DOE/RL-2013-53
Revision 6

Hanford Site Environmental Surveillance Master Sampling Schedule for Calendar Year 2020

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY | Richland Operations Office

P.O. Box 550
Richland, Washington 99352

TRADEMARK DISCLAIMER

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Summary

Mission Support Alliance (MSA) conducts environmental surveillance of the Hanford Site and surrounding areas for the U.S. Department of Energy, Richland Operations Office (DOE-RL). Sampling is conducted to evaluate levels of radioactive and nonradioactive pollutants in the Hanford Site environs, as required in DOE O 436.1, Supp Rev. 0, *Departmental Sustainability*, and DOE O 458.1, Chg. 2, *Radiation Protection of the Public and the Environment*. The environmental surveillance sampling design is described in the *Hanford Site Environmental Monitoring Plan*, (DOE/RL-91-50).

This document contains the calendar year (CY) 2020 schedule for routine radiological surveys and collection of samples for the Environmental Surveillance Program. Samples are analyzed for radionuclides and chemical constituents. Each section includes a general timeline for surveys and collection of samples, sampling locations, sampling frequencies, sample types, and analyses to be performed. In some cases, samples are scheduled on a rotating basis. If a sample will not be collected during the current year, the anticipated year for collection is provided. A sample collection schedule summary for each media is provided in Table 1.

Environmental Surveillance Program Sampling

The Environmental Surveillance Program is a multimedia effort to measure the concentrations of radionuclides and chemicals in environmental media and external radiological exposure levels. The data obtained from these efforts are used to support long-term trend analysis, demonstrate compliance with applicable environmental quality standards and public exposure limits, and assess environmental impacts. Project personnel collect samples of air, surface water, agricultural products, fish, wildlife, soil, vegetation, and sediment; exchange environmental dosimeters; and perform radiological surveys at or near known radioactive waste sites.

A radiological pathway analysis and exposure assessment is performed annually. The results of the pathway analysis and exposure assessment, as well as a biota dose screening evaluation, serve as the basis for the design of the environmental sampling program. The surveillance design is reviewed and evaluated annually based on the above considerations with an awareness of planned waste management and environmental restoration activities at the Hanford Site.

Quality Control

Field quality control (QC) samples are collected to evaluate field sampling and laboratory performance, as described below.

- Equipment blanks may be collected from each type of sampling equipment used to ensure that cleaning protocols are adequate. Equipment blanks are not collected for routine air samples.

- Trip blanks are prepared and submitted for laboratory analysis when volatile organic analysis is requested for an aqueous matrix. They are used to measure possible cross contamination of samples during collection and transport to and from the field to the laboratory.

- Collocated samples are independent samples collected in such a manner that they are equally representative of the parameter(s) of interest at a given point in space and time.

- Field duplicate samples provide information regarding the precision and reproducibility of the sampling and analysis process. A sampling event includes collection, handling, storage, shipment, and laboratory analyses. Field duplicate QC samples are obtained at a frequency of 5-10% (duplicate to sample ratio) and are sent to the same laboratory for analyses as the parent sample.

The Environmental Surveillance Program collects environmental samples that are split or collocated with Washington State Department of Health (DOH) samples. The results from these analyses are independently evaluated and reported annually by DOH to verify the quality of the Environmental Surveillance Program.

Data Management

The Hanford Environmental Information System (HEIS) and the Automated Bar Coding of All Samples at Hanford (ABCASH) databases are used as repositories for data gathered during environmental surveillance activities at the Hanford Site. Beginning in 2020 the new Sample Management and Report Tracking (SMART) database will also be used. For ease in retrieving environmental surveillance data from the databases, the majority of the location names in this document are the location names used in these databases.

Schedule Changes

This schedule is subject to modification during the year in response to changes to Hanford Site operations, program requirements, project funding, and the nature of the observed results. Operational limitations such as weather, mechanical failures, sample availability, and other factors may also affect scheduled sampling. As a result, this document should not be considered an accurate record of samples collected during the year, rather, a planned sample collection for the year. The Environmental Surveillance Program is a flexible environmental monitoring and sampling program that responds to changes in environmental regulations, on-site activities and conditions, as well as off-site influences (e.g., changes in agricultural products based on market interests).

This schedule includes two appendices:

- Appendix A provides descriptions of changes to the schedule from the previous year along with rationale for those changes.

- Appendix B provides a summary of media-specific sampling rationale and design.

- Appendix C provides a summary of the individual parameters for the analytical methods requested.

Table 1. Environmental Surveillance CY 2020 Sample Schedule Summary

2020 Sample Schedule Summary													
Sample Media		**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
AIR	On-site & Off-site Air	●	●	●	●	●	●	●	●	●	●	●	●
	Effluent/Stacks*	●	●	●	●	●	●	●	●	●	●	●	●
SURFACE WATER	Columbia River (Continuous/Monthly Composite)	●	●	●	●	●	●	●	●	●	●	●	●
	Columbia River (Transects)			●					●				
	Offsite Irrigation					●	●	●					
	River Bank Seeps									●	●	●	
	Onsite Pond			●		●							
SEDIMENT	Columbia River									●	●	●	
	Onsite Pond			●		●							
FOOD & FARM PRODUCTS	Cherries						●						
	Corn							●					
	Leafy Vegetables						●						
	Melons							●					
	Milk		●			●			●			●	
	Potatoes								●				
	Tomatoes								●				
	Wine Must												●
WILDLIFE	Carp					●							
	Bass								●				
	Upland Game Birds									●			
	Deer/Elk†	●	●	●	●	●	●	●	●	●	●	●	●
SOIL & VEGETATION	On-site Soil					●							
	On-site Vegetation					●				●			
TLD	TLD			●			●			●			●
RADIOLOGICAL SURVEYS	Radiological Surveys	●	●	●	●							●	

**MSA is responsible for the analyses and reporting of effluent samples; other Hanford Contractors are responsible for planning, scheduling, and collecting stack samples at facilities they operate. See HNF-61951 for more information.*

† Elk and mule deer are collected as available by opportunistic takes as a result of vehicle strikes

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Contents

Appendices

Figures

Acronyms and Symbols

^{241}Am	americium-241
^{14}C	carbon-14
^{129}I	iodine-129
^{241}Pu	plutonium-241
^{90}Sr	strontium-90
^{99}Tc	technetium-99
^{3}H	tritium
^{236}U	uranium-236
A	annually
ABCASH	Automated Bar Coding of All Samples at Hanford
AEA	alpha energy analysis
Alpha	gross alpha activity of a sample
Anions	major anions – generally chloride, fluoride, nitrate, nitrite, sulfate
BE	biennially (every two years)
Beta	gross beta activity of a sample
Cr^{+6}	hexavalent chromium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CSB	Canister Storage Building
CHPRC	CH2M Hill Plateau Remediation Company
DOE	U.S. Department of Energy
DOH	Washington State Department of Health
DR	Downriver
EDP	Environmental Data Point
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
ES	Environmental Surveillance
ETF	Effluent Treatment Facility
GEA	Gamma Energy Analysis
HEIS	Hanford Environmental Information System
Hg-CVAA	mercury by cold vapor atomic absorbance spectrometry
HRM	Hanford River Mile
ICP-MS	inductively coupled plasma mass spectrometry
IDF	Integrated Disposal Facility
Lo ^{3}H	low-level method for the electrolytic enrichment of tritium
MEI	Maximally Exposed Individual
MNA	Monitored Natural Attenuation
MSA	Mission Support Alliance
PFP	Plutonium Finishing Plant

Pu-iso	isotopic plutonium (^{238}Pu, $^{239/240}$Pu)
Q	quarterly
RESRAD	RESidual RADioactivity
RI/FS	Remedial Investigation/Feasibility Study
RPH	Richland Pumphouse
SA	semi-annually (twice each year)
SMART	Sample Management and Report Tracking database
TA	tri-annually (three times a year)
TBD	to be determined
TCE	trichloroethene
TE	triennially (every three years)
TLD	Thermoluminescent Dosimeter
TOC	total organic carbon
TPH	total petroleum hydrocarbons
U-iso	isotopic uranium (^{234}U, ^{235}U, ^{238}U)
VOA	volatile organic analysis
WRPS	Washington River Protection Solutions
WTP	Hanford Tank Waste Treatment and Immobilization Plant

Schedule by Media

This section of the schedule shows planned sampling events by media. The locations, sampling frequency, and radiochemical and chemical analyses are also provided. Figures 1-30 provide maps for each media sampled.

1.0 Air Surveillance

1.1 Air Monitoring

Air Monitoring Locations[a]	EDP Codes	Analyses			
		Weekly	Bi-Weekly[b]	Monthly[c]	Semi-Annual Composite
On-Site					
100-K Area	N476, N534, N535, N575, N576[d], N578, N900[e]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am, ^{241}Pu
100 B Area	N588[d]		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
200 East Area	N019[f], N158, N498, N499[d], N582, N583[f], N924[f], N931[e], N932, N957, N967, N968, N969, N970, N972, N973[f], N976[f], N977[d], N978, N984, N985[d], N999		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
WTP (200 E Area)[g, h]	N584, N920[e]	^{14}C	Alpha, Beta	Tritium, ^{129}I	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
CSB (200 E Area)	N480, N481		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am, ^{241}Pu
IDF (200 E Area)	N532, N559		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA
200 West Area	N161, N168, N304[i], N449, N456, N457, N901, N965, N966[i], N974, N987, N994		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA
REDOX (200 W Area)	N441, N442, N956, N963		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA
Plutonium Finishing Plant (200 W Area)	N155, N165[d], N433, N554[d], N555[d], N964, N975[d]		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am, ^{241}Pu
300 Area	N130[d, e], N557, N902[e], N903[d, e, j], N904[e], N905[d, e, k], N918[e]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA
400 Area	N911, N912[e]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, GEA
600 Area	N589[d], N928, N929, N930		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA
Rattlesnake Barricade (600 Area)	N587[d]		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am
ERDF[l]	N482[d], N517, N518		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA
Wye Barricade[d]	N906[m], N981[m]		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am

Air Monitoring Locations[a]	EDP Codes	Analyses			
		Weekly	Bi-Weekly[b]	Monthly[c]	Semi-Annual Composite
Perimeter					
Yakima Barricade[d]	N907		Alpha, Beta		^{90}Sr, Pu-iso, GEA, ^{241} Am
Ringold Met Tower	N933[n]		Alpha, Beta	Tritium	Pu-iso, GEA, ^{241} Am
W End of Fir Road [d, g, h]	N934[n]	^{14}C	Alpha, Beta	Tritium, ^{129}I	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
Dogwood Met Tower	N935[n]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
Byers Landing	N936[n]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
Battelle Complex[d, k]	N937[n]		Alpha, Beta	Tritium	Pu-iso, U-iso, GEA, ^{241} Am
Horn Rapids Substation	N938[n]		Alpha, Beta		^{90}Sr, Pu-iso, GEA, ^{241} Am
Prosser Barricade[d]	N939[n]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, GEA, ^{241} Am
Rattlesnake Springs	N940		Alpha, Beta		^{90}Sr, Pu-iso, GEA
Wahluke Slope	N941[n]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, GEA, ^{241} Am
S End Vernita Bridge	N942		Alpha, Beta		^{90}Sr, Pu-iso, GEA, ^{241} Am
Off-site Nearby Community					
Basin City School	N943[n]		Alpha, Beta	Tritium	Pu-iso, U-iso, GEA, ^{241} Am
Leslie Groves-Richland	N944[n]		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
Pasco	N945[n]		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
Kennewick-Ely Street	N946[n]		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, GEA
Benton City	N947		Alpha, Beta		Pu-iso, GEA, ^{241} Am
Mattawa	N948		Alpha, Beta		GEA, ^{241} Am
Othello	N949		Alpha, Beta		Pu-iso, U-iso, GEA, ^{241} Am
Off-site Distant Community					
Yakima	N909		Alpha, Beta	Tritium	^{90}Sr, Pu-iso, U-iso, GEA, ^{241} Am
QC Samples					
Trip Blank	N899		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, ^{241}Am, GEA, ^{241}Pu
Trip Blank	N950		Alpha, Beta		^{90}Sr, Pu-iso, U-iso, ^{241}Am, GEA, ^{241}Pu

(a) Table 4-1 of *The Department of Energy Hanford Site Radioactive Air Emissions License* #FF-01 includes a list of "near-facility" air monitoring stations, cited in various DOH Notices of Construction and/or similar regulatory documents, as well as all of the DOH required stations

(b) Particulate samples are collected for analysis every two weeks (47-mm 3000TN W/ WA™ filters). These filters are then stored for the semi-annual composite.

(c) Four-week atmospheric water vapor samples for tritium analysis are collected using silica gel columns.

(d) Collocated DOH particulate air sampler at this location.

(e) Tritium air sampler at this location.4

(f) Additional Am-241 analysis at this location.

(g) Carbon-14 and Iodine-129 sampling/analyses start date TBD.

(h) Iodine-129 samples are collected every four weeks and analyzed quarterly.

(i) Collocated samples (N304 and N966) collected at this location.

(j) Two tritium samples are collected from this location, one as a duplicate sample

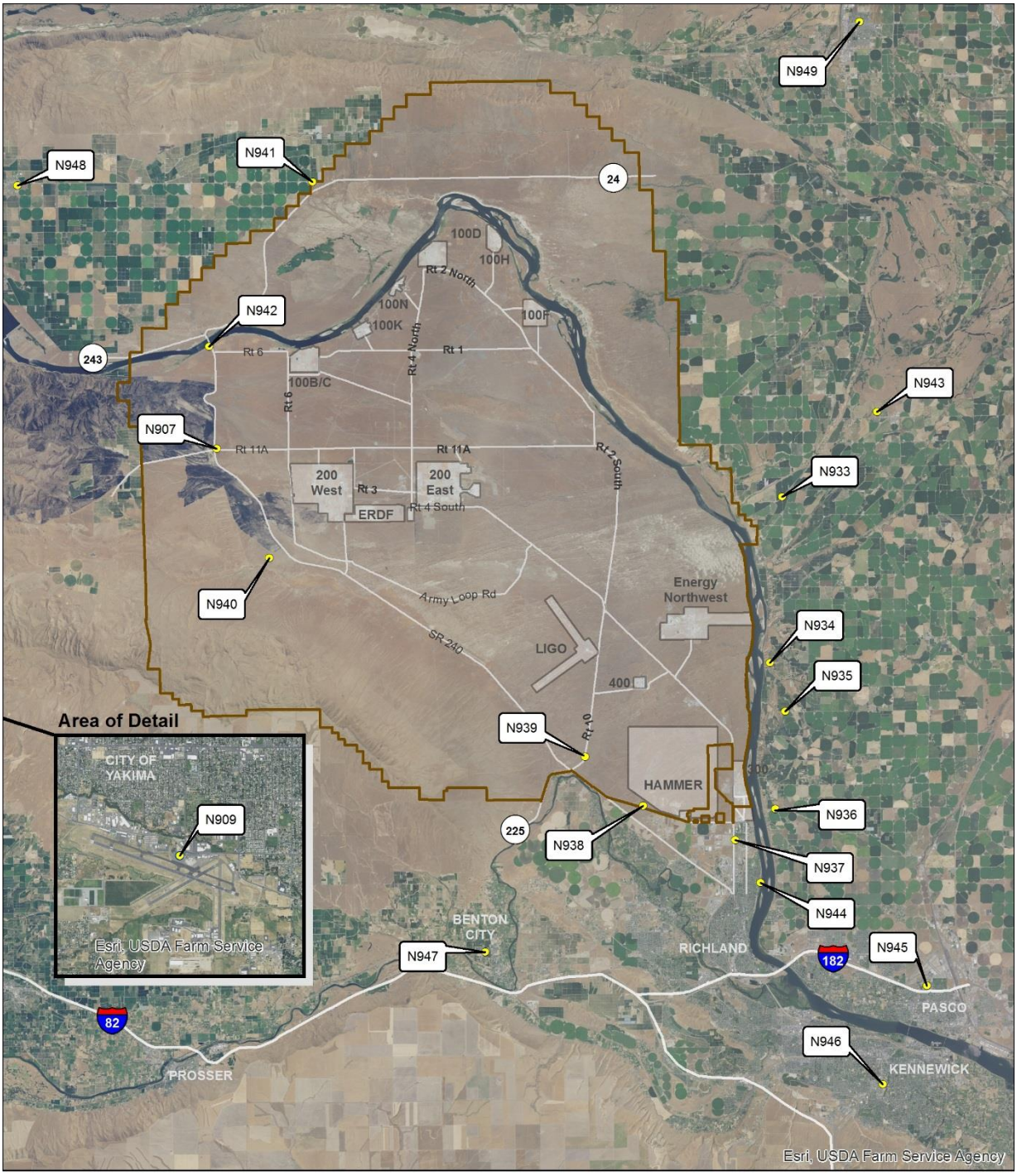
(k) DOH tritium air sampler also at this location.

(l) Project specific samples for CHPRC.

(m) Duplicate samples (N906 and N981) collected at this location.

(n) Air monitoring stations used to support annual off-site dose compliance calculations.

Figure 1. Off-site Air Sampling Locations



Legend

- Air Sampling Locations
- Operational Areas
- Hanford Site Boundary

N
W E
S

0 2 4 6 8 10 Miles

0 5 10 15 20 Kilometers

NOTE: Aerial Imagery, 2017, NAIP.

DIGS G:\MSA\MapFiles\2019MasterSampling\2019MasterSampling_Air_Offsite.mxd

Figure 2. Air Sampling Locations in the 100 K Area

Figure 3. Air Sampling Location in the 100 B Area

Figure 4. Air Sampling Locations in the 200 East Area

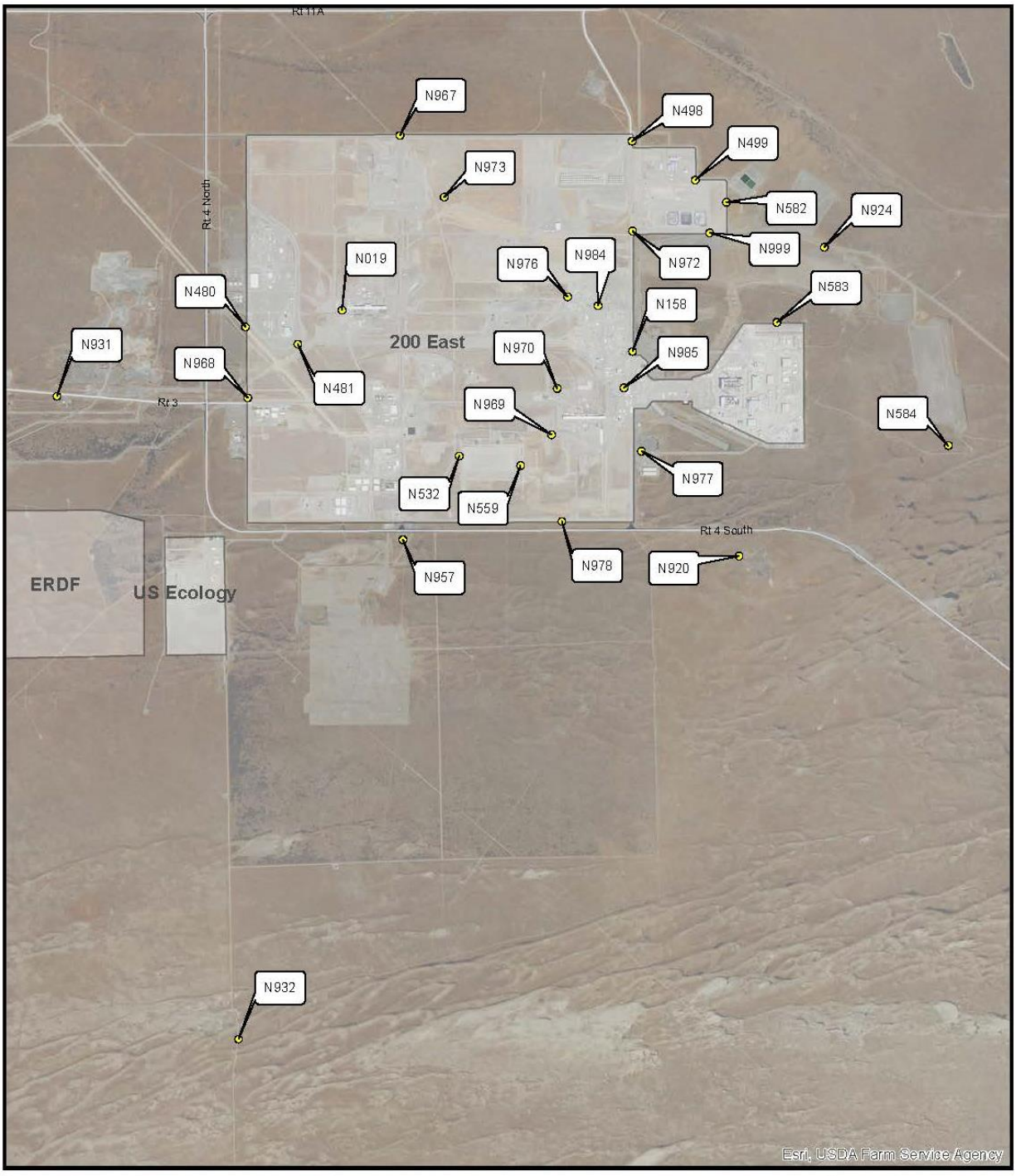


Figure 5. Air Sampling Locations in the 200 West Area

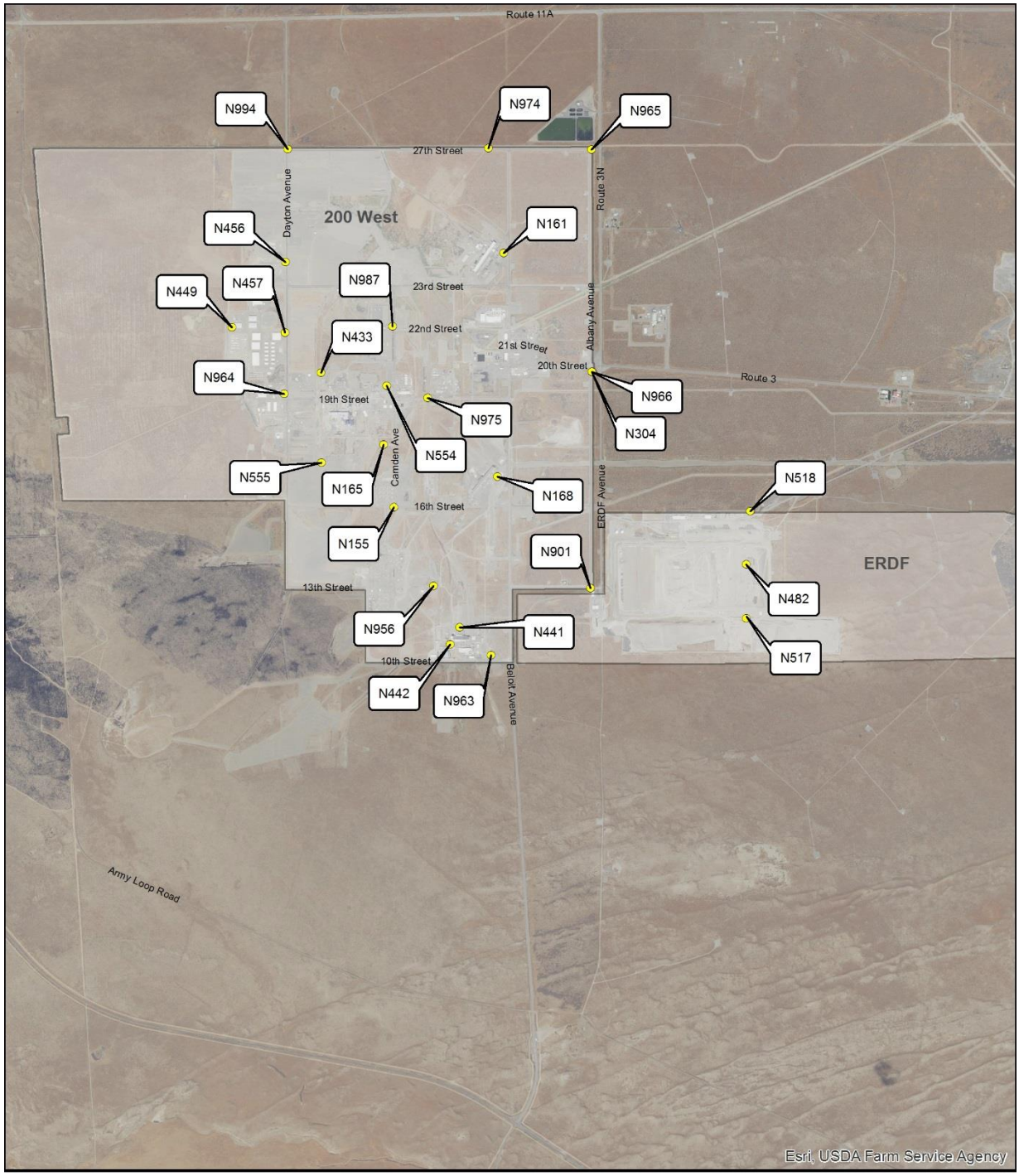


Figure 6. Air Sampling Locations in the 600 Area

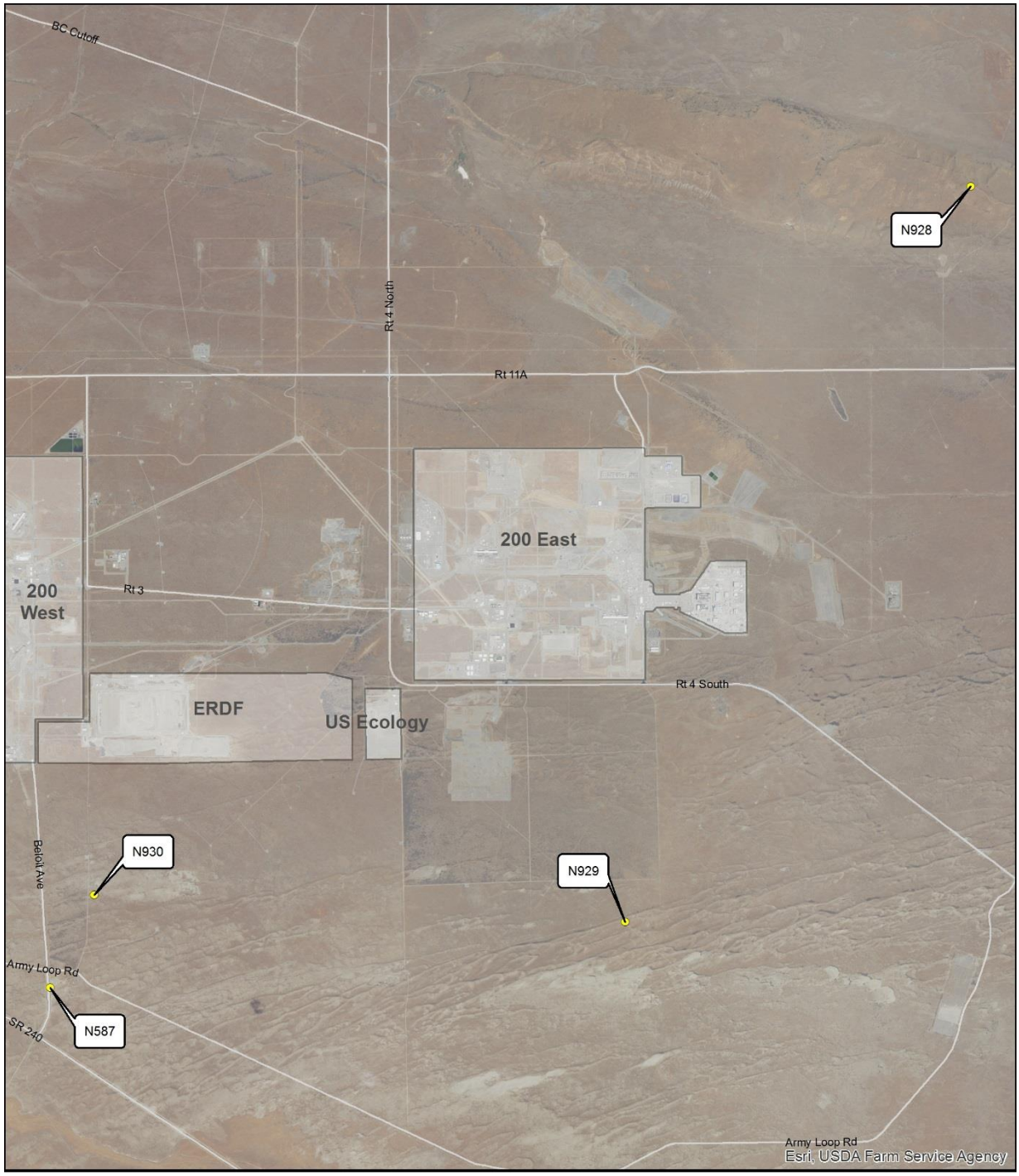


Figure 7. Air Sampling Locations in the 300 Area

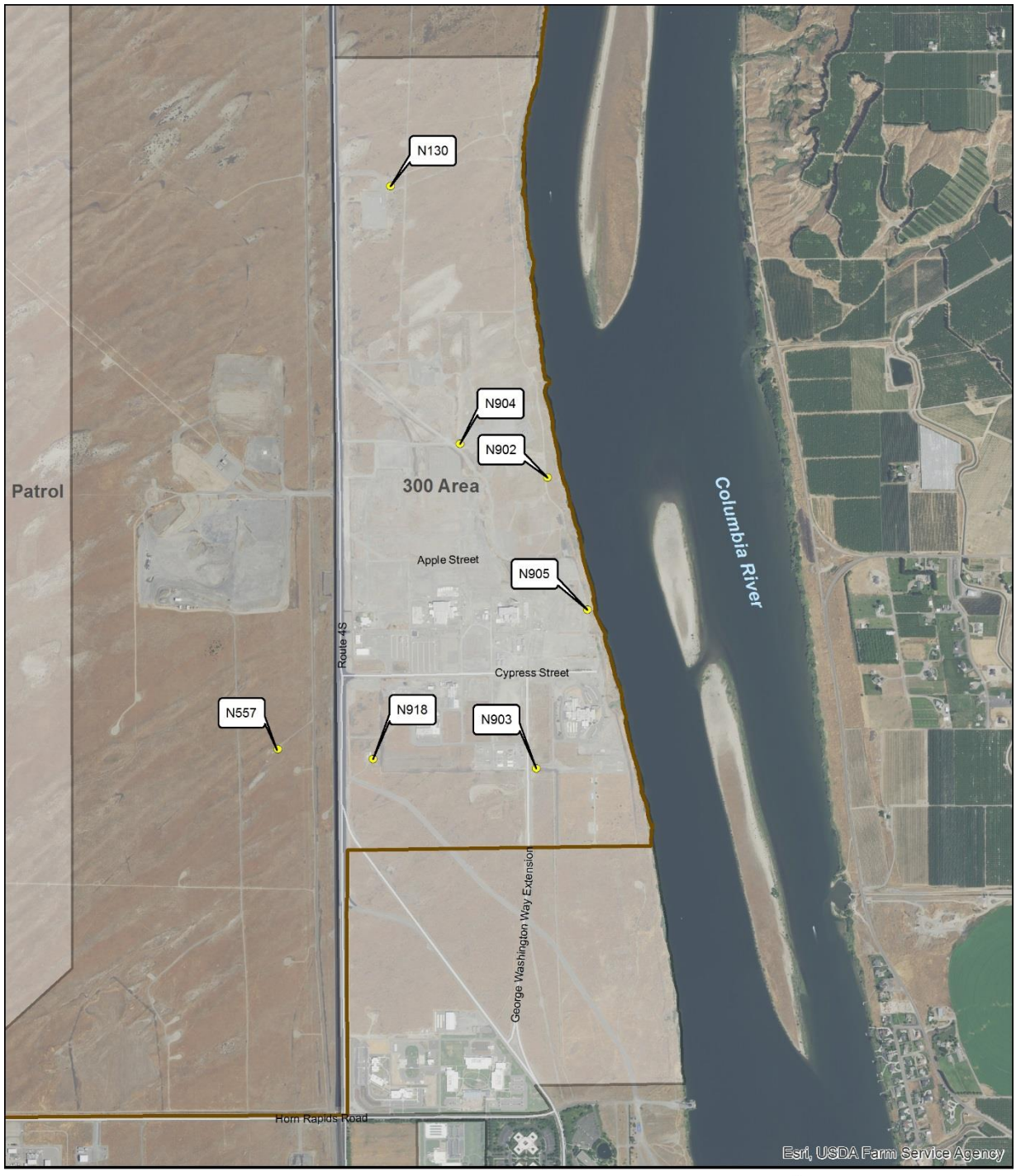
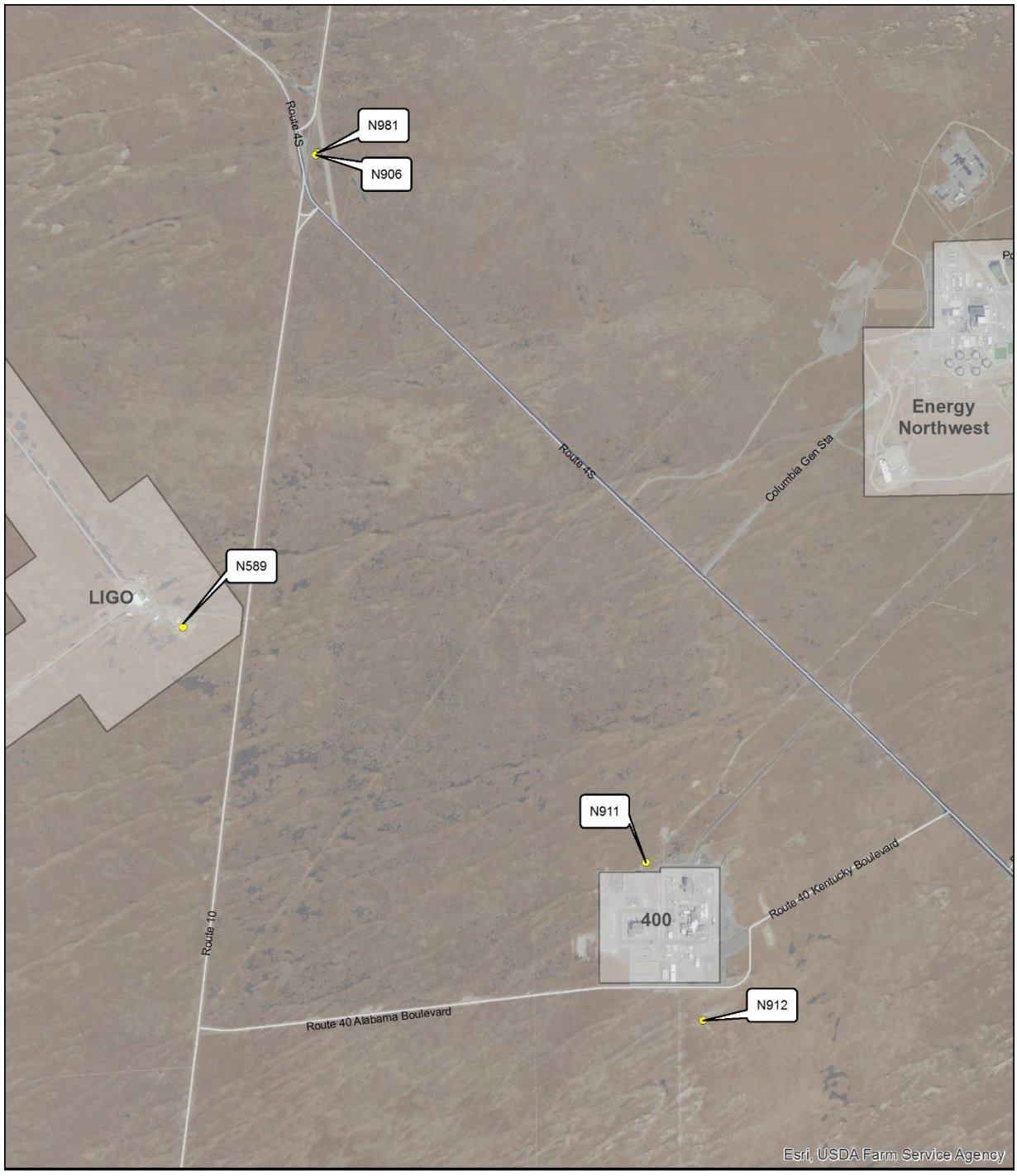


Figure 8. Air Sampling Locations in the 400 Area, Wye Barricade, and LIGO



2.0 Surface Water Surveillance

2.1 Columbia River – Continuous Water

Location	EDP Code	Sample Type	Sample Frequency	Analyses
Priest Rapids Dam	Y850 (water)	Cumulative (water)[a]	Monthly Composite[b]	Lo ^{3}H, ^{90}Sr, ^{99}Tc, U-iso
	Y851 (filter)	Particulate (filter) [a]	Monthly Composite	GEA, Pu-iso
	Y852 (resin)	Soluble (resin) [a]	Monthly Composite	GEA, Pu-iso
	Y850 (water)	Grab (water)	February, May, August, November	Anions
Richland Pump House	Y853 (water)	Cumulative (water)[a]	Monthly Composite[c]	Lo ^{3}H, ^{90}Sr, ^{99}Tc, U-iso
	Y854 (filter)	Particulate (filter) [a]	Monthly Composite	GEA, Pu-iso
	Y855 (resin)	Soluble (resin) [a]	Monthly Composite	GEA, Pu-iso
	Y853 (water)	Grab (water)	February, May, August, November	Anions

(a) Samples are collected bi-weekly and composited every 4 weeks for analysis.

(b) Additional sample provided to DOH (March and September only).

(c) Field duplicate sample collected in July. Analyses for the duplicate sample will be the same as the parent sample.

2.2 Columbia River – Transects

Location	EDP Code	Sample Frequency	Collection Period	Analyses[a]
Richland Pumphouse -1 HRM 46.4[b]	Y856	SA	March and August	GEA, Lo ^{3}H, ^{90}Sr, U-iso, Pu-iso, ^{99}Tc, Anions, ICP-MS, ICP-MS Filtered, Hg-CVAA, VOA
Richland Pumphouse -3 HRM 46.4	Y857			
Richland Pumphouse -5 HRM 46.4	Y858			
Richland Pumphouse -7 HRM 46.4	Y859			
Richland Pumphouse -9 HRM 46.4	Y860			
Vernita-1 HRM 0.3[c]	Y861	SA	March and August	GEA, Lo ^{3}H, ^{90}Sr, U-iso, Pu-iso, ^{99}Tc, Anions, ICP-MS, ICP-MS Filtered, Hg-CVAA, VOA
Vernita-2 HRM 0.3	Y862			
Vernita-3 HRM 0.3	Y863			
Vernita-4 HRM 0.3	Y864			
100-N -1 HRM 9.5[c, d]	Y865	A	August	GEA, Lo ^{3}H, ^{90}Sr, U-iso, Anions, ICP-MS, ICP-MS Filtered
100-N -3 HRM 9.5[c]	Y866			
100-N -5 HRM 9.5	Y867			
100-N -7 HRM 9.5	Y868			
100-N -9 HRM 9.5	Y869			
100-H -1 HRM 15.3[c]	Y960	A	August	GEA, Lo ^{3}H, ^{90}Sr, U-iso, Anions, ICP-MS, ICP-MS Filtered
100-H -3 HRM 15.3	Y961			
100-H -5 HRM 15.3	Y962			
100-H -7 HRM 15.3	Y963			
100-H -9 HRM 15.3	Y964			
Hanford Townsite -1 HRM 28.7	Y870	A	August	GEA, Lo ^{3}H, ^{90}Sr, U-iso, Anions, ICP-MS, ICP-MS Filtered
Hanford Townsite -3 HRM 28.7	Y871			
Hanford Townsite -5 HRM 28.7	Y872			
Hanford Townsite -7 HRM 28.7	Y873			
Hanford Townsite -9 HRM 28.7	Y874			
300 Area -1 HRM 43.1[c, e]	Y875	A	August	GEA, Lo ^{3}H, ^{90}Sr, U-iso, ^{236}U[e], Anions, ICP-MS, ICP-MS Filtered, VOA
300 Area -3 HRM 43.1[c, e]	Y876			
300 Area -5 HRM 43.1	Y877			
300 Area -7 HRM 43.1	Y878			
300 Area -9 HRM 43.1	Y879			
QC Samples				
Trip Blank			March and August	VOA

(a) Field parameters measured and reported include conductivity, temperature, and pH.
(b) Field duplicate sample collected in March. Analyses for the duplicate sample will be the same as the parent sample.
(c) Additional sample provided to DOH; Vernita sample provided to DOH in March and August.
(d) Field duplicate sample collected in August. Analyses for the duplicate sample will be the same as the parent sample.
(e) Only the 300 Area samples that are split with DOH are to be analyzed for ^{236}U.
(f) One trip blank per day if VOA is requested.

2.3 River Bank Seeps

Location[a]	EDP Code	HRM[b]	Collection Period	Analyses[c]
100-B Spring 38-3[d, f]	Y880	3.8	September-November	^{3}H, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity, VOA
100-B Spring 39-2[e, f]	Y881	3.9	September-November	^{3}H, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity, VOA
100-K Spring 63-1[d, e, f]	Y882	6.3	September-November	Alpha, Beta,^{3}H, ^{90}Sr, ^{99}Tc, ^{14}C, ICP-MS, ICP-MS Filtered, Anions, VOA, Alkalinity
100-N Spring 89-1[d]	Y885	9.1	September- November	^{3}H, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, TPH, Alkalinity
100-N Spring 8-13[d, e]	Y886	9.3	September- November	Alpha, Beta,^{3}H, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity
100-D Spring 110-1[e]	Y888	11	September- November	Alpha, Beta,^{3}H, ^{99}Tc , U-iso, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity
100-H Spring 152-2[d]	Y890	15.2	September- November	Alpha, Beta,^{3}H, U-iso, ^{99}Tc, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity
100-F Spring 207-1[d, e, f]	Y892	20.7	September- November	^{3}H, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity, VOA
100-F Spring 211-1[d]	Y916	21.1	September- November	^{3}H, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, Alkalinity
Hanford Townsite 25-4[f, g]	Y917	25.4	September- November	Alpha, Beta,^{3}H, ^{99}Tc, ^{90}Sr, ICP-MS, ICP-MS Filtered, Anions, ^{129}I , VOA, Alkalinity
Hanford Spring 28-2	Y893	28.1	September- November	Alpha, Beta,^{3}H, ICP-MS, ICP-MS Filtered, Anions, ^{129}I, Alkalinity
300 Area Spring 42-2[d, e, f]	Y895	42.1	September- November	Alpha, Beta,^{3}H, U-iso, ^{236}U, ICP-MS, ICP-MS Filtered, Anions, VOA, Alkalinity
300 Area Spring DR 42-2[e, f]	Y896	42.4	September- November	Alpha, Beta,^{3}H, U-iso, ^{236}U, ICP-MS, ICP-MS Filtered, Anions, VOA, Alkalinity
QC Samples				
Trip Blank[f]				VOA

(a) Sample locations may be adjusted based on field conditions (e.g., no discharge observed at the time of sampling) or new contaminant information becomes available (e.g., change in plume concentration or plume location).
(b) HRMs are signposts along the Hanford Site shoreline of the Columbia River that are roughly 1.6 km (1 mi) apart. The Vernita Bridge is HRM #0, and Ferry Street in Richland is HRM #46.
(c) Field parameters measured and reported include conductivity, temperature, pH, and dissolved oxygen.
(d) Drive point sample collection available.
(e) Additional sample provided to DOH.
(f) One trip blank per day if VOA is requested. One trip blank may apply to more than one seep/sample location if collections take place on the same day.
(g) Field duplicate samples collected. Analyses for the duplicate sample will be the same as the parent sample.

2.4 Onsite Pond

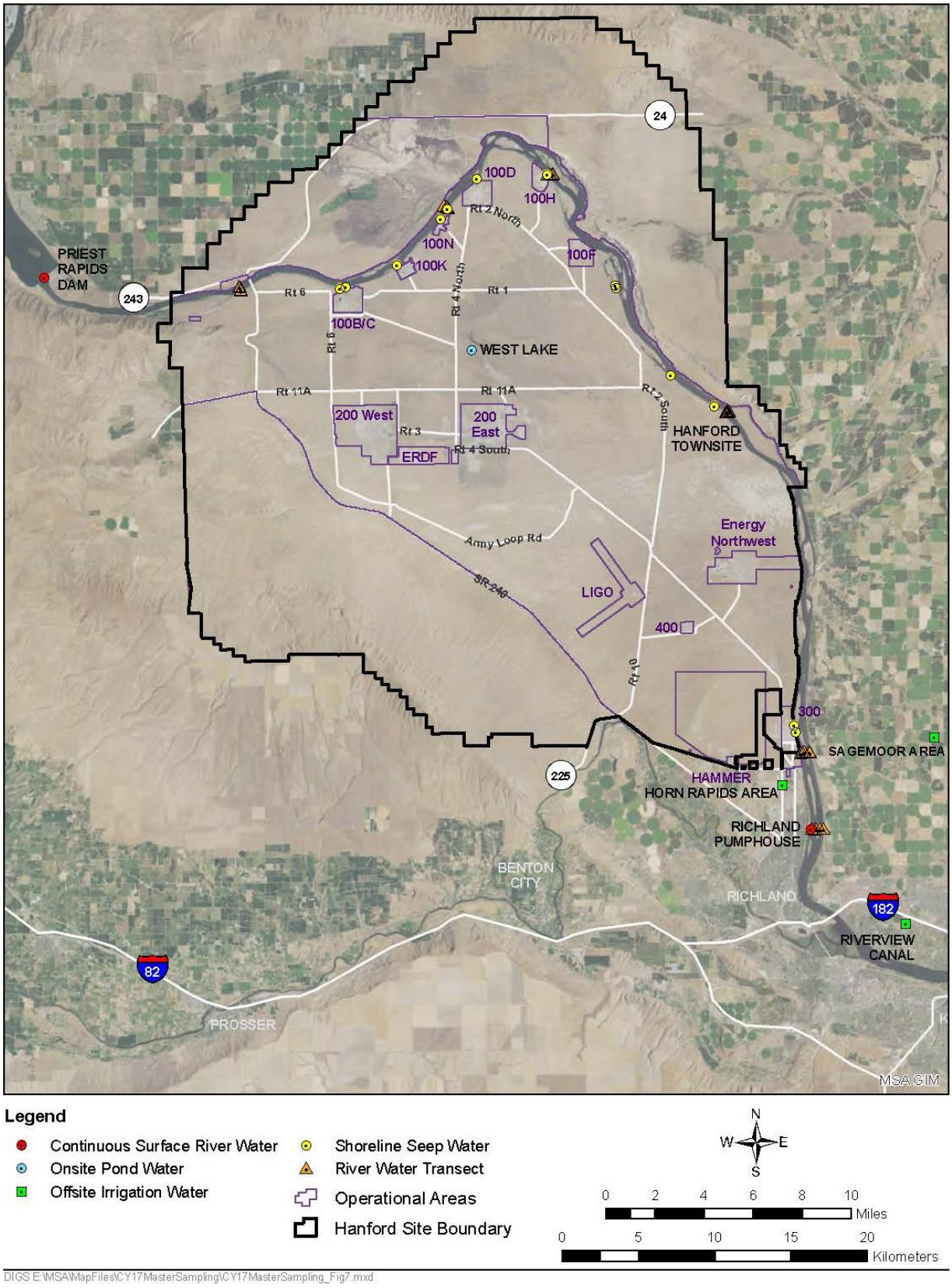
Location	EDP Code	Collection Period	Analyses
West Lake Seep	Y897	March	^{3}H, U-iso, ^{99}Tc
West Lake Water	Y898	May	^{3}H, U-iso, ^{99}Tc

2.5 Offsite Irrigation

Location	EDP Code	Collection Period	Analyses
Riverview Canal	Y900	May[(a)], June, July	Alpha, Beta, Lo ^{3}H, ^{90}Sr, GEA
Horn Rapids Area	Y901	May[(a)], June, July	Alpha, Beta, Lo ^{3}H, ^{90}Sr, GEA
Sagemoor Area	Y965	May, June, July	Alpha, Beta, Lo ^{3}H, ^{90}Sr, GEA

(a) Additional sample provided to DOH.

Figure 9. Surface Water Sampling Locations



3.0 Biota

3.1 Food and Farm Products

3.1.1 Milk

Location	EDP Code	Frequency	Collection Period	Analyses
East Wahluke Area[a]	Y908	Q	Feb., May, Aug., and Nov.	Lo ^{3}H, ^{90}Sr, GEA, ^{129}I, ^{14}C
Sagemoor Area[a]	Y909	Q	Feb., May[b], Aug., and Nov.	Lo ^{3}H, ^{90}Sr, GEA, ^{129}I, ^{14}C
Sunnyside Area	Y910	Q	Feb., May, Aug., and Nov.	Lo ^{3}H, ^{90}Sr, GEA, ^{129}I, ^{14}C

(a) Sample composited from multiple dairies in each area.
(b) Field duplicate sample collected. Analyses for the duplicate sample will be the same as for the parent sample.

3.1.2 Alfalfa/ Hay

Location[a, b]	EDP Code	Frequency	Collection Period	Analyses
Sagemoor Area	V484	BE (2021)	May	^{90}Sr, GEA, ^{14}C
Riverview Area[c]	V485	BE (2021)	May	^{90}Sr, GEA, ^{14}C
Sunnyside Area	V486	BE (2021)	May	^{90}Sr, GEA, ^{14}C
Horn Rapids Area[c]	V487	BE (2021)	May	^{90}Sr, GEA, ^{14}C

(a) Two (2) samples collected within each area; one is sent to lab to be analyzed and one is archived.
(b) Attempt to collect one field duplicate sample from any one of the listed locations. Analyses for the duplicate sample will be the same as the parent sample.
(c) Collections in this area are based on available media; may include other food and farm products that could potentially be consumed by livestock.

3.1.3 Vegetables

Location[a]	EDP Code	Frequency	Collection Period	Analyses
Leafy Vegetables				
Riverview Area[b, c]	V460	A	June	^{90}Sr, ^{3}H, GEA, ^{14}C
Sunnyside Area	V461	A	June	^{90}Sr, ^{3}H, GEA, ^{14}C
East Wahluke Area[b]	V462	A	June	^{90}Sr, ^{3}H, GEA, ^{14}C
Sagemoor Area[b]	V463	A	June	^{90}Sr, ^{3}H, GEA, ^{14}C
Corn [d]				
Riverview Area[b]	V500	A	July	^{90}Sr, GEA, ^{14}C
Sunnyside Area[b]	V501	A	July	^{90}Sr, GEA, ^{14}C
East Wahluke Area[b, c]	V498	A	July	^{90}Sr, GEA, ^{14}C
Sagemoor Area[b]	V499	A	July	^{90}Sr, GEA, ^{14}C
Potatoes				
Riverview Area[b]	V464	A	August	^{90}Sr, GEA, ^{14}C
Sunnyside Area	V465	A	August	^{90}Sr, GEA, ^{14}C
East Wahluke Area[b, c]	V466	A	August	^{90}Sr, GEA, ^{14}C
Sagemoor Area[b]	V467	A	August	^{90}Sr, GEA, ^{14}C
Horn Rapids Area[b, e]	V468	A	August	^{90}Sr, GEA, ^{14}C

(a) Two (2) samples collected within each area; one is sent to lab to be analyzed and one is archived.
(b) Additional sample provided to DOH.
(c) Field duplicate sample collected. Analyses for the duplicate sample will be the same as the parent sample.
(d) Each sample will be made up of several whole ears of corn.
(e) Collections in this area are based on available media; may include food and farm products other than potatoes.

3.1.4 Fruits

Location[a]	EDP Code	Frequency	Collection Period	Analyses
Tomatoes				
Riverview Area	V469	A	August	^{90}Sr, ^{3}H, GEA, ^{14}C
Sunnyside Area	V470	A	August	^{90}Sr, ^{3}H, GEA, ^{14}C
Cherries				
Riverview Area[b, c]	V475	TE (2020)	June	^{90}Sr, GEA, ^{14}C
Sagemoor Area[c]	V476	TE (2020)	June	^{90}Sr, GEA, ^{14}C
Sunnyside Area	V477	TE (2020)	June	^{90}Sr, GEA, ^{14}C
Ringold Area[c]	V478	TE (2020)	June	^{90}Sr, GEA, ^{14}C
East Wahluke Area[c]	V479	TE (2020)	June	^{90}Sr, GEA, ^{14}C
Apples				
Mattawa Area[c]	V480	TE (2021)	September	^{90}Sr, GEA, ^{14}C
Riverview Area[c]	V481	TE (2021)	September	^{90}Sr, GEA, ^{14}C
Sagemoor Area[b, c]	V482	TE (2021)	September	^{90}Sr, GEA, ^{14}C
Sunnyside Area	V483	TE (2021)	September	^{90}Sr, GEA, ^{14}C
Apricots				
Riverview Area[c]	V502	TE (2022)	June	^{90}Sr, GEA, ^{14}C
Sunnyside Area[c]	V503	TE (2022)	June	^{90}Sr, GEA, ^{14}C
East Wahluke Area[b]	V504	TE (2022)	June	^{90}Sr, GEA, ^{14}C
Sagemoor Area[c]	V505	TE (2022)	June	^{90}Sr, GEA, ^{14}C
Melons				
Riverview Area[c]	V496	A	July	^{90}Sr, ^{3}H, GEA,^{14}C
Sunnyside Area	V497	A	July	^{90}Sr, ^{3}H, GEA,^{14}C
East Wahluke Area[c]	V494	A	July	^{90}Sr, ^{3}H, GEA,^{14}C
Sagemoor Area[c]	V495	A	July	^{90}Sr, ^{3}H, GEA,^{14}C

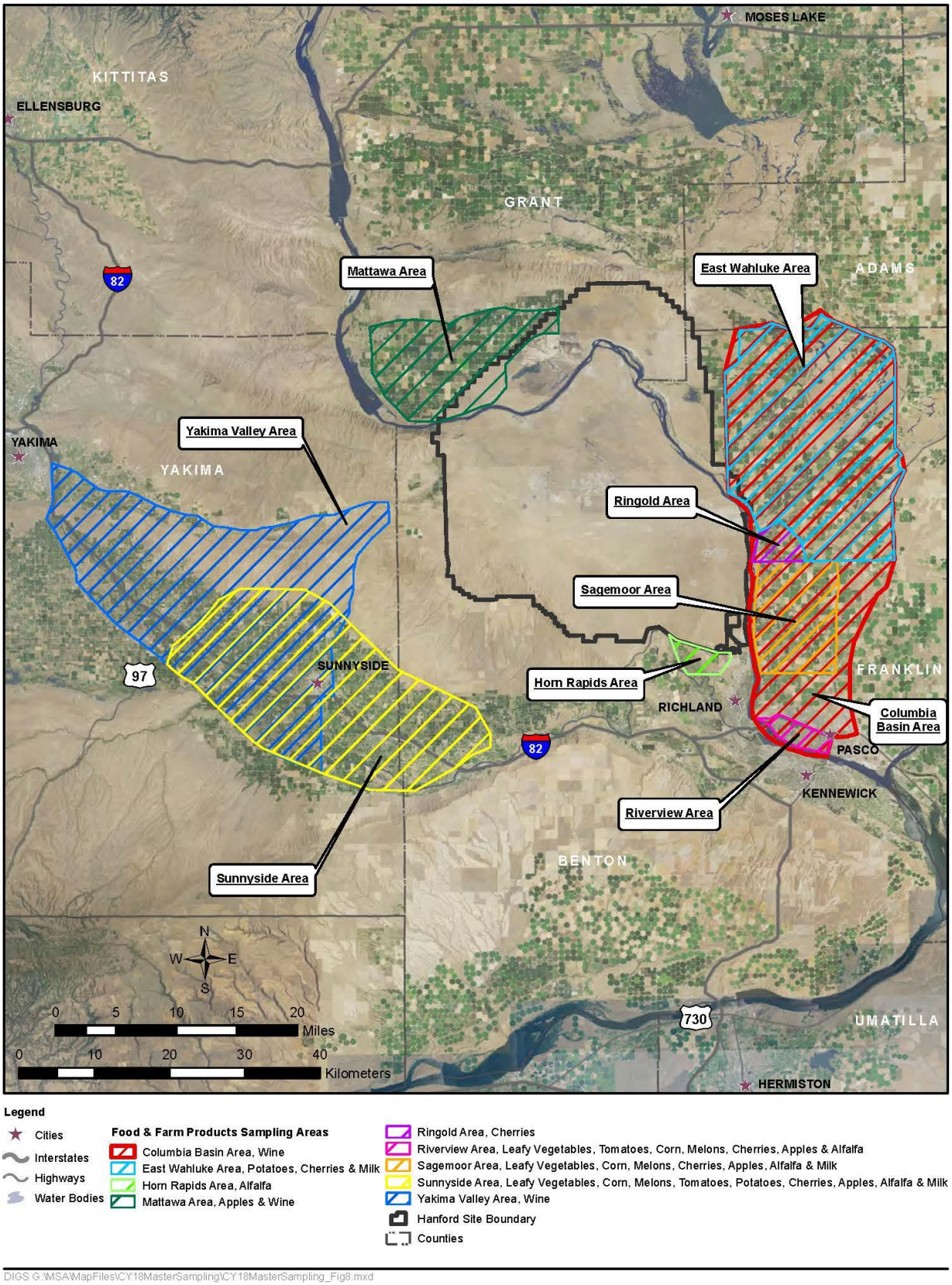
(a) Two (2) samples collected within each area; one is sent to lab to be analyzed and one is archived.
(b) Field duplicate sample collected. Analyses for the duplicate sample will be the same as the parent sample.
(c) Additional sample provided to DOH.

3.1.5 Wine Must[a]

	EDP Code				
Location[b]	Red	White	Frequency	Collection Period	Analyses
Columbia Basin[c]	Y902	Y903	A	December	Lo ^{3}H, GEA, ^{14}C
Yakima Valley[c]	Y904	Y905	A	December	Lo ^{3}H, GEA, ^{14}C
Mattawa Area[c]	Y906	Y907	A	December	Lo ^{3}H, GEA, ^{14}C

(a) The wine must is sampled. The samples consist primarily of juice and may contain grape skins, seeds, and stems.
(b) Two samples each of red and white wine must are collected within each area; one is sent to lab to be analyzed and one is archived.
(c) Additional sample provided to DOH.

Figure 10. Food and Farm Products Sampling Locations



3.2 Wildlife

3.2.1 Fish

Location	EDP Code	Sample Item	Number of Samples	Frequency	Collection Period	Analyses
Carp[a]						
100 Areas[b]	F113	Fillet (composite)	3	BE (2020)	May	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2020)	May	^{90}Sr
Hanford Townsite to 300 Area[b]	F133	Fillet (composite)	3	BE (2020)	May	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2020)	May	^{90}Sr
Reference[c]	F153	Fillet (composite)	3	BE (2020)	May	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2020)	May	^{90}Sr
Bass[a]						
100 Areas[b]	F114	Fillet	3	BE (2020)	August	GEA
		Fillet (composite)	1	BE (2020)	August	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2020)	August	^{90}Sr
Hanford Townsite to 300 Area [b]	F134	Fillet	3	BE (2020)	August	GEA
		Fillet (composite)	1	BE (2020)	August	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2020)	August	^{90}Sr
Reference[c]	F154	Fillet	3	BE (2020)	August	GEA
		Fillet (composite)	1	BE (2020)	August	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2020)	August	^{90}Sr
Walleye[a]						
100 Areas[b]	F115	Fillet	3	BE (2021)	July	GEA
		Fillet (composite)	1	BE (2021)	July	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2021)	July	^{90}Sr
Hanford Townsite to 300 Area[b]	F135	Fillet	3	BE (2021)	July	GEA
		Fillet (composite)	1	BE (2021)	July	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2021)	July	^{90}Sr
Reference[c]	F155	Fillet	3	BE (2021)	July	GEA
		Fillet (composite)	1	BE (2021)	July	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2021)	July	^{90}Sr
Whitefish[a]						
100 Areas[b]	F116	Fillet	3	BE (2021)	November	GEA
		Fillet (composite)	1	BE (2021)	November	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2021)	November	^{90}Sr
Reference[c]	F156	Fillet	3	BE (2021)	November	GEA
		Fillet (composite)	1	BE (2021)	November	GEA, U-iso, Pu-iso, ICP, Hg-CVAA, ^{90}Sr, ^{3}H
		Carcass	3	BE (2021)	November	^{90}Sr

(a) Attempt to collect one field duplicate fillet and carcass sample from any one of the listed locations. Analyses for the duplicate sample will be the same as for the parent sample.
(b) Additional fish sample provided to DOH.
(c) Reference location is Priest Rapids/Wanapum Pools.

3.2.2 Birds

Location	EDP Code	Sample Item	Number of Samples	Frequency	Collection Period	Analyses
Waterfowl[a]						
100 Areas [b]	B111	Muscle	3	BE (2021)	June	GEA
		Bone	3	BE (2021)	June	^{90}Sr
Hanford Townsite to 300 Area [b]	B131	Muscle	3	BE (2021)	June	GEA
		Bone	3	BE (2021)	June	^{90}Sr
Reference	B151	Muscle	3	BE (2021)	June	GEA
		Bone	3	BE (2021)	June	^{90}Sr
Upland Game Birds[a]						
100 Areas [b]	B112	Muscle	3	BE (2020)	September	GEA
		Bone	3	BE (2020)	September	^{90}Sr
Hanford Townsite to 300 Area [b]	B132	Muscle	3	BE (2020)	September	GEA
		Bone	3	BE (2020)	September	^{90}Sr
Reference	B152	Muscle	3	BE (2020)	September	GEA
		Bone	3	BE (2020)	September	^{90}Sr

(a) Attempt to collect one field duplicate muscle and bone sample from any one of the listed locations. Analyses for the duplicate sample will be the same as for the parent sample.
(b) Additional bird sample provided to DOH.

3.2.3 Mammals

Location	EDP Code	Sample Item	Number of Samples	Frequency	Collection Period	Analyses
Deer/Elk[a]						
Road Strike at Onsite Locations[b]	M178, M188, M198	Muscle	≤10	A (2020)	As Available	GEA
		Bone	≤10	A (2020)	As Available	^{90}Sr
		Liver	≤10	A (2020)	As Available	GEA, Pu-iso, ICP, Hg-CVAA
Reference[c]	M158	Muscle	1	A (2020)	As Available	GEA
		Bone	1	A (2020)	As Available	^{90}Sr
		Liver	1	A (2020)	As Available	GEA, Pu-iso, ICP, Hg-CVAA

(a) Attempt to collect one field duplicate muscle and bone sample from any one of the listed locations. Analyses for the duplicate sample will be the same as for the parent sample.
(b) Additional sample (elk preferred) provided to DOH.
(c) The reference sample is obtained from DOH.

Figure 11. Fish Sampling Locations

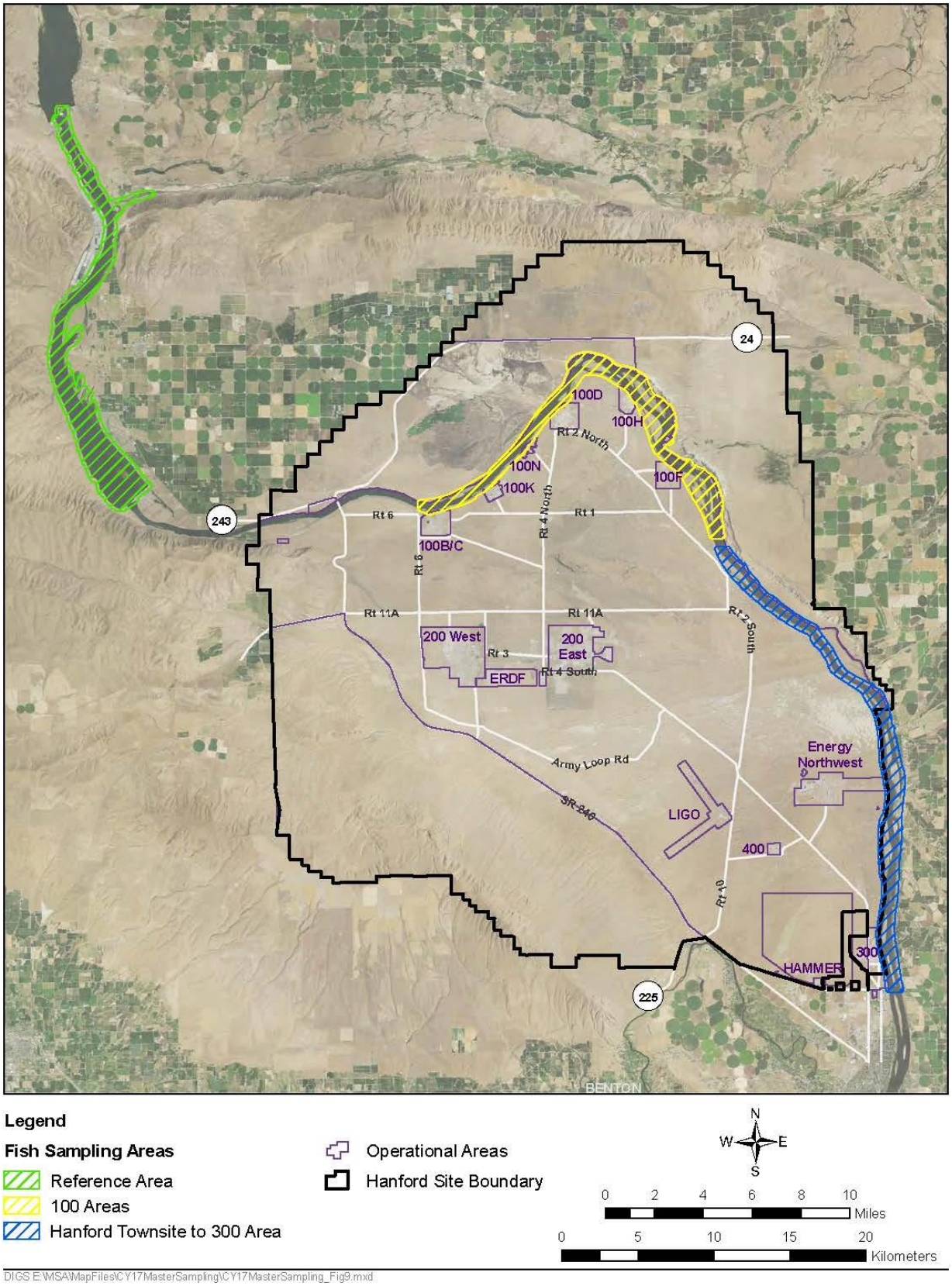
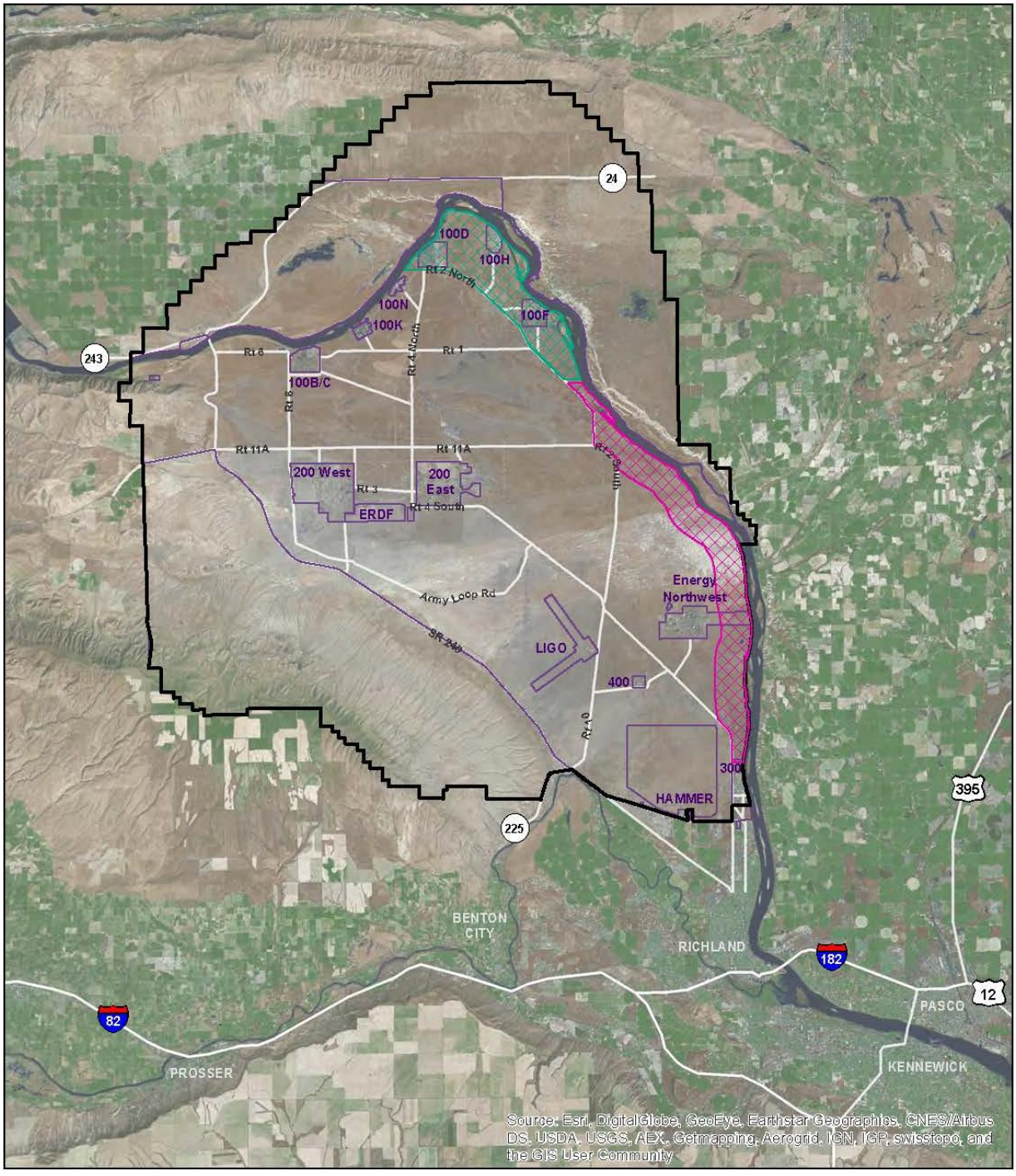


Figure 12. Upland Game Bird Sampling Locations



Legend

Upland Game Sampling Areas

- 100 Areas
- Hanford Townsite to 300 Area
- Operational Areas
- Hanford Site Boundary

N W E S

0 2 4 6 8 10 Miles

0 5 10 15 20 Kilometers

DIGS D:\MSA\MapFiles\FY16MasterSampling_Fig10.mxd

4.0 Soil and Vegetation

4.1 Off-site Soil Monitoring

Sample Location	EDP Code	Collection Period[a]	Analyses
N end Vernita Bridge	D424	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Wahluke Slope	D425	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Berg Ranch	D426	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Ringold	D427	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
W end Fir Road	D428	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Taylor Flats No. 2	D429	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Sagemoor Farms[b]	D430, D493	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso, ^{241}Am
Byers Landing	D431	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Benton City	D433	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Sunnyside	D434	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso, ^{241}Am
McNary Dam	D435	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Walla Walla	D436	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Washtucna	D437	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Toppenish	D438	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
George	D439[c]	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Othello	D440[c]	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Wanapum	D441[c]	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso

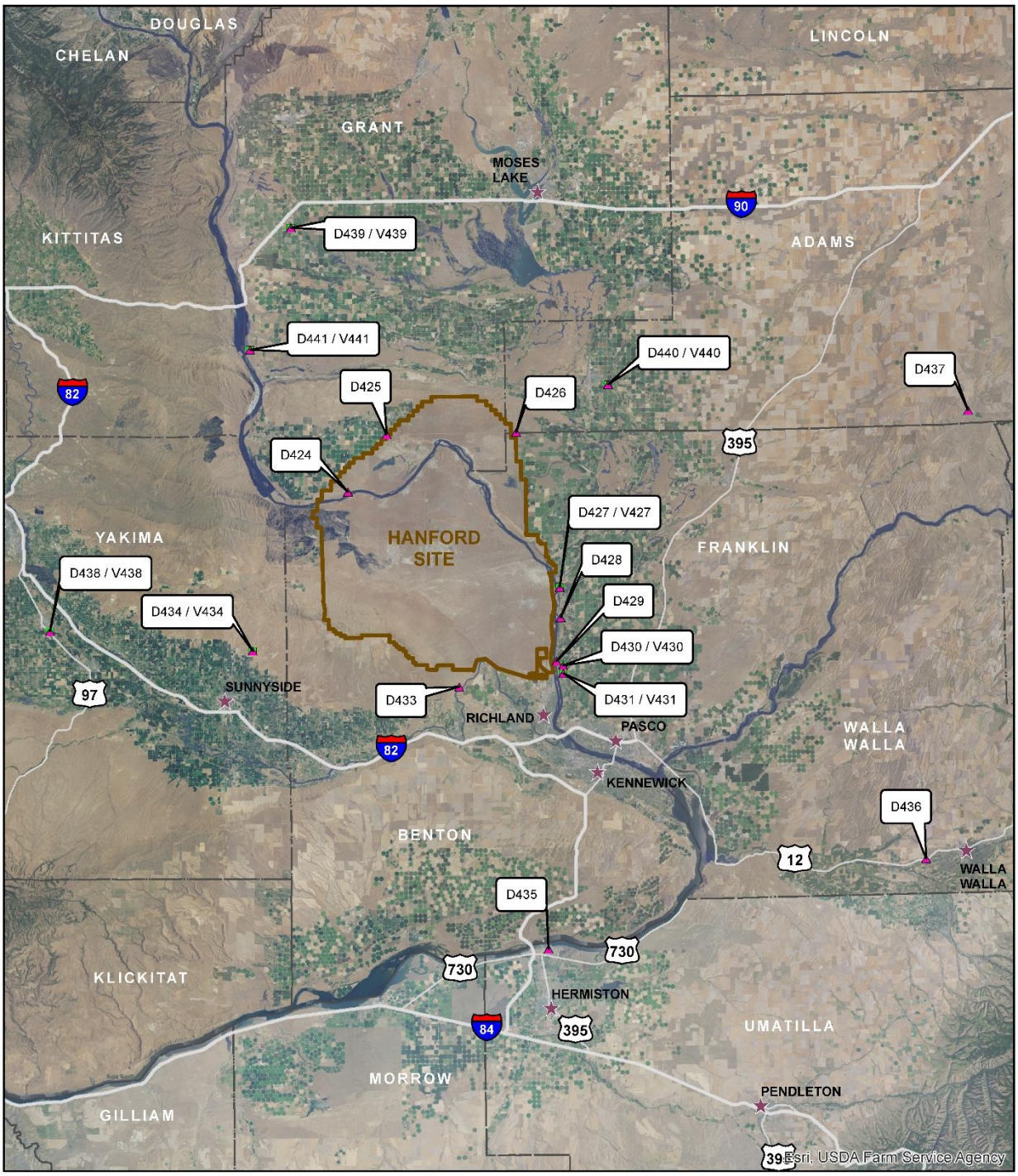
(a) Samples are collected approximately every 3-5 years, and were last collected in 2019.
(b) Duplicate samples (D430 & D493) collected at this location.
(c) Additional sample provided to DOH.

4.2 Off-site Vegetation Monitoring

Sample Location	EDP Code	Collection Period[a]	Analyses
Ringold	V427	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Sagemoor Farms[b]	V430, V493	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Byers Landing	V431	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Sunnyside	V434	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Toppenish	V438	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
George	V439[c]	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Othello	V440[c]	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso
Wanapum	V441[c]	June (2022)	GEA, ^{90}Sr, U-iso, Pu-iso

(a) Samples are collected approximately every 3-5 years, and were last collected in 2019.
(b) Duplicate samples (V430 & V493) collected at this location.
(c) Additional sample provided to DOH.

Figure 13. Off-site Soil and Vegetation Sampling Locations



4.3 On-site Soil Monitoring

Location	EDP Codes	Collection Period	Analyses
200 East Area	D054, D058[a], D060, D062, D064, D066, D072[b], D076, D078, D112[b]	May	^{90}Sr, Pu-iso, U-iso, GEA
Trench 94 (200 E Area) [c]	D458, D460, D461, D462	May	^{90}Sr, Pu-iso, U-iso, GEA
200 West Area	D002, D004, D006, D012, D016, D020, D022, D024, D026, D028[b], D030, D036, D038, D042, D046, D048[a], D050, D052, D142[b]	May	^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am
Plutonium Finishing Plant (200 W Area)	D008, D010, D032, D034, D040, D044[b]	May	^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am
ERDF at N482 (200 W Area) [d]	D146	May	^{90}Sr, Pu-iso, U-iso, GEA
300 Area	D120[b], D121, D123[a, b], D125, D126, D132[b], D140[b], D207	May	^{90}Sr, Pu-iso, U-iso, GEA
400 Area	D130	May	^{90}Sr, Pu-iso, U-iso, GEA
600 Area	D080, D082, D084, D086, D088[a], D090, D092[b], D094, D096, D098, D100, D102, D104, D106, D108, D110, D114[b]	May	^{90}Sr, Pu-iso, U-iso, GEA

(a) Additional sample provided to DOH.
(b) Duplicate samples (D072 & D112, D028 & D142, D120 & D132, D123 & D140, and D092 & D114) collected at these locations.
(c) Samples for CHPRC. Only three of the four locations will be sampled depending on wind rose analysis.
(d) ERDF soil sample is collected every year. Sample is for CHPRC.

Figure 14. On-site Soil Sampling Locations in the 200 East Area

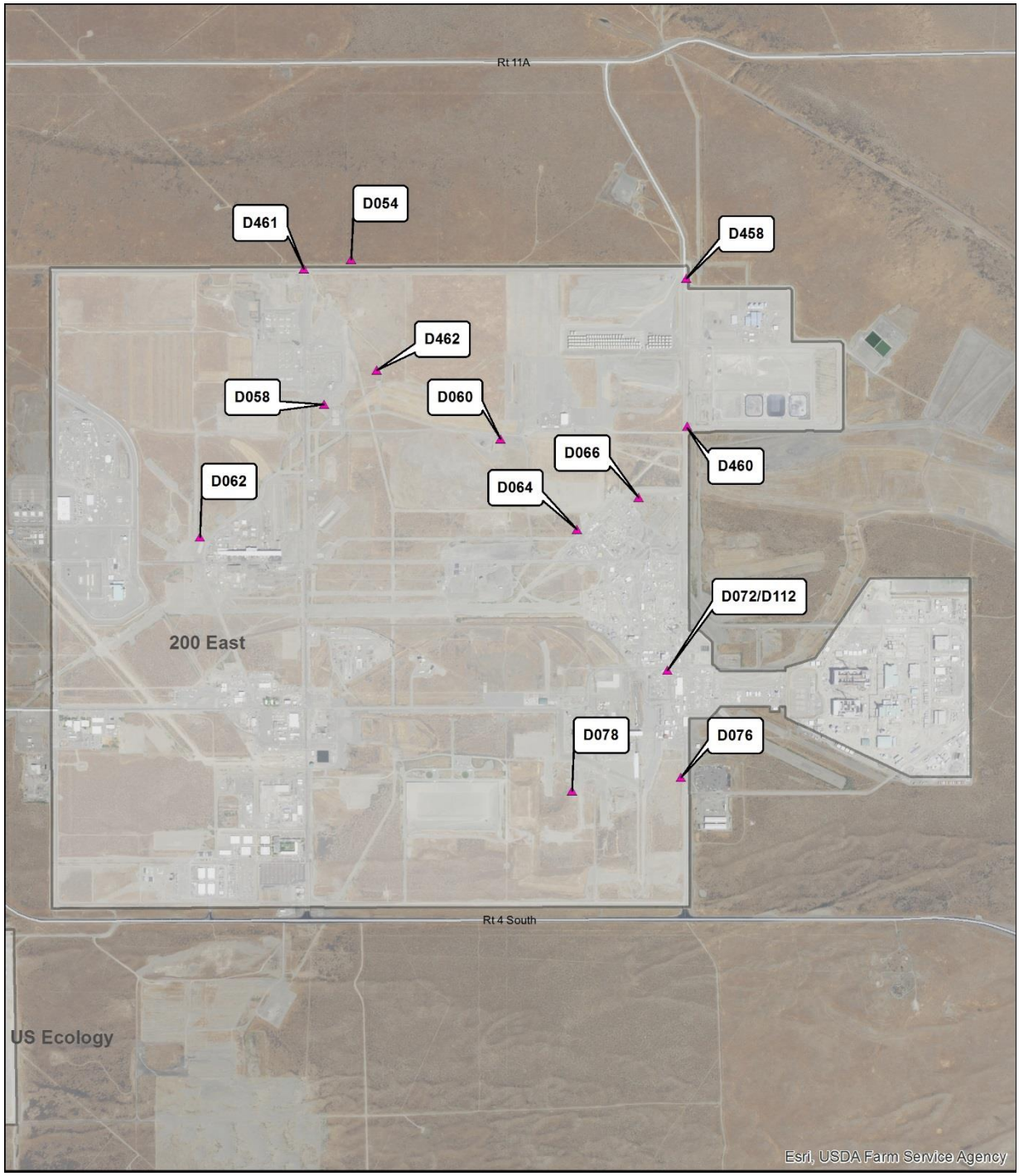


Figure 15. On-site Soil Sampling Locations in the 200 West Area

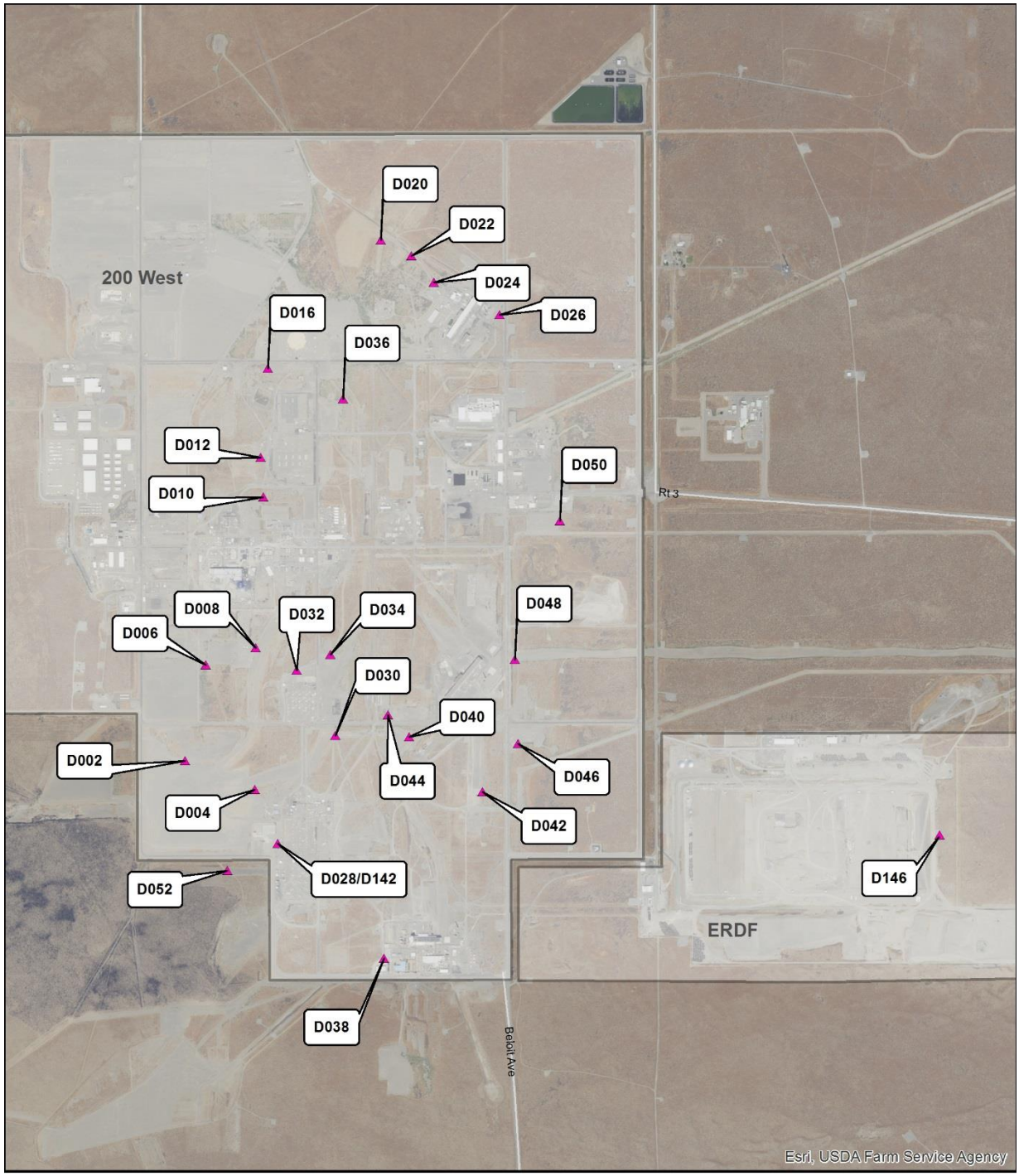


Figure 16. On-site Soil Sampling Locations in the 600 Area

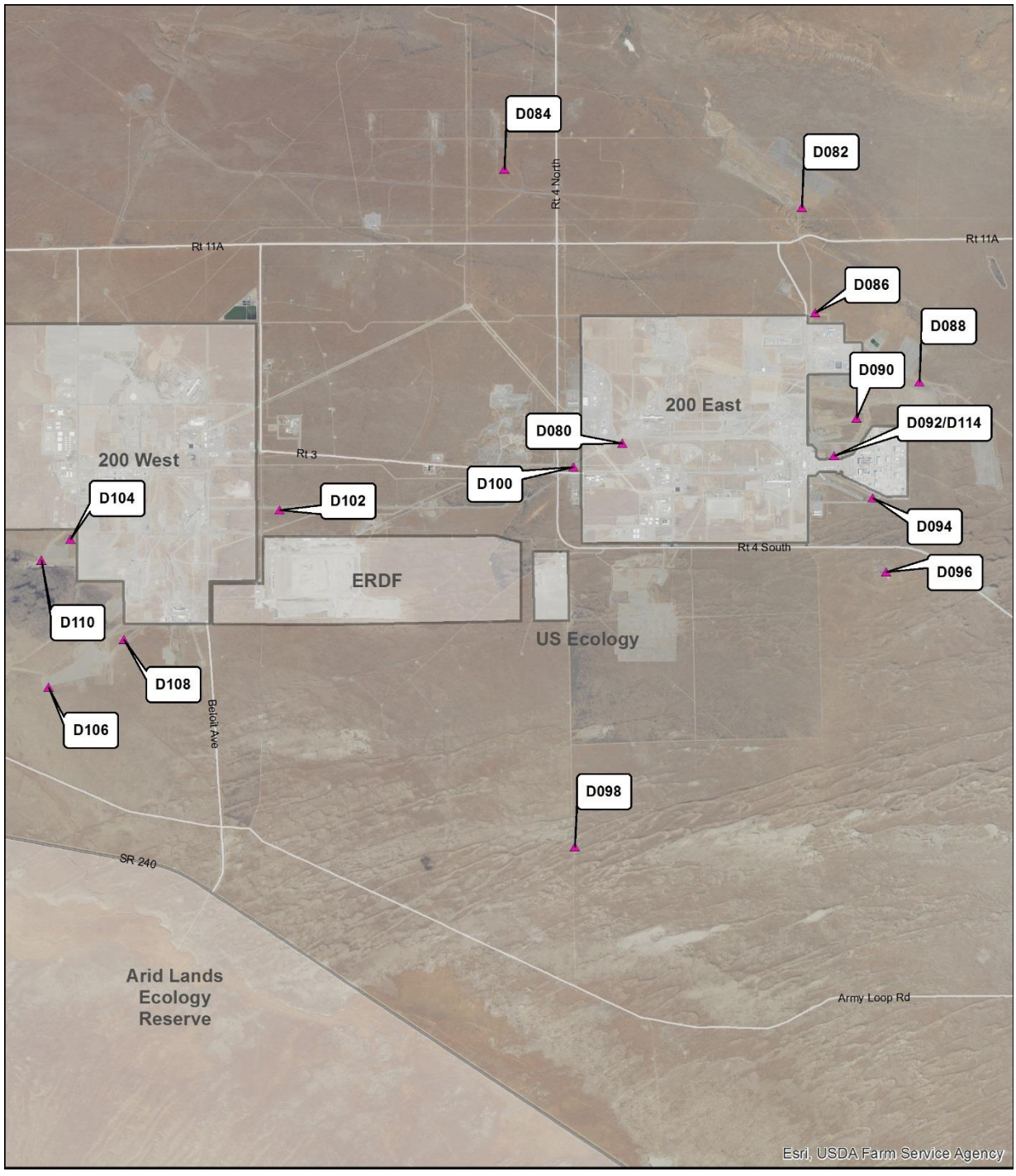


Figure 17. On-site Soil Sampling Locations in the 300 Area

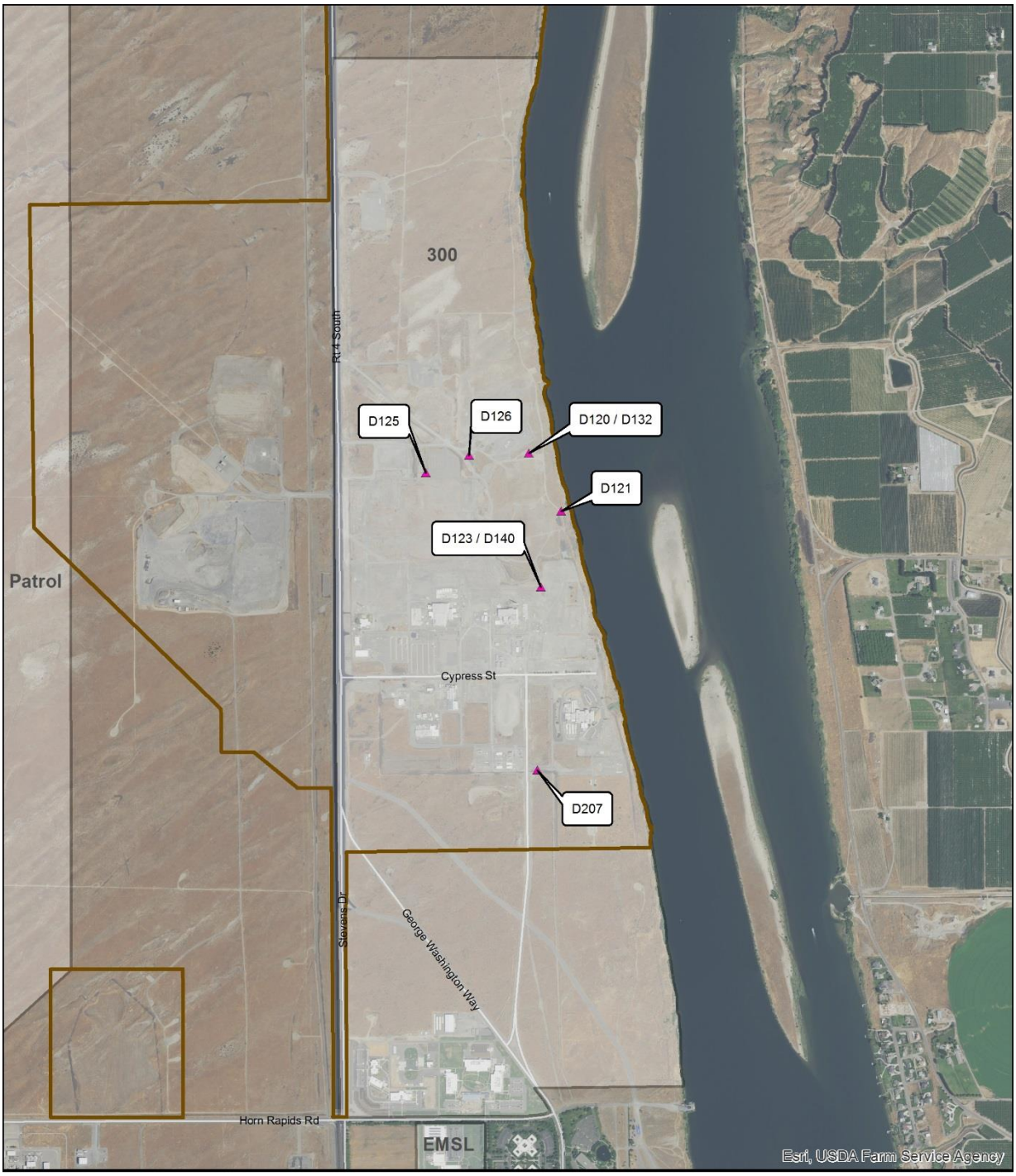


Figure 18. On-site Soil Sampling Location in the 400 Area

Legend

- Soil Sampling Locations
- Operational Areas

N
W E
S

0 400 800 1,200 1,600 Feet

0 100 200 300 400 Meters

NOTE: Aerial Imagery, 2017, NAIP.

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4.4 On-site Vegetation Monitoring

Location	EDP Codes	Collection Period	Analyses
100-N Area	Y719, Y724	May or September[a]	^{90}Sr, Pu-Iso, U-Iso, GEA
200 East Area	V054, V058[b], V060, V062, V064, V066, V076, V078	May	^{90}Sr, Pu-Iso, U-Iso, GEA
200 West Area	V004, V006, V012, V016, V020, V022, V024, V026, V042, V046, V048[b], V050, V052	May	^{90}Sr, Pu-Iso, U-Iso, GEA
Plutonium Finishing Plant (200 W Area)	V010, V032[c], V034, V040, V044[b], V112[c]	May	^{90}Sr, Pu-iso, U-iso, GEA, ^{241}Am
300 Area	V123[b, c], V132[c]	May	^{90}Sr, Pu-Iso, U-Iso, GEA
400 Area	V130	May	^{90}Sr, Pu-Iso, U-Iso, GEA
600 Area	V080, V082, V086, V088[b], V090, V092, V094, V096[c], V098, V100, V102, V104, V106, V108, V114[c]	May	^{90}Sr, Pu-Iso, U-Iso, GEA

(a) May be sampled at the same time as seep collections to provide access to the shoreline via boat.
(b) Additional sample provided to DOH.
(c) Duplicate samples (V032 & V112, V123 & V132, and V096 & V114) collected at these locations.

Figure 19. On-site Vegetation Sampling Locations in the 100 N Area

Figure 20. On-site Vegetation Sampling Locations in the 200 East Area

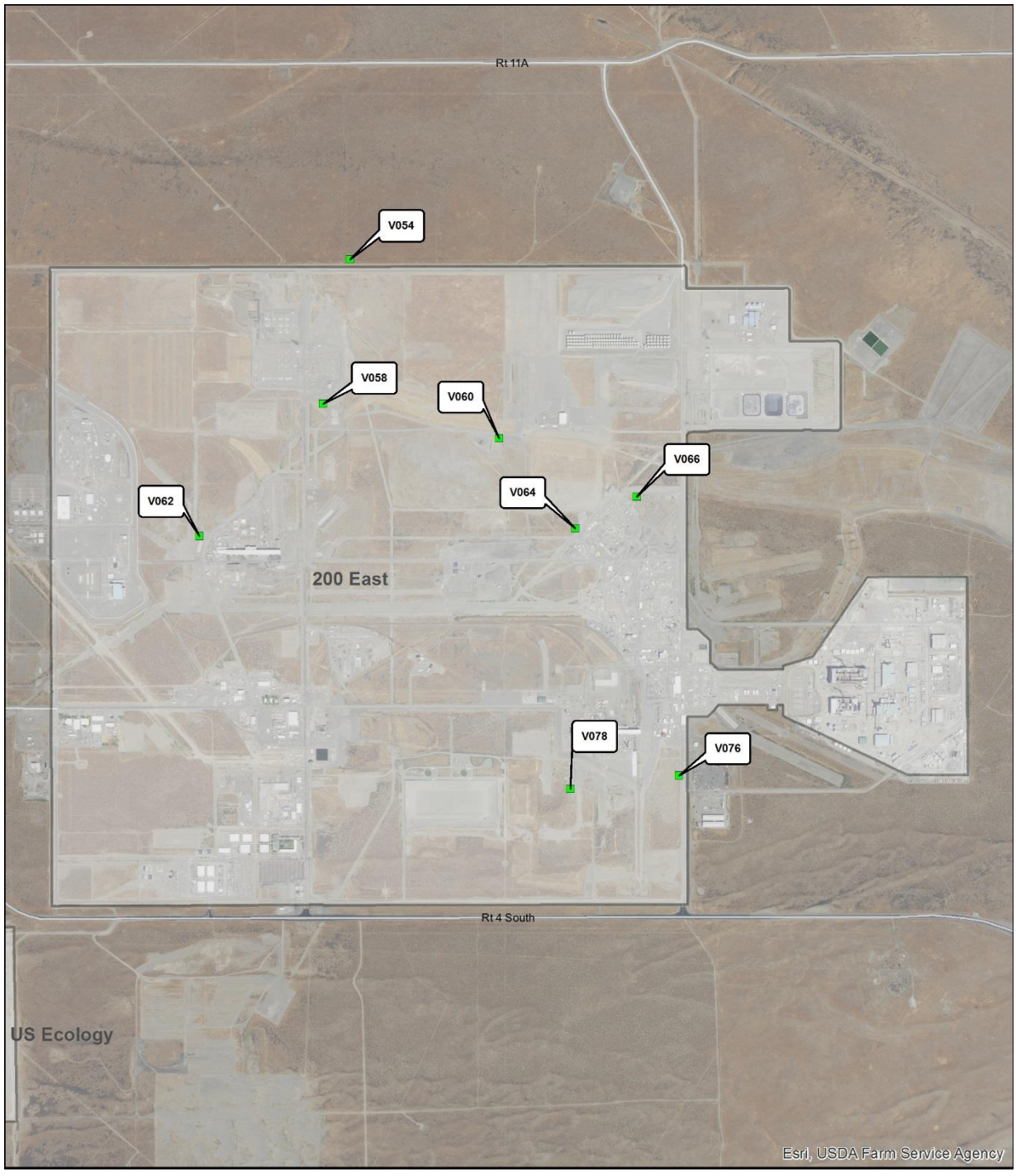


Figure 21. On-site Vegetation Sampling Locations in the 200 West Area

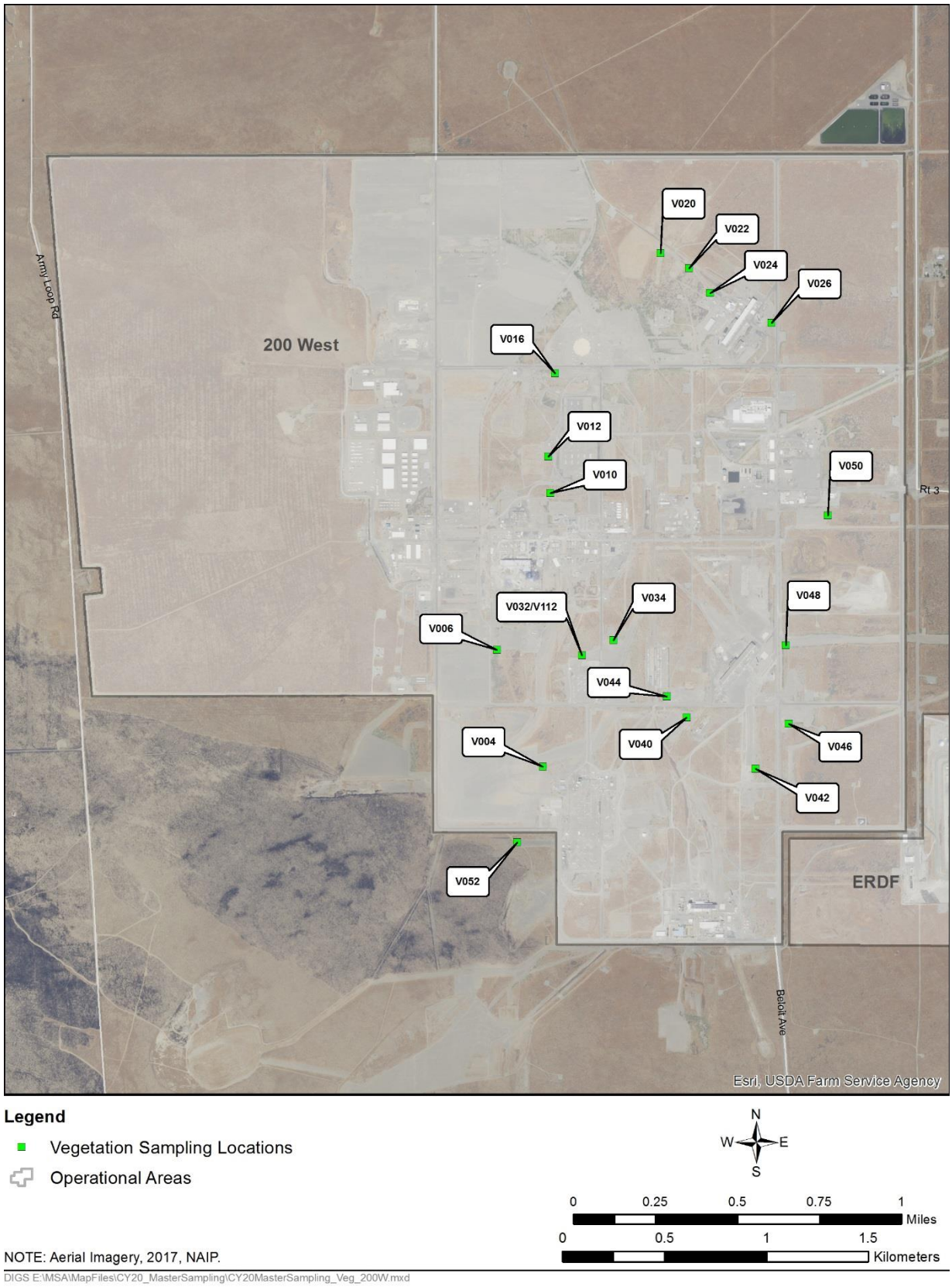
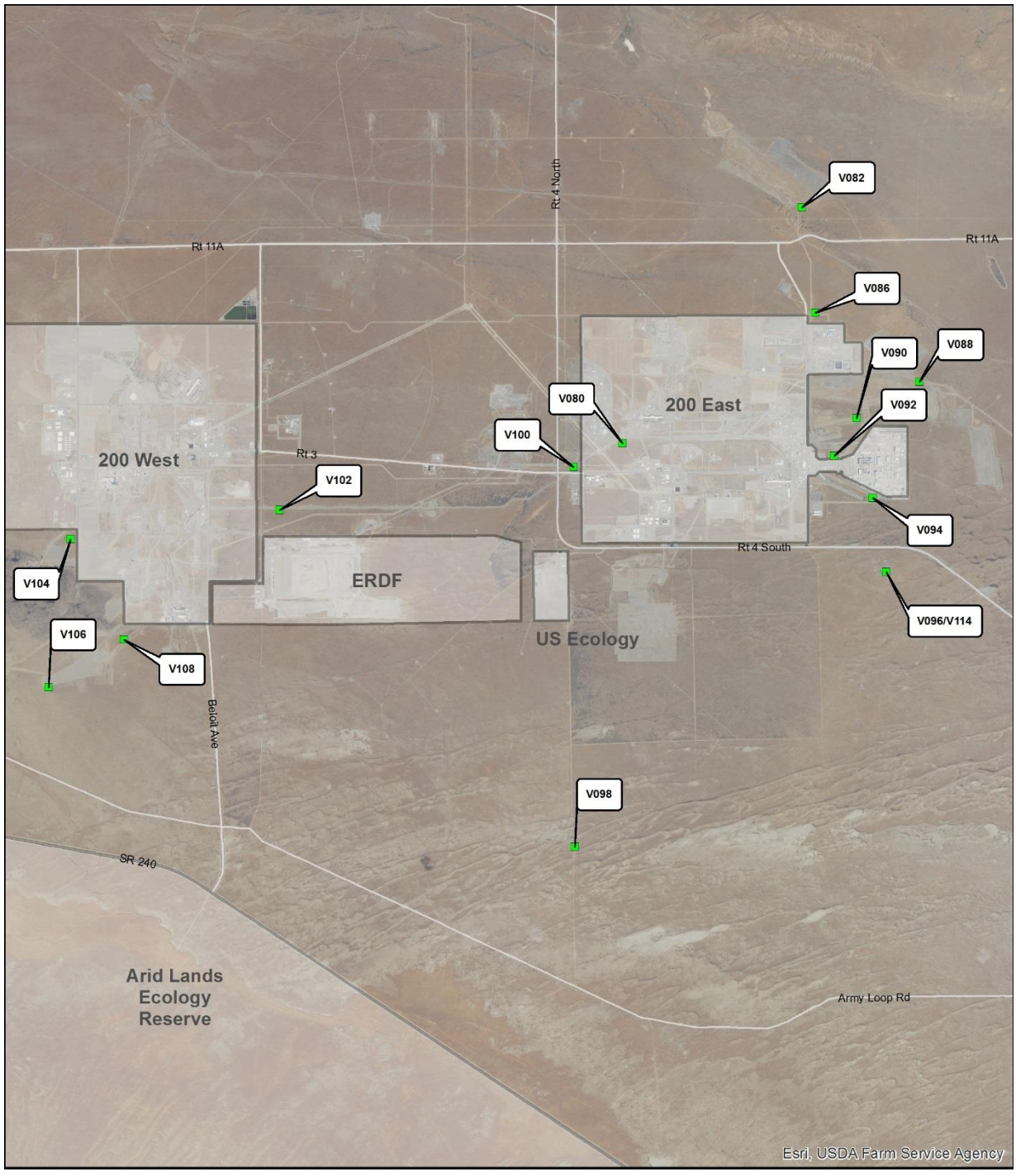


Figure 22. On-site Vegetation Sampling Locations in the 600 Area



Legend

- Vegetation Sampling Locations
- Operational Areas

N
W E
S

0 0.5 1 1.5 2 Miles

0 1 2 3 4 Kilometers

NOTE: Aerial Imagery, 2017, NAIP.

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Figure 23. On-site Vegetation Sampling Locations in the 300 Area

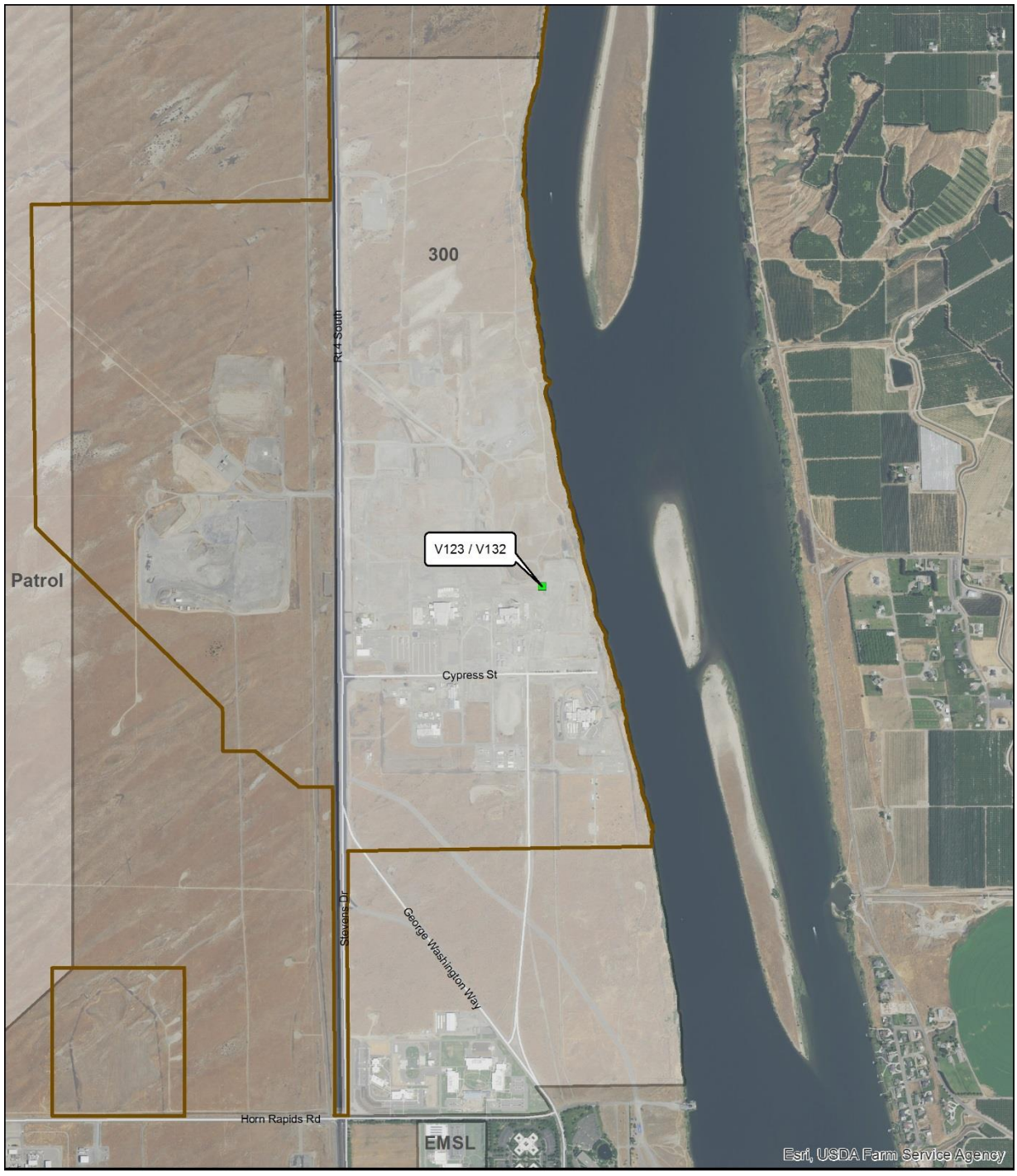
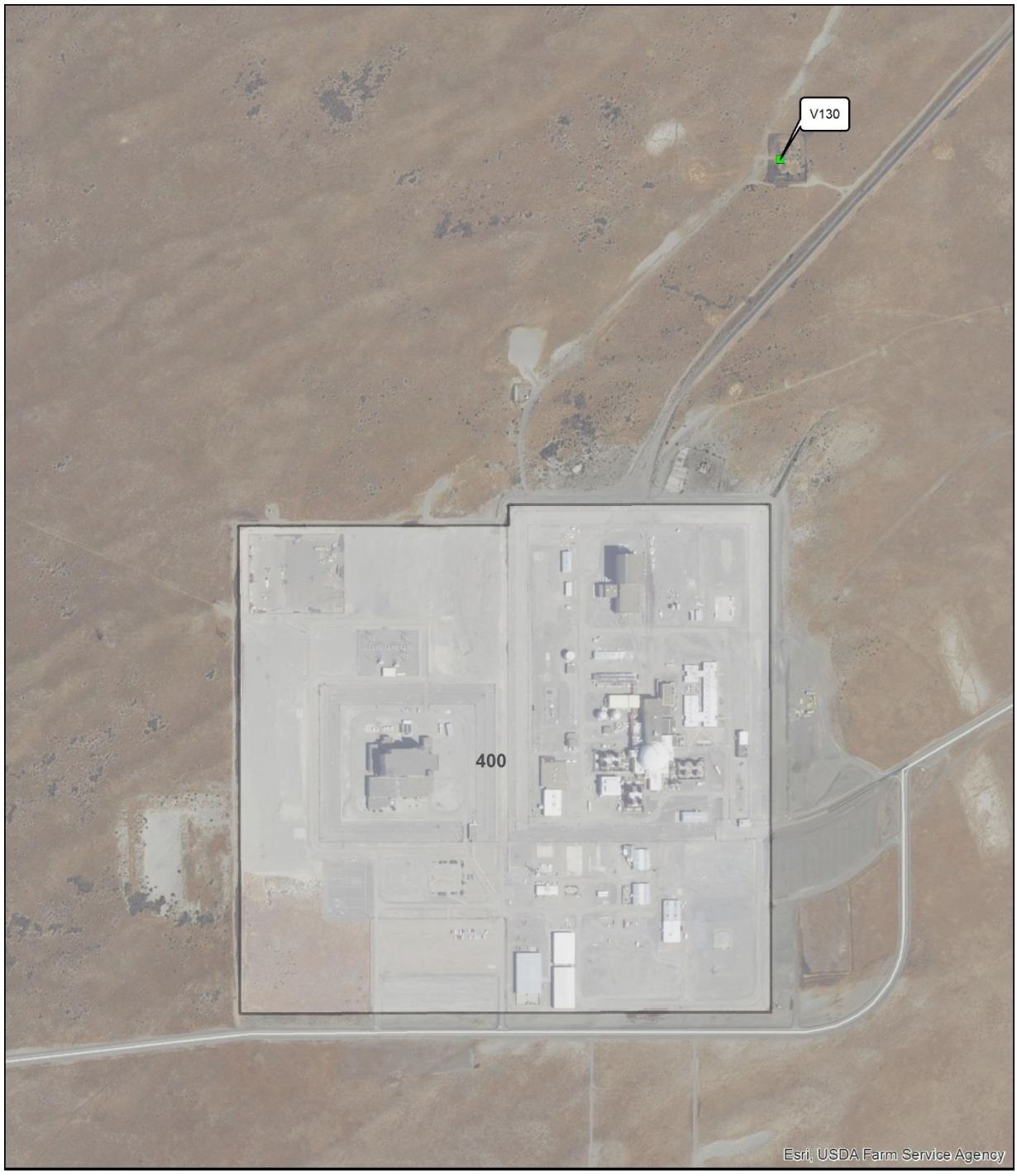


Figure 24. On-site Vegetation Sampling Location in the 400 Area



5.0 Sediment

5.1 Columbia River

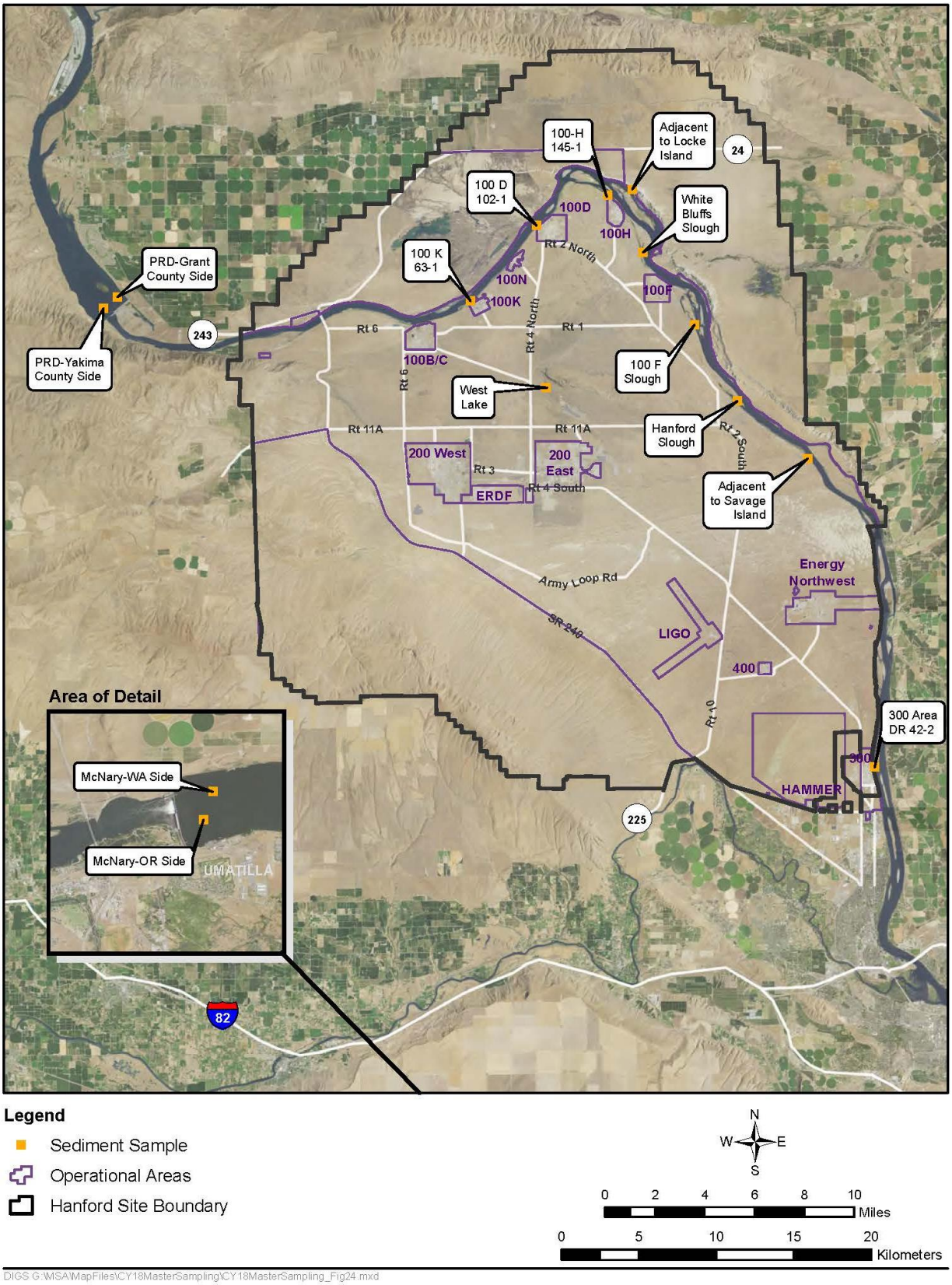
Location	EDP Code	Collection Period	Analyses
McNary Dam - Oregon Side[a]	D442	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
McNary Dam - Washington Side[a]	D443	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
Priest Rapids Dam – Grant County Side[a]	D444	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
Priest Rapids Dam – Yakima County Side[a]	D445	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
100-D Spring 102-1[b]	D446	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
100-K Spring 63-1[a]	D463	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC, ^{14}C
100-H Spring 145-1[a]	D499	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
Adjacent to Locke Island	D447	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA
White Bluffs Slough[a]	D448	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
100-F Slough	D450	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
Hanford Slough	D451	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
300 Area DR 42-2[a]	D500	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, ^{236}U, Anions, Cr^{+6}, ICP-MS, Hg-CVAA, TOC
Adjacent to Savage Island	D452	September-November	GEA, ^{90}Sr, U-iso, Pu-iso, Anions, Cr^{+6}, ICP-MS, Hg-CVAA

(a) Additional sample provided to DOH.
(b) Field duplicate sample collected. Analyses for the duplicate sample will be the same as the parent sample.

5.2 Onsite Pond

Location	EDP Code	Collection Period	Analyses
West Lake	D456	March and May	GEA, ^{90}Sr, U-iso, ^{99}Tc, Alpha, Beta

Figure 25. Sediment Sampling Locations



6.0 Thermoluminescent Dosimeter

Area	Number of Locations	EDP Codes	Frequency[a]
On-Site			
100-K	18	T218, T219, T220, T221, T222, T223, T224, T225, T226, T227, T228[b], T347, T348, T349, T350, T376, T377, T378	Q
100-N	1	T246[b]	Q
100-B	1	T392	Q
100-D	1	T391	Q
100-F Met Tower	1	T390	Q
Hanford Townsite Met Tower	1	T389	Q
200 E	45	T259, T260, T261, T262, T263, T264, T265, T266, T267, T268, T269, T270, T271, T272, T273, T274, T275, T276, T277, T278, T279, T280, T281, T282, T283, T284, T285, T286, T287, T288, T289, T290, T291, T292, T293, T294, T295, T296, T297, T298, T299, T300, T375, T382, T383	Q
WTP (200 E Area)	1	T388	Q
200 W	28	T301, T302, T303, T304, T305, T306, T307, T308, T309, T310, T311, T312, T313, T314, T315, T316, T317, T318, T319[b], T320[b], T321, T322, T323, T324, T325, T351, T352, T353	Q
300 Area	14	T326[b], T327, T328, T329, T330, T331, T332, T333, T334, T335, T336, T337, T338, T339	Q
400 Area	7	T340, T341, T342, T343, T344, T345, T346	Q
Off-Site			
Ringold	1	T384	Q
W End of Fir Road	1	T385[b]	Q
Dogwood Met Tower	1	T386	Q
Yakima	1	T387	Q

(a) TLDs are exchanged quarterly in March, June, September and December.
(b) DOH TLD also at this location.

Figure 26. Thermoluminescent Dosimeter Locations in the 100-K Area

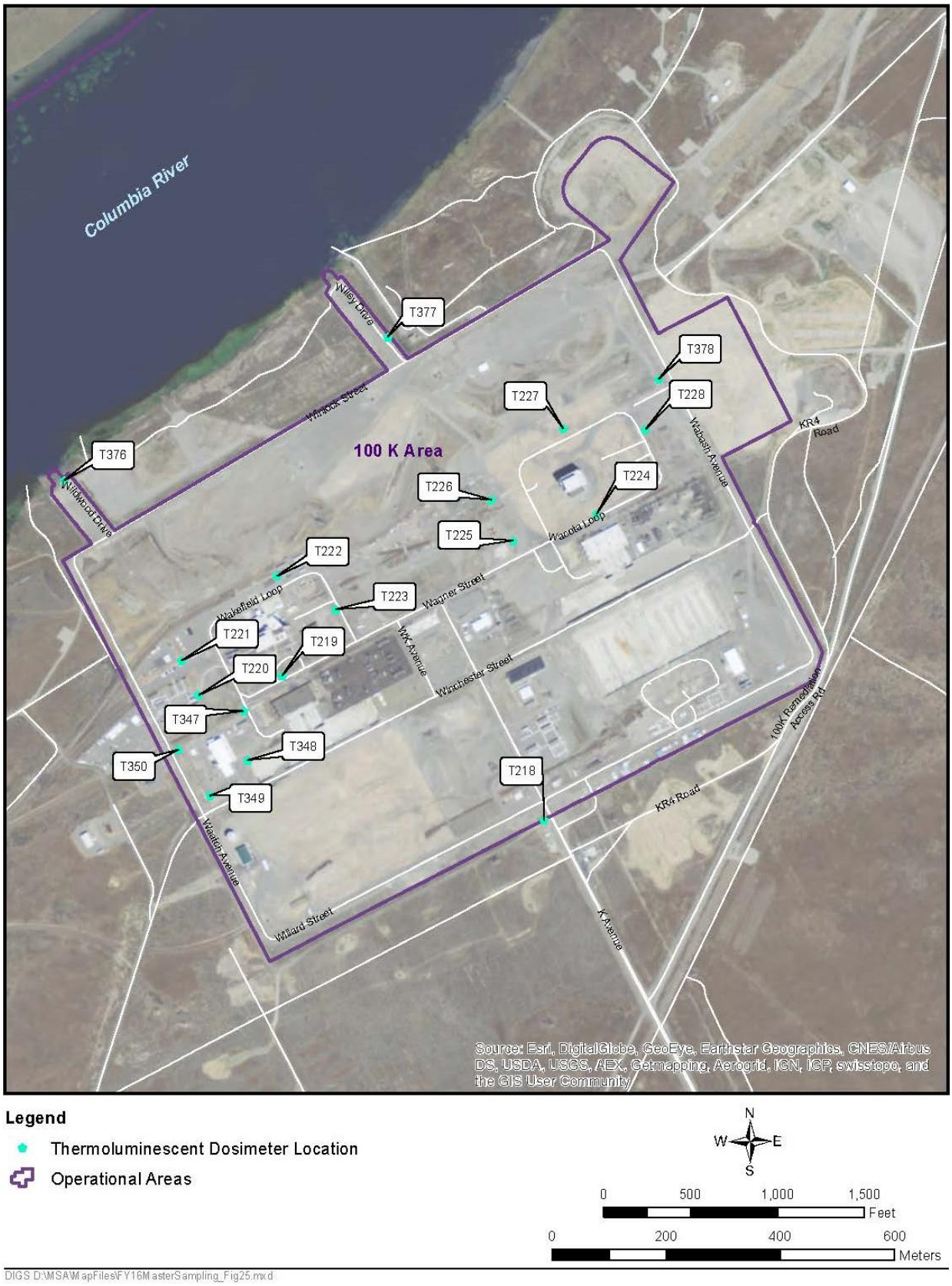


Figure 27. Thermoluminescent Dosimeter Location in the 100 Areas and Hanford Townsite

Figure 28. Thermoluminescent Dosimeter Locations in the 200 East Area

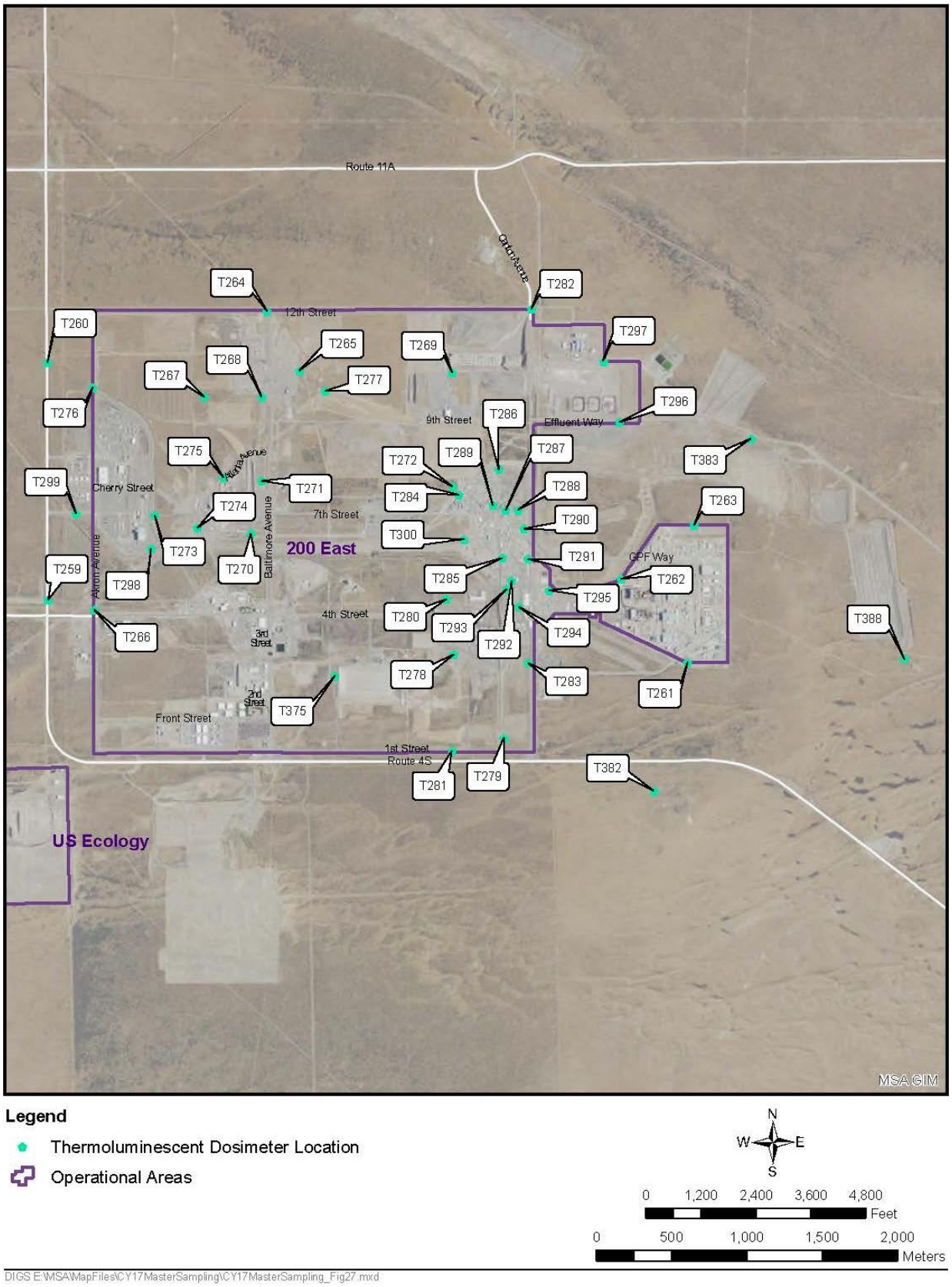


Figure 29. Thermoluminescent Dosimeter Location in the 200 West Area

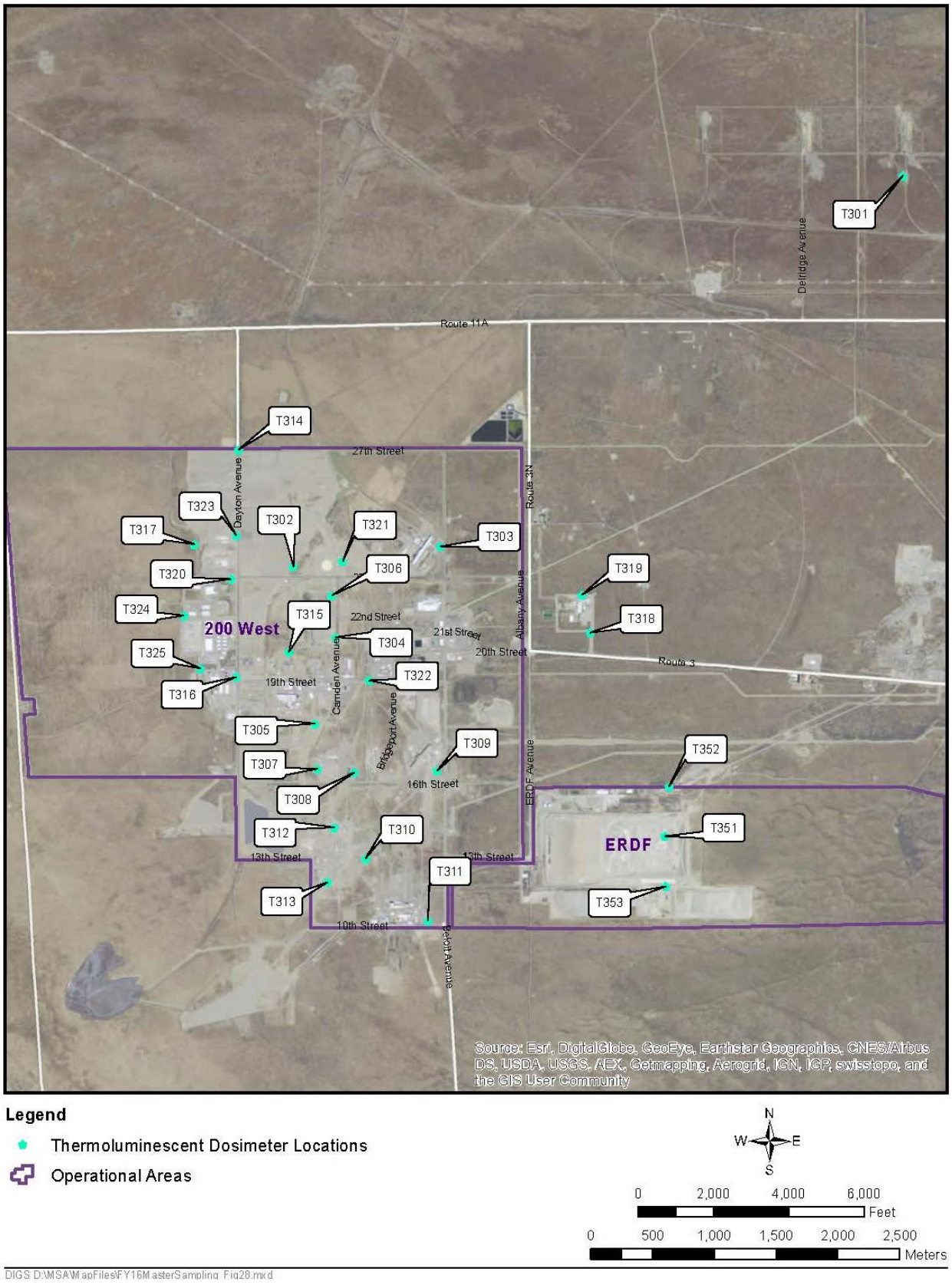


Figure 30. Thermoluminescent Dosimeter Locations in the 300 Area

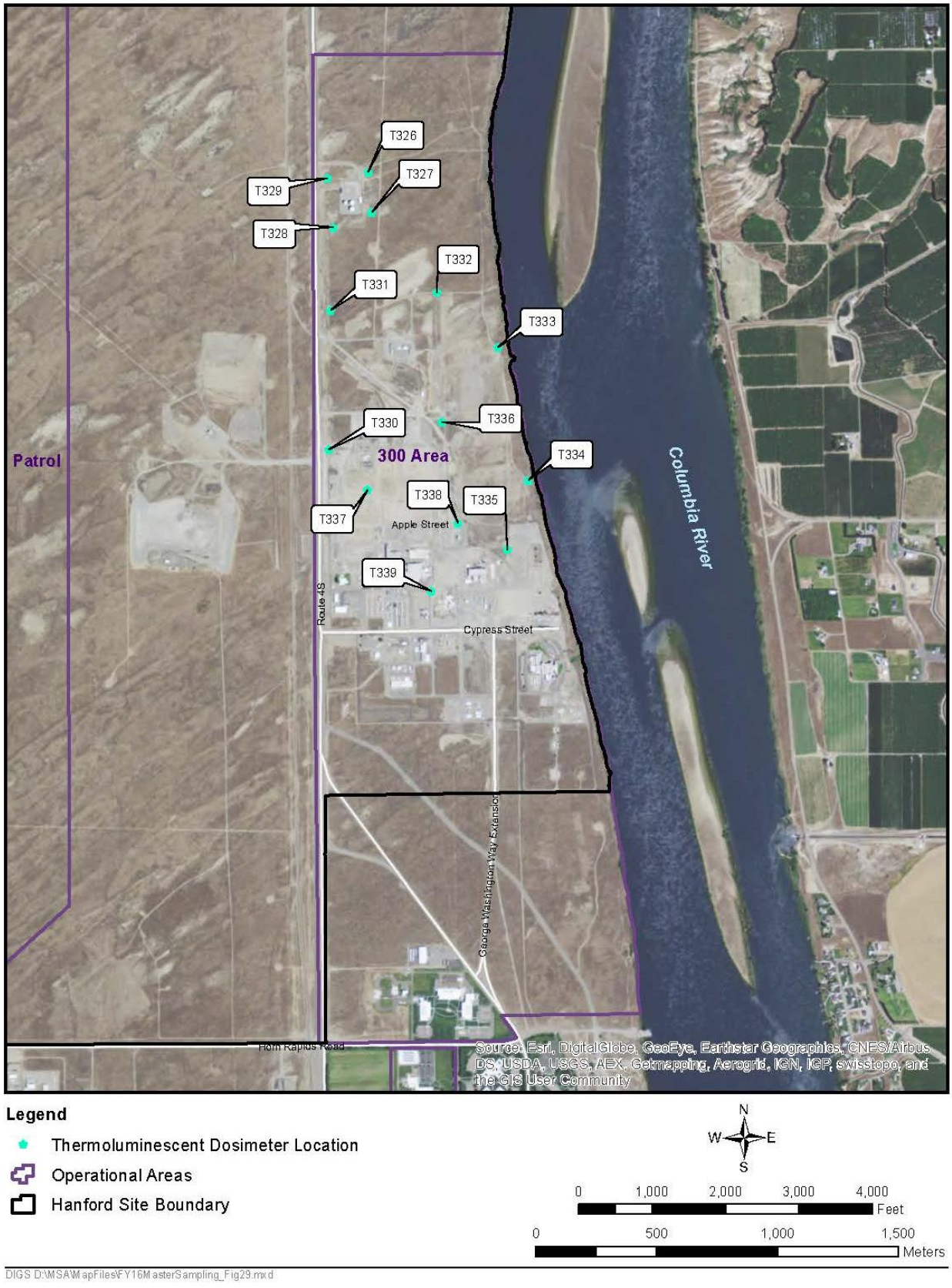


Figure 31. Thermoluminescent Dosimeter Locations in the 400 Area

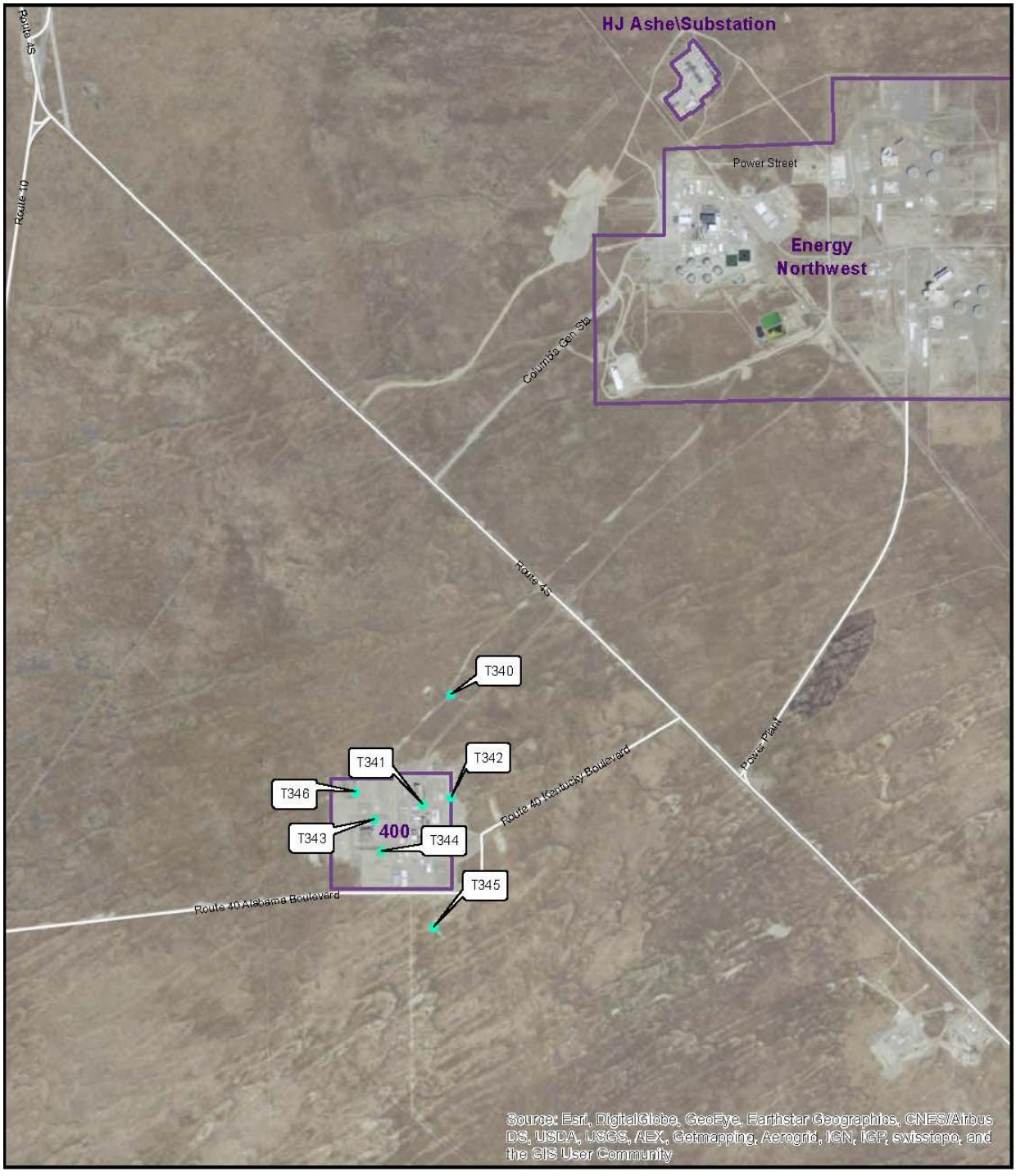
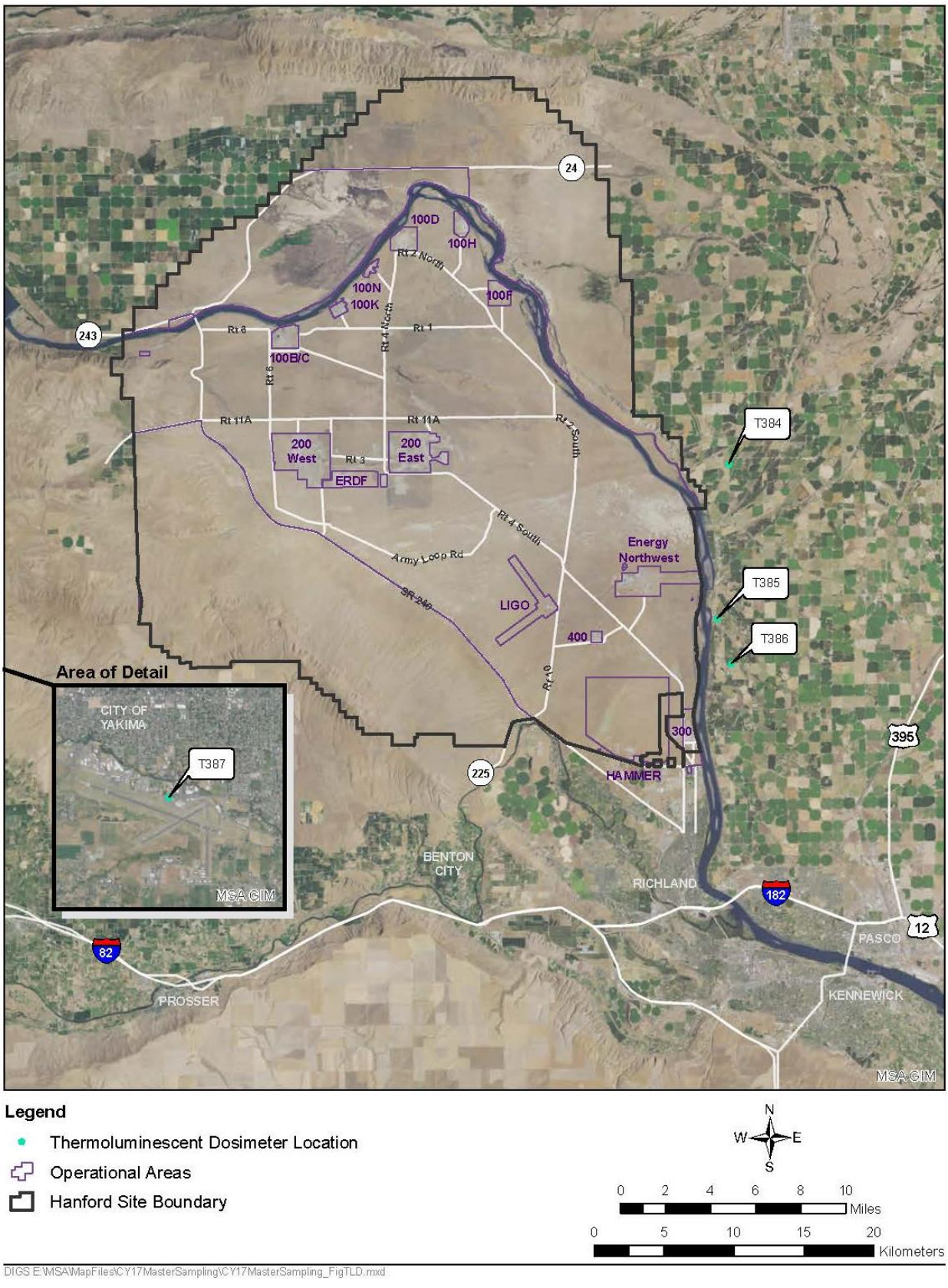


Figure 32. Thermoluminescent Dosimeter Off-Site Locations



7.0 Radiological Surveys

7.1 Weekly Inspections

Location
2724-WB RMA

7.2 Annual Radiological Surveys

Location	Area	Survey Period
218-E-12B outside perimeter	200E	January
241-B tank farm perimeter	200E	January
241-S/SX/SY tank farm perimeters (including 200-W-54 and 216-SX-2)	200W	January
218-E-12A outside perimeter	200E	February
241-A, AN, AX, AY, AZ & 242-A tank farm perimeters	200E	February
241-BX/BY tank farm perimeters (including 216-BY-201 tank)	200E	February
241-C tank farm perimeter (including posted Contamination Area South of 7th Street)	200E	February
241-U (including 200-W-91 and 200-W-95) tank farm perimeters	200W	February
218-E-10 outside perimeter	200E	March
216-S-17 Pond	200W	March
218-W-4A perimeter	200W	March
241-TX/TY tank farm perimeters	200W	March
2025E, LERF/ETF, and 200-E-17 perimeters	200E	April
241-T tank farm perimeter	200W	April
600-214 perimeter (including 289E MODU-Tanks)	600	April
Tumbleweed surveys inside and outside of the NE corners of 200 E and 200 W perimeter fences	200E/200W	April
200/600 Areas emergency plots	200/600	November
Haul routes (as identified by EIS-ES)		TBD

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Appendix A Master Sampling Schedule changes for Calendar Year 2020

A.1 Air Surveillance

A.1.1 Air Monitoring

- Added Americium-241 analyses to N019, N973, and N976; ECF-HANFORD-17-0042 Rev. 0, *Radiological and Toxic Air Emissions for the 224B Plutonium Concentration Facility* cites these air sample stations as required during CERCLA removal action and Am-241 is >10% unabated dose contributor.

- Carbon-14 sampling will be reimplemented at the following three stations to establish a new baseline for the Hanford Tank Waste Treatment and Immobilization Plant (WTP):
  - N584
  - N920
  - N934

A.1.2 Effluent/Stack Monitoring

- Effluent/stack monitoring footnote in Table 1 is to recognize that MSA is responsible for the analyses and reporting of effluent samples; other Hanford Contractors are responsible for planning, scheduling, and collecting stack samples at facilities they operate. See HNF-61951 for more information.

A.2 Surface Water

A.2.1 Transects

- Removed Hexavalent Chromium analyses from all transect locations due to closure of the local analytical laboratory (Test America Richland Laboratory).

A.2.2 Seeps

- Added isotopic Uranium analysis to 100-H Spring 152-2. Per the Hanford Site Groundwater Monitoring Report for 2018 (DOE/RL-2018-66), Uranium is present in groundwater at the former 183-H Solar Evaporation Basins in the 100-H Area. Concentrations exceeded the 30 µg/L DWS in wells 199-H4-84 and 199-H4-88 in 2018, with a maximum of 89 µg/L in well 199-H4-84 (June 2018). The uranium concentrations near the basins fluctuate considerably during the year, with higher concentrations present during high river stage. Uranium values follow the same trends as for both nitrate and Cr(VI). This type of trend is consistent with the presence of a continuing source at the 183-H Solar Evaporation Basins.

- Removed Hexavalent Chromium analyses from all seep locations due to closure of analytical laboratory (Test America Richland Laboratory).

A.3 Food and Farm Products

A.3.1 Vegetables and Fruit

- Added tritium analysis to leafy vegetables and melons as those are comprised of >90% water at maturity (similar to tomatoes). Historically, there has been a low number of tritium detections in tomato samples irrigated by water downriver of the Hanford site; however, irrigation sample results show high frequency

of detections for tritium. These additional analyses would allow a bigger picture as to how tritium is transferred into foodstuffs that are high in water content.

A.3.2 Potatoes

- Increased the collection frequency of potatoes in the Sagemoor and Horn Rapids Areas to align with the collection frequency of potatoes in all other sample areas.

A.4 Wildlife

A.4.1 Fish

- Electrofishing for carp can only occur under certain water conditions, including below a maximum temperature. Recent sampling events were unsuccessful when water temperatures exceeded those maximum temperatures. The sampling date for carp has been moved up to May to allow staff to monitor flows and temperatures of the river to identify the ideal point in time to perform fishing activities while keeping with permit conditions. This change will not affect expected results or accumulation of contaminants; the change is strictly to maintain work within permit requirements.

A.4.2 Rabbits

- Collection of rabbits in support of the program mission can no longer be justified. Rabbits are not a highly hunted species within the local region, however the state does maintain a season of September-March for hunting. A Nuttall's cottontail has been shown to have a home range of about $300m^2$ – $500m^2$ during GPS collar studies on Hanford. Unlike many of the other animals within the environmental surveillance program, it is highly improbable that a rabbit will leave the Hanford Site and get across river or to other acceptable hunting areas. The 300 Area had been sampled as it provided the most likely opportunity to have animals impacted by Hanford operations be obtainable to the public. Poor sampling success over recent years and the unlikely probability of the public hunting in or near the industrial and residential areas of north Richland has devalued the effort of this collection. Rabbit collections have been removed from the sampling schedule for these reasons.

A.4.3 Deer/Elk

- Increased collection frequency of deer/elk from biennial to annual. In 2016, Washington State initiated a salvage permit program that allows the public to remove deer and elk that have been struck and killed by a vehicle. This has become a very common occurrence in the state with many to most of the animals killed by vehicular strike being removed from the road by public. With this increased opportunity for the public to remove animals from a roadway that are from or have been on the Hanford Site it behooves this program to extend the monitoring of deer and elk to an annual basis. This increased collection frequency will also fill the gap left with the removal of rabbit collections.

A.5 Soil and Vegetation

A.5.1 Off-site Soil and Vegetation Monitoring

- Off-site soil and vegetation samples are collected every 3-5 years and were last collected in 2019. Off-site sampling is used for long-term trend analysis and is not used in dose model calculations. The sampling frequency of every 3 to 5 years is consistent with the guidance provided in DOE handbook DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance,* and was last conducted in 2015.

A.5.2 On-site Soil and Vegetation Monitoring

- Includes the 200/600 Area even-numbered locations where samples are collected only during even-numbered years. This is a standard rotation to minimize annual analytical costs.

Appendix B Sampling Rationale

B.1 Air Monitoring

Atmospheric releases of radioactive materials from Hanford Site facilities and operations to the surrounding region are potential sources of exposure to humans. Radioactive constituents in air are monitored at Hanford Site facilities and projects, at Hanford Site locations away from facilities, and offsite around the site perimeter as well as in nearby and distant communities. The use of TLDs, soil and vegetation sampling are other methodologies used to support the detection of any atmospheric releases both past and present.

Air sampling at/near facilities/projects is conducted to ensure compliance with predetermined regulatory limits (i.e., EPA concentration values (40 CFR 61, Appendix E, Table 2, per *#FF-01 License*) and to detect airborne radiological contaminants resulting from site operations.

Air monitoring is a recommended practice per section 6.0 of DOE handbook DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

Air sampling at perimeter, nearby community and distant community locations is conducted to provide analytical data that are used to support radiological dose modeling to the public via the air pathway using the U.S. Environmental Protection Agency Clean Air Act Assessment Package (CAP-88) dose model (EPA/600/R-09/052) *Exposure Factors Handbook 2011 Edition (Final)*.

Data collected from locations on and around the Hanford Site are also compared to concentrations measured at upwind locations assumed to be uninfluenced by Hanford Site operations to evaluate the impact of radionuclide air emissions from the site on surrounding air.

Airborne particle samples are collected biweekly at each location and combined into semiannual composite samples.

Atmospheric water vapor samples are collected for tritium analysis by continuously drawing air through multi-column samplers containing adsorbent silica gel. The water-vapor samples are exchanged every 4 weeks.

B.2 Surface Water Surveillance

B.2.1 Columbia River Continuous Water

Groundwater contaminants related to historical Hanford operations are known to enter the Columbia River through surface water discharges of groundwater at certain locations along the site shoreline from the 100-B/C Area downstream to the 300 Area. The impact of these discharges is evaluated as the difference between near-shore river water radionuclide concentrations downstream of the Hanford Site (monthly samples collected at the Richland Pumphouse) and upstream samples collected below Priest Rapids Dam. Radionuclides are measured in unfiltered, filtered samples (in solution) and in samples that capture suspended particulates (adhered to resin).

Radionuclides of interest are selected for analyses based on their:

- Contaminants found in groundwater underlying the Hanford Site near the Columbia River.
- Importance in determining water quality and compliance with applicable water quality standards.
- Importance in key pathway-specific exposure dose assumption calculations based on 95th percentile of drinking water ingestion rate of 3.1 L/day for 350 days/year per EPA's *Exposure Factors Handbook* (EPA/600/R-09/052F, Table ES-1).

Constituents of interest in Columbia River water samples collected at Priest Rapids Dam and the city of Richland include gamma-emitting radionuclides (e.g., cesium-137, cesium-134), tritium, strontium-90, technetium-99, uranium-234, uranium-235, plutonium-238, uranium-238, and plutonium-239/240.

B.2.2 Columbia River Transects

Transect sampling (i.e., a series of samples collected along a line across the Columbia River) was initiated due to findings of a special study conducted in the late 1980s: PNL-8531, *Columbia River Monitoring: Distribution of Tritium in Columbia River Water at the Richland Pumphouse*. The study concluded that, under certain flow conditions, contaminants entering the Columbia River from the Hanford Site are not completely mixed when sampled at routine monitoring stations located downriver. Incomplete mixing results in a conservative bias in the data generated using the routine, single-point sampling system at the city of Richland drinking water intake. Transect sampling provides cross-river concentration profiles relevant to a larger portion of the Hanford Site shoreline and river upwelling where the highest contaminant concentrations of concern would be expected.

Columbia River transect water samples are analyzed for radionuclides, metals, and inorganic and organic contaminants. These analyses were selected following reviews of existing surface-water and groundwater data, various Remedial Investigation/Feasibility Study (RI/FS) work plans, and preliminary Hanford Site risk assessments (DOE/RL-92-67, *Final Remedial Investigation/Feasibility Study-Environmental Assessment Report for the 1100-EM-1 Operable Unit, Hanford* and WCH-380, *Field Summary Report for Remedial Investigation of Hanford Site Releases to the Columbia River, Hanford Site, Washington*). Metals analyses include hexavalent chromium and both unfiltered and filtered samples. Hexavalent chromium analysis requires a local contracted laboratory due to short hold times.

B.2.3 River Bank Seeps

Groundwater beneath the Hanford Site discharges on the shoreline surface of the Columbia River via seeps and subaqueous (below the riverbed) groundwater upwelling. Groundwater provides a means for transporting Hanford Site-associated contaminants into the Columbia River. Routine monitoring of selected Columbia River seeps was initiated in 1988. The objectives of seep sampling are multi-fold and include monitoring the locations and levels of contaminants entering the river; support Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) evaluation of remediation strategies and Monitored Natural Attenuation (MNA); evaluating the nature and extent of potential ecological and human exposures and bioaccumulation; and providing assistance in discerning whether public and biological access needs to be restricted (e.g., institutional controls such as fencing, sign postings). Samples are collected at least annually during low river level periods (fall) when dilution by river water is minimal and relatively higher contaminant concentrations are expected.

It is important to know the inventory of contaminants and locations where known contaminants are entering the Columbia River along the Hanford Reach shoreline to (DOE/RL-91-50):

- Ensure human health and the environment are protected on and off the Hanford Site
- Assess the impact of Hanford Site operations on Columbia River water quality
- Identify significant changes in contaminant concentrations (radiological and chemical) in surface water
- Assess potential sources of new contaminants or whether remediation strategies are or have been effective
- Characterize contaminants in the surface water environment and discern whether any human health or biological risks are associated with these contaminants
- Determine the status of the site's compliance with applicable regulatory-driven water quality standards and criteria
- Provide public assurance that Hanford-derived contaminant exposure risks associated with using the Columbia River are continually monitored and evaluated

The following contaminants are present in groundwater that discharges to the river (DOE/RL-2018-66):

- 100-BC: hexavalent chromium, strontium-90, tritium, trichloroethene
- 100-K: hexavalent chromium, carbon-14, tritium, strontium-90, nitrate, trichloroethene
- 100-N: strontium-90, petroleum hydrocarbons (diesel), nitrate, tritium, hexavalent chromium
- 100-D: hexavalent chromium, strontium-90, nitrate
- 100-H: hexavalent chromium, strontium-90, nitrate
- 100-F: nitrate, hexavalent chromium, strontium-90, and trichloroethene
- 300 Area: uranium, tritium, trichloroethene, cis-1,2-dichloroethane, and nitrate

Sample locations and analytes of interest for riverbank springs/seeps are selected based on findings of previous investigations, reviews of contaminant concentrations observed in nearby groundwater monitoring wells and locations of regional groundwater contamination plumes relative to the spring/seep locations, and results of preliminary risk assessments. Several seep locations (e.g., F Area Slough) are targeted for sampling because they are easily accessible and highly used by wildlife.

The results of the seep sampling are trended and data are used to determine radiological dose to humans and aquatic, riparian, and terrestrial biota. The contaminant concentrations in seeps are greater than those observed in the river water and have the potential for higher contaminant concentration level exposures due to lack of mixing and dilution which occurs when contaminated groundwater is directly discharged into the much heavier flow of the Columbia River. Therefore, the dose assessment results using these discrete areas of elevated concentrations are

conservative and are protective relative to the potential for impacts on populations of biota in and adjacent to the Columbia River.

B.2.4 Onsite Pond

West Lake is a highly saline and alkaline pond that is accessible to wildlife, providing a biological pathway for the dispersion of contaminants and a potential source of exposure to ecological receptors. Although West Lake did not directly receive effluent from any Hanford Site facilities, it has been identified as a CERCLA waste site, located within the 200-OA-1 Operable Unit; this designation is partly attributable to the increased upwelling of groundwater brought about by historic wastewater discharge practices in the 200 East Area that occurred between the 1950s and 1980s. As this wastewater infiltrated into the underlying aquifer, it mixed with groundwater, and a portion of the water was transported north to the West Lake basin by the regional groundwater flow gradient. More recent groundwater elevation data show that both the groundwater gradient and flow direction have shifted away from West Lake towards the Gable Mountain Gap.

Evaporative losses and rising groundwater elevations associated with seasonal rainfall and snowmelt infiltration currently control the appearance of surface water in West Lake during the winter and spring months. Small isolated groundwater seeps have also been observed along the southeast margin of the lake. The natural upwelling and evaporation process at West Lake has resulted in the concentration of chemical and radiological constituents in surface water, salt, and sediments to levels that are higher than found in natural freshwater bodies and Hanford Site soil. The elevated concentrations for many of these constituents, including naturally occurring uranium isotopes, may be a function of the normal evaporative processes that have been occurring for many years.

West Lake surface water samples have been routinely collected as part of the Environmental Surveillance Program since the 1970s. The sample results are used on an annual basis for estimating doses to biota associated with West Lake. Radionuclides are chosen for analysis based on their presence in local groundwater and their potential to contribute to the overall radiation dose to biota that frequent the pond. Analytes include tritium, uranium-234, uranium-235, and uranium-238. Technetium-99 is also included beginning in 2018 because it has not been analyzed since 2007, elevated levels were measured in some historical samples, and a technetium-99 groundwater plume is located up-gradient.

B.2.5 Offsite Irrigation

The consumption of food products irrigated with Columbia River water downstream of the Hanford Site has been identified as one of the primary pathways contributing to the potential dose to the hypothetical Maximally Exposed Individual (MEI) and any other member of the public. Irrigation water samples are collected three times per year to cover variations in harvest periods.

There are only a few farms that pump irrigation water from the Columbia River downstream of Hanford. The majority of irrigators on the east side of the Columbia River use water from a series of Columbia Basin Irrigation Project canals that originate behind Grand Coulee Dam.

B.3 Biota Sampling

B.3.1 Food and Farm Products

B.3.1.1 Milk, Alfalfa/Hay, Vegetables, Fruits, and Wine

Food and farm products are collected at locations near the Hanford Site. These products are used to verify pathway-specific exposure assumptions by way of annual dose calculations. Sample locations include:

- Generally downwind (east and southeast) of the Hanford Site where airborne emissions or contaminated dust from the site potentially would be deposited
- Generally upwind of and distant from the Hanford Site to provide information about reference (background) contaminant levels
- Agricultural products in all areas adjacent to the Hanford Site are sampled to provide public assurance that environmental conditions from past and current Hanford activities are monitored
- Farms irrigated with water taken from the Columbia River downstream of the Hanford Site

Results of sample analyses are used to document contaminant trends and assess the amounts of Hanford Site-origin contaminants in food and farm products by comparing analytical results obtained from similar samples collected from the same regions over long periods of time. For example, results from samples collected at downwind locations are compared to those obtained from generally upwind or distant locations. Results from samples collected in areas irrigated with Columbia River water downstream of the Hanford Site are compared with those from samples obtained from locations irrigated with water from other regional sources.

B.3.2 Wildlife

B.3.2.1 Fish, Birds, and Mammals

Fish and wildlife, on and off the Hanford Site, are valued natural and recreational resources. Fish from the Hanford Reach may be caught and consumed by anglers, and wildlife residing onsite (elk, deer, rabbits, upland game birds, and waterfowl) may move offsite and be harvested by the public for consumption. It is important, therefore, that consumable fish and wildlife on and near the site be sampled to monitor levels of potential contaminants. Reference samples of fish and wildlife are collected from distant locations that have not been exposed to Hanford contaminants and compared to data collected from samples on and near the site.

The objectives of fish and wildlife surveillance include the following:

- Verifying that radiological exposure and dose to consumers of fish and wildlife remain below criteria established by the U.S. Department of Energy handbook DOE-HDBK-1216-2015
- Providing assurance to consumers of fish and wildlife collected near the Hanford Site that the degree of contamination caused by site operations and cleanup activities is known and documented in publicly available reports (e.g., the annual Hanford Site Environmental Report)

- Monitoring the occurrence and accumulation of long-lived radionuclides and trace metals in fish and wildlife tissues

- Evaluating radionuclide concentrations and associated exposure to key wildlife near onsite operational areas to determine the degree of risk to biological resources

Fish and wildlife species on and around the Hanford Site are sampled based on their likelihood of exposure to contaminants, potential for accumulating contaminants, and potential for moving off the site and being consumed by humans (i.e., hunters or anglers). Consideration is given to species that may be consumed by various cultures. Fish and wildlife species selected for sampling are found in sufficient abundance to ensure sampling will not affect population stability. Specific biota is selected based on their significance to human dose, as described below.

- Aquatic biota – Whitefish historically have been sampled because of their value to recreational fishing and their habitat selection and diet of salmonid eggs. Additionally, smallmouth and largemouth bass have a high recreational value in the area including local tournaments for these sport fish. Carp have been historically collected for their foodstuff value to some cultures and the primarily demersal activities nearest to any potential deposits of benthic contamination. Walleye are a highly popular sport fish and considered an appetizing white-fleshed fish. As with bass, many local tournaments occur each year for this species. For human dose assessment purposes, two sample types are obtained: edible muscle and remaining carcass, not including the internal organs or skin.

- Terrestrial biota – Terrestrial biota are collected to monitor contaminant concentrations of Hanford Site-sourced radionuclides. Mammal species collected include mountain cottontail rabbits and mule deer/elk. Rabbits are collected at the 300 Area due to the proximity to the general public with the relatively small home range of the animals. Elk and mule deer have been collected by opportunistic takes as a result of vehicle strikes in recent years. Bird species collected include waterfowl, primarily young Canada Geese, and upland game birds, usually California Quail but may include Ring-necked Pheasant or Chukar. Canada Geese and California Quail are common game species hunted by the general public, and Hanford Site birds may be represented in hunted populations. Samples from terrestrial wildlife generally include muscle and bone tissue for all species. In addition, for deer and elk, liver samples also are collected because their livers may often be consumed by the general public as a foodstuff.

Fish and wildlife samples are analyzed for 1) radionuclides, and in some cases chemicals, that are found in Hanford Site effluent and emissions, 2) radionuclides that contribute to doses associated with various potential human and biota exposure pathways, and 3) radionuclides and chemicals that are of concern to DOE, the public, American Indian Tribes, activist groups, environmental organizations, public officials, and regulatory agencies. Fish and wildlife samples are analyzed for strontium-90, which accumulates in bones, and gamma emitters, specifically cesium-137, which accumulates in muscle tissues. When sampled, livers are analyzed for metals, and some fish are analyzed for mercury.

Fish and wildlife are collected annually from Hanford Reach locations, although some species are collected in alternating years (biennially). Wildlife populations undergo natural fluctuations, and routinely scheduled species are not always abundant or easily collected. When this occurs, scheduling changes or species substitutions may be considered. The current level of sampling is consistent with meeting DOE concerns for public assurance about

contamination levels in fish and game in the region and concerns about contaminants in the Columbia River. Due to the variable nature of these collections and animal movements, most wildlife will be collected in areas classified as the 100 Areas—extending from the 100B/C area to south of the 100-F Area and the Hanford Townsite to the 300 Area. These locations are used because they provide the nearest proximity to historical operation areas and proximity to the general public.

Reference samples of fish and wildlife are also are collected each year. They are collected at locations upwind or upstream of, or distant from, the Hanford Site.

B.4 Soil and Vegetation Sampling

Radiological monitoring of soil and vegetation is conducted 1) onsite near facilities and operations, 2) onsite away from facilities and operations (Hanford Site), and 3) offsite at perimeter and distant locations and in nearby communities. Contaminant concentration data collected are used to:

- Determine the effectiveness of effluent monitoring and controls within facilities
- Assess the adequacy of containment at waste disposal sites
- Detect and monitor unusual conditions
- Provide long-term radionuclide contamination trends in soil at undisturbed locations
- Provide alternative air-borne detection monitoring methodologies for atmospheric releases both past and present.

Soil provides an integrating sample medium that can account for contaminants released to the atmosphere either directly (gaseous effluent) or indirectly (re-suspension/deposition), or through liquid effluents released to a stream that is subsequently used for irrigation.

Vegetation provides an integrating sample medium that can account for contaminants released to the atmosphere either directly (gaseous effluent) or indirectly (re-suspension/deposition), through liquid effluents released to a stream that is subsequently used for irrigation, or from uptake of contaminants via their root system.

B.4.1 Off-site Soil and Vegetation Monitoring

Offsite soil and native vegetation sampling is designed to monitor atmospheric deposition of contaminants not influenced by agricultural activities. Offsite samples are collected every 3 to 5 years to evaluate long-term trends (per DOE-HDBK-1216-2015).

B.4.2 On-site Soil and Vegetation Monitoring

Onsite soil and vegetation sampling is conducted annually and is required by Washington State Department of Health as a qualitative indicator of the environmental monitoring program (#FF-01 License, Section 5.1.2). It also is a recommended practice per the DOE handbook DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

In the 200 and 600 Areas, as a cost-savings measure, sample locations are alternated between even and odd numbered years, aligning with even and odd numbered sample locations.

B.5 Sediment Sampling

B.5.1 Columbia River

During historical peak operating years at the Hanford Site, large amounts of effluents associated with reactor operations were discharged to the Columbia River. Some constituents in these effluents may have become associated with particulate matter that accumulated in riverbed sediment, particularly in slack-water areas and reservoirs behind dams located downstream of the Hanford Site. The majority of short-lived radioactive constituents have decayed away, but some longer-lived radionuclides, such as isotopes of cesium, plutonium, strontium, and uranium are still detectable. Fluctuations in flow from upriver hydroelectric dam operations, annual spring high river flows, and occasional floods have resulted in re-suspension, relocation, and subsequent re-deposition of sediment. Upper-layer sediment in the Columbia River downstream of the Hanford Site contains low concentrations of radionuclides, metals of Hanford Site origin, and radionuclides from worldwide atmospheric fallout, as well as metals and other non-radioactive contaminants from mining and agricultural activities (*Simultaneously Extracted Metals/Acid-Volatile Sulfide and Total Metals in Surface Sediment from the Hanford Reach of the Columbia River and the Lower Snake River* [PNNL-13417], and *Summary of Radiological Monitoring of Columbia and Snake River Sediment, 1988 through 2004* [PNNL-16990]). Periodic sediment sampling confirms that concentrations are low, and that no significant changes in concentrations have occurred. The accumulation of radioactive materials in sediment can lead to human exposure from ingestion of aquatic organisms associated with the sediment or sediment re-suspension into drinking water supplies. Sediment with accumulated radioactive materials can be an external radiation source, irradiating people who are fishing, wading, swimming, sunbathing, or participating in other recreational activities associated with the river or shoreline (*Environmental Radiological Effluent Monitoring and Environmental Surveillance* [DOE-HDBK-1216-2015]). Sediment contaminant concentrations are also used to model potential pathway exposures to riparian (e.g., raccoon, coyote) and aquatic receptors (e.g., fish, benthic organisms) and to establish DOE guidelines for organisms within the Hanford Reach.

B.5.2 Onsite Pond

West Lake is accessible to wildlife, creating a potential biological pathway for the dispersion of residual, historic contaminants. West Lake, the only naturally occurring pond on the Hanford Site, is located north of the 200-East Area. West Lake has not received direct effluent discharges from Hanford Site facilities. Historic discharges of billions of gallons of process water into nearby cribs, ditches, and ponds created groundwater mounding which, in recent years, is slowly receding. The water level in West Lake fluctuates due to precipitation and changing water table elevations. The lake changes from standing water in winter and spring to dry or nearly dry in summer and fall. The water level and size of the lake has been decreasing over the past several years due to the falling water table associated with reduced 200 Area wastewater discharges. West Lake sediment is analyzed for gross alpha, gross beta, cesium-137, strontium-90, technetium-99, uranium-234, uranium-235, uranium-238, and other gamma-emitting radionuclides. Radionuclides are chosen for analysis based on their presence in local groundwater and sediment and on their potential to contribute to the overall radiation dose to biota that frequent the ponds.

B.6 Thermoluminescent Dosimeter

External radiation is monitored at the Hanford Site in relative proximity to known or potential radiation sources. Sources of external radiation include waste materials associated with the historical production of plutonium for defense; stack and fugitive emissions from residual nuclear inventories in former production and processing facilities; radioactive waste handling, storage, and disposal activities; waste cleanup and remediation activities; atmospheric fallout from historical nuclear weapons testing; and natural sources such as cosmic radiation.

The Harshaw thermoluminescent dosimeter (TLD) system is used to measure external radiation on the Hanford Site. This system includes the Harshaw 8800-series dosimeter and the Harshaw 8800 reader. The Harshaw 8800-series environmental dosimeter consists of two TLD-700 chips and two TLD-200 chips and provides both shallow- and deep-dose measurement capabilities using filters in the dosimeter. Data obtained from the two TLD-700 chips are used to determine the average total environmental dose at each location. The two TLD-200 chips are included to determine doses in the event of a radiological emergency not in calculating average total environmental dose.

TLD monitoring is required by the Washington State Department of Health as a qualitative indicator of the near-field environmental monitoring program (#FF-01 License, Section 5.1.2) and is a recommended practice per Section 6.0 of DOE handbook DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

B.7 Radiological Surveys

B.7.1 Weekly Inspections and Annual Radiological Surveys

Radiation surveys with portable instruments are conducted at active and inactive waste disposal sites and the surrounding terrain to monitor and detect contamination and to provide a coarse screening for external radiation fields. The types of areas surveyed included underground radioactive material areas, contamination areas, soil contamination areas, high-contamination areas, roads, and fence lines.

Radiological surveys are required by Washington State Department of Health as a qualitative indicator of the environmental monitoring program (#FF-01 License, section 5.1.2) and are a recommended practice per Section 6.0 of DOE handbook DOE-HDBK-1216-2015, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*.

Appendix C Analytical Parameters

Gamma Energy Analysis (GEA)	Anions	Method 6020 (ICP-MS) Surface Water	Method 6010 (ICP) Wildlife	Method 6020 (ICP-MS) Wildlife	SW-846 Method 8260 Volatile Organic Analysis (VOA) Surface Water		
Antimony-125	Bromide	Aluminum	Aluminum	Thorium (6020)	1,1,1,2-Tetrachloroethane	Acrolein	Iodomethane
Beryllium-7	Nitrogen, Nitrate as NO3	Antimony	Antimony		1,1,1-Trichloroethane	Acrylonitrile	Isobutyl alcohol
Cesium-134	Phosphate	Arsenic	Arsenic		1,1,2,2-Tetrachloroethane	Allyl chloride	Isopropylbenzene
Cesium-137	Nitrogen, Nitrite as NO2	Barium	Barium		1,1,2-Trichloro-1,2,2-trifluoroethane	Benzene	m-&p-Xylenes
Cobalt-60	Chloride	Beryllium	Beryllium		1,1,2-Trichloroethane	Benzyl chloride	Methacrylonitrile
Europium-152	Fluoride	Bismuth	Cadmium		1,1-Dichloroethane	Bis(2-chloro-1-methylethyl)ether	Methyl Acetate
Europium-154	Sulfate	Boron	Chromium		1,1-Dichloroethene	Bromobenzene	Methyl methacrylate
Europium-155		Cadmium	Cobalt		1,1-Dichloropropene	Bromochloromethane	Methyl tert-butyl ether
Potassium-40		Calcium	Copper		1,2,3-Trichlorobenzene	Bromodichloromethane	Methylcyclohexane
Ruthenium-106		Cesium	Lead		1,2,3-Trichloropropane	Bromoform	Methylene chloride
		Chromium	Manganese		1,2,4-Trichlorobenzene	Bromomethane	Naphthalene
		Cobalt	Nickel		1,2,4-Trimethylbenzene	Carbon disulfide	n-Butylbenzene
		Copper	Selenium		1,2-Dibromo-3-chloropropane	Carbon tetrachloride	n-Propylbenzene
		Iron	Silver		1,2-Dibromoethane	Chlorobenzene	o-Xylene
		Lead	Thallium		1,2-Dichlorobenzene	Chloroethane	p-Cymene
		Magnesium	Uranium		1,2-Dichloroethane	Chloroform	Pentachloroethane
		Manganese	Zinc		1,2-Dichloropropane	Chloromethane	sec-Butylbenzene
		Molybdenum			1,3,5-Trimethylbenzene	Chloroprene	Styrene
		Nickel			1,3-Dichlorobenzene	cis-1,2-Dichloroethylene	tert-Butylbenzene
		Phosphorus			1,3-Dichloropropane	cis-1,3-Dichloropropene	Tetrahydrofuran
		Potassium			1,4-Dichlorobenzene	cis-1,4-Dichloro-2-butene	Toluene
		Selenium			1,4-Dioxane	Cyclohexane	trans-1,2-Dichloroethylene
		Silver			1-Butanol	Cyclohexanone	trans-1,3-Dichloropropene
		Sodium			2,2-Dichloropropane	Cyclohexene	trans-1,4-Dichloro-2-butene
		Strontium			2-Butanone	Dibromochloromethane	Trichloroethene
		Thallium			2-Chlorotoluene	Dibromomethane	Trichloromonofluoromethane
		Thorium			2-Hexanone	Dichlorodifluoromethane	Vinyl acetate
		Tin			2-Nitropropane	Diethyl ether	Vinyl chloride
		Titanium			2-Pentanone	Ethyl acetate	
		Uranium			4-Chlorotoluene	Ethyl cyanide	
		Vanadium			4-Methyl-2-pentanone	Ethyl methacrylate	
		Zinc			Acetone	Ethylbenzene	
		Zirconium			Acetonitrile	Hexachlorobutadiene	