UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3507

TECHNICAL MEMORANDUM

DATE: November 26, 2007

TO: Ross del Rosario, Region 5 RPM

FROM: Chuck Roth, John Bing-Canar, FIELDS Program
Advanced Analysis and Decision Support Section, Innovative Systems and Technology Branch, Superfund Division

SUBJECT: Sediment analysis of Little Menomonee River, Milwaukee, WI

Introduction

The Little Menomonee River in Milwaukee, WI is currently under remediation for carcinogenic polycyclic aromatic hydrocarbons (CPAH) along its 5-mile length. This is the final phase of cleanup for the Moss American Superfund Site under the September 1990 Record of Decision (ROD). This technical memorandum will summarize the 2006 data, evaluate the PRP removal plan, incorporate the findings from the November 2007 sediment profile work, and assess the need for secondary sampling in the 4,300 ft stretch of Reach 4/5 where elevated CPAH concentrations were found. The original releases were from the former wood-preserving Moss American facility, which produced creosote that entered the floodplain and river.

Summary of Recommendations

Based on evaluation of the data generated in 2006 and the 2007 sediment profiling work, we recommend the following steps for remediating Reach 4/5:

- Samples with CPAH results over the 15 ppm threshold should be included in a hotspot removal; and

- Secondary sampling, based on DQO principles, should be performed such that a minimum of 14 additional core locations will be sampled in order to meet the DQO 70% confidence level for acceptable inaccuracy. The additional cores should be located in the segments (see details below) where no previous exceedances have been found.

Hot spot removal: Tronox previously proposed a hotspot removal plan in reach 4/5 for sediments over 15 ppm. The proposal includes removal of a 50 x 10 ft polygon around each 15 ppm exceedance. This would result in removing a minimum of 170 cubic yards

(cy) of sediment, remediating an area of approximately 516 m^2 (0.13 acres) of sediment. A post-removal sampling plan includes basement samples and samples along the perimeter of the removal polygon, with three locations along the 50 ft border and a single sample at each of the 25 ft ends. The midpoint along the 50 ft edge is generally a location previously sampled that does not need to be replicated. If no previous transect is present (in the case of the DNR samples) the entire transect should be sampled for confirmation. All of the confirmation samples around the border should be to refusal and subdivided the same as the 2006 sampling. If an exceedance is determined, the removal area should expand accordingly, an additional 25 ft up/downstream and an additional 5 ft cross channel. Confirmation sampling should be performed along the new border as well.

Additional sampling: The secondary goal to removing hotspots over 15 ppm is to assure that additional remedial action does not have to occur later on. It is to all parties' benefit that the likelihood of incurring additional cost and effort as a result of not meeting the cleanup criteria be minimized. A secondary sampling design in areas where no hotspots have yet been detected would decrease uncertainty about additional hotspots and also increase confidence in the proposed remedy.

We recommend using a statistical approach (DQO, Data Quality Objectives) to assess the number of samples needed per section. The DQO calls for the calculation of a sample number dependent upon the following parameters: acceptable false positive (alpha), acceptable false negative (beta), estimated sample standard deviation, action level, and acceptable inaccuracy (D). See Guidance for the Data Quality Objectives Process (G-4) at www.epa.gov/quality1/qs-docs/g4-final.pdf for a more complete discussion. A secondary sample design would require from 14 to 29 additional core locations. Between transect 49 – 58 a total of 31 samples (10 core locations) are required, between transect 21 – 80 requires 24 samples (8 core locations), and between transect 84 – 16 requires 32 samples (11 core locations). The sample numbers can be reduced to 15, 11, & 15 (5, 4, & 5 core locations) if uncertainty were lowered from 80% to 70%. Placement of the cores should be in a gridded pattern to maximize areal coverage since there seems to be little correlation within each transect.

Basis of the Recommendations

1. Results of 2006 Sampling: The 2006 sampling used transects varying from 50 to more than 300 ft apart. There were a total of 41 locations on 20 transects with 123 analyses. Nine of the locations were sampled by the WDNR, with 30 analyses. The WDNR locations were not complete transects, opting for left bank (4), right bank (4), or center channel (1). More concisely, there are 11 complete transects and 9 single locations along this 4300 ft section of reach 4/5 (figure 1). CPAH concentrations over 15 ppm constitute 13 of 123 sample results (10.6%) and occur on 10 of the 20 transects (50%). Eight of the 13 were detected in the top 6 inches (61.5%) and the remaining five from 6-15 inches (38.5%). There were no exceedances of greater than 15 ppm deeper than 15 inches. The highest concentration detected in the 0-6 in layer was 210 ppm, while 22.0 ppm was the maximum within the 6-15 in layer. The highest concentration from 15-24 inches

was 14.8 ppm with three samples 12 ppm or greater. The average concentration of the 2006 sampling is 9.3 ppm, with the top 6 inches 13.7 ppm, 6-15 inches at 5.3 ppm and below 15 inches 2.09 ppm. The trend is for the average to be less in the deeper sediment layers. The top 6 inches is above the total data mean and the rest, 6 inches and deeper, below the complete data set average. See table 1 for summarized results.

2. Spatial distribution of CPAHs in reach 4/5: Over half of the exceedances tended to be clustered in one section (transects 21-58), with two distinct sections having relatively low concentrations, all under 15 ppm (transects 80-20 &27-29). Two areas are mixed, having transects with exceedances (transects with at least one hit over 15 ppm) and transects with all lower concentrations. The upstream end of reach 4/5, beginning with transect 92, and continuing down to transect 80 had three of six transects with an exceedance. At the downstream end, the last transect (49) contained one sample over 15 ppm.

3. Evaluation of Tronox removal plan: Tronox has previously proposed a hotspot removal plan in reach 4/5 for sediments over 15 ppm. The proposal included removal of a 50 x 10 ft polygon around each 15 ppm exceedance. This would result in removing a minimum of 170 cy of sediment, remediating an area of approximately 516 m^2 (0.13 acres) of sediment. A post removal sampling plan included basement samples and samples along the perimeter of the removal polygon. One area of clarification remains, the sampling distance out from the remediated area needs to be clearly defined (it wasn't clear what the PRP proposed sampling distance was). The distance out from the removal area is important since post-removal sampling will provide the data to determine when hot spot sizes are larger than 50x10 ft.

4. FIELDS approach to removal data: FIELDS used the 2006 data set to develop a contamination model of Reach 4/5. The sediment thickness survey performed in November 2007 helped to estimate the sediment volume for the entire reach and for the hotspots (areas over 15 ppm). The sediment data and the contamination data were interpolated to create a sediment thickness contour and a contaminant gradient for the entire reach (Figures 2a and 2b). Contouring provides an estimated hotspot footprint that correlates to the underlying data. The parameters used for both the sediment thickness and CPAH concentration were the same, Natural Neighbor interpolation with 1x1 meter cell size. To limit the extent of the interpolation, a polygon of the waterline (outer edge sediment probe plus 1 foot) was developed. Using the approach above, the volume and mass of sediment to be removed were estimated, along with the hotspot footprint. The analysis indicated the interpolated footprint would contain an estimated 524 cy of sediment with CPAHs greater than 15 ppm. The footprint consists of eight areas comprising 2,352 m^2 (0.6 acre), with removal depths of 6-15 inches (see Table 2). Please note that this FIELDS analysis can be replicated, and modified, using the FIELDS tools for ArcGIS or ArcView (available online at epa.instepsoftware.com/fields/).

Comparing FIELDS and Tronox approaches

Post removal sampling will provide a back-up if hot spot sizes are larger than 50x10 ft. The goal of the remedial plan is to remove all sediments with CPAH concentrations greater than 15 ppm and, with an adequate confirmation sampling around the border of each hotspot removal, it seems that this goal should be achieved. The complete extent of each hotspot should be detected and removed. Tronox's approach could remove as little as 1/3 less sediment (176 cy versus 524 cy), although confirmation sampling recommended by FIELDS will likely expand the remediation area considerably.

Points for Consideration

The Tronox removal plan assumes that hotspots were local and possibly do not exceed 25 ft with the stream and 5 ft across stream. An alternative explanation of the data suggests that detecting over 15 ppm may be random and that extended hot spots may not be present in this portion of the stream. Since exceedances were detected in 8 of 41 (19.5%) in the top 6 inches and 5 of 41 (12.2%) times in the 6-15 inch layer, the probability of detecting CPAHs over 15 ppm at any location may be as high as 31.7 %. The fact that the 2006 sample design was a biased sampling (i.e., favoring locations that looked oily?) and that some clustering of hits was seen, suggest that there may be clean sections and dirty sections. However Tronox should be prepared to remove far greater than the 10x50 hotspot if 30 % of confirmation samples exceed 15 ppm.

Appendix

Table 1. Sample results over 15 ppm (hits) and average CPAH concentration by layer.

Table 2. Summary of contaminated sediment volume by CPAH concentration

Figure 1a. Reach 4/5, Transects 16-76. Sample transects with maximum ppm [CPAH] for each location. Sediment thickness is shown in feet.

Figure 1b Reach 4/5, Transects 76-49. Sample transects with maximum ppm [CPAH] for each location. Sediment thickness is shown in feet.

Figure 2a. Reach 4/5, Transects 16-76. Sample transects with maximum ppm [CPAH] for each location. Footprint of sediments over 15 ppm.

Figure 2b. Reach 4/5, Transects 76-49. Sample transects with maximum ppm [CPAH] for each location. Footprint of sediments over 15 ppm.

	hits	total analyses	percent	
>/=15 ppm	13	123	10.6	plus 3 dupes
	hits	total hits		
0-6"	8	13	61.5	plus 2 dupes
6-15"	5	13	38.5	plus 1 dupe

	hits	total analyses	
0-6"	8	41	19.5
6-15"	5	41	12.2

	hits	total analyses	
0-6 only	6	41	14.6
6-15 only	3	41	7.3
both	2	41	4.9

	ave conc (ppm)
all samples	9.3
0-6"	13.7
6-15"	5.3
15"-over	2.1

Table 1. Sample results over 15 ppm (hits) and average PAH concentration by layer.

Layer	Top Depth	Bottom Depth	Min. Conc.	Max. Conc.	Density (lbs/yd3)	Volume (cu yd)	Mass(lb)
0-6 inches	0	0.5	0	15	1198	1749.8	15.3
	0	0.5	15	over	1198	**344.8**	**8.7**
Subtotals:						2094.6	24.0
6-15 inches	0.5	1.25	0	15	1198	2177.8	12.5
	0.5	1.25	15	over	1198	**179.2**	**3.7**
Subtotals:						2357.0	16.2
15 inches and over	1.25	3	0	15	1198	1226.2	3.7
	1.25	3	15	over	1198	**0.0**	**0.0**
Subtotals:						1226.2	3.7
GRAND TOTALS:						5677.7	44.0

Table 2. Summary of contaminated sediment volume by [PAH].

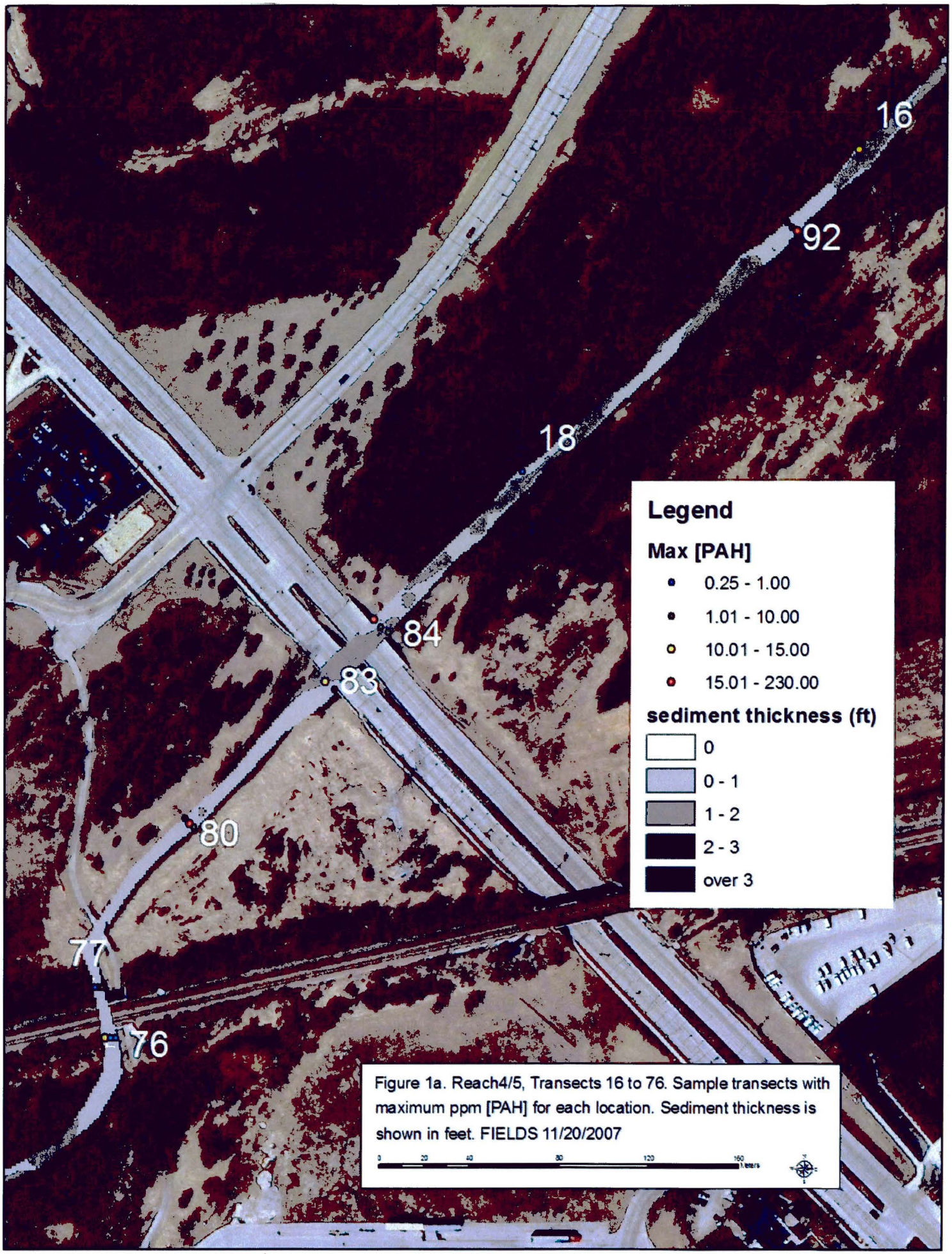

Figure 1a. Reach4/5, Transects 16 to 76. Sample transects with maximum ppm [PAH] for each location. Sediment thickness is shown in feet. FIELDS 11/20/2007

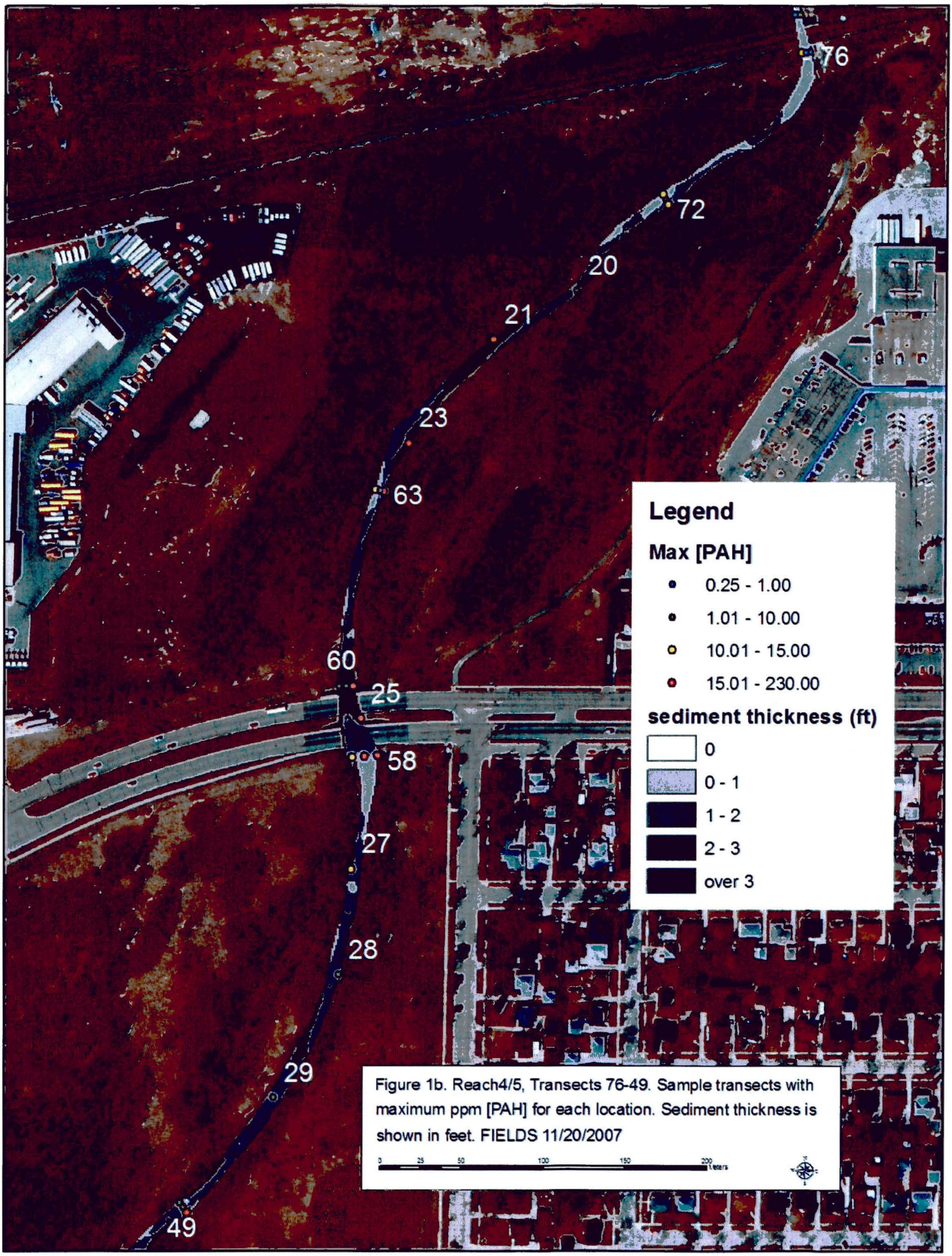

Figure 1b. Reach4/5, Transects 76-49. Sample transects with maximum ppm [PAH] for each location. Sediment thickness is shown in feet. FIELDS 11/20/2007

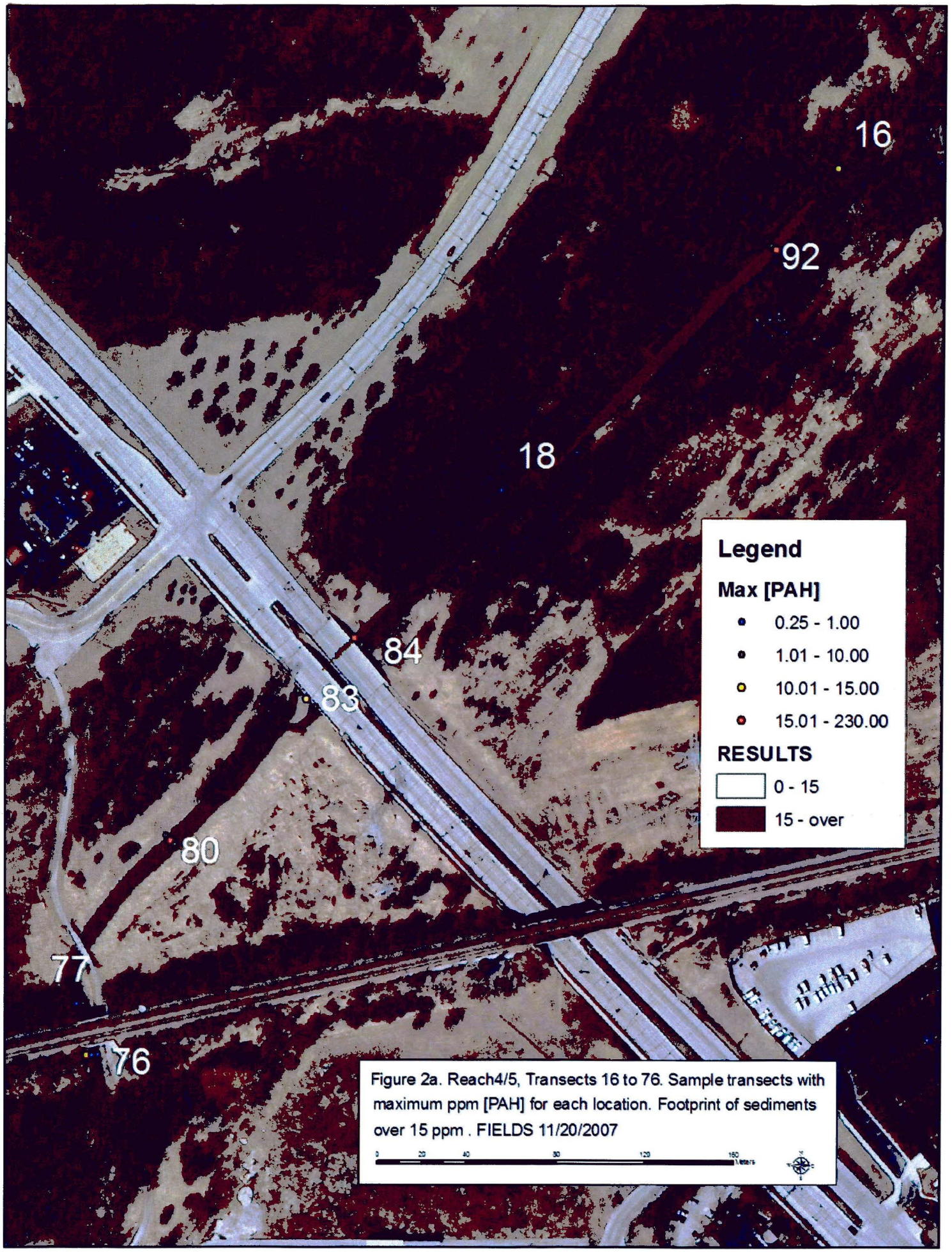

Figure 2a. Reach4/5, Transects 16 to 76. Sample transects with maximum ppm [PAH] for each location. Footprint of sediments over 15 ppm . FIELDS 11/20/2007

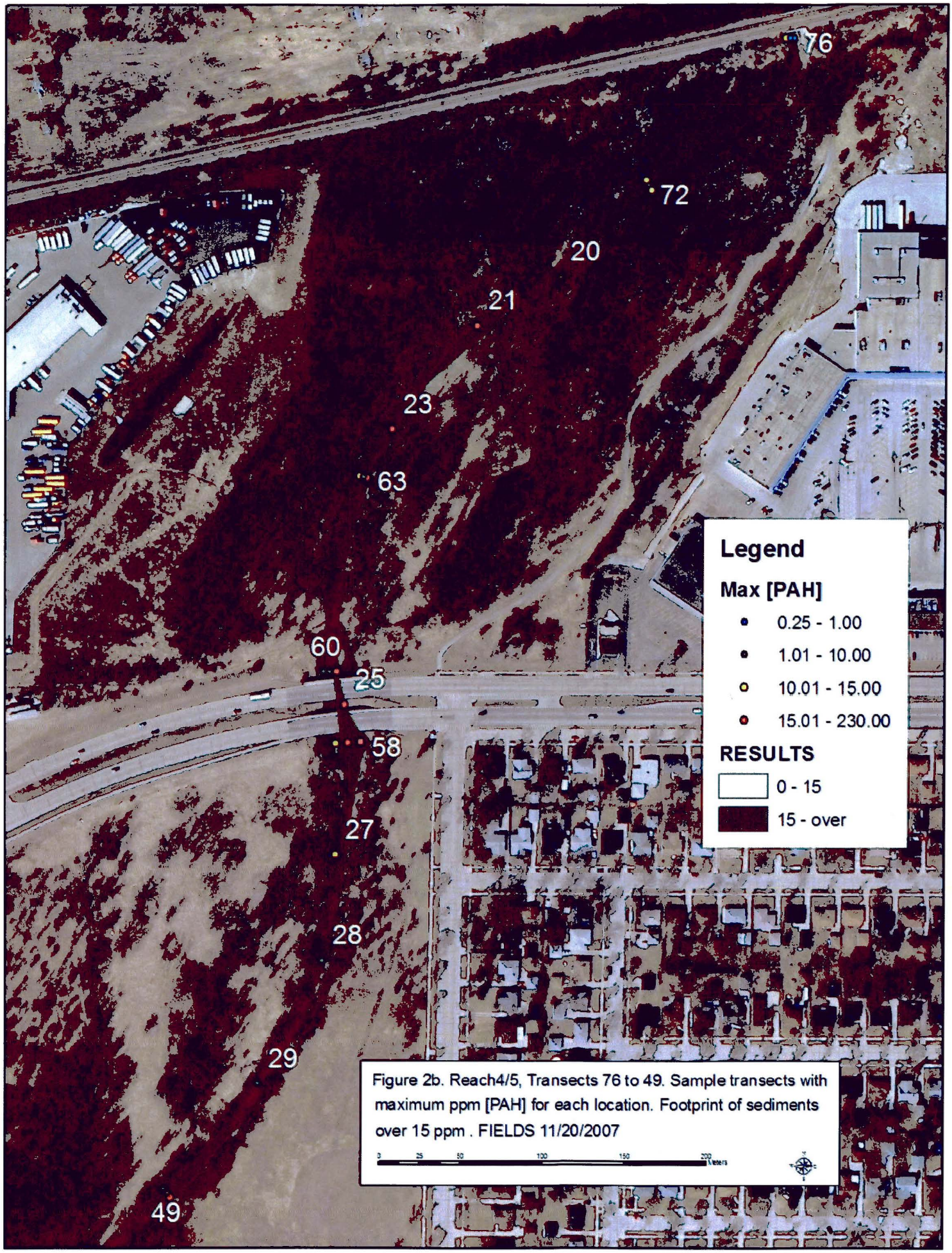

Figure 2b. Reach4/5, Transects 76 to 49. Sample transects with maximum ppm [PAH] for each location. Footprint of sediments over 15 ppm . FIELDS 11/20/2007