and the rationale for the design. Detailed information regarding the sample design is listed in Table A-9 and includes the following:

- Further investigation and sampling (active gas sampling) of areas showing elevated levels of soil gas detected during past characterization activities.
- Active gas sampling may also be performed in areas where remotely stored waste (RSW)-transuranic (TRU) has been retrieved.

- Data gap investigation using passive soil gas sampling of areas not previously investigated for soil gas, with further active gas sampling pending the outcome of passive gas screening
- Data gap investigation using baseline geophysics at landfills not previously investigated with baseline geophysical techniques
- Advanced geophysical investigation of landfills having conditions that may be favorable for the formation of leachate and downward fluid flow through the vadose zone
- In the future if additional wells are installed as part of remedial activities at other OUs, geophysical logging within the well casing, if not already performed, may be conducted
- Advanced remote geophysical assessment of caissons and existing wells
- Aerial radiation surveys to identify radiation hot spots
- Limited test pit excavations of landfills to provide calibration/control for the geophysical surveys and provide additional information on waste contents
- Direct pushes into landfills (between trenches) to provide additional geophysical calibration/controls with respect to vadose zone stratigraphy, features, and characteristics
- Direct pushes into trenches where RSW-TRU has been removed for assessment of the potential for contaminant migration directly below buried solid waste
- Horizontal borings beneath trenches for further assessment of the potential for leachate development and investigation of possible preferential pathways; samples will be collected from underneath the center of each trench

Additional sampling is anticipated following the ROD to collect confirmatory, design, and verification samples at sites, as needed. Post-ROD sampling needs will be identified through a series of DQO processes, as described in Chapter 5 of this work plan.

A8 Review of Existing Data

Prior to and during field investigations, a comprehensive review of existing data will be performed. The expectation is that further data review may reveal some additional information on landfill contents; however, another primary goal of the existing data review is to catalog all relevant data by landfill. The information review also should be used to refine the number and location of characterization activities proposed herein. For example, subsidence information will be organized by landfill to provide a summary of the potential for direct exposure to waste. Nearby well information will be reviewed to provide information on vadose zone stratigraphy, the likelihood of fluid flow in the unsaturated zone, and the frequency of potential preferential pathways in the general vicinity of each landfill. Recent and historical radiological surveys will provide important health and safety information prior to field work on each landfill, and radiological surveys will provide data on the migration of radioisotopes due to bioturbation (e.g., uptake by biota and subsequent surface deposition) at each landfill.

Table A-9. Sample Design for 200-SW-2 OU Landfills

			Previous Characterization		Proposed Characterization											
					Baseline Geophysics	Advanced Geophysics: MASW	Advanced Geophysics: STS	Advanced Geophysics: ERT	Horizontal Boring	Direct Push	Passive Soil Gas	Active Soil Gas	Multi Detector Probe	Test Pit	Radiation Survey	
					Characterization Reasoning											
Landfill (Including Collocated Waste Sites)	**Landfill Type**	**Understanding of Landfill Contents**	**Baseline Geophysics**	**Passive Soil Gas**	**Identify Landfill Anomalies (Metallic Objects), Trench Boundaries**	**Identify Potential Release Mechanisms (i.e., Plumes) and Transport Media, Voids**			**Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination, Future Monitoring, Below Landfills**	**Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination; Adjacent and Below Landfills**	**Identify Potential Release and Transport Media; Organic Contamination**	**Identify Potential Release and Transport Media; Organic Contamination**	**Invest Contents of Caissons**	**Confirm Landfill Contents**	**Identify Radiological Hot Spots**	**PSQ Addressed by Proposed Characterization**
218-C-9 (216-C-9 Pond)	Construction	Good	X	—	—	X	X	X	—	2 - 1 NE and 1 SW corners, based on advanced geophysics	5 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	—	Aerial	1, 2
218-E-1 (UPR-200-E-53)	Dry Waste	Moderate	X	X	—	—	—	—	—	5 - 2 north, 1 south and 2 center, based on baseline geophysics	—	—	—	2 – 1 random, 1 focused locations	Aerial	1, 2, 3
218-E-2	Industrial	Poor	X	—	—	X	X	X	1, NE to SW, with E-2, E-2A, and E-9	2 - between T10 and T08, south of T11	4 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	2 – 1 random, 1 focused locations (collocated with E-2, E-2A, E-5, E-5A, E-9)	Aerial	1, 2, 3
218-E-2A	Industrial	Poor	X	X	—	X	X	X	1 - NE to SW with E-2, E-2A, and E-9	1 - south of T13	1 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	2 – 1 random, 1 focused locations (collocated with E-2, E-2A, E-5, E-5A, E-9)	Aerial	1, 2, 3
218-E-4	Construction	Poor	X	—	—	X	X	X	—	4 - 1 southeast end, 1 west, 1 east side, 1 west end	4(1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	2 – 1 random, 1 focused locations	Aerial	1, 2, 3
218-E-5	Industrial	Moderate	X	X	—	X	X	X	—	1 - between 2 trenches	3 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	2 – 1 random, 1 focused locations (collocated with E-2, E-2A, E-5, E-5A, E-9)	Aerial	1, 2, 3

Table A-9. Sample Design for 200-SW-2 OU Landfills

Landfill (Including Collocated Waste Sites)	Landfill Type	Understanding of Landfill Contents	Previous Characterization		Proposed Characterization											PSQ Addressed by Proposed Characterization
			Baseline Geophysics	Passive Soil Gas	Baseline Geophysics	Advanced Geophysics: MASW	STS	ERT	Horizontal Boring	Direct Push	Passive Soil Gas	Active Soil Gas	Multi Detector Probe	Test Pit	Radiation Survey	
					Characterization Reasoning											
					Identify Landfill Anomalies (Metallic Objects), Trench Boundaries	Identify Potential Release Mechanisms (i.e., Plumes) and Transport Media, Voids			Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination, Future Monitoring, Below Landfills	Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination; Adjacent and Below Landfills	Identify Potential Release and Transport Media; Organic Contamination	Identify Potential Release and Transport Media; Organic Contamination	Invest Contents of Caissons	Confirm Landfill Contents	Identify Radiological Hot Spots	
218-E-5A	Industrial	Moderate	X	X	—	X	X	X	—	1 - north end	1 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	2 – 1 random, 1 focused locations (collocated with E-2, E-2A, E-5, E-5A, E-9)	Aerial	1, 2, 3
218-E-8	Construction	Poor	X	X	—	—	—	—	1 - north to south	2 - 1 east, 1 west	—	—	—	2 – 1 random, 1 focused locations	Aerial	1, 2, 3
218-E-9	Industrial	Poor	X	X	—	X	X	X	1 - NE to SW with E-2, E-2A, and E-9	1 - between T07 and T08	2 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	2 – 1 random, 1 focused locations (collocated with E-2, E-2A, E-5, E5A, E-9)	Aerial	1, 2, 3
218-E-10, (UPR-200-E-23, UPR-200-E-24, UPR-200-E-30)	TSD	Moderate	—	—	X	—	—	—	2 at 600 ft - lower half east to SW	8 - 4 in NW, SW, NE, and SE corners, 1 west, 1 in Ncntrl, 1 Scntrl, 1 east on SG and geophysics	57 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	—	Aerial	1, 2
218-E-12A	Dry Waste	Moderate	X	X	—	—	—	—	2 at 600 ft - middle of west to SE	6 - 4 in corners, 2 in middle	—	—	—	2 – 1 random, 1 focused locations	Aerial	1, 2, 3
218-E-12B	TSD	Good	—	—	X	X	X	X	3 at 600 ft east to west in middle	8 - 4 in NE, NW, SE, SW corners, 3 north half and between 2 halves, based on baseline, and passive SG, rad survey	182 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any In locations of retrieved waste if sampling not performed by M-091 project	—	—	Aerial	1, 2
218-W-1 (UPR-200-W-11, UPR-200-W-16)	Dry Waste Alpha	Moderate	X	X	—	—	—	—	—	1 - near center	—	—	—	2 - 1 random, 1 focused locations	Aerial	1, 2, 3

Table A-9. Sample Design for 200-SW-2 OU Landfills

			Previous Characterization		Proposed Characterization											
					Baseline Geophysics	Advanced Geophysics			Horizontal Boring	Direct Push	Passive Soil Gas	Active Soil Gas	Multi Detector Probe	Test Pit	Radiation Survey	
						MASW	STS	ERT								
					Characterization Reasoning											
Landfill (Including Collocated Waste Sites)	Landfill Type	Understanding of Landfill Contents	Baseline Geophysics	Passive Soil Gas	Identify Landfill Anomalies (Metallic Objects), Trench Boundaries	Identify Potential Release Mechanisms (i.e., Plumes) and Transport Media, Voids			Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination, Future Monitoring, Below Landfills	Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination; Adjacent and Below Landfills	Identify Potential Release and Transport Media; Organic Contamination	Identify Potential Release and Transport Media; Organic Contamination	Invest Contents of Caissons	Confirm Landfill Contents	Identify Radiological Hot Spots	PSQ Addressed by Proposed Characterization
218-W-1A (UPR-200-W-26)	Industrial	Moderate	X	X	—	—	—	—	—	4, - NE, NW, SE, SW corners	—	—	—	—	Aerial	1, 2
218-W-2	Dry Waste Alpha	Poor	X	X	—	—	—	—	1 at 600 ft SW corner to NE	6 - 4 in corners, 2 in middle between trenches	—	—	—	2 - 1 random, 1 focused locations	Aerial	1, 2, 3
218-W-2A (UPR-200-W-53, 216-T-4A and 216-T-4B Ponds, 216-T-4-1 and 216-T-4-2 Ditches)	Industrial	Moderate	X	X	—	X	X	X	1 at 600 ft - under ponds in NE	6 - 3 west and 3 east	41 (1/acre) - locations TBD, based on baseline geophysics	At passive SG hits (>1,000 ng), if any	—	—	Aerial	1, 2
218-W-3	Dry Waste Alpha	Moderate	X	X	—	—	—	—	1 at 600 ft, mid-west to mid-north	3 - 1 east side, off east end of T16, 1 on south end in T03 east half, (based on geophysics, if needed)	—	At passive SG hits (>1,000 ng), if any	—	2 - 1 random, 1 focused locations	Aerial	1, 2, 3
218-W-3A (UPR-200-W-84)	TSD - Dry Waste	Good	—	X	X	X	X	X	2 at 600 ft - 1 north, 1 south	9 - 6 down center, 1 west side, 2 east, based on active SG, geophysics, rad survey	54 (1/acre) locations TBD, based on baseline geophysics, do not duplicate previous locations	At passive SG hits (>1,000 ng), if any In locations of retrieved waste if sampling not performed by M-091 project	—	—	Aerial	1, 2

Table A-9. Sample Design for 200-SW-2 OU Landfills

			Previous Characterization		Proposed Characterization											
					Baseline Geophysics	Advanced Geophysics: MASW	Advanced Geophysics: STS	Advanced Geophysics: ERT	Horizontal Boring	Direct Push	Passive Soil Gas	Active Soil Gas	Multi Detector Probe	Test Pit	Radiation Survey	
					Characterization Reasoning											
Landfill (Including Collocated Waste Sites)	Landfill Type	Understanding of Landfill Contents	Baseline Geophysics	Passive Soil Gas	Identify Landfill Anomalies (Metallic Objects), Trench Boundaries	Identify Potential Release Mechanisms (i.e., Plumes) and Transport Media, Voids			Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination, Future Monitoring, Below Landfills	Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination; Adjacent and Below Landfills	Identify Potential Release and Transport Media; Organic Contamination	Identify Potential Release and Transport Media; Organic Contamination	Invest Contents of Caissons	Confirm Landfill Contents	Identify Radiological Hot Spots	PSQ Addressed by Proposed Characterization
218-W-3AE (216-T-4A and 216-T-4B Ponds, 216-T-4-1 and 216-T-4-2 Ditches)	TSD	Good	—	X	X	X	X	X	1 sy 600 ft - near GI	5 - 2 north, 2 middle, 1 south	57 (1/acre) locations TBD, based on baseline geophysics, do not duplicate previous locations	At passive SG hits (>1,000 ng), if any	—	—	Aerial	1, 2
218-W-4A (UPR-200-W-72)	Dry Waste Alpha	Good	X	X	—	X	X	X	2 at 600 ft from midwest to N and S	7 - 4 in corners, 2 in middle, 1 on east side	—	—	X	2 - 1 random, 1 focused locations	Aerial	1, 2, 3
218-W-4B	TSD	Good	—	X	X	X	X	X	1 at 600 ft NW corner to SE	3 - near RSW, 1 east, 1 west, 1 south	10 (1/acre) locations TBD, based on baseline geophysics, do not duplicate previous locations	At passive SG hits (>1,000 ng), if any In locations of retrieved waste if sampling not performed by M-091 project	X	—	Aerial	1, 2, 3
218-W-4C (UPR-200-W-37, Z Plant burn pit)	TSD	Good	—	X	X	X	X	X	—	6 - 2 north, 2 middle, 2 south	56 (1/acre) locations TBD, based on baseline geophysics, do not duplicate previous locations	At passive SG hits (>1,000 ng), if any In locations of retrieved waste if sampling not performed by M-091 project	—	—	Aerial	1, 2
218-W-5	TSD	Good	—	X	X	—	—	—	—	7 - 4 in corners and 3 middle away from Green Islands	—	At passive SG hits (>1,000 ng), if any	—	2 - 1 random, 1 focused locations	Aerial	1, 2, 3

Table A-9. Sample Design for 200-SW-2 OU Landfills

			Previous Characterization		Proposed Characterization											
					Baseline Geophysics	Advanced Geophysics: MASW	Advanced Geophysics: STS	Advanced Geophysics: ERT	Horizontal Boring	Direct Push	Passive Soil Gas	Active Soil Gas	Multi Detector Probe	Test Pit	Radiation Survey	
					Characterization Reasoning											
Landfill (Including Collocated Waste Sites)	Landfill Type	Understanding of Landfill Contents	Baseline Geophysics	Passive Soil Gas	Identify Landfill Anomalies (Metallic Objects), Trench Boundaries	Identify Potential Release Mechanisms (i.e., Plumes) and Transport Media, Voids			Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination, Future Monitoring, Below Landfills	Identify Potential Release and Transport Media; Past or Current Vadose Zone Contamination; Adjacent and Below Landfills	Identify Potential Release and Transport Media; Organic Contamination	Identify Potential Release and Transport Media; Organic Contamination	Invest Contents of Caissons	Confirm Landfill Contents	Identify Radiological Hot Spots	PSQ Addressed by Proposed Characterization
218-W-11	Industrial	Poor	X	X	—	—	—	—	—	1 - north of northern trench near passive SG hits	—	—	—	2 - 1 random, 1 focused locations	Aerial	1, 2, 3

1. What data are required to support evaluation of risk, pathways, and development of remedial action alternatives?
2. Were enough data collected to support the RFI/CMS/RI/FS and selection of remedial action alternatives?
3. Were enough data collected to evaluate whether buried waste presents a long-term effect on human health and the environment?

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The cataloging of existing information will include the following activities:

- Review of relevant historical records, process knowledge, and anecdotal information
- Review of subsidence events, history, and pertinent data (including review of light detection and ranging data)
- Review of existing well information, with potential geophysical logging of some wells
- Aerial radiological surveys

A9 Sampling Methods

The 200-SW-2 OU characterization approach employs both nonintrusive and intrusive methods. The nonintrusive techniques consist of aerial radiation surveys, soil gas sampling (passive and active), and several types of geophysical techniques, each of which is suited to particular investigation objectives. Intrusive techniques consist of direct push and horizontal borings, which will include collection of soil samples; and installation of test pits. Technology descriptions are included in Chapter 4 of this work plan.

A9.1 Aerial Radiation Survey

The aerial radiation survey will be done on all of the landfills as part of a larger Central Plateau radiation survey. The aerial radiation survey will be done to measure radiation emissions from the ground surface in the area of the landfills and used to evaluate human health and ecological direct contact. This radiological mapping may provide insight on potential near surface releases of radiation. The survey will be done on a grid spacing of 30.5 m (100 ft) and will be conducted at an elevation of 15.2 m (50 ft) above the ground surface using a fixed wing aircraft or helicopter.

A9.2 Geophysics

Two categories of geophysics, comprising several types of methods, will be used to characterize the 200-SW-2 OU landfills. Some shallow focused investigation methods have been used already on most of the landfills to establish a geophysical baseline. The primary investigation target of these methods was the landfill waste and trenches. These baseline methods were used to confirm trench locations and locate anomalies (e.g., metal objects) that might be containers for liquids. This information was also used to focus earlier rounds of passive soil gas sampling.

In addition to filling data gaps with baseline geophysics, this SAP also will use advanced geophysical methods to fill data gaps and achieve other purposes. Multi-channel analysis of surface waves (MASW) combined with downhole electrical methods (ERT) and surface-to-surface (STS) high-resolution electrical resistivity surveys will target possible preferential flow pathways and moisture/leachate in the vadose zone. These methods also may provide incidental additional information about the trenches and landfill waste.

After a review of existing information from nearby wells, geophysical borehole logging of relevant wells may be warranted. In addition, caissons will be assessed using a geophysical tool developed at Idaho National Laboratory (INL). The multi-detector caisson probe, which provides rapid, remote assessment of caissons, has been used successfully at the Hanford Site.

A9.2.1 Baseline Geophysics

The geophysical techniques used to establish a geophysical baseline in previous investigations at the 200-SW-2 OU landfills were primarily GPR, EMI, and TMF methods. Some time-domain electromagnetic data also were collected. These methods were selected because they are cost effective and nonintrusive and have been successful in similar waste characterization projects conducted at the Hanford Site. These methods have been aimed at defining the following characteristics:

- Locations of landfill trench edges, ends, and centerlines
- Locations of buried waste or other significant features/anomalies
- Presence and extent of voids within a given trench
- Depth of soil cover above waste items
- Depth to trench bottom (where possible)

The depth of investigation has been limited to approximately 3 to 4 m (10 to 12 ft). Brief descriptions of the baseline geophysical methods are found in Chapter 4 of this work plan.

The advanced geophysical methods include MASW seismic, STS electrical resistivity, and ERT. The primary investigation target for these methods is not the landfill waste but characteristics of the vadose zone. MASW can provide information on the stratigraphy of the vadose zone and the location of possible preferential pathways. STS resistivity may be able to locate areas of former or current leachate formation or transport. ERT can be used in series with MASW to monitor suspected preferential pathways. Because ERT electrodes are installed in direct-push boreholes and are left in place, ERT can provide time series geophysics and the ability to observe the presence and behavior of wetting fronts.

The investigation strategy for the advanced geophysical methods is to employ MASW first, using it to choose targets for investigation via STS resistivity and ERT. The design of the precise STS and ERT configurations will depend upon the targets chosen, so the STS and ERT field plan needs to be designed in detail only after input from the interpretation of MASW data. Additional planning and data review are needed to ensure that MASW is deployed in the precise location where ponding or episodic precipitation water has occurred.

A typical data acquisition configuration for MASW would involve an “end-on/roll along” recording configuration. For example, the shot point (e.g., using a sledge hammer or weight drop) would be positioned 1.5 m (5 ft) off one end of a geophone line (e.g., landstreamers) having geophones spaced 1.5 m (5 ft) apart. Typically, 48 geophones will record during one shot. After recording is completed at one shot point, the shot point advances 3 m (10 ft) along the geophone line, and a constant offset of 1.5 m (5 ft) is maintained between the shot point and the first active (recording) geophone. Data collection “rolls along” as the shot points advance by 3 m (10 ft) each time, and the first 48 geophones in front of the shot point collect the seismic (MASW) data.

The seismic waves generated from each shot point are recorded over an 8-second period (or less) using a sampling rate of 0.5 msec. Longer recording times provide an opportunity for recording both active and passive source MASW.

MASW data are processed using the computer program SurfSeis developed by the Kansas Geological Survey. The SEG-2 format field records are input into the program to perform a specialized sequence of processing to prepare dispersion curves showing Rayleigh wave (surface waves) phase velocity versus frequency for each 48-channel field record. These curves are then used to calculate one-dimensional models of shear-wave velocity layering for the center of each 48-channel geophone array. The resulting one-dimensional models are generated at 3 m (10 ft) intervals and then gridded and color contoured to prepare the two-dimensional or three-dimensional shear-wave velocity profiles.

The MASW shear-wave velocity profiles are then used to interpret the lithologic and permeability conditions of the alluvium and bedrock channels. Correlation with nearby wells or direct-push data is useful for providing integrated controls on geologic interpretations.

The STS resistivity method can employ many different electrode configurations (e.g., pole-pole, dipole-dipole, Wenner, Schlumberger, and monopole), but they all rely upon electric current being passed into the earth through one pair of transmitting electrodes and voltage measurements being made at a pair of receiving electrodes. A progression of measurements is made along transects, resulting in measurements of current, voltage, and distance and allowing for the calculation of apparent resistivity in ohmmeters. Following acquisition, data are pre-processed to identify poor quality readings. Data quality is further assessed by contouring an apparent resistivity pseudo-section, showing values of ohmmeters at linear depth intervals associated with the separation distance between transmitting and receiving electrodes. This apparent resistivity data are then processed through a nonlinear inverse model to obtain estimates of the true electrical resistivity of the subsurface that gave rise to the voltage measurements in the original data file.

ERT works on the same principles of STS resistivity surveys, except that readings of voltage and current are made in separate boreholes. The spacing of the electrodes in the borehole and the separation between the boreholes affects data quality and resolution.

A9.2.2 Other Specialty Geophysical Methods That May Be Used

Other geophysical methods, such as the INL multi-detector probe, borehole geophysical logging, and time domain reflectometry (TDR) are described in Chapter 4 of this work plan and have specific uses. However, their specific plan of deployment cannot be identified presently. Like the advanced geophysical data techniques, the deployment of those geophysical instruments can only be generally described. Further planning and review of data will be needed to specify the exact circumstances of use.

The INL multi-detector probe will be deployed to investigate one or more caissons in the 218-W-4A and 218-W-4B Landfills. The deployment plan and selection of caissons will require further development and discussion with the subject matter experts from INL after considering existing caisson information along with radiological health and safety information. This probe can be deployed along with remote video to evaluate the contents of the caissons.

Borehole geophysical logging will be planned and conducted after reviewing existing information on nearby wells and determining whether additional information is required. Chapter 4 describes the geophysical logging techniques. In brief, passive gamma logs indicate the presence of gamma-emitting materials, and radionuclides can be identified from characteristic gamma energies. The passive neutron logging system uses a helium-3 detector to count epithermal neutrons originating in the surrounding media. Any detectable neutron activity can be attributed to the products of alpha interactions and/or spontaneous fission and is, thus, at least a qualitative indicator of transuranium. Active neutron logs are sensitive to the presence of moisture. In combination, these logs can show the location of radioactive substances and water, indicating the possible presence of leachate. If performed, geophysical logging data will be collected in HEIS; a summary report also will be prepared by the logging contractor to document the logging activity and results. The logging summary reports will be documented in the field summary report so they can be referenced in the RI report and other documents, as necessary.

TDRs will be deployed within the direct-push boreholes planned for the 200-SW-2 OU landfills. Both the direct-push boreholes and directional boreholes are described in Section A10. Where TDR deployment is technically feasible, it is useful in detecting the advance of wetting fronts in the vadose zone.

A9.2.3 Survey Grid Parameters for Geophysics

Civil survey coordinates shown on the site drawings will be used to develop base grids for the geophysical transects at each site. Base grids will be created on centers of a chosen distance throughout the individual sites. The coordinates of the nodes will be supplied to the DOE-RL supporting contractor(s) civil survey personnel, who will use GPS instrumentation to stake the grids in the field. Personnel then will mark data collection lines at set intervals between the nodes. Coordinates will be recorded in *North American Vertical Datum of 1988* (NAVD88) and *North American Datum of 1983* (NAD83), Washington State Plane (WSP) South Zone, with the 1991 adjustment for directional coordinates. All survey data will be recorded in meters and feet.

The geophysical data plots will be presented in local grid coordinates. The local grids generally are established by assigning, to the southwestern-most grid node, the arbitrary location of North 100, East 100 (N100/E100). Positions then can be measured from this position. In some instances, the grids may be expanded after establishment and, therefore, may have coordinates less than N100/E100. The interpretation drawings for each site will show WSP coordinates (in meters) for selected grid nodes, allowing a tie between them and the local grid coordinates.

A9.3 Soil Vapor Samples

Both passive and active soil gas data are needed. Passive soil gas data are needed to fill data gaps, and active data are needed to provide concentration information for the risk assessment.

A9.3.1 Passive Soil Vapor Samples

Passive soil vapor sampling will be collected to fill data gaps for those landfills that have not previously been sampled. Results will be used to provide a qualitative indication of mobile contaminants in the landfills and determine the general location of waste packages that may contain liquid organics that have breached their containment.

BESURE[1] sample collection kits or an equivalent system, will be used. These passive soil vapor sampling systems are designed for use in shallow deployments to identify and quantify a broad range of VOCs and SVOCs including halogenated compounds, petroleum hydrocarbons, polynuclear aromatic hydrocarbons, and other compounds.

A passive soil vapor sampler consists of a glass vial containing hydrophobic adsorbent cartridges with a length of wire or string attached to the vial for retrieval. The sampler is placed in a shallow, vertical hole in the soil. The sampler is covered with soil, and the location of the sampler is recorded. At the end of the exposure period, the samplers are withdrawn and sent to the appropriate laboratory for analysis.

If a release is found during field investigations, Ecology will be notified as soon as possible after the release is confirmed. As part of the notification, DOE-RL will present options for conducting additional site investigations to determine the nature and extent of the release, if warranted. Where possible, the additional site investigations will be the same as the ones described in this work plan but may include different locations.

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[1] BESURE® is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.

If VOCs are detected during passive soil gas monitoring, the following procedure will be followed.

- Additional passive soil gas samples will be collected at 15.2 m (50 ft) offsets to the north, south, east, and west of the initial detection.
- If the mass of VOC detected increases at any of the new locations described in Step 1, additional soil gas monitoring will be performed at 15.2 m (50 ft) offsets to the north, south, east, and west of the higher detection location with the exception of not collecting a sample from the direction of the original offset. The offset will be extended, as required, to the edge of the trench.
- Step 2 will be repeated until the approximate location of the largest VOC mass is determined. If the mass of VOC is less than 1,000 ng, no additional passive soil gas samples will be done in that direction.

A9.3.2 Active Soil Vapor Sampling

Active soil vapor sampling will be collected to obtain concentration data for use in risk assessments for those landfills that have had previous detections from passive soil gas sampling events. Field soil gas instruments (i.e., Miran SapphIRe and Brüel & Kjær) may be used in conjunction with active soil gas samplers. Active soil gas samples will be collected in SUMMA canisters. A SUMMA canister is a highly polished, stainless steel canister that prevents permeation of VOCs through the vessel wall and the degradation of constituents by exposure to sunlight during shipment to the laboratory. The recommended size for sample collection at the 200-SW-2 OU landfills is a 6 L (1.6 gal) canister.

Sample collection with SUMMA canisters occurs by placing a soil gas probe into the subsurface, while the canister rests on the surface. Typically, collection probes are placed several feet deep into the subsurface with the aid of a drill or direct-push rig, and equilibration is needed before sample collection. For a direct-push rig, equilibration times are relatively brief, approximately 30 minutes; but for rotary or other drill methods that create more of a disturbance, equilibration times of up to 2 days are typical.

At the 200-SW-2 OU, some waste is buried as shallow as 45.7 cm (18 in.) from the surface; therefore, soil gas collection probes will be installed by hand, or by hand auger, in the top few inches of soil after an equilibration time of 30 minutes. A calibrated flow controller will be used to provide a consistent flow rate for each sample collected. One flow controller will be used for each sample collected. Flow rates should not exceed approximately 100 to 200 mL/min, and vacuums should be maintained to below 25.4 cm (10 in.) of water, if practical.

A9.3.3 Approach to Coordination with TPA Milestone M-091-40, Requirement 2

Appendix H of this work plan summarizes soil vapor extraction and soil vapor sampling performed to date in the 200-SW-2 OU in support of the TPA (Ecology et al., 1989) Milestone M-091-40, Requirement 2. As of the publication date of this work plan (March 2015), the four 200-SW-2 OU landfills containing RSW-TRU (218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C) have been sampled for soil gas prior to retrieval of RSW-TRU. One landfill, 218-W-4C, has also been sampled for soil gas after retrieval of RSW-TRU. The remaining three landfills are not yet fully retrieved under M-091-40 and M-091-41. It is not certain whether the field work specified in this work plan will precede the remaining RSW-TRU retrievals. If the retrievals proceed prior to 200-SW-2 OU field investigation the three remaining landfills (218-W-3A, 218-W-4B, and 218-E-12B) will undergo post-retrieval sampling as directed in the following M-091-40/41 SAPs (or subsequent revisions to them, if any).

- DOE/RL-2003-48, *218-W-4C Sampling and Analysis Plan*
- DOE/RL-2004-32, *218-E-12B Burial Ground Sampling and Analysis Plan*
- DOE/RL-2004-70, *218-W-4B Burial Ground Sampling and Analysis Plan*
- DOE/RL-2004-71, *218-W-3A Burial Ground Sampling and Analysis Plan*

If the 200-SW-2 OU field investigation specified by this work plan precedes post-retrieval vapor sampling under M-091-40 and M-091-41, then the vapor sampling following retrieval of RSW-TRU in 218-W-3A, 218-W-4B, and 218-E-12B will be performed under this work plan.

Post-retrieval sampling for M-091-40 and M-091-41 will fulfill requirements of both the M-091 project and the 200-SW-2 OU field investigation regardless of which project collects the data.

A9.3.4 Positional Surveying

All sampling locations established during this sampling activity will be surveyed after the sampling and decommissioning activities are completed. Data will be recorded in NAVD88 and the NAD83 WSP (South Zone), with the 1991 adjustment for directional coordinates. All survey data will be recorded in meters and feet.

A9.4 Direct-Push Sampling

Direct-push technologies use a pushing method, such as a diesel hammer, hydraulic hammer, cone penetrometer, or Geoprobe, to penetrate the vadose zone to obtain physical samples or provide opportunities for collecting downhole geophysical data (e.g., small-diameter gross/spectral gamma and active neutron [moisture]). These methods generally are limited in the depth of penetration and in sample volume as compared to borehole drilling; however, they are well suited for vadose zone investigations. In general, direct-push methods do not generate drill cuttings, thereby minimizing personnel exposure to contamination and minimizing the volume of investigation-derived waste.

Direct-push holes will be installed between waste trenches to avoid direct contact with landfill material. They will be used to obtain samples for analysis or provide opportunities for geophysical logging. Samples will be collected at 1.5 m (5 ft) intervals, down to a maximum depth of 18 m (60 ft). Direct-push boreholes are decommissioned in the same manner as standard boreholes, in accordance with appropriate state regulations.

A9.5 Horizontal Boring and Sampling

Chapter 4 of this work plan describes horizontal boring. Horizontal borings are achieved using specially modified mud-rotary rigs. The purpose of horizontal borings is to complete a directional well and use it as a delivery system for obtaining information below the trenches. Leak detection instrumentation or geophysical logs can be run to assess the condition of the vadose zone under the landfill waste as part of this investigation. These borings should be constructed to allow continued future use for routine monitoring in lieu of, or in addition to, conventional wells. It may be possible to collect soil samples during boring; however, site-specific factors will determine the technical feasibility of sampling success based on matrix and equipment limitation.

Horizontal boring success is based on many site-specific factors. While successful in most instances, site-specific techniques and approaches are sometimes required to achieve characterization goals. It is recommended that this method be piloted at one waste site to evaluate its effectiveness and utility for this investigation. The use of conventional methods, such as slant drilling methods or direct push, to obtain information below the landfills may be considered where horizontal boring methods are impractical or ineffective to implement.

A9.6 Test Pit Excavations

Random and focused test pit excavations will be performed in landfills for the purpose of confirming and validating the interpretation of the geophysical data. These excavations also will provide information that allows for the inspection and verification of process knowledge for landfills.

Test pit excavations in the selected landfills will mean that physical inspection of excavated waste will occur in each category (e.g., treatment, storage, and/or disposal [TSD] or industrial) of landfills.

All landfills will receive test pits unless they have one or more of these characteristics:

- Highly radioactive waste in any part of the landfill, defined for this purpose only as greater than 120 R/hr at burial
- Waste mainly packaged in very large boxes (waste in test pit will not be visible)
- Photo history demonstrating good correlation with records (test pits not needed)
- Adequate burial records (test pits not needed)

The specific landfills selected to receive test pits are listed in Tables A-7 and A-9.

Each of the selected landfills will receive two test pits: one in a randomly selected location, and the other in a focused location based on historical process knowledge.

Random locations are selected using the random number generator in Microsoft Excel[2] to select a trench number and a cross-coordinate along the trench. Focused locations are based on the following characteristics; one or more characteristics is/are sufficient to select a location:

- A passive soil gas sampler detected a volatile organic in the location.
- Historical records indicate that the location is believed to contain waste with mobile contaminants.
- Geophysical surveys indicate a metallic signature.

Test pits will be approximately 10 to 13 m (30 to 40 ft) wide, across the width of the trench. Trench location will be determined by site drawings and geophysics results. Initial selections of test pit locations are shown in Table A-10, with the rationale for each location. If locations require adjustment based on results of future field reconnaissance activities such as geophysics or soil gas samples, the revised locations will be selected in consultation with Ecology.

After inspection, excavated waste will be handled as investigation-derived waste and disposed of to the Environmental Restoration Disposal Facility.

A9.7 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with the sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated equipment for each sampling activity.

[2] Microsoft® and Excel® are registered trademarks of Microsoft Corporation in the United States and other countries.

Table A-10. Initial Selection of Test Pit Locations

Landfill	Random, Focused?	Rationale for Test Pit Location within Selected Landfills	Location
218-C-9	No test pits. Good records.		
218-E-1	R	Excel® random number generator used to select Trench Number and cross-coordinate	Trench 3, at Hanford coordinates 45519N/54965W
	F	Location of soil gas detect	WSP coordinates 135568N/574742E
218-E-2, -2A, -5, -5A, -9	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 13, at Hanford coordinates 44275N/53790W
	F	Large metallic signature; record of railroad car contaminated with uranium nitrate.	Trench 3, at WSP coordinates 137085N/573441E
218-E-4	R	Excel random number generator used to select Trench Number and cross-coordinate	At Hanford coordinates 44102N /53889W
	F	Geophysics indicates debris	At Hanford coordinates 43800N /53700W
218-E-8	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 1, at Hanford coordinates 45271N/48490W
	F	Location of soil gas detect and significant metallic debris	At WSP coordinates 137193N/575136E
218-E-10	No test pits. Highly radioactive waste packaged in very large boxes.		
218-E-12A	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 4, at Hanford coordinates 44136N/48790W
	F	Burial log records from 1962 indicate possible uranium scrap	Trench 12, at Hanford coordinates 43335N/49065W
218-E-12B	No test pits. Good records, highly radioactive waste.		
218-W-1	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench T4A, at Hanford coordinates 41757N/77711W

Table A-10. Initial Selection of Test Pit Locations

Landfill	Random, Focused?	Rationale for Test Pit Location within Selected Landfills	Location
	F	Location of soil gas detect	Trench 7, at Hanford coordinates 41807N/77729W
2 18-W-1A	No test pits. Good photo history shows waste forms.		
2 18-W-2	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 12, at Hanford coordinates 41392N/77904W
	F	Location of soil gas detect	WSP coordinates 135988N/566172E
218-W-2A	No test pits. Highly radioactive waste, good photo history shows waste forms.		
218-W-3	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 16, at Hanford coordinates 43753N/78012W
	F	Records for Trench 19 indicate this location may contain uranium scrap.	Trench 19, at Hanford coordinates 43884N/77890W
218-W-3A	No test pits. Good records, highly radioactive waste.		
218-W-3AE	No test pits. Good records, highly radioactive waste.		
218-W-4A (Note: Although this site has good records and contains highly radioactive waste, test pits needed because of uncertainty in the waste form of large amounts of uranium in this landfill.)	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 21, at Hanford coordinates 43118N/77917W
	F	Location of burial of depleted uranium in 1962. There are approximately 30 such burials in 218-W-4A; this is believed to be the largest (310 55-gal drums).	Trench 8, at Hanford coordinates 42598N/77669W
218-W-4B	No test pits. Good records, highly radioactive waste.		
218-W-4C	No test pits. Good records, highly radioactive waste.		

Table A-10. Initial Selection of Test Pit Locations

Landfill	Random, Focused?	Rationale for Test Pit Location within Selected Landfills	Location
218-W-5 (Note: Although this site has good records, test pits are needed in at least one Treatment, Storage and Disposal unit. 218-W-5 is the only TSD unit in 200-SW-2 OU that does not contain waste over 120 R/hr)	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 9, at Hanford coordinates 46055N/79045W
	F	"Green Island" waste	Trench 22, at Hanford coordinates 45445N/78724W
218-W-11	R	Excel random number generator used to select Trench Number and cross-coordinate	Trench 1, at Hanford coordinates 42203N/77833W
	F	Location of soil gas detect and high concentration of metallic debris	WSP coordinates 136330N/566184E

Note: Microsoft® and Excel® are registered trademarks of Microsoft Corporation in the United States and other countries.

F = focused

R = random

WSP = Washington State Plane

Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events

A9.8 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. As a rule, cuttings from boreholes (excluding slough) will be field screened for evidence of radiological contamination. Screening will be conducted visually and with field instruments. Radiological screening will be performed by the RCT or other qualified personnel. The RCT will record field measurements, noting the depth of the sample and the instrument reading. Measurements will be relayed to the field geologist (for borehole and wells) for daily inclusion in the field logbook or operational records, as applicable.

The following information will be distributed to personnel performing work in support of this SAP:

- Instructions to RCTs on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate
- Information regarding the portable radiological field instrumentation; including a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument (these instruments are commonly used on the Hanford Site to obtain measurements of removable surface contamination measurements and direct measurements of the total surface contamination)
- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, "Occupational Radiation Protection"
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of radiological information
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related information
- The requirements associated with preparing and transporting regulated material
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities (data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results)

A9.9 Documentation of Field Activities

Logbooks or data forms are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook and only authorized persons may make entries in logbooks. Logbooks entries will be reviewed by the FWS, cognizant scientist/engineer or other responsible manager; the review will be documented with signature and date. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms may be used to collect field information; however, the information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks is as follows:

- Purpose of activity
- Day, date, time, and weather conditions
- Names, titles, and organizations of personnel present
- Deviations from the QAPjP
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (e.g., preparation, splits, duplicates, matrix spikes, and blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations testing, inspections, maintenance and surveys, and equipment identification numbers, as applicable
- Equipment decontaminated, number of decontaminations, and variations to decontamination methods
- Equipment failures or breakdowns, and descriptions of any corrective actions
- Telephone calls relating to field activities

A9.10 Corrective Actions and Deviations for Sampling Activities

The 200-SW-2 OU Project Manager, FWS, appropriate BTR (or designee), and SMR personnel must document deviations from protocols, problems pertaining to sample collection, chain-of-custody forms, target analytes, COPCs, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions, changes in sample locations because of physical obstructions, or additions of sample depth(s).

As appropriate, such deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with internal corrective action methods. The 200-SW-2 OU Project Manager, FWS, appropriate BTR (or designee) or SMR personnel will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities.

A9.11 Calibration of Field Equipment

Construction management, the appropriate BTR, or the FWS is responsible for ensuring that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or field instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in accordance with HASQARD (DOE/RL-96-68).

Field instrumentation, calibration, and QA checks will be performed as follows:

- Prior to initial use of a field analytical measurement system.
- At the frequency recommended by the manufacturer or methods, or as required by regulations.
- Upon failure to meet specified QC criteria.
- Calibration of radiological field instruments on the Hanford Site is performed by the MSA prime contractor, as specified by their calibration program.
- Daily calibration checks will be performed and documented for each instrument used to characterize areas under investigation. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.
- Standards used for calibration will be traceable to nationally or internationally recognized standard agency source or measurement system, if available.

A9.12 Sample Handling

Sample handling and transfer will be in accordance with established methods to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape will be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process.

A9.12.1 Sample Preservation and Hold Times

For certain types of samples, preservatives are required. While the preservative may be added to the collection bottles before their use in the field, it is allowable to add the preservative at the sampling vehicle immediately after collection. Samples may require filtering in the field, as noted on the chain-of-custody forms.

To ensure sample and data usability, the sampling associated with this SAP will be performed in accordance with HASQARD (DOE/RL-96-68) pertaining to sample collection, collection equipment, and sample handling.

Holding time is the elapsed time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the analytical method, as specified for three-digit EPA methods (EPA/600/4-79-020) or for the four-digit EPA methods (SW-846).

Suggested sample preservation and holding time requirements will be specified in Field Sampling Instructions for samples collected in accordance with this SAP. These requirements are in accordance with the analytical method specified. The final container type and volumes will be identified on the SAF and chain-of-custody form. This SAP defines a "sample" as a filled sample bottle for starting the clock for holding-time restrictions.

A9.12.2 Containers

Pre-cleaned sample containers with certificates of analysis denoting compliance with EPA specifications (EPA 540/R-93/051, *Specifications and Guidance for Contaminant-Free Sample Containers*) for the intended analyses will be used for soil samples collected for chemical analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. The Radiological Engineering organization will measure both the contamination levels and dose rates associated with the filled sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's radioactivity acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the FWS (in consultation with the SMR organization), can send smaller volumes to the laboratory. Container types and sample amounts/volumes will be identified when field sampling instructions are prepared.

A9.12.3 Container Labeling

Each sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- SAF
- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Chain-of-custody number
- Bottle type and size
- Laboratory performing the analyses
- Sample location

Sample records must include the following information:

- Analysis required
- Source of sample
- Matrix (e.g., water and soil)
- Field data (e.g., pH and radiological readings)

A9.12.4 Sample Custody

Sample custody will be maintained in accordance with existing protocols to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory.

Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to the SMR organization within 48 hours of shipping.

The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses (or reference thereto)

A9.12.5 Sample Transportation

All packaging and transportation instructions will comply with applicable transportation regulations and DOE requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous waste are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 177, "Carriage by Public Highway." Carrier-specific requirements defined in the International Air Transportation Association Dangerous Goods Regulations should also be considered when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents will be considered hazardous material in transportation and transported according to DOT requirements (49 CFR). If the sample material is known or can be identified, then it will be packaged, marked, labeled, and shipped according to the specific instructions for that material.

Materials are classified by DOT as radioactive when the isotope specific activity concentration and the exempt consignment limits described in 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings," are exceeded. Samples will be screened, or relevant historical data will be used, to determine if these values are exceeded. When screening or historical data indicate that samples are radioactive, they will be properly classified, described, packaged, marked, labeled, and transported according to DOT requirements.

A10 Health and Safety

The hazardous waste operations safety and health program was established to ensure the safety and health of workers involved in hazardous waste site activities. The program was developed to comply with the requirements of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," and 10 CFR 835. The health and safety program defines the chemical, radiological, and physical hazards and specifies the controls and requirements for day-to-day work activities on the overall Hanford Site. Personal training; control of industrial safety and radiological hazards; personal protective equipment; site control; general emergency response to spills, fire, accidents, and injuries; site visitors; and incident reporting are governed by the health and safety program.

Site-specific health and safety plans will be prepared to supplement the general health and safety program. Site access and sampling work activities will be controlled in accordance with the site-specific and general health and safety plans.

A11 Management of Waste

Waste materials are generated during sample collection, processing, and subsampling activities. The method of identification, storage, and disposition of hazardous, radioactive, or mixed waste materials and unused samples (including unexpected waste), generated by sampling or test pit excavation activities, will be managed in accordance with a project-specific waste management plan and must be characterized to the extent necessary to meet DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*, and the waste acceptance criteria for the relevant disposal facility.

Offsite analytical laboratories are responsible for the disposal of unused sample quantities. On a monthly basis, the laboratory will coordinate sample disposal and status with SMR by providing a list of samples more than 90 days post-data delivery for which disposal is requested in the following month. The laboratory will also provide, on a monthly basis, a list of samples disposed in the preceding month that includes disposal date and method or other relevant information. Signed chain-of-custody forms indicating sample disposal will be retained in laboratory case files pending return of case files to the contractor.

Pursuant to 40 CFR 300.440, "Procedures for Planning and Implementing Off-Site Response Actions," approval from the DOE Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

A12 References

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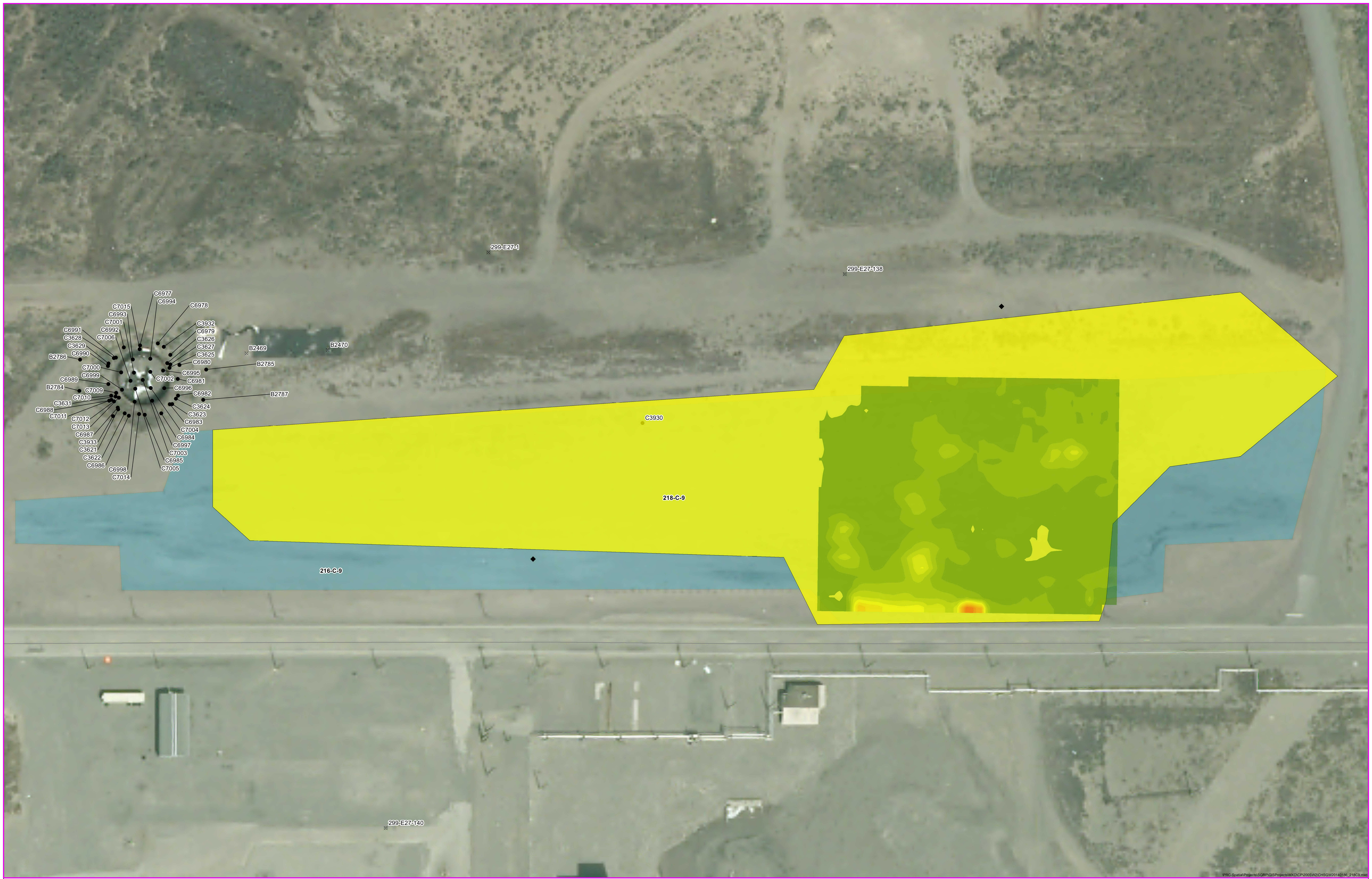
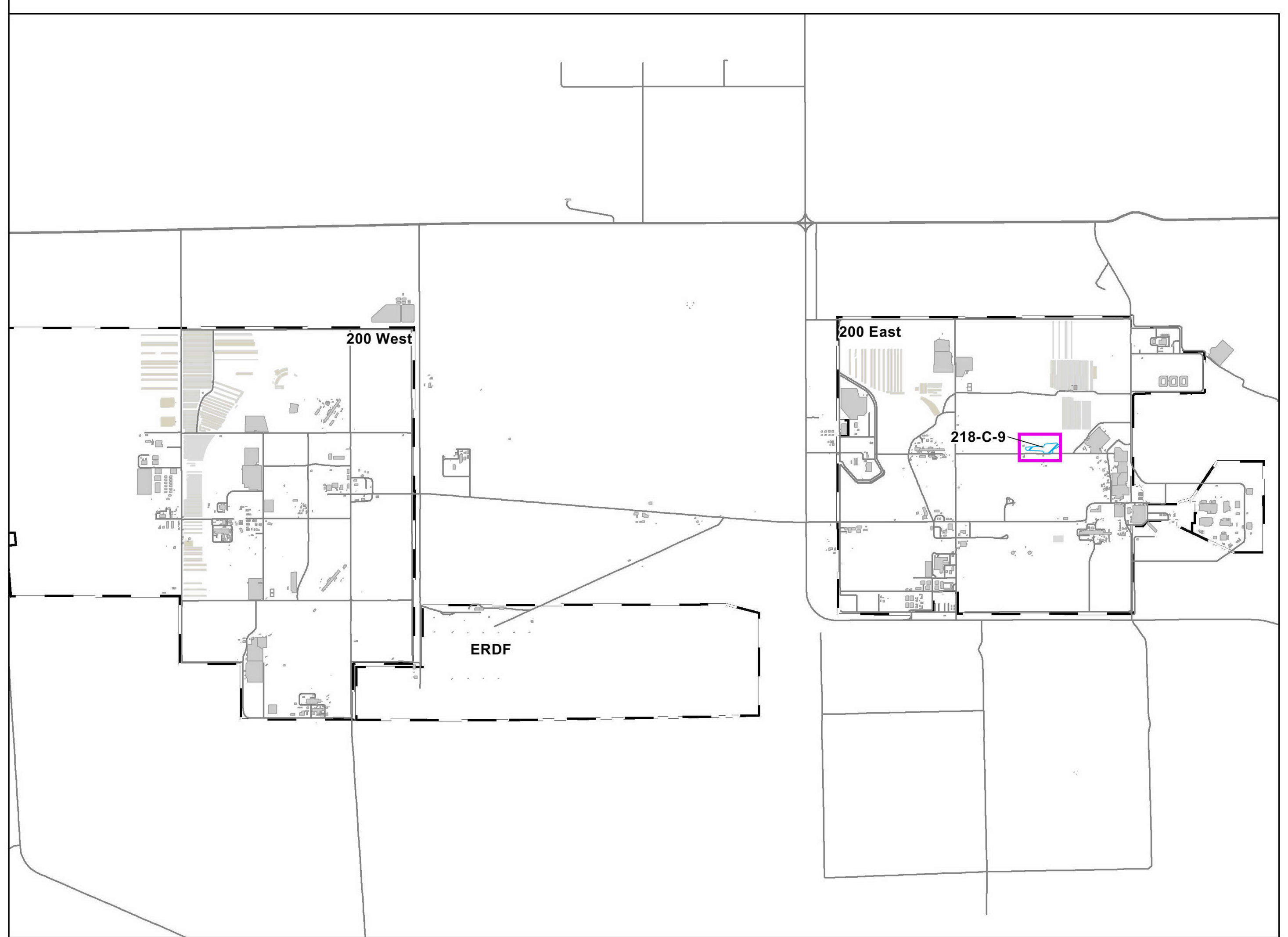




218-C-9 Landfill

Proposed Field Work Activities

- ◆ Direct Push Borehole
- ⟷ Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Waste Site of Interest

Operational Boundary

Roads

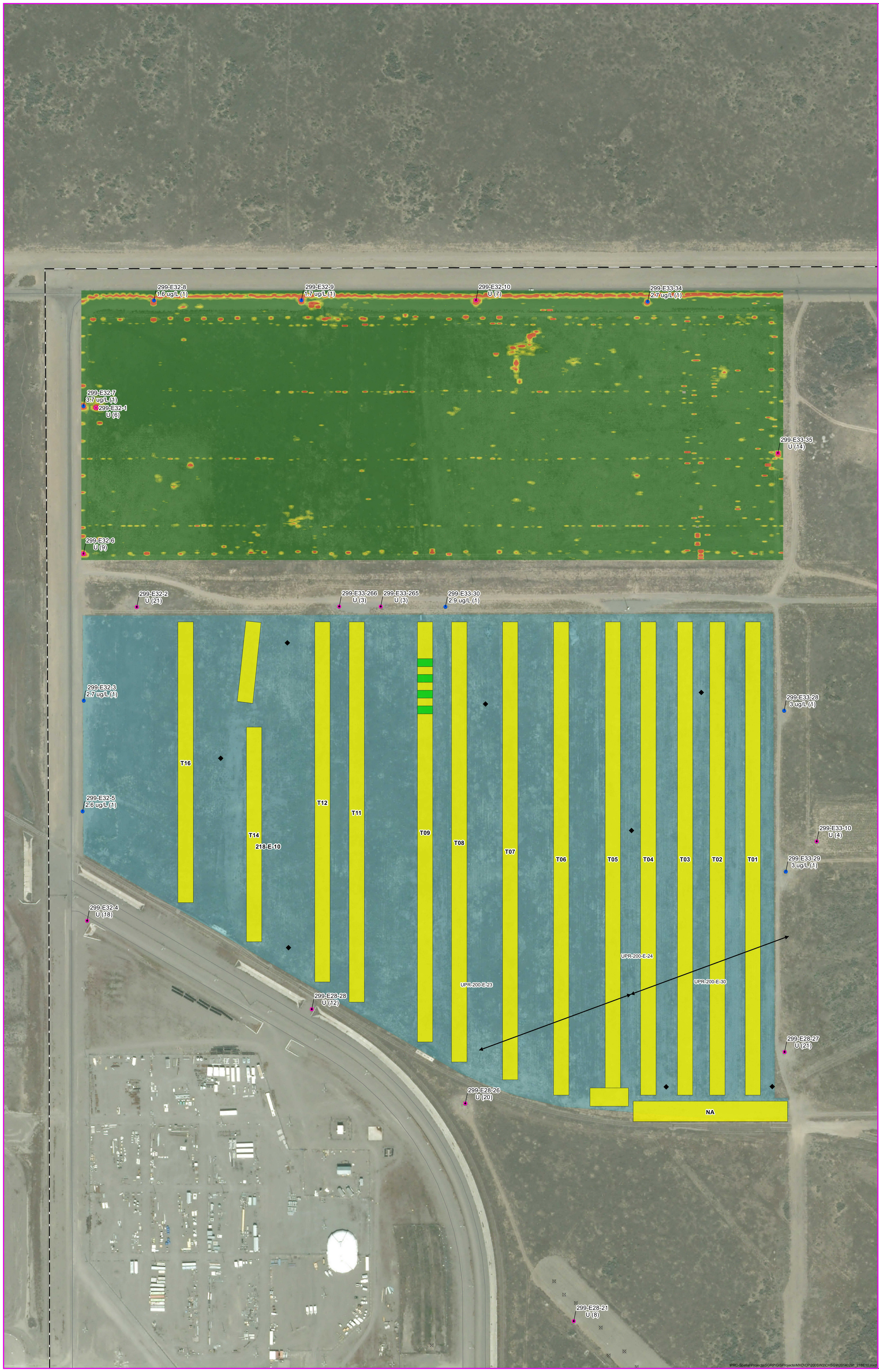
Notes:

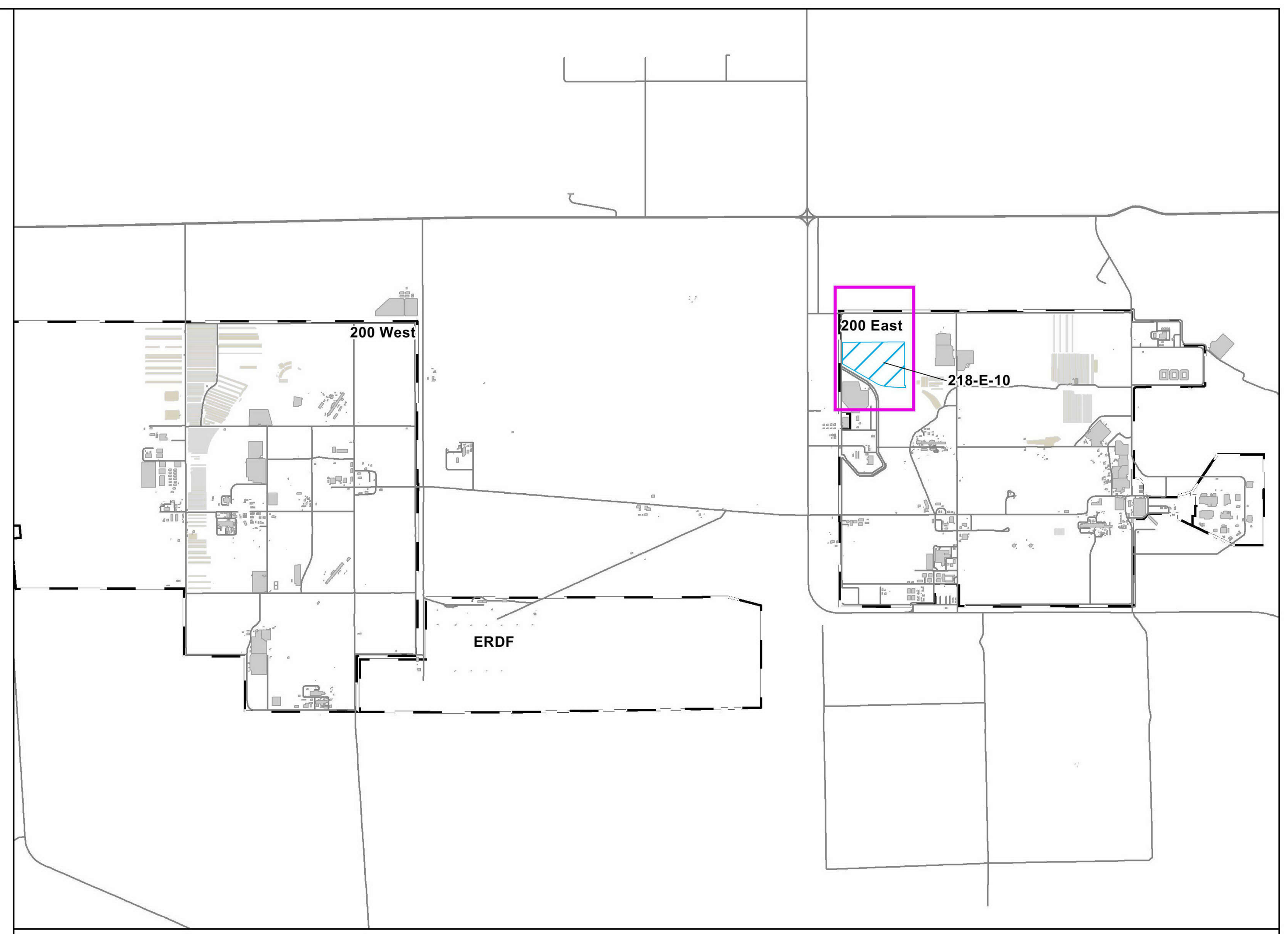
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 7.5 15 22.5 30 m

0 25 50 75 100 ft

CHSGW20140186





218-E-10 Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number
of detects or if U, total number of samples)

Proposed Field Work Activities

- Direct Push Borehole
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Post-August 19, 1987 Mixed Waste
- Radioactive Solid Waste

- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Waste Site
- Operational Boundary
- Roads

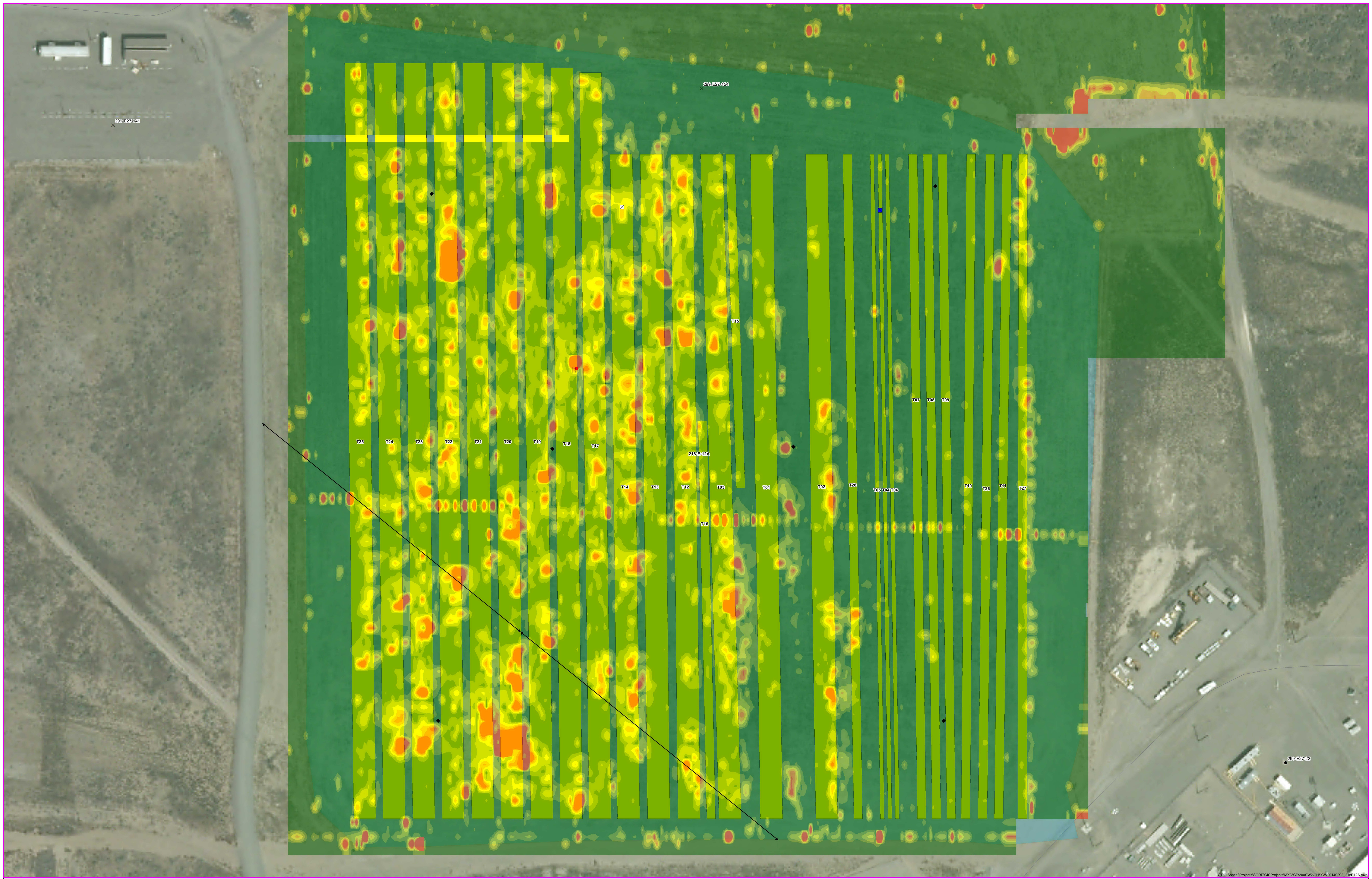
Notes:

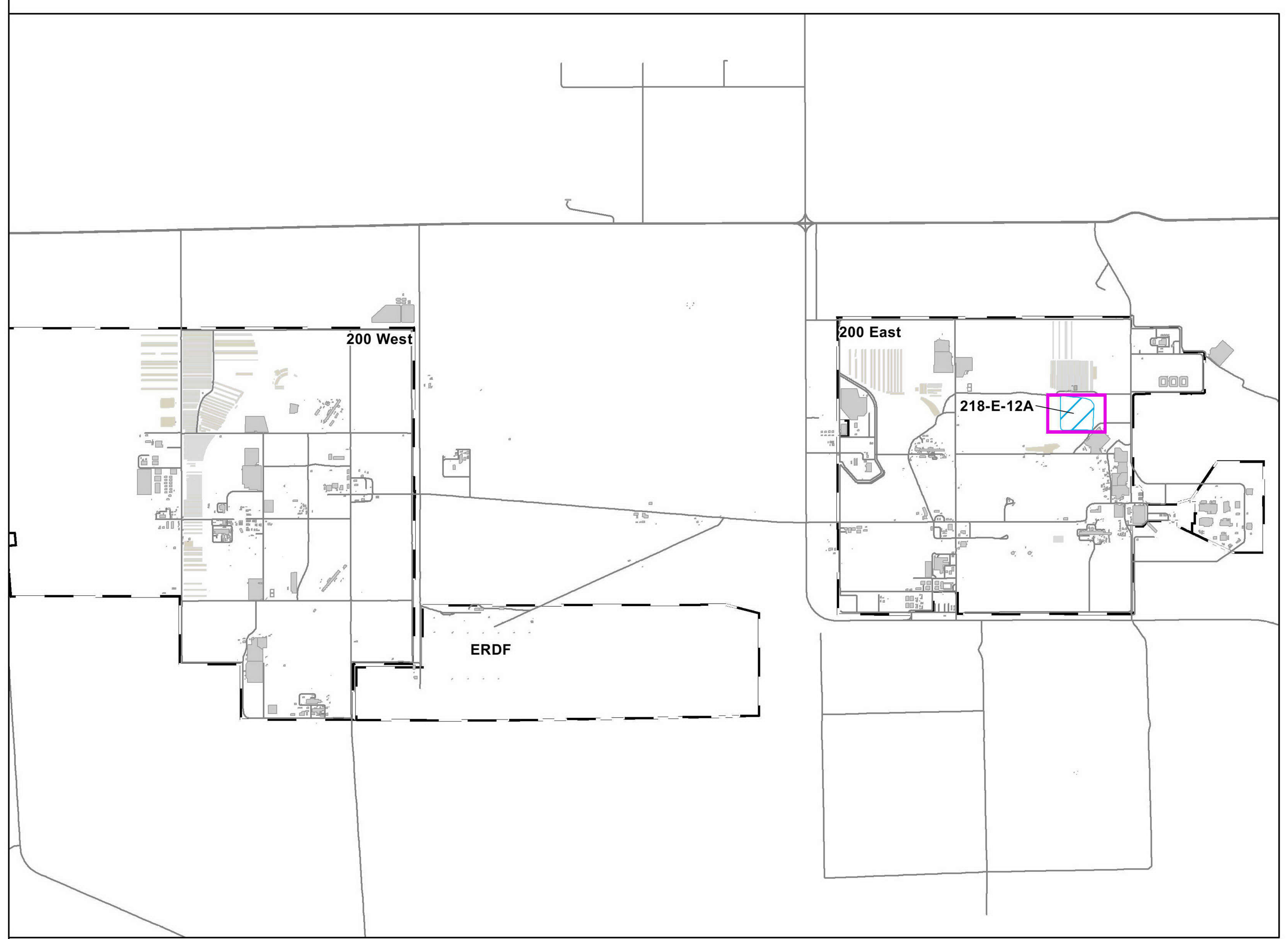
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 50 100 150 m

0 125 250 375 500 ft

CHSGW20140291





218-E-12A Landfill

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

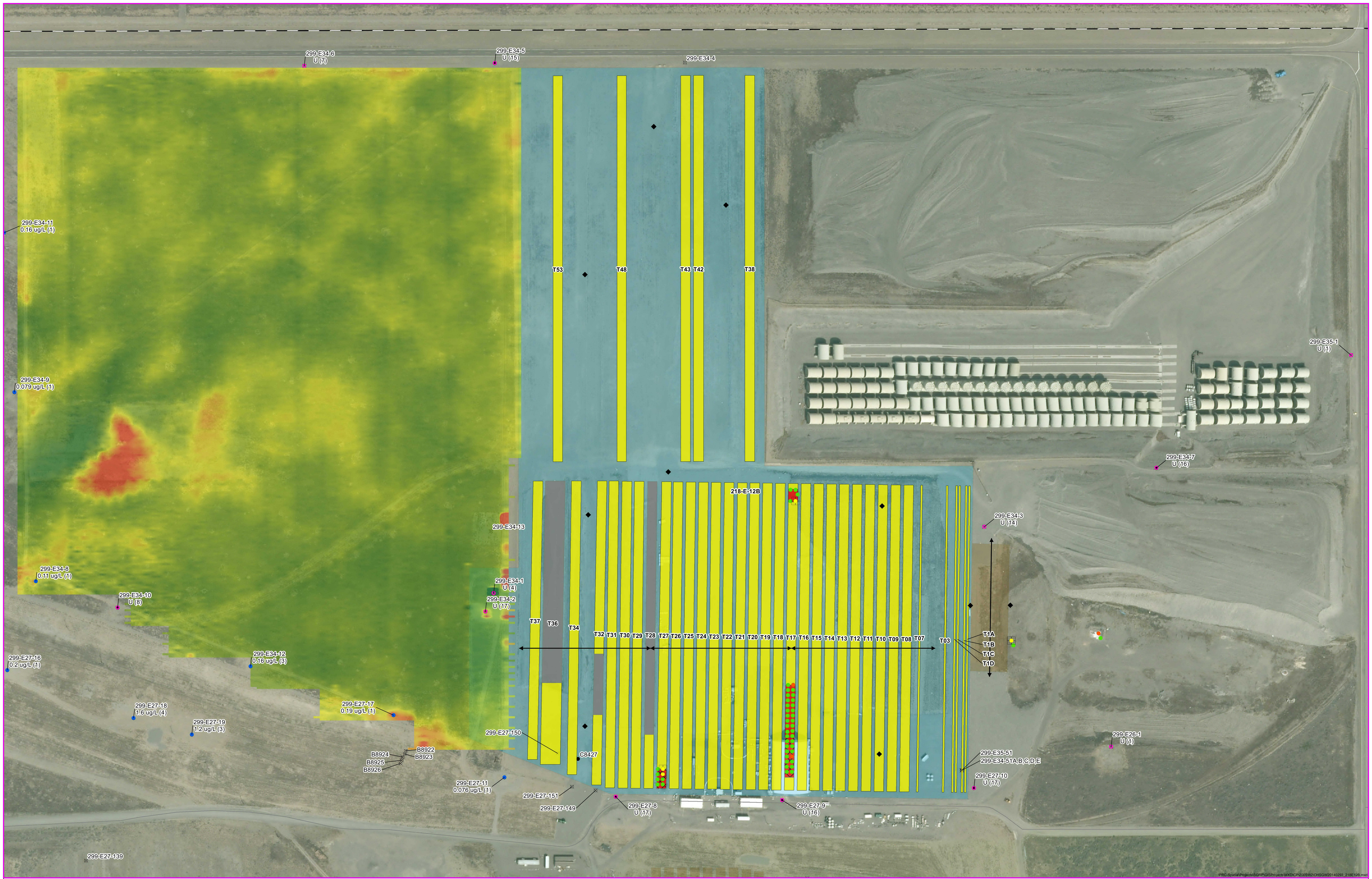
Notes:

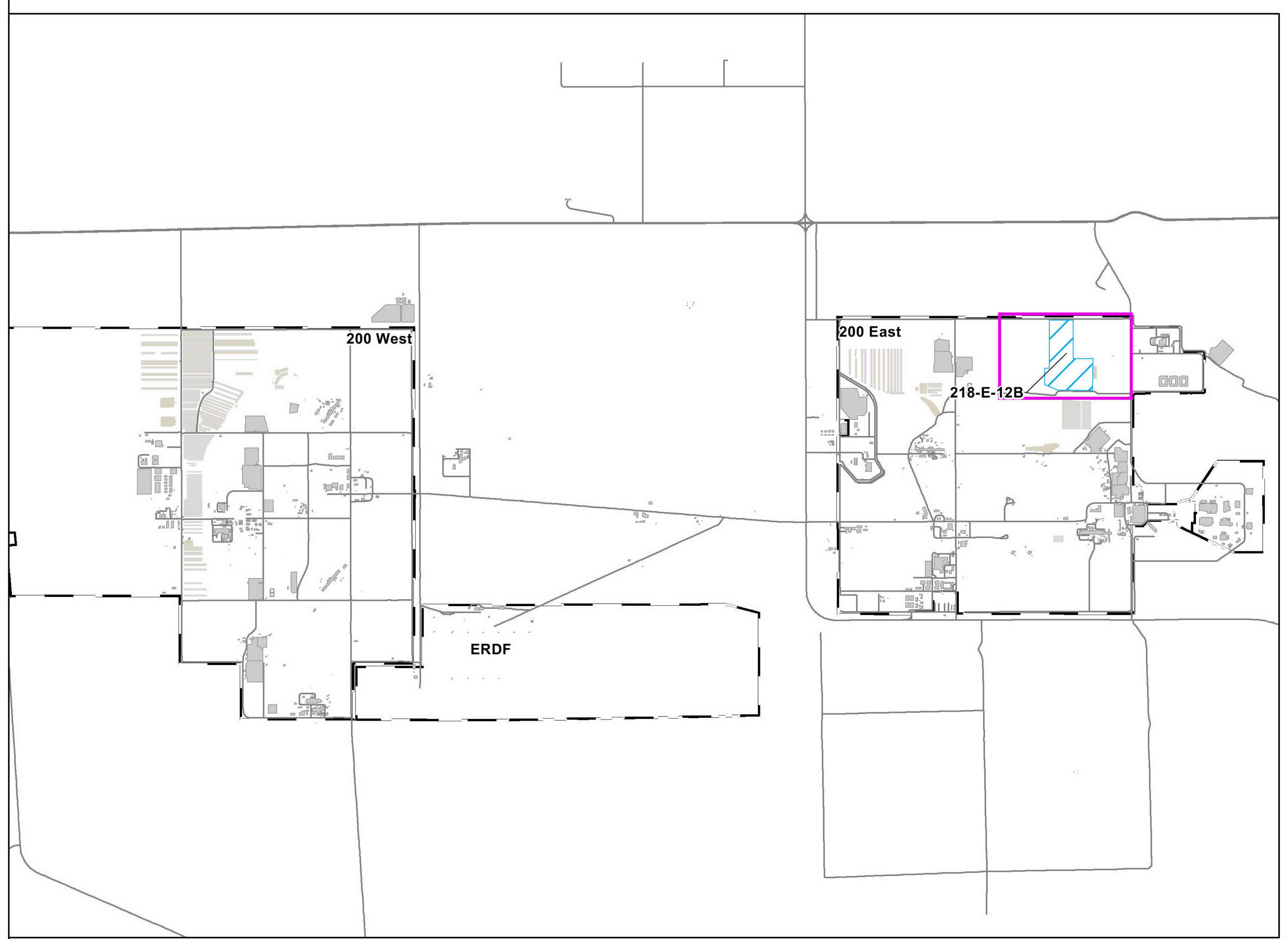
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 10 20 30 40 50 m

0 50 100 150 ft

CHSGW20140292





218-E-12B Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number
of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

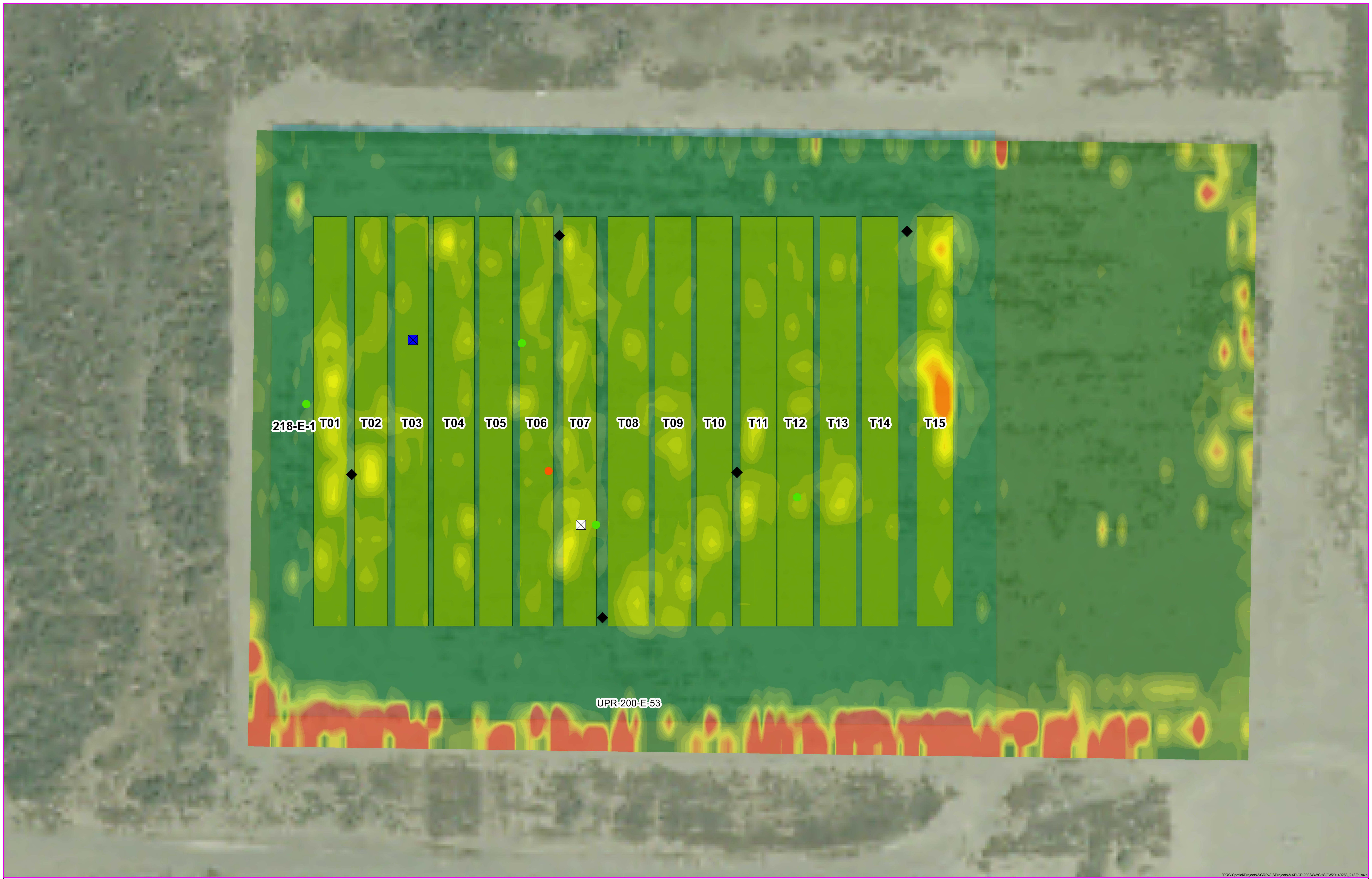
- TRU Stored Waste
- Radioactive Solid Waste
- Unused Trench Area
- Excavation
- Surrounding Burial Trenches
- Unused Waste Area
- Waste Site of Interest
- Operational Boundary
- Roads

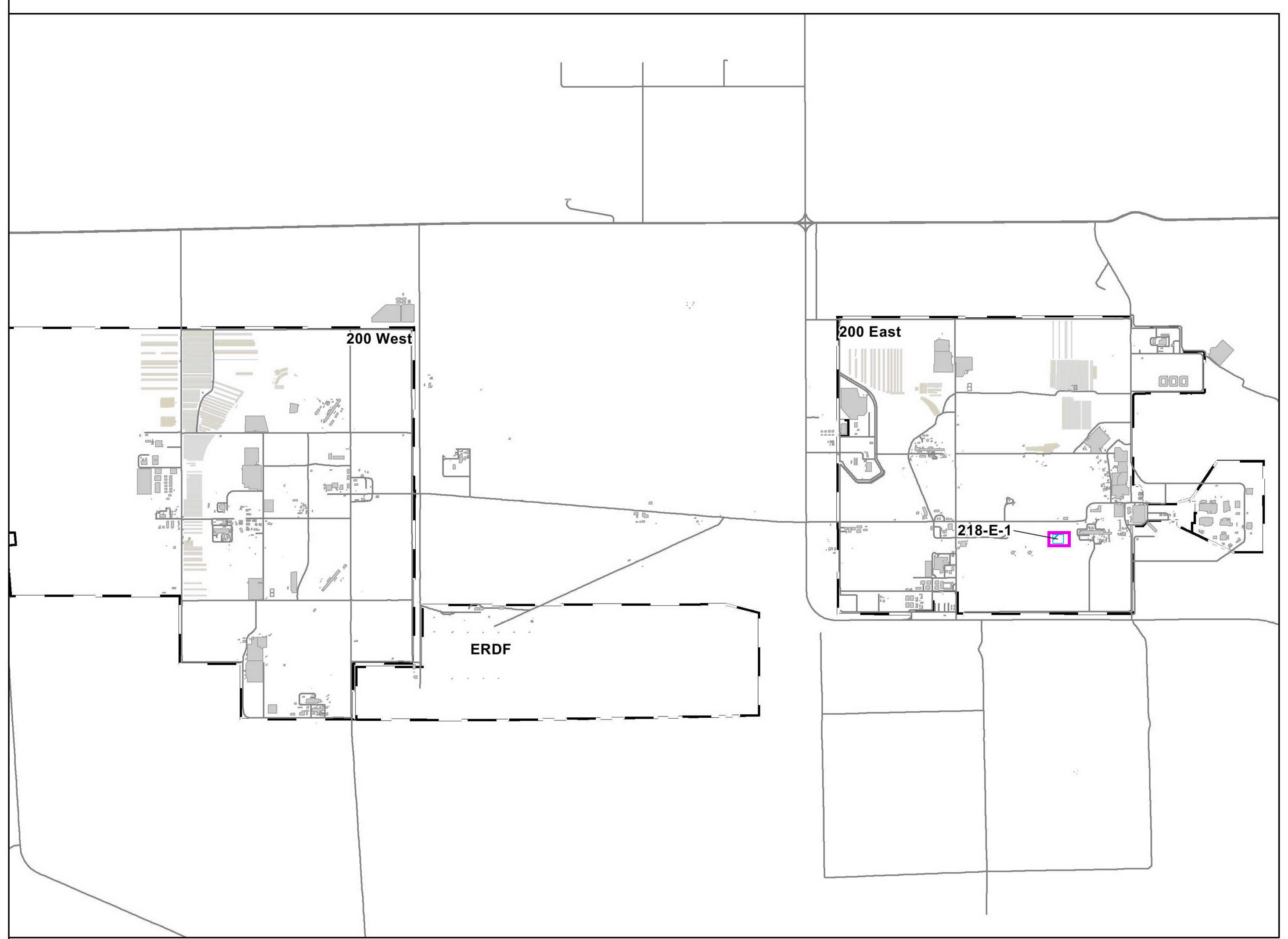
Notes:

- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 25 50 75 100 m
0 75 150 225 300 ft

CHSGW20140293





218-E-1 Landfill

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest

- Waste Site
- Operational Boundary
- Roads

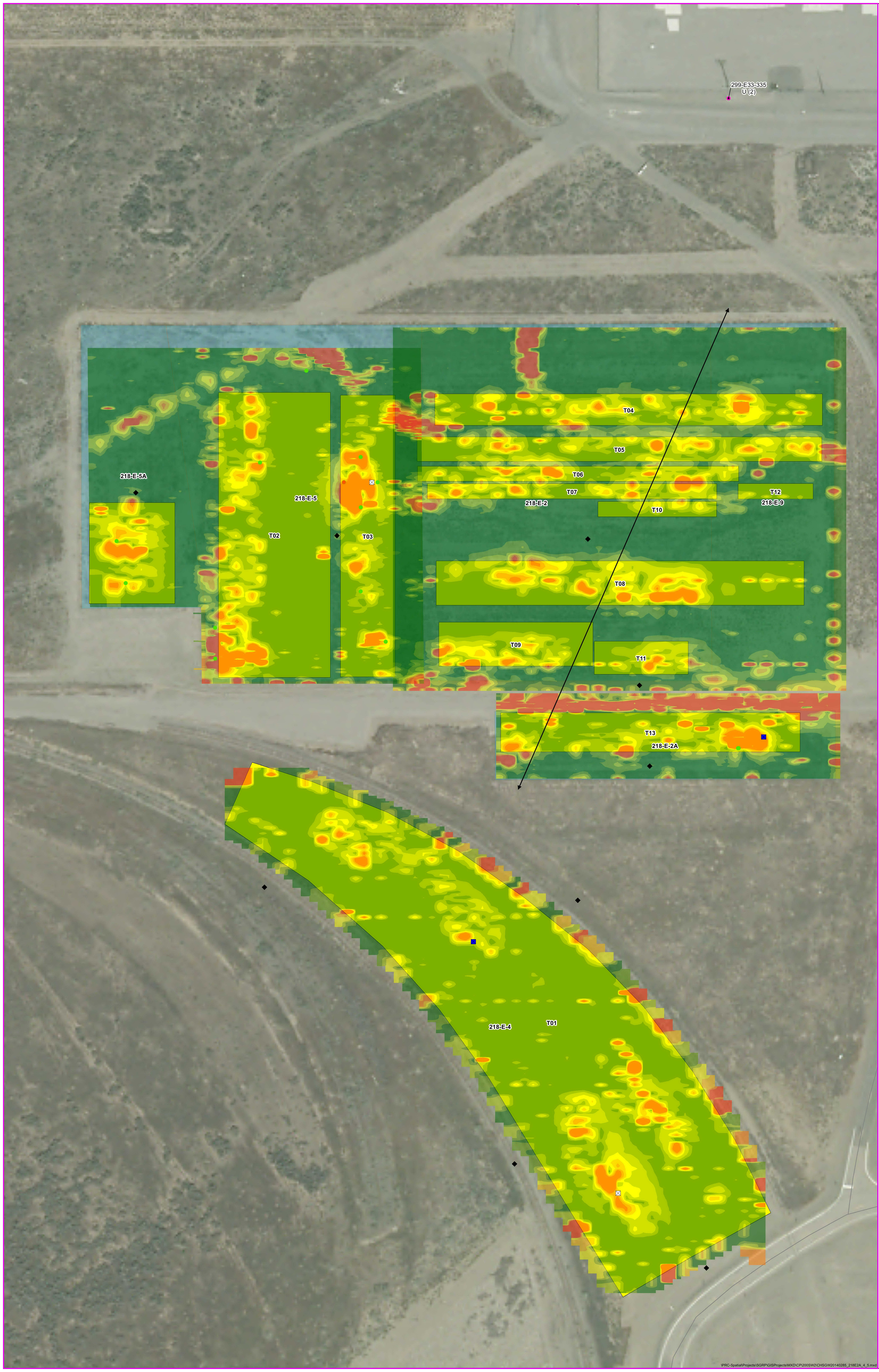
Notes:

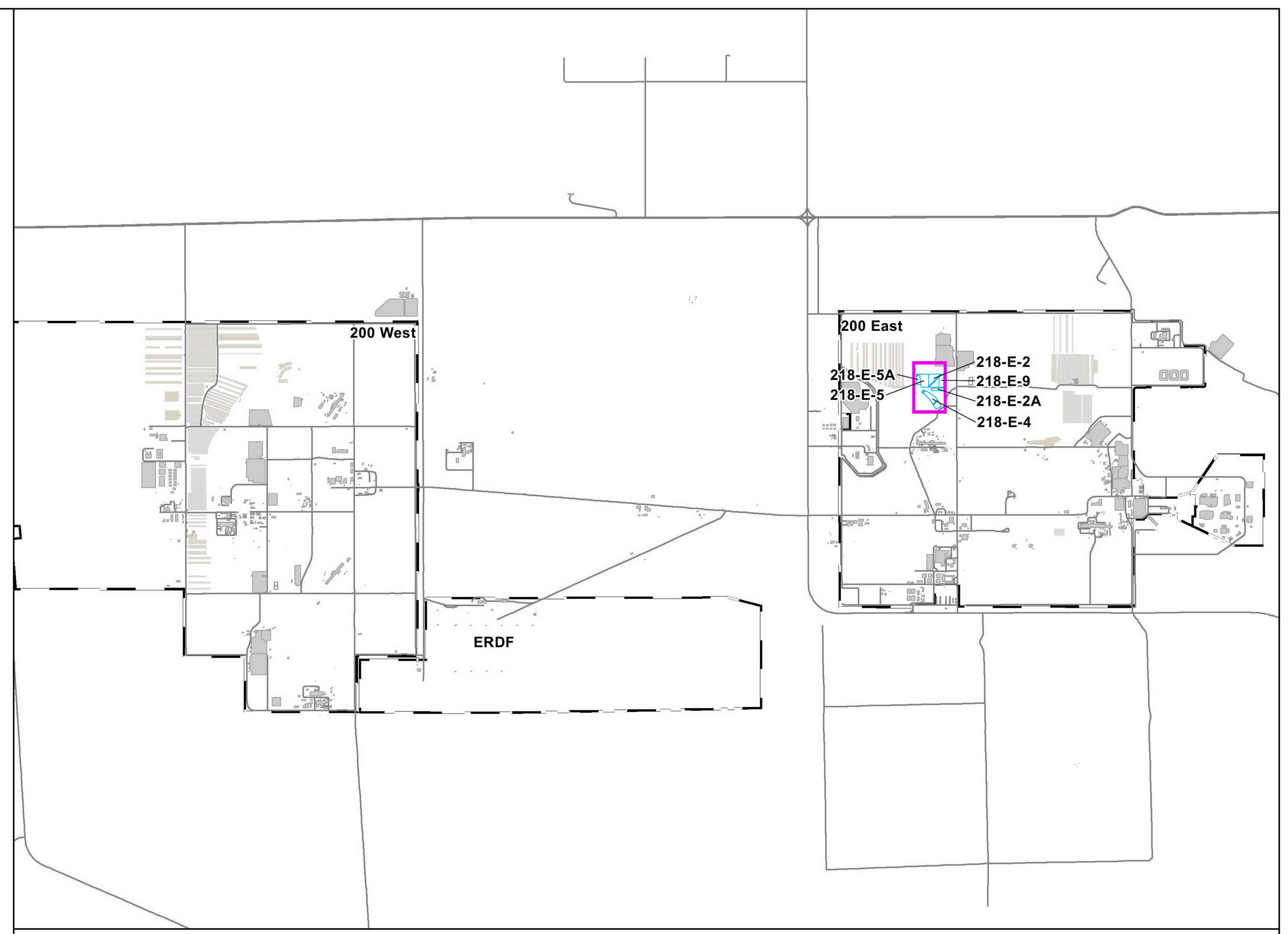
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 5 10 15 m

0 10 20 30 40 50 ft

CHSGW20140283





218-E-2, 2A, 4, 5, 5A, & 9 Landfills

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

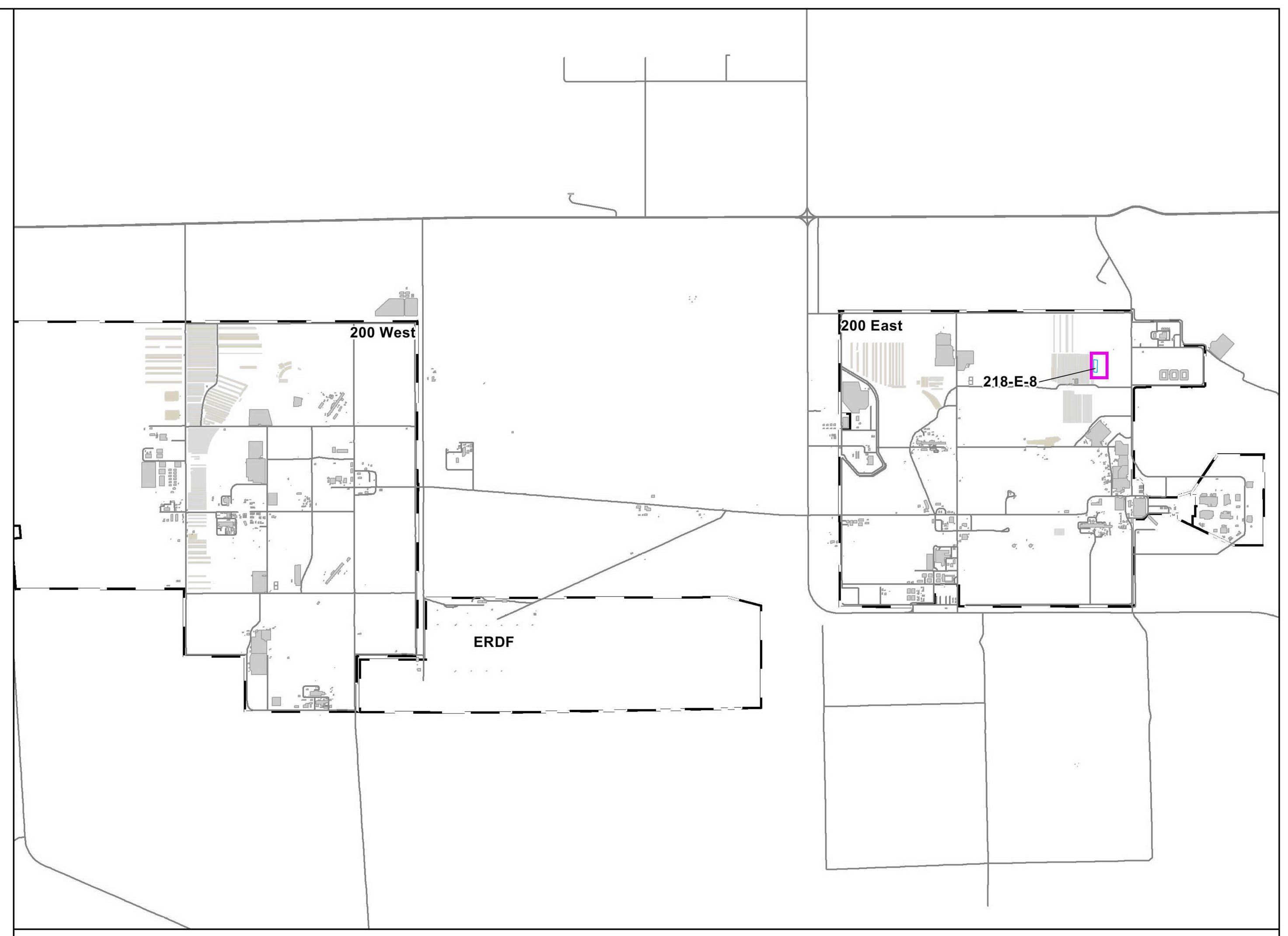
Notes:

- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 10 20 30 40 50 m

0 50 100 150 ft

CHSGW20140285



218-E-8 Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Potential Burial Trench Location (see 1969 aerial image)
- Roads

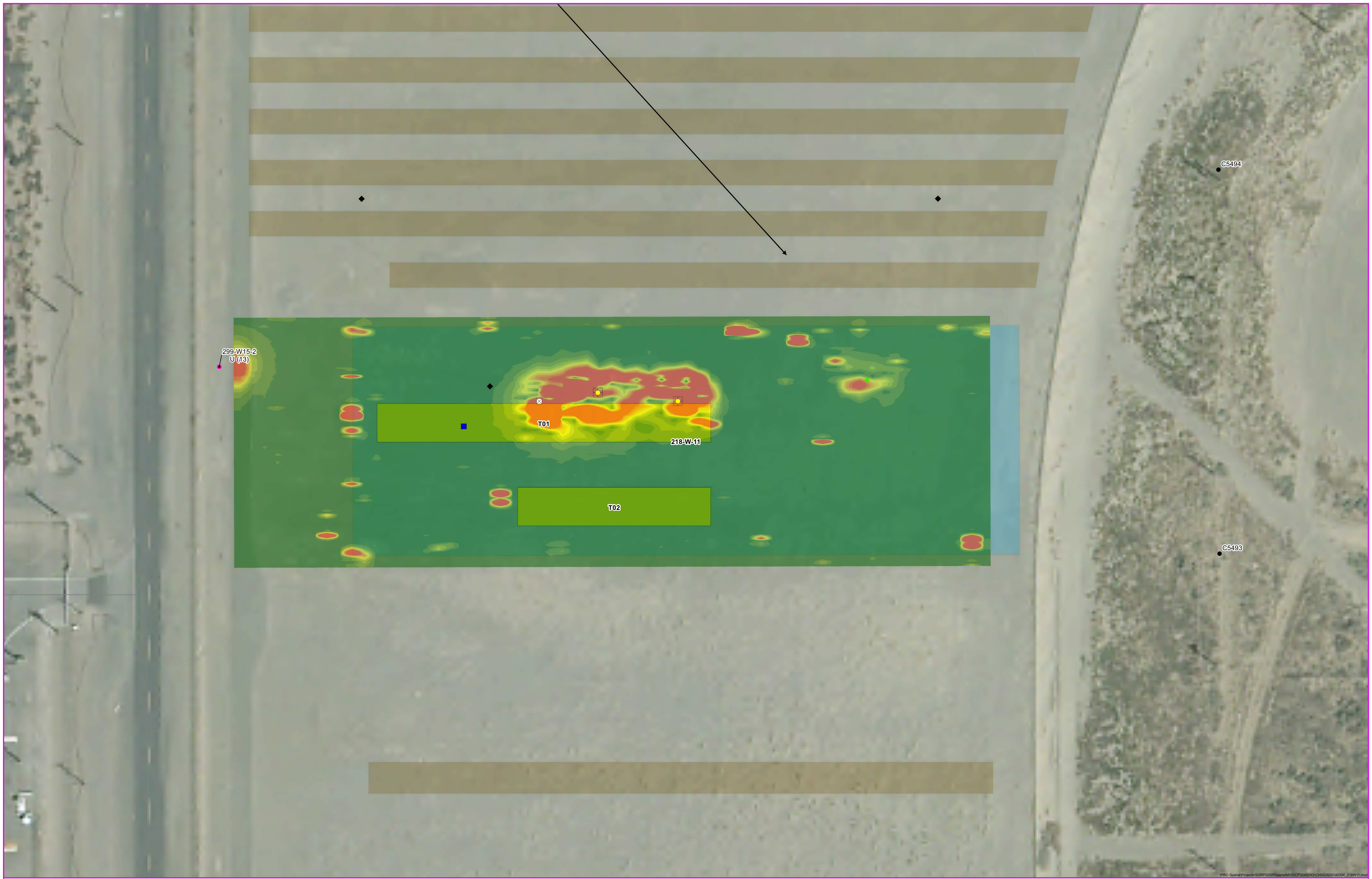
Notes:

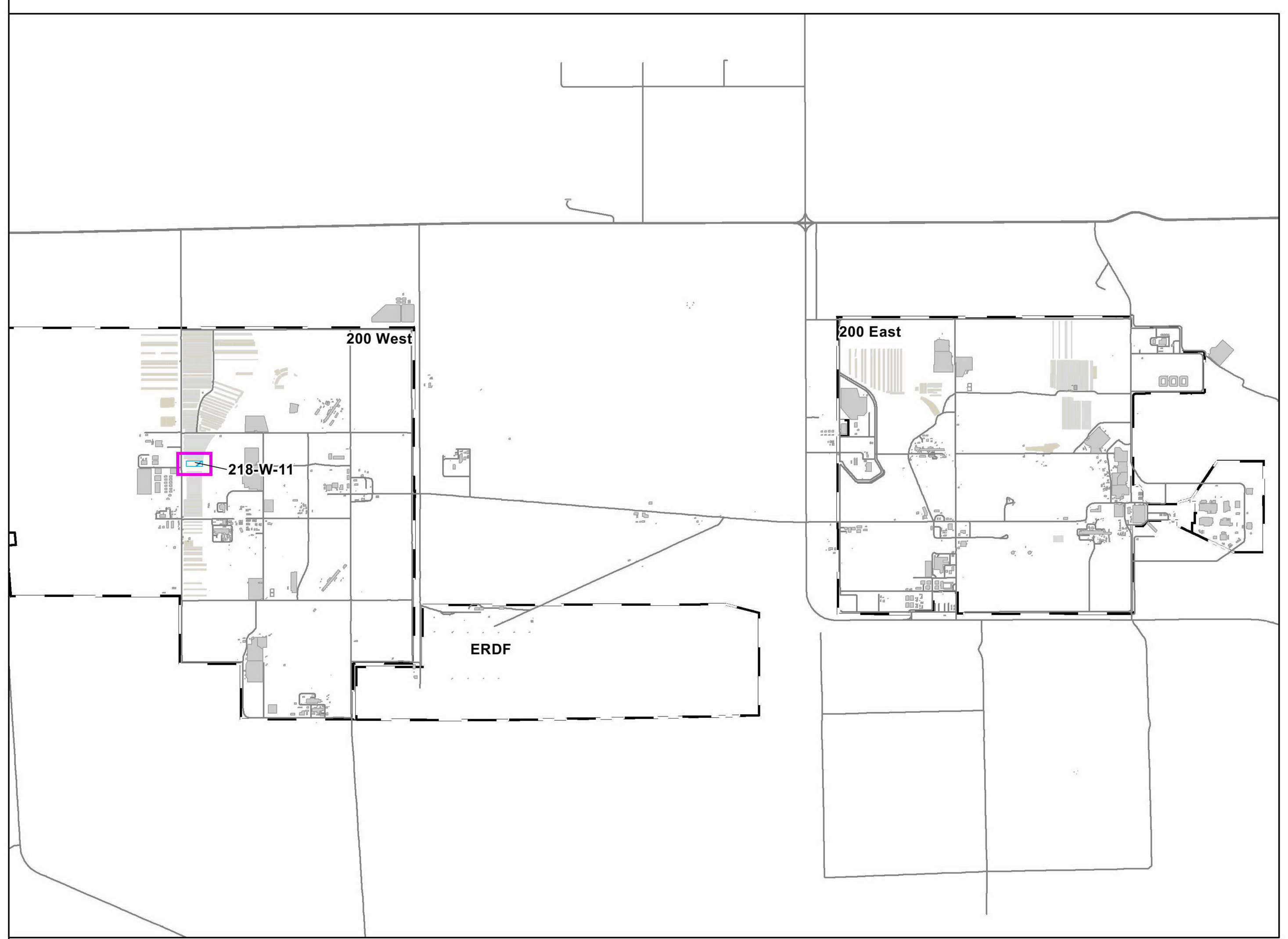
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 7.5 15 22.5 30 m
0 25 50 75 100 ft

CHSGW20140289

1969 Aerial Image - Looking South-West





218-W-11 Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number
of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

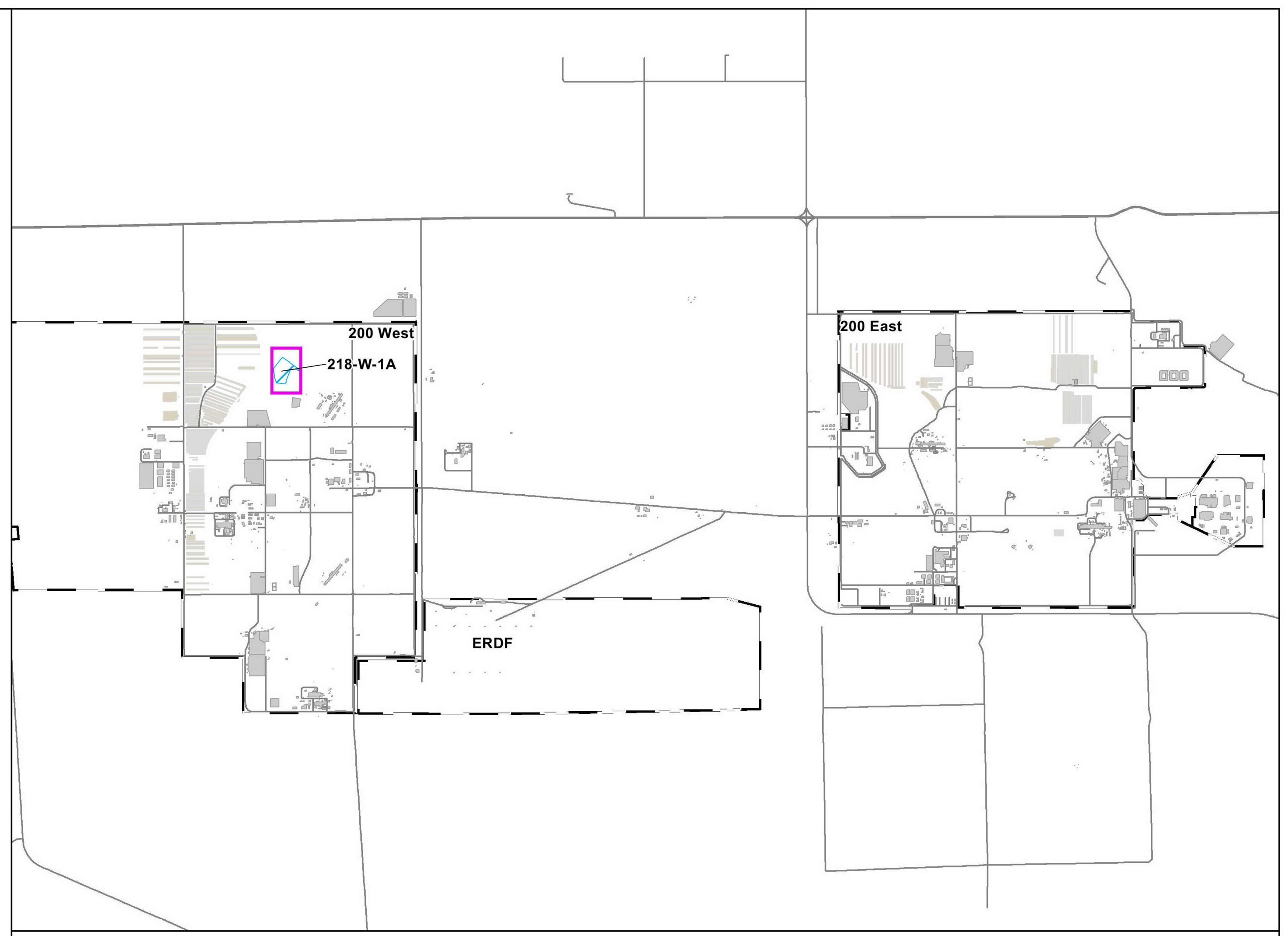
Notes:

- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 10 20 30 m

0 25 50 75 100 ft

CHSGW20140304



218-W-1A Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole

Well Locations

- In Use Location
- Decommissioned Location

Burial Trench Catagory

- Radioactive Solid Waste

Unused Waste Area

Surrounding Burial Trenches

Waste Site of Interest

Operational Boundary

Roads

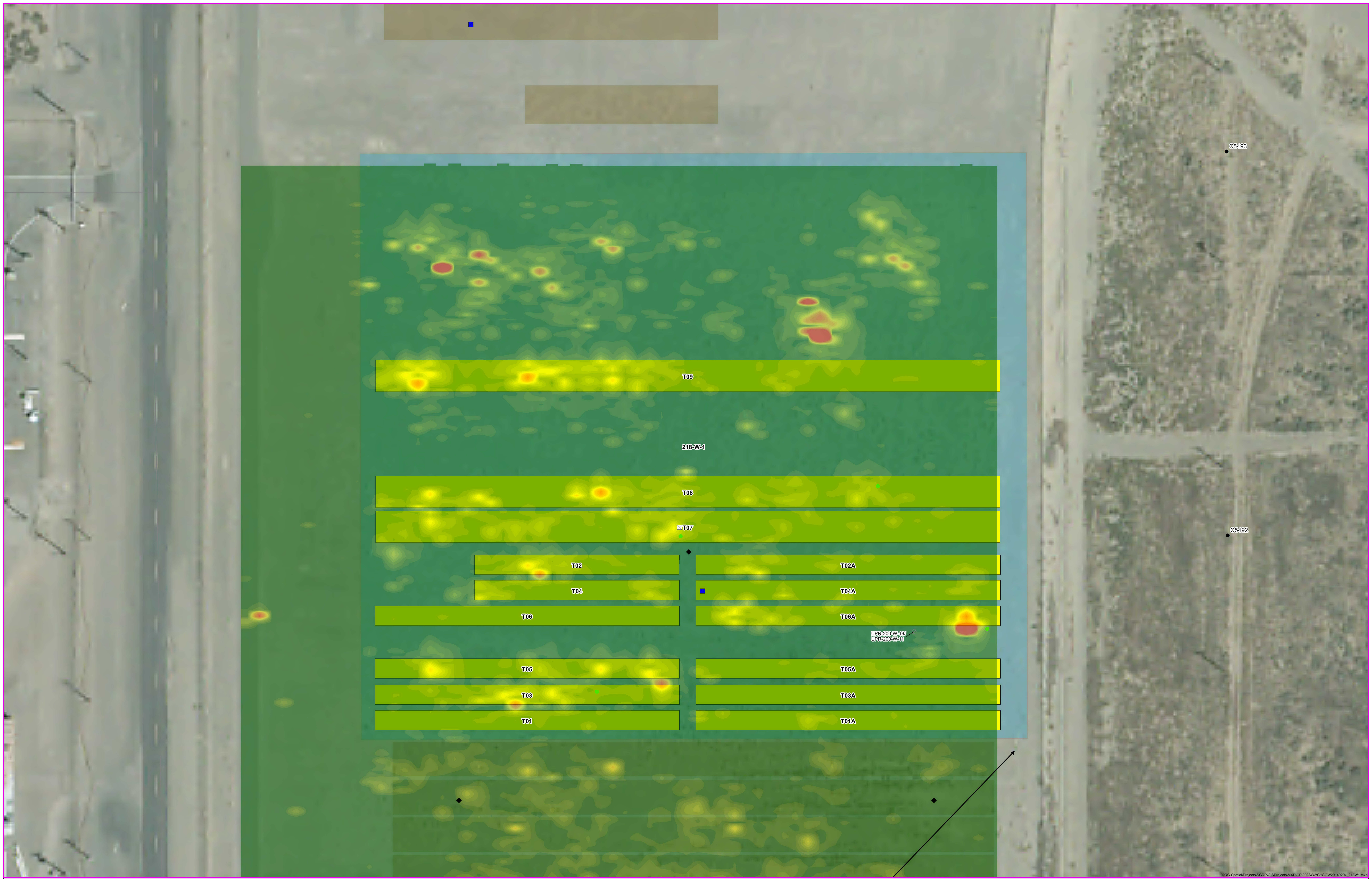
Notes:

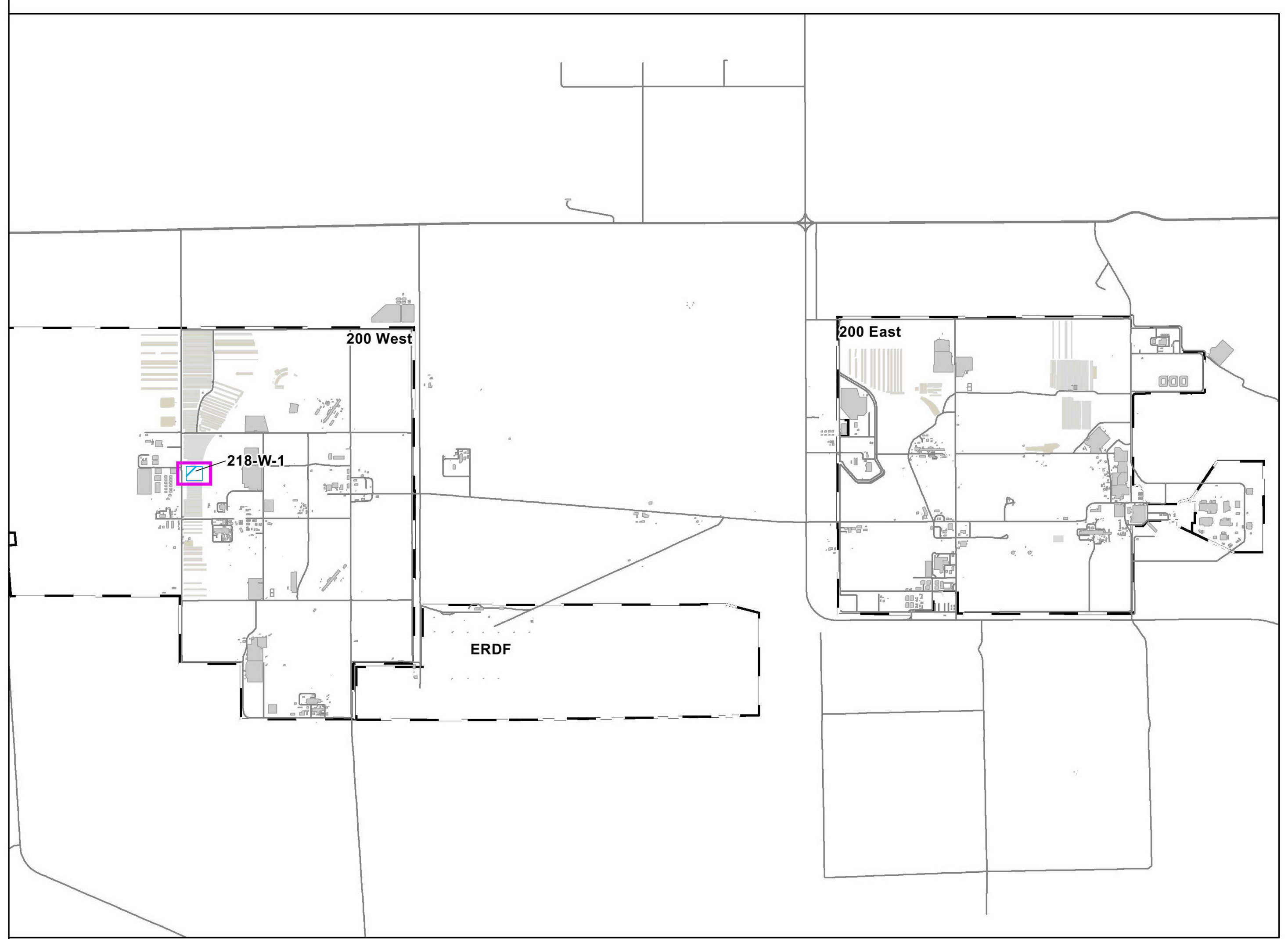
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 10 20 30 40 m

0 30 60 90 120 ft

CHSGW20140295





218-W-1 Landfill

Soil Gas Locations
- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities
- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations
- In Use Location
- Decommissioned Location
- Proposed Location

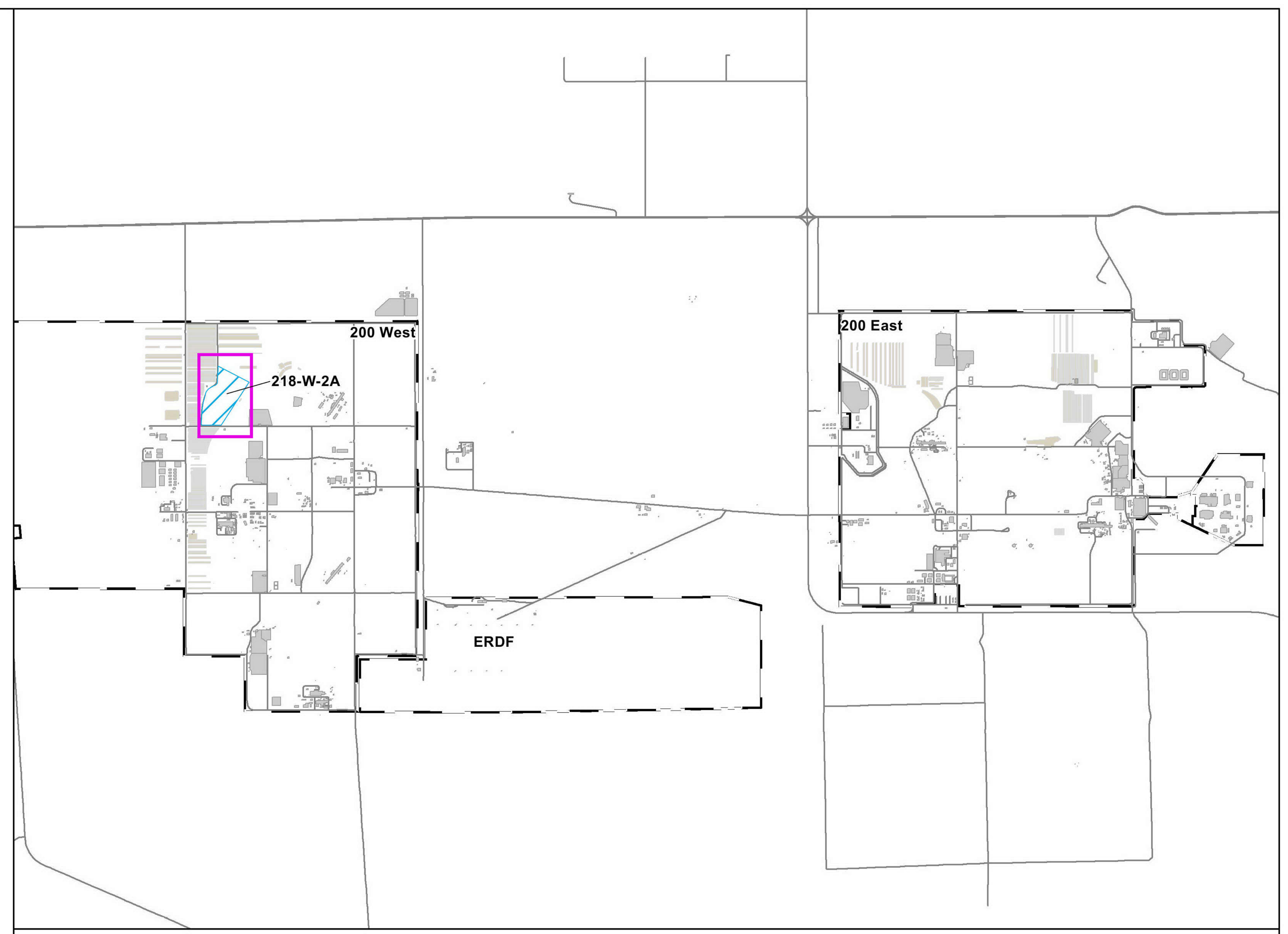
Burial Trench Catagory
- Radioactive Solid Waste

- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Waste Site
- Operational Boundary
- Roads

Notes:
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 6 12 18 24 m
0 25 50 75 100 ft

CHSGW20140294



218-W-2A Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Waste Site
- Operational Boundary
- Roads

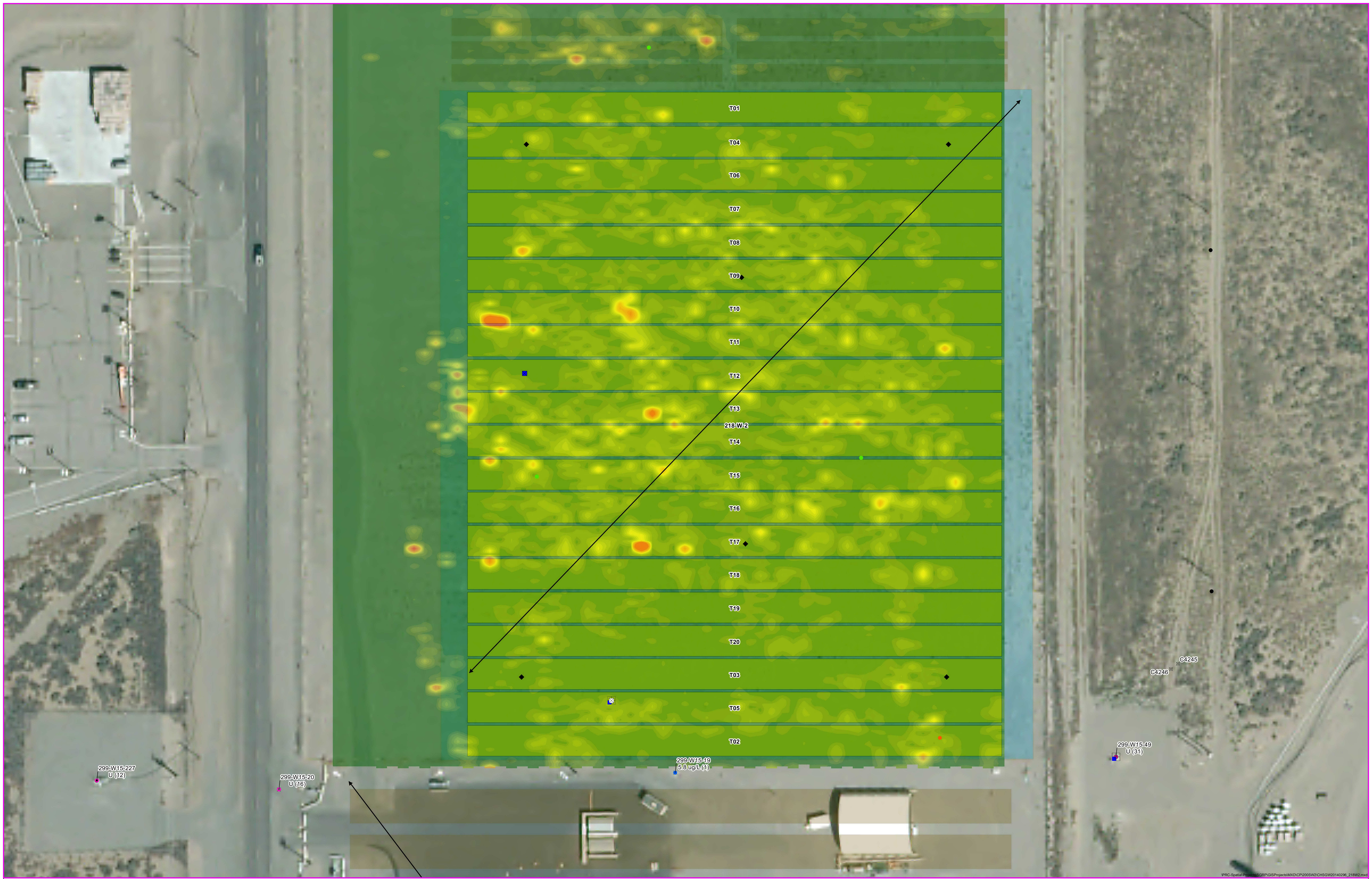
Notes:

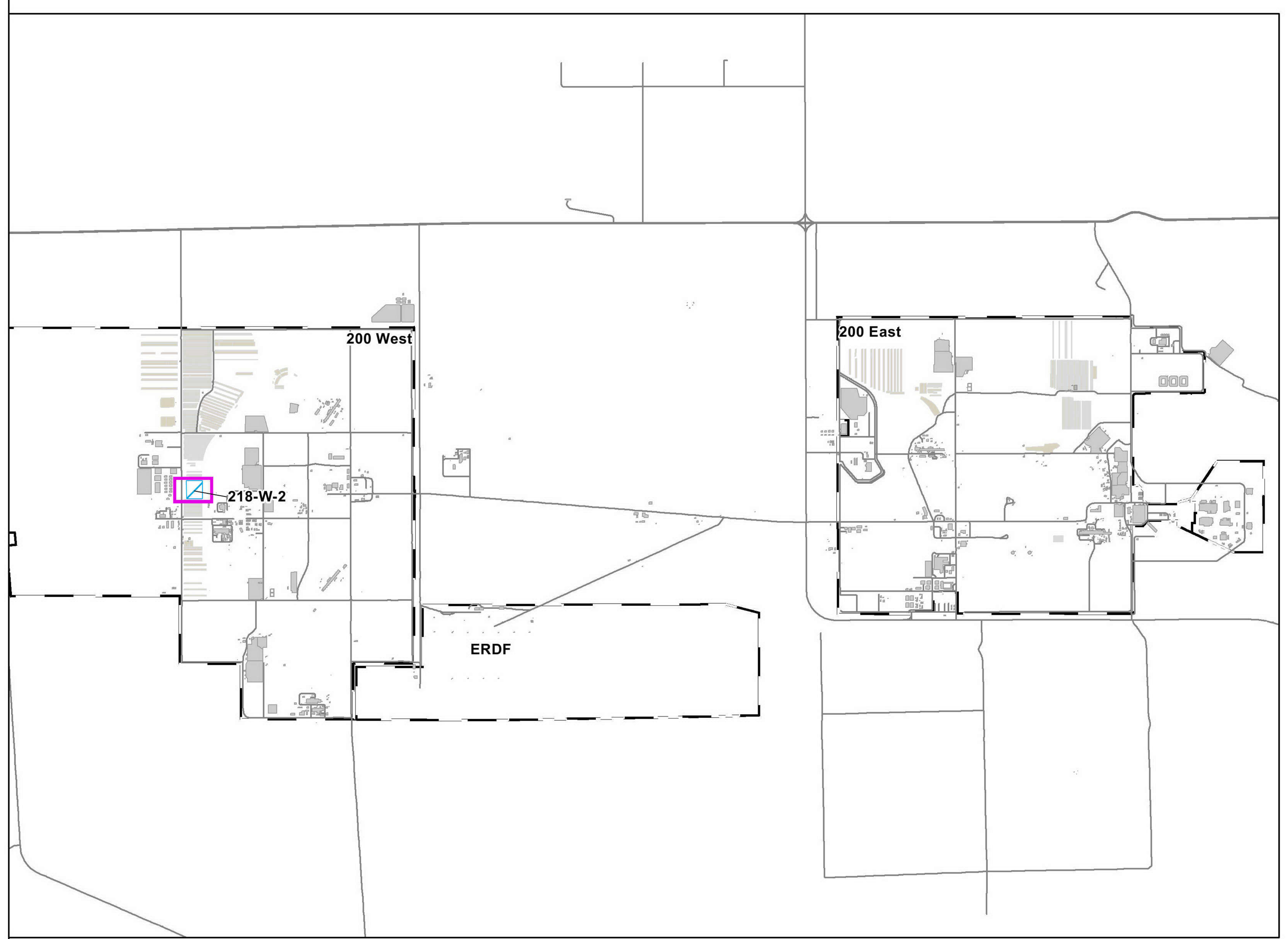
- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 25 50 75 100 m

0 75 150 225 300 ft

CHSGW20140297





218-W-2 Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

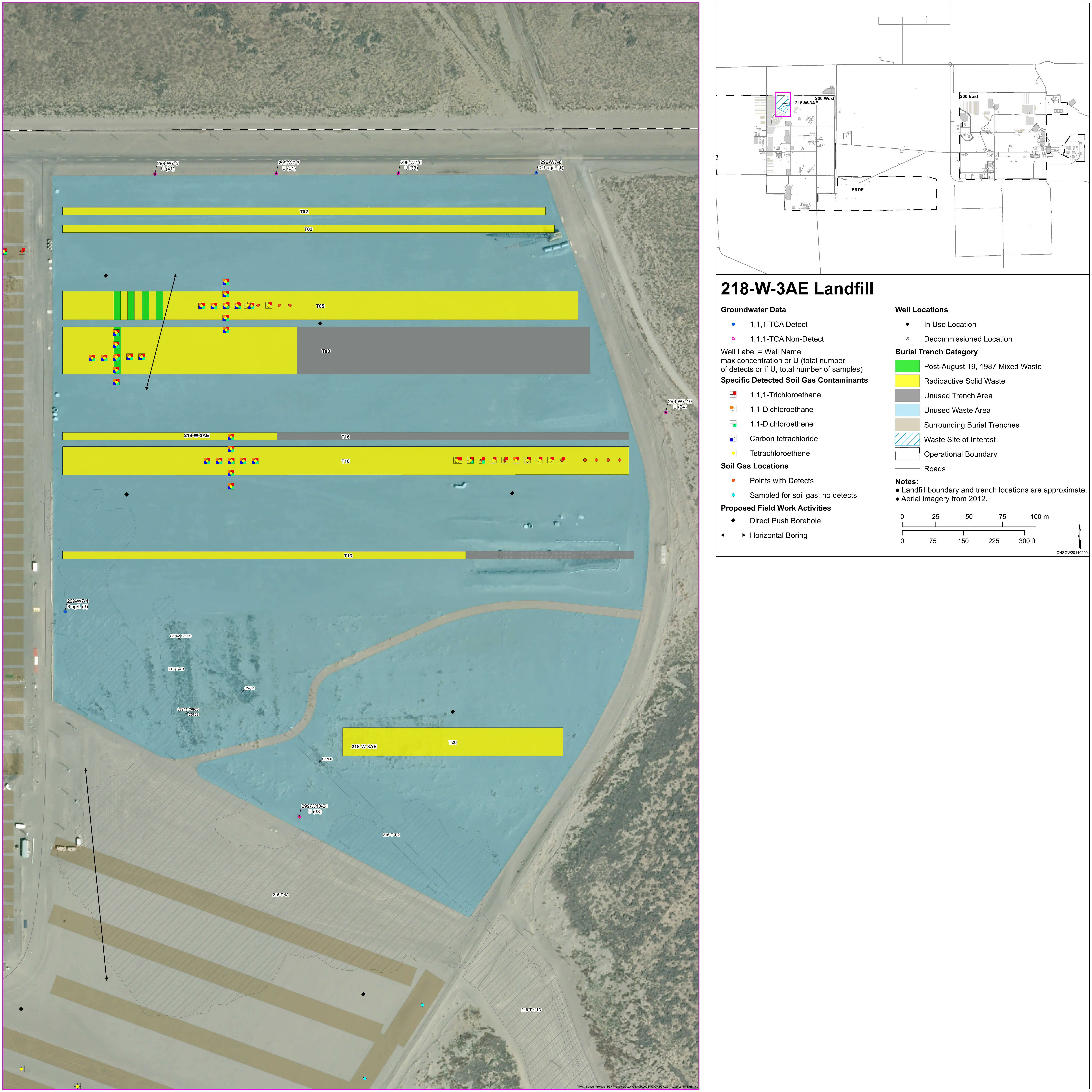
Notes:

- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

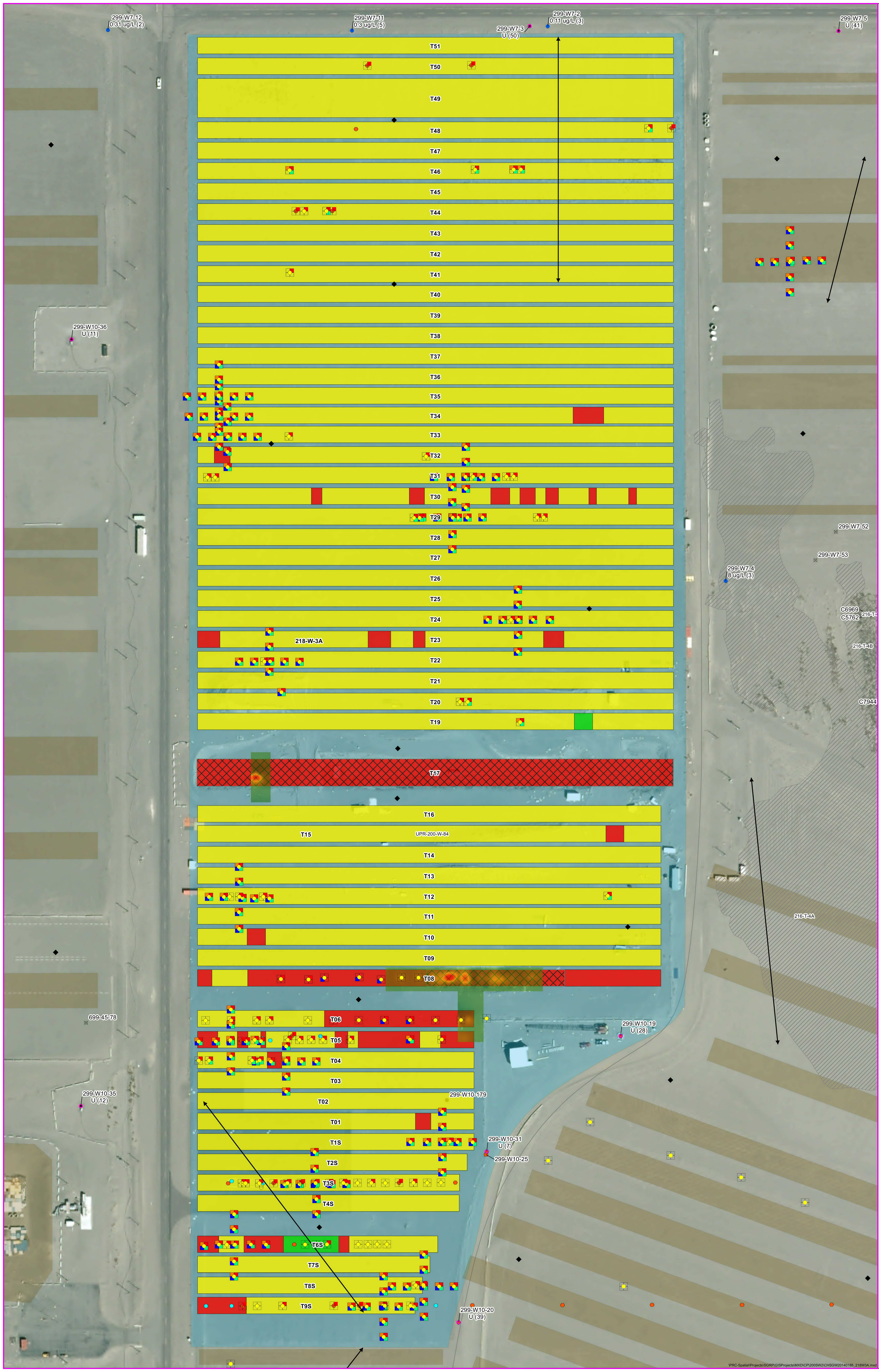
0 7.5 15 22.5 30 m

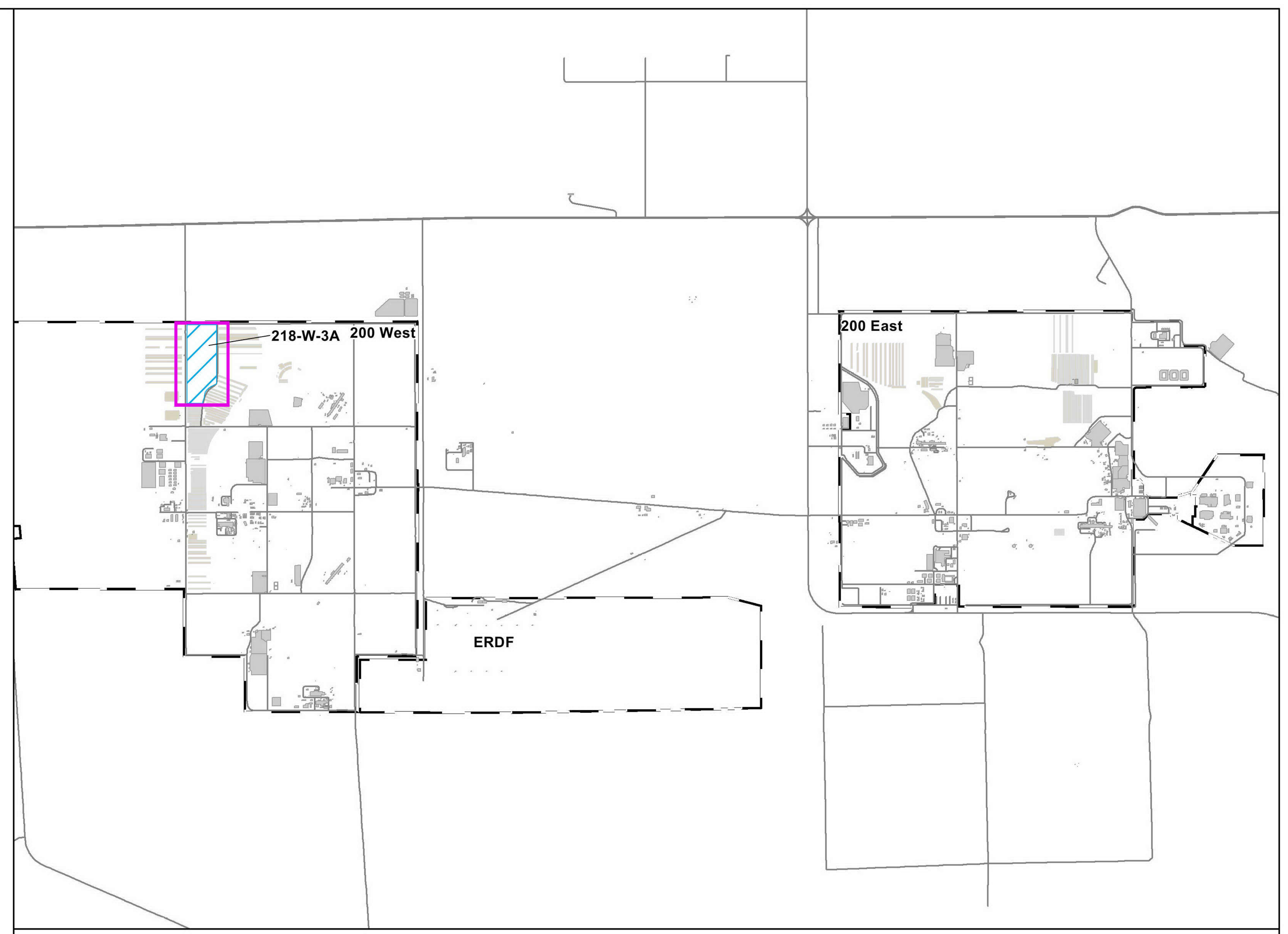
0 25 50 75 100 ft

CHSGW20140296



218-W-3AE Landfill
Groundwater Data
1,1,1-TCA Detect
1,1,1-TCA Non-Detect
Well Label = Well Name
max concentration or U (total number
of detects or if U, total number of samples)
Specific Detected Soil Gas Contaminants
1,1,1-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethene
Carbon tetrachloride
Tetrachloroethene
Soil Gas Locations
Points with Detects
Sampled for soil gas; no detects
Proposed Field Work Activities
Direct Push Borehole
Horizontal Boring
Well Locations
In Use Location
Decommissioned Location
Burial Trench Catagory
Post-August 19, 1987 Mixed Waste
Radioactive Solid Waste
Unused Trench Area
Unused Waste Area
Surrounding Burial Trenches
Waste Site of Interest
Operational Boundary
Roads
Notes:
● Landfill boundary and trench locations are approximate.
● Aerial imagery from 2012.
0 25 50 75 100 m
0 75 150 225 300 ft
CHSGW20140299
200 West
218-W-3AE
200 East
ERDF
299-W7-5 U (41)
299-W7-7 U (34)
299-W7-6 U (33)
299-W7-8 0.3 ug/L (1)
T02
T03
T05
T08
218-W-3AE
T16
T10
T13
299-W7-10 U (24)
299-W7-4 8 ug/L (3)
T26
299-W10-21 U (38)





218-W-3A Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas: no detects

Proposed Field Work Activities

- Direct Push Borehole
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

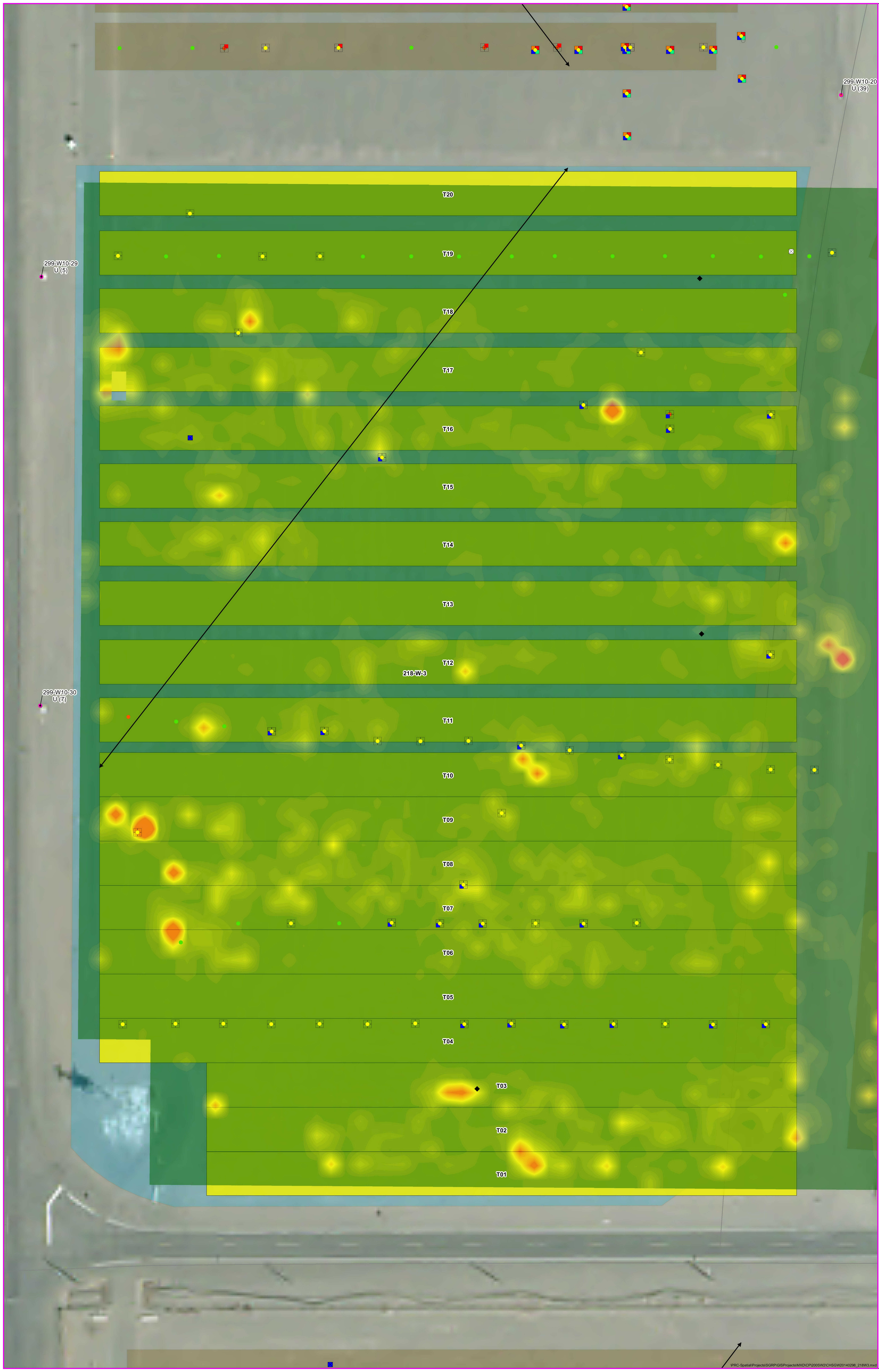
- Post-August 19, 1987 Mixed Waste
- TRU Stored Waste
- Radioactive Solid Waste
- Excavated Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Waste Site
- Operational Boundary
- Roads

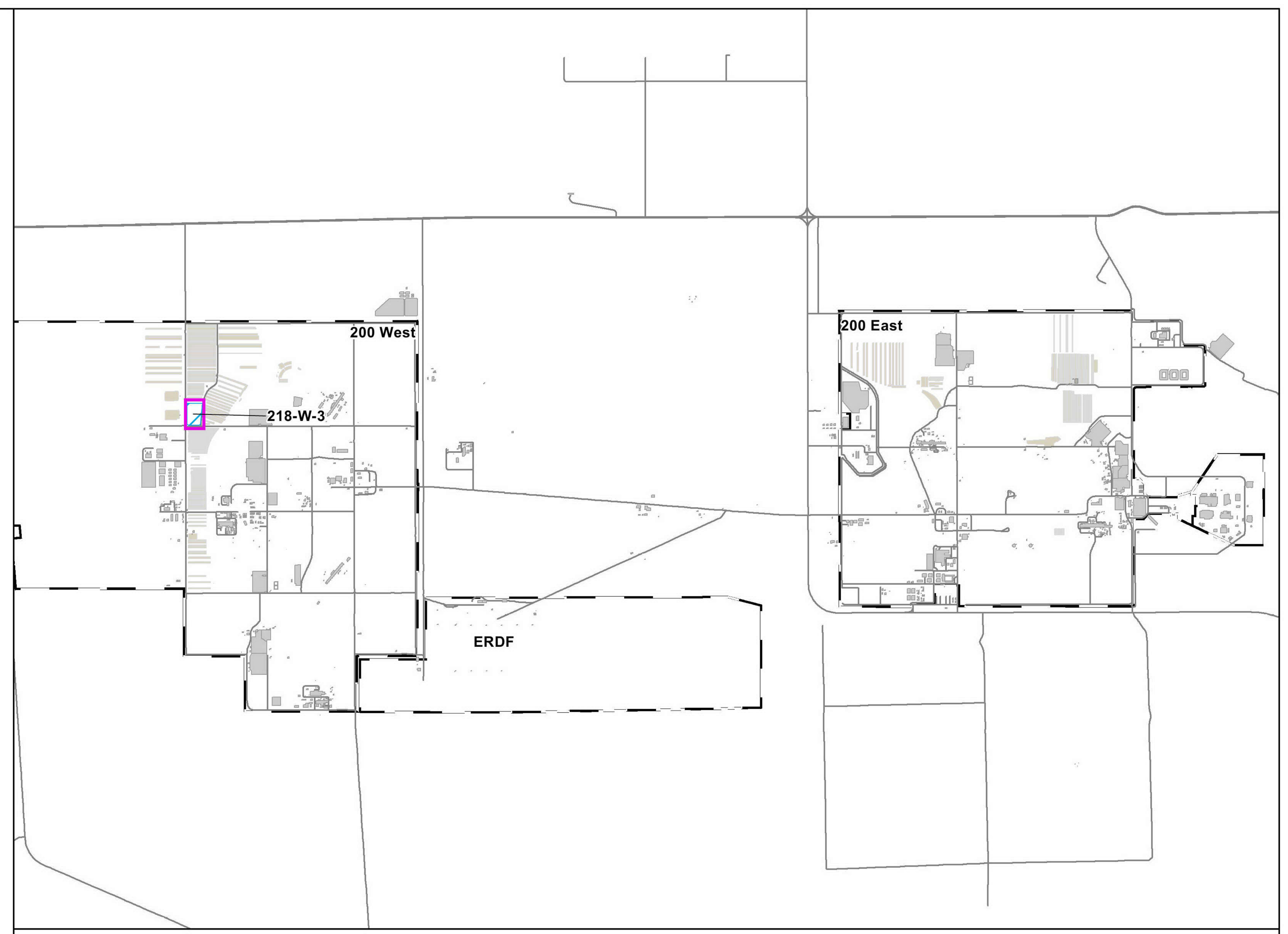
Notes:

- Landfill boundary and trench locations are approximate.
- Geophysical survey results are shown as background colors in red (highest intensity signal), yellow (medium), and green (lowest). High intensity signals suggest the presence of natural objects, waste, or soil matrices with high electrical conductivity.
- Aerial imagery from 2012.

0 25 50 75 100 m
0 75 150 225 300 ft

CHSGW20140185





218-W-3 Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location

Burial Trench Catagory

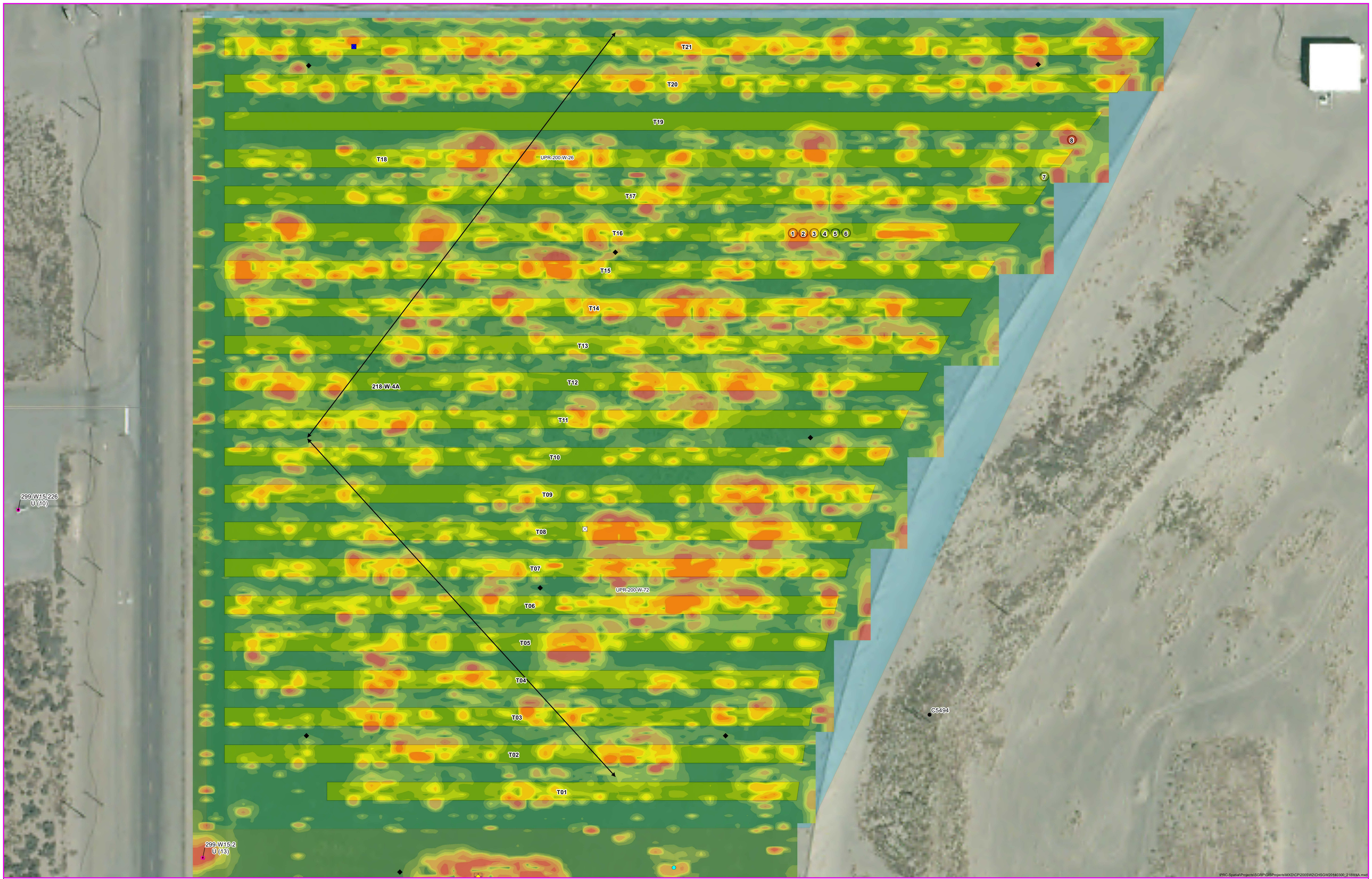
- Radioactive Solid Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

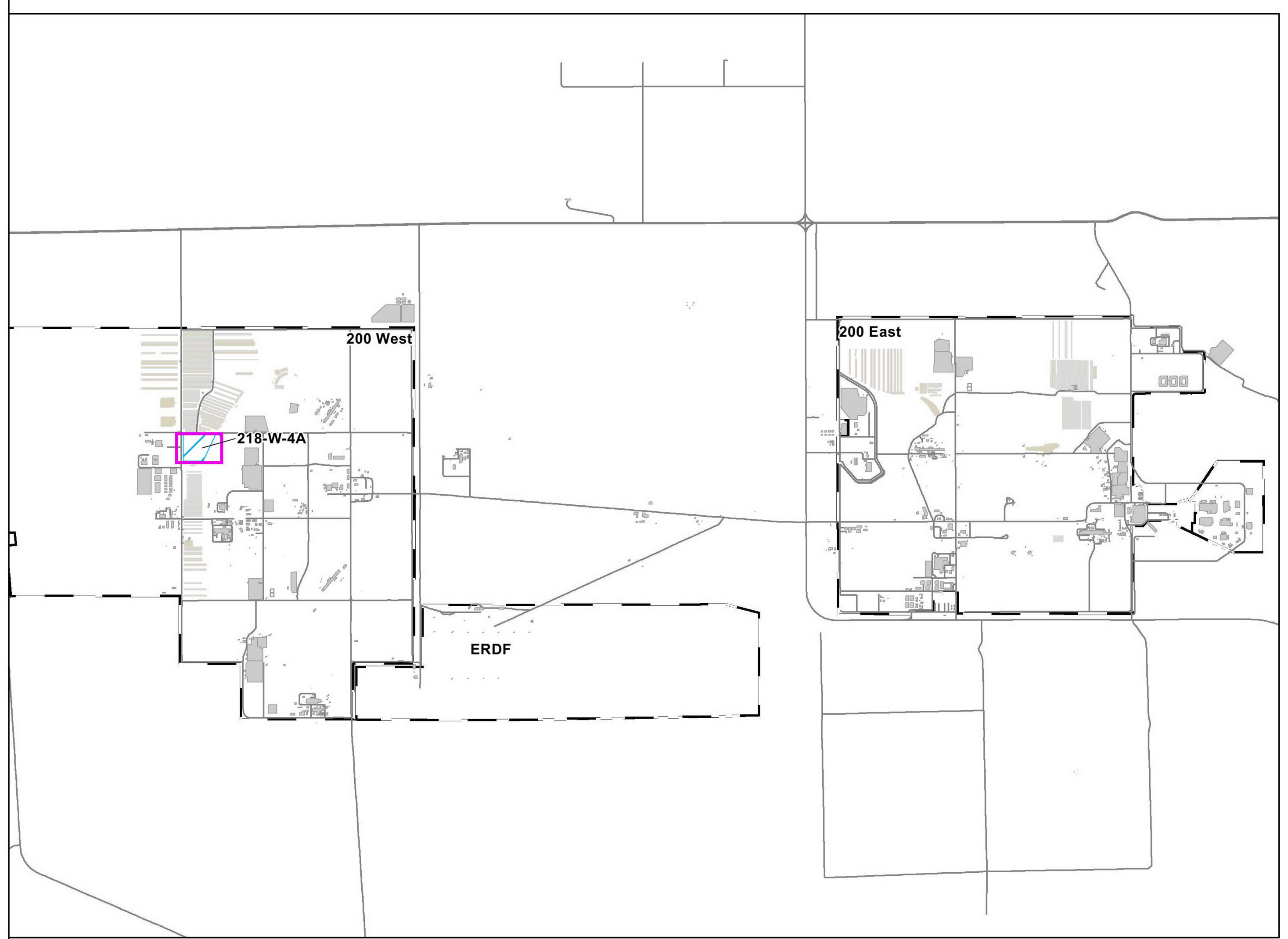
Notes:

- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 7.5 15 22.5 30 m
0 25 50 75 100 ft

CHSGW20140298





218-W-4A Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Caisson
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Waste Site
- Operational Boundary
- Roads

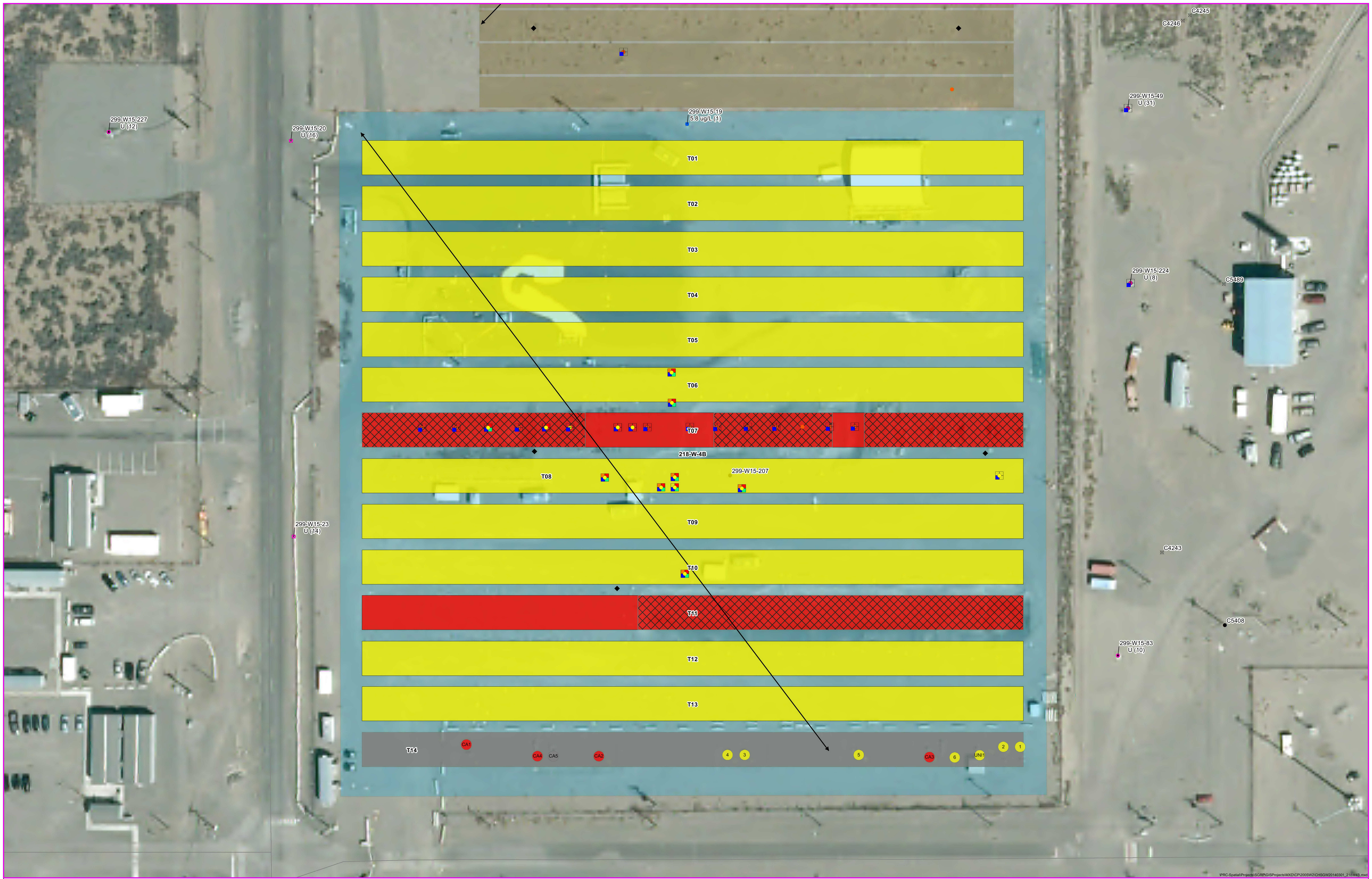
Notes:

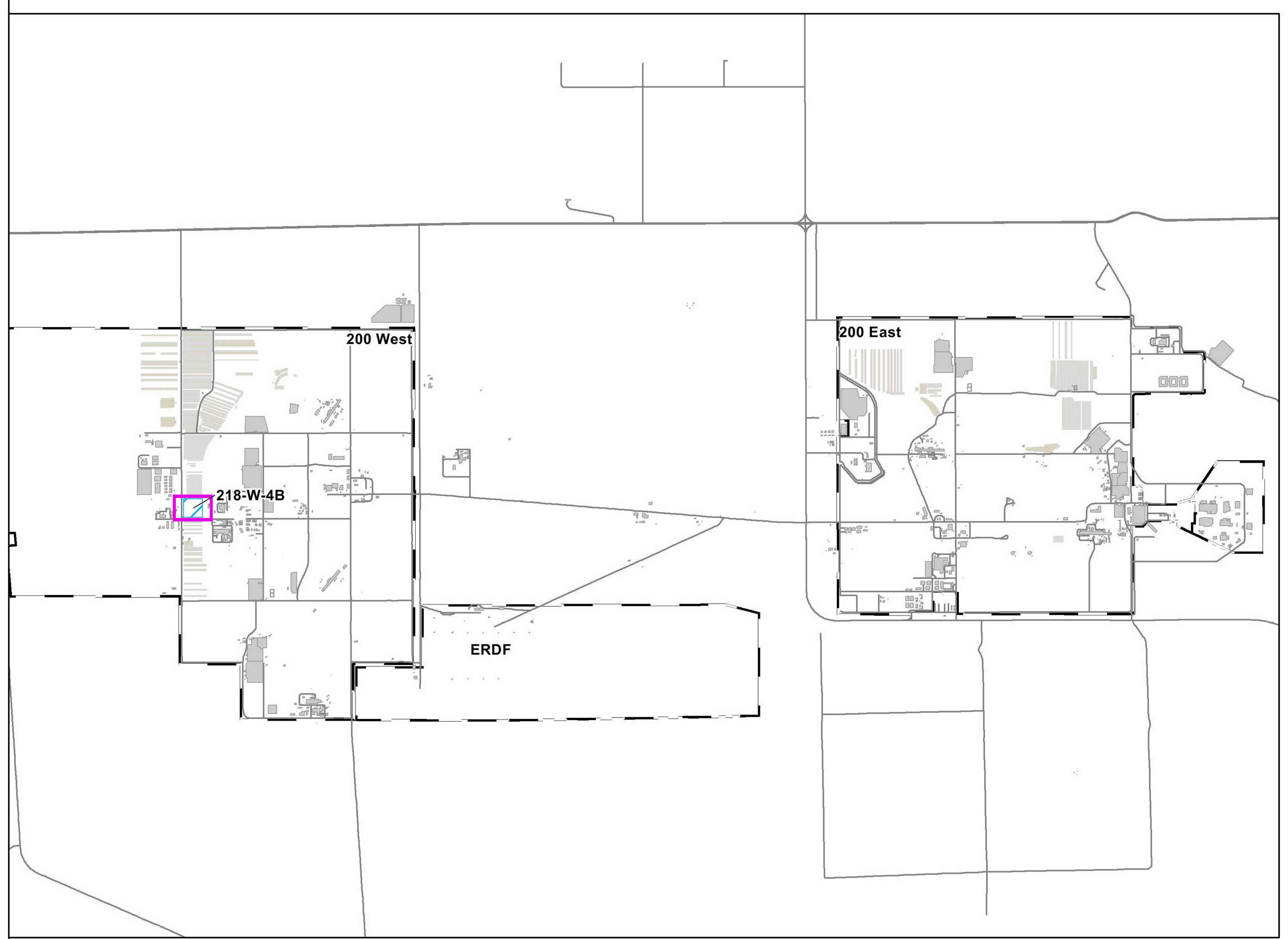
- Landfill boundary and trench locations are approximate.
- Geophysical survey results are shown as background colors in red (highest intensity signal), yellow (medium), and green (lowest). High intensity signals suggest the presence of natural objects, waste, or soil matrices with high electrical conductivity.
- Aerial imagery from 2012.

0 10 20 30 40 50 m

0 50 100 150 ft

CHSGW20140300





218-W-4B Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

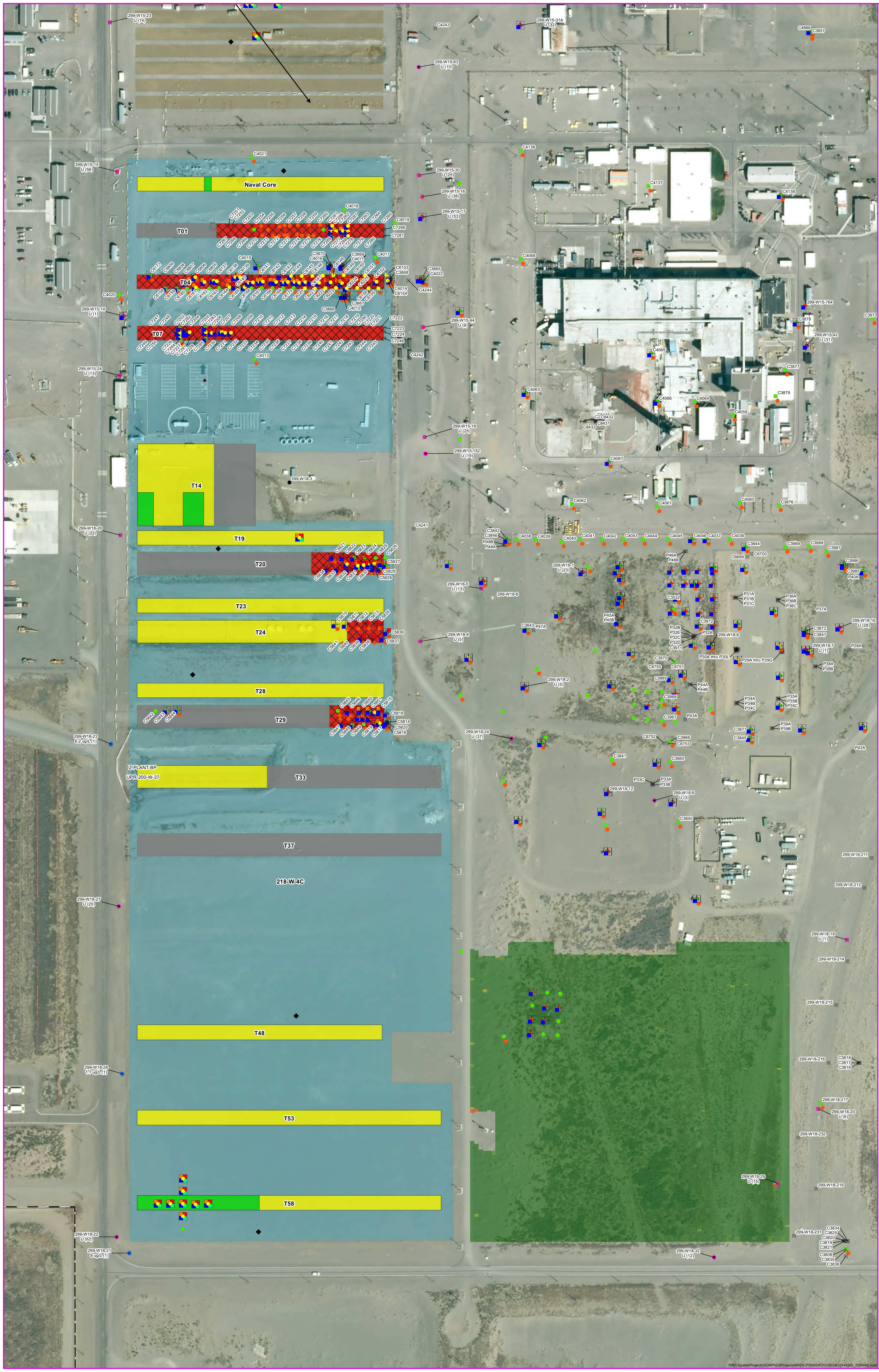
- TRU Stored Waste
- Radioactive Solid Waste
- Unused Trench Area
- Excavated Waste
- Caisson: Red = Alpha; Yellow = LLW
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

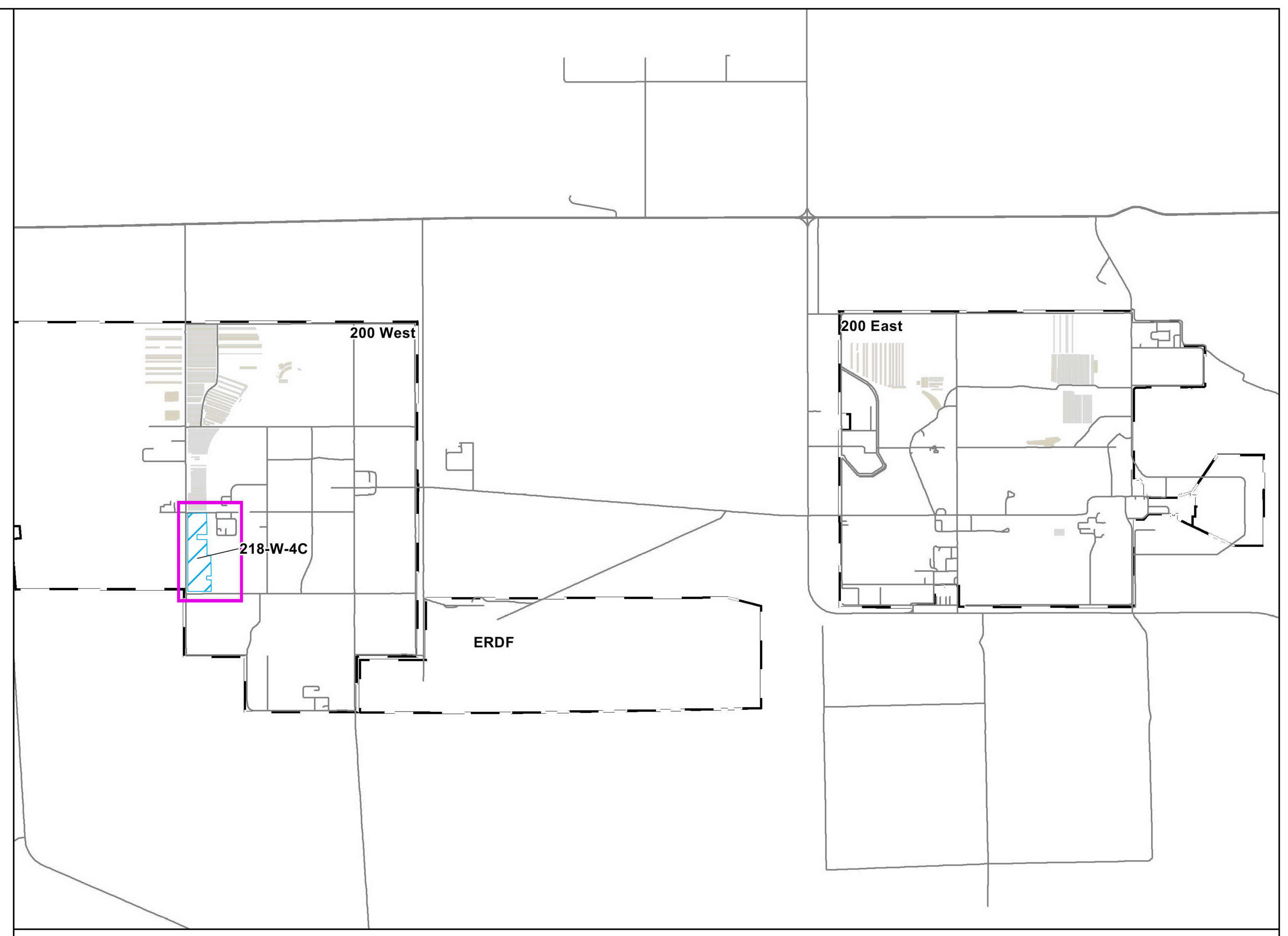
Notes:

- Landfill boundary and trench locations are approximate.
- Aerial imagery from 2012.

0 10 20 30 m
0 25 50 75 100 ft

CHSGW20140301a





218-W-4C Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location

Burial Trench Catagory

- Post-August 19, 1987 Mixed Waste
- TRU Stored Waste
- Radioactive Solid Waste
- Unused Trench Area
- Excavated Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Waste Site
- Operational Boundary
- Roads

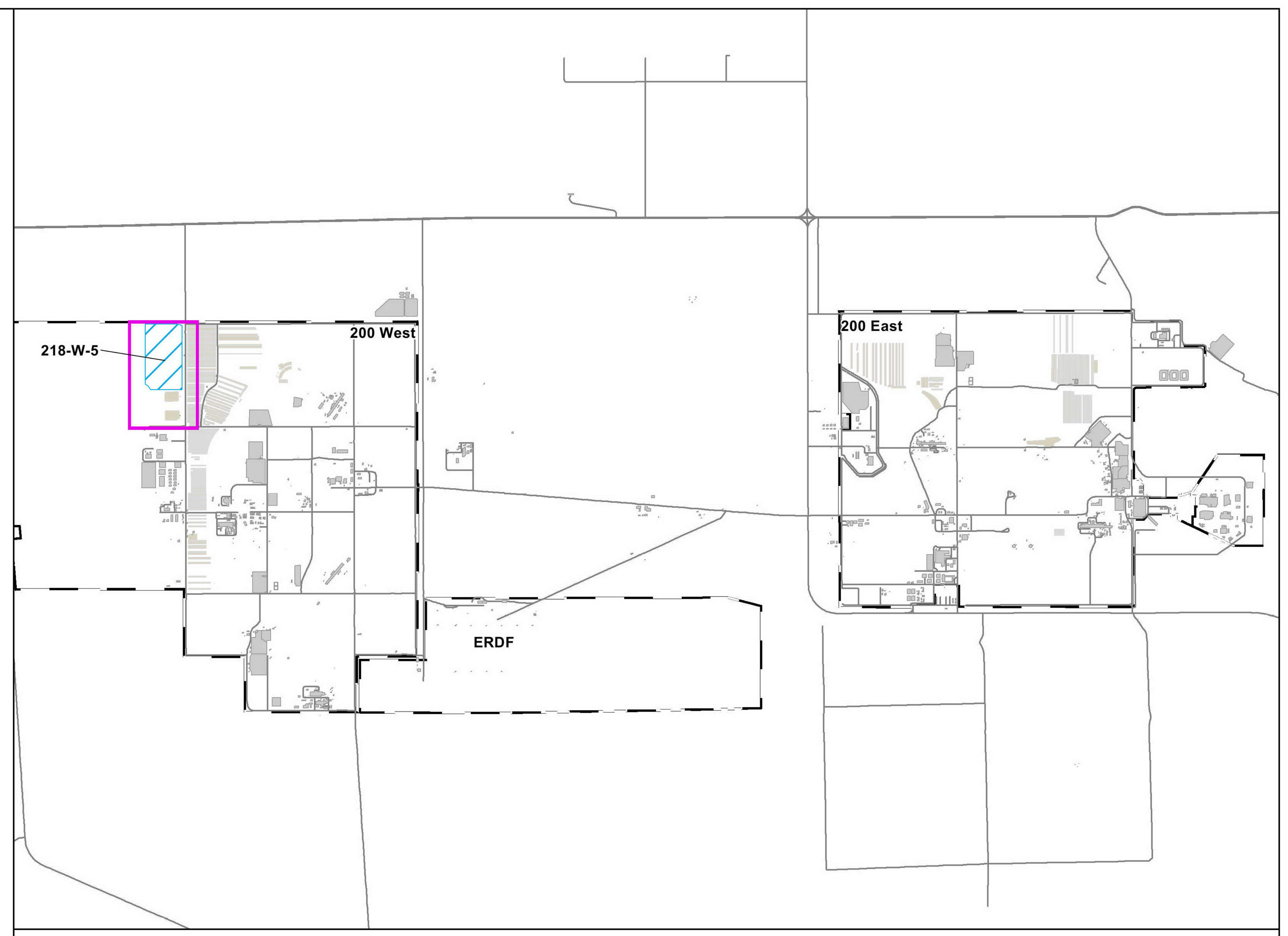
Notes:

- Landfill boundary and trench locations are approximate.
- Red/Yellow/Green shading represents approximate location of a geophysical survey performed at the given location. Red represents high values; Green represents low values.
- Aerial imagery from 2012.

0 25 50 75 100 m

0 75 150 225 300 ft

CHSGW20140302a



218-W-5 Landfill

Groundwater Data

- 1,1,1-TCA Detect
- 1,1,1-TCA Non-Detect

Well Label = Well Name
max concentration or U (total number
of detects or if U, total number of samples)

Specific Detected Soil Gas Contaminants

- 1,1,1-Trichloroethane
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Carbon tetrachloride
- Tetrachloroethene

Soil Gas Locations

- Points with Detects
- Sampled for soil gas; no detects

Proposed Field Work Activities

- Direct Push Borehole
- Focused Test Pit
- Random Test Pit
- Horizontal Boring

Well Locations

- In Use Location
- Decommissioned Location
- Proposed Location

Burial Trench Catagory

- Radioactive Solid Waste
- Post-August 19, 1987 Mixed Waste
- Unused Waste Area
- Surrounding Burial Trenches
- Waste Site of Interest
- Operational Boundary
- Roads

Notes:

- Landfill boundary and trench locations are approximate.
- Aerial imagery from 2012.

0 40 80 120 m

0 100 200 300 400 500 ft

CHSGW20140303a