CHPRC-02085
Revision 0

Development of Average and Maximum Contaminant Plumes at the Hanford Site, SSP-1393 Hanford Technical Memorandum

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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July 2013

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Release Approval   Date

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1. Introduction

Contaminant plumes were delineated and the corresponding concentration distributions were developed for the contaminants of interest (COI) in each Groundwater Interest Area (GIA) across the Hanford Site. Maps of the extent of contamination, referred to as average contaminant plume maps, were developed by interpolating point sample analytical measurements over a specified time window obtained from monitoring wells, injection wells, inactive extraction wells, and aquifer tubes to a fine grid using Ordinary Kriging (OK) in two dimensions (2-D). Sample data obtained within the monitoring period are in some instances supplemented with data obtained prior to the monitoring period to ensure that historical plume migration patterns are reflected in the calculated contaminant distributions. These average concentration maps are fully documented in the *Hanford Site Groundwater Monitoring for 2012* report (DOE/RL-2013-22, Rev.0).

The purpose of this Technical Memorandum (TM) is to describe the methodology used to delineate contaminant plumes and the corresponding concentration distributions for each COI and GIA, considering maximum measured concentrations at each well and present a comparison of the delineated plumes to the average contaminant plumes based on the plume areal extent within predefined concentration intervals.

2. Methodology

2.1 Average Contaminant Plumes

Concentration distributions were developed by interpolating point sample data obtained from point sample data using Ordinary Kriging (OK) in two dimensions (2-D), as presented in the *Hanford Site Groundwater Monitoring for 2012* (DOE/RL-2013-22, Rev. 0) report.

A brief description of the plume mapping procedure is provided below.

2.1.1 Plume mapping procedure

The plume mapping procedure involves the following steps:

1. Data overview to review, and supplement, if necessary, the dataset to be used for mapping each COI plume in each GIA.
2. Data transformation, as necessary, depending on the data values and their distribution for each COI in each GIA.
3. Application of OK to interpolate the transformed data set.
4. Back-transformation of the OK interpolation results.
5. Estimation of plume areas corresponding to defined concentration intervals for each contaminant plume.

2.1.2 Mapping Input Data

The mapping input data for each combination of GIA and COI selection is based on a multi-step process described below:

1. Using a Microsoft Access query, the chemical concentration table was linked to the location data table so that each measurement was associated with its X-Y coordinates. A master table containing all chemical concentration measurements obtained from 2010 to 2012 was generated from this query.

2. Monitoring locations were removed from the master chemical concentration table if the screened interval was outside the aquifer zone of interest.

3. Rejected samples (measurements flagged with the "R" qualifier) were removed.

4. For each combination of GIA and COI, an input dataset required for interpolation was generated using an automated method developed in the open-source programming language R (R Development Core Team, 2012). For each input dataset, a single representative COI concentration was determined for each measurement location in the GIA, using the following process:

   a. All measurements for the specified GIA/COI combination were selected from the master chemical concentration table: then, the annual or seasonal average and maximum COI concentration for each measurement location were calculated for every year from 2010 to 2012.

   b. If at least one COI measurement was available for the location during 2012, the average concentration from 2012 was used for the kriging input dataset.

   c. If no COI measurements were available for 2012, the average concentration from 2011 was used for the kriging input dataset.

   d. If no COI measurements were available for 2011 or 2012, the average concentration from 2010 was used for the kriging input dataset.

   e. If the location was an aquifer tube, or if the samples were taken during drilling (characterization data), the maximum value rather than the average value was used. If both characterization data and routine measurements were available for a location, the routine measurement data were used. Specific data selections are discussed in the OU-specific sections that follow.

5. If a measurement was flagged with the "U" qualifier or any combination including the "U" qualifier, then the reported value was replaced with zero (0.0) before the annual average (or maximum) value was calculated.

6. In some cases "control" points were added at existing monitoring locations or other spatial locations, provided by the GIA project scientist. This usually occurred in one of the following cases:

   a. No nearby location was measured for the specified COI since 2010, or the concentration selected by application of the logic sequence described above was suspect. In this case, measurements from an earlier sampling event may be used; or,

   b. The origin, shape, or extent of a plume was considered well constrained on the basis of previous investigations. In this case, a synthetic data point (control point) may be added so that the calculated plume provides a better reflection of this prior information.

   c. Project scientist knowledge of plume sources, historical plume configuration, and other conceptual site model considerations.

2.1.3 Exceptions to data selection rules

While the rules outlined above determined the data selection process, some adjustments were made to the process and/or input datasets for specific GIA/COI combinations. Examples include:

- Cases where plume depictions were assumed to be dependent upon the stage of the Columbia River – in this case, separate plume maps were prepared using measurements obtained during (a) high or (b) low river stage rather than using annual average or maximum concentration values.
- For Iodine-129 measurements flagged with the "U" qualifier or any combination including the "U" qualifier, the reported concentration was used in place of zero for all measurements, at the direction of the GIA project scientists.

2.2 Numerical Interpolation

Numerical interpolation was performed using the program QUANTILE (SSP&A, 2011) which is based upon the United States Geological Survey (USGS) geostatistical interpolation (kriging) routines of Skrivan and Karlinger (1980). QUANTILE is implemented using Fortran 90/95 through a modular program structure. It has been developed to be independent of any specific computer platform, requiring simple ASCII input files and producing ASCII output files. QUANTILE incorporates routines to conduct the logarithmic, quantile and categorical indicator data transforms, undertake OK of the transformed values, and complete the necessary back-transformations. QUANTILE undertakes spatial interpolation in two dimensions (2-D). Data transformation options used in QUANTILE include log-transform kriging (LK), quantile kriging (QK) and multiple-indicator kriging (MIK).

Kriging is based on the use of the variogram (or, semi-variogram) which, qualitatively, is a descriptor of how the relationship between two values sampled from a random field changes with increasing separation distance of their sampled locations. Quantitatively, if the random field exhibits a constant mean, then the spatial relationship is described in terms of the variance of the difference between the sampled values at the two locations.

Variograms are generally presented as one-dimensional (1D) curves that depict the theoretical (semi-)variance versus separation distance (h). A variogram used for purposes of two-dimensional (2D) (i.e., single-layer) interpolation can be defined in terms of the following parameters:

- Sill – the value of the (semi-)variance at which the variogram levels off (i.e., in a single-structure variogram, this is equivalent to the total [semi-]variance).
- Range – the distance at which the semi-variogram reaches the sill value.
- Nugget – small-scale variability that occurs within separate distances smaller than the typical sample spacing. The nugget typically incorporates measurement and/or sample support error(s).

In the case that the relationship between the (semi-)variance and separation distance is the same in all directions, the variogram is isotropic. Often, however, the relationship is not isotropic. For example, when mapping groundwater contamination it is often the case that sampled values are more similar in the direction of groundwater flow (and, presumably, contaminant transport) than in the direction orthogonal to groundwater flow. In such cases, an anisotropic variogram can be defined by specifying a principal direction (angle) and a range in that direction (maximum range); and specifying a range in the secondary direction which is in most cases orthogonal to the principal direction (minimum range). The ratio of the ranges in the principal and secondary directions is referred to as the (horizontal) anisotropy.

2.3 Maximum Contaminant Plumes

The mapping input data for the maximum contaminant plumes for each combination of GIA and COI were selected based on a multi-step process described below:

- All measurements for the specified GIA/COI combination were selected from the master chemical concentration table: then, the maximum COI concentration for each measurement location was calculated for every year from 2010 to 2012.
- If at least one COI measurement was available for the location during 2012, the maximum concentration from 2012 was used for the kriging input dataset.
- If no COI measurements were available for 2012, the maximum concentration from 2011 was used for the kriging input dataset.
- If no COI measurements were available for 2011 or 2012, the maximum concentration from 2010 was used for the kriging input dataset.

While the rules outlined above determined the data selection process, the following adjustments were made to the process and/or input datasets:

- If the calculated maximum concentration was lower than the concentration used in the average plume interpolation, the concentration used in the average plume mapping was used for the kriging input dataset. Typically, this condition occurs at injection wells where treatment effluent concentrations are applied.
- If no COI measurements were available for the period 2010-2012, the concentration used in the average plume mapping was used for the kriging input dataset.

The interpolation parameters used for the maximum plume mapping were identical to those used for the average plume mapping. As a result, factors associated with the origin, shape, and/or extent of a plume as defined on the basis of previous investigations, were not further considered in developing the maximum plume maps.

3. Calculations

Data interpolation was conducted for each GIA and COI using the QUANTILE program implementing the OK technique: the maximum datasets were developed following compilation and review of all available sample data as described in Section 2.3. The interpolation parameters for the maximum contaminant plumes per COI and GIA are presented in Section 3.1. Plume areas calculations for each GIA and COI are tabulated in Section 3.2, where a comparison of average and maximum plume areas is presented for defined concentration intervals. Maps illustrating the comparison between average and maximum contaminant plumes for each COI and GIA are presented in Section 3.3.

3.1 Interpolation parameters

The interpolation parameters for each COI for the maximum concentration plumes are tabulated per GIA in the following subsections.

3.1.1 100-BC-5

The interpolation method and corresponding variogram parameters for each COI in 100-BC-5 are tabulated below:

Table 3.1 COIs and Interpolation Parameters for 100-BC-5

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Chromium	MIK	700	900	20	
Nitrate	QK	1200	1500	0	
Strontium-90	QK	1200	1500	0	
Tritium	MIK	1200	1600	15	

3.1.2 100-FR-3

The interpolation method and corresponding variogram parameters for each COI in 100-FR-3 are tabulated below:

Table 3.2. COIs and Interpolation Parameters for 100-FR-3

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Chromium	MIK	800	1400	45	
Nitrate	QK	3000	3000	130	
Strontium-90	MIK	400	400	45	
Trichloroethene	MIK	1000	1000	70	

3.1.3 100-HR-3

The interpolation method and corresponding variogram parameters for each COI in 100-HR-3 are tabulated below:

Table 3.3. COIs and Interpolation Parameters for 100-HR-3

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Chromium High river stage 100-D area	MIK	2000	2000	0	
Chromium High river stage 100-H area	MIK	1000	1300	90	
Chromium Low river stage 100-D area	MIK	2000	2000	-40	
Chromium Low river stage 100-H area	MIK	1000	1300	80	

Table 3.3. COIs and Interpolation Parameters for 100-HR-3

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Nitrate	MIK	1000	1000	45	
Strontium-90	MIK	300	600	100	
Tritium	MIK	1000	1000	0	

3.1.4 100-KR4

The interpolation method and corresponding variogram parameters for each COI in 100-KR-4 are tabulated below:

Table 3.4. COIs and Interpolation Parameters for 100-KR-4

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Carbon-14	QK	280	700	315	
Chromium High river stage	MIK	650	1120	345	
Chromium Low river stage	MIK	650	1120	345	
Nitrate	QK	830	1100	315	
Strontium-90	MIK	400	600	335	
Trichloroethene	LOG	400	750	315	
Tritium	MIK	830	1200	315	

3.1.5 100-NR-2

The interpolation method and corresponding variogram parameters for each COI in 100-NR-2 are tabulated below:

Table 3.5. COIs and Interpolation Parameters for 100-NR-2

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Nitrate	MIK	850	1700	330	
Strontium-90	MIK	400	600	10	Vicinity of C7934
		80	200	335	Remaining GIA
Sulfate	MIK	830	1100	340	
TPH - diesel	MIK	700	1400	290	
Tritium	QK	400	350	40	

3.1.6 200-BP-5

The interpolation method and corresponding variogram parameters for each COI in 200-BP-5 are tabulated below:

Table 3.6. COIs and Interpolation Parameters for 200-BP-5

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Chromium	QK	400	1650	310	
Cyanide	QK	950	1050	320	North Plume
	LOG	300	400	50	South Plume
Iodine-129	MIK	2300	4750	350	
Nitrate	MIK	650	1000	305	Waste Area Management C
	QK	2400	4350	315	Remaining GIA
Strontium-90	LOG	700	2400	305	
Sulfate	MIK	1150	2250	315	
Technetium-99	LOG	1500	4000	310	North Plume
	MIK	950	3050	320	Middle Plume
	MIK	150	450	290	South Plume
Tritium	MIK	700	1000	270	North Plume
		900	1000	310	South Plume
Uranium	MIK	900	4000	305	North Plume
		300	750	60	South Plume

3.1.7 200-PO-1

The interpolation method and corresponding variogram parameters for each COI in 200-PO-1 are tabulated below:

Table 3.7. COIs and Interpolation Parameters for 200-PO-1

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Iodine-129	MIK	3200	7800	110	
Nitrate	MIK	1500	1500	90	
Technetium-99	QK	3610	4800	90	
Tritium	MIK	3500	7400	143	North-South Plume
		3500	4350	75	West-East Plume
Uranium	QK	3610	4800	90	

3.1.8 200-UP-1

The interpolation method and corresponding variogram parameters for each COI in 200-UP-1 are tabulated below:

Table 3.8. COIs and Interpolation Parameters for 200-UP-1

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Chromium	MIK	180	500	100	SSX Area
		3000	8000	80	Remaining GIA
Iodine-129	QK	3000	3550	90	
Technetium-99	QK	300	850	100	Middle Plume
	QK	350	400	90	North Plume
	MIK	750	1550	120	South Plume
Tritium	MIK	1700	5500	80	
Uranium	MIK	650	1500	75	

3.1.9 200-ZP-1

The interpolation method and corresponding variogram parameters for each COI in 200-ZP-1 are tabulated below:

Table 3.9. COIs and Interpolation Parameters for 200-ZP-1

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Chromium	QK	950	850	45	
Iodine-129	MIK	800	1050	40	
Nitrate	MIK	150	280	90	SSX Area
		2900	3600	66	Remaining GIA
Trichloroethene	MIK	500	700	85	
Technetium-99	MIK	750	900	95	
Tritium	MIK	500	800	60	

Development of the depiction of the groundwater plume for Carbon Tetrachloride in 200-West was completed using a process consistent with certain Remedial Action Objectives (RAOs) specified in the Record of Decision (ROD), together with the remedy implementation outlined in the Remedial Design Remedial Action Work Plan (RDRW-WP) requirements of the monitoring program for 200-ZP-1 as laid out in the Performance Monitoring Plan (PMP). In accordance with the objectives and requirements set forth in these documents, a three-dimensional depiction of the extent of carbon tetrachloride was constructed using data obtained from Fiscal and Calendar Years 2012, comprising the period October 2011 through December 2012 [there is a small number of wells for which data were used outside this period] for use in groundwater modeling calculations to calculate (a) the extent of hydraulic containment developed by the pump-and-treat (P&T) remedy versus the extent of contamination, and (b) likely rates of mass recovery by the P&T system. A step-wise process was followed to assemble the necessary input data to construct the three-dimensional "plume shells": this process is detailed in the calculation brief "*Description of Groundwater Modeling Calculations for the Calendar Year 2012 (CY2012) 200 Areas Pump-and-Treat Report*" (ECF-200ZP1-13-0006). At the completion of that data selection process, a three-dimensional depiction of the extent of carbon tetrachloride was prepared using methods detailed in ECF-200ZP1-13-0006. Simultaneously, a two-dimensional depiction of the extent of carbon tetrachloride was constructed using the QUANTILE program that was used to prepare all other plume depictions for the sitewide monitoring report. Since the data selection process for carbon tetrachloride for this calendar year emphasized the selection of maximum values per the direction of the 200-ZP-1 project scientists, an independent "maximum values" plume map was not prepared for purposes of this technical memorandum.

3.1.10 300-FF-5 and 1100-EM-1

The interpolation method and corresponding variogram parameters for each COI in 300-FF-5 and 1100-EM-1 are tabulated below:

Table 3.10. COIs and Interpolation Parameters for 300-FF-5 and 1100-EM-1

COI	Kriging Type	Minimum Range	Maximum Range	Angle	Comment
Nitrate (300-FF-5 Burial Ground)	QK	350	1100	75	
Tritium (300-FF-5 Burial Ground)	QK	150	600	80	
Nitrate	MIK	3000	5000	40	
Trichloroethene (TCE)	QK	1052	1400	90	
Tritium	QK	1200	1400	110	
Uranium	LOG	900	1200	160	High River Stage
		600	900	130	Low River Stage

3.2 Plume Area Calculations

Plume area and mass calculations were performed using the R Code by identifying the grid cells with concentrations above predefined levels and calculating the corresponding plume areal extent. Tables 3.11 through 3.20 list the plume areas in each GIA corresponding to concentration levels defined for each COI. All areas are reported in units of meters-squared.

Table 3.11. Calculated Areas for Carbon-14 Average and Maximum Plumes per GIA

GIA	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-KR-4	1,000	58,075	68,725	18%
	2,000	44,900	46,900	4%
	5,000	19,400	24,775	28%
	10,000	9,600	10,350	8%

Table 3.12. Calculated Areas for Chromium Average and Maximum Plumes per GIA

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-BC-5	10	1,598,650	2,114,375	32%
	20	1,031,575	1,225,850	19%
	48	199,700	367,775	84%
	100	-	7,200	-
	480	-	-	-
	4,800	-	-	-
100-KR-4: High River Stage	10	1,617,500	1,935,175	20%
	20	1,034,125	1,263,850	22%
	48	207,725	303,700	46%
	100	4,675	9,675	107%
	480	-	-	-
	4,800	-	-	-
100-KR-4: Low River Stage	10	1,842,025	2,099,450	14%
	20	1,088,225	1,240,550	14%
	48	194,525	294,275	51%
	100	3,925	8,675	121%
	480	-	-	-
	4,800	-	-	-
100-NR-2: High River Stage	10	407,050	637,375	57%
	20	207,825	284,800	37%
	48	14,325	31,575	120%

Table 3.12. Calculated Areas for Chromium Average and Maximum Plumes per GIA

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	100	-	150	-
	480	-	-	-
	4,800	-	-	-
100-NR-2: Low River Stage	10	438,450	689,750	57%
	20	185,300	264,450	43%
	48	2,050	16,675	713%
	100	-	-	-
	480	-	-	-
	4,800	-	-	-
100-HR-3: High River Stage	10	5,836,625	6,461,225	11%
	20	3,712,975	4,502,125	21%
	48	1,048,050	1,372,325	31%
	100	289,450	350,075	21%
	480	118,150	155,950	32%
	4,800	6,175	25,900	319%
100-HR-3: Low River Stage	10	6,889,125	7,222,475	5%
	20	4,096,350	4,458,250	9%
	48	1,018,550	1,148,650	13%
	100	313,100	344,200	10%
	480	111,625	134,300	20%
	4,800	-	425	-
100-FR-3: High River Stage	10	321,825	530,675	65%
	20	88,650	113,350	28%
	48	-	-	-
	100	-	-	-
	480	-	-	-
	4,800	-	-	-
100-FR-3: Low River Stage	10	403,900	651,200	61%
	20	95,925	123,450	29%

Table 3.12. Calculated Areas for Chromium Average and Maximum Plumes per GIA

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	48	-	-	-
	100	-	-	-
	480	-	-	-
	4,800	-	-	-
200-BP-5	10			
	20			
	48	33,475	43,300	29%
	100	-	-	-
	480	-	-	-
	4,800	-	-	-
200-ZP-1	10			
	20			
	48	521,025	521,025	0%
	100	140,300	163,150	16%
	480	-	-	-
	4,800	-	-	-
200-UP-1	10			
	20			
	48	4,088,300	4,194,400	3%
	100	653,175	743,800	14%
	480	2,000	2,725	36%
	4,800	-	-	-
200-PO-1	10			
	20			
	48	1,040,950	1,040,950	0%
	100	-	-	-
	480	-	-	-
	4,800	-	-	-
Total Area: High River	**Concentration**	**Average**	**Maximum**	**Change from Average**

Table 3.12. Calculated Areas for Chromium Average and Maximum Plumes per GIA

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
Stage	(µg/L)	Plume Area (m^2)	Plume Area (m^2)	Area
	10	9,781,650	11,678,825	19%
	20	6,075,150	7,389,975	22%
	48	7,153,550	7,872,500	10%
	100	1,087,600	1,274,050	17%
	480	120,150	158,675	32%
	4,800	6,175	25,900	319%
Total Area: Low River Stage	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	10	11,172,150	12,777,250	14%
	20	6,497,375	7,312,550	13%
	48	7,098,575	7,624,500	7%
	100	1,110,500	1,267,025	14%
	480	113,625	137,025	21%
	4,800	-	425	-
Total Area: River Corridor High River Stage	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	10	9,781,650	11,678,825	19%
	20	6,075,150	7,389,975	22%
	48	1,469,800	2,075,375	41%
	100	294,125	367,100	25%
	480	118,150	155,950	32%
	4,800	6,175	25,900	319%
Total Area: River Corridor Low River Stage	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	10	11,172,150	12,777,250	14%
	20	6,497,375	7,312,550	13%

Table 3.12. Calculated Areas for Chromium Average and Maximum Plumes per GIA

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	48	1,414,825	1,827,375	29%
	100	317,025	360,075	14%
	480	111,625	134,300	20%
	4,800	-	425	
Total Area: Central Plateau High River Stage	**Concentration (µg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	48	5,683,750	5,797,125	2%
	100	793,475	906,950	14%
	480	2,000	2,725	36%
	4,800	-	-	

Table 3.13 Calculated Areas for Cyanide Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
200-BP-5	200	215,400	267,600	24%
	500	104,650	136,500	30%
	1000	15,300	35,875	134%

Table 3.14 Calculated Areas for Iodine-129 Average and Maximum Plumes per GIA.

Total	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
200-ZP-1	1	99,425	118,625	19%
	5	1,150	1,225	7%
	10	100	100	0%
200-UP-1	1	4,610,700	4,677,375	1%
	5	1,423,875	1,527,950	7%
	10	951,425	949,750	0%

Table 3.14 Calculated Areas for Iodine-129 Average and Maximum Plumes per GIA.

Total	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
200-BP-5	1	3,918,625	4,180,550	7%
	5	50,400	180,650	258%
	10	-	-	-
200-PO-1	1	39,221,475	42,945,925	9%
	5	2,747,025	3,132,925	14%
	10	3,175	3,250	2%
Total Area	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	1	47,850,225	51,922,475	9%
	5	4,222,450	4,842,750	15%
	10	954,700	953,100	0%

Table 3.15 Calculated Areas for Nitrate Average and Maximum Plumes per GIA.

GIA	Concentration (mg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-BC-5	45	1,300	1,325	2%
	200	-	-	-
	450	-	-	-
100-KR-4	45	35,725	132,225	270%
	200	-	-	-
	450	-	-	-
100-NR-2	45	634,000	650,775	3%
	200	-	-	-
	450	-	-	-
100-HR-3	45	338,375	536,875	59%
	200	-	-	-
	450	-	-	-
100-FR-3	45	9,312,525	9,328,700	0%

Table 3.15 Calculated Areas for Nitrate Average and Maximum Plumes per GIA.

GIA	Concentration (mg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	200	-	-	-
	450	-	-	-
300-FF-5	45	2,899,775	3,277,350	13%
	200	360,925	399,025	11%
	450	-	-	-
200-ZP-1	45	10,223,950	10,267,250	0%
	200	806,825	848,675	5%
	450	2,175	3,975	83%
200-UP-1	45	5,530,800	5,597,050	1%
	200	845,075	865,175	2%
	450	325	325	0%
200-BP-5	45	7,759,750	8,001,950	3%
	200	667,900	721,875	8%
	450	177,275	203,775	15%
200-PO-1	45	4,369,375	4,428,750	1%
	200	-	-	-
	450	-	-	-
1100-EM	45	1,856,400	1,856,400	0%
	200	503,200	543,575	8%
	450	-	-	-
Total Area	**Concentration (mg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	45	42,961,975	44,192,550	3%
	200	3,183,925	3,378,325	6%
	450	179,775	208,075	16%
Total Area: River Corridor	**Concentration (mg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	45	15,078,100	15,783,650	5%
	200	864,125	942,600	9%

Table 3.15 Calculated Areas for Nitrate Average and Maximum Plumes per GIA.

GIA	Concentration (mg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	450	-	-	
Total Area: River Corridor	**Concentration (mg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	45	27,883,875	28,295,000	1%
	200	2,319,800	2,435,725	5%
	450	179,775	208,075	16%

Table 3.16 Calculated Areas for Strontium-90 Average and Maximum Plumes per GIA.

GIA	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-BC-5	8	511,125	511,125	0%
	20	97,450	97,450	0%
	80	-	-	-
100-KR-4	8	40,350	59,200	47%
	20	20,400	33,725	65%
	80	6,475	7,000	8%
100-NR-2	8	609,475	612,825	1%
	20	570,350	574,800	1%
	80	411,825	419,550	2%
100-HR-3	8	29,875	36,275	21%
	20	6,975	12,550	80%
	80	-	-	-
100-FR-3	8	167,950	178,925	7%
	20	94,925	112,700	19%
	80	59,425	80,600	36%
200-BP-5	8	603,425	603,725	0%
	20	460,150	460,300	0%
	80	240,900	241,000	0%
200-PO-1	8	66,575	66,575	0%

Table 3.16 Calculated Areas for Strontium-90 Average and Maximum Plumes per GIA.

GIA	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	20	-	-	-
	80	-	-	-
Total Area	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	8	2,028,775	2,068,650	2%
	20	1,250,250	1,291,525	3%
	80	718,625	748,150	4%
Total Area: River Corridor	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	8	1,358,775	1,398,350	3%
	20	790,100	831,225	5%
	80	477,725	507,150	6%
Total Area: Central Plateau	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	8	670,000	670,300	0%
	20	460,150	460,300	0%
	80	240,900	241,000	0%

Table 3.17 Calculated Areas for TCE Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-KR-4	5	34,750	79,625	129%
	8	-	-	-
	10	-	-	-
100-FR-3	5	638,225	662,950	4%
	8	138,800	149,650	8%
	10	1,225	1,275	4%
300-FF-5	5	150	1,925	1183%

Table 3.17 Calculated Areas for TCE Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	8	-	100	-
	10	-	25	-
200-ZP-1	5	292,550	341,300	17%
	8	80,200	84,375	5%
	10	24,075	24,375	1%
200-UP-1	5	92,200	123,200	34%
	8	225	250	11%
	10	-	-	-
200-BP-5	5	-	325	-
	8	-	-	-
	10	-	-	-
Total Area	**Concentration (µg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	5	1,057,875	1,209,325	14%
	8	219,225	234,375	7%
	10	25,300	25,675	1%
Total Area: River Corridor	**Concentration (µg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	5	673,125	744,500	11%
	8	138,800	149,750	8%
	10	1,225	1,300	6%
Total Area: Central Plateau	**Concentration (µg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	5	384,750	464,825	21%
	8	80,425	84,625	5%
	10	24,075	24,375	1%

Table 3.18 Calculated Areas for Technetium-99 Average and Maximum Plumes per GIA.

GIA	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
200-ZP-1	900	80,875	84,750	5%
	3,000	16,075	19,675	22%
	9,000	-	-	-
	20,000	-	-	-
200-UP-1	900	302,675	305,100	1%
	3,000	171,800	176,550	3%
	9,000	38,725	43,325	12%
	20,000	-	-	-
200-BP-5	900	2,293,975	2,441,475	6%
	3,000	1,088,175	1,183,900	9%
	9,000	470,300	526,225	12%
	20,000	40,025	44,500	11%
200-PO-1	900	20,650	37,200	80%
	3,000	-	-	-
	9,000	-	-	-
	20,000	-	-	-
Total Area	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	900	2,698,175	2,868,525	6%
	3,000	1,276,050	1,380,125	8%
	9,000	509,025	569,550	12%
	20,000	40,025	44,500	11%

Table 3.19 Calculated Areas for TPHd Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-NR-2	200	5,900	5,900	0%
	1,000	3,825	4,000	5%
	2,000	2,200	2,675	22%
	5,000	675	1,625	141%

Table 3.19 Calculated Areas for TPHd Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	10,000	300	1,000	233%

Table 3.20 Calculated Areas for Tritium Average and Maximum Plumes per GIA.

GIA	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
100-BC-5	20,000	204,950	263,525	29%
	45,000	-	-	-
100-KR-4	20,000	34,650	135,950	292%
	45,000	4,300	47,400	1002%
100-NR-2	20,000	250	300	20%
	45,000	-	50	-
300-FF-5	20,000	138,900	141,800	2%
	45,000	80,025	83,875	5%
200-ZP-1	20,000	490,275	547,375	12%
	45,000	117,425	174,400	49%
200-UP-1	20,000	5,763,425	5,786,675	0%
	45,000	4,353,075	4,388,625	1%
200-BP-5	20,000	164,300	173,500	6%
	45,000	-	-	-
200-PO-1	20,000	82,286,000	82,492,725	0%
	45,000	13,866,600	14,371,825	4%
Total Area	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	20,000	89,082,750	89,541,850	1%
	45,000	18,421,425	19,066,175	4%
Total Area: River Corridor	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	20,000	378,750	541,575	43%
	45,000	84,325	131,325	56%

Table 3.20 Calculated Areas for Tritium Average and Maximum Plumes per GIA.

GIA	Concentration (pCi/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
Total Area: Central Plateau	**Concentration (pCi/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	20,000	88,704,000	89,000,275	0%
	45,000	18,337,100	18,934,850	3%

Table 3.21 Calculated Areas for Uranium Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
300-FF-5: High River Stage	30	619,350	624,500	1%
	300	4,400	9,200	109%
300-FF-5: Low River Stage	30	723,775	724,050	0%
	300	25	25	0%
200-BP-5	30	636,575	676,675	6%
	300	44,575	53,575	20%
200-UP-1	30	349,650	353,850	1%
	300	6,825	7,075	4%
200-PO-1	30	59,000	59,125	0%
	300	-	-	-
1100-EM-1	30	-	3,050	-
	300	-	-	-
Total Area: High River Stage	**Concentration (µg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	30	1,664,575	1,717,200	3%
	300	55,800	69,850	25%
Total Area: Low River Stage	**Concentration (µg/L)**	**Average Plume Area (m^2)**	**Maximum Plume Area (m^2)**	**Change from Average Area**
	30	1,769,000	1,816,750	3%
	300	51,425	60,675	18%
Total Area:	**Concentration**	**Average Plume**	**Maximum Plume**	**Change from Average Area**

Table 3.21 Calculated Areas for Uranium Average and Maximum Plumes per GIA.

GIA	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
River Corridor High River Stage	(µg/L)	Area (m^2)	Area (m^2)	
	30	619,350	627,550	1%
	300	4,400	9,200	109%
Total Area: River Corridor Low River Stage	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	30	723,775	727,100	0%
	300	25	25	0%
Total Area: Central Plateau	Concentration (µg/L)	Average Plume Area (m^2)	Maximum Plume Area (m^2)	Change from Average Area
	30	1,045,225	1,089,650	4%
	300	51,400	60,650	18%

3.3 Average versus Maximum Plume Maps

The average and maximum contaminant plume maps for each COI and GIA are presented below.

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(a) Average Plume *(b) Maximum Plume*

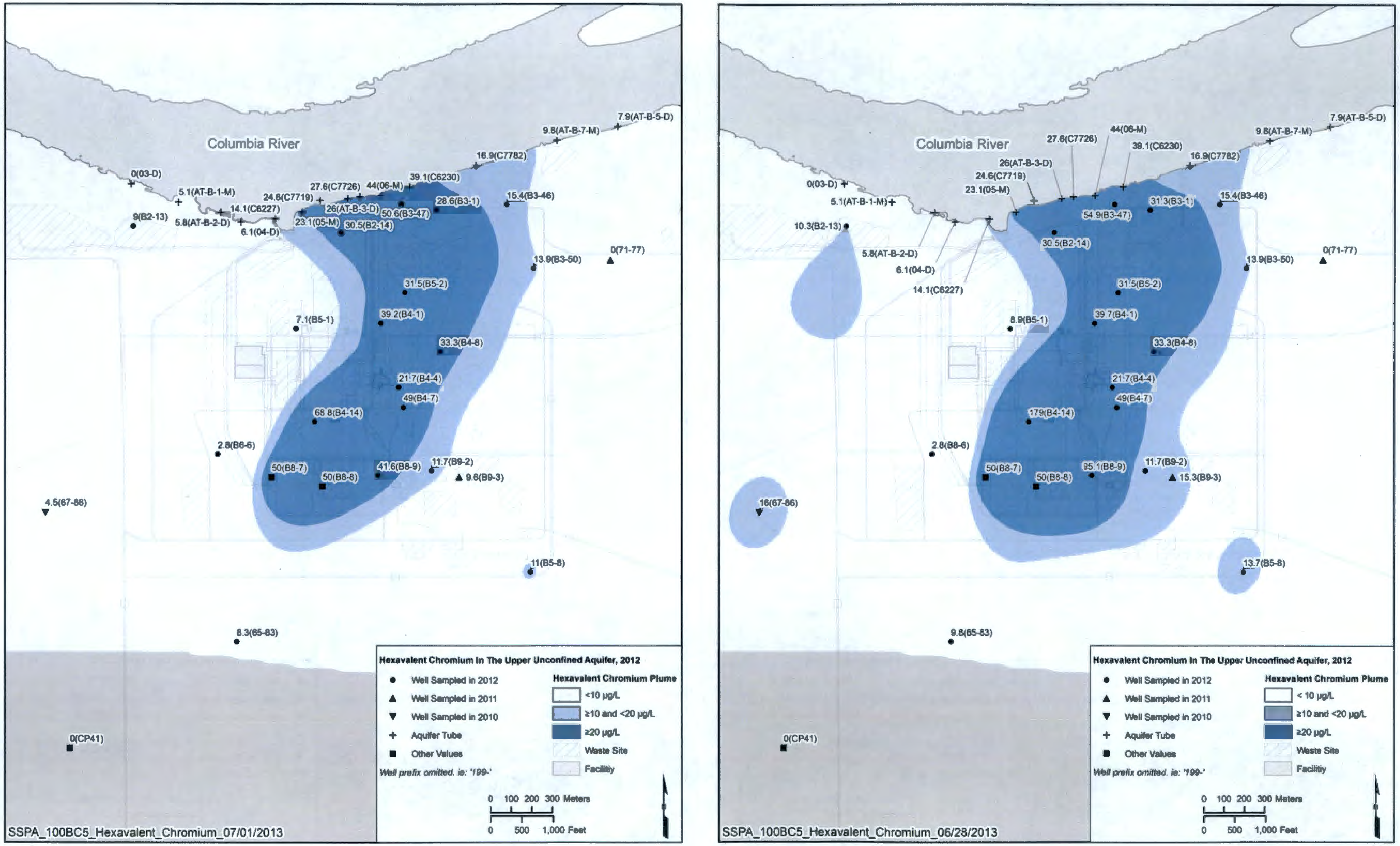


Figure 3-1. Hexavalent Chromium Plume Maps for (a) Average and (b) Maximum Concentrations in 100-BC-5

(a) Average Plume　　　　*(b) Maximum Plume*

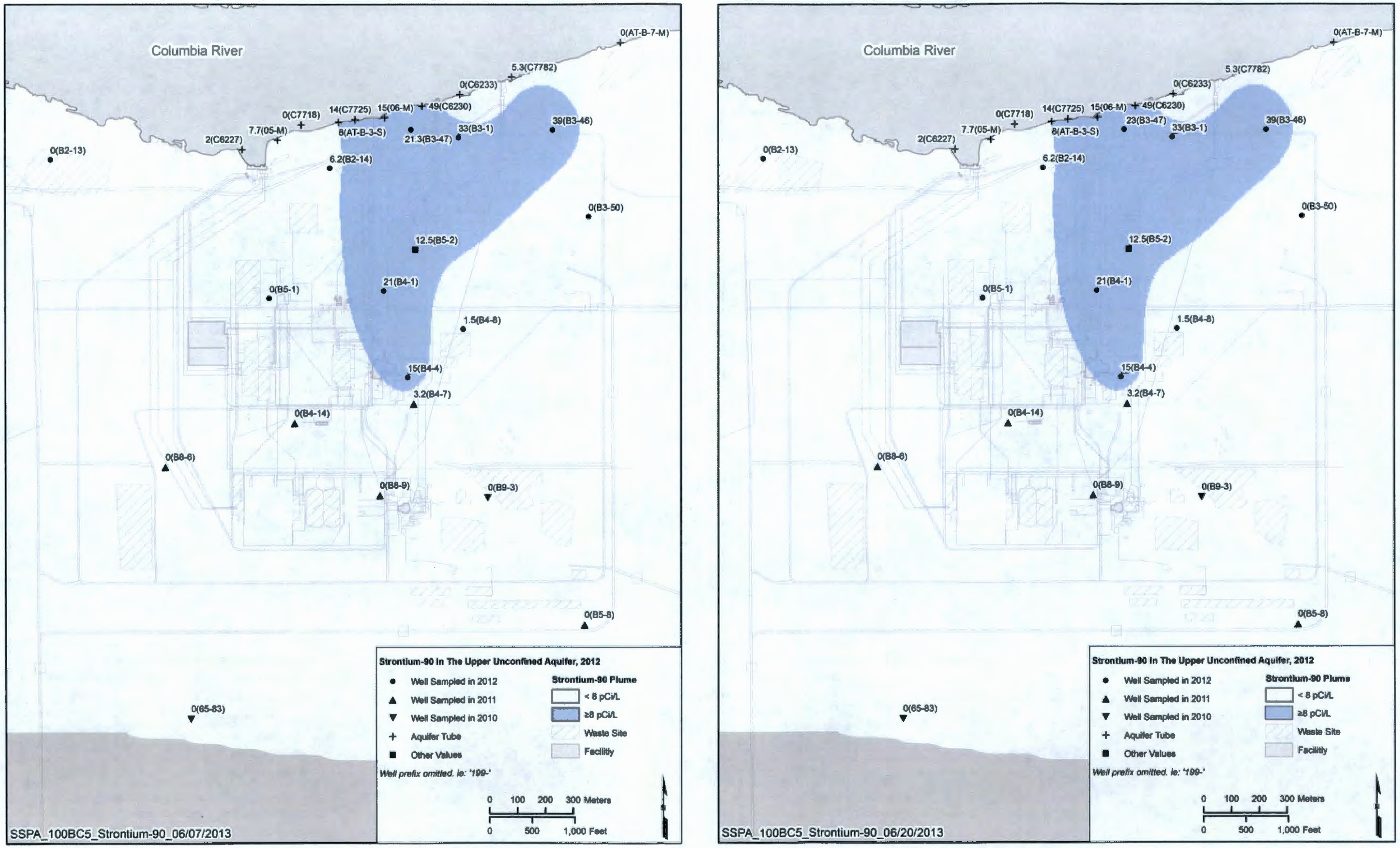


Figure 3-2. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-BC-5

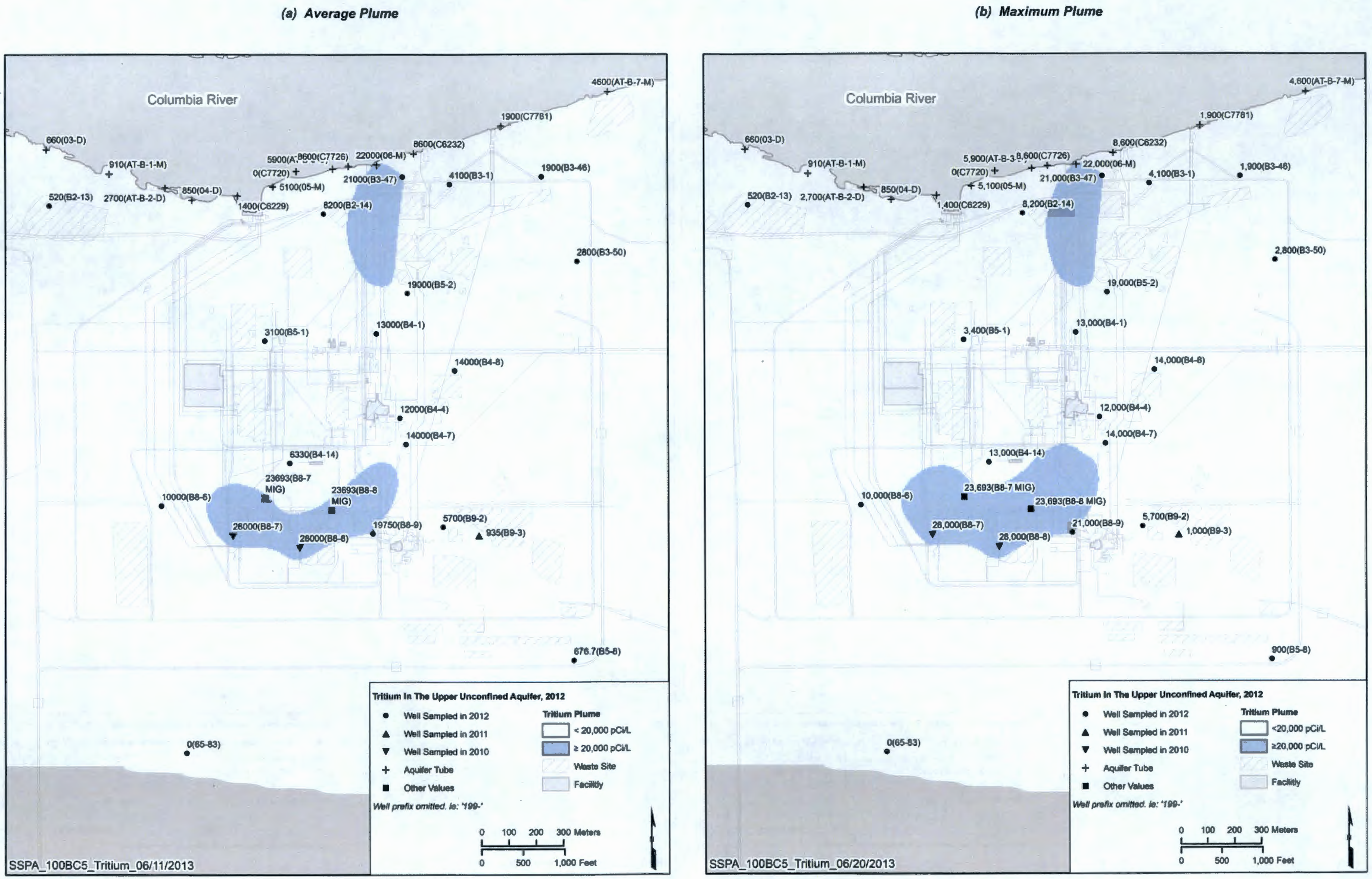
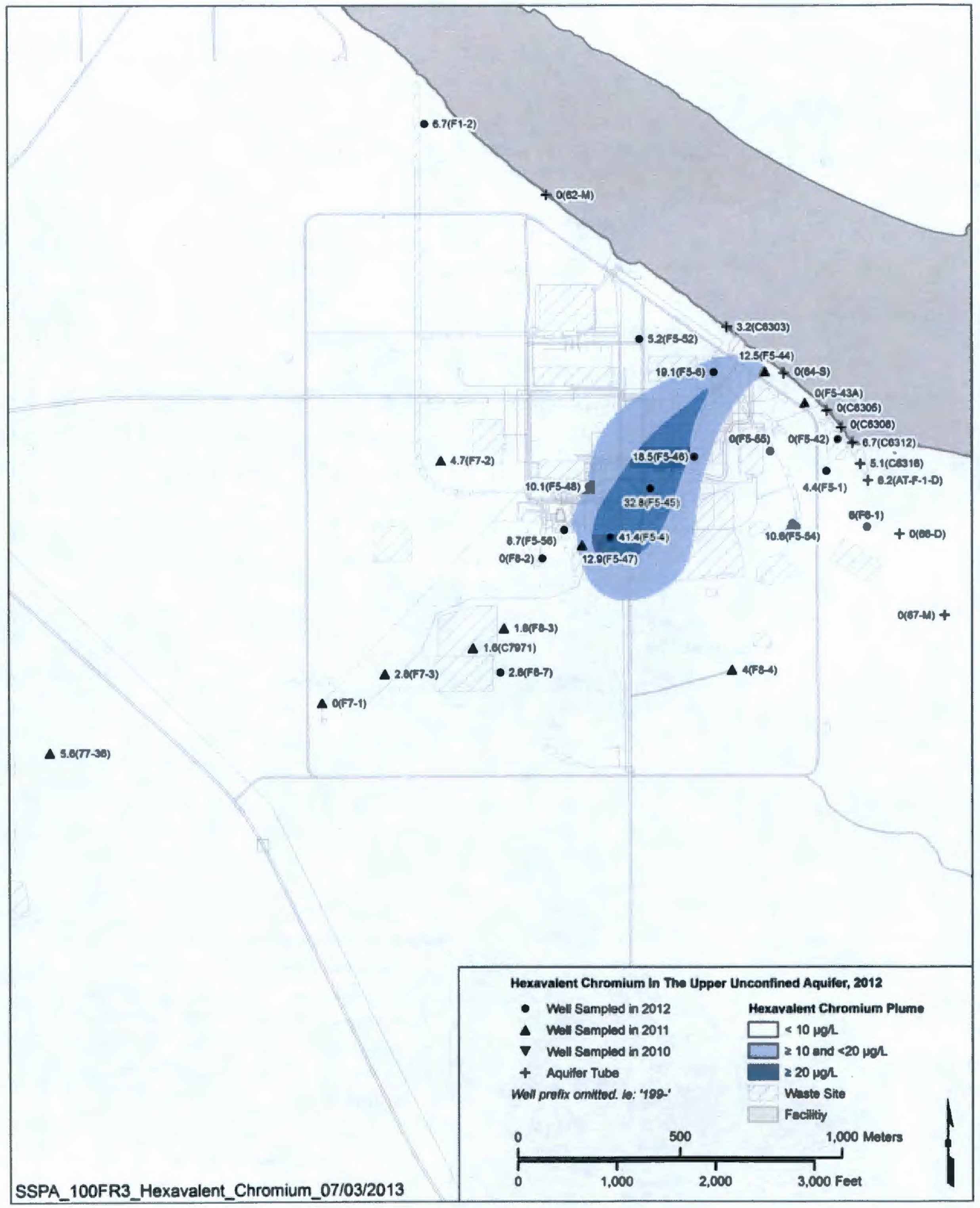


Figure 3-3. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 100-BC-5

(a) Average Plume



(b) Maximum Plume

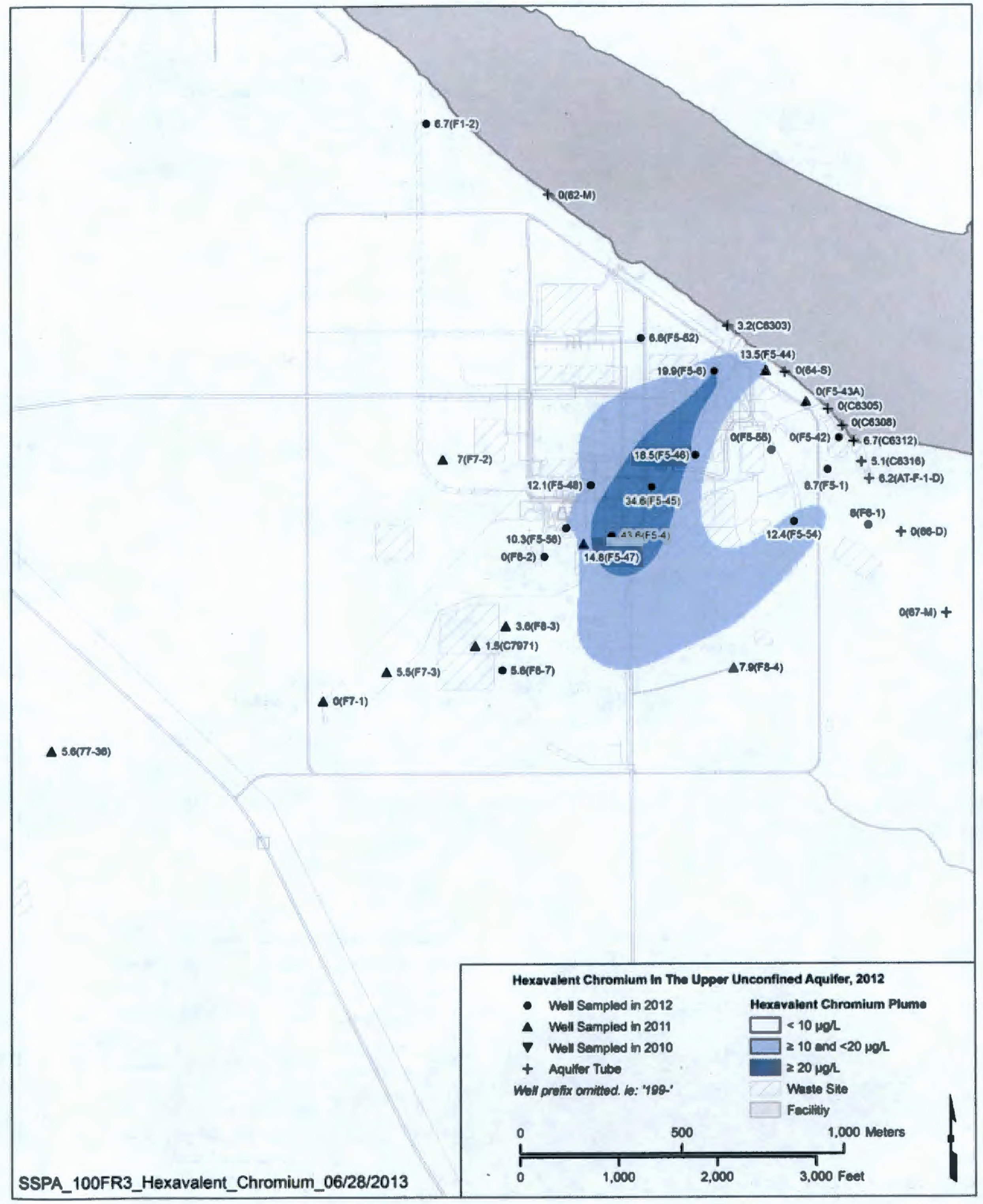


Figure 3-4. Hexavalent Chromium Plume Maps for (a) Average and (b) Maximum Concentrations in 100-FR-3

(a) Average Plume *(b) Maximum Plume*

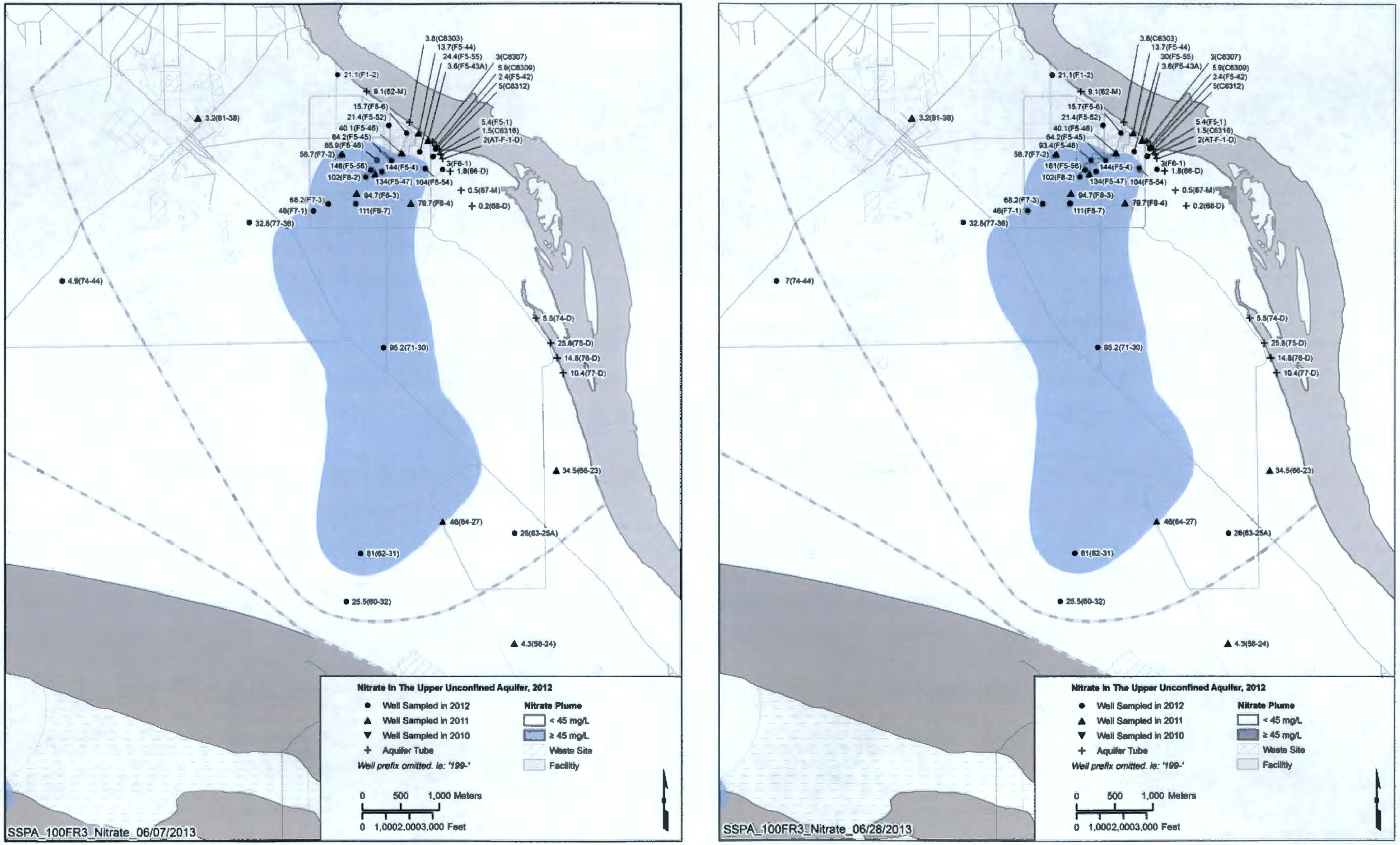


Figure 3-5. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 100-FR-3

(a) Average Plume *(b) Maximum Plume*

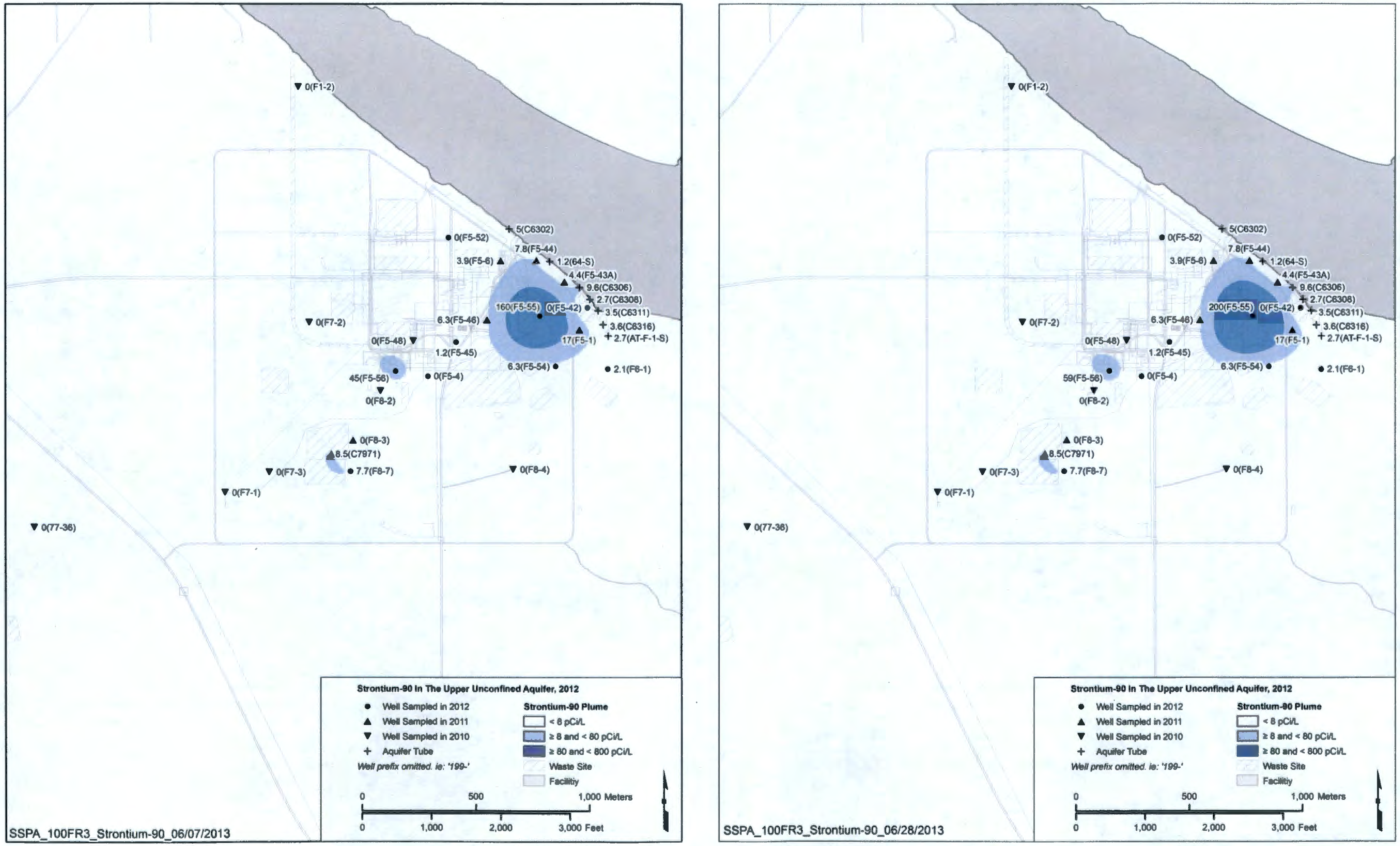


Figure 3-6. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-FR-3

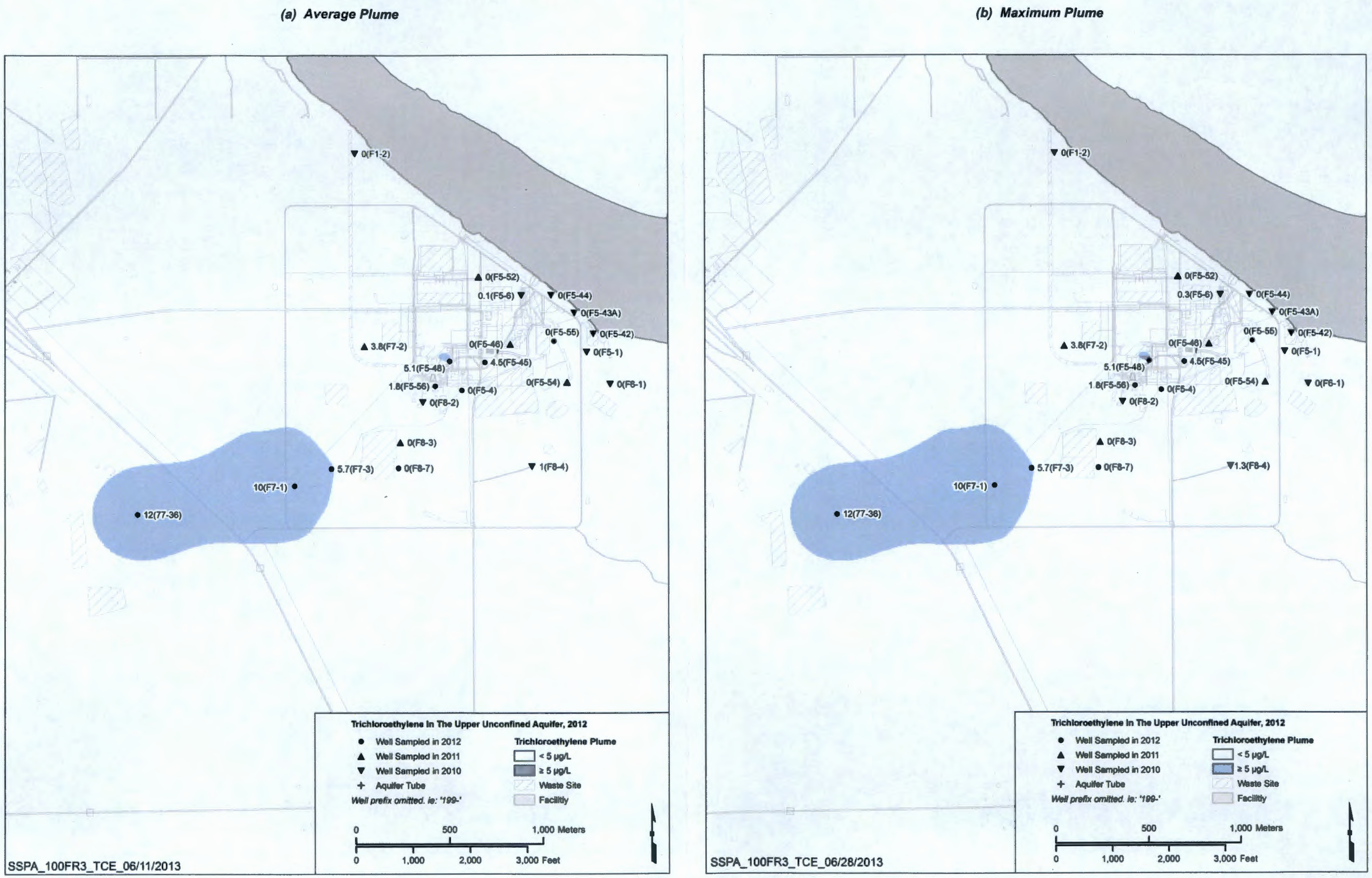


Figure 3-7. TCE Plume Maps for (a) Average and (b) Maximum Concentrations in 100-FR-3

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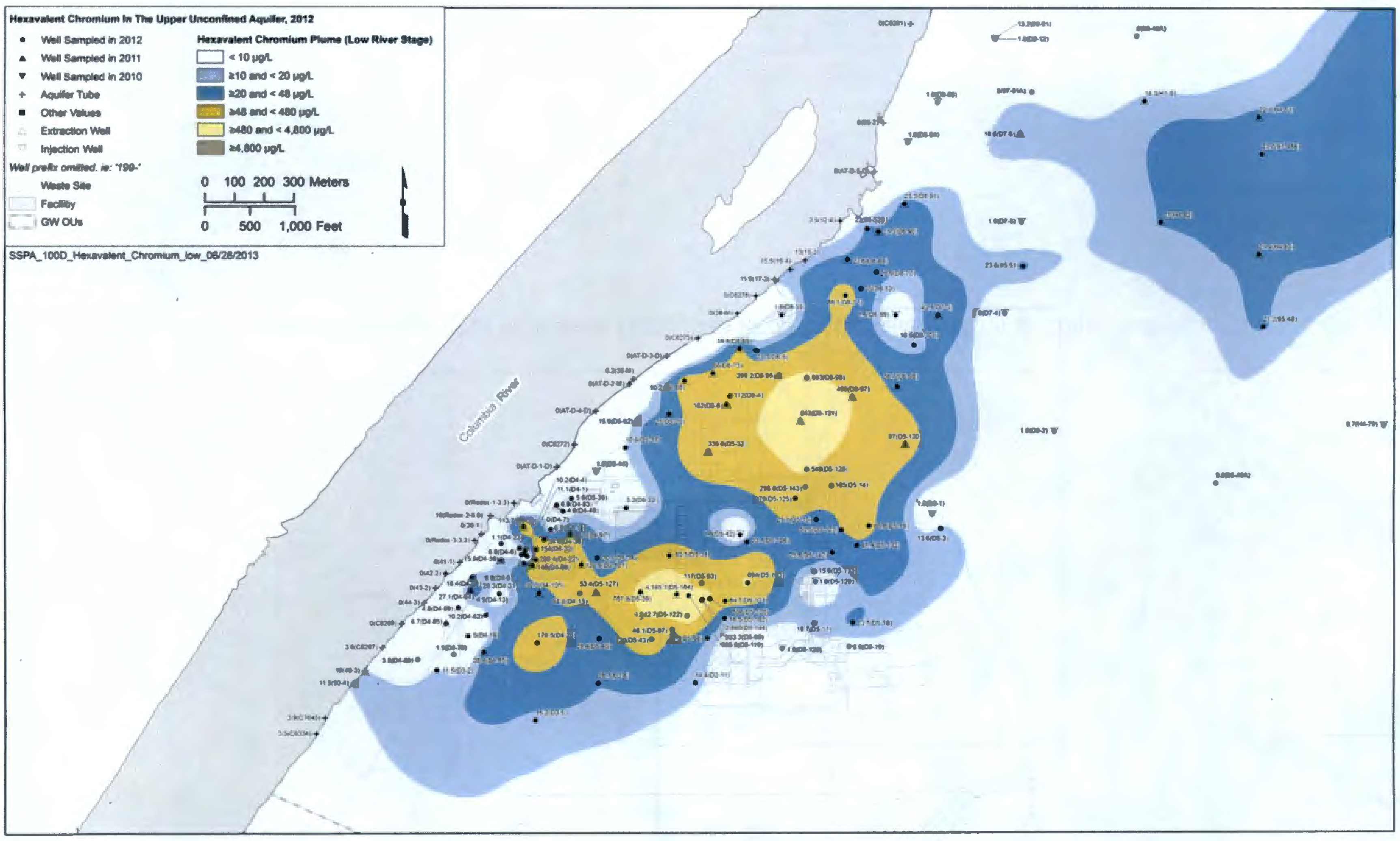
(a) Average Plume



(b) Maximum Plume

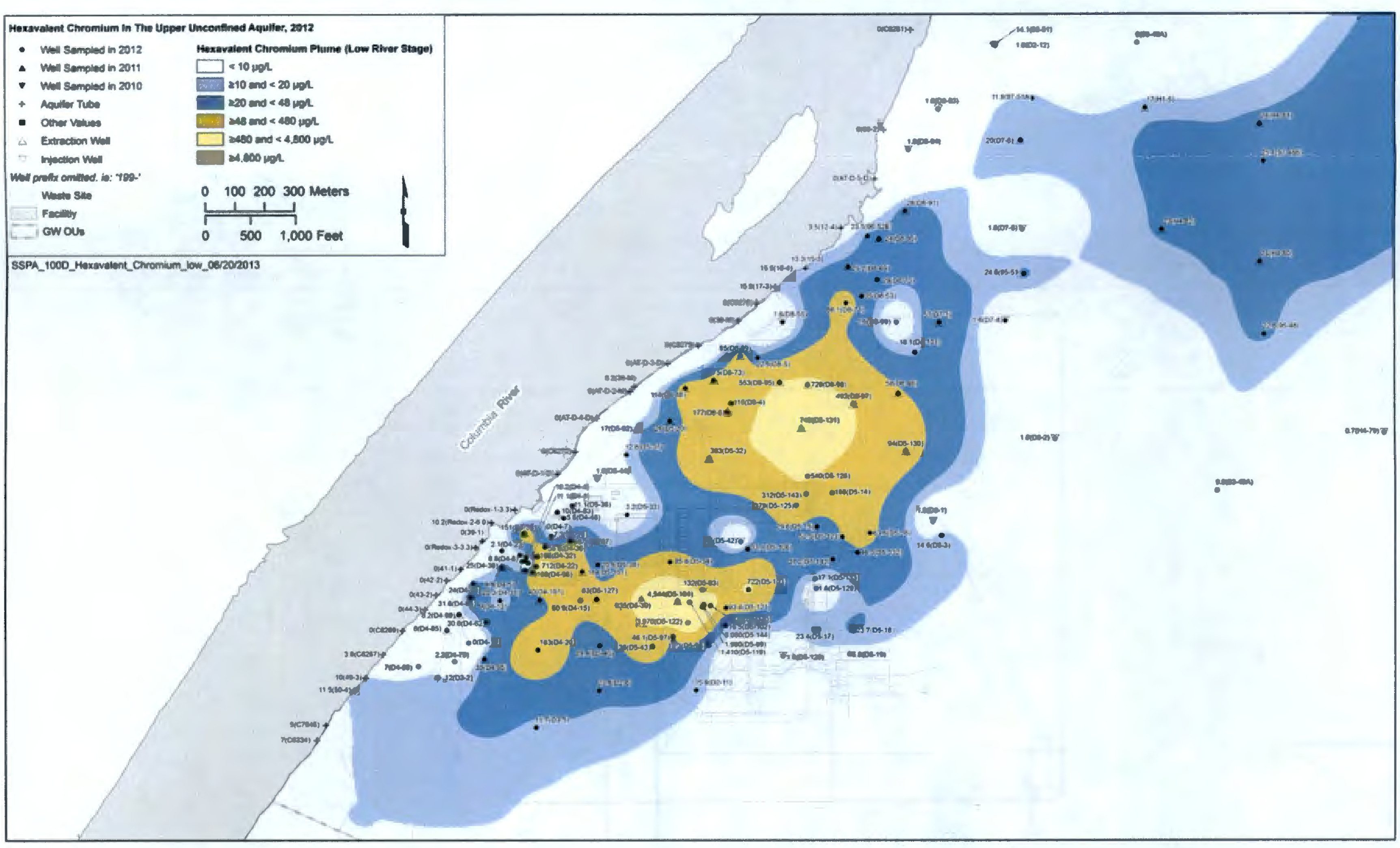
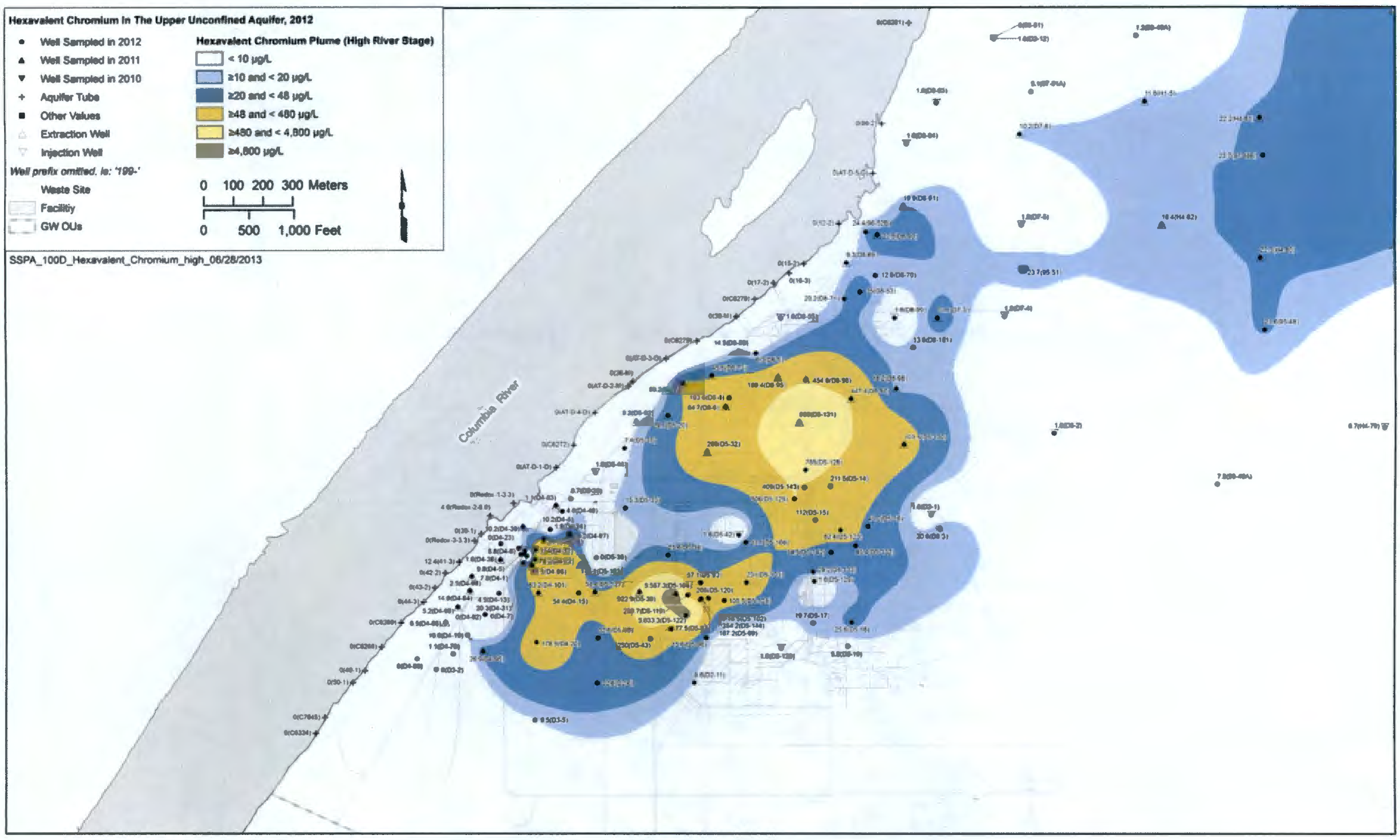


Figure 3-8. Hexavalent Chromium (Low River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 100-D

(a) Average Plume



(b) Maximum Plume

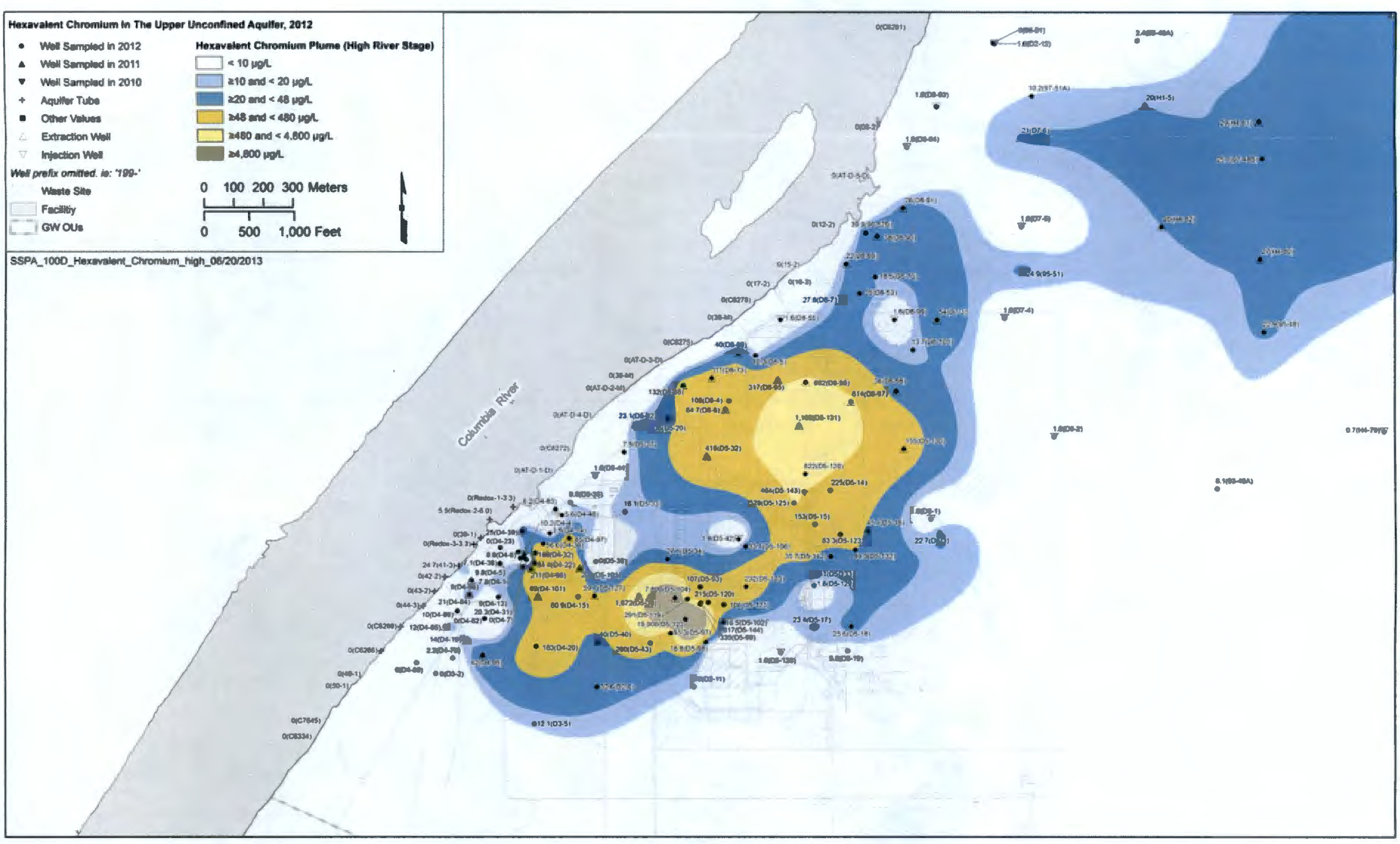
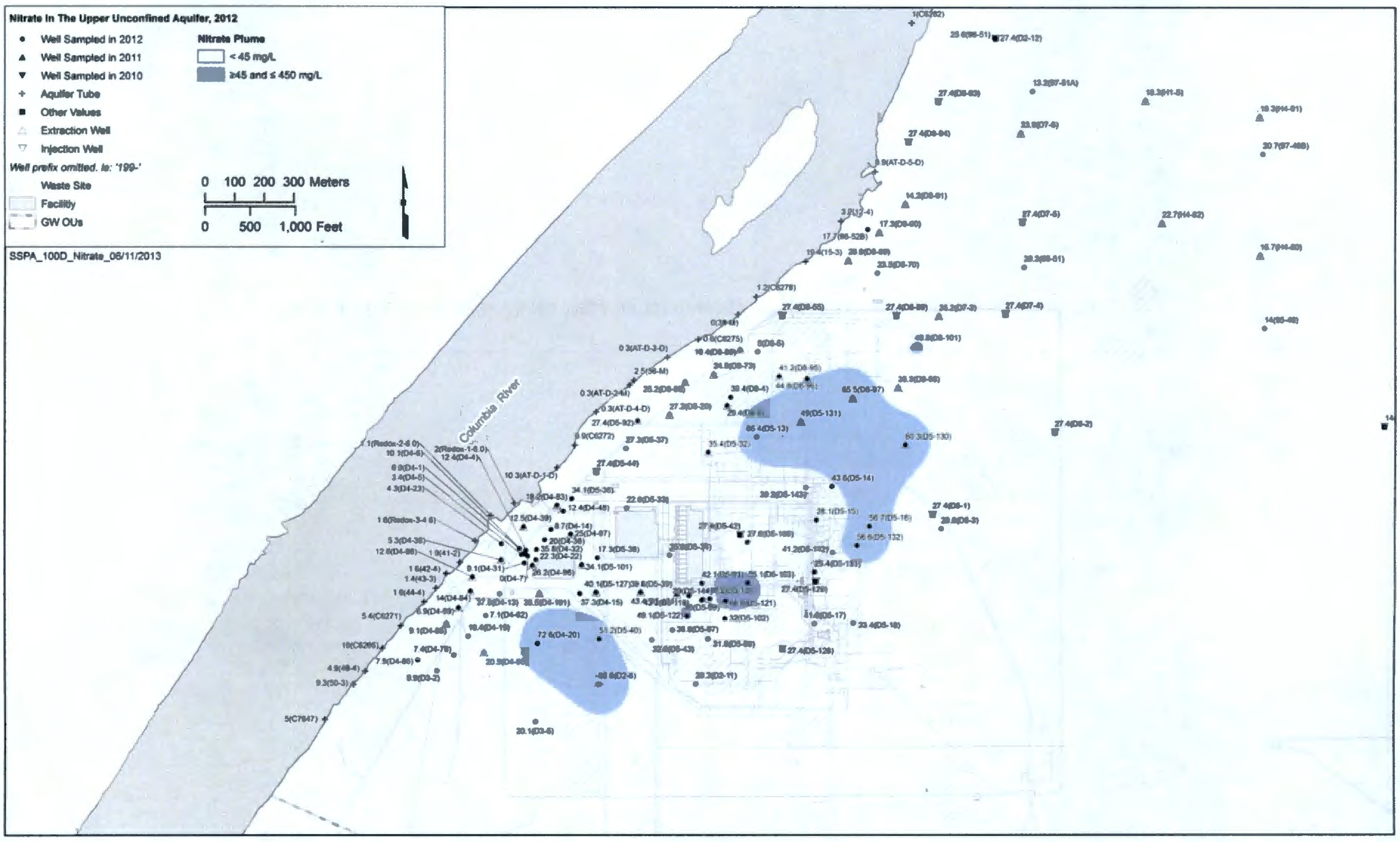


Figure 3-9. Hexavalent Chromium (High River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 100-D

(a) Average Plume



(b) Maximum Plume

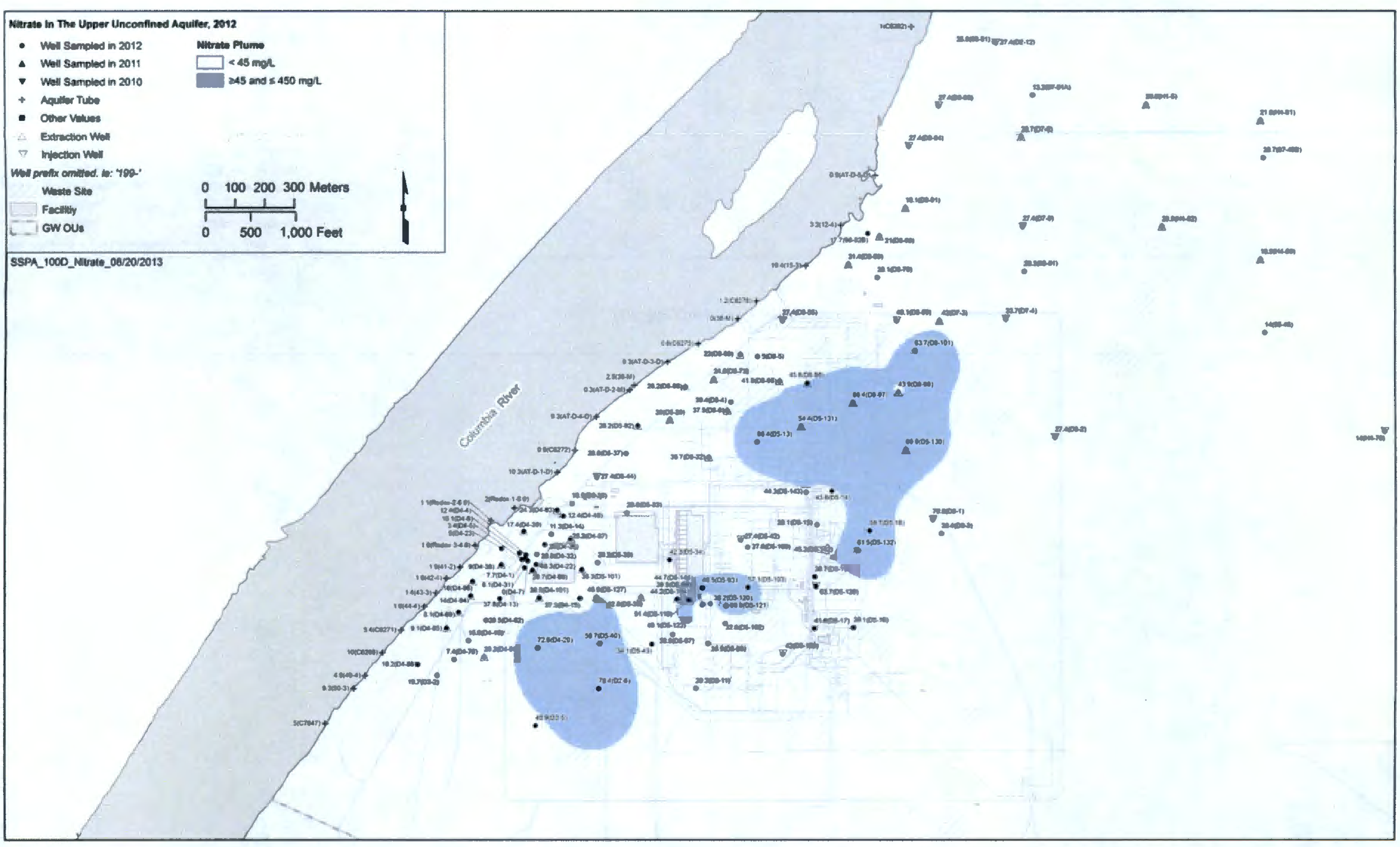
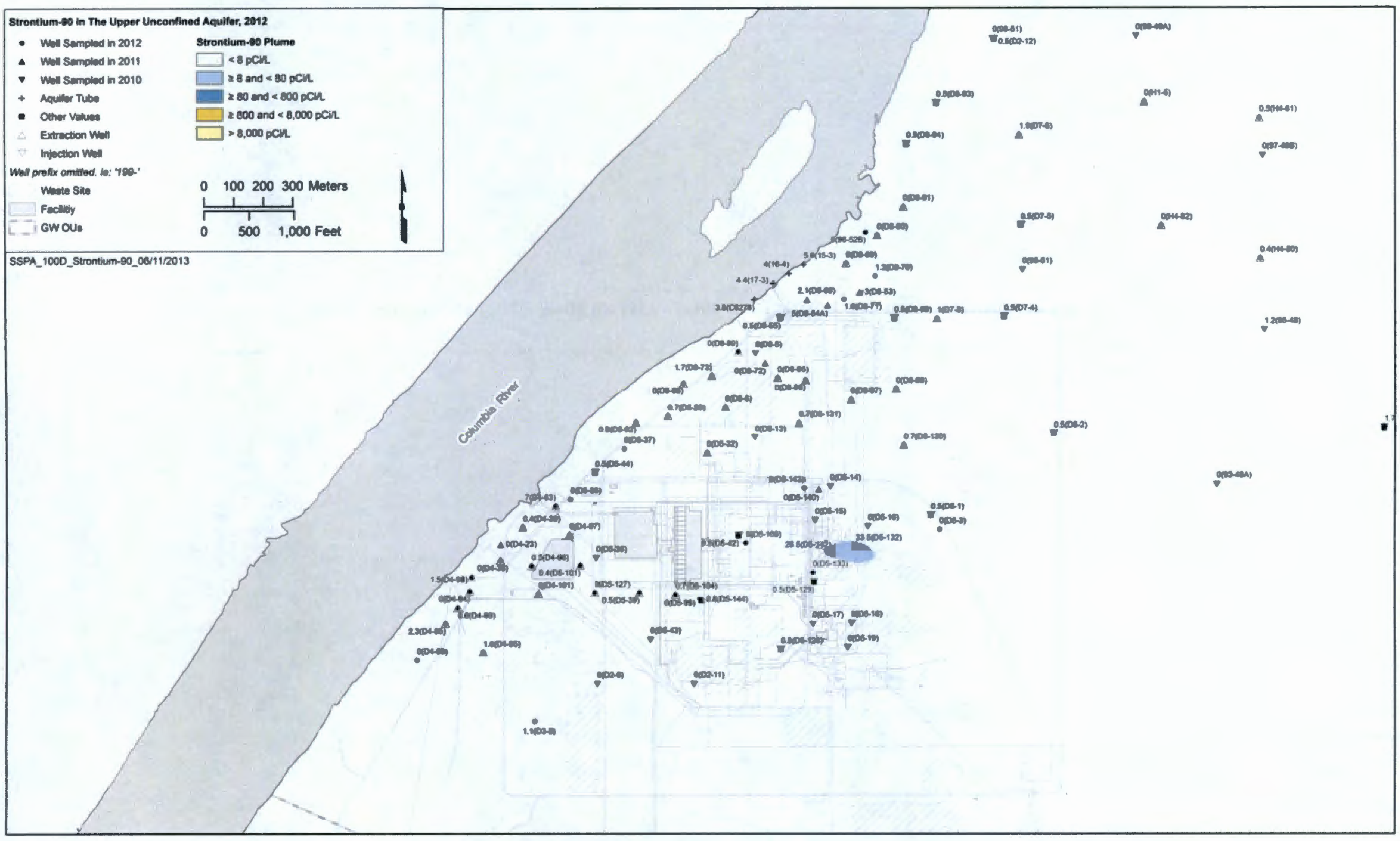


Figure 3-10. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 100-D

(a) Average Plume



(b) Maximum Plume

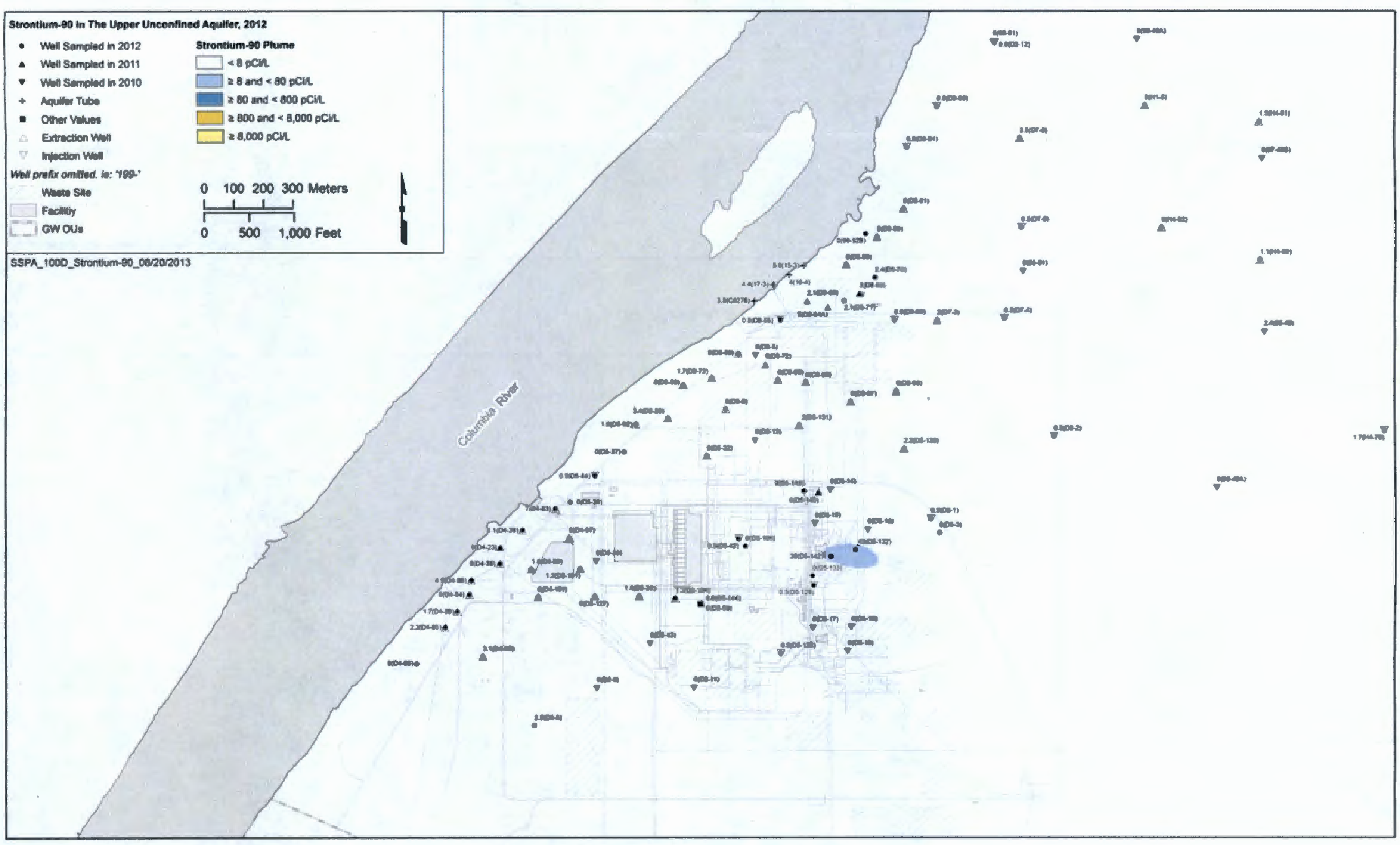
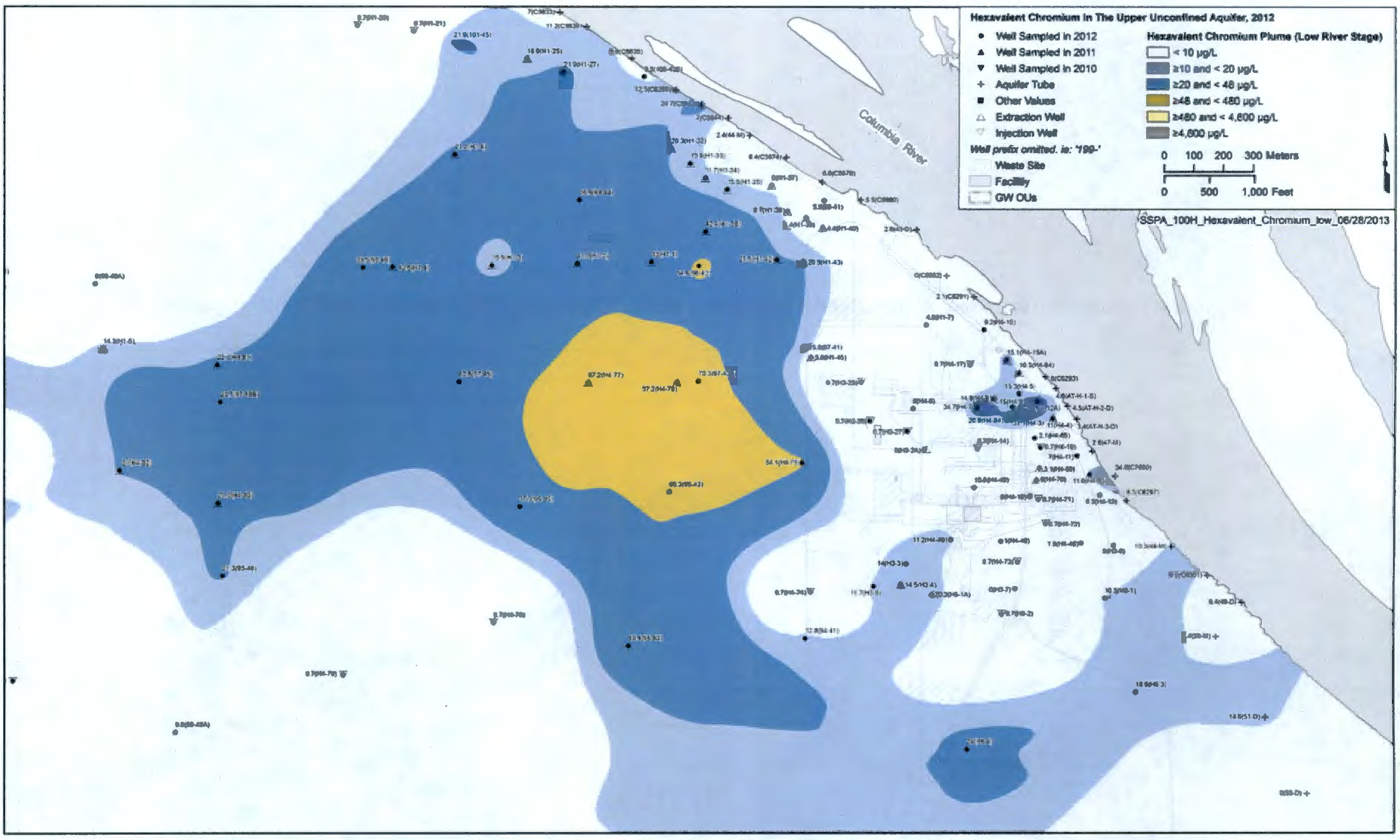


Figure 3-11. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-D

(a) Average Plume



(b) Maximum Plume

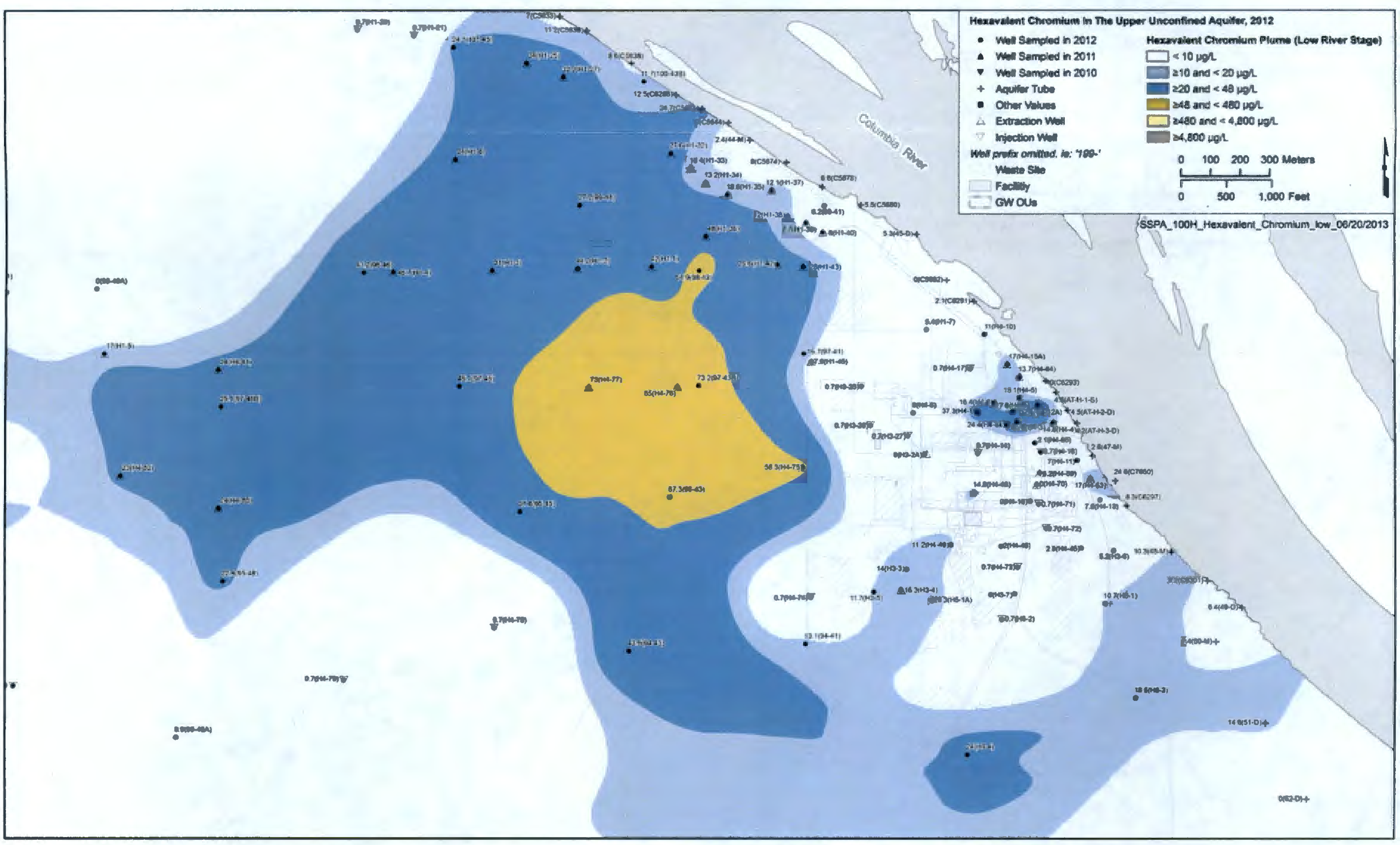
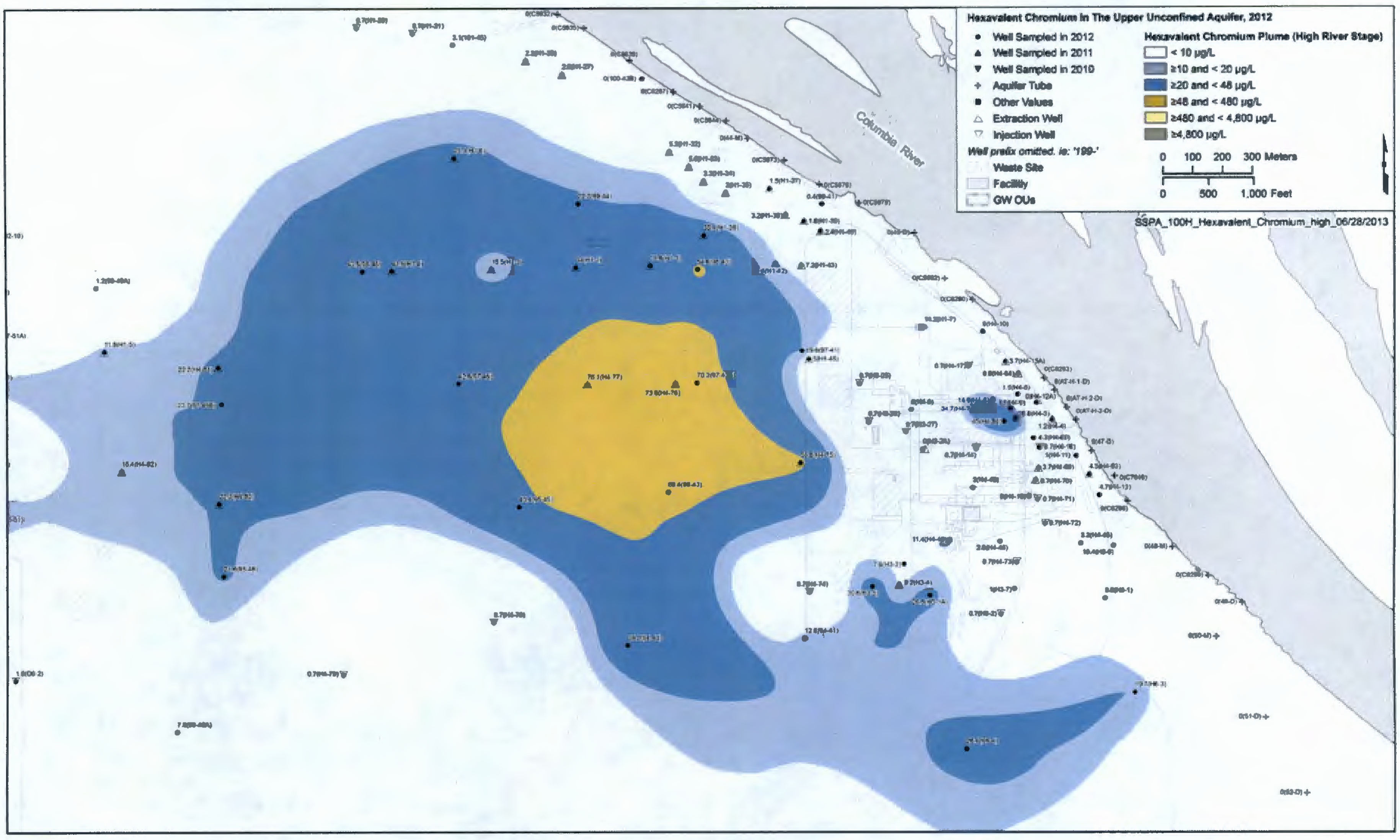


Figure 3-12. Hexavalent Chromium (Low River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 100-H

(a) Average Plume



(b) Maximum Plume

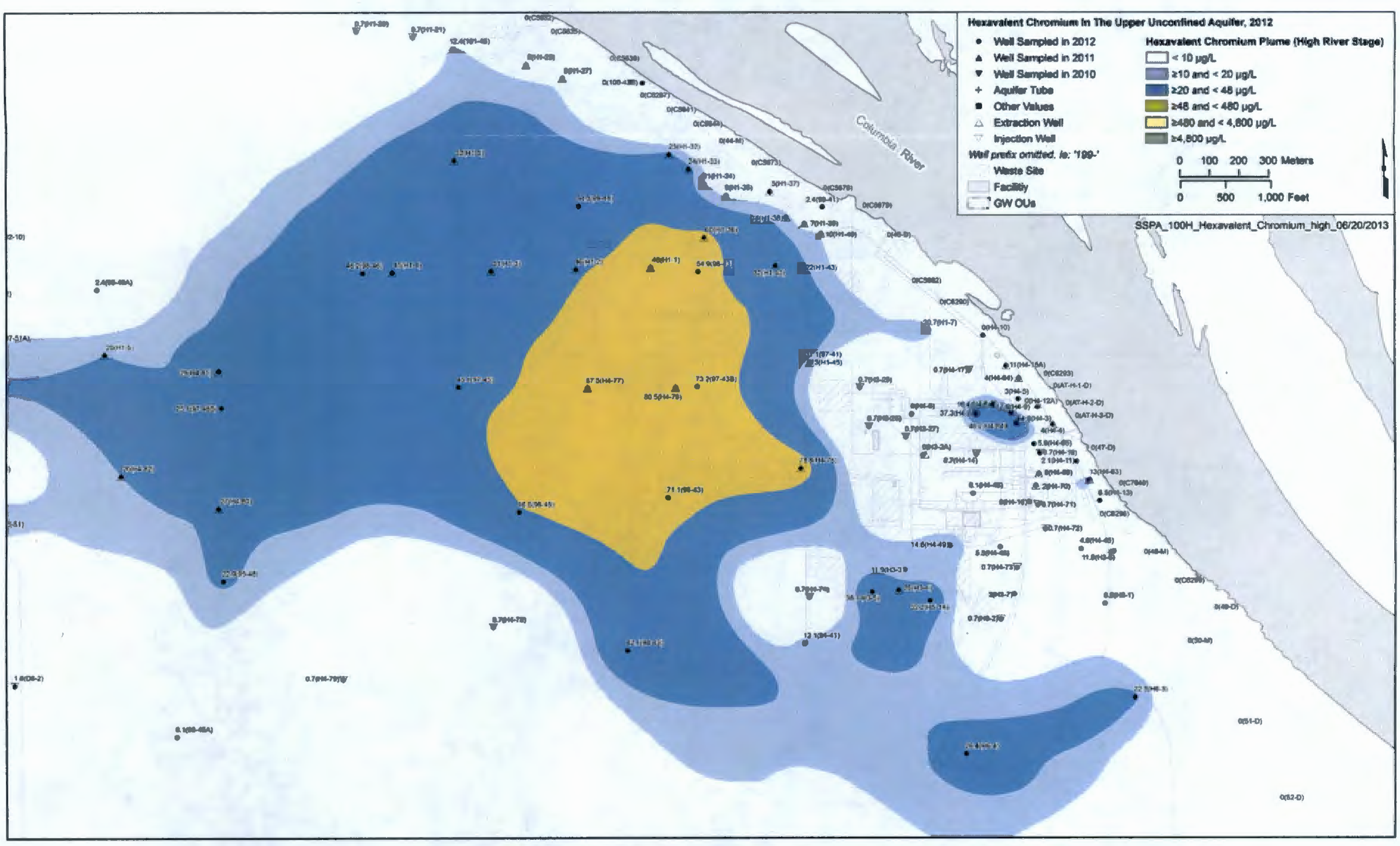


Figure 3-13. Hexavalent Chromium (High River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 100-H

(a) Average Plume

(b) Maximum Plume

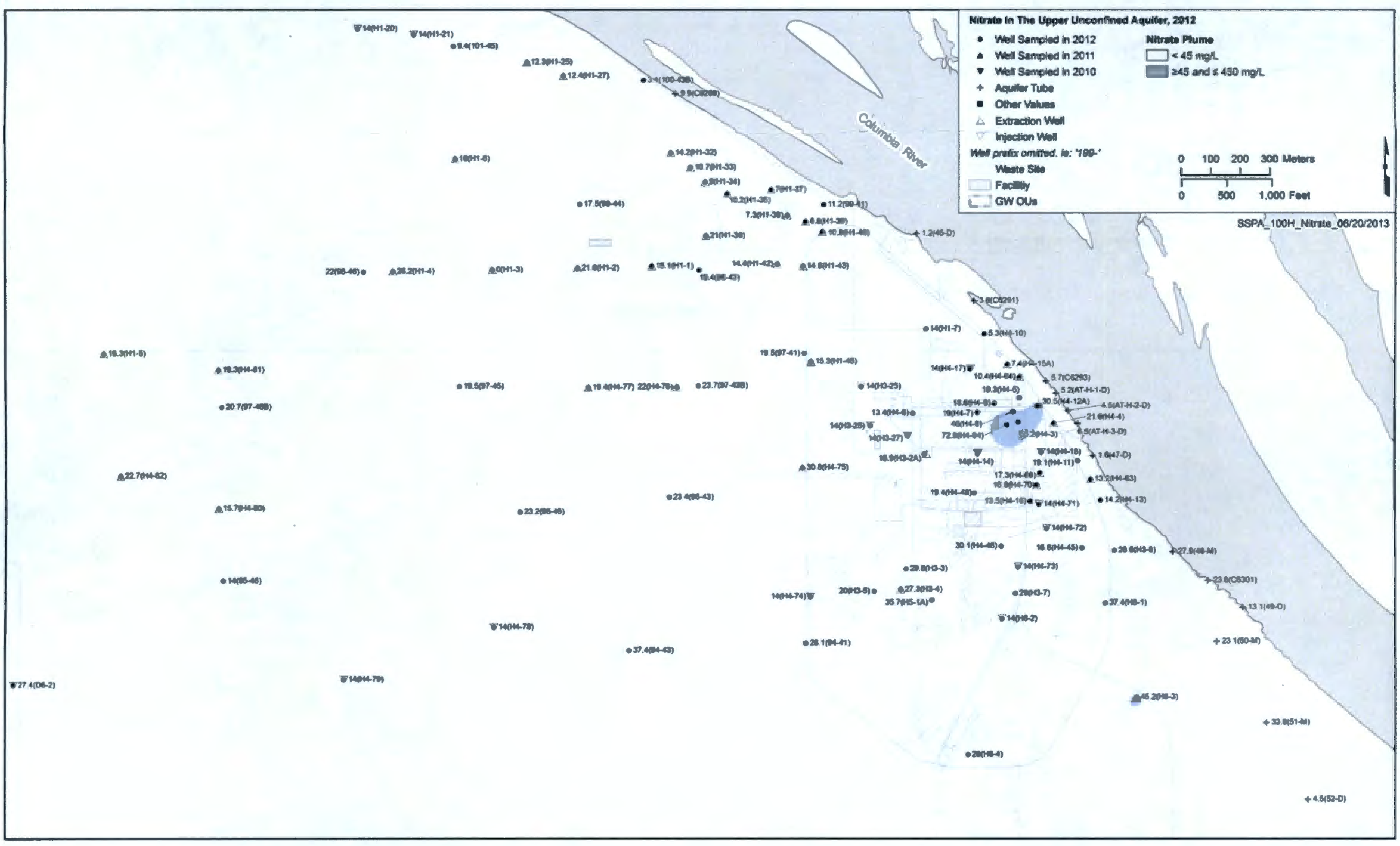
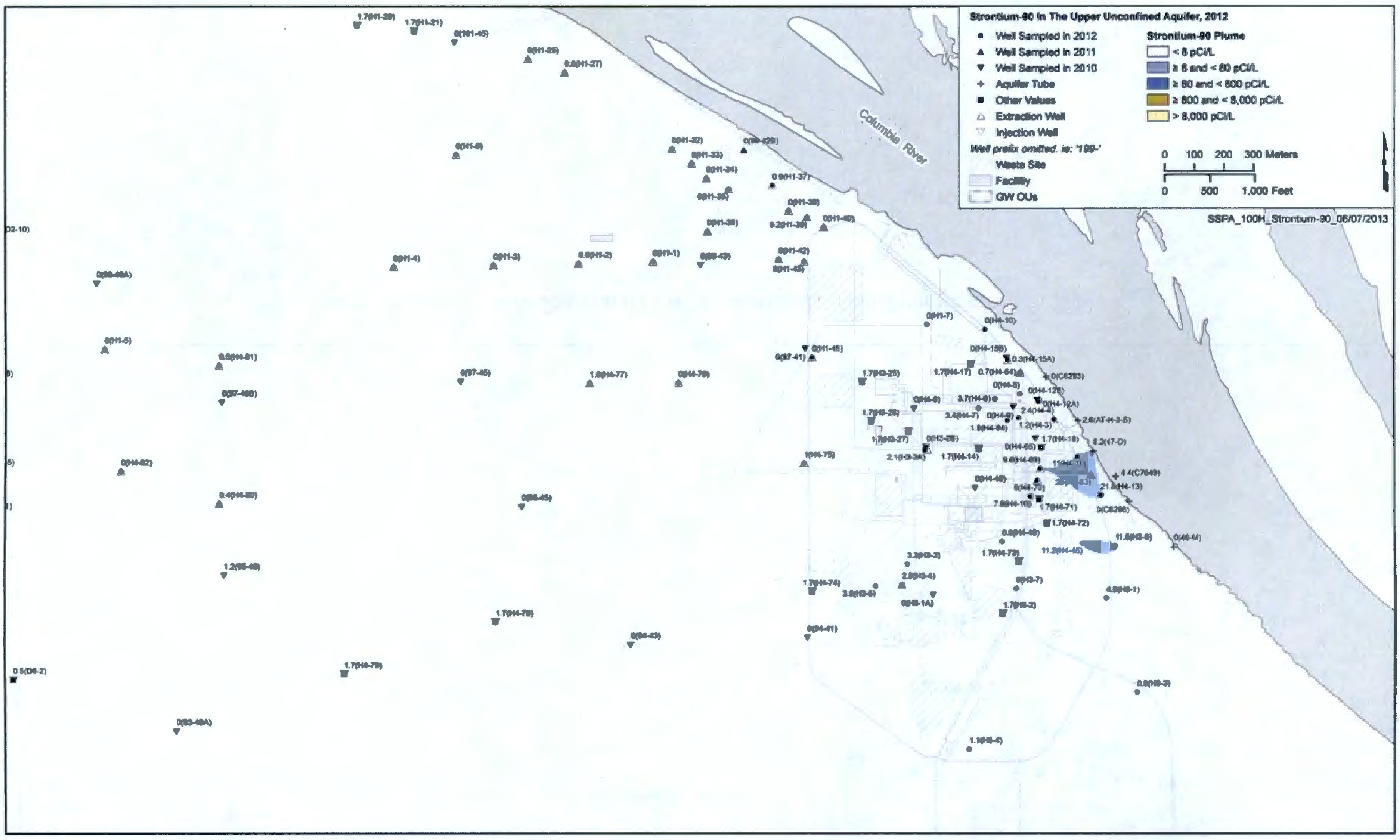


Figure 3-14. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 100-H

(a) Average Plume



(b) Maximum Plume

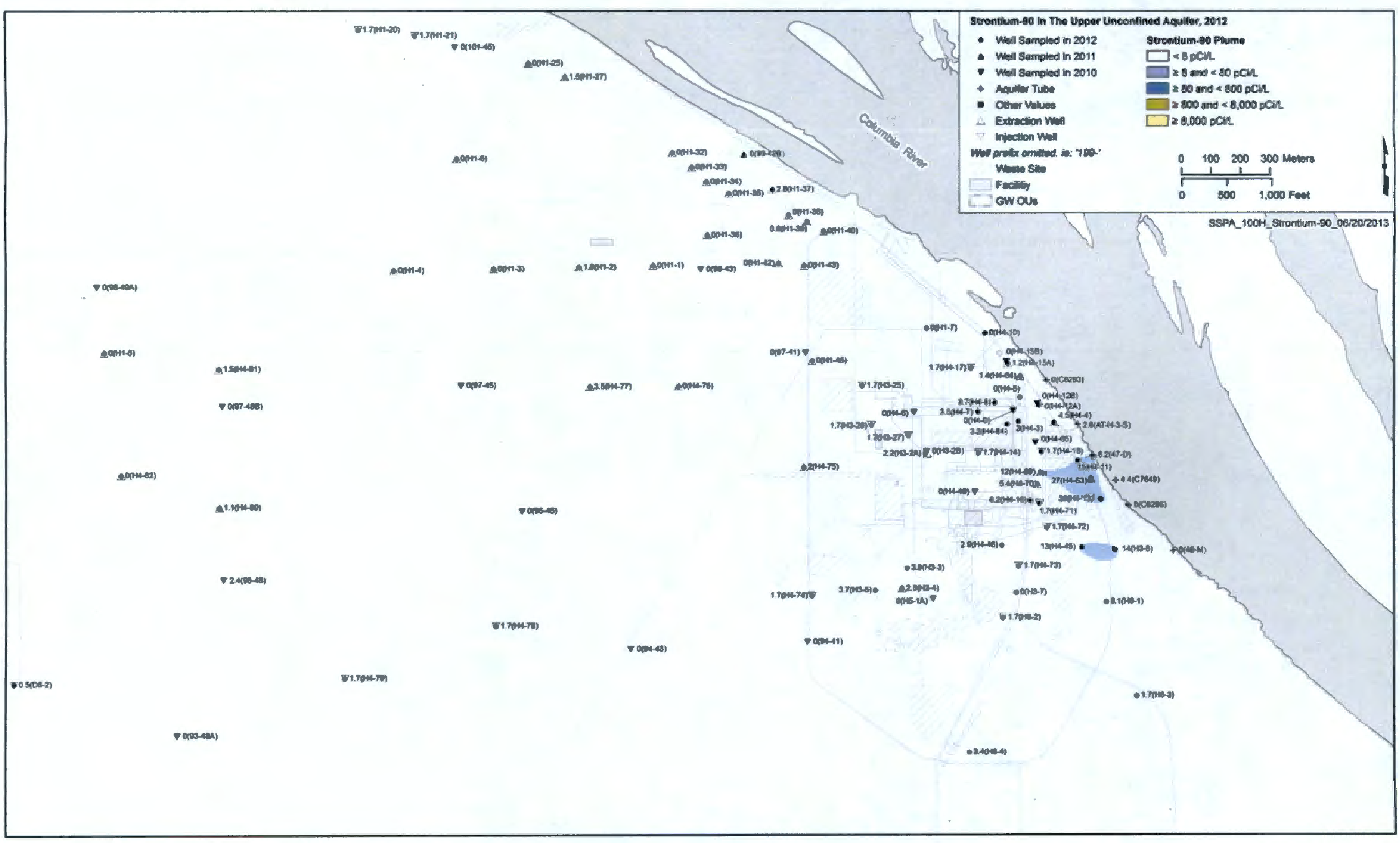
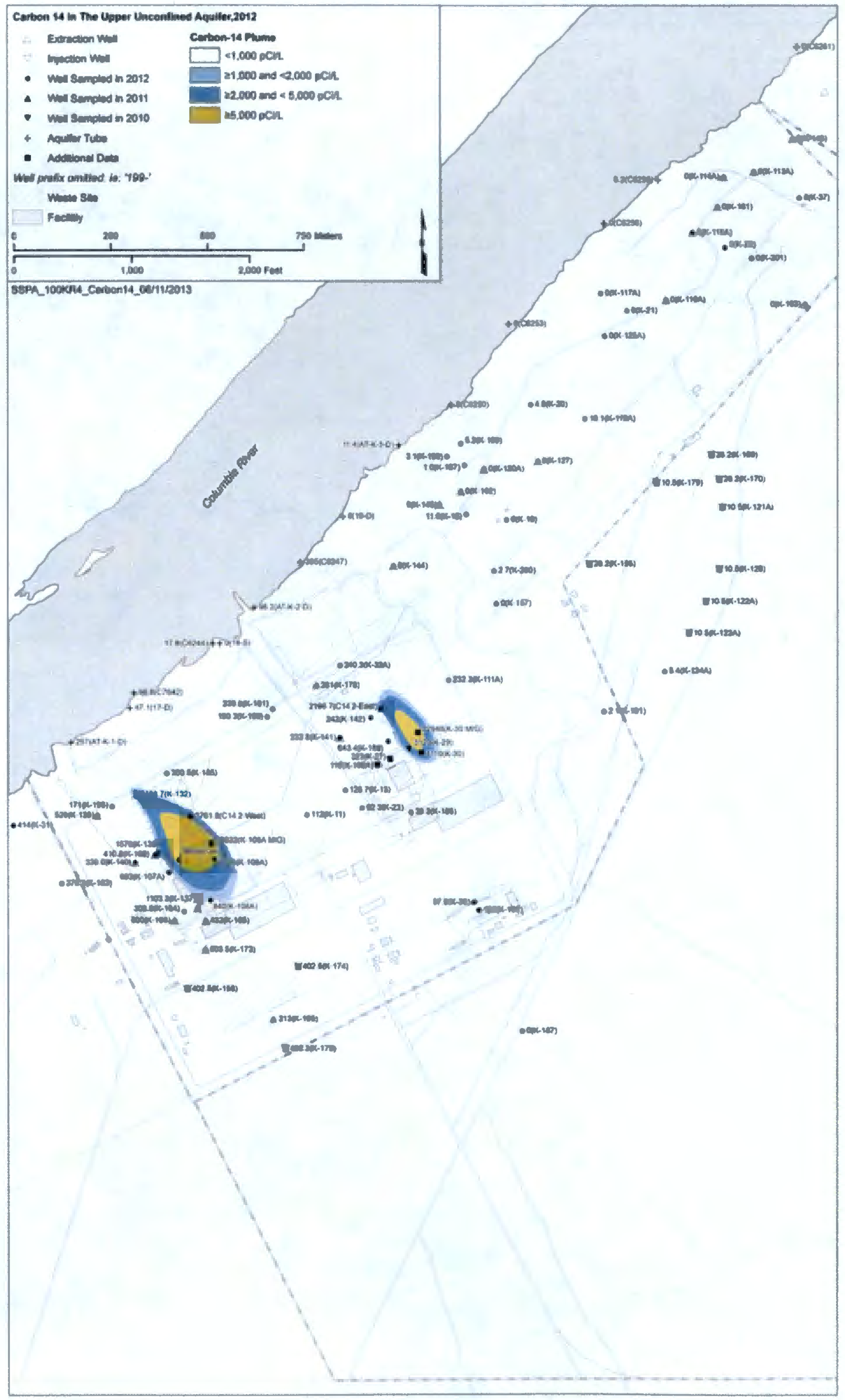


Figure 3-15. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-H

(a) Average Plume



(b) Maximum Plume

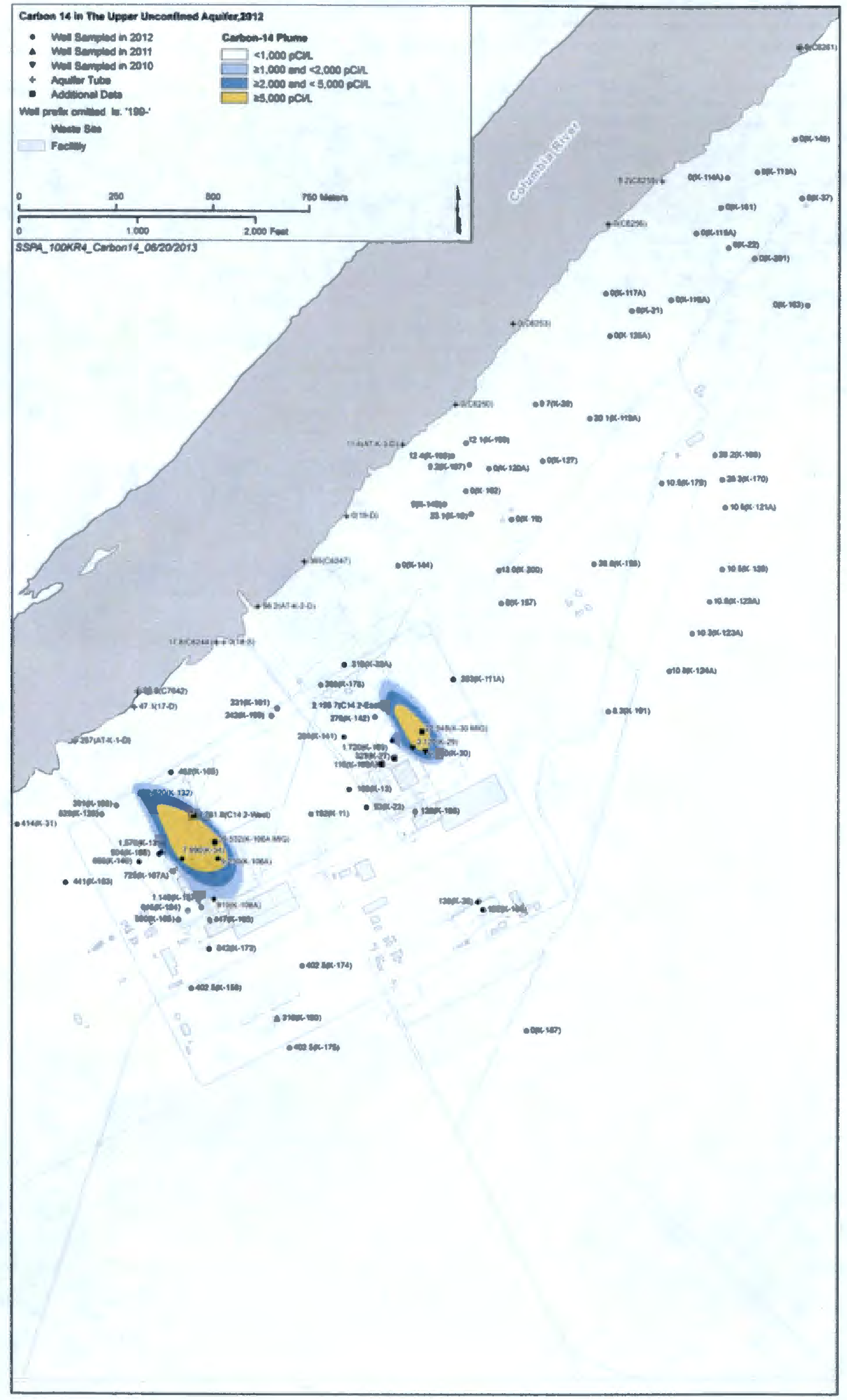


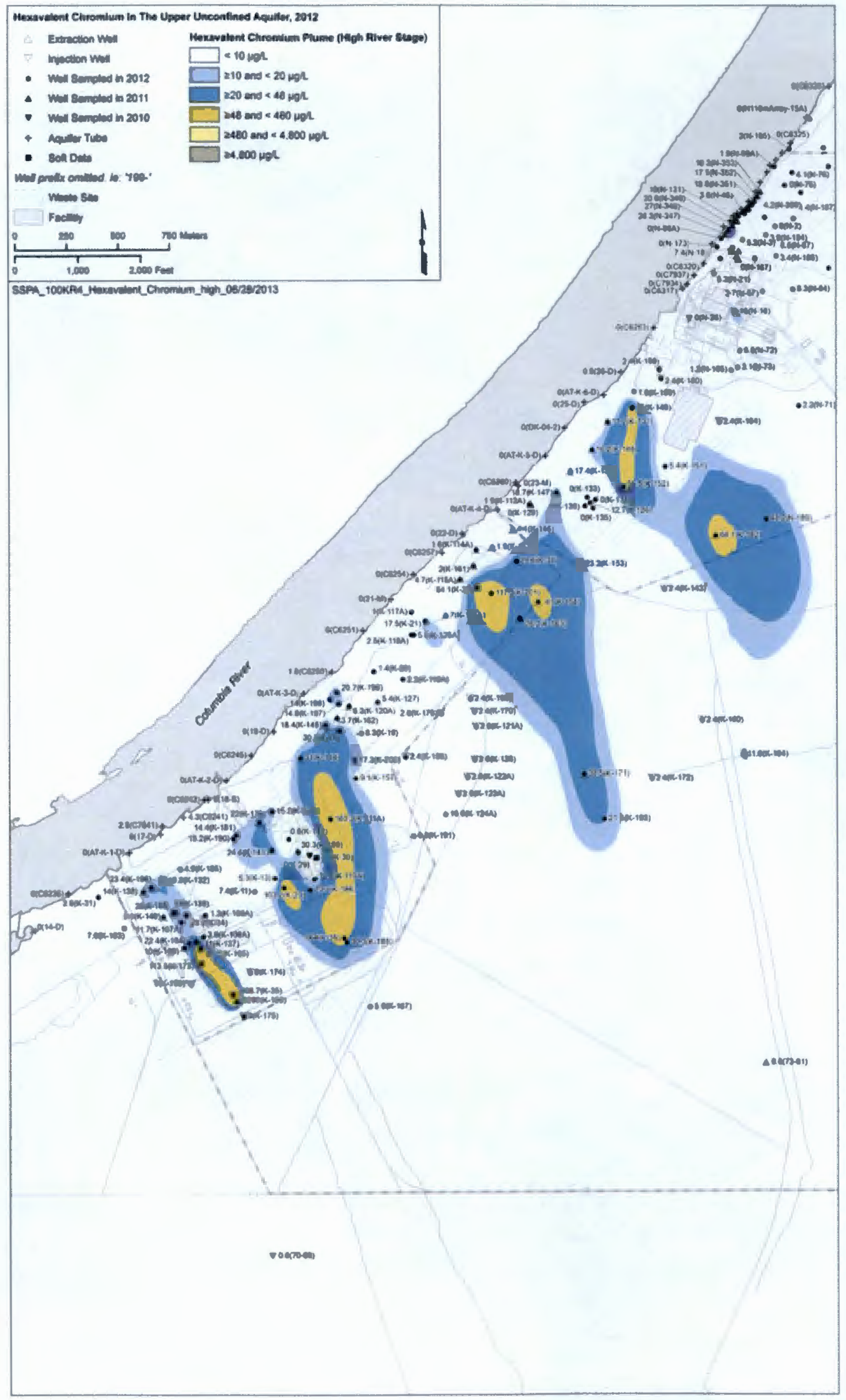
Figure 3-16. Carbon-14 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume

(b) Maximum Plume

Figure 3-17. Hexavalent Chromium (Low River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume



(b) Maximum Plume

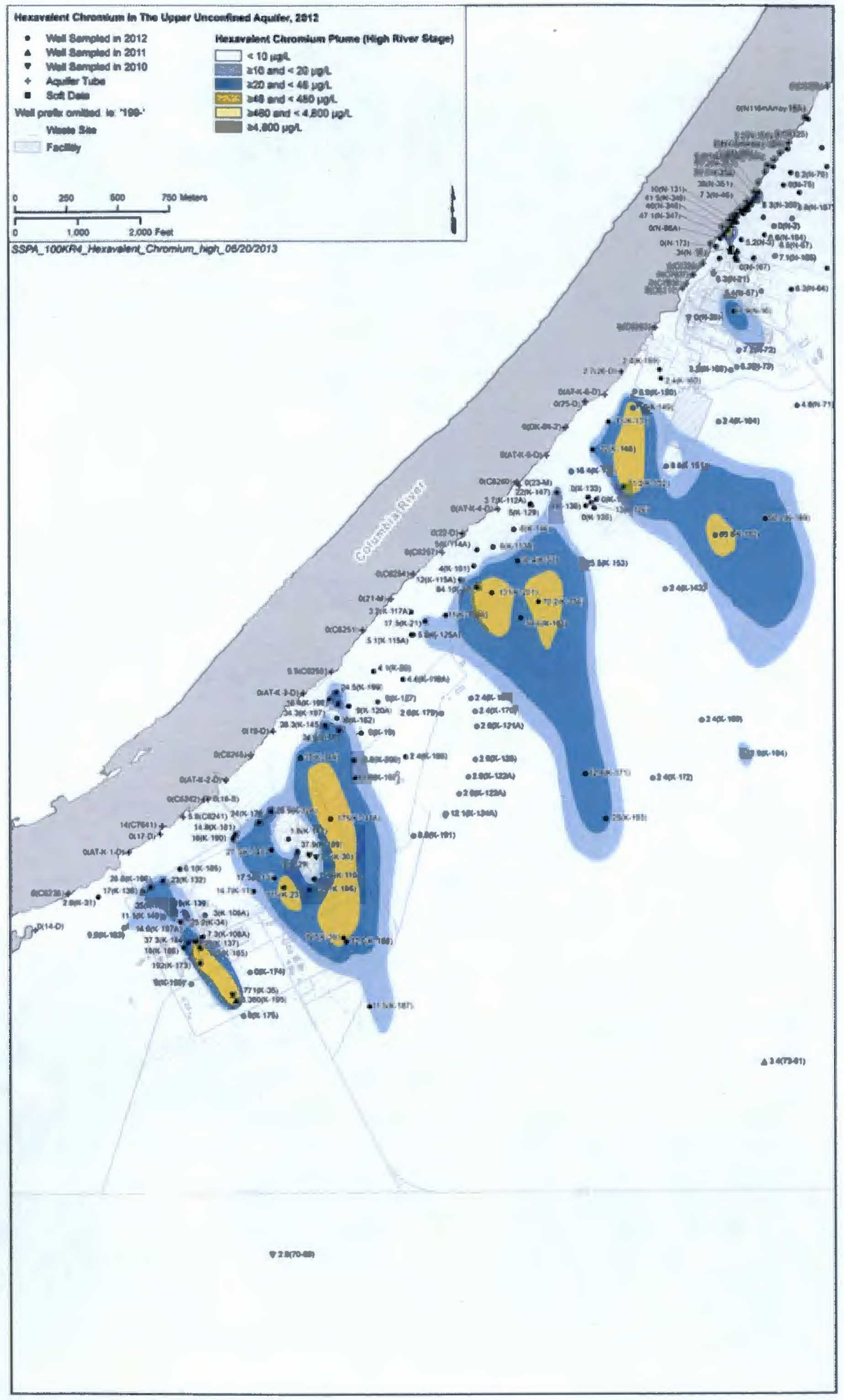


Figure 3-18. Hexavalent Chromium (High River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume *(b) Maximum Plume*

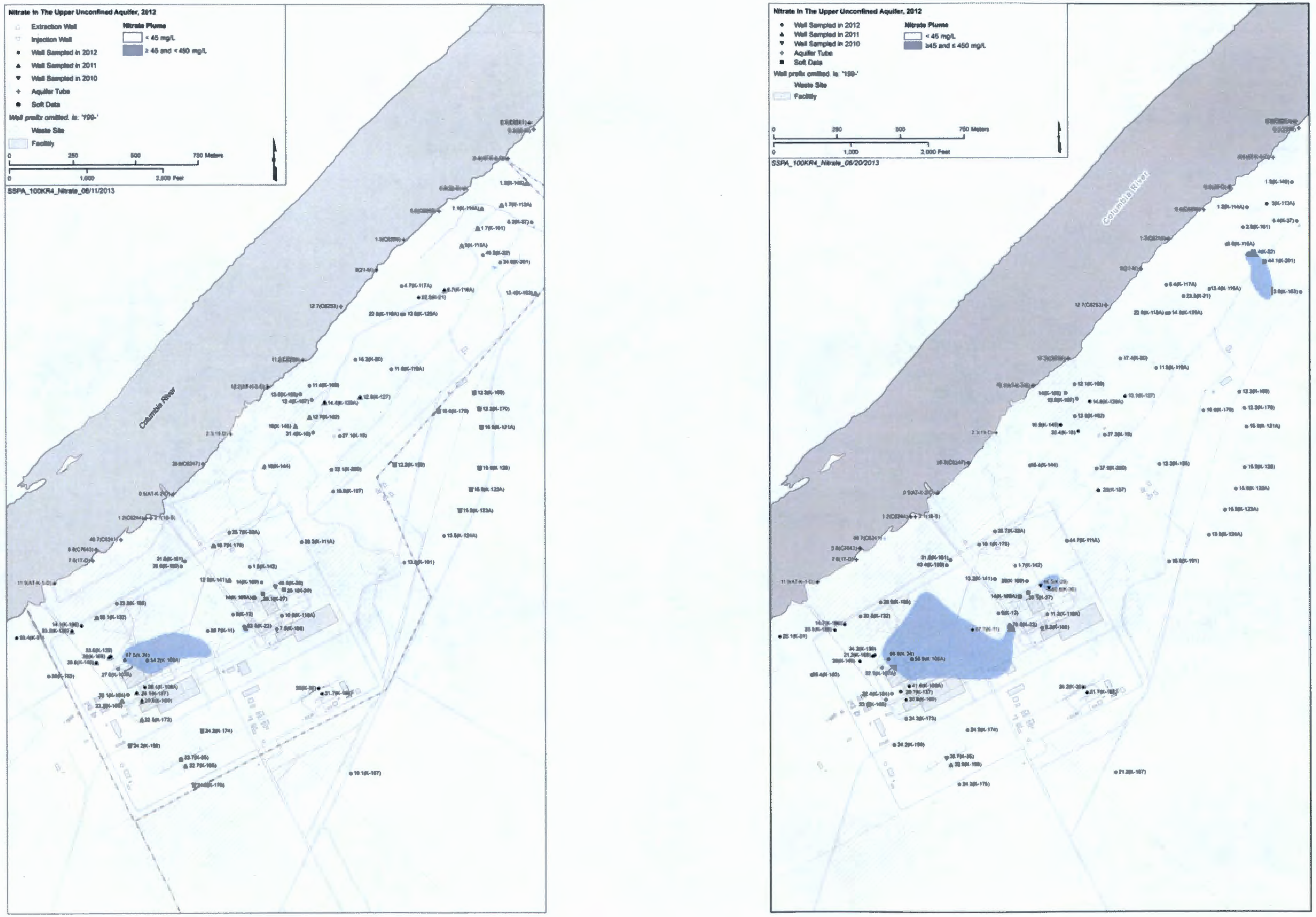


Figure 3-19. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume

(b) Maximum Plume

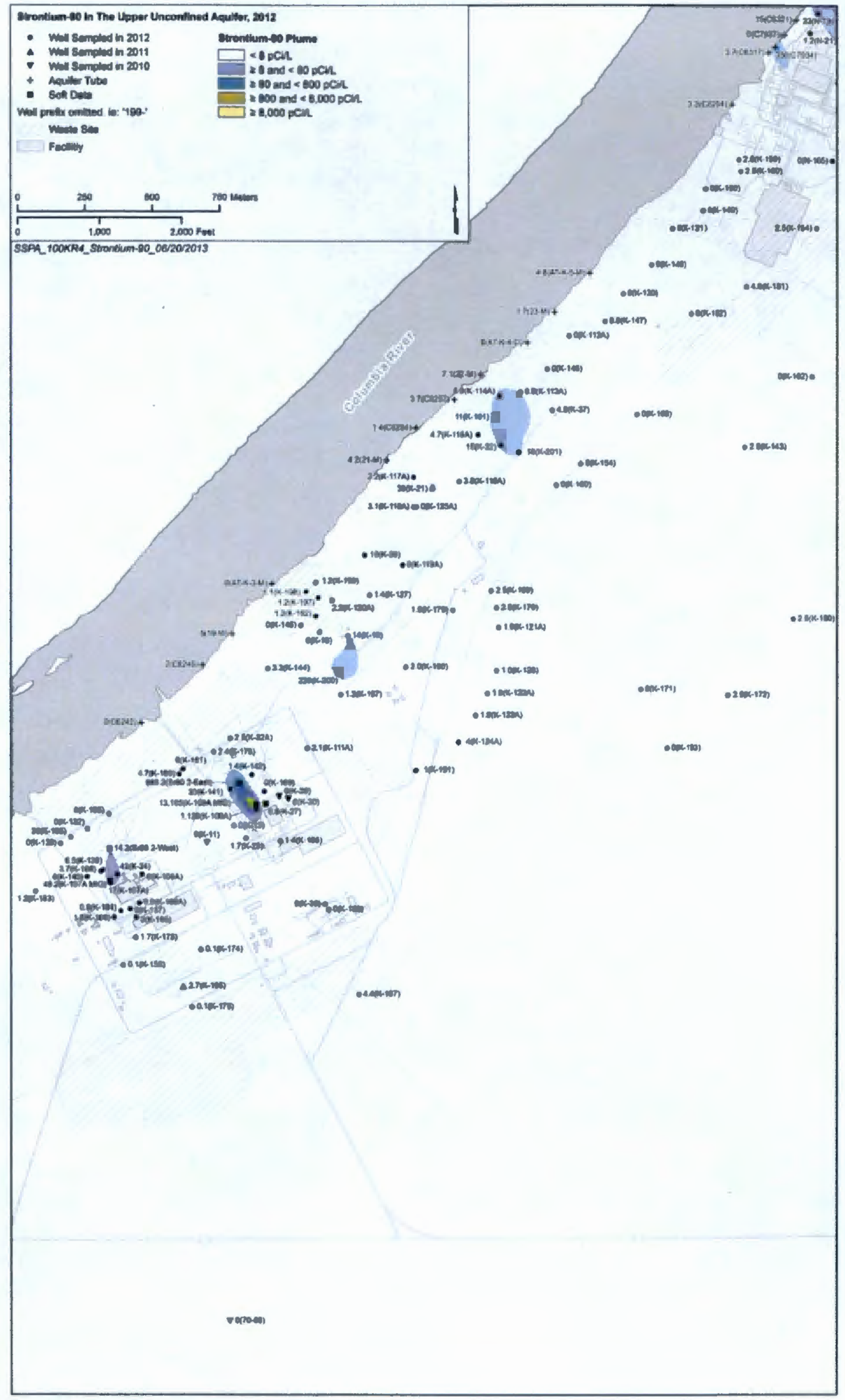


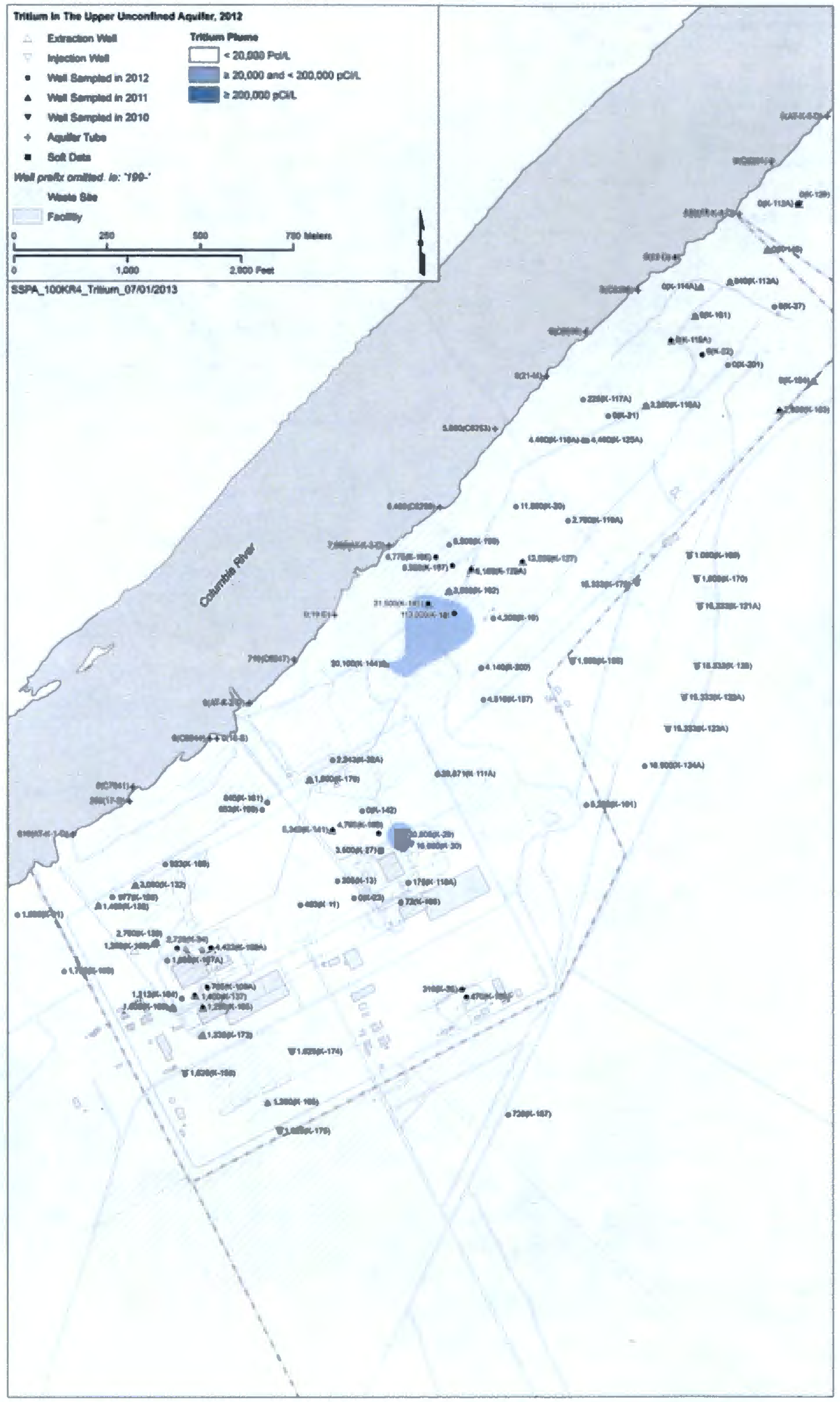
Figure 3-20. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume

(b) Maximum Plume

Figure 3-21. TCE Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume



(b) Maximum Plume

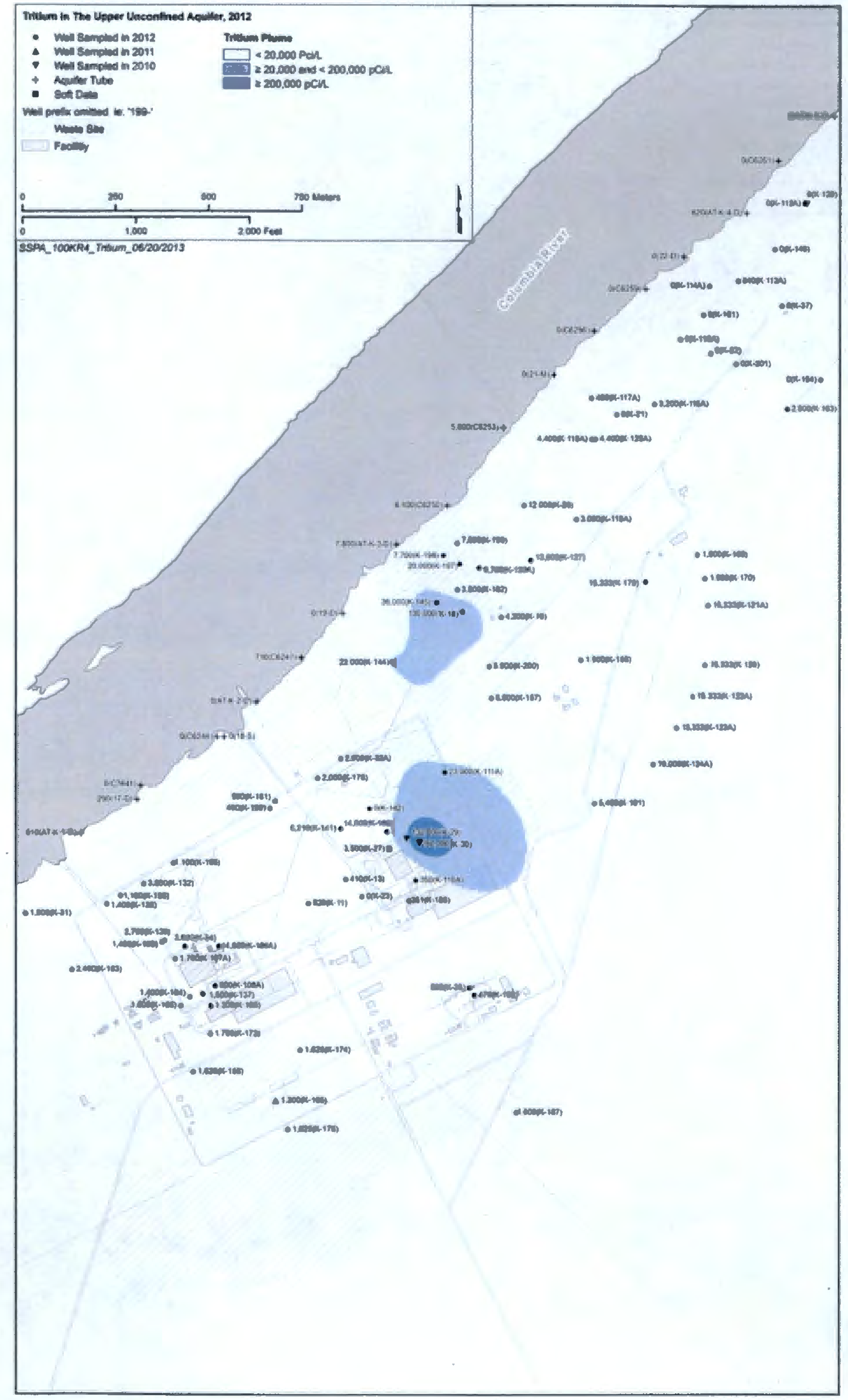


Figure 3-22. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 100-KR-4

(a) Average Plume

(b) Maximum Plume

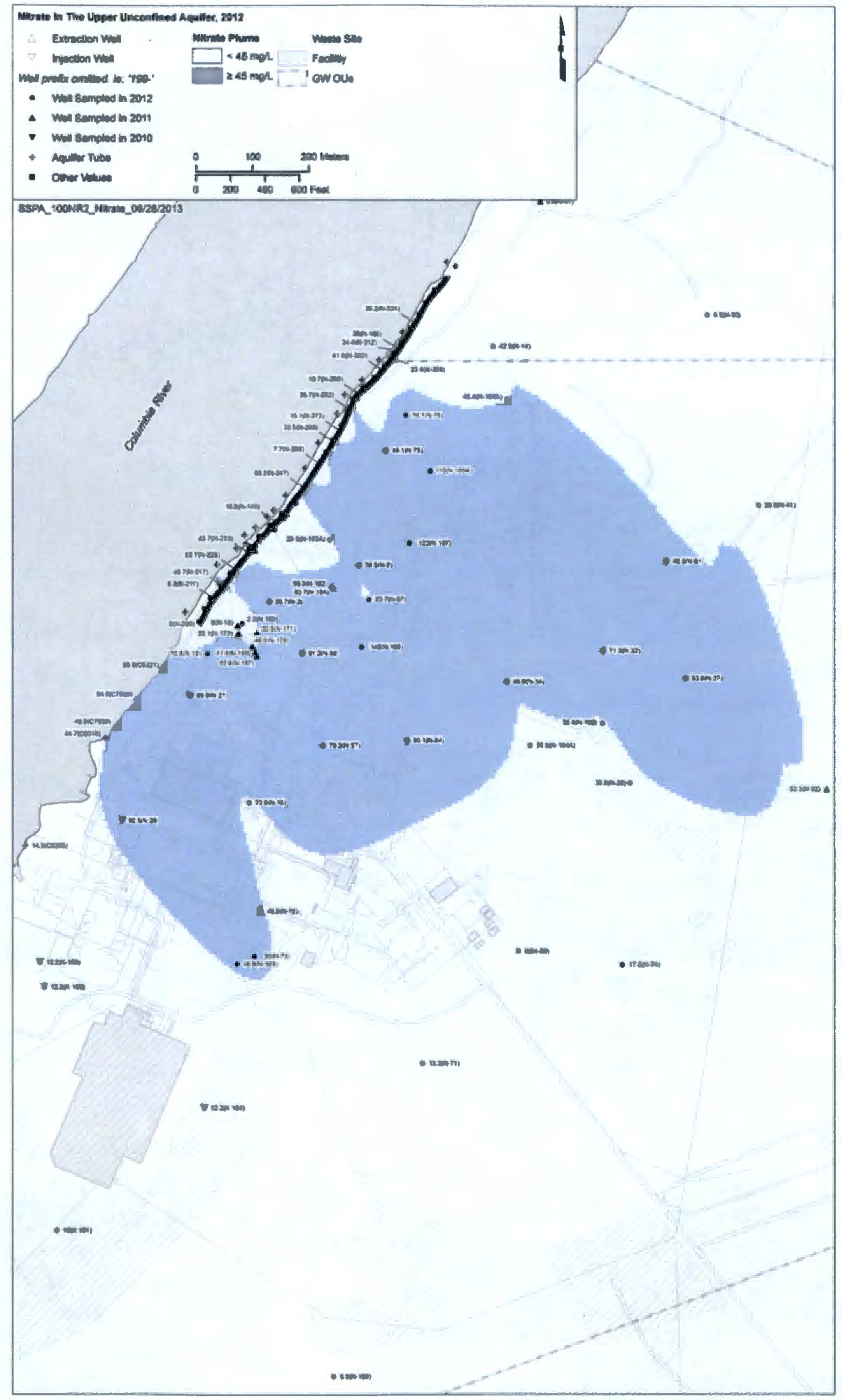


Figure 3-23. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 100-NR-2

(a) Average Plume ***(b) Maximum Plume***

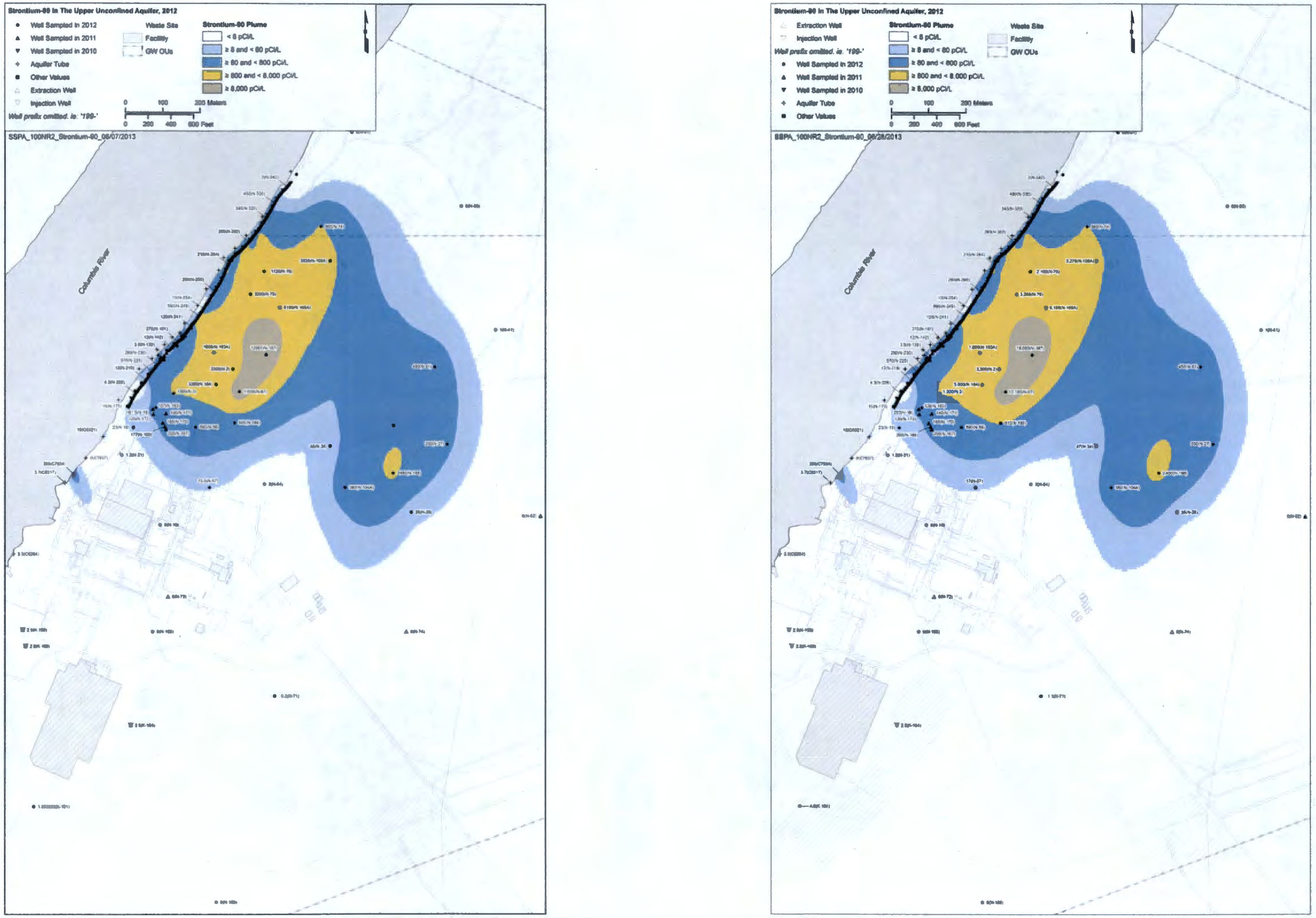


Figure 3-24. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 100-NR-2

(a) Average Plume *(b) Maximum Plume*

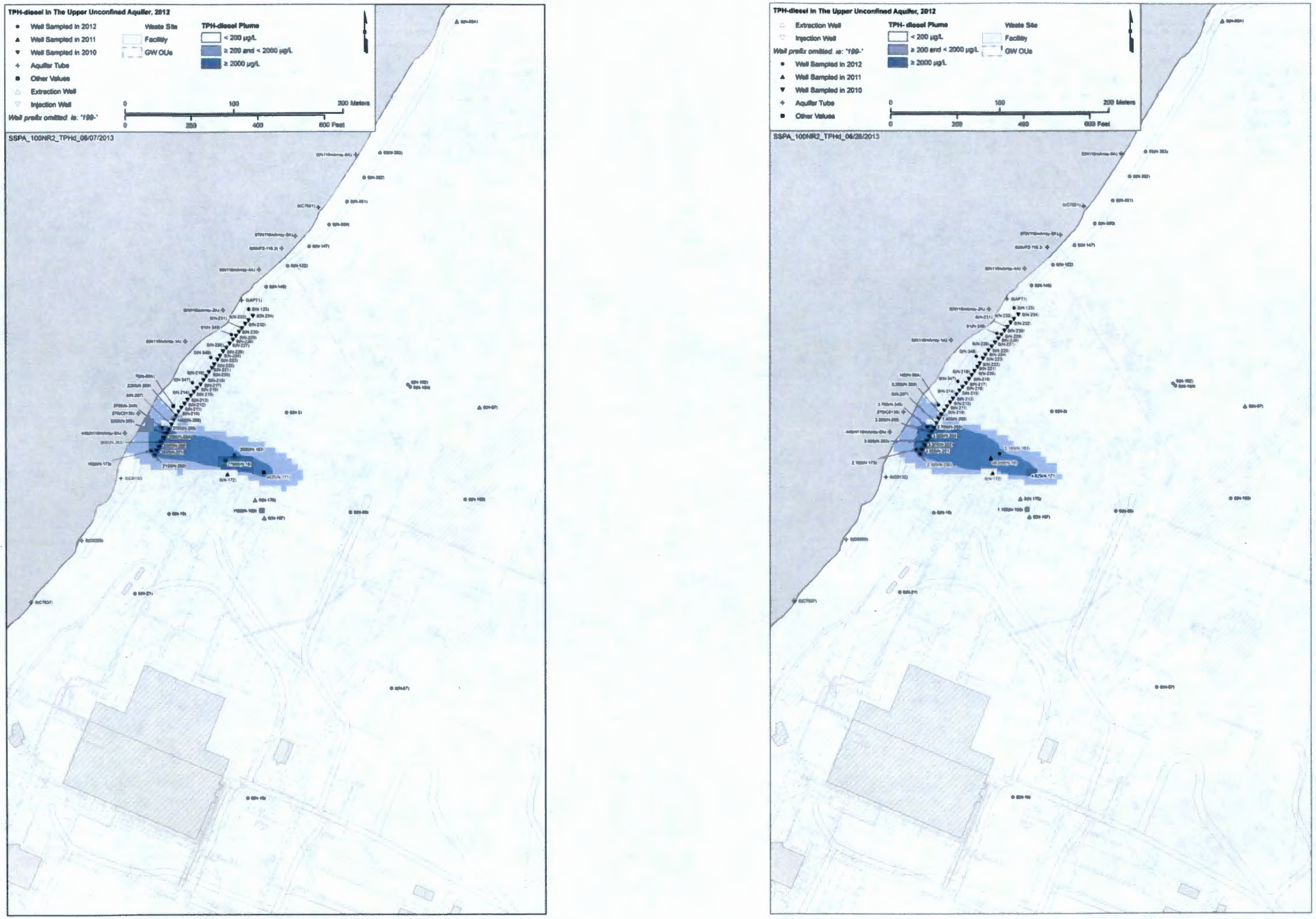


Figure 3-25. TPHd Plume Maps for (a) Average and (b) Maximum Concentrations in 100-NR-2

(a) Average Plume *(b) Maximum Plume*

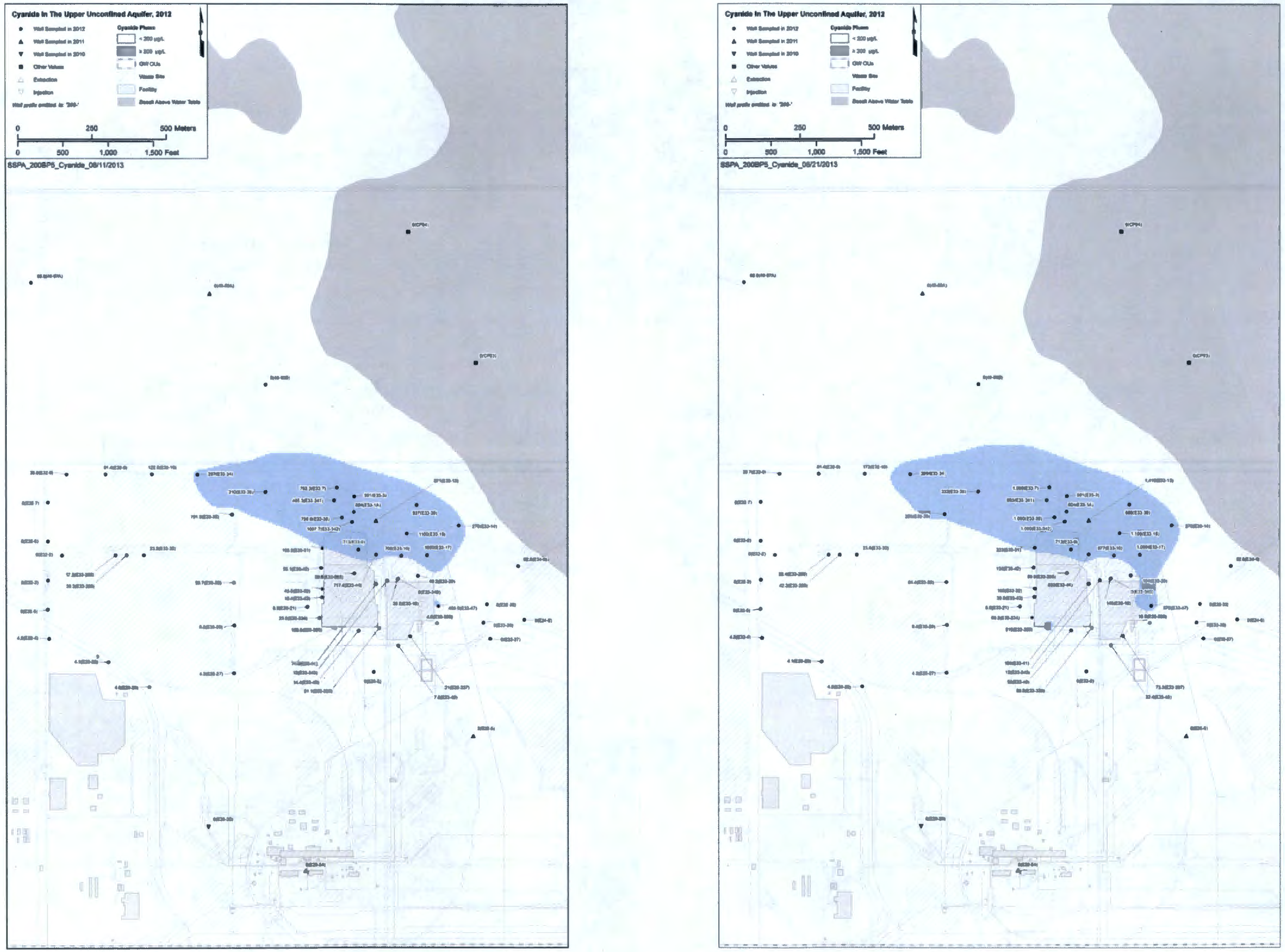


Figure 3-26 Cyanide Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume

(b) Maximum Plume

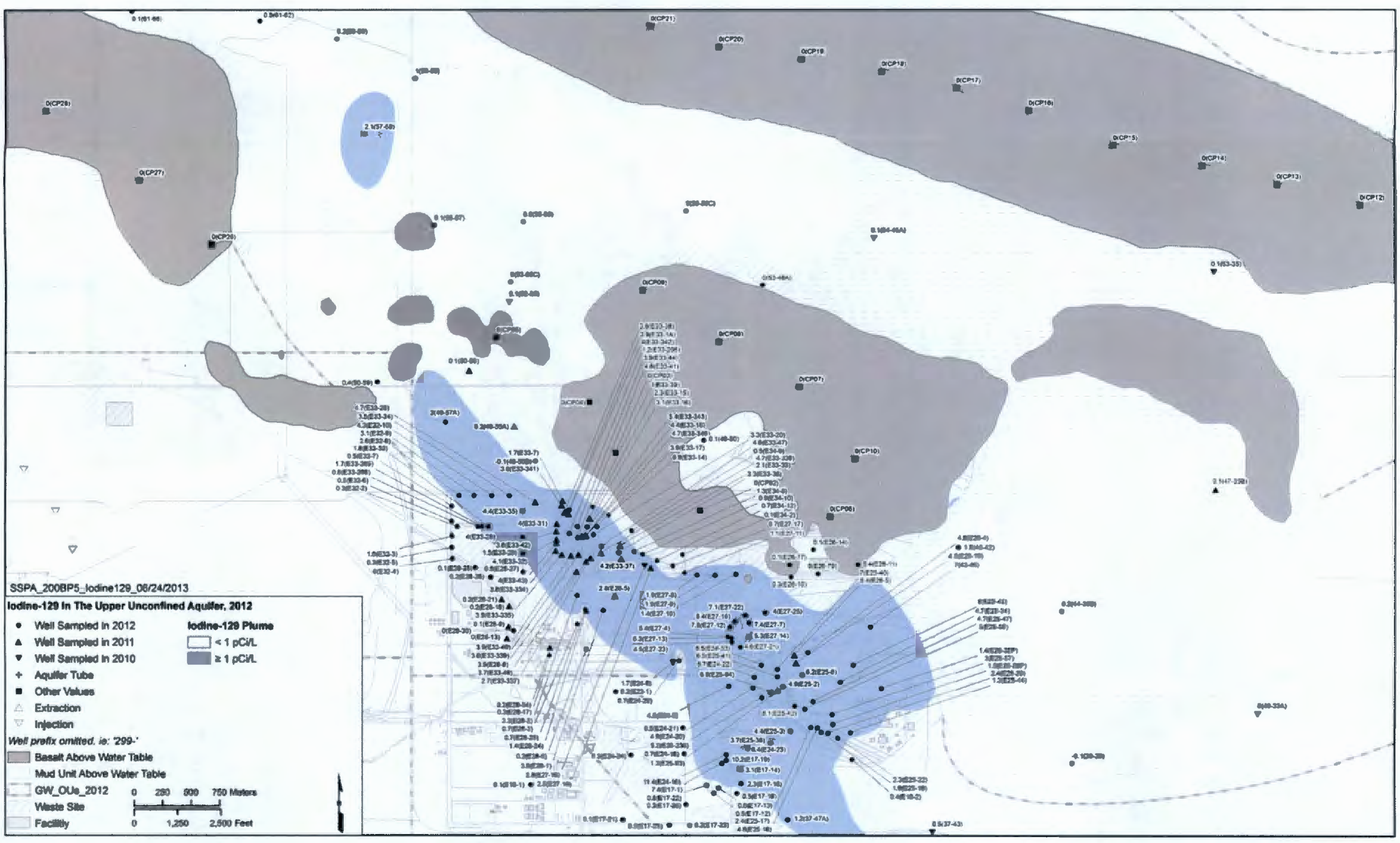
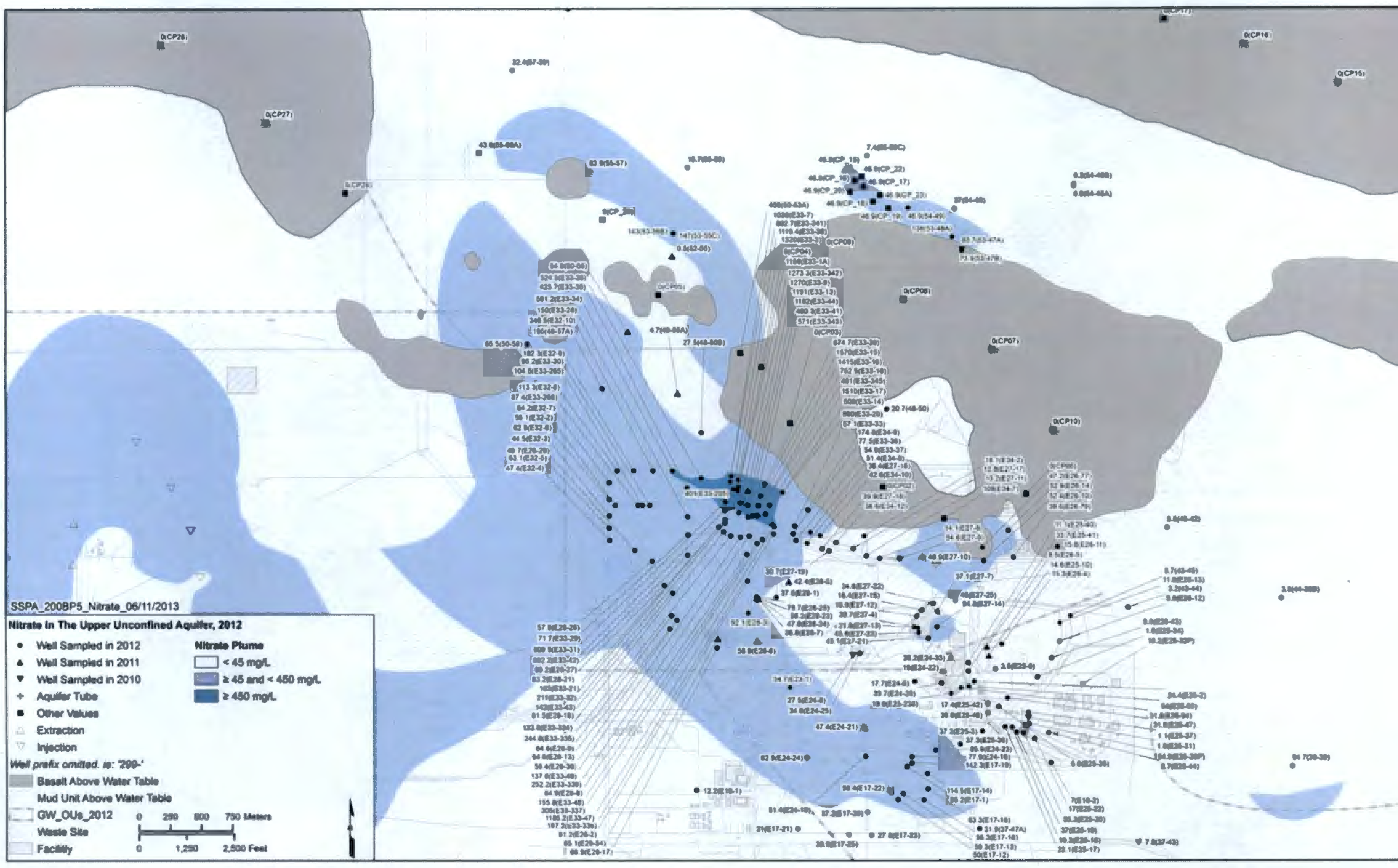


Figure 3-27. Iodine-129 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume



(b) Maximum Plume

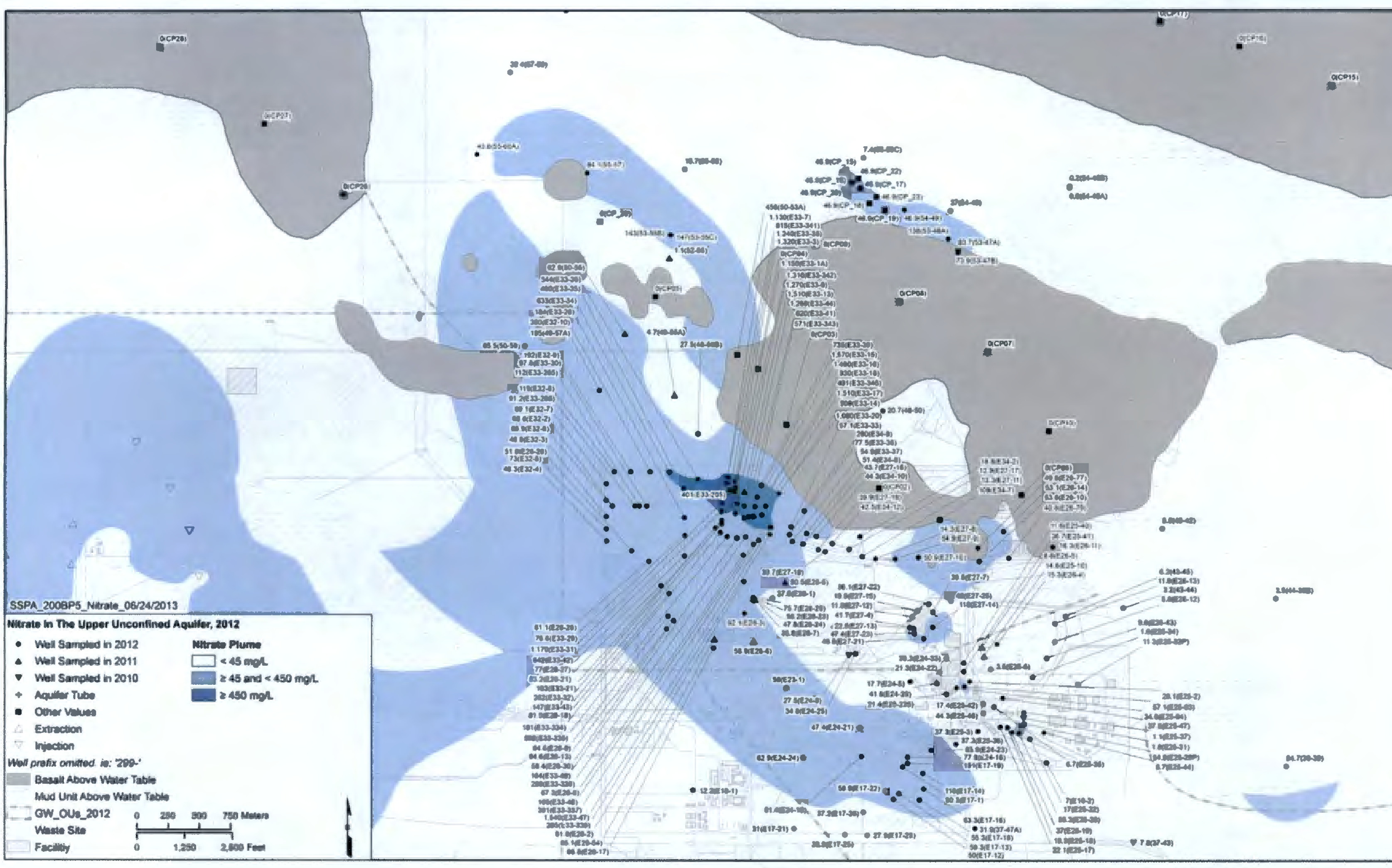
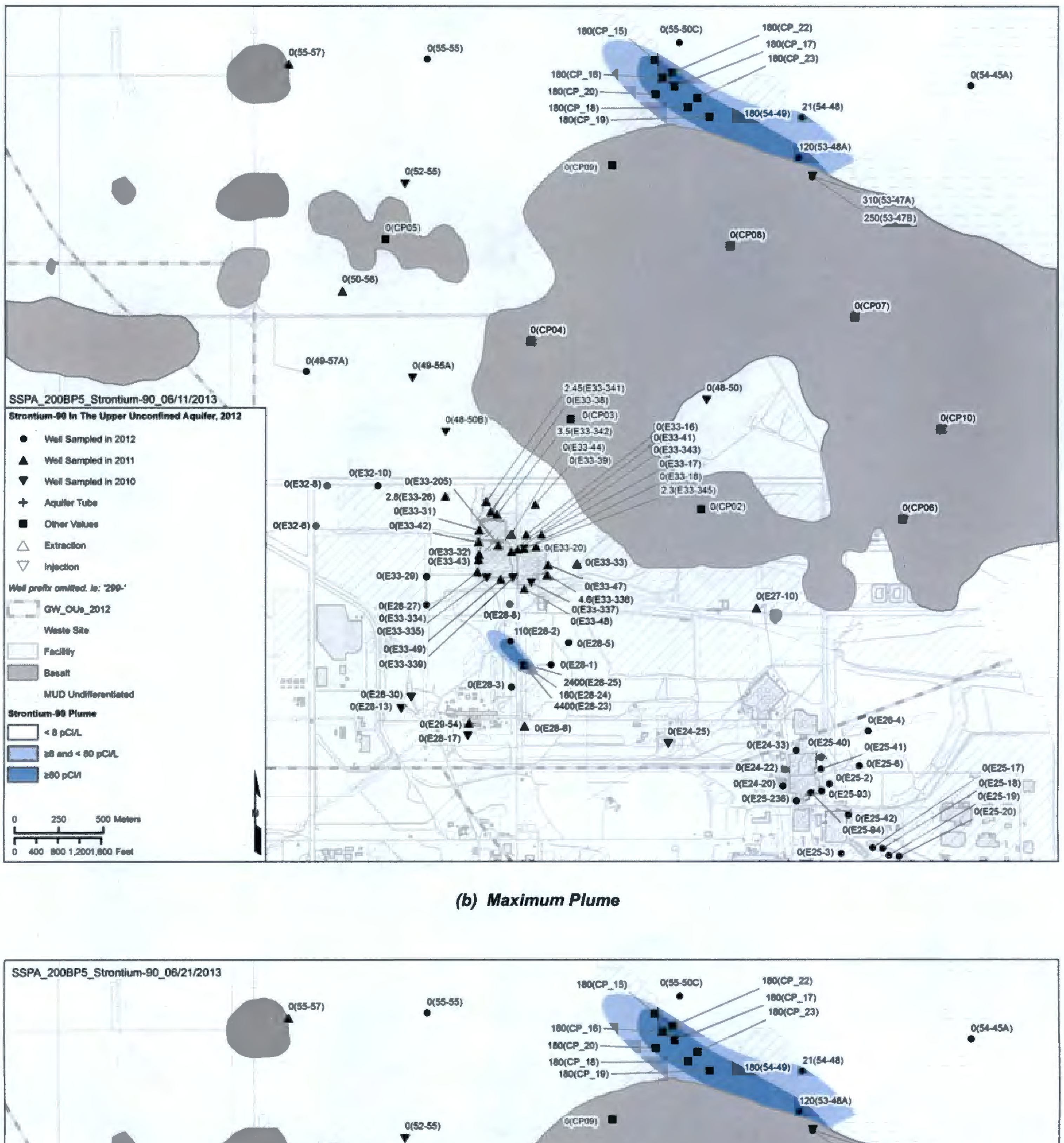


Figure 3-28. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume



(b) Maximum Plume

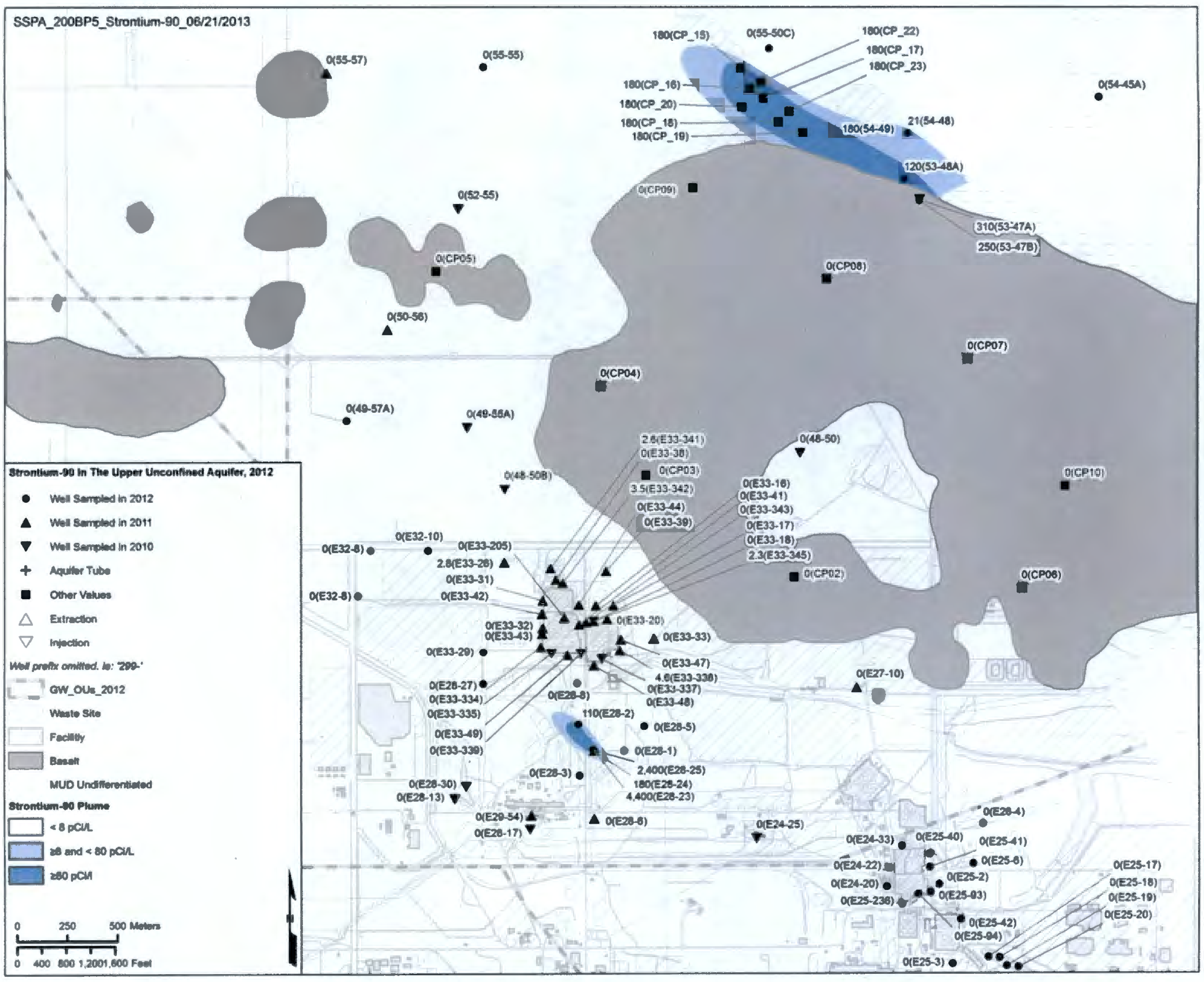
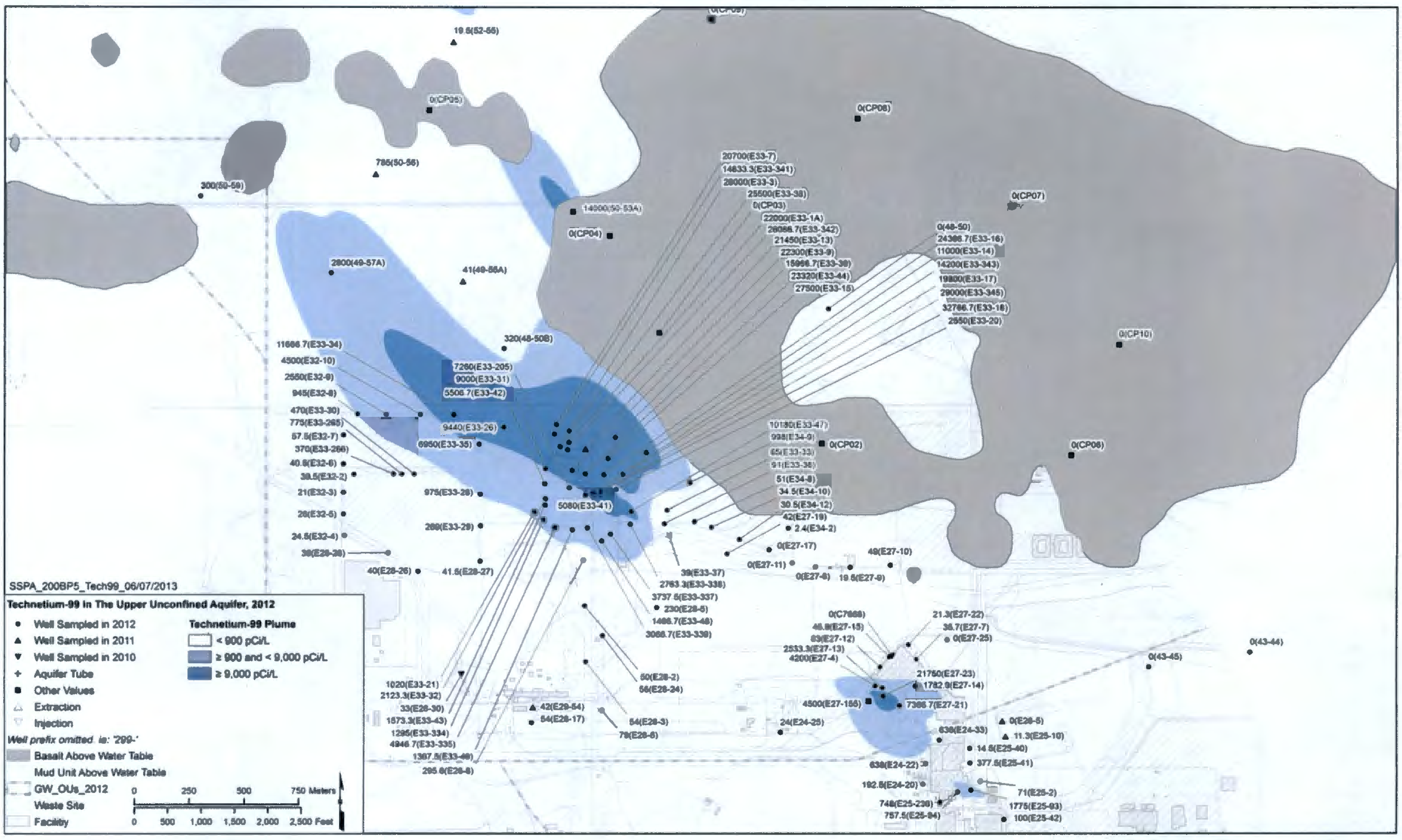


Figure 3-29. Strontium-90 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume



(b) Maximum Plume

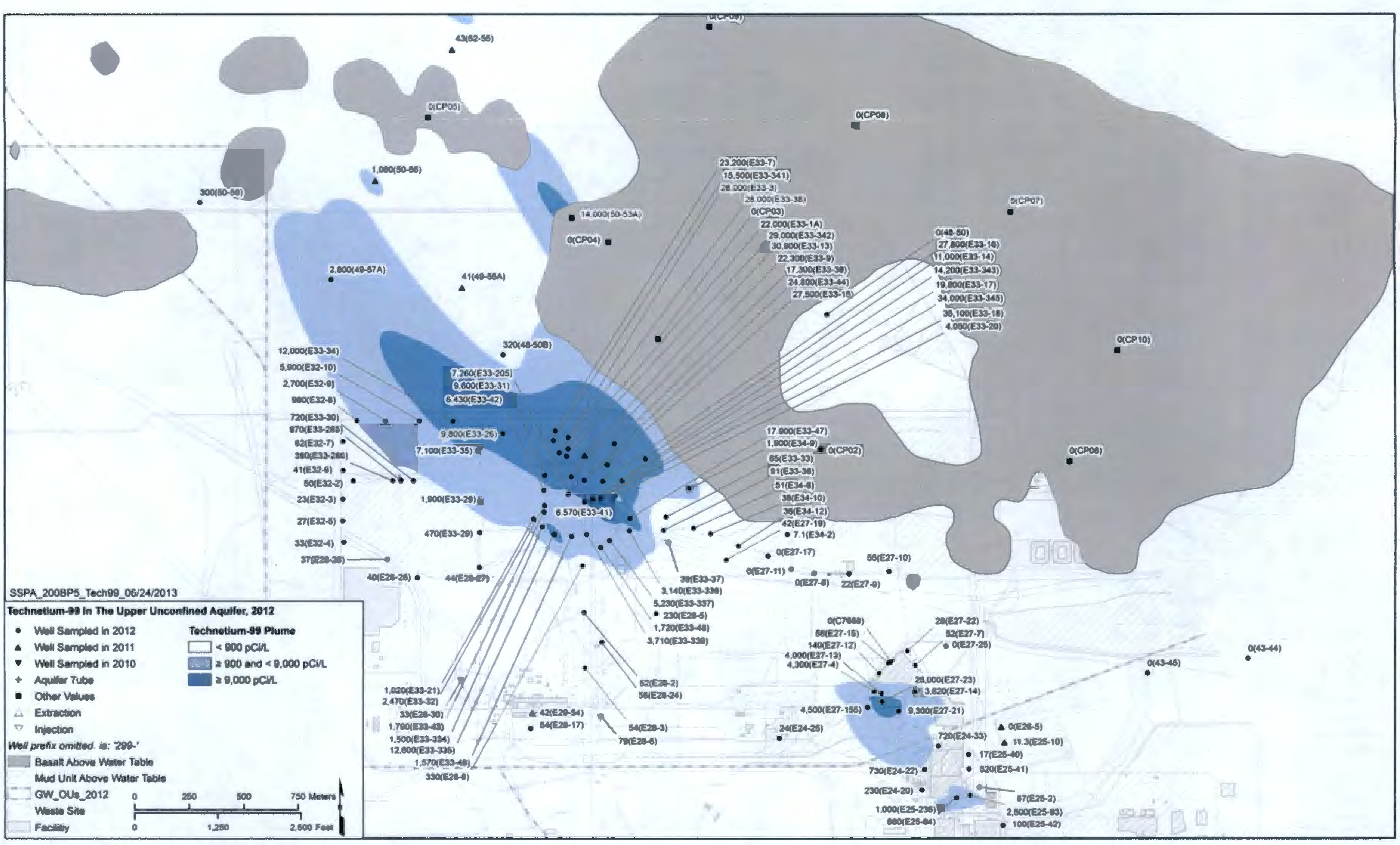
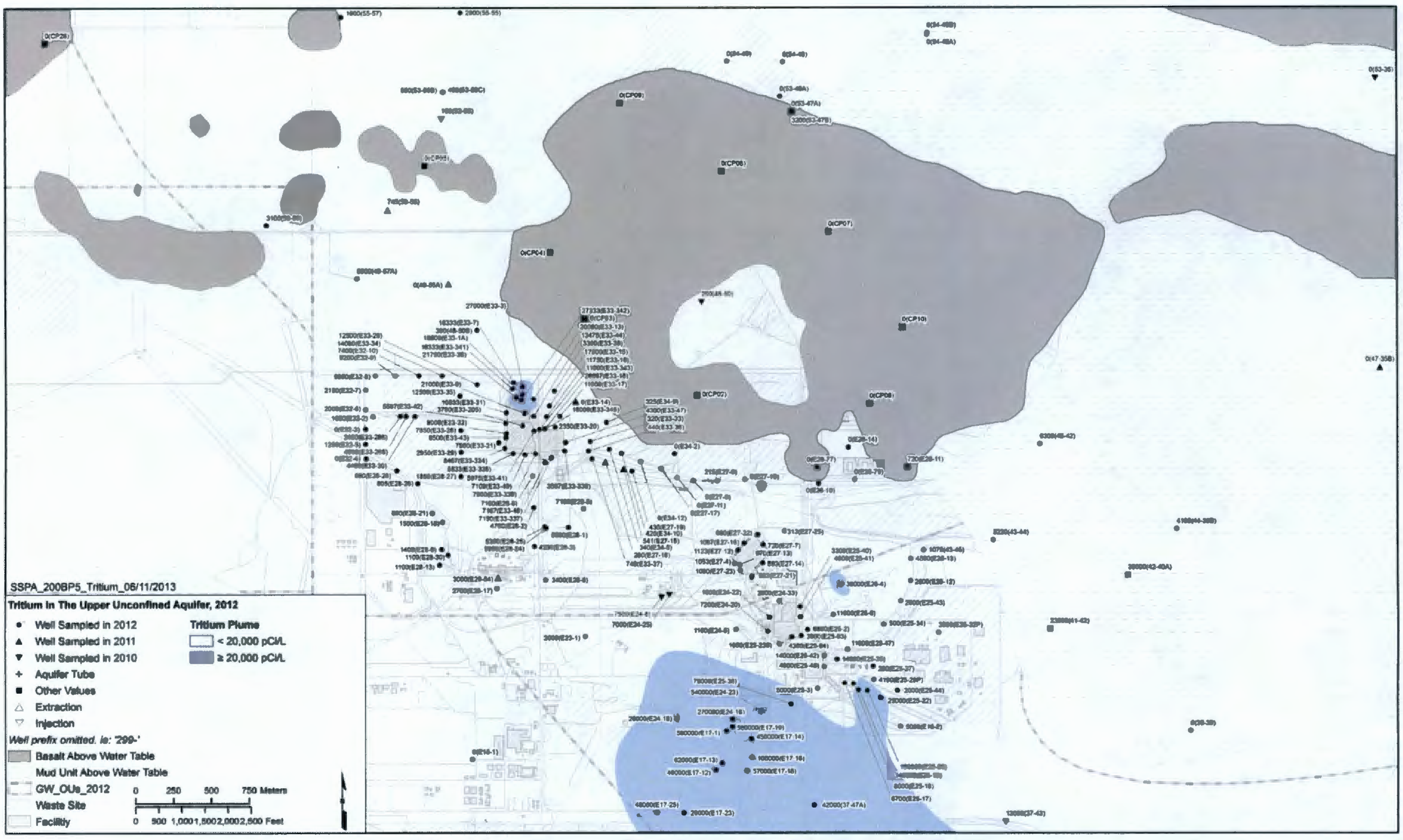


Figure 3-30. Technetium-99 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume



(b) Maximum Plume

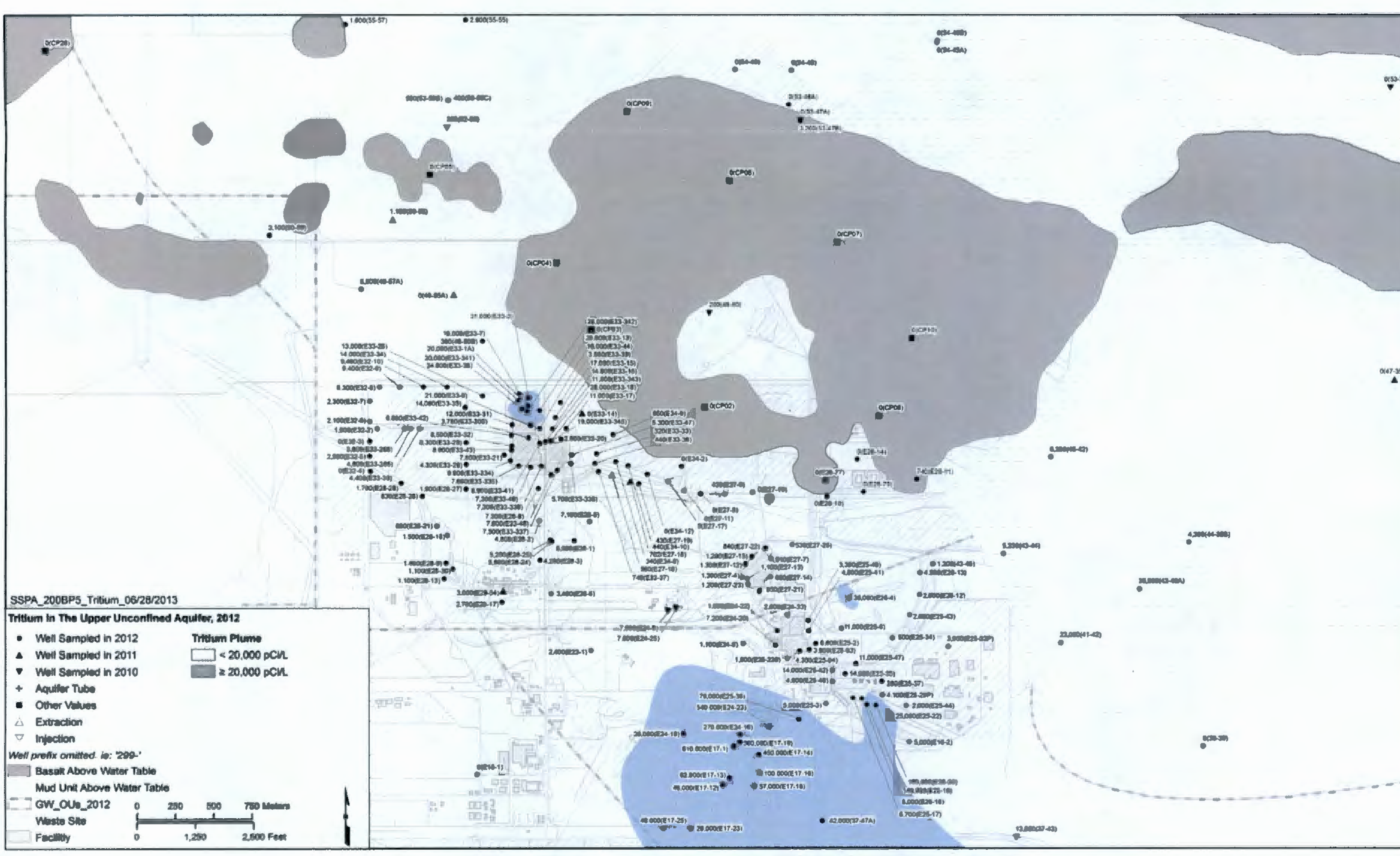
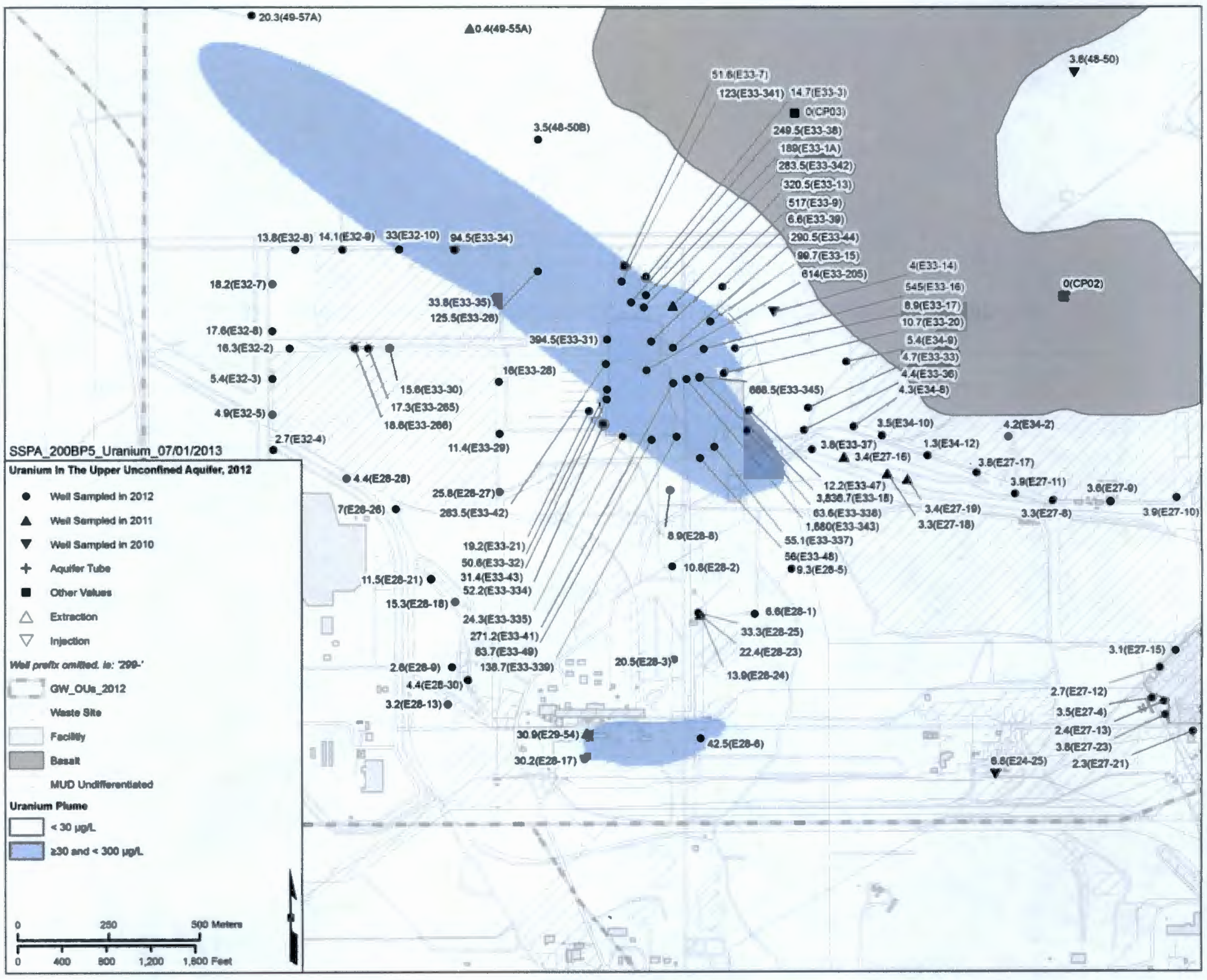


Figure 3-31. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume



(b) Maximum Plume

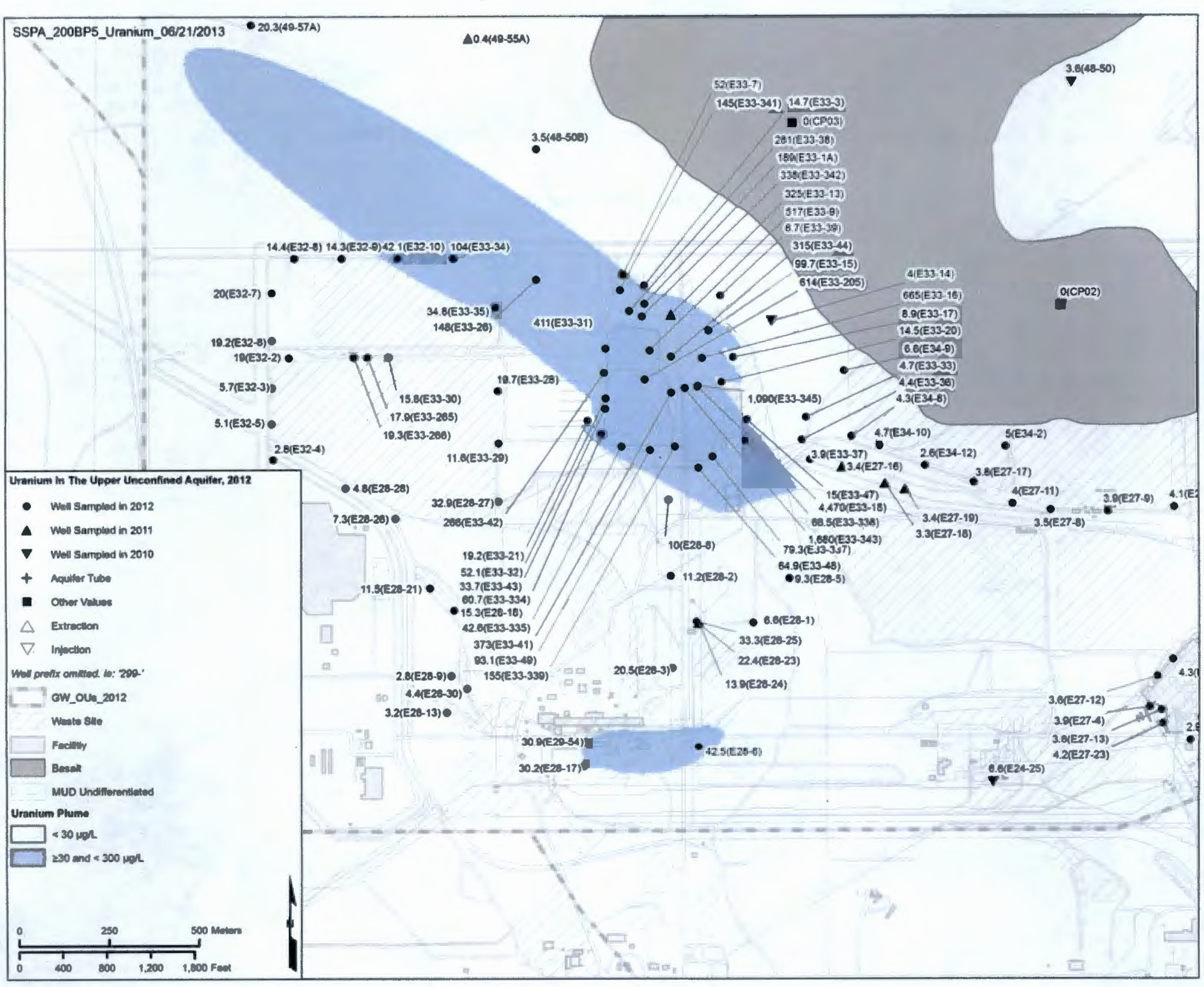
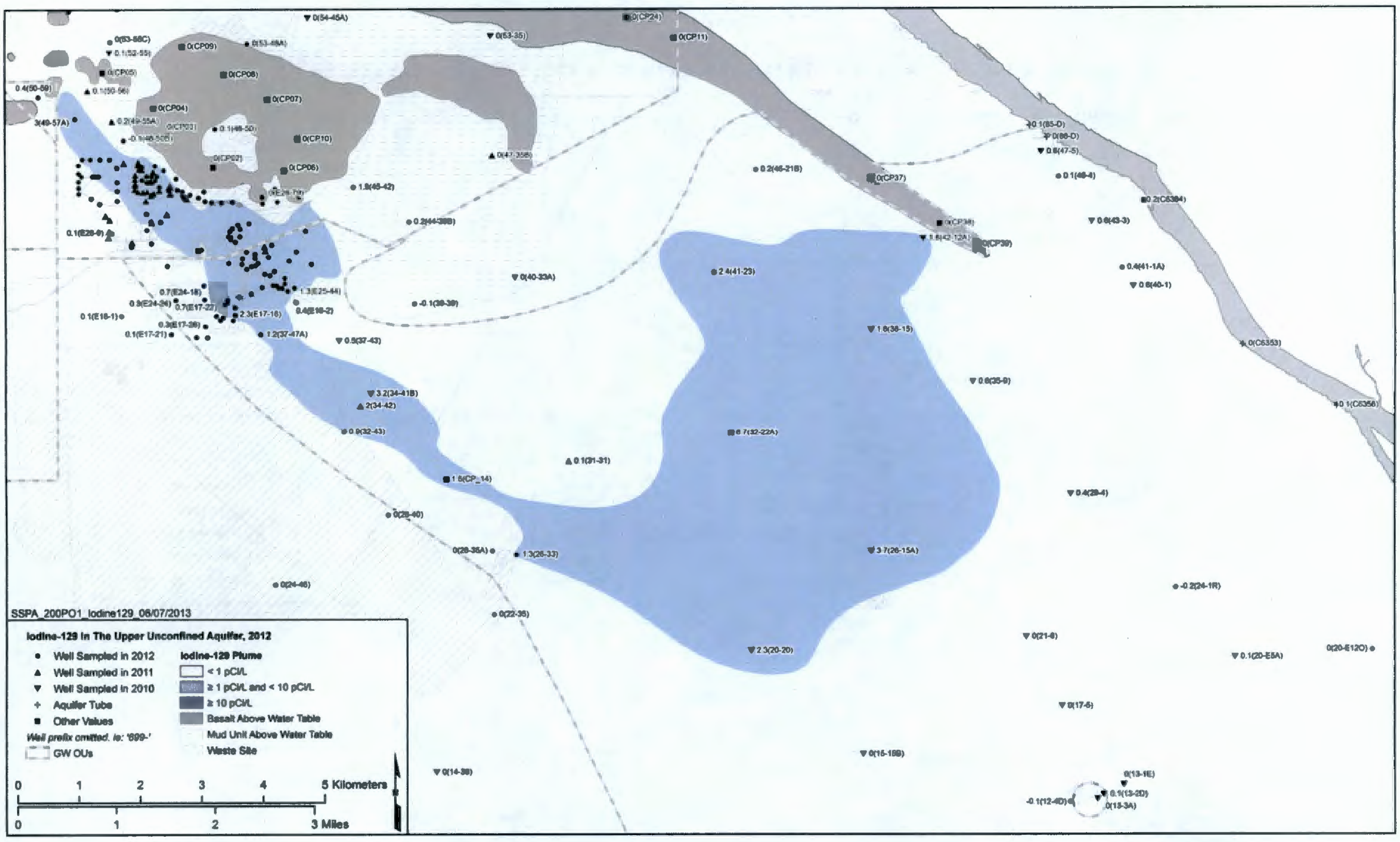


Figure 3-32. Uranium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-BP-5

(a) Average Plume



(b) Maximum Plume

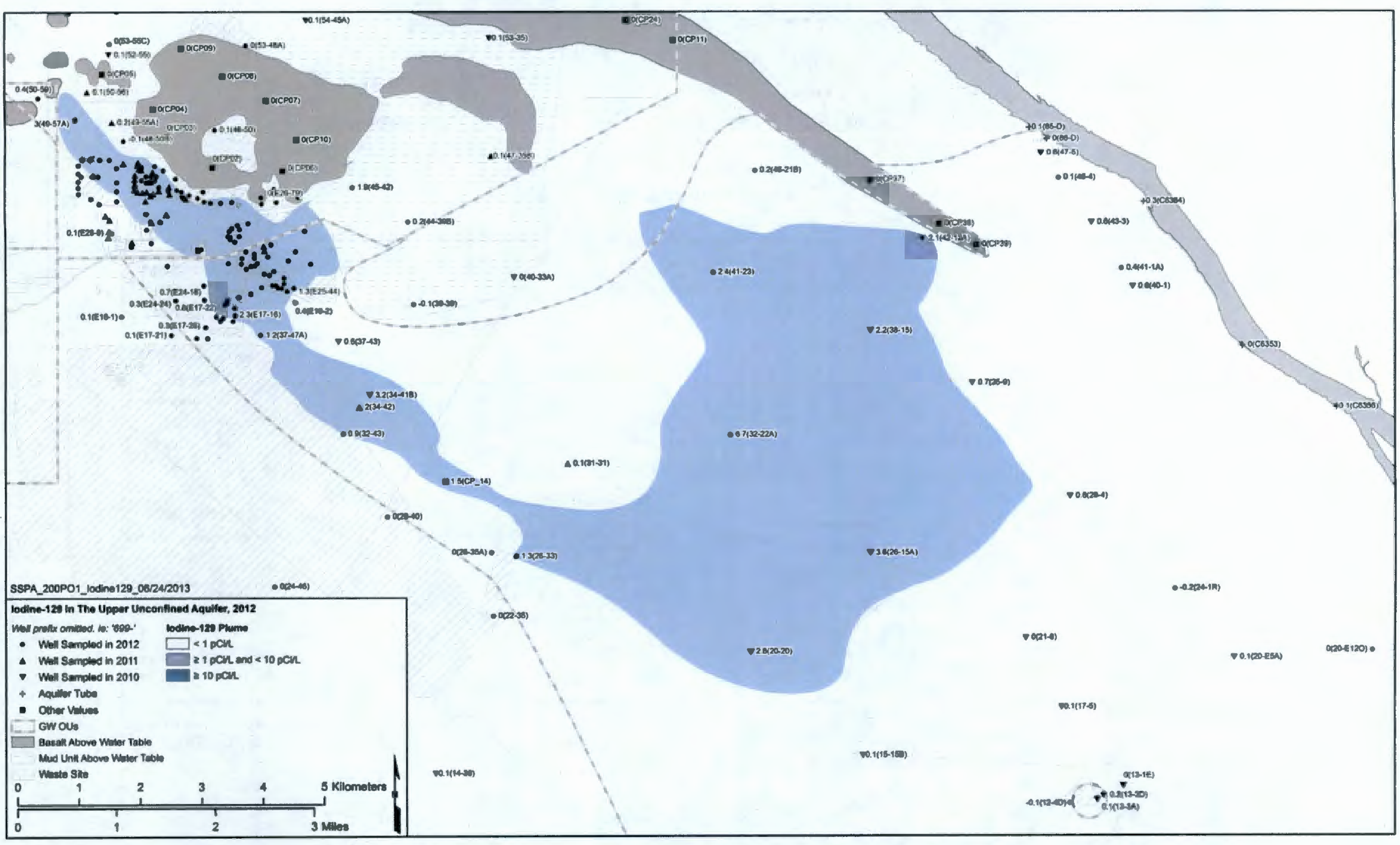
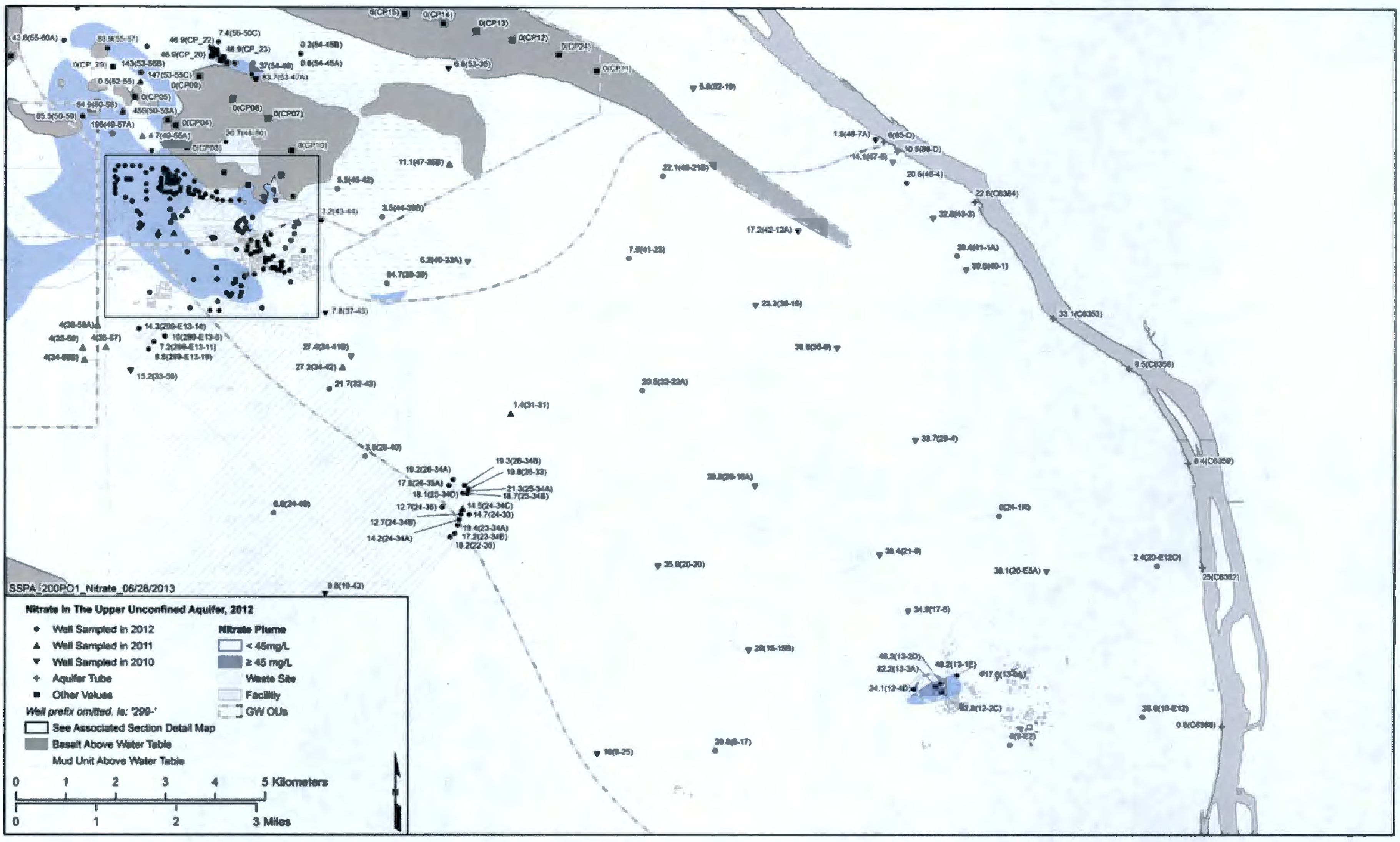


Figure 3-33. Iodine-129 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-PO-1

(a) Average Plume



(b) Maximum Plume

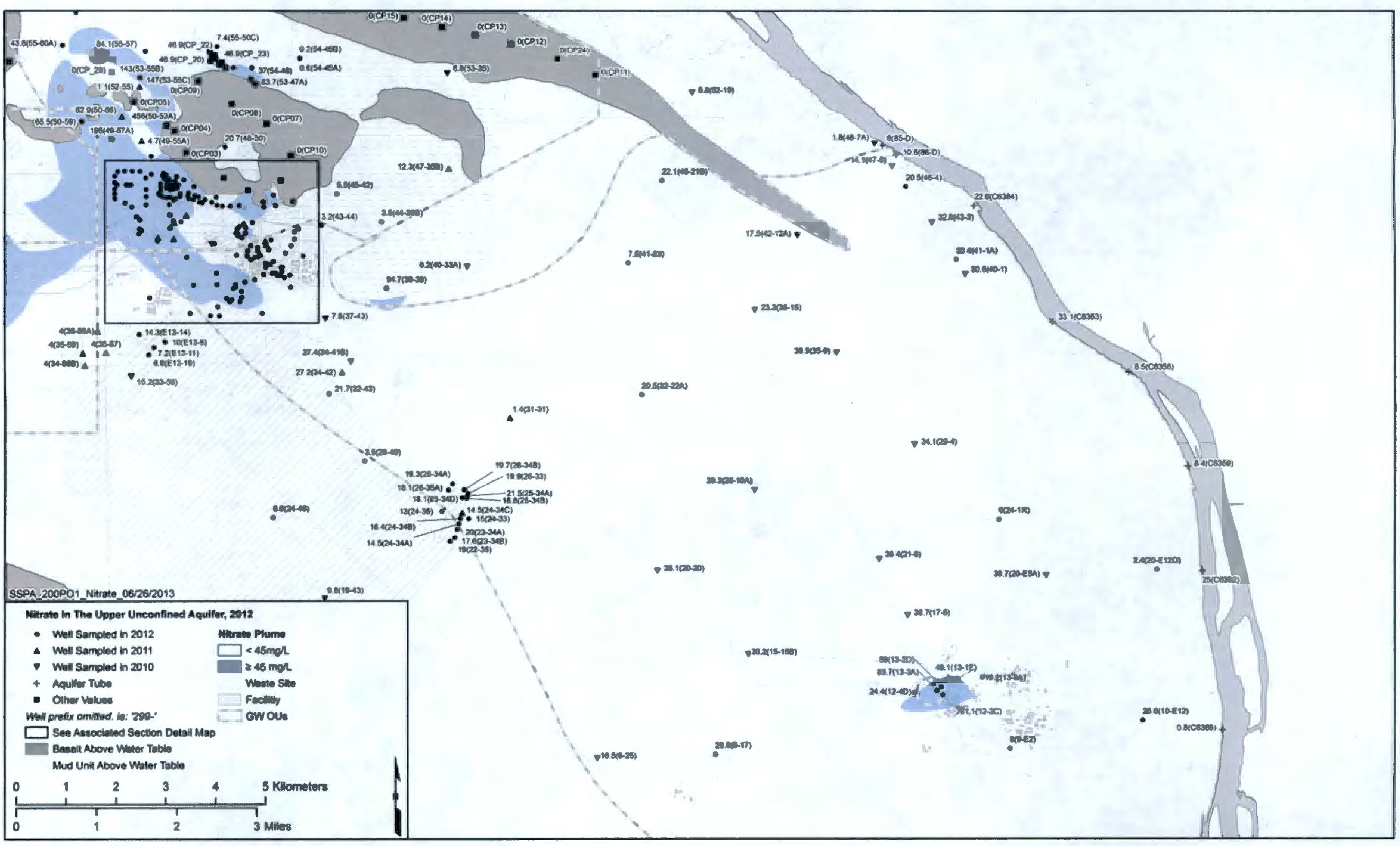
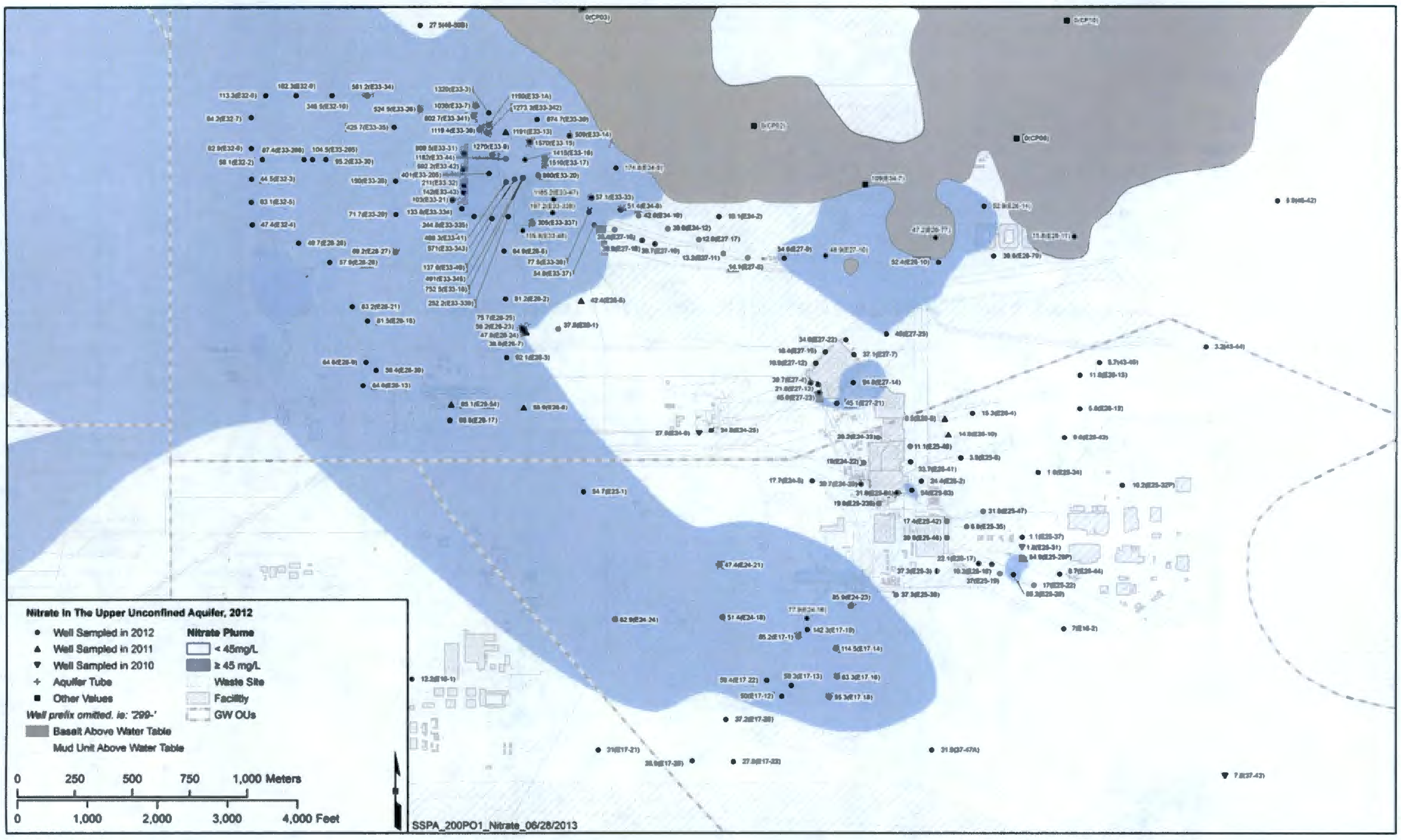


Figure 3-34. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 200-PO-1

(a) Average Plume



(b) Maximum Plume

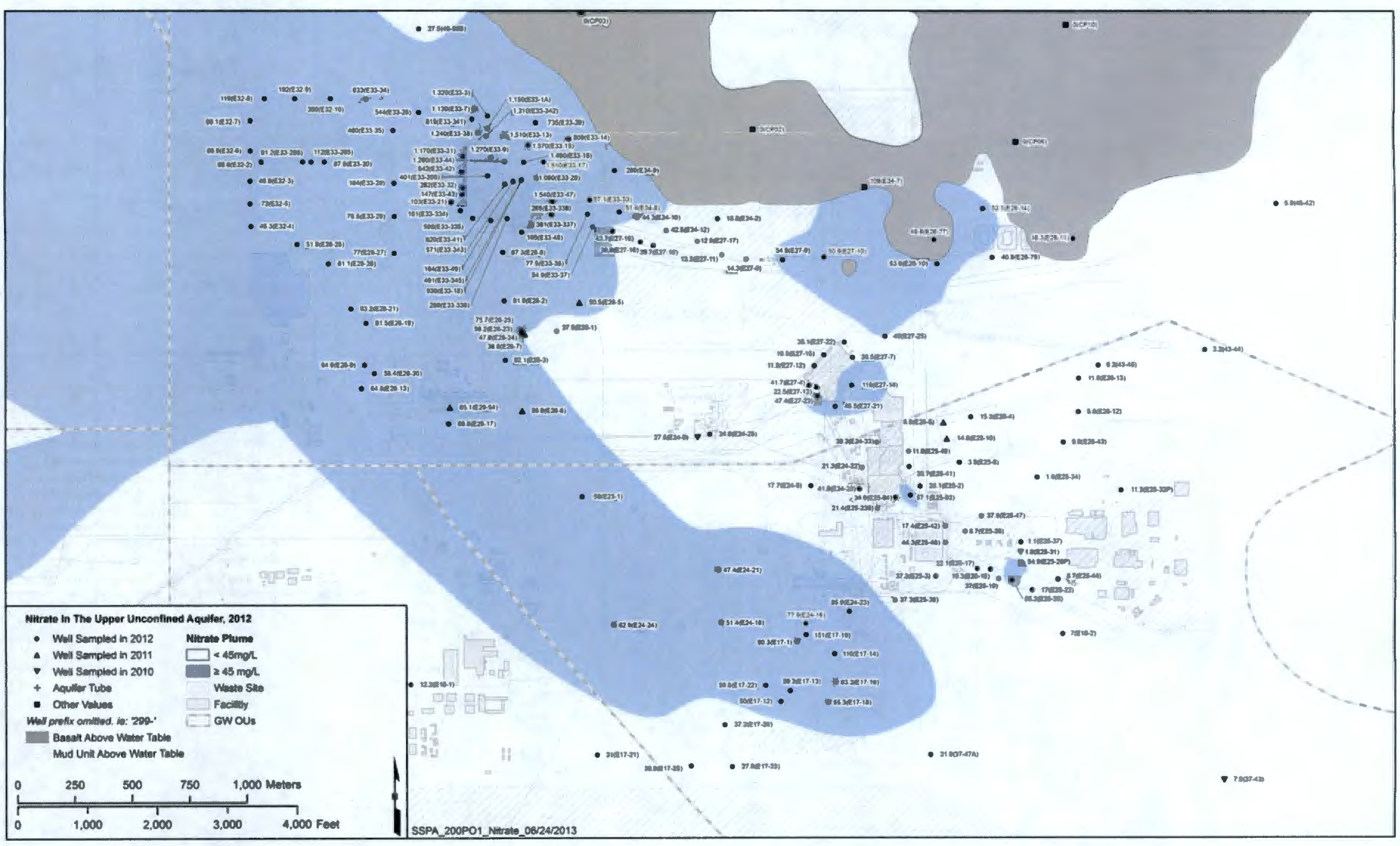
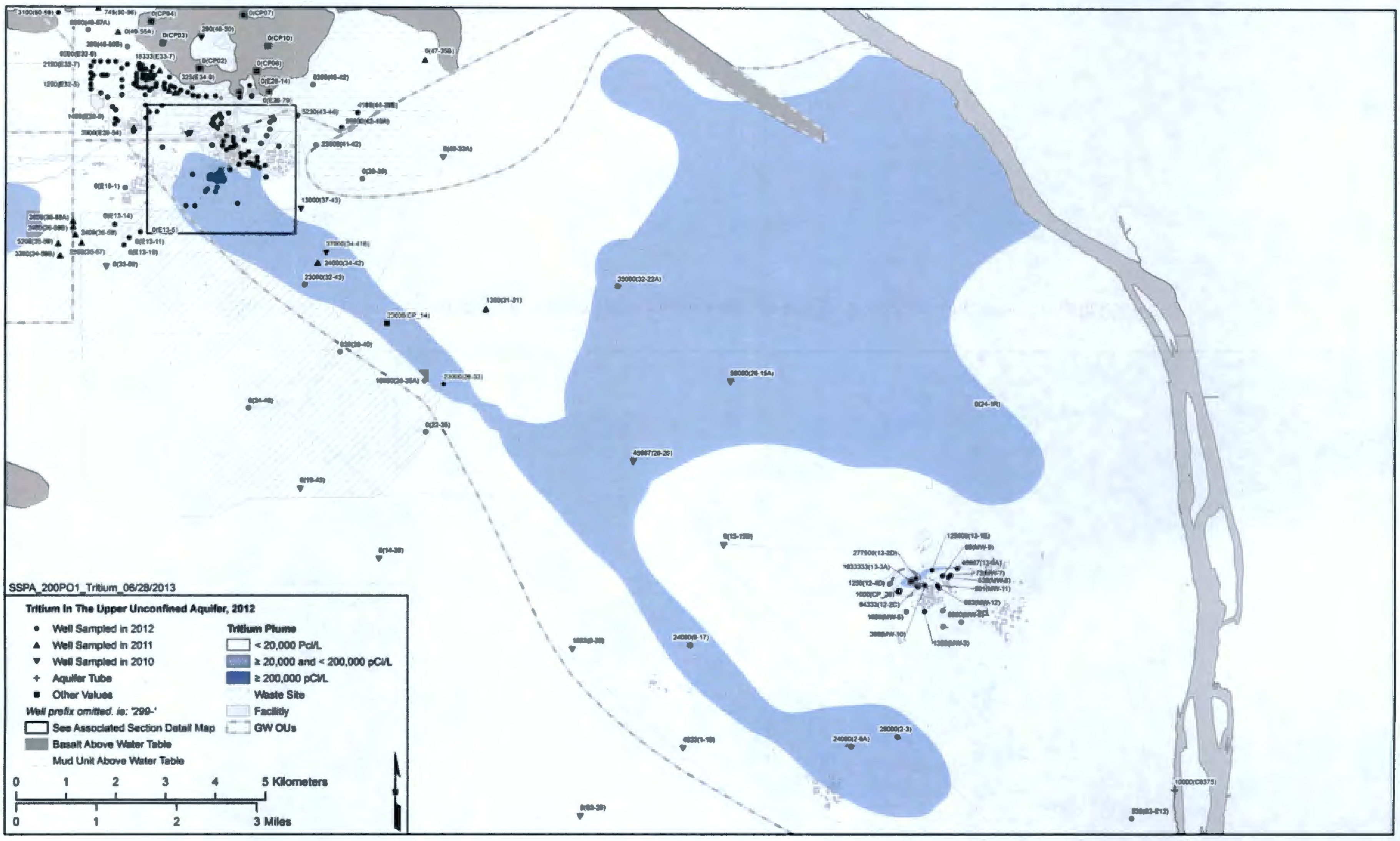


Figure 3-35. Nitrate (Zoomed View) Plume Maps for (a) Average and (b) Maximum Concentrations in 200-PO-1

(a) Average Plume



(b) Maximum Plume

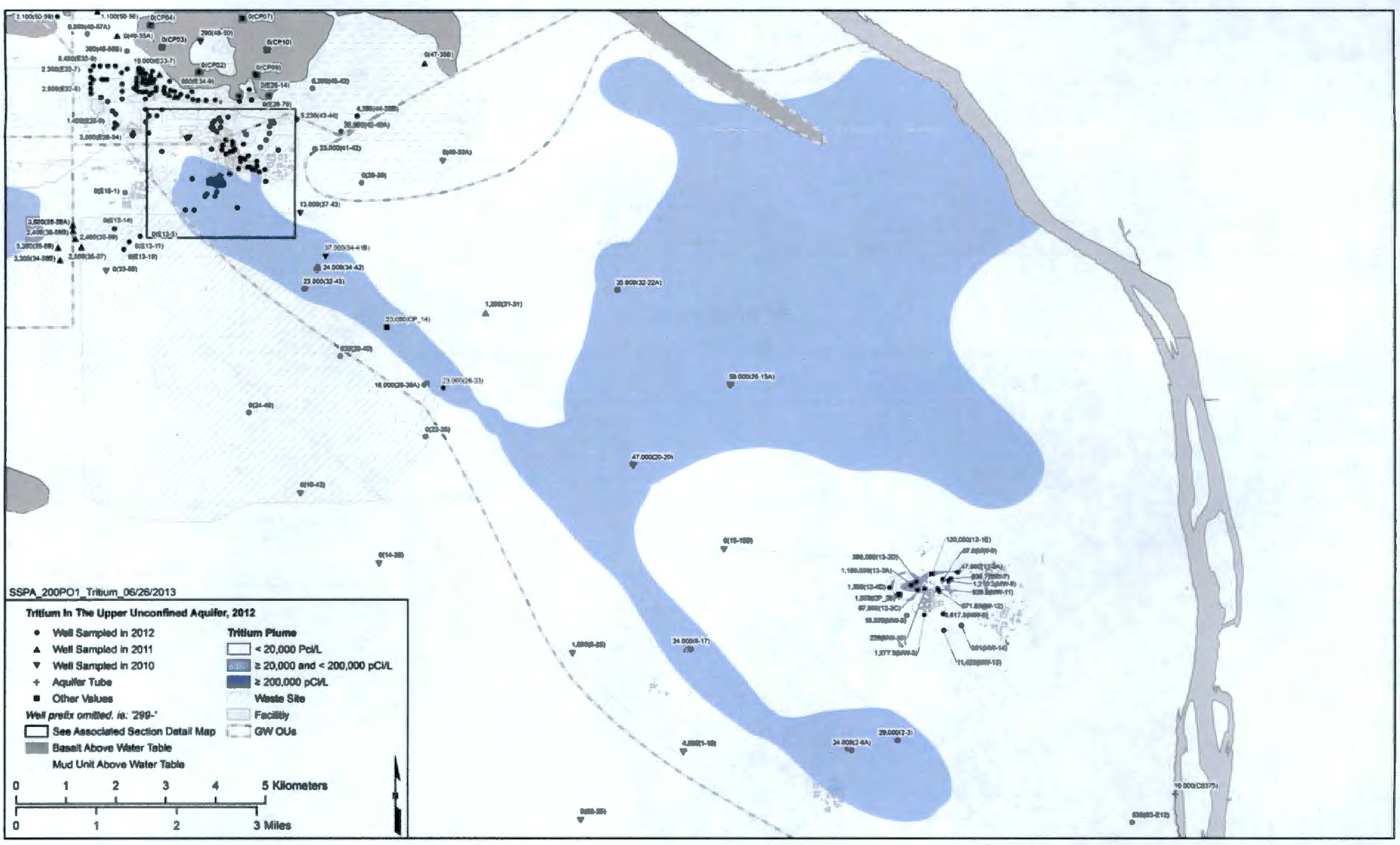
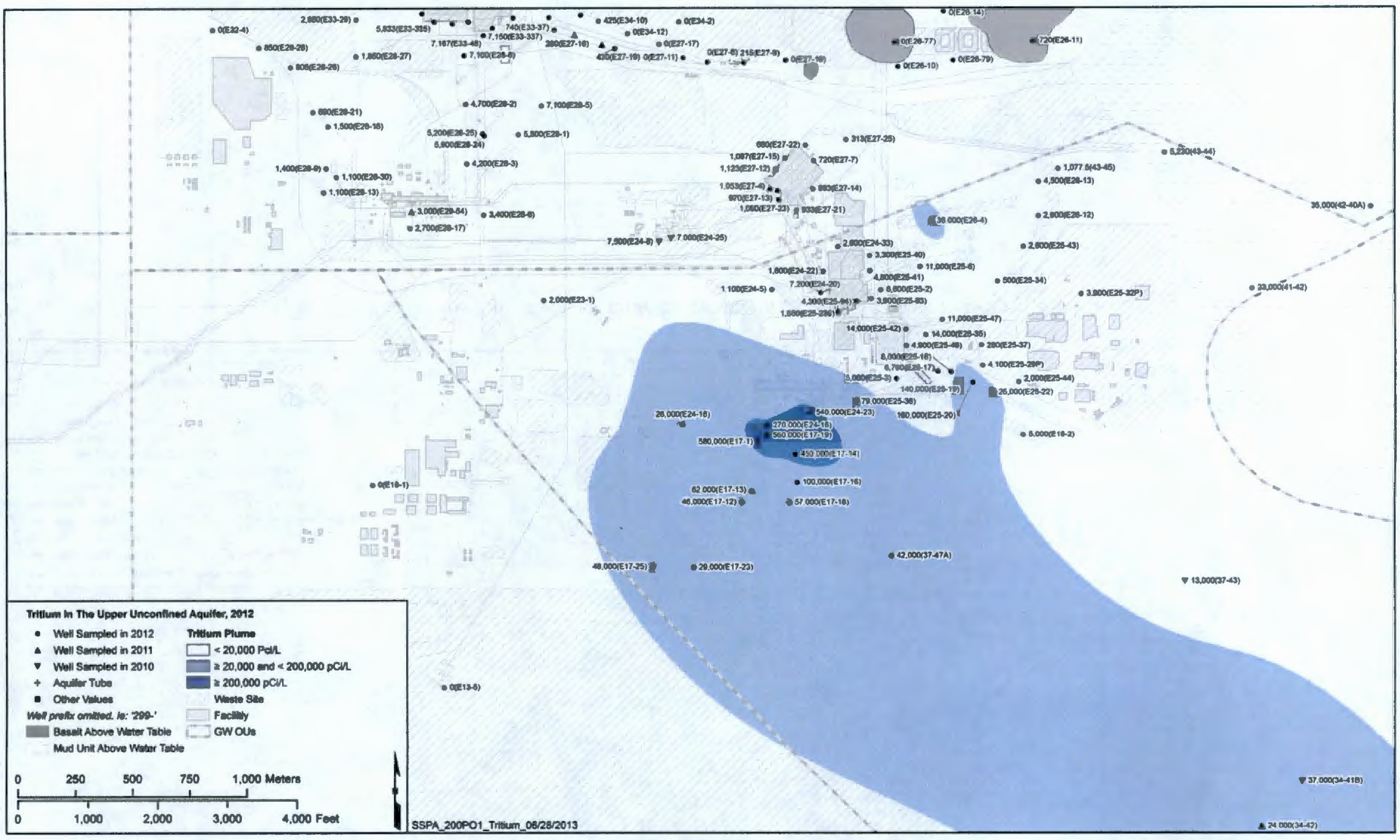


Figure 3-36. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-PO-1

(a) Average Plume



(b) Maximum Plume

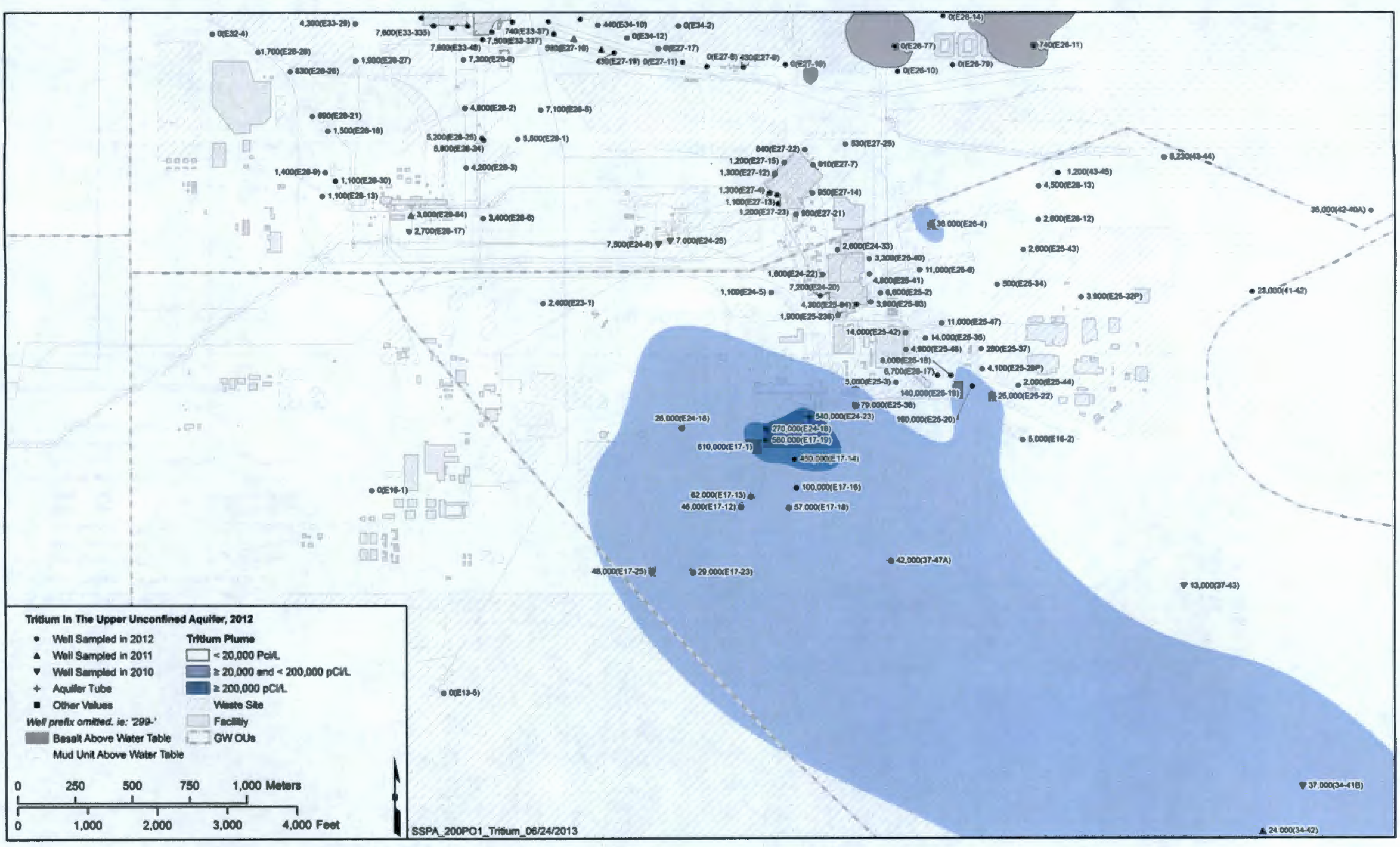
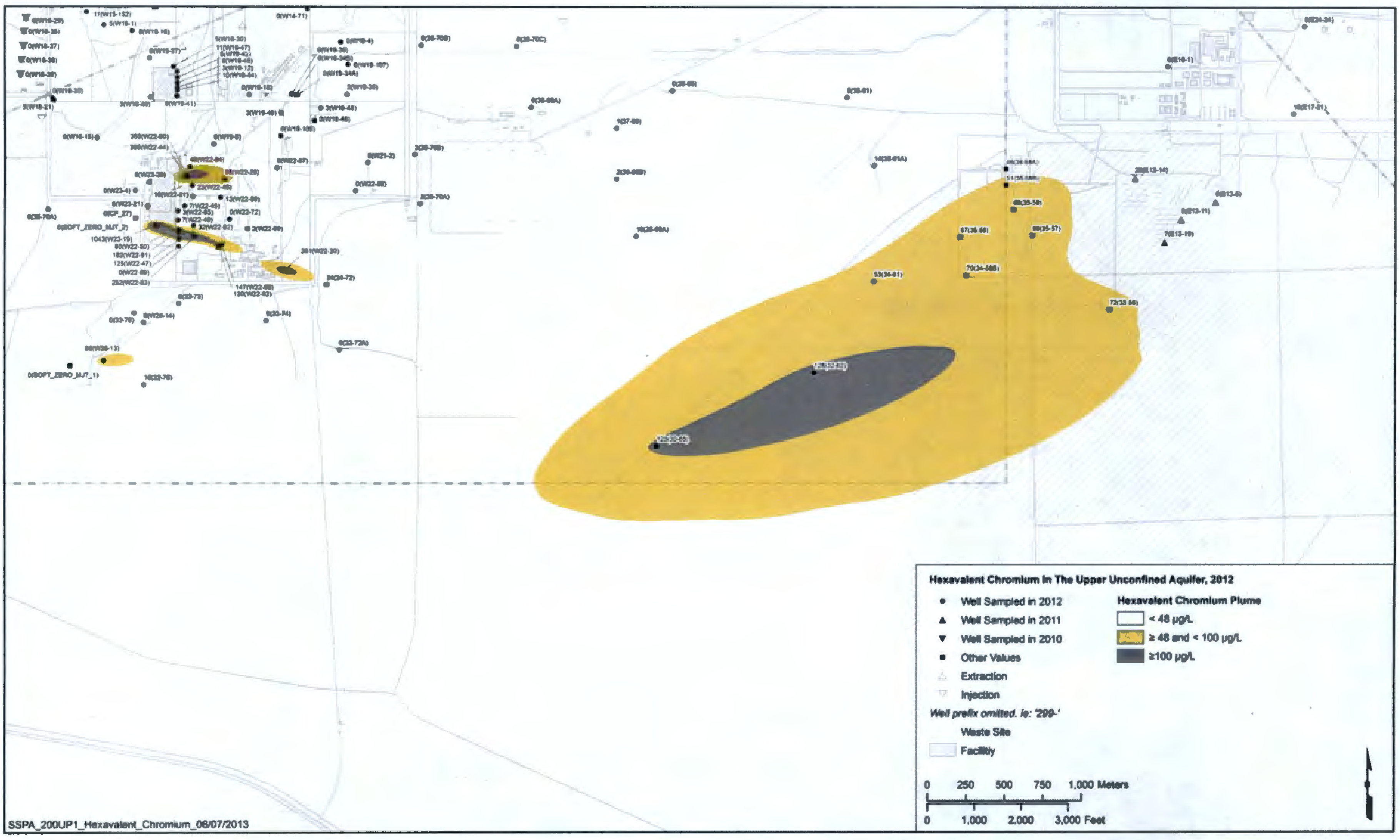


Figure 3-37. Tritium (Zoomed View) Plume Maps for (a) Average and (b) Maximum Concentrations in 200-PO-1

(a) Average Plume



(b) Maximum Plume

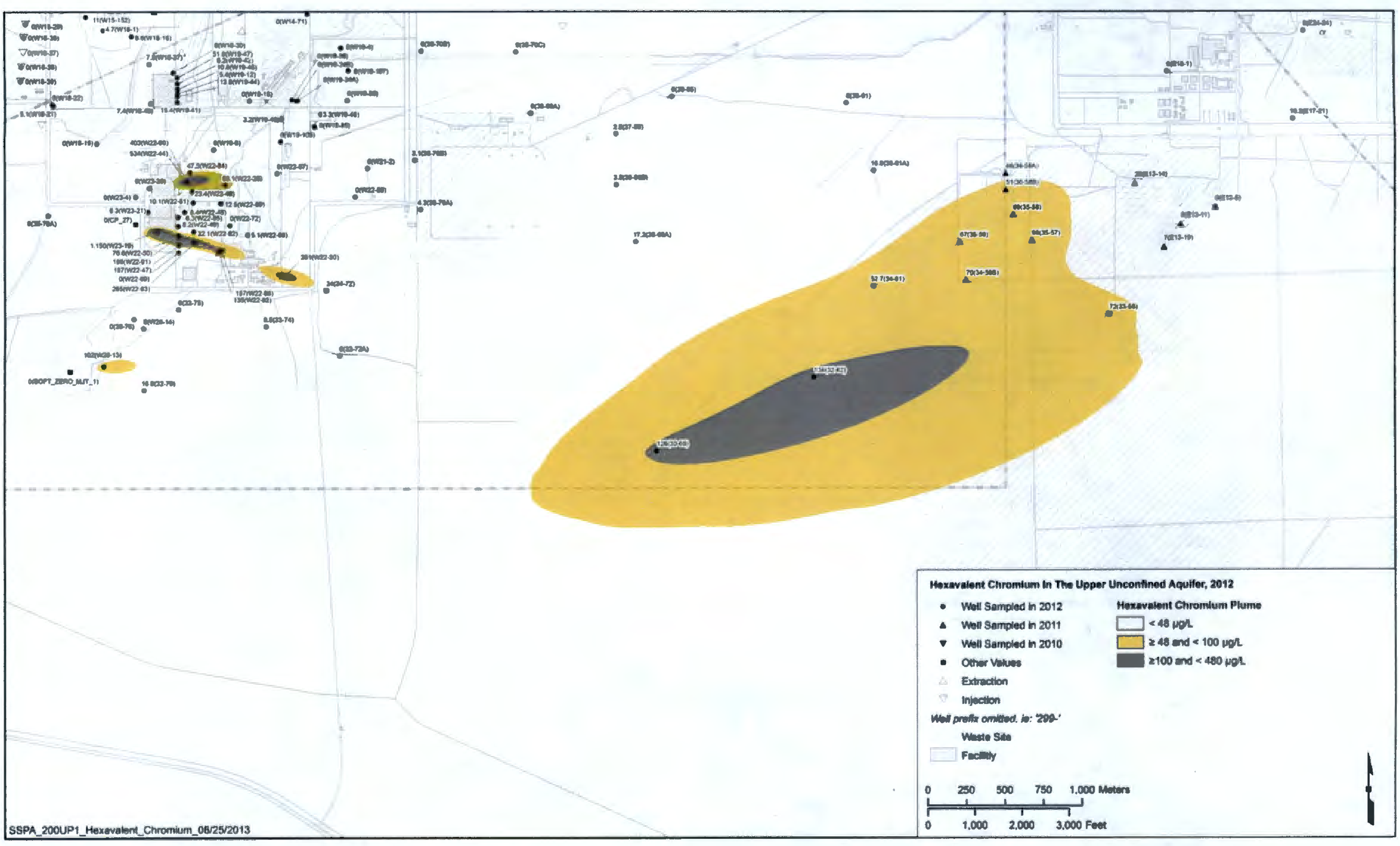
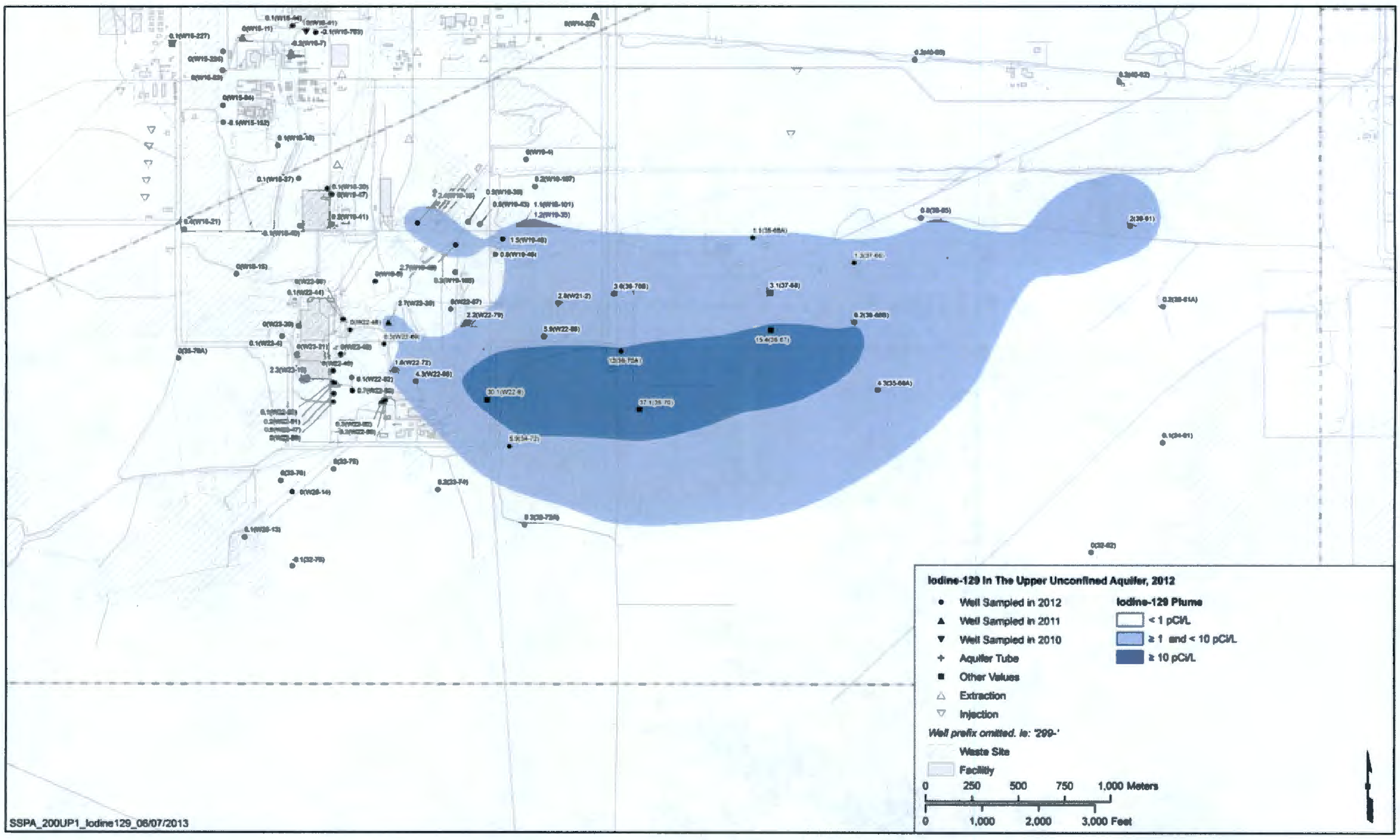


Figure 3-38. Hexavalent Chromium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-UP-1

(a) Average Plume



(b) Maximum Plume

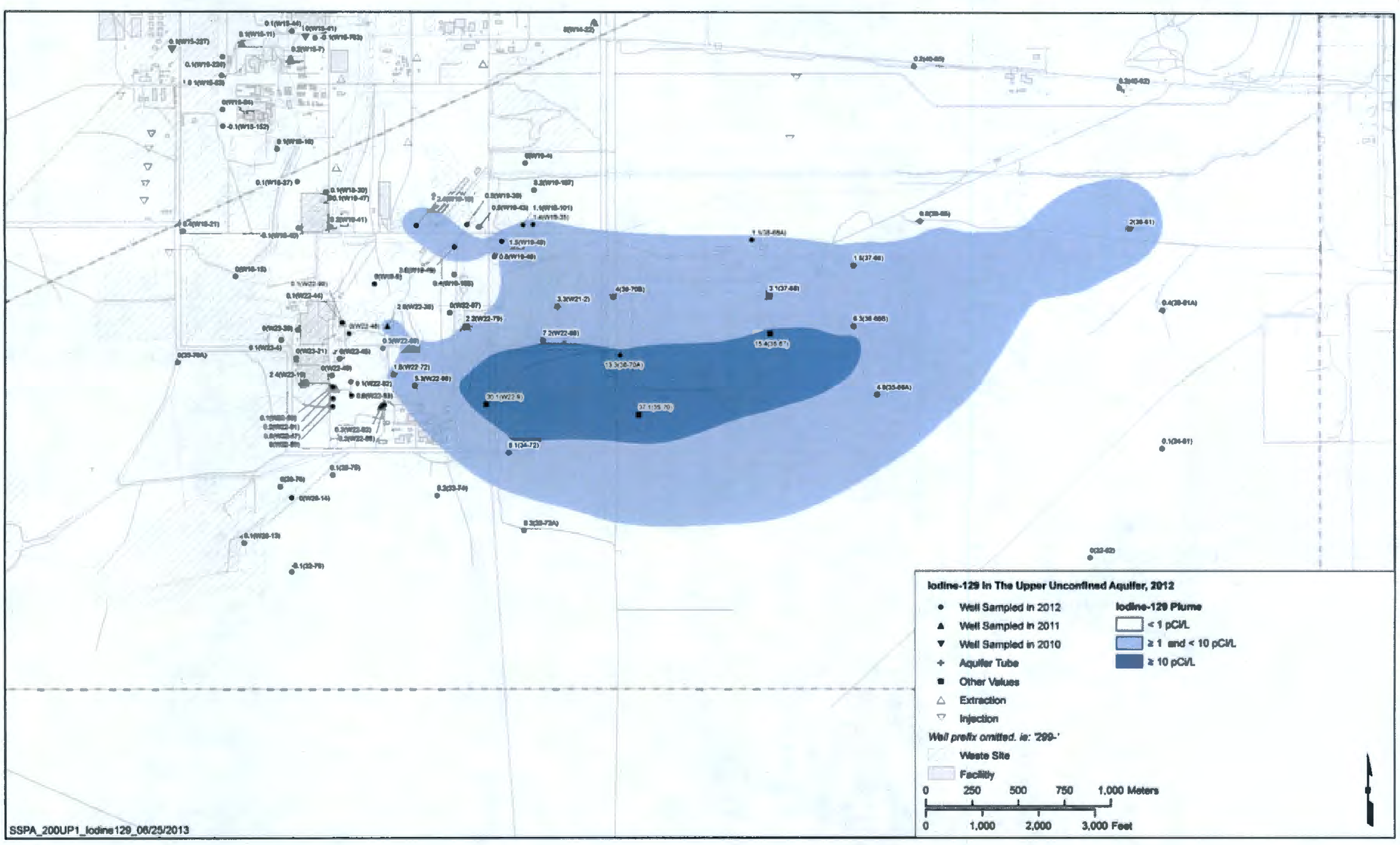
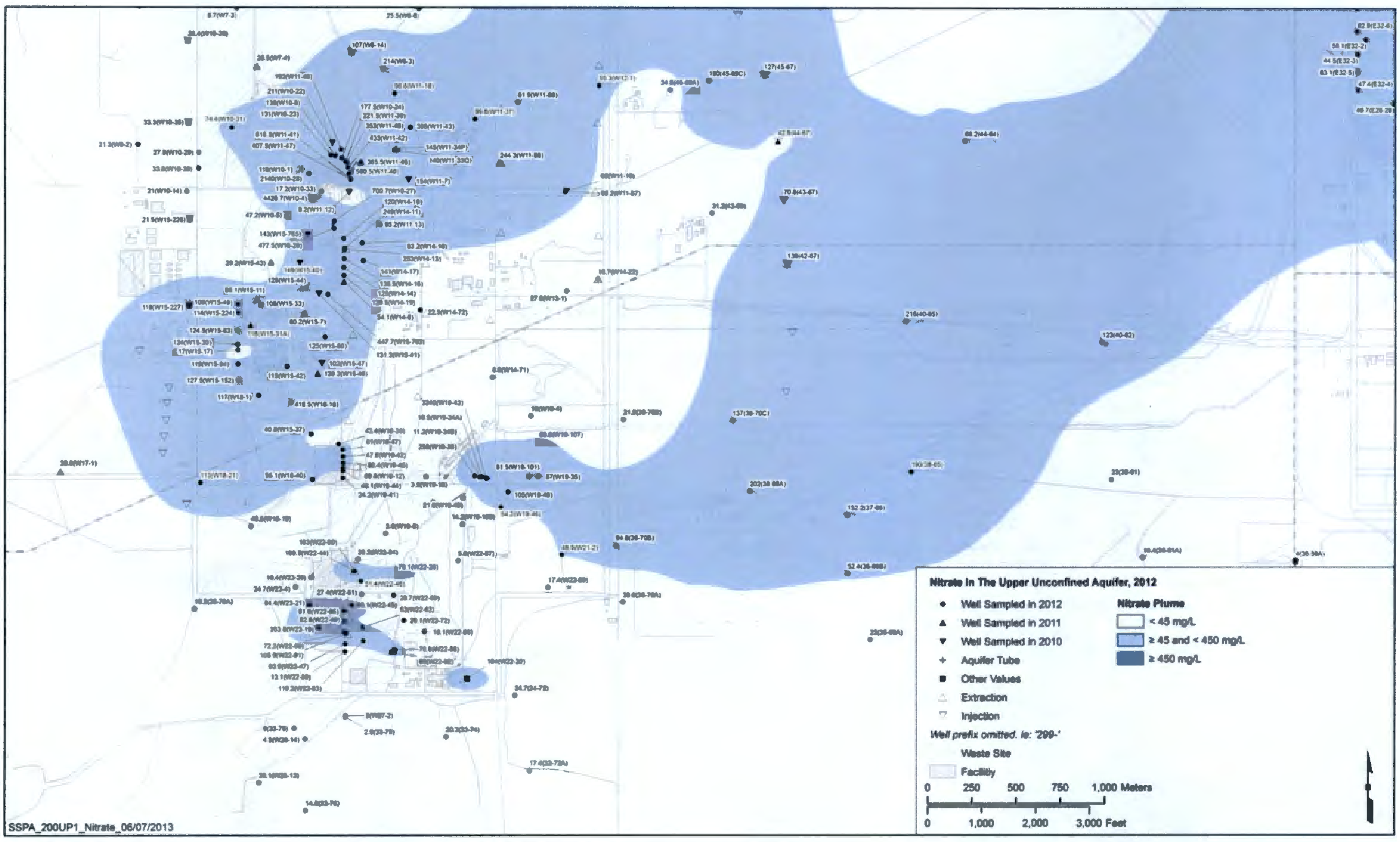


Figure 3-39. Iodine-129 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-UP-1

(a) Average Plume



(b) Maximum Plume

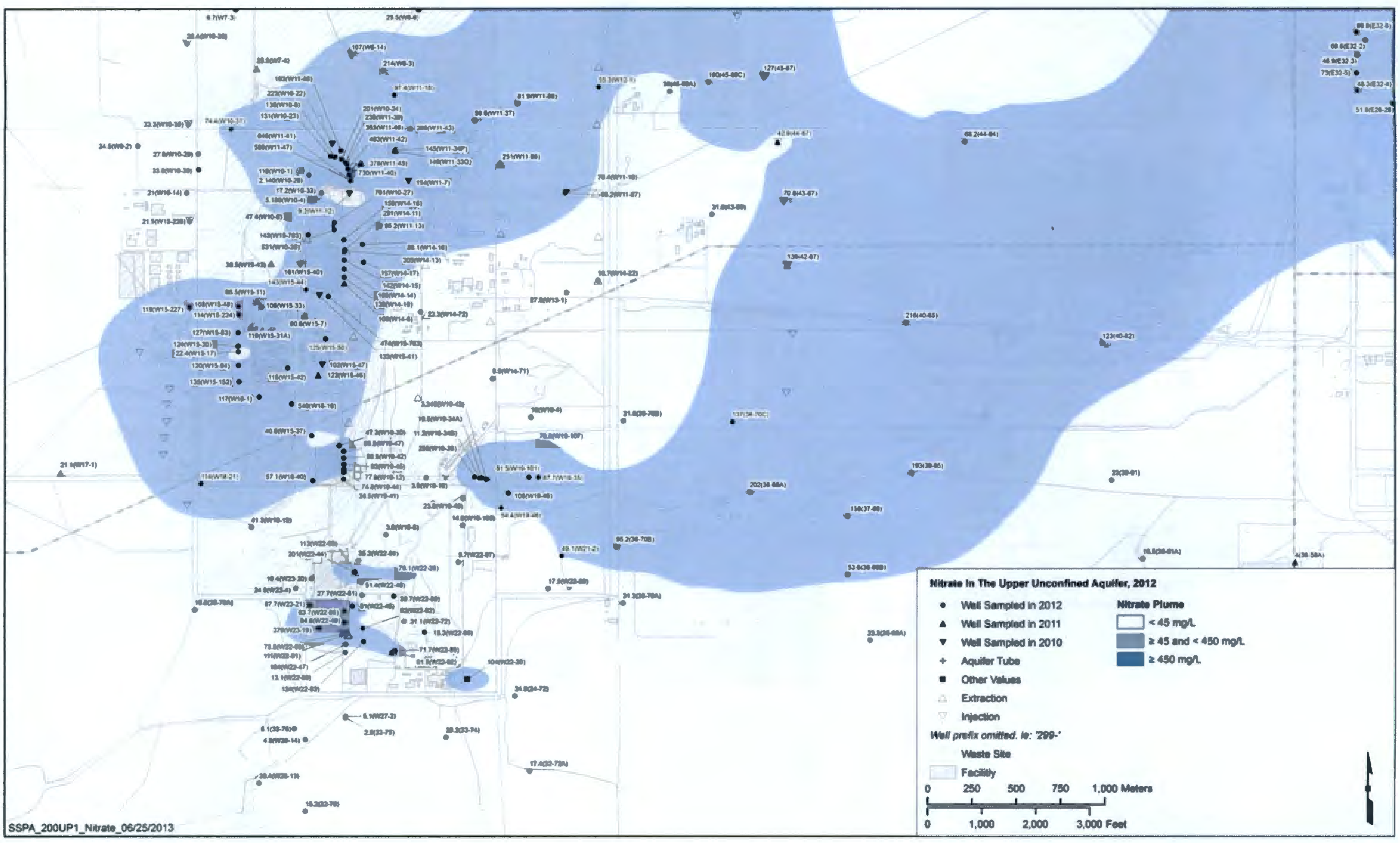
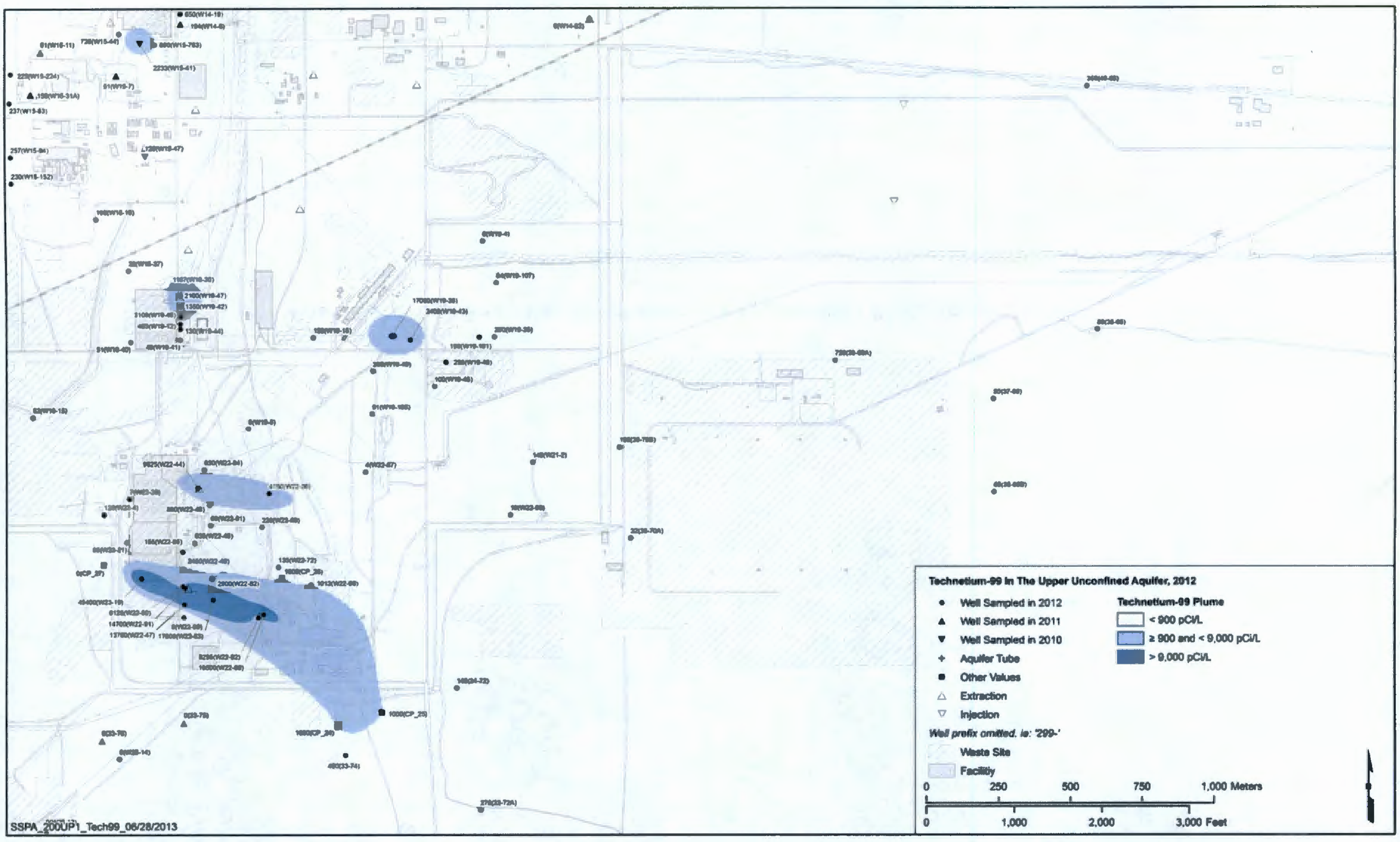


Figure 3-40. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 200-UP-1

(a) Average Plume



(b) Maximum Plume

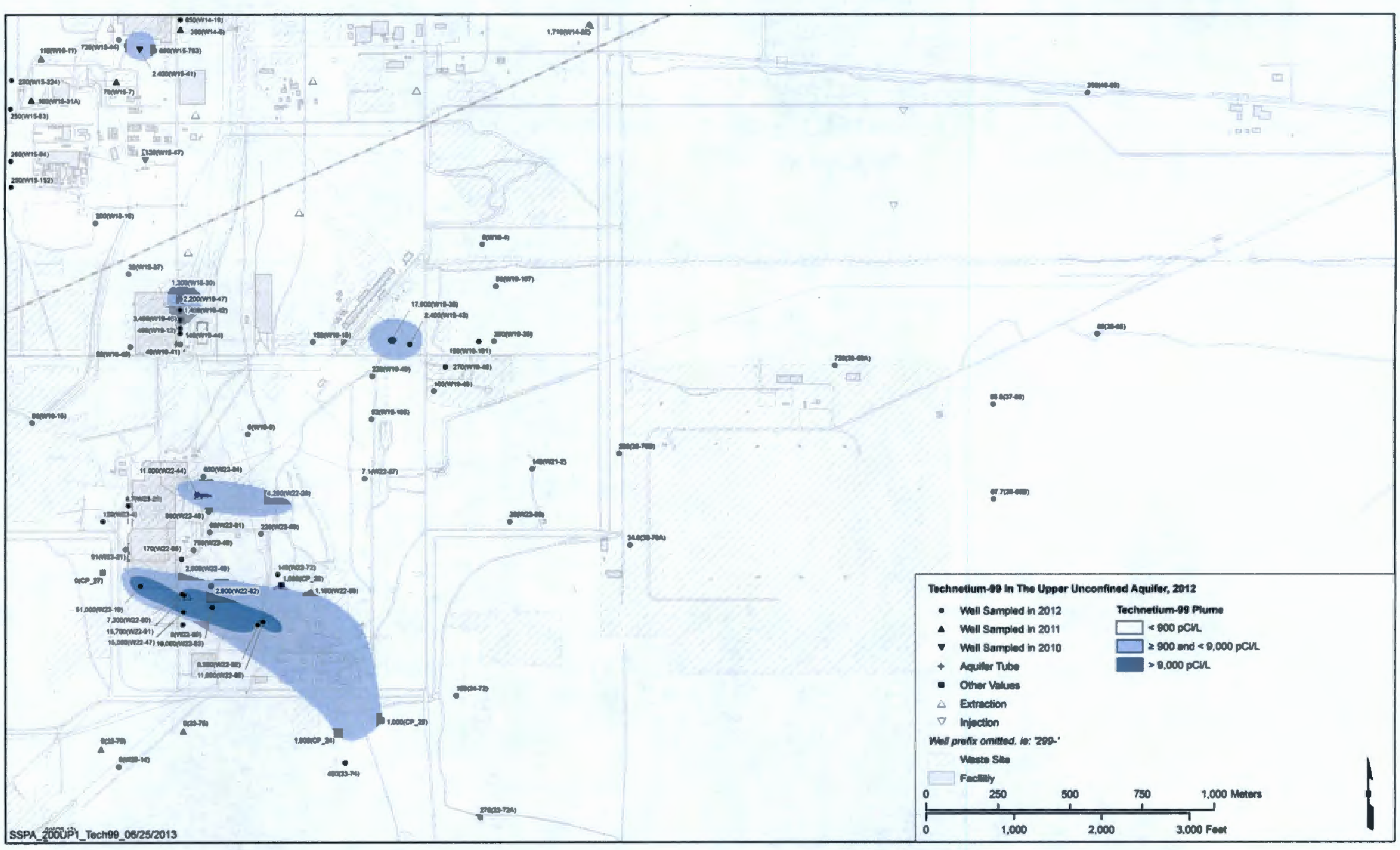
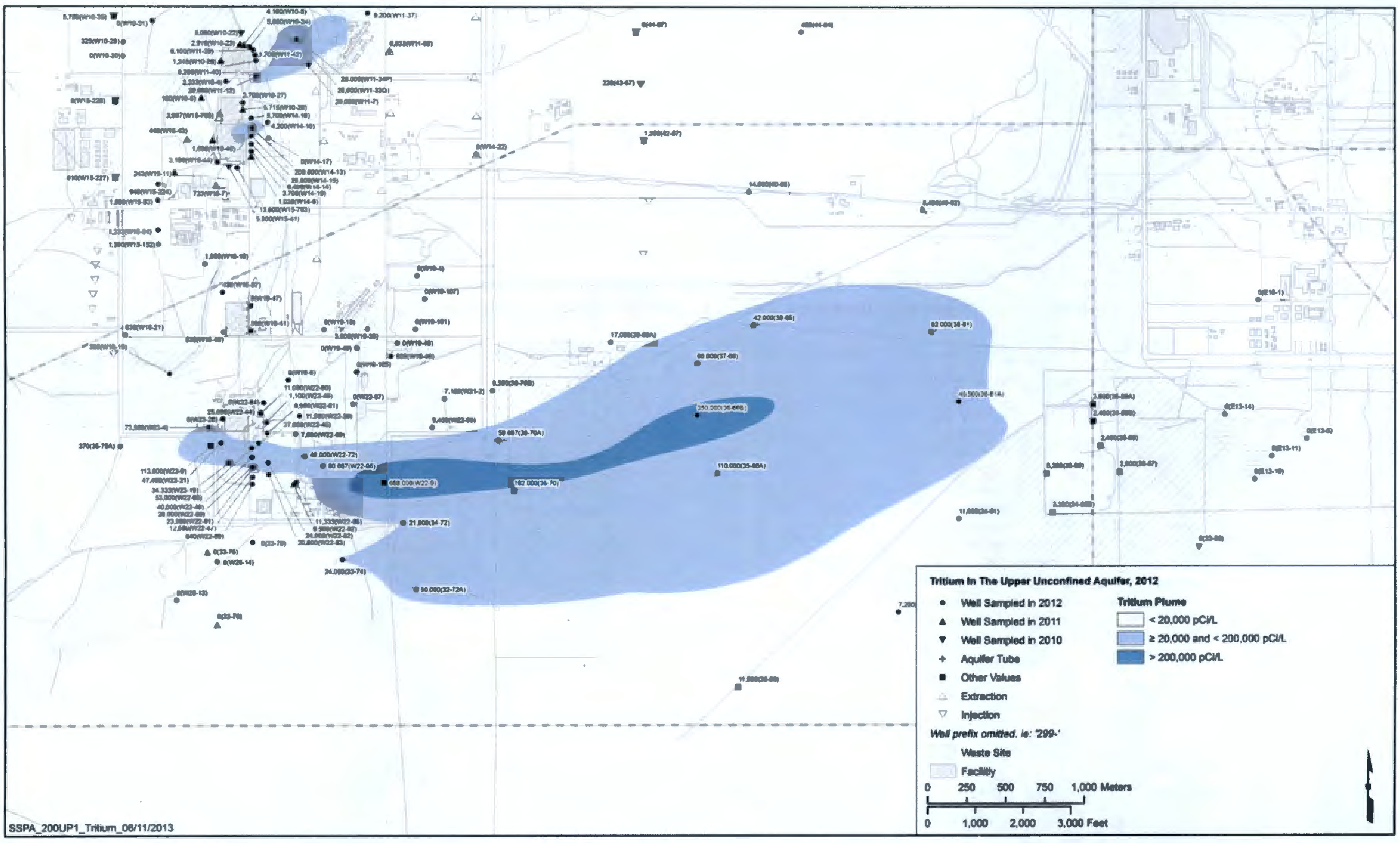


Figure 3-41. Technetium-99 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-UP-1

(a) Average Plume



(b) Maximum Plume

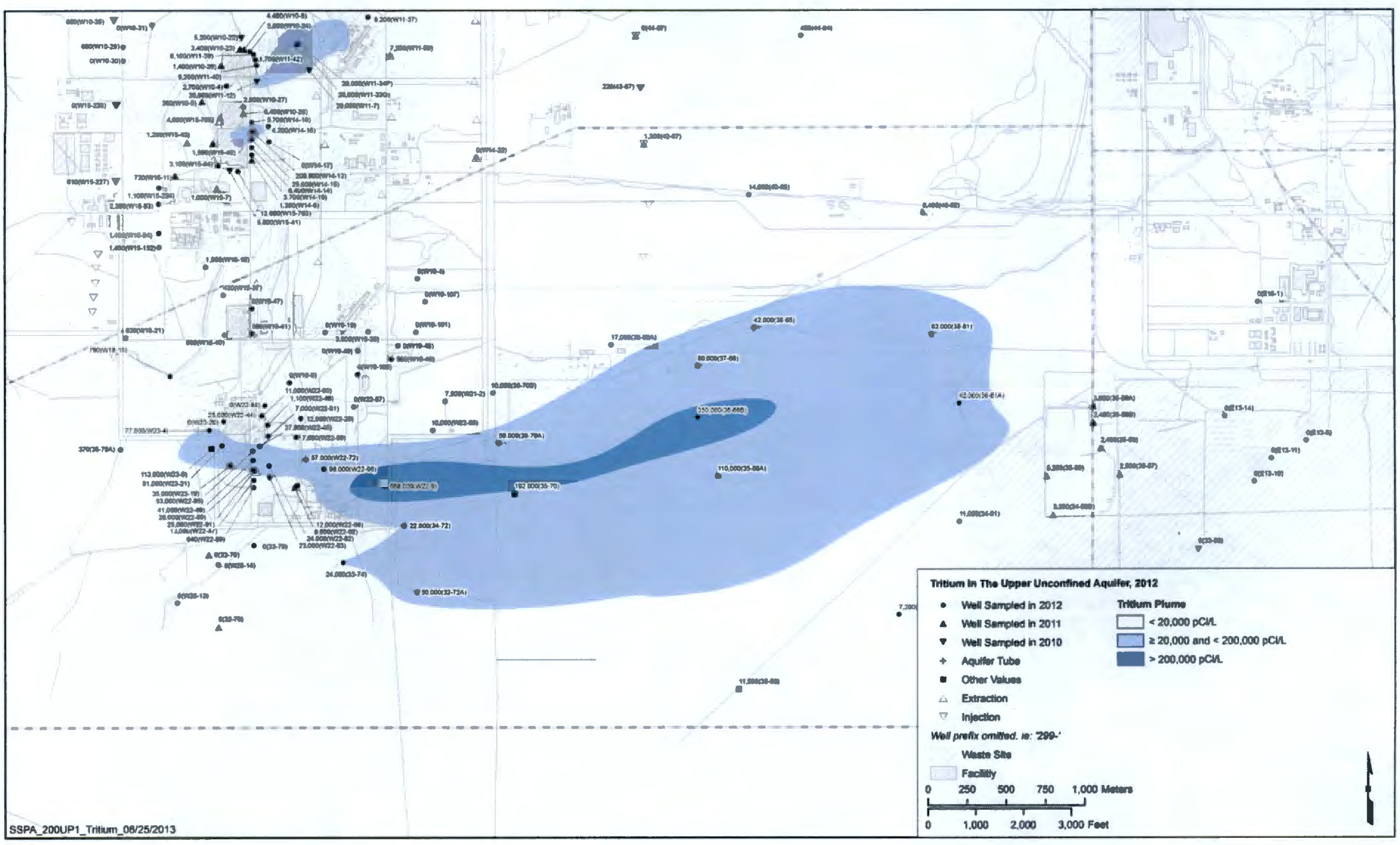
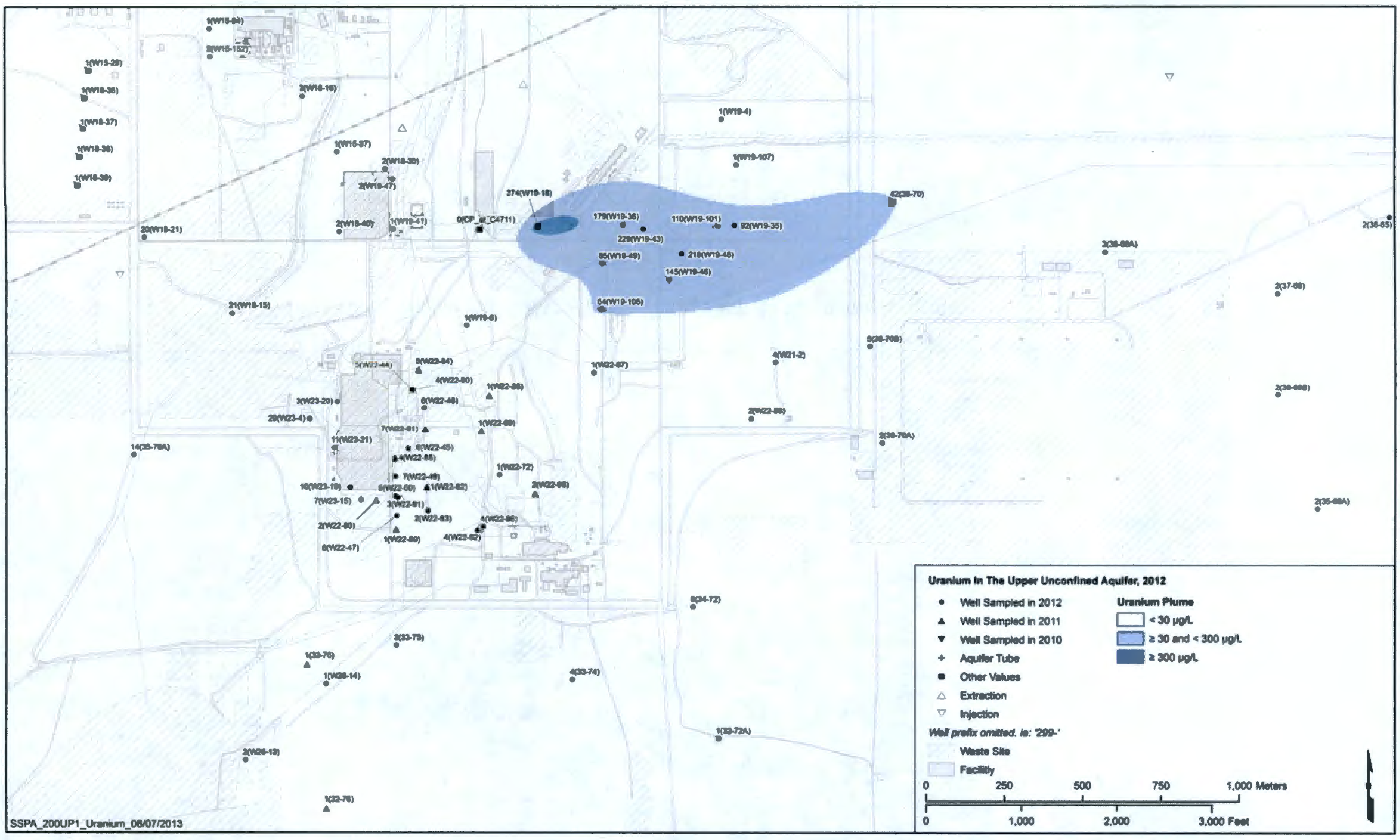


Figure 3-42. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-UP-1

(a) Average Plume



(b) Maximum Plume

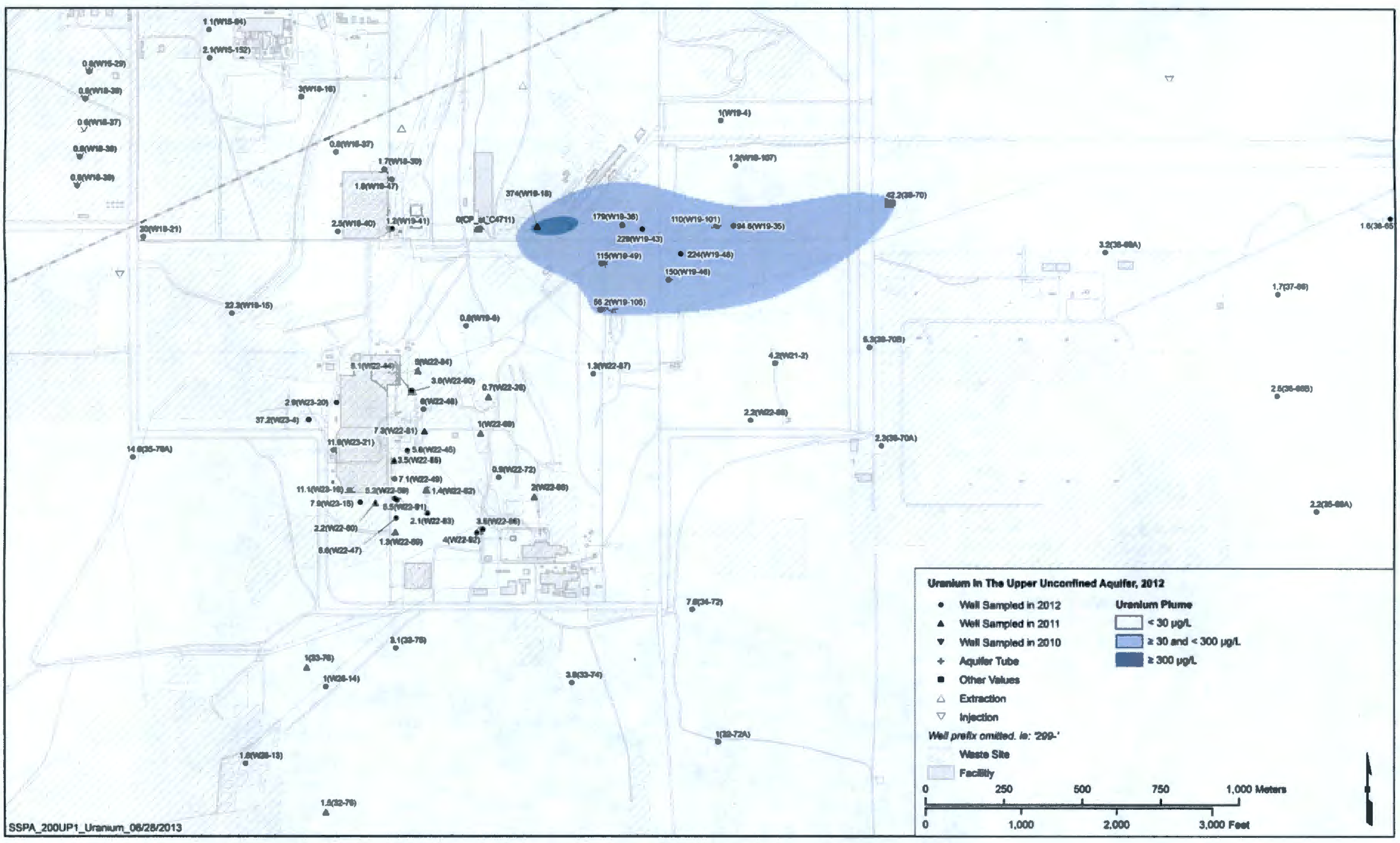


Figure 3-43. Uranium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-UP-1

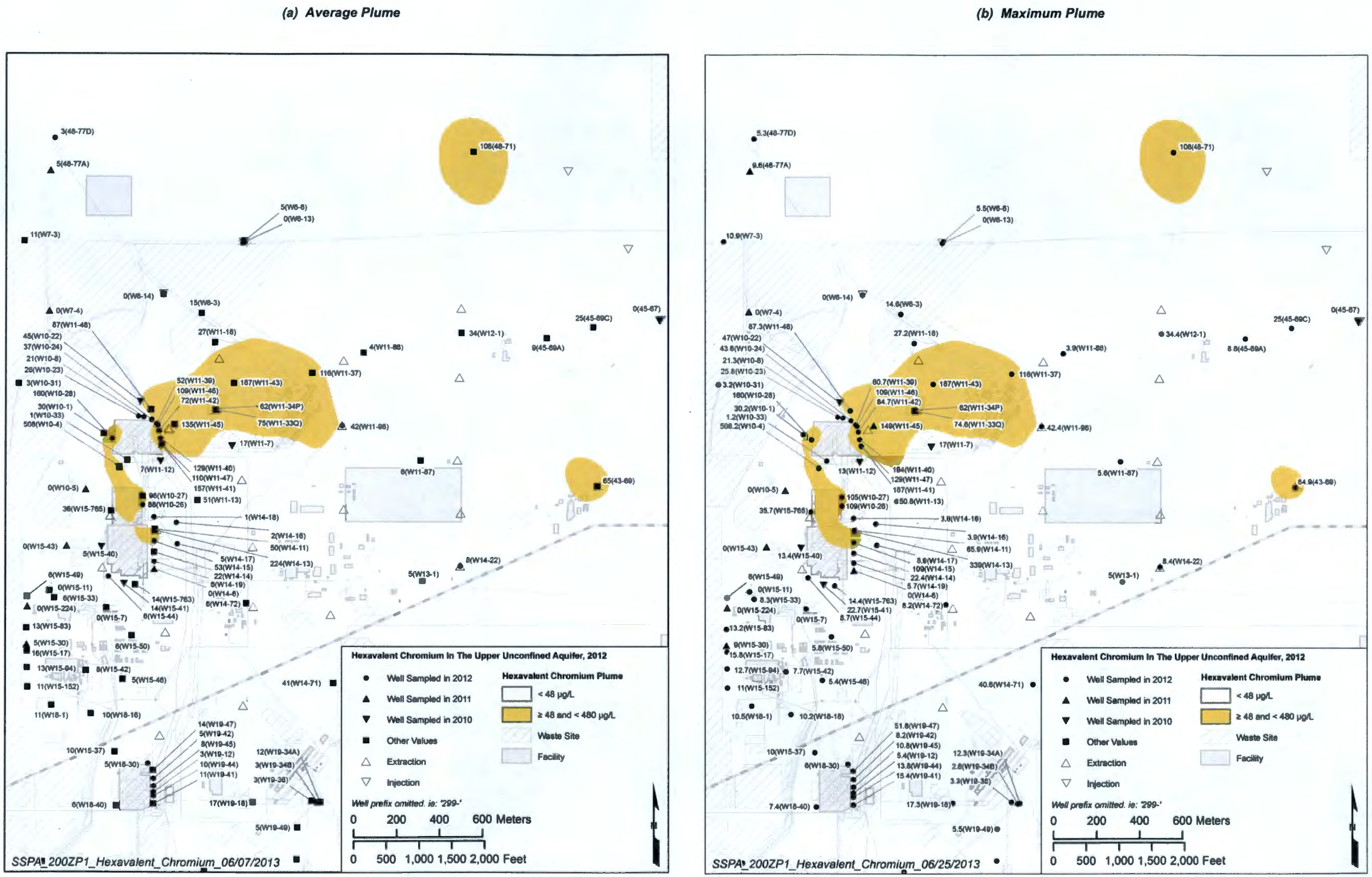


Figure 3-44. Hexavalent Chromium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-ZP-1

(a) Average Plume *(b) Maximum Plume*

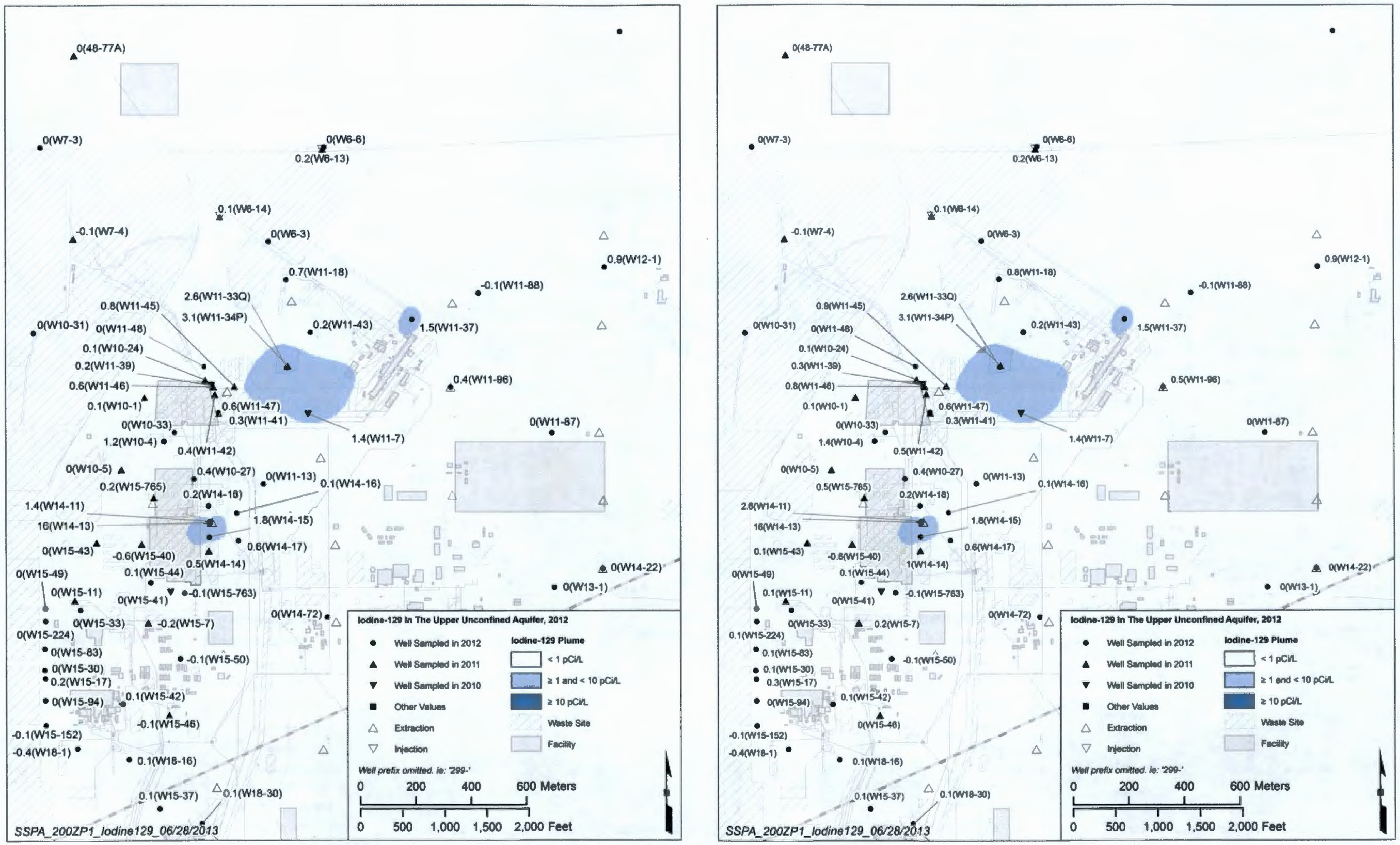
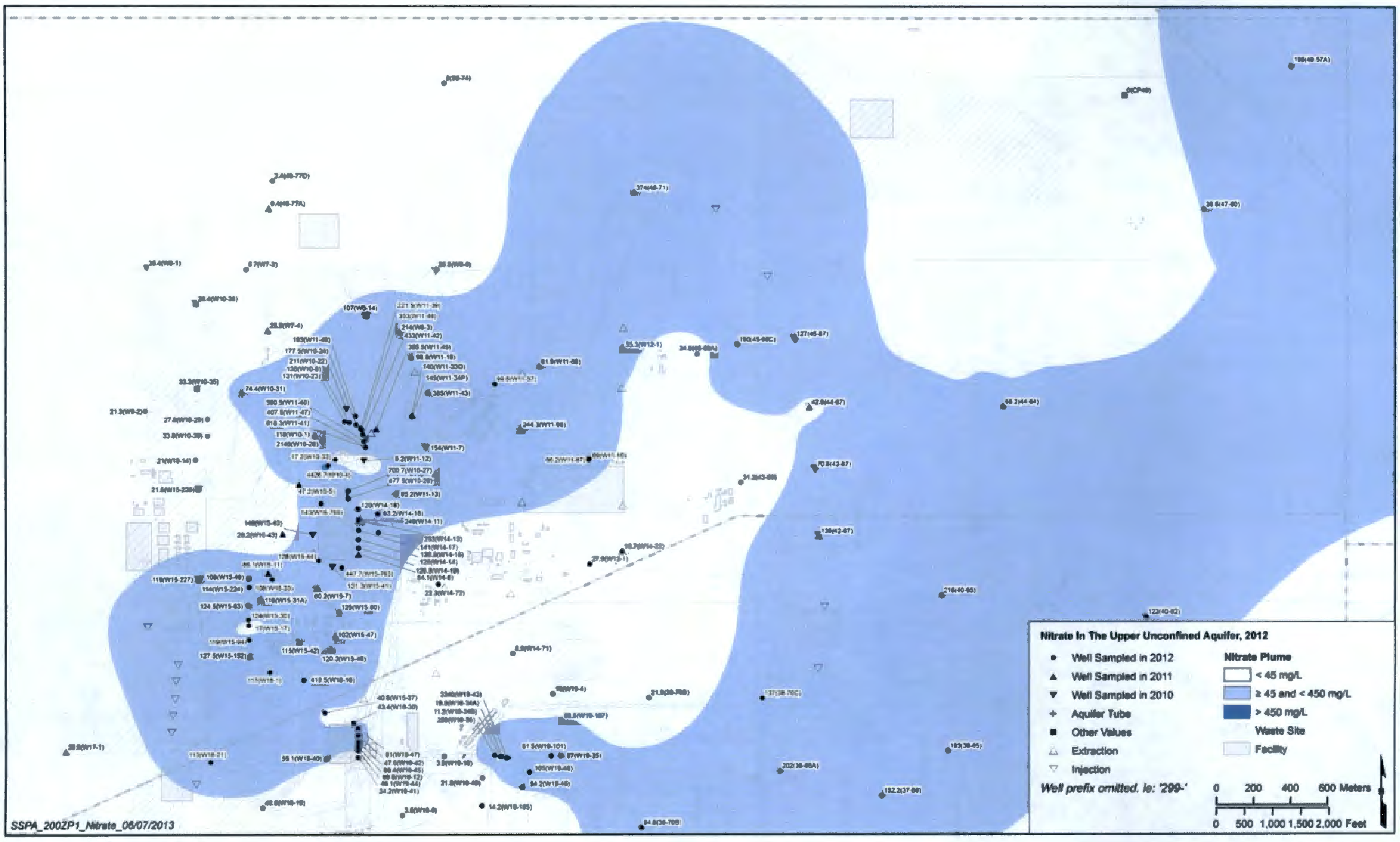


Figure 3-45. Iodine-129 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-ZP-1

(a) Average Plume



(b) Maximum Plume

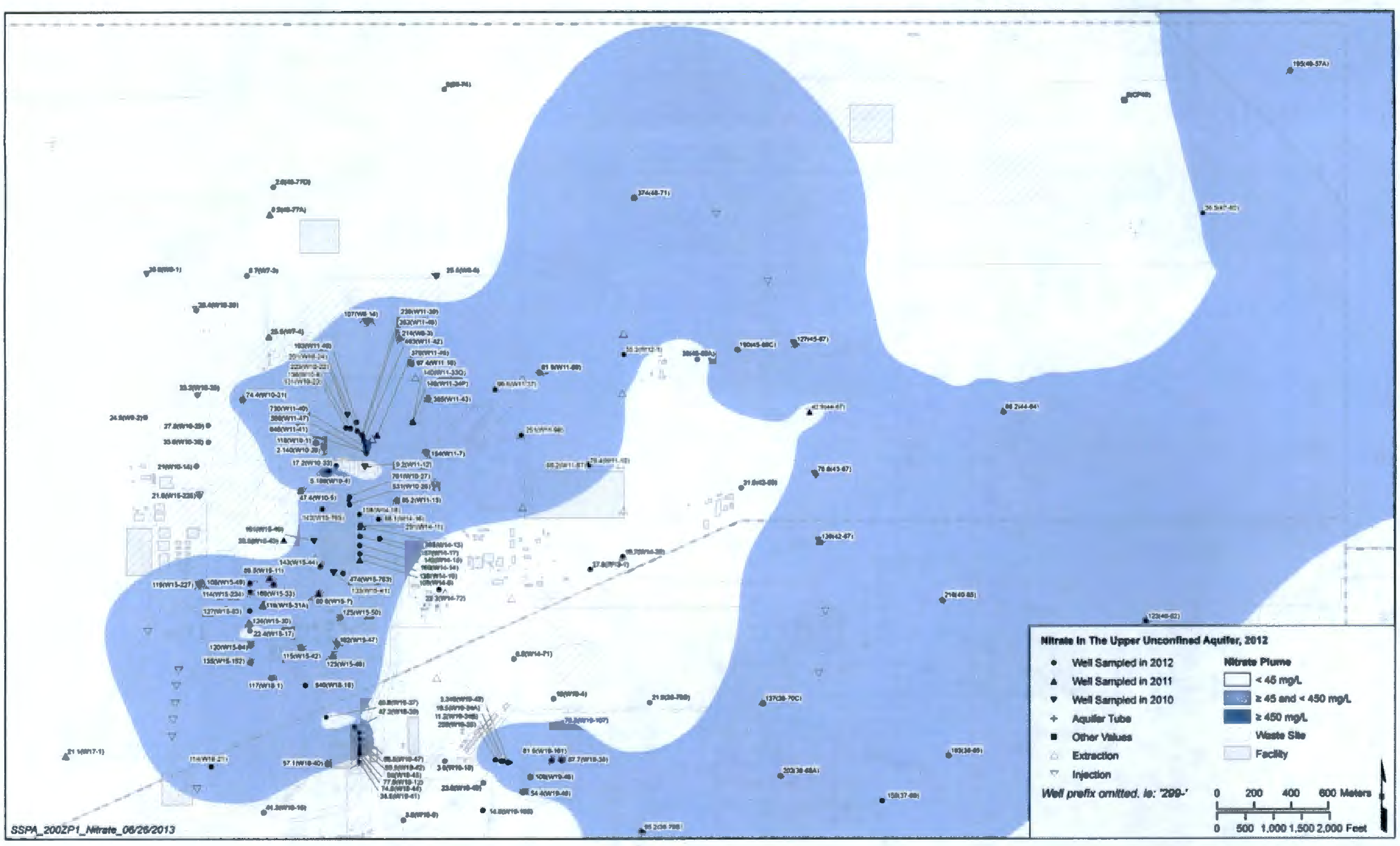


Figure 3-46. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 200-ZP-1

(a) Average Plume *(b) Maximum Plume*

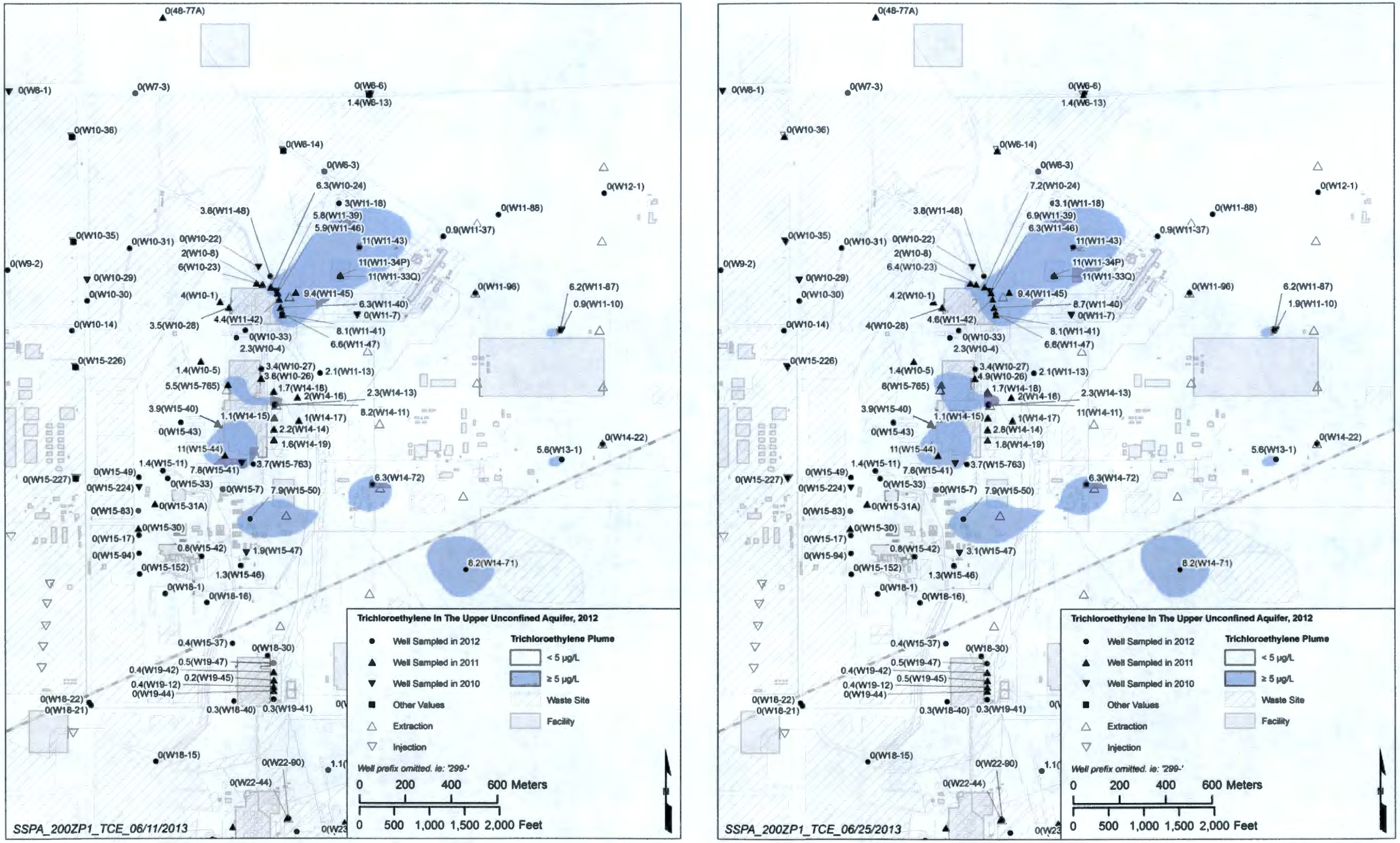


Figure 3-47. TCE Plume Maps for (a) Average and (b) Maximum Concentrations in 200-ZP-1

(a) Average Plume *(b) Maximum Plume*

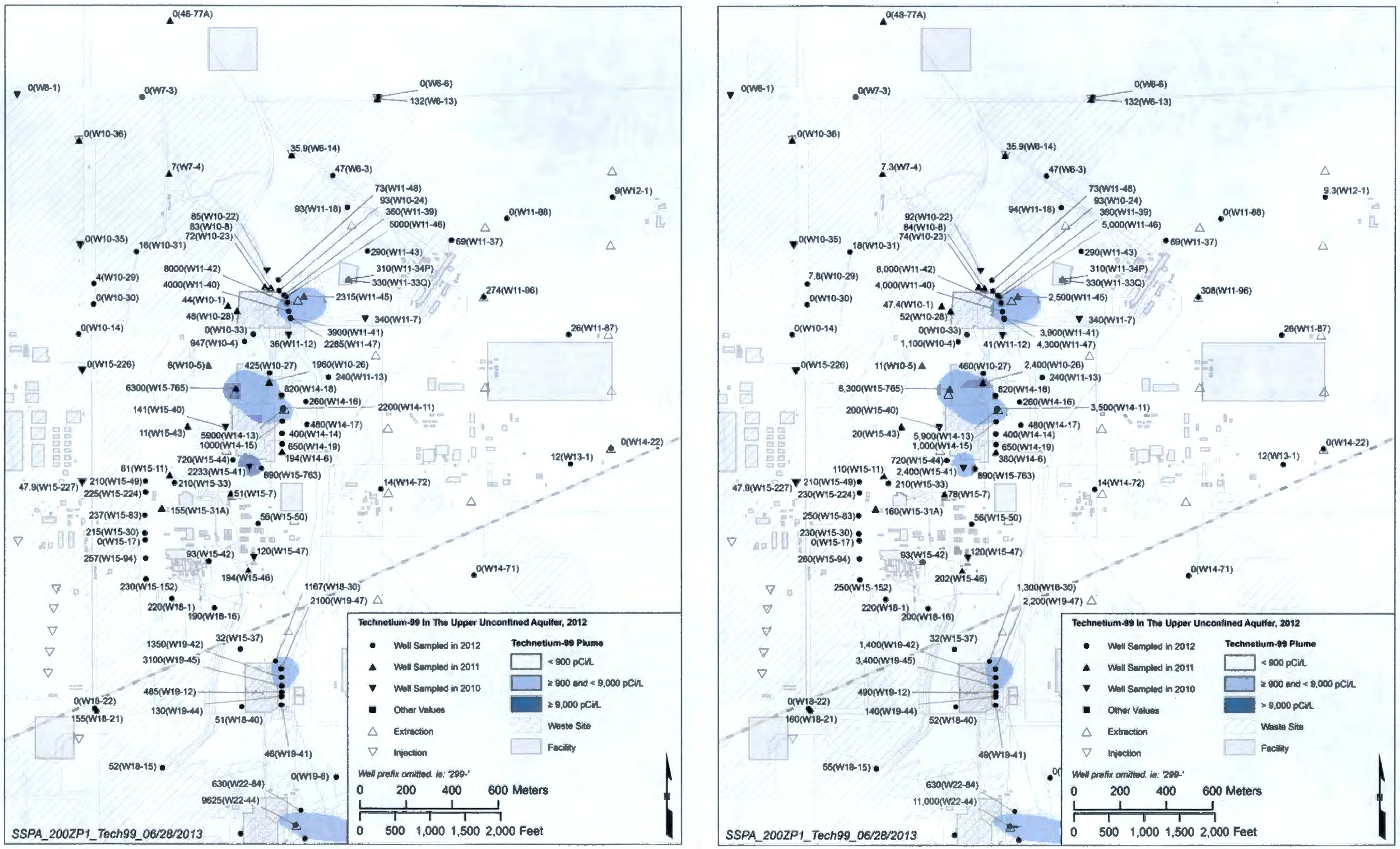


Figure 3-48. Technetium-99 Plume Maps for (a) Average and (b) Maximum Concentrations in 200-ZP-1

(a) Average Plume *(b) Maximum Plume*

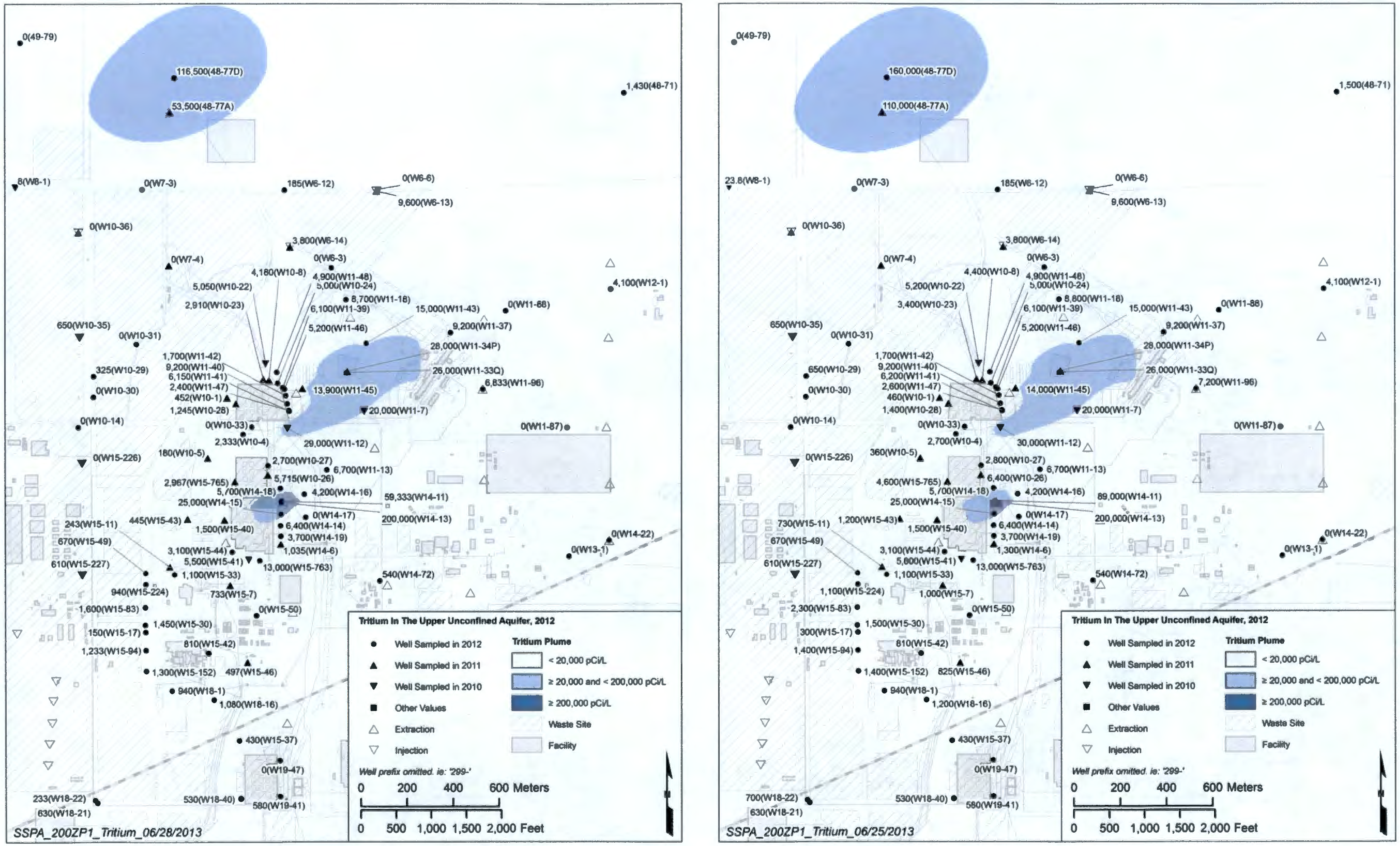


Figure 3-49. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 200-ZP-1

(a) Average Plume *(b) Maximum Plume*

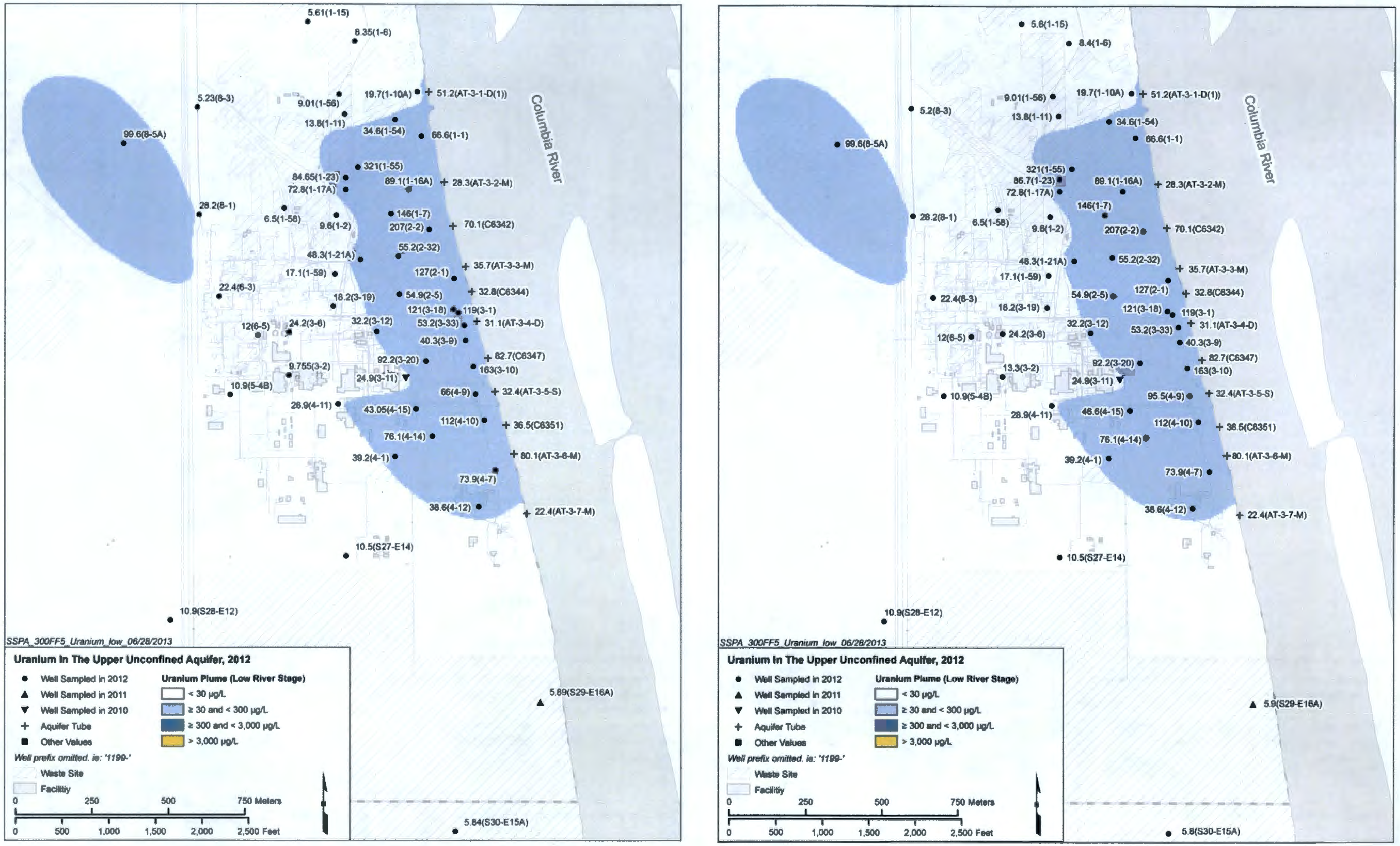


Figure 3-50. Uranium (Low River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 300-FF-5

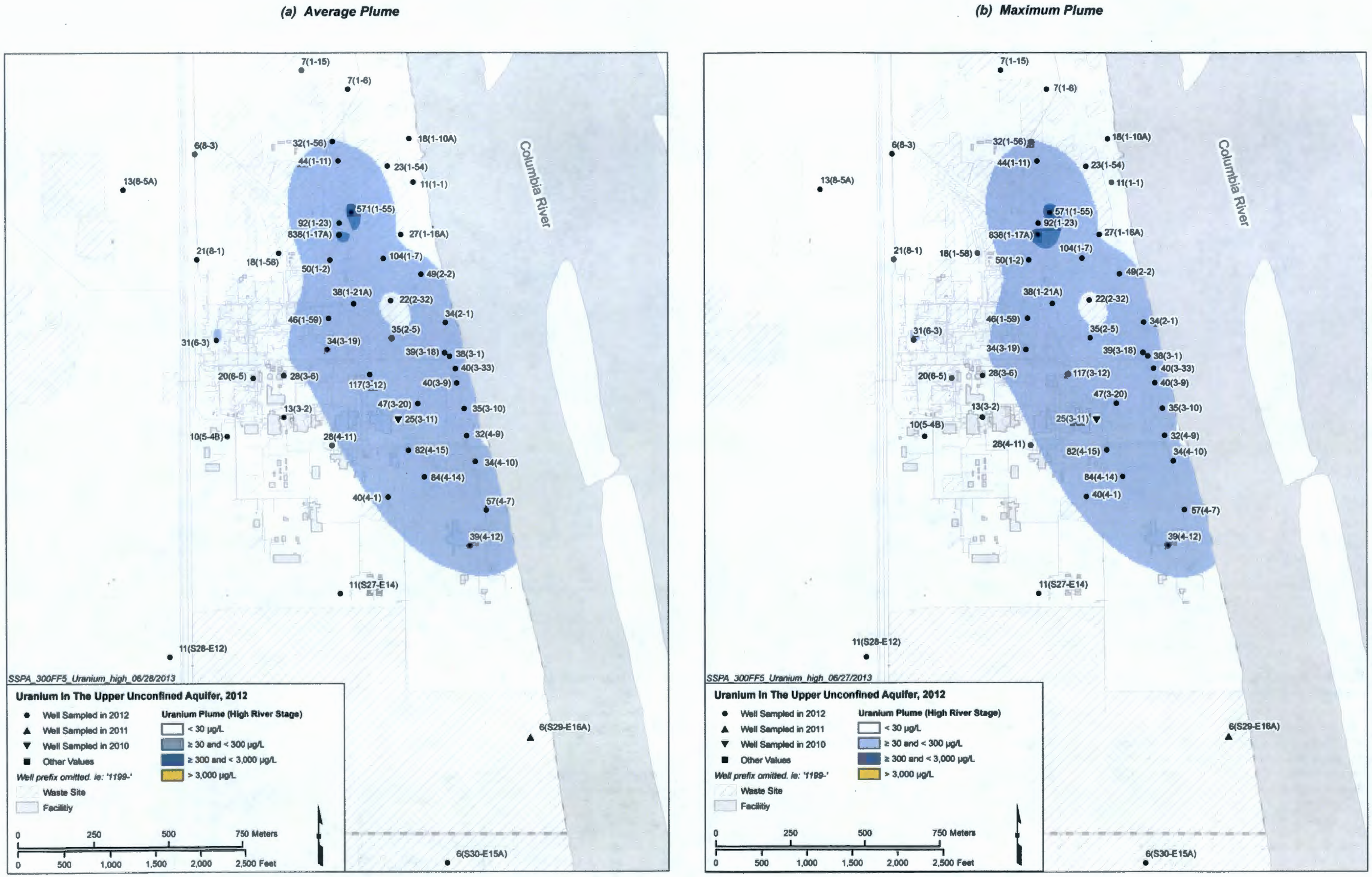


Figure 3-51. Uranium (High River Stage) Plume Maps for (a) Average and (b) Maximum Concentrations in 300-FF-5

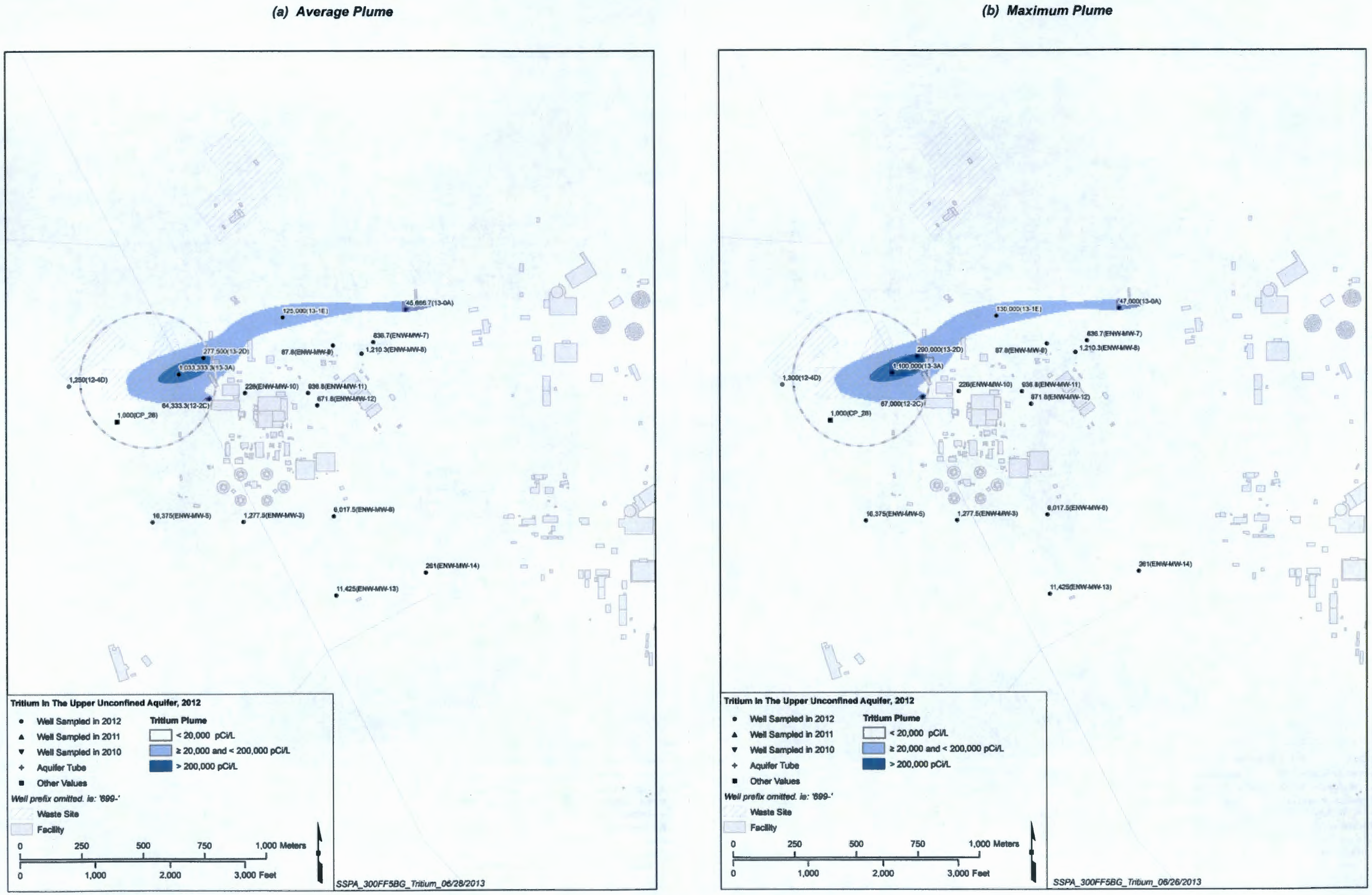
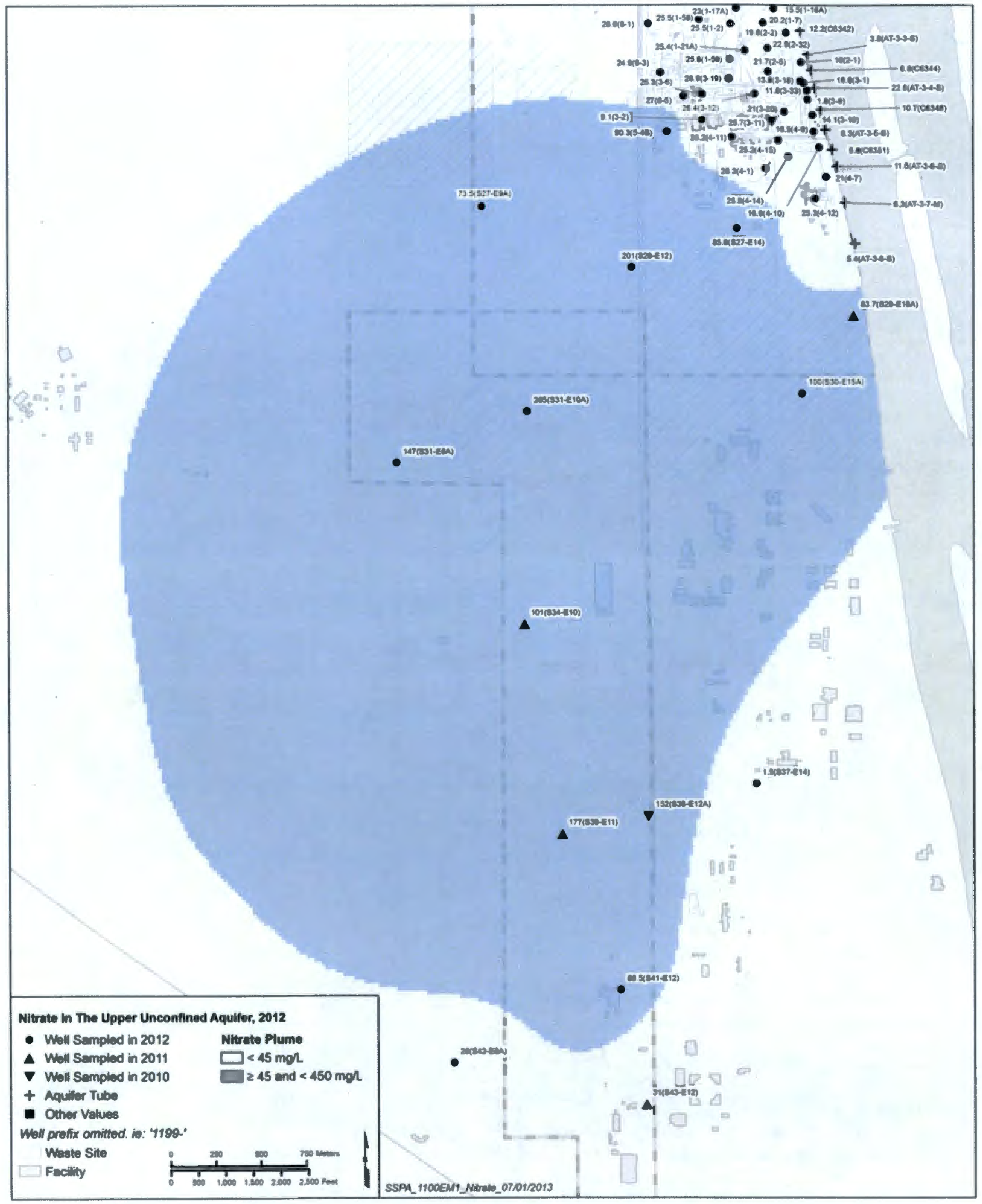


Figure 3-52. Tritium Plume Maps for (a) Average and (b) Maximum Concentrations in 300-FF-5 BG

(a) Average Plume



(b) Maximum Plume

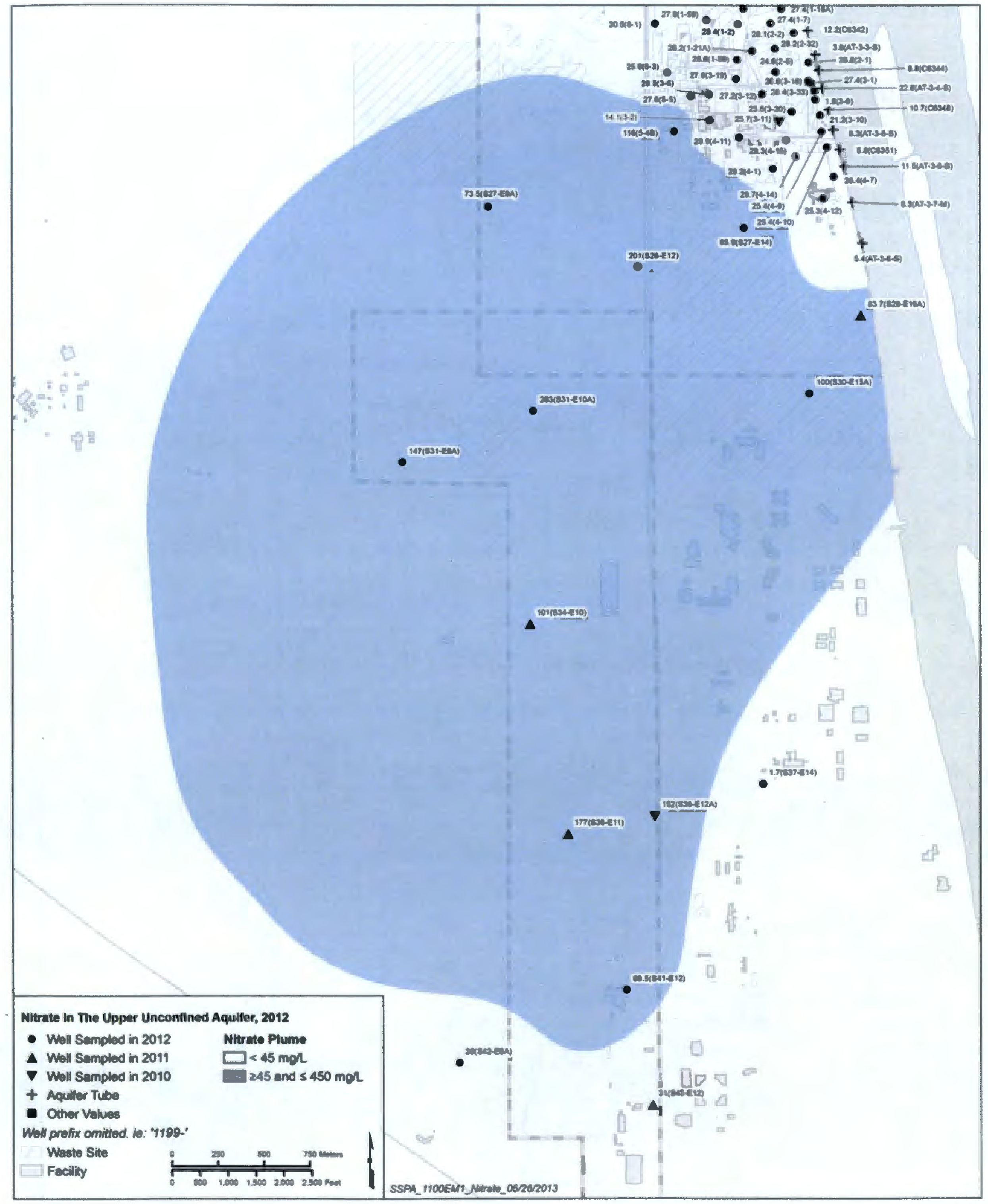


Figure 3-53. Nitrate Plume Maps for (a) Average and (b) Maximum Concentrations in 1100-EM-1

4. Assumptions and Limitations

The major assumptions for the analytical data sets used for construction of the plume maps are:

- The data set used as input to the mapping procedure provides a representative sampling of the upper portion of the unconfined aquifer throughout the extent of contamination for the corresponding COI and GIA.
- Incorporated control points in the form of either (a) previous sampling results or (b) values that are considered by the project scientist as representative given the scale of the contaminant plume(s) and the rate(s) of migration of contamination over time.

Assumptions and limitations of the contaminant plume interpolation approaches that are used to prepare the plume maps are summarized below:

- With regard to the depicted lateral extents of contamination:
  - The distribution of contaminants in groundwater is reasonably well represented by the qualified data used as inputs.
  - There are no contributing source areas that do not lie within the depicted extent of contamination that would result in increases to the lateral extents of contamination.
- In the absence of replicates (i.e., multiple values at one location) or small-scale variance - such as measurement errors - represented using a nugget, ordinary kriging honors the sample data values at the sampled locations. However:
  - When interpolating to a grid for mapping purposes, this is not guaranteed.
  - Because the interolation data set can include data over a period of up to three years the resulting map does not necessarily represent an actual "instantaneous" condition within the aquifer, but rather provides a representative composite depiction.
- Studies by other investigators (e.g., Reed et al. 2004) suggest that use of ordinary kriging together with data transformations - such quantile kriging - produces robust interpolation results, which mitigate bias due to highly skewed data and/or variations in the spacing of measured data (i.e., data support). However, each of the logarithmic, uniform-score and indicator transforms generally lead to median-unbiased estimators that may under-estimate the contaminant mass, depending on the true distribution of the data.

The interpolation parameters used for the maximum plume mapping were identical to those used for the average plume mapping. As a result, factors associated with the origin, shape, and/or extent of a plume as defined on the basis of previous investigations, were not further considered in developing the maximum plume maps.

5. References

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