Appendix J
Mapping of Contaminant Concentrations in Lower Passaic River Sediments

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ATTACHMENTS

Attachment 1 Support for Geomorphic Groups for Additional Mapped COPCs
Attachment 2 Pooled Data for Resampling of Layer B for Additional COPCs
Attachment 3 Comparison of Mapped Surfaces for Layer A and Resampled Layer B for Additional COPCs

ABBREVIATIONS

1,2,3,4,6,7,8-HPCDF	1,2,3,4,6,7,8-heptachlorodibenzofuran
1,2,3,7,8-PeCDD	1,2,3,7,8-Pentachlorodibenzo-p-dioxin
2,3,4,7,8-PeCDF	2,3,4,7,8-Pentachlorodibenzofuran
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
CFT	contaminant fate and transport
cm	centimeter
COPC	chemical of potential concern
CPG	Cooperating Parties Group
CS	conditional simulation
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
FS	Feasibility Study
IC	initial condition
LPRSA	Lower Passaic River Study Area
mg/kg	milligrams per kilogram
NBSA	Newark Bay Study Area
ng/kg	nanograms per kilogram
PCB	polychlorinated biphenyl
QC	quality control
Region 2	U.S. Environmental Protection Agency Region 2
RI	Remedial Investigation
RM	river mile
ROD	Record of Decision
SSS	side scan sonar
SWAC	surface-weighted average concentration
tetra-CB	tetrachlorobiphenyl
TIN	triangulated irregular network
USEPA	U.S. Environmental Protection Agency
WY	water year

1 Introduction

Interpolated surface (0 to 6 inches) and subsurface sediment contamination concentration maps of the 17-mile Lower Passaic River Study Area (LPRSA) and the Newark Bay Study Area (NBSA) are needed to display contemporary contamination patterns, support the development of remedial alternatives, set initial conditions for the modeling evaluation of these alternatives, and assess temporal trends in surface weighted-average concentrations (SWACs). This appendix describes the mapping developed for the following three primary calibration chemicals of potential concern (COPCs) and the six secondary calibration COPCs that are used in the contaminant fate and transport (CFT) modeling:

- 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)
- Tetrachlorobiphenyl (tetra-CB)
- 1,2,3,4,6,7,8-heptachlorodibenzofuran (1,2,3,4,6,7,8-HPCDF)
- 1,2,3,7,8-Pentachlorodibenzo-p-dioxin (1,2,3,7,8-PeCDD)
- 2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8-PeCDF)
- Polychlorinated biphenyl (PCB)-126
- PCB-167
- Sum of 4,4′-DDx[1]
- Mercury

The mapping was developed for two time periods: 1) using contemporary datasets (2005 to 2013); and 2) using historical datasets (1995 to 1999) for LPRSA surface sediments (0 to 6 inches) and subsurface sediments. Three mapping methods were used: 1) a Thiessen polygon interpolation (for all COPCs); 2) a conditional simulation (for contemporary surface 2,3,7,8-TCDD and tetra-CB concentrations between river mile [RM] 0 and RM 14.7); and 3) a resampling approach for the 6- to 18-inch sediments between RM 0 and RM 14.7. The use of conditional simulation for surface sediments is the result of a collaborative discussion with U.S. Environmental Protection Agency (USEPA) Region 2 (Region 2) on the need to factor uncertainty into the estimation of remedial benefit for alternatives considered in the Feasibility Study (FS). Modeled contaminants other than 2,3,7,8-TCDD and tetra-CB are mapped using Thiessen polygons (see Anchor QEA 2016).

[1] Historical data from 1995 to 1999 are available for the sum of 4,4′-DDx but not total DDx. The sum of 4-4′-DDx is defined as the sum of three isomers: 4-4′-DDD, 4-4′-DDE, and 4 4′ DDT. To allow the use of the historical data, the sum of 4,4′-DDx is used rather than total DDx (total DDx also includes isomers 2,4′-DDD, 2,4′-DDE, and 2,4′-DDT). A comparison of total DDx and 4,4′-DDx for the post-2005 data is presented in Figure 8 of Appendix I and indicates that 4,4′-DDx is well correlated to total DDx and comprises most of the total DDx.

2 Sediment Datasets and Data Treatment

In the mapping developed herein, data collected between 2005 and 2013 are taken as representative of the contemporary contamination in the LPRSA and are referred to as the "2010 dataset." Data collected between 1995 and 1999 are taken as representative of historical contamination in the LPRSA and are referred to as the "1995 dataset." The studies that comprise each of these datasets are listed in Table 2-1.[2]

Some sampling programs characterize a location using co-located samples, with different contaminants analyzed in the different samples (Table 2-1 identifies these studies). The centroid of the convex hull of these co-located cores was used as the sample location in the mapping, with the exception of core cluster 12A-0427 from the 2012 Supplemental Sampling Program for which the sampling location of the 2,3,7,8-TCDD measurement was used (the reason for this exception is described in Section 3.4).

All available data from the LPRSA, Newark Bay, Hackensack River, Kill van Kull, and Arthur Kill were used—no tributary samples were used.[3]

2.1 COPC-Specific Data Treatments

In some samples, a total PCB concentration was available, but the tetra-CB homolog was not available. For these samples, tetra-CB concentrations were estimated from total PCB concentrations using a sediment data regression (transmitted to USEPA on April 5, 2017, ahead of the April 6, 2017 USEPA-Cooperating Parties Group (CPG) Modeling Meeting). Equation 1 shows the regression equation.

[2] The analysis excluded data flagged as "rejected." Non-detects were set to half of the detection limit, and duplicates were averaged. Data treatments used here differ from Windward and AECOM (2015). Pre-2007 data were used, and treatment of duplicates differed. This mapping is used for modeling, which is exempt from the rules in Windward and AECOM (2015).

[3] Available data were used when they met the data treatment requirements described here. For the conditional simulation described in Section 5, only surface sediment LPRSA data between RM 0 and RM 14.7 were used.

Equation 1

$$x = \frac{y - b}{m}$$

where:

x	=	tetra-CB concentration in milligrams per kilogram (mg/kg)
y	=	total PCB concentration in mg/kg
b	=	intercept
m	=	slope

The values for *b* and *m* vary depending on the total PCB concentration range and are listed in Table 2-2. The studies for which the equation was applied are listed in Table 2-1.

2.2 Surface Mapping Data Treatment

The surface mapping characterizes the top 6 inches of sediment, which is the surface segment of most datasets listed in Table 2-1. To include data not measured precisely to 6 inches, the data query included single segments measured from the surface to a depth in the range of 5 to 7 inches (0.4167 to 0.59 foot). Length-weighted averages were also calculated to include cores with multiple segments within the upper 6 inches. Cores considered for length-weighted averaging had segments starting within 0 to 6 inches and ending no deeper than 7 inches (0.59 foot), and when combined were required to extend from the surface to a depth in the 5- to 7- inch (0.4167 to 0.59 foot) range.[4]

2.3 Subsurface Mapping Data Treatment

Subsurface mapping was conducted for five layers: B: 6 to 18 inches (0.5 to 1.5 feet), C: 18 to 30 inches (1.5 to 2.5 feet), D: 30 to 42 inches (2.5 to 3.5 feet), E: 42 to 66 inches (3.5 to 5.5 feet), and F: below 66 inches (5.5 feet). These depth intervals were chosen because they corresponded with the most common segmentation scheme in the datasets used. Length-weighted averages were calculated for each layer in instances where a core's segmentation scheme differed from these intervals.[5] Tables 2-3 through 2-11 list cores with overlapping segments for all nine modeled COPCs.

[4] Cores where only a small segment of the top 6 inches (0.5 foot) was sampled were excluded from the surface mapping because they may not be representative of the full 6 inches (0.5 foot). If the bottom core segment ended at 5 inches (0.4167 foot), the 0- to 5-inch length-weighted average was used as the surface concentration. If the bottom of the last segment used in surface mapping ended at 7 inches (0.59 foot), a length-weighted average down to 6 inches (0.5 foot) was used as the surface concentration.

[5] Some core locations contained an additional segment that overlapped a continuous core profile. These overlapping core segments were removed. An example is location 274, which had segments from 0 to 0.5, 0.5 to 0.9, 0.9 to 2.8, 2.8 to 4, and 4 to 5.1 feet. It also had an additional segment from 1.8 to 3.4 feet, which was excluded from this analysis.

Concentrations were assumed to be zero in layers below the deepest core segment for cores that sampled to native material or were judged to have captured the entire chemical inventory. The criteria used to identify these cores is described in Section 1.2 of Appendix I.

2.3.1 Professional Judgement Adjustments

Length-weighted averaging over Layer B was not performed for core 13B-0563-C2 (located at RM 14.4). This core was segmented at 1.1 feet rather than 1.5 feet because of a visual change in sediment type. The 0.5- to 1.1-foot segment had a 2,3,7,8-TCDD concentration of 1.1 nanograms per kilogram (ng/kg) and was composed primarily of fine and medium grain sand. The 1.1- to 2.5-foot segment had a concentration of 2,130 ng/kg and was composed of silt with a hydrocarbon-like odor. Length-weighting of these concentrations would characterize the location as having 853 ng/kg in the 0.5- to 1.5-foot interval, which brings contamination closer to the surface than exists there. This has implications for modeling because the model simulates vertical gradients on 1 centimeter (cm) resolution and the influence of contamination below the top 15 cm (6 inches) on the concentrations in the top 15 cm (6 inches) occurs mostly with the concentrations in the upper portion of the 0.5- to 1.5-foot interval. The model is much less impacted by the choice of concentrations in the lower portion of this interval. For this reason, the concentration of 1.1 ng/kg was used for Layer B and the concentration of 2,130 ng/kg was used for Layer C. Table 2-12 lists core segment concentrations and descriptions from the boring logs (AECOM 2015).

Within the Lower Passaic River, other cores which had Layer B segments with start depths greater than 0.5 and end depths greater than 1.5 feet were examined for potential adjustment (Table 2-13)[6]. However, no further adjustments were made as most of the remaining cores either had concentration differences within an order of magnitude, the segments were mostly within the Layer B interval, or the Layer B concentration at the core location was specified by resampling. Moreover, most of the cores in Table 2-13 are located within the Lower 8.3 Miles (below RI RM 8) of the LPR and consequently they are unlikely to strongly impact model projection results because this reach of the river will be remediated.

2.3.2 Layer F (below 5.5 feet)

Concentrations more than 5.5 feet below the sediment surface are required for simulating contaminant release during dredging beyond 5.5 feet, which is planned in certain navigation channel areas in the Lower 8.3 Miles (below RI RM 8) of the LPR (Record of Decision [ROD]; USEPA 2016). To achieve better spatial coverage for interpolating the deep layers, data collected between 1995 and 2013 were used. The interpolation comprised two types of cores: 1) cores with measured

[6] High-resolution cores have short segmentation and were not examined here.

concentrations below 5.5 feet and less than 0.5 foot of total gaps in the core profile[7]; and 2) full inventory cores as described in Section 1.2 of Appendix I. Length-weighted-average concentrations were calculated from 5.5 feet down to the dredge depth in the model grid cell or the last measured end depth, whichever was shorter.[8] Core profiles of full inventory cores beneath which the concentration was assumed to be zero are shown in Appendix I, Figure 4[9].

[7] There were five exceptions where high-resolution cores had greater than 0.5 foot of total gaps but had a significant resolution of segments to estimate concentrations: G0000004-7A and G0000005-9A of the USEPA/Malcom Pirnie, Inc. – High-Resolution Sediment Coring Program; and HRC-02H, HRC-03H, and HRC-04H of the 2011 Joint Defense Group – Sediment Sampling Program. Other cores with gaps below 5.5 feet were excluded from this analysis, but none of these excluded cores fell within the model grid cells identified for deep dredging (dredging below 5.5 feet).

[8] For cores below 5.5 feet that ended before the modeled dredge depth and were not complete cores, the length-weighted-average was calculated down to the last measured depth in the core.

[9] Layer F was developed for the purpose of mapping contaminant concentrations in areas that undergo dredging below 5.5 feet in the Lower 8.3 Miles. Layer F as described here was not used in the chemical mass inventories presented in Section 6 of the RI; the methodology used in the chemical mass inventories includes mass down to the last measured depth (even if this is deeper than the depth of deep dredging) and is described in Attachment I.

3 Geomorphic Groups

In mapping, the entire 17-mile LPRSA[10] was divided into geomorphic "groups" based on the observation that COPC concentration patterns differed among these groups.[11] The groups were used to establish interpolation boundaries directly in the Thiessen polygon mapping approach (Section 4) and in modified form in the conditional simulation mapping approach (due to the geostatistical assumptions of that approach; see Section 5).

Geomorphic groups within the LPR were delineated differently upstream and downstream of RM 7.8 to account for differences in sediment characteristics. Upstream of RM 7.8, there is a mixture of fine and coarse sediments, whereas muddy sediments dominate downstream of RM 7.8 (see Section 4 of the Remedial Investigation [RI] report).

The geomorphic group delineations are shown in Figure 3-1, and the distributions of Passaic River surface sediment 2,3,7,8-TCDD concentrations by group are shown in Figure 3-2. Surface sediment concentrations by group for other modeled COPCs are shown in Attachment 1. The basis for the geomorphic delineations is provided in Sections 3.1, 3.2, and 3.3 for regions below RM 7.8, above RM 7.8, and outside of the LPR, respectively.

3.1 Geomorphic Groups Downstream of RM 7.8

Downstream of RM 7.8, shoals were separated from the channel to reflect the steep contaminant concentration gradients typically observed moving from shoal to channel (see Section 4.1 of the RI report) and the fact that the shoals have—for the most part—not been dredged, whereas the channel has been dredged for navigation at various times (see Section 1 of the RI report). The shoals were separated into *Left Shoal* or *Right Shoal LPR*[12] groups to allow interpolation within a shoal but not across the channel into the opposing shoal. These shoal groups combine the "broad shoals" and "margins" in Region 2's geomorphic regions (SEI and HQI 2011).

The channel between RM 7.8 and RM 2.3 was subdivided based on historical deposition patterns evident in changes in bathymetry measured in this reach. These patterns were defined using three

[10] NBSA, parts of the Hackensack, and the Kills were also divided into groups using the navigational channel.

[11] USEPA conducted evaluations of the grouping approach used here and concluded that this stratification approach had low predictive power (USEPA 2015, 2017). The concept of stratification was retained with the expectation that pre-design investigation data would be used to reevaluate the value of the stratification approach and potentially develop a new mapping procedure.

[12] "Left" and "Right" are used here from the perspective of an observer moving upstream (i.e., the left shoal is the western shoal along most of the LPR).

bathymetric datasets: 1949, 1966, and 2011.[13] Release of 2,3,7,8-TCDD from the Lister Avenue site started in approximately 1948 (Bopp et al. 1991); thus, the 1949 bathymetry dataset represents the river bathymetry at approximately the time the Lister Avenue site discharge started, and the 1966 bathymetry dataset represents the river bathymetry toward the end of contaminant discharge. (The active release of 2,3,7,8-TCDD from the Lister Avenue site is presumed to have ceased in 1969 based on plant operating history [Bopp et al. 1991]; other point source contaminant loadings are thought to have decreased significantly after the passing of the Clean Water Act in 1972.)

The channel between RM 7.8 and RM 2.3 was divided into the following three groups:

- *No Deposition Since 1949*:[14] Areas deeper in 2011 than 1949 (using 0.4 foot deeper as the break point,[15] reflecting uncertainty in the bathymetry data), indicating that post-1949 sediments that would have contained 2,3,7,8-TCDD released from the Lister Avenue site may be absent
- *Mixed Depositional Since 1966:*[16] Areas that accumulated sediment between 1949 and 1966 but underwent little net change (i.e., less than 6 inches) between 1966 and 2011
- *Highly Depositional Since 1966:*[17] Areas that accumulated 6 inches or more of net sediment between 1966 and 2011

Due to the lack of 1949 bathymetry data above RM 6.8 and below RM 2.3, the channel areas between RM 6.8 and RM 7.8 and between RM 2.3 and RM 2.5 were classified based on 1966 to 2011 bathymetric differencing alone (i.e., there are not any *No Deposition Since 1949* areas in this region).

This delineation of the channel is generally supported by the 2,3,7,8-TCDD concentrations characteristic of each group. Locations in the *No Deposition Since 1949* group tend to have low concentrations (Figure 3-3, left portion of top panel). The highest concentrations tend to be found at locations in the *Mixed Depositional Since 1966* group, presumably reflecting minimal net burial since the time of active 2,3,7,8-TCDD discharges to the river or burial followed by erosion (Figure 3-3, left

[13] As described in Appendix A, the 1949 bathymetry dataset extends from RM 2.5 to RM 6.8 and consists of post-dredge bathymetry surveys conducted in 1949 (RM 2.5 to RM 5) and 1950 (RM 5 to RM 6.8). The 1966 bathymetry survey extends from RM 2.3 to RM 7.8. Uncertainties related to these datasets are also discussed in Appendix A. The 2011 multi-beam bathymetry survey, which extends from RM 0 to RM 14, was used as an end-year in defining bathymetric groups because it captures the influence of Hurricane Irene. Fifty-two percent of the surface sediment data (including the four highest concentrations) used in the mapping of the channel between RM 2.3 and RM 7.8 are collected post-Hurricane Irene. Bathymetry survey comparisons were done on a 5-foot by 5-foot grid. Assessments of bathymetry differences between 1949 and 1966 or 2011 are limited to RM 2.5 to RM 6.8 in the navigational channel because of the extent of the 1949 survey. Assessments of bathymetry differences between 1966 and 2011 are limited to RM 2.3 to RM 7.8 in the channel because of the extent of the 1966 survey.

[14] This group may include areas that have experienced no deposition since 1949, along with areas where net erosion has exceeded net deposition since 1949.

[15] The cut-off of 0.4 foot of erosion for defining interpolation group boundaries was selected based on the transition in 2,3,7,8-TCDD concentrations observed at approximately this value (Figure 3-3, top panel).

[16] This group may include areas in the river that experience routine erosion and deposition.

[17] This group may include areas that are depositional in the long term but have also experienced erosion that was exceeded by deposition.

portion of bottom panel). Locations in the *Highly Depositional Since 1966* group tend to have intermediate surface sediment contaminant concentrations with relatively low variability (Figure 3-3, right portion of bottom panel), consistent with more recent deposition. These differences among the geomorphic groups are further illustrated by comparing the distribution of 2,3,7,8-TCDD concentrations among them (Figure 3-4).

Parts of the channel where no 1966 bathymetry data were available (14 out of 181 acres in the channel between RM 2.3 to 7.8) were assigned to the *Highly Depositional Since 1966* group (Figure 3-5, hatched areas), except for one area (0.7 acre) that was assigned to the adjoining *Mixed Depositional Since 1966* group (Figure 3-6, hatched area) based on professional judgment. Many of the areas assigned to *Highly Depositional Since 1966* in Figure 3-5 (hatched areas) are near bridges. The four 2,3,7,8-TCDD samples in these areas have concentrations ranging from 150 to 223 ng/kg, which supports their classification as *Highly Depositional Since 1966* (Figure 3-5). Conversely, the area shown in Figure 3-6 has two characteristics consistent with other *Mixed Depositional Since 1966* areas: it is located on an outer bend of the channel and contains an elevated surface sediment 2,3,7,8-TCDD concentration (4,900 ng/kg).

Due to the lack of 1949 and 1966 bathymetry data, the channel downstream of RM 2.3 was classified as a single interpolation group termed *Downstream LPR and Newark Bay Channel.*[18] This region has generally been subject to significant historical infilling, particularly below RM 1.7 where the channel was dredged as recently as 1983 (see Section 1.2 of the main RI report). Consistent with that fact, this region of the LPR has surface sediment 2,3,7,8-TCDD concentration in line with those in the *Highly Depositional Since 1966* areas previously discussed (Figure 3-2, upper panel).

For the other mapped COPCs, Attachment 1 contains comparisons of surface sediment concentration distributions for all geomorphic groups below RM 7.8 (as in the top panel of Figure 3-2 for 2,3,7,8-TCDD) and for channel geomorphic groups between RM 2.6 and RM 6.8 alone (as in Figure 3-4 for 2,3,7,8-TCDD), as well as evaluations of surface concentrations versus bathymetry change (as in Figure 3-3 for 2,3,7,8-TCDD).

The comparison of surface sediment concentrations among geomorphic groups for other COPCs shows both similarities to and differences from the 2,3,7,8-TCDD patterns:

- Similar to 2,3,7,8-TCDD (Figures 3-2 [top panel] and 3-4), for all COPCs, the concentration distributions are visually higher in the *Mixed Depositional Since 1966* channel group than in the *Highly Depositional Since 1966* group (Attachment 1, Figures 1, 3, 4, 6, 7, 9, 10, 12, 13, 15, 16, 18, 19, 21, 22, and 24, albeit with somewhat more overlap in the lower portion of the

[18] On the upper panel of Figure 3-2, this group is labeled *Downstream LPR Channel* because this panel shows only RM 0 to RM 7.8 and excludes Newark Bay.

distributions for PCB-167 and mercury (Attachment 1, Figures 16, 18, 22, and 24). The tendency for *Mixed Depositional Since 1966* to capture the highest channel COPC concentrations is also evident in the cross plots with bathymetric change (Figure 3-3 for 2,3,7,8-TCDD and Attachment 1, Figures 2, 5, 8, 11, 14, 17, 20, and 23 for the other COPCs).

- Similar to 2,3,7,8-TCDD (Figure 3-2 [top panel]), there is substantial overlap between the concentration distributions for the *Downstream LPR Channel* and *Highly Depositional Since 1966* groups for tetra-CB, PCB-126, PCB-167, total 4,4′-DDx, and mercury (Attachment 1, Figures 1, 13, 16, 19, and 22). However, there is comparatively less overlap in these distributions for 1,2,3,4,6,7,8-HpCDF, 1,2,3,7,8-PeCDD, and 2,3,4,7,8-PeCDF (Attachment 1, Figures 4, 7, and 10).

- The relationship between the *No Deposition Since 1949* and the other distributions is variable among COPCs (albeit with a low data count in this group), with tetra-CB (Attachment 1, Figure 1) showing the most similar pattern to 2,3,7,8-TCDD (Figure 3-2 [top panel]). This is also apparent on the cross plots with bathymetric change (Figure 3-3 for 2,3,7,8-TCDD and corresponding figures in Attachment 1 for other COPCs).

- The relationship between the shoal concentration distribution and the channel geomorphic groups varies by contaminant (Figure 3-2 [top panel] for 2,3,7,8-TCDD and corresponding figures in Attachment 1 for other COPCs).

Despite some differences noted above, adjustment of geomorphic groups below RM 7.8 for individual contaminants was not attempted for practical reasons and to avoid COPC-specific interpolation boundaries from causing the mapping to underrepresent the correlation between other contaminants and 2,3,7,8-TCDD (e.g., see Section 4 of the main RI report).

It should also be noted that additional sediment chemistry and physical data have been and will be collected below RM 7.8 as part of the Lower 8.3 Mile remedial design (per the ROD; USEPA 2016). These data will supplement and may in part supersede the RI data, allowing the mapping analysis presented in this appendix to be refined, including the definition of the interpolation groups described above.

3.2 Geomorphic Groups Upstream of RM 7.8

Upstream of RM 7.8, contaminant concentrations correlate with fine sediment content (Figure 3-7). For this reason, fine sediment deposits were delineated as geomorphic groups.

The boundaries of the fine sediment deposits were initially defined as the boundaries of the silt areas identified by the 2005 side scan sonar (SSS) survey and then expanded, as warranted, by probing data and grain size data (see Table 3-1 for the probing and grain size surveys used).

The following rules were applied when expanding boundaries or delineating new silt areas (Figure 3-8)[19]:

- Two sediment characteristics were taken as indicative of silt:
  - Probing measurements classified as silt[20] at the surface
  - Core data with at least 20% fine sediments[21] measured at the surface based on the observation that samples with less than 20% fine sediments tend to have lower contaminant concentration (Figure 3-7)
- The boundaries of the silt areas were generally expanded to include a 10-foot radius around probing or grain size measurements meeting the above characteristics. An exception was where a "silt" probing location was adjacent to probing measurements that indicated a mixture of fine and coarser sediment (i.e., "silt and sand" or "gravel and silt or clay"). In this case, the silt boundary was drawn to include the "silt" location and exclude the mixed sediment location with the boundary being drawn halfway between the two locations, rather than 10 feet beyond the "silt" probe.
- Expanded or new silt areas based on probing were accepted only if the "silt" probing was confirmed by at least one sediment sample containing 20% or more fine sediment.
- New silt areas that were not continuous with existing SSS silt deposits were not incorporated into the mapping if they were smaller than 1 acre.

Surface sediment 2,3,7,8-TCDD concentrations within the expanded silt areas are compared to those in other sediment types upstream of RM 7.8 in Figure 3-9. This figure shows that the silt areas contain consistently higher surface concentrations, with the exception of a few samples in areas mapped as "rock and coarse gravel" and "gravel and sand" in the SSS survey. Based on the nature of those samples (e.g., fine sediment content), they likely reflect small pockets of fine sediment within the larger coarse deposits (as discussed in Sections 4.1 and 4.2 of the main RI report).

The majority of the individual silt deposits were separated into subgroups to prevent interpolation between deposits on opposite sides of the channel (these are collectively shown as *Silt* in Figures 3-1c through 3-1g and labeled individually for referencing purposes). A subgroup was split from the RM 10.9 silt deposit to account for the low 2,3,7,8-TCDD concentrations in the coarse

[19] Silt groupings were discussed in interactions with USEPA. Silt groupings will be reassessed for revision pending the collection of additional sediment type data.

[20] Probing results indicating "silt and sand" were included in the expanded silt areas if there was other evidence of silt around them (see Figures 3-8c, 3-8d, and 3-8f). There were only four locations with "clay" probing results above RM 7.8. These "clay" probing results were not used to expand the silt areas.

[21] Fine sediment is here defined as sediment passing through either the 63-micron sieve (#230) or the 75-micron sieve (#200), depending on the method used for grain size.

sediments that exist along the eastern shore (Figure 3-10, hatched area), presumably reflecting shallow water turbulence that prevents long-term accumulation of fine sediment.

The non-silt areas upstream of RM 7.8 were grouped as *Right Shoal LPR*, *Left Shoal*, and *Upstream Channel*.[22] These shoals were continuous with the shoals downstream of RM 7.8. The *Upstream Channel* group comprises non-silt regions upstream of RM 7.8 that are not within the shoals.

Distributions of surface sediment concentrations by geomorphic group above RM 7.8 are shown in the bottom panel of Figure 3-2 for 2,3,7,8-TCDD and in Attachment 1 for other COPCs (bottom panel of Figures 1, 4, 7, 10, 13, 16, 19, and 22). Similar to 2,3,7,8-TCDD, concentrations of the other COPCs tend to be somewhat higher in the *Silt* group than in the *Shoal* group (albeit with varying degrees of overlap at the upper and lower tails), and concentrations in both of these groups tend to be notably higher than in the *Upstream Channel* group.

It should be noted that additional sediment chemistry and physical data above RM 7.8 will be collected as part of the Lower 8.3 Mile remedial design (per the ROD; USEPA 2016) and in connection to the remedies currently under consideration upstream of RM 8. These data will supplement and may, in part, supersede the RI data, such that the mapping analysis above RM 7.8 may also be refined in the future.

3.3 Geomorphic Groups Outside of the Lower Passaic River

The CFT model required sediment concentrations for initial conditions (ICs) within the LPR, Newark Bay, the Hackensack River, Arthur Kill, and Kill van Kull. This section describes the mapping groups used to interpolate sediment concentrations outside the LPR.

Outside the LPR, the navigation channel was used to delineate between channel and shoal for the purpose of mapping; the history of channel dredging and the resulting bathymetric differences justified separating the channel from the less perturbed shoals.

Within Newark Bay, the area within the navigation channel delineation was termed *Downstream LPR and Newark Bay Channel* and was continuous with the channels at the mouth of the LPR and the Kills. Areas not defined by the navigation channel were classified as one of three shoal groupings. The *Left Shoal* grouping follows the western bank of Newark Bay into Arthur Kill and is continuous with the *Left Shoal* grouping of the LPR. The *Hackensack and Newark Bay Right Shoal* grouping lies along the eastern bank starting from within the Hackensack River continuing through Kill van Kull (Figures 3-1n, o, and r). The *Staten Island Shoal and Southern Arthur Kill* grouping lies along the

[22] Non-silt shoals from RM 7.8 to RM 14.5 were based on the combination of "broad shoals" and "margins" in Region 2's geomorphic regions (SEI and HQI 2011). Above the upstream extent of USEPA's geomorphic region at RM 14.5, two shoal areas were identified based on the 2007 bathymetry (Figure 3-1a).

southern bank of Newark Bay between the confluence of Arthur Kill and Kill van Kull and continues into the Kills (Figures 3-1o and p). The *Staten Island Shoal and Southern Arthur Kill* grouping was also used as the default grouping beyond the navigation channel definition in Arthur Kill (Figures 3-1o and p).

The Hackensack River was delineated into three groups. The navigation channel was used to define the *Hackensack Channel*, and areas not defined by the channel were classified as either *Upper Hackensack and Lower Left Shoal* or *Hackensack and Newark Bay Right Shoal* (continuous with Newark Bay Shoals). Similar to Arthur Kill, the navigation channel definition does not extend to the end of the mapped area. Areas beyond the navigation channel were defaulted into the *Hackensack and Lower Left Shoal* grouping (Figure 3-1r).

Due to a lack of data[23] in the channel area of Kill van Kull, the average concentration of samples in lower Newark Bay within the *Downstream LPR and Newark Bay Channel* grouping was used to estimate the channel concentration in Kill van Kull (Figure 3-11).

3.4 Professional Judgement Adjustments

Two adjustments made on the basis of professional judgment are detailed below.

As noted in Section 2, the location of the 2,3,7,8-TCDD measurement for core cluster 12A-0427 was used in favor of the cluster's centroid location from the 2012 Supplemental Sampling Program. This choice was made because the core cluster consists of samples that straddled two geomorphic groups. As shown in Figure 3-12, the centroid location of the 12A-0427 cluster is located in the *No Deposition Since 1949* group, while the specific core that was analyzed for 2,3,7,8-TCDD falls within the *Mixed Depositional Since 1966* group. Because the concentration of 11,700 ng/kg in this surface sample was more similar to cores in the *Mixed Depositional Since 1966* group, the 2,3,7,8-TCDD sample location was used in favor of the centroid location in this case.

As shown in Figure 3-13, the boundary between *Right Shoal LPR* and *Upstream Channel* at RM 11.75 was moved 5 feet toward the channel. This choice was made so that core LPRT12E is included in the shoal. The 2004[24] bathymetry data indicate that this core is at the top of a channel side slope, so its concentration would not be expected to represent the channel. The first inset map in Figure 3-13 shows a 3D view of this location with a five-times vertical exaggeration.

[23] The dataset available at the time of mapping lacked sufficient data in the channel area of Kill van Kull.

[24] The 2004 single-beam bathymetry survey is used in Figure 3-13 due to its coverage of this shoal (the roughly 100-foot spaced transects were interpolated onto a 5-foot by 5-foot grid using a triangulated irregular network [TIN]). The 2008 multi-beam survey also shows core LPRT12E at the top of the channel side slope.

3.5 Shallow Sediment Areas

Some parts of the LPR have less than 6 inches of sediment on top of hard bottom that likely contains little contaminant inventory. Such areas were identified by probing and core depth information and termed shallow sediment areas. They were delineated around groups of probing locations and cores that did not reach below 0.5 foot, as well as abandoned locations where cores were attempted but failed because of shallow coarse sediment. These areas were assumed to have no sediment below 0.5 foot and, thus, were assigned a concentration of zero for all subsurface layers. The delineation of shallow sediment areas is shown in Figure 3-14.

The zero subsurface concentrations are constrained to the spatial extent of the shallow sediment areas and are not interpolated beyond this extent.

4 Thiessen Polygon Mapping Approach

A Thiessen polygon delineates an area of influence for a sample location such that any point within the polygon is closer to that sample location than to any other sample location. The concentration throughout the polygon is assumed equal to the measurement at the sample location. This interpolation method is a simple representation of spatial correlation that assumes concentrations are perfectly correlated at the scale of the polygon and change abruptly at the boundary between adjacent polygons. When used to compute SWAC, it amounts to weighting each measured value by a polygon area that depends on the local data density (i.e., concentrations from areas of high density are assigned a smaller weight than concentrations from low-density areas), so the technique is sometimes referred to as de-clustering. Interpolation by Thiessen polygons has the benefit of honoring the distribution of the measured data and has been used at many contaminated sediment sites, including the Grasse and Hudson rivers (New York), Fox River (Wisconsin), and Housatonic River (Massachusetts).

Contaminant concentrations were interpolated using Thiessen polygons, with one exception in Kill van Kull (Figure 3-11).[25] Thiessen polygons were created for each geomorphic group described in Section 3 and clipped to the boundaries of the group. The interpolations for each group were combined to generate a continuous map of concentrations. For subsurface groupings, concentrations were set to zero within shallow sediment area polygons.[26] Maps of Thiessen polygon concentrations for the 2010 dataset Layers A and B are shown in Appendix O, Attachment 1 Figures 19 through 36.

4.1 Mapping Layer F (below 5.5 feet)

The layer F dataset described in Section 2.3.1 was interpolated using the Thiessen polygon methodology described in Section 4.

4.2 1995 Mapping

Mapped sediment concentrations in 1995 are required to set the ICs for the long-term model calibration period, water year (WY)1996 to WY2013. For increased spatial coverage and data density, data collected between 1995 and 1999 were taken as representative of 1995 (the start of the calibration period). Table 2-1 lists the studies used in the 1995 dataset. Sufficient data from the 1995 dataset were only available between RM 1 and RM 7 and in part of the Newark Bay channel.

[25] Due to lack of data and to prevent interpolation from Newark Bay across land into Kill van Kull, Thiessen polygons were not used in the channel area of Kill van Kull. Instead, an average of the data in the black-hatched "averaging area" was used to set the concentration in the magenta-hatched "applied area" as shown in Figure 3-11.

[26] The zero concentration in shallow sediment areas is constrained to the spatial extent of the shallow sediment areas and is not interpolated beyond this extent. The zero concentrations below full inventory cores are not interpolated into areas with measured concentrations for that depth interval.

(Appendix O, Attachment 1, Figures 1 through 18 show maps of the 1995 COPC concentrations in Layers A and B.) Elsewhere, the 2010 mapped surface was used to set 1995 ICs, with the exception of Layer A 2,3,7,8-TCDD and tetra-CB for which thiessen polygons based on the 2010 dataset were used to set 1995 ICs—see Appendix O, Attachment 1, Figures 21 through 36 (a to g and m to q).

5 Conditional Simulation Mapping Approach

From RM 14.7 to the mouth, conditional simulation was used as the basis for mapping surface sediment 2,3,7,8-TCDD and tetra-CB. Conditional simulation provides a way to account for uncertainty in the mapping and in the estimation of remedial benefit for alternatives considered in the FS. An overview of the approach is provided in Section 5.1, and a more detailed discussion of its components is provided in Sections 5.2 to 5.4.

5.1 Overview

Conditional simulation is based on kriging, which is an interpolation method that produces gridded estimates of the parameter of interest and the uncertainty of those estimates (i.e., the prediction error), given the observed data and a variogram function that characterizes spatial correlation. The kriging estimate has the minimum variance among all estimates that are linear functions of the data, providing the best estimate of concentration and its variance at each grid node. The conditional simulation uses the kriging predictions, along with the variogram and the observed data, to create equally probable random realizations of the concentration field. These concentration fields are realistic in the sense that they (on average) reproduce the mean and variance of the observed data and the covariance as defined by the variogram. The measured concentrations at sample locations are also honored, although some deviation may arise from the resolution of the grid and the assumed variance at very small separation distance (termed the nugget of the variogram; see Section 5.3).

Kriging methods have been described many times (e.g., Cressie 1993; Chilés and Delfiner 1999; Isaaks and Srivastava 1989; Goovaerts 1997) and multiple variations of the approach exist. The basic simple kriging model used herein may generally be expressed as:

Equation 5-1

$$Z(s) = \mu + W(s) + \varepsilon(s)$$

where:

s	=	a spatial location
$Z(s)$	=	the value to be predicted; in this case, chemical concentration
μ	=	the mean, which is assumed constant over the interpolation domain
$W(s)$	=	the fluctuation, which is assumed to be a stationary Gaussian random field with zero mean and a covariance function defined by the variogram
$\varepsilon(s)$	=	an independent Gaussian random variable with zero mean and variance equal to the nugget of the variogram (τ^2), corresponding to the variance at zero separation distance (e.g., due to measurement error or microscale variance)

The kriging model defined in Equation 5-1 assumes that the field being interpolated is normally distributed[27] with stationary (constant) mean and variance, and the conditional simulation used herein is based on the same assumption. In an effort to conform to these assumptions, the concentration data were natural log transformed and divided into spatial groups that were kriged and simulated separately. In particular, the river was divided into areas with similar mean concentration (termed data groups or "mgroups"), and then mgroup data were converted to residuals by subtracting the mgroup mean from the data.[28] Mgroups whose residuals have similar variances were aggregated into kriging groups (termed "vgroups"). Kriging and conditional simulation were performed on residual concentrations using a variogram derived on the same basis. The simulation results for each vgroup were combined to generate a continuous map of results via a series of post-processing steps that include re-trending the predicted residuals (i.e., adding back the mgroup mean) and back-transforming the predictions to arithmetic space (by exponentiation).

The kriging and conditional simulations were conducted on a 20-foot by 20-foot grid in a straightened river coordinate system, yielding predictions on grid cell center points. Geostatistical calculations were performed using Ribeiro and Diggle's (2001) GeoR package for the R environment for programming, graphics, data analysis, and statistical computation (R Core Team 2014).

[27] When kriging is applied to a skewed data distribution, the values from the longer tail of the distribution tend to exert disproportionate influence over the interpolator, thereby negatively impacting the accuracy of the interpolator. It is common practice to apply a data transformation to generate a dataset whose marginal frequency distribution is reasonably close to a normal distribution. This step is done prior to variogram development and kriging, and the kriging predictions are then back-transformed.

[28] The mean concentration μ in Equation 5-1 is zero when kriging is performed on a residual basis.

Conditional simulation was implemented using GeoR's Bayesian approach (Diggle and Ribeiro 2007), which is part of the krige.conv function.[29]

Details of the major components of the conditional simulation approach are provided in the following sections. Data preparation, including the delineation of kriging groups, is covered in Section 5.2, development of the variogram is covered in Section 5.3, and post-processing results are in Section 5.4.

5.2 Data Preparation and Analysis

5.2.1 Transformation of the Data

The surface sediment dataset described in Section 2 was transformed in three ways prior to conducting the interpolation by kriging and conditional simulation.

First, the coordinates of the sample locations were converted to a straightened river coordinate system, which removes the sinuosity of the LPR by defining longitudinal position as distance along the thalweg and lateral position as cross-channel distance from the thalweg (Figure 5-1; based on a combination of the 2004 and 2011 bathymetry surveys). This coordinate transform is commonly implemented to allow the anisotropy of correlation distances of concentration to be represented in the interpolation; concentrations tend to be better correlated in the longitudinal direction than the lateral direction in the LPR (see Section 5.3).

Second, measured contaminant concentrations were converted to natural logarithm space, based on the observation that 2,3,7,8-TCDD and tetra-CB concentrations in the LPR are approximately log-normally distributed.

Third, the natural log concentrations were converted to residual concentrations by subtracting out the mean of the log concentrations within each mgroup (see Section 5.2.2.1).

5.2.2 Groups for Kriging and Conditional Simulation

As described in Section 5.1, the conditional simulation approach used herein is based on simple kriging, which assumes a stationary distribution of concentrations (i.e., no trend in mean or variance). Stationarity in the mean concentration was accomplished in an approximate fashion by sub-dividing the geomorphic groups described in Section 3 into data groups with similar means (mgroups). The stationarity of the residual concentration field (i.e., after subtracting out the mgroup mean) was then

[29] It is noted that variogram anisotropy (Section 5.3) was implemented manually in the kriging and conditional simulations via a coordinate transform in the input files rather than directly in the GeoR parameter settings, due to an error that was noted in the GeoR anisotropy inputs.

considered and used to define kriging groups (vgroups) by combining mgroups with similar residual variances. The mgroup and vgroup delineations are described below.

5.2.2.1 Data Groups (mgroups)

In constructing the mgroups, the geomorphic groups (Section 3) were generally split at natural breaks[30] or breaks in Region 2's delineation of geomorphic regions (SEI and HQI 2011). The mgroup subdivisions are shown in Figure 5-2 (maps of mgroups) and Figures 5-3 and 5-4 (spatial plots of the mean plus or minus 2 standard errors and variance plus or minus its 95th percentile confidence bounds of natural log transformed 2,3,7,8-TCDD concentrations, and tetra-CB concentrations, respectively). The mgroup delineations are summarized as follows:

- The left shoal geomorphic group was split at RM 11.5 (break in Region 2's geomorphic regions), RM 9 (silt splits shoal), and RM 6 (Region 2 geomorphic break at the Fourth Avenue Bridge). The resulting left shoal mgroups are designated in Figure 5-2 as *Left Shoal RM 11.3-14.4*, *Left Shoal RM 9-11.3*, and *Left Shoal RM 6-9*.
- The right shoal geomorphic group was split at RM 12 (gap in shoal), RM 10.5 (RM 10.9 silt deposit splits shoal), RM 8.5 (silt splits shoal), and RM 6.5 (Region 2 geomorphic break). The resulting right shoal mgroups are designated in Figure 5-2 as *Right Shoal RM 12-14.7, Right Shoal RM 11-12, Right Shoal RM 8.5-10.5, Right Shoal RM 6.5-8.5,* and *Right Shoal RM 0-6.5*.
- The channel upstream of RM 7.8 geomorphic group was split at RM 13.75 (Region 2 geomorphic break at the Gregory Avenue Bridge), RM 13 (Region 2 geomorphic break at the Douglas O. Mead Bridge), RM 12.5 (Region 2 geomorphic break), and RM 9.5 (silt deposit splits channel). The resulting non-silt upstream channel mgroups are designated in Figures 5-2a through 5-2f as *Upstream Channel RM 13.75-14.7, Upstream Channel RM 13-13.75, Upstream Channel RM 12.5-13, Upstream Channel RM 9.5-12.5,* and *Upstream Channel RM 7.8-9.5*.
- The channel geomorphic groups downstream of RM 7.8 were adopted directly as individual mgroups. They are designated in Figures 5-2f through 5-2l as:
  - *No Deposition Since 1949,* also shown in Figures 3-1g through 3-1l
  - *Mixed Depositional Since 1966,* also shown in Figures 3-1g through 3-1l
  - *Highly Depositional Since 1966,* also shown in Figures 3-1g through 3-1l
  - *Downstream LPR and Newark Bay Channel,* also shown in Figures 3-1l through 3-1m
- Delineated silt mgroups include:
  - The silt deposit just upstream of RM 12 (*Silt RM 12* in Figures 5-2b and 3-1c)
  - The RM 10.9 silt deposit (*Silt RM 10.9* in Figures 5-2c and 3-1d)

[30] Natural breaks refer to gaps that give rise to separate polygons within a geomorphic group—for instance, multiple individual silt deposits comprise the silt geomorphic group above RM 7.8.

- The nearshore area along the RM 10.9 silt deposit (*Silt RM 10.9 Nearshore* in Figures 5-2c and 3-1d)
- A group of seven silt deposits between RM 10.4 and RM 8.2 (*Silt RM 8-10* in Figures 5-2c through 5-2e; comprises *Silt RM 10 Left, Silt RM 9-10, Silt RM 9 Left,* and *Silt RM 8-9 Right* in Figures 3-1e through 3-1f)
- The silt deposit just upstream of RM 7.8 (*Silt RM 7.8* in Figure 5-2f and Figure 3-1g)

5.2.2.2 Kriging Groups (vgroups)

To provide a basis for combining mgroups of similar variance for kriging despite differing means, the natural log transformed data were de-trended by subtracting the mean, and the similarity of the residual distributions was evaluated. Adjacent mgroups were generally judged to have similar variance if the 95th percentile confidence limits on the residual variances overlapped significantly[31] and merged into a kriging group (vgroup). Reducing the number of groups in this manner results in more data per group and yields a better estimate of the variance. It also means fewer instances of the sharp concentration breaks that typically occur at boundaries between interpolation groups.

Kriging vgroups are shown in Figure 5-5 (maps of vgroups) and Figures 5-6 and 5-7 (concentration residuals [upper panel] and the variances plus or minus 95th percentile confidence bounds [lower panel] in relation to river mile). Overall, the 26 mgroups were reduced to 9 vgroups[32]:

- Left shoal mgroups *Left Shoal RM 9-11.3* and *Left Shoal RM 6-9* were combined into vgroup *Left Shoal RM 6-11.3*.
- Right shoal mgroups upstream of RM 6.5 were combined into vgroup *Right Shoal RM 6.5-14.7*.
- All silt mgroups were combined into vgroup *Silt*.
- Upstream channel mgroups (non-silt areas above RM 7.8) were combined into vgroup *Upstream Channel*.
- Downstream channel mgroups *No Deposition Since 1949* and *Mixed Depositional Since 1966* were combined into vgroup *No Deposition Since 1949 and Mixed Depositional*. Mgroups *Highly Depositional Since 1966* and *Downstream Channel* were combined into vgroup *Downstream Channel and High Deposition Since 1966*.

The distribution of COPC concentration and residual concentration within each vgroup is shown in Figures 5-8 and 5-9 for 2,3,7,8-TCDD and tetra-CB, respectively.

[31] An F-test of equality of variances was performed on the residuals. P-values are printed above the bottom panel in Figures 5-3 and 5-4.

[32] The mgroups *Left Shoal RM 0-6*, *Left Shoal RM 11.3-14.4*, and *Right Shoal RM 0-6.5* were not combined with other mgroups and remain as separate vgroups.

5.3 Variogram Development

Variograms characterize spatial correlation. They describe both the strength and directionality of spatial correlation—in effect, the zone of influence of individual data values on predictions at nearby locations, typically with declining influence of a data point with increasing distance from its location. Variograms take the form of a curve relating semivariance (half the variance) to separation distance, which is fitted to an experimental variogram developed from analyzing the observed data in pairs binned by their separation distance (e.g., Isaaks and Srivastava 1989).

Data in the LPR are generally too sparse to develop a variogram for each vgroup, with the exception of the RM 10.9 silt deposit (Figure 5-10), which contains high-density sediment data collected for remedial design (spaced nominally 90 feet apart). The data within this deposit were used to develop an experimental variogram and fit a variogram model (Section 5.3.1), which was then generalized for application to other parts of the river[33] (Section 5.3.2). Directionality (anisotropy) was incorporated into the variogram based on the observation that surface sediment concentrations within the LPR tend to be more correlated in the along-flow direction than in the cross-flow direction (e.g., Figure 5-11, which suggests sharper gradients laterally than longitudinally).

5.3.1 RM 10.9 Silt Deposit Variogram

The along-flow variograms derived for the RM 10.9 silt deposit dataset for 2,3,7,8-TCDD and tetra-CB are presented in Figures 5-12 and 5-13, where the experimental variogram based on binned data pairs is shown in red (including the number of data pairs per bin) and the fitted Gaussian variogram model is shown in black. Directionality was incorporated by restricting the experimental variogram to data pairs within a search band tolerance of plus or minus 20 degrees around the along-flow axis, and a bin size of 95 feet was used.[34] The variogram indicates structure in the along-flow direction, in that there is a five-fold difference between the "nugget" (the y-intercept) and the "sill" (the semivariance at large separation distances)[35]. Conceptually, the nugget represents variance at near-zero separation distance (e.g., due to measurement error or microscale variance) and the sill reflects the background or global variance. The 2,3,7,8-TCDD variogram in Figure 5-12 indicates a "range" of spatial correlation of 505 feet, which is here defined as the separation distance

[33] The use of contemporary data in other parts of the LPRSA and additional datasets (e.g., historical LPRSA sediment data and Lister Avenue Phase 1/Phase 2 data) in variogram development was explored with Region 2 but ultimately not adopted due to data limitations.

[34] Implementation notes: The variogram was developed from the natural log transformed data. The along-flow direction corresponds to the zero azimuth within the straightened river coordinate system; thus, the angle of anisotropy is also zero. Bin size was selected such that most bins would be populated with at least 15 pairs of data; bins with no data are not shown on the variogram. The GeoR package uses the variogram estimator suggested by Hawkins and Cressie (1984), which provides a robust alternative to the classical estimator (see Cressie 1993 for details).

[35] For the 2,3,7,8-TCDD variogram (Figure 5-12), the nugget (0.68) is 21% of the sill (3.28, the sum of the nugget and the "partial sill"). For the tetra-CB variogram (Figure 5-13), the nugget (0.34) is 15% of the sill (2.34).

corresponding to a semi-variance equal to the nugget plus 63% of the "partial sill" (defined as the sill minus the nugget)[36]. Note that definitions of range vary in the literature. The tetra-CB variogram in Figure 5-13 indicates a "range" of spatial correlation of 390 feet.

The variogram in the cross-flow direction is assumed to differ only in the range of spatial correlation (i.e., using the same nugget and sill), and the strength of the anisotropy is expressed by the ratio of the range in the along-flow direction to the range in the cross-flow direction—a quantity termed the anisotropy ratio. The anisotropy ratio was estimated from the 2,3,7,8-TCDD data via rose diagrams (Figure 5-14), which evaluate variogram range along a series of azimuths spanning all directions to characterize anisotropy (see Isaaks and Srivastava 1989). In order to have sufficient data in both the along-flow and cross-flow directions, additional data beyond the RM 10.9 silt deposit were included in constructing the rose diagrams; the expanded dataset is shown in Figure 5-15. The rose diagrams[37] in Figure 5-14 suggest an anisotropy ratio between 3 (tolerance of 30 degrees) and 6 (tolerance of 20 degrees).[38] A ratio of 5 was selected for the kriging and conditional simulations. Given the high spatial correlation between 2,3,7,8-TCDD and tetra-CB, as discussed in Section 7.1.1.4, the anisotropy was modeled the same for both COPCs. It is noted that an anisotropy ratio of 5 may be an upper bound estimate given that the rose diagram analysis combines data from vgroups that are interpolated separately within the conditional simulation.

5.3.2 Generalization of the RM 10.9 Silt Deposit Variogram to Other Areas

Because there was not enough data to develop a variogram for each of the vgroups, the variogram developed from the RM 10.9 silt deposit dataset was scaled and applied to other vgroups. In particular, the sill and nugget of the RM 10.9 variogram model (Figures 5-12 and 5-13) were scaled to each vgroup based on the local variance relative to that of the RM 10.9 deposit dataset (variance of the natural log transformed data). This approach preserves the shape and range of the RM 10.9 deposit variogram when applying it to other vgroups. This scaling was performed separately for 2,3,7,8-TCDD and tetra-CB. Tables 5-1 and 5-2 list the variogram model parameters used for each vgroup. The anisotropy ratio was set to 5 for all vgroups, in accordance with the RM 10.9 variogram development.

When scaling the variogram, an exception was made for the vgroup encompassing the right shoal below RM 6.5 (*Right Shoal RM 0-6.5*), in that the two lowest 2,3,7,8-TCDD and tetra-CB

[36] For 2,3,7,8-TCDD, the range of 505 feet is where the semi-variance is 2.32, corresponding to 63% of the partial sill (2.6) plus the nugget (0.68).

[37] The anisotropy ratio corresponds here to the ratio of the major to minor axis lengths of the ellipse fitted to the rose diagram "spokes," each of which quantifies the range of spatial correlation along a given azimuth using data pairs within the specified directional tolerance (Figure 5-14 evaluates tolerances of 20 and 30 degrees).

[38] The anisotropy ratio is lower for the higher tolerance values (here 30 degrees) because data farther from each azimuth are included in the variogram, which dilutes the anisotropy. Lower tolerance values emphasize the directionality of spatial correlation but reduce the number of pairs in the variogram, which can cause the rose diagram to have erratic spokes.

concentrations[39] were dropped prior to calculating the variances of 0.8 and 0.7 that were used to scale the variogram for 2,3,7,8-TCDD and tetra-CB, respectively (see Figures 5-8h and 5-9h). This was done to prevent these low outliers from inflating the variance, which allowed the conditional simulation to better reproduce the remainder of the concentration distribution. For tetra-CB, a second exception was made for *No Deposition Since 1949 and Mixed Depositional Since 1966* where the lowest tetra-CB concentration of 0.0031 milligrams per kilogram (mg/kg) (12A-0455) was dropped prior to calculating the variance of 1.9 that was used to scale the variogram (see Figure 5-9b).

5.4 Post-Processing of Results

The kriging and conditional simulation results were re-trended and back-transformed using Equation 5-2.

Equation 5-2

$$C = e^{(Z+\mu)}$$

where:

C	=	2,3,7,8-TCDD concentration in arithmetic space
Z	=	residual concentration in transformed space (output from kriging or conditional simulation)
μ	=	the mean of the natural-log-transformed concentration data in the mgroup

Conditional simulation occasionally predicts unrealistically high or low concentrations (i.e., far outside the range of measured data), which can bias mean concentrations and the estimated benefit achieved by remediation to a particular concentration threshold. To eliminate this, results within each vgroup were capped at two times the maximum measured value within the vgroup and globally at the maximum surface sediment concentration measured in the LPRSA (51,100 ng/kg for 2,3,7,8-TCDD and 10.8 mg/kg for tetra-CB). Likewise, low values within each vgroup were bottomed-out at half the minimum measured value within the vgroup. Tables 5-3 and 5-4 list information relating to capping and bottoming-out for each vgroup for 2,3,7,8-TCDD and tetra-CB, respectively.

[39] Sample IDs CLRC-002 (0.05 ng/kg 2,3,7,8-TCDD and 0.0036 mg/kg tetra-CB) and 12A-0421 (0.77 ng/kg 2,3,7,8-TCDD and 0.00026 mg/kg tetra-CB) were dropped. Excluding these samples makes the data distribution closer to log-normal; see Figures 5-8h and 5-9h.

6 Resampling of Layer B

6.1 Overview/Rational

Layer B mapping was initially conducted using Thiessen polygons. Overlaying the resultant Layer A and Layer B maps revealed less correlation and greater differences than exist in the underlying data. The problem derives from two sources of incompatibility:

1. The conditional simulation used for 2010 Layer A 2,3,7,8-TCDD and tetra-CB mapping is incompatible with the Thiessen polygon interpolation originally used in Layer B.[40] Figure 6-1 shows an example of this for 2,3,7,8-TCDD from RM 8 to RM 14.7 in 2010, where the relationship between Layer A and Layer B core concentration data (left panel) was not preserved when Layer A conditional simulation results were paired with the original Layer B interpolation using Thiessen polygons (note the greater density of points away from the one-to-one line).
2. The original Layer A and Layer B Thiessen polygons developed for 1995 and for 2010[41] are mismatched in some areas due to differing data densities. Figure 6-2 shows an example of this for 2,3,7,8-TCDD between RM 0 to RM 7.8 for 1995; the relationship between the Layer A interpolation and the original Layer B interpolation (right panel) was weaker than the relationship between Layer A and Layer B core data (left panel) due to the inclusion of locations where both Layer A and Layer B measurements were not available (see Section 7.1.2 for an example of this issue and its resolution).

To eliminate unrealistic concentration gradients between the layers, a method was developed to select Layer B concentrations based on the Layer A concentrations such that the overall degree of correlation in the data is preserved.

No adjustments were made to deeper layer Thiessen polygon maps because the CFT model is less sensitive to the mapping of these layers than it is to the Layer B mapping. Moreover, the core data indicated that concentrations were less correlated between layers, relative to the Layer A to Layer B correlation.

6.2 Methodology

Layer B values were assigned based on the local Layer A value. To accomplish this, measured Layer A concentrations were segmented into bins. Bin sizes were selected to preserve the overall relationship between measured Layer A and Layer B concentrations while capturing the random variability in Layer B concentrations occurring within relatively narrow ranges of Layer A concentration. The Layer

[40] This does not apply to the seven other modeled COPCs where Thiessen polygons were used to map Layer A. Also, this only applies to RM 0 to RM 14.7. Outside of this RM range, Thiessen polygons were used for mapping all COPCs.

[41] For the seven modeled COPCs for which conditional simulation was not conducted.

A bins used for each modeled COPC are listed in Table 6-1 and are shown as vertical dashed lines in Figures 6-3 and 6-4 for 2,3,7,8-TCDD and in Attachment 2, Figures 1 through 16 for other COPCs (these figures are described further in the subsections below). For locations with Layer A concentrations within a bin, Layer B concentrations were randomly chosen with replacement from the measured Layer B values within the bin.[42] Layer B values of zero were removed from the analysis[43] and the shallow areas described in Section 3.5 were not resampled because these areas are defined as having a sediment depth of 6 inches or less and are therefore assigned a zero Layer B concentration.

The resampling depended on the method used to map Layer A. For Layer A conditional simulation mapping, Layer B concentrations were assigned at every point on the conditional simulation map. For Layer A Thiessen polygon mapping, Layer B concentrations were assigned only at Layer A sampling locations where a measured Layer B concentration was lacking in the data (largely where grab samples were collected). This resulted in a map comprised of paired Thiessen polygons for the two layers (i.e., equally sized polygons containing either measured concentrations in both Layer A and Layer B or a Layer B concentration assigned based on a measured Layer A concentration).

Implementation details for the 2010 conditional simulation mapping and the 2010 and 1995 thiessen polygon mapping are described in Section 6.2.1 through 6.2.2. Table 6-2 summarizes the datasets and the interpolated layer A surfaces used in the resampling.

6.2.1 Conditional Simulation Resampling (2010 Only)

The largest mismatch between the Layer A mapping and the original Layer B Thiessen polygon mapping occurred where the conditional simulation was used to represent Layer A (Figure 6-1).

Resampling was done separately for RM 0 to RM 7.8, silt areas between RM 7.8 to RM 14.7, and non-silt areas between RM 7.8 to RM 14.7.[44] The split at RM 7.8 was chosen to be consistent with how the conditional simulation mapping was conducted. Above RM 7.8, Layer A-Layer B relationships for silt and non-silt regions were established using the 2010 data (Figures 6-3a and 6-3b for 2,3,7,8-TCDD and Figures 1a and 1b of Attachment 2 for tetra-CB). Below RM 7.8, 1995 and 2010 data were pooled to form a larger resampling dataset because of the similarity in the Layer A-Layer B relationship in the two individual datasets (blue and green points in Figure 6-3c for

[42] There were some cases of no available paired Layer A and Layer B data in the smallest or largest concentration bins. In these cases, the next smallest or largest bin was used to resample the data (i.e., bins were merged during resampling in these cases).

[43] There were zeros in layer B data due to the assumption of zero concentrations below the last measured segment for complete cores (see Appendix I). These zeros were excluded from the pool of data for resampling because they are not likely to be representative of other areas of the river outside of the specific locations where they were collected. Zeros are not shown on the cross-plots, but the number of zeros is indicated in the notes.

[44] Layer B was not resampled above RM 14.7 because less data are available here and the Layer B mapping is of lesser importance to the CFT model in this region because it is treated as non-erodible hard-bottom in the sediment transport model.

2,3,7,8-TCDD and Figure 1c of Attachment 2 for tetra-CB). Layer B values were assigned based on the local Layer A value using the methodology described above (i.e., randomly selected from the measured Layer B values within the relevant Layer A concentration bin) applied on the 20-by-20-foot kriging grid. Results of the resampling are discussed Section 7.1.2.

6.2.2 Thiessen Polygon Resampling

For cases where the Layer A mapping and the original Layer B mapping were both based on Thiessen polygons, the disconnect between the interpolated Layer A and Layer B concentrations was limited to locations that did not have measured concentrations for both Layer A and Layer B (as seen in Figure 6-2 and described in Section 6.1). Thus, the Thiessen polygon resampling was applied only at these locations, i.e., a Layer B concentration was assigned to the Layer A sampling location and a new Layer B polygon was drawn around this point. Outside of these areas, the original Layer B Thiessen polygon mapped concentrations were maintained (i.e., those based on measured Layer B concentrations).

6.2.2.1 2010 Thiessen Polygon Resampling

For the 2010 Layer B Thiessen polygon mappings (i.e., all COPCs except 2,3,7,8-TCDD and tetra-CB), resampling was applied as needed to the Layer A 2010 mapped surfaces described in Section 4. The resampling was performed separately for RM 0 to RM 7.8, silt areas between RM 7.8 to RM 14.7, and non-silt areas between RM 7.8 to RM 14.7 using the datasets shown in Attachment 2, Figures 2 through 8. For Thiessen polygons that overlapped the RM 7.8 boundary, the resampled Layer B concentrations from the 0 to 7.8 RM data pool were used.

6.2.2.2 1995 Thiessen Polygon Resampling

For the 1995 Layer B Thiessen polygon mappings (all COPCs), resampling of Layer B was applied as needed to the Layer A 1995 mapped surfaces described in Section 4.2, and was conducted separately within RM 1 to RM 7 and outside this RM extent.

RM 1 to RM 7 is the only region where there are 1995 data available for Layer B resampling. Within this region, the 1995 data were supplemented with 2010 data in order to have sufficient data counts in each of the Layer A concentration bins, as shown in Figure 6-4 for 2,3,7,8-TCDD and Figures 9 through 16 of Attachment 2 for the other COPCs.

Outside of RM 1-7, the datasets used for resampling are the same as for 2010 (Section 6.2.1 for 2,3,7,8-TCDD and tetra-CB and Section 6.2.2.1 for other COPCs).

7 Results of the Mapping in the LPR

The mapped concentrations resulting from the methods described above are shown in Figures 7-1 (2,3,7,8-TCDD) and 7-2 (tetra-CB) (two example conditional simulations). Maps for Layer A and Layer B for all COPCs are shown in Appendix O, Attachment 1, Figures 1 through 36 (see Attachment 1, Table 1 for a list of maps used in CFT model ICs).[45]

7.1 Quality Control

Quality control (QC) checks were performed on the mapping results to verify that the approaches were behaving as expected, particularly for the results of the conditional simulation (Section 7.1.1) and Layer B resampling (Section 7.2.2) because they are derived from the more complicated approaches.

7.1.1 Quality Control for Conditional Simulation Mapping

A representative subset of the QC checks conducted is presented in the following subsections to illustrate the performance of the conditional simulation implementation.

7.1.1.1 Recovery of the Input Concentration Distributions

The output from the simulations should approximately honor the distribution of the input data. This is checked in Figures 7-3 and 7-4 on a full river basis (Figures 7-3a and 7-4a) and vgroup basis (Figures 7-3b through 7-3j and 7-4b through 7-4j) for the two sample conditional simulations illustrated in Figures 7-1 and 7-2. The Thiessen polygon approach was for the purposes of this QC check sampled on the 20-foot-grid used in the conditional simulations to approximate de-clustered data (red markers) and appropriately area-weight the data for the full river comparison.

Exact agreement is not expected for the following reasons:

- The data are not perfectly log-normally distributed.
- There are cases where Thiessen polygons draw from data outside the vgroup (e.g., for *Left Shoal RM 11.3-14.4* in Figure 7-3f, the 0.12 ng/kg concentration in the Thiessen results [red points] is based on a sample upstream of the vgroup and is therefore not included in the conditional simulation for this vgroup [blue and green points]).
- The variance of the Thiessen-predicted distributions may slightly differ from the variance of raw data used to generate the conditional simulation results.

[45]Note that the COPC maps developed for areas downstream of RM 8 were used solely for initializing the CFT model. For the FS, simulated scenarios will assume the ROD remedy for the Lower 8.3 Miles (below RI RM 8).

Regardless, the agreement in Figures 7-3 and 7-4 is judged to be reasonable, and it is therefore concluded that the conditional simulations are adequately recovering the concentration distributions of the data.

7.1.1.2 Recovery of the Input Variograms

The output from the simulations should, on average, honor the variograms from which they were constructed. A variogram (azimuth zero, tolerance 5 degrees) was developed from the conditional simulation output separately for each vgroup and for each conditional simulation. The 100 variograms were then aggregated into a single variogram for each vgroup (Figures 7-5 and 7-6, blue dots) and compared to the input variogram (black lines). The conditional simulation results generally indicate good recovery of the model variogram, particularly at small separation distances. Some deviation is exhibited at larger separation distances, which is attributed to factors such as the shape of the interpolation groups and the normality of the input dataset (i.e., the de-trended residual concentrations). The largest deviation for 2,3,7,8-TCDD is observed for the *Right Shoal RM 0-6.5* vgroup, where the aggregate variogram is generally higher than the variogram model. In this instance, the comparison is likely influenced by the fact that the input variogram was scaled with a variance calculated by excluding the two lowest points from the distribution (blue dashed line; as discussed in Section 5.3, the two data points cause the input distribution for this vgroup to depart from log normality and they were excluded from the variance calculation to avoid inflating the variance). Because the conditional simulations include these two data points, it is not surprising that the aggregate variogram derived from the simulations predicts a higher population variance (higher sill) than the input variogram. For tetra-CB, the largest deviation in Figure 7-6 is observed for *No Deposition Since 1949 and Mixed Depositional Since 1966*. For this vgroup, the input tetra-CB variogram was scaled with a variance that excluded the lowest data point.[46] Because the conditional simulations include this data point, it is not surprising that the aggregate variogram derived from the simulations predicts a higher population variance (higher sill) than the input variogram.

7.1.1.3 Recovery of the Observed Concentrations Near Sample Locations

Predicted concentrations compared reasonably well to the input data on a residuals basis (Figures 7-7 and 7-8) and after back-transformation (Figures 7-9 and 7-10) and do not indicate a bias. It is noted that the concentrations are not expected to fall exactly on the one-to-one line because concentrations are predicted on a 20-foot by 20-foot rectangular grid that is not perfectly aligned with the sample locations, and the interpolations are based on a variogram with a non-zero nugget (Figures 5-12 and 5-13).

[46] This low data point (which caused the input distribution to deviate from log normality) was excluded to avoid inflating the variance.

7.1.1.4 Recovery of the Correlation Between 2,3,7,8-TCDD and Tetra-CB Data

Surface sediment 2,3,7,8-TCDD and tetra-CB concentrations are correlated (Figure 7-11, right panel). It was important to preserve this correlation in the conditional simulation used for model initial conditions. Using the same random seed for both the 2,3,7,8-TCDD and tetra-CB conditional simulations resulted in correlated simulations (Figure 7-11, left panel).

7.1.2 Quality Control for Layer B Resampling

A representative subset of the QC checks conducted is presented below to illustrate the performance of the Layer B resampling.

The resampled Layer B surface was compared to the mapped Layer A surface in cross-plots and box-plots to verify that the resampled layer approximately honored the relationship between the Layer A and Layer B in the measured data. Cross-plots comparing resampled Layer B to Layer A for 2,3,7,8-TCDD are shown in Figures 7-12 through 7-14. Table 7-1 lists the appropriate data versus data plots and Layer A mapped surface versus resampled Layer B plots for comparison across all COPCs. The box plots on the right panels are qualitatively consistent between the mapped surfaces and the measured data, indicating that the mean, median, and outliers of the resampled data are generally representative[47] of the relationship between the Layer A and Layer B measured data.[48]

Maps of Layer B concentrations in Appendix O, Attachment 1, Figures 10 through 18 and 28 through 36 allow for a visual comparison with maps of Layer A concentrations in Appendix O, Attachment 1, Figures 1 through 9 and 19 through 27. The relationship between Layer A and Layer B is particularly evident for the conditional simulation (within Appendix O, Attachment 1, compare Figure 19 with Figure 28 for 2,3,7,8-TCDD and Figure 20 with Figure 29 for tetra-CB). In these two sets of maps, the Layer B mapped surface has more noise than the Layer A surface, but they have similar patterns such that high values on the Layer A map are generally also elevated on the Layer B map, and the same correspondence applies to low values between the maps.

Figure 7-15 compares the 1995 Layer A Thiessens (left panel), with the old layer B Thiessens (middle panel) and the resampled layer B (right panel). In this map, resampled areas on the right panel occur in areas where there was a mismatch between the polygons based on point data in Layer A (left panel) and Layer B (middle panel). For example, Figure 7-15t shows areas with more 2,3,7,8-TCDD

[47] In some cases, a divergence between the box plots of the resampling data and the mapping results may be caused by a low number of resampled points in the mapping. For example, in Figure 10 of Attachment 3 there are no resampled points in the 100 to 300 ng/kg bin and thus the statistics of the resampling dataset (Figure 10 of Attachment 2) are not reproduced in the mapping for this bin.

[48] Note that the number of instances of zero concentrations (reported in the figure notes) differs between the cross-plots of Layer A versus Layer B concentrations in the data and the corresponding plots for the mapped concentrations. Whereas both plots reflect the number of complete cores (where a concentration of zero is assumed below the last measured segment; see Appendix I), the cross-plots of mapping results also have zero Layer B concentration within shallow sediment areas (see Section 3.5).

data points in Layer A (left panel) than Layer B (middle panel), which are addressed by resampling Layer B (right panel).

7.2 Combining Results from Different Interpolation Methods

For the 2,3,7,8-TCDD and tetra-CB mapping of the surface sediment concentrations in the 2010 dataset, conditional simulation (CS) 37 was used as a base simulation based on USEPA-CPG interactions from the May 1, 2017 mapping meeting and subsequent interactions. This simulation is shown in the right panel of Figures 7-1 and 7-2. CS 37 was used to represent concentrations between RM 0 and RM 14.7. Outside the extent of the conditional simulation, the 2010 Thiessen polygon mapping shown in Appendix O, Attachment 1, Figures 19 and 21 was used to represent surface sediment concentrations.

For subsurface mapping of all COPCs, Layer B concentrations, as described in Section 6, were used to represent concentrations between RM 0 and RM 14.7. Outside RM 0 to RM 14.7, the Thiessen polygon Layer B mapping was used to represent surface sediment concentrations. Appendix O, Attachment 1, Figures 28 through 36 show the combination of these two mappings.

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Tables

Table 2-1
Studies Used in Mapping of 1995 and 2010 Dataset Surface and Subsurface Concentrations

Study Name	Sample Years	Dataset	Centroid	RM Range	Layer*	2,3,7,8-TCDD	Tetra-CB	1,2,3,4,6,7,8-HPCDF	1,2,3,7,8-PeCDD	2,3,4,7,8-PeCDF	PCB 126	PCB 167	Total DDx	Mercury	Tetra-CB Source**
Tierra – 1995 Remedial Investigation Sampling Program	1995	1995	no	1.0 - 6.7	A,B,C,D,E,F	yes	yes	yes	yes	yes	yes	yes	yes	yes	Total PCB Aroclor
Tierra – 1995 Sediment Surface (Grab) Sampling Program	1995	1995	no	2.6 - 2.6	A	yes	no	yes	yes	yes	no	no	no	no	NA
PANYNJ – 1996 Newark Bay Reach A Sediment Sampling Program	1996	1995	no	-1.8 - -1.5	A,B,C,D	yes	yes	yes	yes	yes	yes	yes	yes	yes	Total PCB Aroclor
PANYNJ – 1997 Newark Bay Reach B,C,D Sediment Sampling Program	1997	1995	no	-4.2 - -2.6	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Total PCB Aroclor
PANYNJ – 1998 Newark Bay Elizabeth Channel Sampling Program	1998	1995	no	-2.9 - -2.6	A,B,C	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
USEPA – 1998 REMAP Sediment Investigation	1998	1995	no	-15.3 - 1.9	A	yes	no	yes	yes	yes	no	no	yes	yes	NA
Tierra – 1999 Late Summer/Early Fall RI-ESP Sampling Program	1999	1995	no	1.0 - 6.8	A	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Tierra – Newark Bay Reach ABCD Baseline Sampling Program	1999	1995	no	-4.2 - -1.6	B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Entrix – 1999 Preliminary Toxicity Identification Evaluation Study	1999	1995	no	-1.6 - 6.8	A	yes	yes	yes	yes	yes	yes	yes	yes	yes	Mixed
Tierra – 1999 Sediment Sampling Program	1999	1995	no	-7.6 - 6.2	B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Tierra – 1999/2000 Minish Park Monitoring Program	1999	1995	no	5.0 - 5.0	A	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Honeywell International Sampling Programs	1999, 2005, 2006	1995 and 2010	no	-3.3 - 0.9	A,B	yes	yes	yes	yes	yes	yes	yes	yes	yes	Mixed
PRG – 2006 Hackensack River Remedial Investigation	2006	2010	no	Hackensack River	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
USEPA/MPI – EMBM	2008	2010	no	8.4 - 14.5	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Mixed
USEPA/MPI – Sediment Sampling Program	2008	2010	no	-0.1 - 0.6	A	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Low-Resolution Coring Program	2008	2010	no	-0.1 - 17.1	A,B,C,D,E,F	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Benthic Program Surface Sediment Sampling (2009)	2009	2010	no	-0.0 - 17.3	A	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Benthic Program Surface Sediment Sampling (2010)	2010	2010	no	1.2 - 14.2	A	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
JDG – Sediment Sampling	2011	2010	no	3.1 - 3.1	B,C,D,E	yes	no	yes	yes	yes	no	no	yes	no	NA
River Mile 10.9 Characterization	2011	2010	yes	10.7 - 11.1	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Tierra – Focused Sediment Investigation (River Mile 10.9)	2012	2010	no	7.8 - 11.5	A,B,C,D,E	yes	no	yes	yes	yes	no	no	no	no	Tetra-CB
River Mile 10.9 Addendum A	2012	2010	yes	10.8 - 11.2	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Low-resolution Coring Program Supplemental Sampling Program 2	2013	2010	yes	7.2 - 14.6	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Low-resolution Coring Program Supplemental Sampling Program	2012	2010	yes	0.2 - 13.0	A,B,C,D,E,F	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
USEPA/MPI – High-Resolution Sediment Coring Program	2005, 2006	2010	no	1.4 - 12.6	A,B,C,D,E,F	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
USEPA/MPI – Low-Resolution Sediment Coring Program	2006	2010	yes	2.8 - 6.7	B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Mixed
Tierra – Newark Bay Phase I/Phase II	2005, 2007	2010	no	-9.3 - -0.0	A,B,C,D,E	yes	yes	yes	yes	yes	yes	yes	yes	yes	Tetra-CB
Phase I Sediment Assessment	2009	2010	no	3.1 - 3.2	B,C,D,E	yes	no	yes	yes	yes	yes	yes	yes	yes	NA

Notes:

*Key to depth intervals: A = 0 to 6 inches (0 to 0.5 foot); B = 6 to 18 inches (0.5 to 1.5 feet); C = 18 to 30 inches (1.5 to 2.5 feet); D = 30 to 42 inches (2.5 to 3.5 feet); E = 42 to 66 inches (3.5 to 5.5 feet); F = below 66 inches (5.5 feet)

**Describes if tetra-CB values were derived from reported measurement or derived from total PCB aroclor using a conversion factor of 0.34. Studies listed as "Mixed" had a mixture of samples that measured one or both tetra-CB and total PCB aroclor. Studies with NA did not measure useable PCBs.

Table includes data up to RM 17.40.

1,2,3,4,6,7,8-HPCDF: 1,2,3,4,6,7,8-heptachlorodibenzofuran

2,3,7,8-TCDD: 2,3,7,8-tetrachlorodibenzo-p-dioxin

NA: not applicable

PCB: polychlorinated biphenyl

PeCDD: Pentachlorodibenzo-p-dioxin

PeCDF: Pentachlorodibenzofuran

tetra-CB: tetrachlorobiphenyl

USEPA: U.S. Environmental Protection Agency

Table 2-2
Concentration-Dependent Constants Used to Estimate Tetra-CB Concentration from Total PCBs

Slope	Intercept	Total PCB Concentration Range (mg/kg)		Tetra-CB Concentration Range (mg/kg)	
		Start	End	Start	End
4.0085	0	>= 0	< 0.2	>= 0	< 0.05
4.1927	-0.0092	>= 0.2	< 0.4	>= 0.05	< 0.1
3.1907	0.091	>= 0.4	< 3.3	>= 0.1	< 1
2.9122	0.3695	>= 3.3	< 292	>= 1	< 100

Notes:

mg/kg: milligrams per kilogram

PCB: polychlorinated biphenyl

Tetra-CB: tetrachlorobiphenyl

Table 2-3
List of Cores with Overlapping Subsurface Segments Used in 2,3,7,8-TCDD Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
Tierra – 1995 Remedial Investigation Sampling Program	1995	222	0.0–0.5; 0.5–3.2; 3.2–5.2; 5.2–8.8; 8.8–11.0; 11.0–13.5	7.0–9.9	22206A
		223	0.0–0.5; 0.5–3.1; 3.1–5.5; 5.5–6.7; 6.7–8.6	4.3–6.1	22306A
		225	0.0–0.5; 0.5–2.1; 2.1–4.6; 4.6–8.8; 8.8–11.1; 11.1–14.0	6.7–10.0	22505A
		226A	0.0–0.5; 0.5–2.3; 2.3–4.3; 4.3–6.4; 6.4–7.2; 7.3–9.1	5.3–6.8	22605A
		228	0.0–0.5; 0.5–1.9; 1.9–4.4; 4.4–7.4; 7.4–8.7; 8.7–10.9	5.9–8.0	22805B
		230	0.0–0.5; 0.5–1.4; 1.4–4.0; 4.0–5.6; 5.6–7.2	2.8–4.8	23005A
		231	0.0–0.5; 0.5–2.7; 2.7–5.0; 5.0–9.1; 9.1–11.0; 11.0–13.0	7.1–10.1	23105A
		234	0.0–0.5; 0.5–2.9; 2.9–4.5; 4.5–8.1; 8.1–9.8; 9.8–12.1	6.3–9.0	23405B
		235	0.0–0.5; 0.5–2.2; 2.2–3.3; 3.3–4.9; 4.9–5.7; 5.7–7.2	4.1–5.3	23505A
		239	0.0–0.5; 0.5–2.3; 2.3–4.0; 4.0–7.3; 7.3–9.2; 9.2–11.8	5.7–8.2	23905A
		241	0.0–0.5; 0.5–3.5; 3.5–5.4; 5.4–8.4; 8.4–10.0; 10.0–11.9	6.9–9.2	24105A
		242	0.0–0.5; 0.5–2.6; 2.6–4.6; 4.6–10.5; 10.5–14.0; 14.0–17.3	7.5–12.2	24205A
		245	0.0–0.5; 0.5–1.5; 1.5–3.7; 3.7–7.3; 7.3–9.4; 9.4–11.4	5.5–8.4	24505B
		248	0.0–0.5; 0.5–4.2; 4.2–6.1; 6.1–10.0; 10.1–12.3; 12.3–14.7	8.1–11.2	24805A
		249	0.0–0.5; 0.5–1.3; 1.3–2.8; 2.8–3.6; 3.6–4.8	2.0–3.2	24904B
		251	0.0–0.5; 0.5–4.2; 4.2–5.0; 5.0–6.5; 6.5–7.3; 7.3–8.5	5.7–6.9	25105B
		252	0.0–0.5; 0.5–2.2; 2.2–2.9; 2.9–5.7; 5.7–7.5; 7.5–9.4	4.3–6.6	25205C
		272	0.0–0.5; 0.5–2.4; 2.4–4.6; 4.6–7.3; 7.3–8.4; 8.4–10.4	6.0–7.8	27205A
		274	0.0–0.5; 0.5–0.9; 0.9–2.8; 2.8–4.0; 4.0–5.1	1.8–3.4	27404A
Tierra – Newark Bay Phase I/Phase II	2005	NB01SED005	0.0–0.5; 0.5–1.5; 1.5–3.5*	2.5–3.5	--
River Mile 10.9 Characterization	2011	11B-0321	0.0–0.5; 0.5–1.5; 1.5–2.5; 2.5–3.5; 3.5–5.5; 5.5–7.5; 7.5–9.1	3.5–4.5	11B-0321-C4ES
Low-Resolution Coring Program Supplemental Sampling Program 2	2013	13B-0515	0.0–0.5; 0.5–1.7	1.5–2.2**	--

Notes:

*The 1.5- to 3.5-foot segment (NB01SED005A-03) was adjusted to 1.5 to 2.5 feet to retain data. This was more conservative than adjusting the 2.5- to 3.5-foot segment judging by the TCDD profile.

**The 1.5- to 2.2-foot segment (13B-0515-C2CS) was adjusted to 1.7 to 2.2 feet to retain data and remove the overlap with the segment above.

TCDD: tetrachlorodibenzo-p-dioxin

Table 2-4
List of Cores with Overlapping Subsurface Segments Used in Tetra-CB Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
Tierra – 1995 Remedial Investigation Sampling Program*	1995	222	0.0–0.5; 0.5–3.2; 3.2–5.2; 5.2–8.8; 8.8–11.0; 11.0–13.5	7.0–9.9	22206A
		223	0.0–0.5; 0.5–3.1; 3.1–5.5; 5.5–6.7	4.3–6.1	22306A
		225	0.0–0.5; 0.5–2.1; 2.1–4.6; 4.6–8.8; 8.8–11.1; 11.1–14.0	6.7–10.0	22505A
		226A	0.0–0.5; 0.5–2.3; 2.3–4.3; 4.3–6.4; 6.4–7.2; 7.3–9.1	5.3–6.8	22605A
		228	0.0–0.5; 0.5–1.9; 1.9–4.4; 4.4–7.4; 7.4–8.7; 8.7–10.9	5.9–8.0	22805B
		230	0.0–0.5; 0.5–1.4; 1.4–4.0; 4.0–5.6; 5.6–7.2	2.8–4.8	23005A
		231	0.0–0.5; 0.5–2.7; 2.7–5.0; 5.0–9.1; 9.1–11.0; 11.0–13.0	7.1–10.1	23105A
		234	0.0–0.5; 0.5–2.9; 2.9–4.5; 4.5–8.1; 8.1–9.8; 9.8–12.1	6.3–9.0	23405B
		235	0.0–0.5; 0.5–2.2; 2.2–3.3; 3.3–4.9; 4.9–5.7; 5.7–7.2	4.1–5.3	23505A
		239	0.0–0.5; 0.5–2.3; 2.3–4.0; 4.0–7.3; 7.3–9.2; 9.2–11.8	5.7–8.2	23905A
		242	0.0–0.5; 0.5–2.6; 2.6–4.6; 4.6–10.5; 10.5–14.0; 14.0–17.3	7.5–12.2	24205A
		245	0.0–0.5; 0.5–1.5; 1.5–3.7; 3.7–7.3; 7.3–9.4; 9.4–11.4	5.5–8.4	24505B
		249	0.0–0.5; 0.5–1.3; 1.3–2.8; 2.8–3.6; 3.6–4.8	2.0–3.2	24904B
		251	0.5–4.2; 4.2–5.0; 5.0–6.5; 6.5–7.3; 7.3–8.5	5.7–6.9	25105B
		252	0.0–0.5; 0.5–2.2; 2.2–2.9; 2.9–5.7; 5.7–7.5; 7.5–9.4	4.3–6.6	25205C
		272	0.0–0.5; 0.5–2.4; 2.4–4.6; 4.6–7.3; 7.3–8.4; 8.4–10.4	6.0–7.8	27205A
Tierra – Newark Bay Phase I/Phase II	2005	NB01SED005	0.0–0.5; 0.5–1.5; 1.5–3.5**	2.5–3.5	
River Mile 10.9 Characterization	2011	11B-0321	0.0–0.5; 0.5–1.5; 1.5–2.5; 2.5–3.5; 3.5–5.5; 5.5–7.5; 7.5–9.1	3.5–4.5	11B-0321-C4ES
Low-Resolution Coring Program Supplemental Sampling Program 2	2013	13B-0515	0.0–0.5; 0.5–1.7	1.5–2.2***	--

Notes:

*Tetra-CB values were derived from total PCB Aroclors for this study.

**The 1.5- to 3.5-foot segment (NB01SED005A-03) was adjusted to 1.5 to 2.5 feet to retain data. This matches the treatment of 2,3,7,8-TCDD (see Table 2-3).

**The 1.5- to 2.2-foot segment (13B-0515-C2CS) was adjusted to 1.7 to 2.2 feet to retain data and remove the overlap with the segment above.

PCB: polychlorinated biphenyl

tetra-CB: tetrachlorobiphenyl

Table 2-5
List of Cores with Overlapping Subsurface Segments Used in 1,2,3,4,6,7,8-HPCDF Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
Tierra – 1995 Remedial Investigation Sampling Program	1995	222	0.0–0.5; 0.5–3.2; 3.2–5.2; 5.2–8.8; 8.8–11.0; 11.0–13.5	7.0–9.9	22206A
		223	0.0–0.5; 0.5–3.1; 3.1–5.5; 5.5–6.7; 6.7–8.6	4.3–6.1	22306A
		225	0.0–0.5; 0.5–2.1; 2.1–4.6; 4.6–8.8; 8.8–11.1; 11.1–14.0	6.7–10.0	22505A
		226A	0.0–0.5; 0.5–2.3; 2.3–4.3; 4.3–6.4; 6.4–7.2; 7.3–9.1	5.3–6.8	22605A
		228	0.0–0.5; 0.5–1.9; 1.9–4.4; 4.4–7.4; 7.4–8.7; 8.7–10.9	5.9–8.0	22805B
		230	0.0–0.5; 0.5–1.4; 1.4–4.0; 4.0–5.6; 5.6–7.2	2.8–4.8	23005A
		231	0.0–0.5; 0.5–2.7; 2.7–5.0; 5.0–9.1; 9.1–11.0; 11.0–13.0	7.1–10.1	23105A
		234	0.0–0.5; 0.5–2.9; 2.9–4.5; 4.5–8.1; 8.1–9.8; 9.8–12.1	6.3–9.0	23405B
		235	0.0–0.5; 0.5–2.2; 2.2–3.3; 3.3–4.9; 4.9–5.7; 5.7–7.2	4.1–5.3	23505A
		239	0.0–0.5; 0.5–2.3; 2.3–4.0; 4.0–7.3; 7.3–9.2; 9.2–11.8	5.7–8.2	23905A
		241	0.0–0.5; 0.5–3.5; 3.5–5.4; 5.4–8.4; 8.4–10.0; 10.0–11.9	6.9–9.2	24105A
		242	0.0–0.5; 0.5–2.6; 2.6–4.6; 4.6–10.5; 10.5–14.0; 14.0–17.3	7.5–12.2	24205A
		245	0.0–0.5; 0.5–1.5; 1.5–3.7; 3.7–7.3; 7.3–9.4; 9.4–11.4	5.5–8.4	24505B
		249	0.0–0.5; 0.5–1.3; 1.3–2.8; 2.8–3.6; 3.6–4.8	2.0–3.2	24904B
		251	0.0–0.5; 0.5–4.2; 4.2–5.0; 5.0–6.5; 6.5–7.3; 7.3–8.5	5.7–6.9	25105B
		252	0.0–0.5; 0.5–2.2; 2.2–2.9; 2.9–5.7; 5.7–7.5; 7.5–9.4	4.3–6.6	25205C
		272	0.0–0.5; 0.5–2.4; 2.4–4.6; 4.6–7.3; 7.3–8.4; 8.4–10.4	6.0–7.8	27205A
		274	0.0–0.5; 0.5–0.9; 0.9–2.8; 2.8–4.0; 4.0–5.1	1.8–3.4	27404A
Tierra – Newark Bay Phase I/Phase II	2005	NB01SED005	0.0–0.5; 0.5–1.5; 1.5–3.5*	2.5–3.5	--
River Mile 10.9 Characterization	2011	11B-0321	0.0–0.5; 0.5–1.5; 1.5–2.5; 2.5–3.5; 3.5–5.5; 5.5–7.5; 7.5–9.1	3.5–4.5	11B-0321-C4ES
Low-Resolution Coring Program Supplemental Sampling Program 2	2013	13B-0515	0.0–0.5; 0.5–1.7	1.5–2.2**	--

Notes:

*The 1.5- to 3.5-foot segment (NB01SED005A-03) was adjusted to 1.5 to 2.5 feet to retain data. This matches the treatment of 2,3,7,8-TCDD (see Table 2-3).

**The 1.5- to 2.2- foot segment (13B-0515-C2CS) was adjusted to 1.7 to 2.2 feet to retain data and remove the overlap with the segment above.

HPCDF: Heptachlorodibenzofuran

TCDD: tetrachlorodibenzo-p-dioxin

Table 2-6

List of Cores with Overlapping Subsurface Segments Used in 1,2,3,7,8-PECDD Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
2011 River Mile 10.9 Field Investigation	2011	11B-0321	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-4.5; 5.5-7.5; 7.5-9.1	3.5-5.5	11B-0321-C4ET
CPG Second Supplemental Sampling Program (SSP2)	2013	13B-0515	0.0-0.5; 0.5-1.7	1.5-2.2	13B-0515-C2CS
		13B-0547-C5	0.0-0.5; 0.5-0.8; 0.8-1.0; 1.0-1.3; 1.3-1.5; 1.5-1.8; 1.8-2.0; 2.0-2.3; 2.3-2.5; 2.5-2.8; 2.8-3.0	0.3-0.5	13B-0547-C5ABS
1995 RI Sampling Program	1995	222	0.0-0.5; 3.2-5.2; 5.2-8.8; 8.8-11.0; 11.0-13.5	7.0-9.9	22206A
		223	0.0-0.5; 0.5-3.1; 3.1-5.5; 5.5-6.7; 6.7-8.6	4.3-6.1	22306A
		225	0.0-0.5; 0.5-2.1; 2.1-4.6; 4.6-8.8; 8.8-11.1; 11.1-14.0	6.7-10.0	22505A
		226A	0.0-0.5; 0.5-2.3; 2.3-4.3; 4.3-6.4; 6.4-7.2; 7.3-9.1	5.3-6.8	22605A
		228	0.0-0.5; 0.5-1.9; 1.9-4.4; 4.4-7.4; 7.4-8.7; 8.7-10.9	5.9-8.0	22805B
		230	0.0-0.5; 0.5-1.4; 1.4-4.0; 4.0-5.6; 5.6-7.2	2.8-4.8	23005A
		231	0.0-0.5; 0.5-2.7; 2.7-5.0; 5.0-9.1; 9.1-11.0	7.1-10.1	23105A
		234	0.0-0.5; 0.5-2.9; 2.9-4.5; 4.5-8.1; 8.1-9.8; 9.8-12.1	6.3-9.0	23405B
		235	0.0-0.5; 0.5-2.2; 2.2-3.3; 3.3-4.9; 4.9-5.7; 5.7-7.2	4.1-5.3	23505A
		239	0.0-0.5; 0.5-2.3; 2.3-4.0; 4.0-7.3; 7.3-9.2; 9.2-11.8	5.7-8.2	23905A
		241	0.0-0.5; 0.5-3.5; 3.5-5.4; 5.4-8.4; 8.4-10.0; 10.0-11.9	6.9-9.2	24105A
		242	0.0-0.5; 0.5-2.6; 2.6-4.6; 4.6-10.5; 10.5-14.0; 14.0-17.3	7.5-12.2	24205A
		245	0.0-0.5; 0.5-1.5; 1.5-3.7; 3.7-7.3; 7.3-9.4; 9.4-11.4	5.5-8.4	24505B
		248	0.0-0.5; 0.5-4.2; 4.2-6.1; 6.1-10.0; 10.1-12.3; 12.3-14.7	8.1-11.2	24805A
		249	0.0-0.5; 0.5-1.3; 1.3-2.8; 2.8-3.6; 3.6-4.8	2.0-3.2	24904B
		251	0.0-0.5; 0.5-4.2; 4.2-5.0; 5.0-6.5; 6.5-7.3; 7.3-8.5	5.7-6.9	25105B
		252	0.0-0.5; 0.5-2.2; 2.2-2.9; 2.9-5.7; 5.7-7.5; 7.5-9.4	4.3-6.6	25205C
		272	0.0-0.5; 0.5-2.4; 2.4-4.6; 4.6-7.3; 7.3-8.4; 8.4-10.4	6.0-7.8	27205A
		274	0.0-0.5; 0.5-0.9; 0.9-2.8; 2.8-4.0; 4.0-5.1	1.8-3.4	27404A
High Res Core Sampling	2005	G0000005	0.0-0.6; 0.6-1.2; 1.2-1.8; 1.8-2.4; 2.4-3.6; 3.6-4.9; 4.9-6.1; 6.1-7.3; 7.3-8.6; 9.8-11.1; 11.1-12.3; 12.3-13.6; 13.6-14.8; 14.8-16.1; 16.1-17.3; 17.3-18.6; 18.6-19.8; 19.8-21.1; 21.1-22.3	8.6-9.2	LPRP-SCSH-PSR-001527
		G0000012	0.0-0.2; 0.2-0.4; 0.4-0.6; 0.6-0.8; 0.8-1.1; 1.3-1.6; 1.6-1.9; 1.9-2.3; 2.3-2.6; 2.6-2.9; 3.1-3.4; 3.4-3.7; 3.7-4.1; 4.1-4.4; 4.4-4.8; 4.8-5.3; 5.3-5.6; 5.6-5.9; 5.9-6.3; 6.3-6.6; 6.6-6.9; 6.9-7.3	2.9-3.1	LPRP-SCSH-PSR-001469

Notes:

CPG: Cooperating Parties Group

PECDD: Pentachlorodibenzo-p-dioxin

RI: remedial investigation

Table 2-7
List of Cores with Overlapping Subsurface Segments Used in 2,3,4,7,8-PECDF Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
2011 River Mile 10.9 Field Investigation	2011	11B-0321	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-4.5; 5.5-7.5; 7.5-9.1	3.5-5.5	11B-0321-C4ET
CPG Second Supplemental Sampling Program (SSP2)	2013	13B-0515	0.0-0.5; 0.5-1.7	1.5-2.2	13B-0515-C2CS
		13B-0547-C5	0.0-0.5; 0.5-0.8; 0.8-1.0; 1.0-1.3; 1.3-1.5; 1.5-1.8; 1.8-2.0; 2.0-2.3; 2.3-2.5; 2.5-2.8; 2.8-3.0	0.3-0.5	13B-0547-C5ABS
1995 RI Sampling Program 2,3,4,7,8-PeCDF_adj_SegmentOverlap	1995	222	0.0-0.5; 0.5-3.2; 3.2-5.2; 5.2-8.8; 8.8-11.0; 11.0-13.5	7.0-9.9	22206A
		223	0.0-0.5; 0.5-3.1; 3.1-5.5; 5.5-6.7; 6.7-8.6	4.3-6.1	22306A
		225	0.0-0.5; 0.5-2.1; 2.1-4.6; 4.6-8.8; 8.8-11.1; 11.1-14.0	6.7-10.0	22505A
		226A	0.0-0.5; 0.5-2.3; 2.3-4.3; 4.3-6.4; 6.4-7.2; 7.3-9.1	5.3-6.8	22605A
		228	0.0-0.5; 0.5-1.9; 1.9-4.4; 4.4-7.4; 7.4-8.7; 8.7-10.9	5.9-8.0	22805B
		230	0.0-0.5; 0.5-1.4; 1.4-4.0; 4.0-5.6; 5.6-7.2	2.8-4.8	23005A
		231	0.0-0.5; 0.5-2.7; 2.7-5.0; 5.0-9.1; 9.1-11.0; 11.0-13.0	7.1-10.1	23105A
		234	0.0-0.5; 0.5-2.9; 2.9-4.5; 4.5-8.1; 8.1-9.8; 9.8-12.1	6.3-9.0	23405B
		235	0.0-0.5; 0.5-2.2; 2.2-3.3; 3.3-4.9; 4.9-5.7; 5.7-7.2	4.1-5.3	23505A
		239	0.0-0.5; 0.5-2.3; 2.3-4.0; 4.0-7.3; 7.3-9.2; 9.2-11.8	5.7-8.2	23905A
		241	0.0-0.5; 0.5-3.5; 3.5-5.4; 5.4-8.4; 8.4-10.0; 10.0-11.9	6.9-9.2	24105A
		242	0.0-0.5; 0.5-2.6; 2.6-4.6; 4.6-10.5; 10.5-14.0; 14.0-17.3	7.5-12.2	24205A
		245	0.0-0.5; 0.5-1.5; 1.5-3.7; 3.7-7.3; 7.3-9.4; 9.4-11.4	5.5-8.4	24505B
		248	0.0-0.5; 0.5-4.2; 4.2-6.1; 6.1-10.0; 10.1-12.3; 12.3-14.7	8.1-11.2	24805A
		249	0.0-0.5; 0.5-1.3; 1.3-2.8; 2.8-3.6; 3.6-4.8	2.0-3.2	24904B
		251	0.0-0.5; 0.5-4.2; 4.2-5.0; 5.0-6.5; 6.5-7.3; 7.3-8.5	5.7-6.9	25105B
		252	0.0-0.5; 0.5-2.2; 2.2-2.9; 2.9-5.7; 5.7-7.5; 7.5-9.4	4.3-6.6	25205C
		272	0.0-0.5; 0.5-2.4; 2.4-4.6; 4.6-7.3; 7.3-8.4; 8.4-10.4	6.0-7.8	27205A
		274	0.0-0.5; 0.5-0.9; 0.9-2.8; 2.8-4.0; 4.0-5.1	1.8-3.4	27404A
High Res Core Sampling	2005	G0000005	0.0-0.6; 0.6-1.2; 1.2-1.8; 1.8-2.4; 2.4-3.6; 3.6-4.9; 4.9-6.1; 6.1-7.3; 7.3-8.6; 9.2-9.8; 11.1-12.3; 12.3-13.6; 13.6-14.8; 14.8-16.1; 16.1-17.3; 17.3-18.6; 18.6-19.8; 19.8-21.1; 21.1-22.3	8.6-9.2; 9.8-11.1	LPRP-SCSH-PSR-001527; LPRP-SCSH-PSR-001530
		G0000012	0.0-0.2; 0.2-0.4; 0.4-0.6; 0.6-0.8; 0.8-1.1; 1.3-1.6; 1.6-1.9; 1.9-2.3; 2.3-2.6; 2.6-2.9; 3.1-3.4; 3.4-3.7; 3.7-4.1; 4.1-4.4; 4.4-4.8; 4.8-5.3; 5.3-5.6; 5.6-5.9; 5.9-6.3; 6.3-6.6; 6.6-6.9; 6.9-7.3; 7.3-8.2	1.1-1.3; 2.9-3.1	LPRP-SCSH-PSR-001502; LPRP-SCSH-PSR-001469

Notes:
PECDF: Pentachlorodibenzofuran
RI: remedial investigation

Table 2-8
List of Cores with Overlapping Subsurface Segments Used in PCB 126 Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
2011 River Mile 10.9 Field Investigation	2011	11B-0321	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-4.5; 5.5-7.5; 7.5-9.1	3.5-5.5	11B-0321-C4ET
CPG Second Supplemental Sampling Program (SSP2)	2013	13B-0515	0.0-0.5; 0.5-1.7	1.5-2.2	13B-0515-C2CS
1995 RI Sampling Program	1995	222	0.0-0.5; 0.5-3.2; 3.2-5.2; 5.2-8.8; 8.8-11.0; 11.0-13.5	7.0-9.9	22206A
		223	0.0-0.5; 0.5-3.1; 3.1-5.5; 5.5-6.7; 6.7-8.6	4.3-6.1	22306A
		225	0.0-0.5; 2.1-4.6; 4.6-8.8; 8.8-11.1; 11.1-14.0	6.7-10.0	22505A
		226A	0.0-0.5; 0.5-2.3; 2.3-4.3; 4.3-6.4; 6.4-7.2; 7.3-9.1	5.3-6.8	22605A
		228	0.0-0.5; 0.5-1.9; 1.9-4.4; 4.4-7.4; 7.4-8.7; 8.7-10.9	5.9-8.0	22805B
		230	0.0-0.5; 0.5-1.4; 1.4-4.0; 4.0-5.6; 5.6-7.2	2.8-4.8	23005A
		231	0.0-0.5; 0.5-2.7; 2.7-5.0; 5.0-9.1; 9.1-11.0	7.1-10.1	23105A
		235	0.0-0.5; 0.5-2.2; 2.2-3.3; 3.3-4.9; 4.9-5.7; 5.7-7.2	4.1-5.3	23505A
		239	0.0-0.5; 0.5-2.3; 2.3-4.0; 4.0-7.3; 7.3-9.2; 9.2-11.8	5.7-8.2	23905A
		241	0.0-0.5; 3.5-5.4; 5.4-8.4; 8.4-10.0; 10.0-11.9	6.9-9.2	24105A
		242	0.0-0.5; 0.5-2.6; 2.6-4.6; 4.6-10.5; 10.5-14.0; 14.0-17.3	7.5-12.2	24205A
		245	0.0-0.5; 1.5-3.7; 3.7-7.3; 7.3-9.4; 9.4-11.4	5.5-8.4	24505B
		248	0.0-0.5; 0.5-4.2; 4.2-6.1; 6.1-10.0; 10.1-12.3; 12.3-14.7	8.1-11.2	24805A
		249	0.0-0.5; 0.5-1.3; 1.3-2.8; 2.8-3.6; 3.6-4.8	2.0-3.2	24904B
		251	0.0-0.5; 0.5-4.2; 4.2-5.0; 5.0-6.5; 6.5-7.3; 7.3-8.5	5.7-6.9	25105B
		252	0.0-0.5; 0.5-2.2; 2.2-2.9; 2.9-5.7; 5.7-7.5; 7.5-9.4	4.3-6.6	25205C
		272	0.0-0.5; 0.5-2.4; 2.4-4.6; 4.6-7.3; 7.3-8.4; 8.4-10.4	6.0-7.8	27205A
		274	0.0-0.5; 0.9-2.8; 2.8-4.0; 4.0-5.1	1.8-3.4	27404A
High Res Core Sampling	2005	G0000005	0.0-0.6; 0.6-1.2; 1.8-2.4; 2.4-3.6; 3.6-4.9; 6.1-7.3; 7.3-8.6; 14.8-16.1; 17.3-18.6	8.6-9.2	LPRP-SCSH-PSR-001527
		G0000012	0.0-0.2; 0.2-0.4; 0.4-0.6; 0.6-0.8; 0.8-1.1; 1.3-1.6; 1.6-1.9; 1.9-2.3; 2.3-2.6; 2.6-2.9; 3.1-3.4; 3.4-3.7; 3.7-4.1; 4.1-4.4; 4.4-4.8; 4.8-5.3; 5.3-5.6; 5.6-5.9; 5.9-6.3; 6.6-6.9	1.1-1.3; 2.9-3.1	LPRP-SCSH-PSR-001502; LPRP-SCSH-PSR-001469

Notes:

CPG: Cooperating Parties Group

PCB: polychlorinated biphenyl

RI: remedial investigation

Table 2-9
List of Cores with Overlapping Subsurface Segments Used in PCB 167 Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
2011 River Mile 10.9 Field Investigation	2011	11B-0321	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-4.5; 5.5-7.5; 7.5-9.1	3.5-5.5	11B-0321-C4ET
CPG Second Supplemental Sampling Program (SSP2)	2013	13B-0515	0.0-0.5; 0.5-1.7	1.5-2.2	13B-0515-C2CS
1995 RI Sampling Program	1995	222	0.0-0.5; 3.2-5.2; 5.2-8.8; 8.8-11.0; 11.0-13.5	7.0-9.9	22206A
		223	0.0-0.5; 0.5-3.1; 3.1-5.5; 5.5-6.7; 6.7-8.6	4.3-6.1	22306A
		225	0.0-0.5; 0.5-2.1; 2.1-4.6; 4.6-8.8; 8.8-11.1; 11.1-14.0	6.7-10.0	22505A
		226A	0.0-0.5; 0.5-2.3; 2.3-4.3; 4.3-6.4; 6.4-7.2; 7.3-9.1	5.3-6.8	22605A
		228	0.0-0.5; 0.5-1.9; 1.9-4.4; 4.4-7.4; 7.4-8.7; 8.7-10.9	5.9-8.0	22805B
		230	0.0-0.5; 0.5-1.4; 1.4-4.0; 4.0-5.6; 5.6-7.2	2.8-4.8	23005A
		231	0.0-0.5; 0.5-2.7; 2.7-5.0; 5.0-9.1; 9.1-11.0	7.1-10.1	23105A
		234	0.0-0.5; 0.5-2.9; 2.9-4.5; 4.5-8.1; 8.1-9.8; 9.8-12.1	6.3-9.0	23405B
		235	0.0-0.5; 0.5-2.2; 2.2-3.3; 3.3-4.9; 4.9-5.7; 5.7-7.2	4.1-5.3	23505A
		239	0.0-0.5; 0.5-2.3; 2.3-4.0; 4.0-7.3; 7.3-9.2; 9.2-11.8	5.7-8.2	23905A
		241	0.0-0.5; 0.5-3.5; 3.5-5.4; 5.4-8.4; 8.4-10.0; 10.0-11.9	6.9-9.2	24105A
		242	0.0-0.5; 0.5-2.6; 2.6-4.6; 4.6-10.5; 10.5-14.0; 14.0-17.3	7.5-12.2	24205A
		245	0.0-0.5; 1.5-3.7; 3.7-7.3; 7.3-9.4; 9.4-11.4	5.5-8.4	24505B
		248	0.0-0.5; 0.5-4.2; 4.2-6.1; 6.1-10.0; 10.1-12.3; 12.3-14.7	8.1-11.2	24805A
		249	0.0-0.5; 0.5-1.3; 1.3-2.8; 2.8-3.6; 3.6-4.8	2.0-3.2	24904B
		251	0.0-0.5; 0.5-4.2; 4.2-5.0; 5.0-6.5; 6.5-7.3; 7.3-8.5	5.7-6.9	25105B
		252	0.0-0.5; 0.5-2.2; 2.2-2.9; 2.9-5.7; 5.7-7.5; 7.5-9.4	4.3-6.6	25205C
		272	0.0-0.5; 0.5-2.4; 2.4-4.6; 4.6-7.3; 7.3-8.4; 8.4-10.4	6.0-7.8	27205A
		274	0.0-0.5; 0.5-0.9; 0.9-2.8; 2.8-4.0; 4.0-5.1	1.8-3.4	27404A
High Res Core Sampling	2005	G0000005	0.0-0.6; 0.6-1.2; 1.2-1.8; 1.8-2.4; 2.4-3.6; 3.6-4.9; 4.9-6.1; 6.1-7.3; 7.3-8.6; 9.2-9.8; 11.1-12.3; 12.3-13.6; 13.6-14.8; 14.8-16.1; 16.1-17.3; 17.3-18.6; 18.6-19.8; 19.8-21.1; 21.1-22.3	8.6-9.2; 9.8-11.1	LPRP-SCSH-PSR-001527; LPRP-SCSH-PSR-001530
		G0000012	0.0-0.2; 0.2-0.4; 0.4-0.6; 0.6-0.8; 0.8-1.1; 1.3-1.6; 1.6-1.9; 1.9-2.3; 2.3-2.6; 2.6-2.9; 3.1-3.4; 3.4-3.7; 3.7-4.1; 4.1-4.4; 4.4-4.8; 4.8-5.3; 5.3-5.6; 5.6-5.9; 5.9-6.3; 6.3-6.6; 6.6-6.9; 6.9-7.3; 7.3-8.2	1.1-1.3; 2.9-3.1	LPRP-SCSH-PSR-001502; LPRP-SCSH-PSR-001469

Notes:
PCB: polychlorinated biphenyl
RI: remedial investigation

Table 2-10
List of Cores with Overlapping Subsurface Segments Used in Total DDx Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
2011 River Mile 10.9 Field Investigation	2011	11B-0321	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-4.5; 5.5-7.5; 7.5-9.1	3.5-5.5	11B-0321-C4ET
CPG Second Supplemental Sampling Program (SSP2)	2013	13B-0515	0.0-0.5; 0.5-1.7	1.5-2.2	13B-0515-C2CS
		13B-0547-C5	0.0-0.5; 0.5-0.8; 0.8-1.0; 1.0-1.3; 1.3-1.5; 1.5-1.8; 1.8-2.0; 2.0-2.3; 2.3-2.5; 2.5-2.8; 2.8-3.0	0.3-0.5	13B-0547-C5ABS
1995 RI Sampling Program	1995	223	0.0-0.5; 0.5-3.1; 3.1-5.5; 5.5-6.7	4.3-6.1	22306A
		228	0.0-0.5; 0.5-1.9; 1.9-4.4; 4.4-7.4	5.9-8.0	22805B
		230	0.0-0.5; 0.5-1.4; 1.4-4.0	2.8-4.8	23005A
		235	0.0-0.5; 2.2-3.3; 3.3-4.9; 4.9-5.7; 5.7-7.2	4.1-5.3	23505A
		239	0.0-0.5; 0.5-2.3; 2.3-4.0; 4.0-7.3; 7.3-9.2; 9.2-11.8	5.7-8.2	23905A
		241	0.5-3.5; 3.5-5.4; 5.4-8.4; 8.4-10.0; 10.0-11.9	6.9-9.2	24105A
		242	0.5-2.6; 2.6-4.6; 4.6-10.5; 10.5-14.0	7.5-12.2	24205A
		245	0.0-0.5; 0.5-1.5; 1.5-3.7; 3.7-7.3; 7.3-9.4	5.5-8.4	24505B
		249	0.0-0.5; 0.5-1.3; 1.3-2.8; 2.8-3.6; 3.6-4.8	2.0-3.2	24904B
		251	0.0-0.5; 0.5-4.2; 4.2-5.0; 5.0-6.5	5.7-6.9	25105B
		272	0.0-0.5; 0.5-2.4; 2.4-4.6; 4.6-7.3; 7.3-8.4; 8.4-10.4	6.0-7.8	27205A
		274	0.0-0.5; 0.5-0.9; 0.9-2.8	1.8-3.4	27404A
2008 CPG Low-resolution Coring Program	2008	CLRC-060	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-5.5; 5.5-7.5	7.2-8.8	08A-0060-G

Notes:

CPG: Cooperating Parties Group

RI: remedial investigation

Table 2-11
List of Cores with Overlapping Subsurface Segments Used in Mercury Mapping

Study Name	Sample Year	Core ID	Core Segments Used (feet)	Core Segment Overlap (feet)	Sample ID of Removed Segment
2011 River Mile 10.9 Field Investigation	2011	11B-0321	0.0-0.5; 0.5-1.5; 1.5-2.5; 2.5-3.5; 3.5-4.5; 5.5-7.5; 7.5-9.1	3.5-5.5	11B-0321-C4ET
CPG Second Supplemental Sampling Program (SSP2)	2013	13B-0515	0.0-0.5; 0.5-1.7	1.5-2.2	13B-0515-C2CS
1995 RI Sampling Program	1995	222	0.0-0.5; 0.5-3.2; 3.2-5.2; 5.2-8.8; 8.8-11.0; 11.0-13.5	7.0-9.9	22206A
		223	0.0-0.5; 0.5-3.1; 3.1-5.5; 5.5-6.7; 6.7-8.6	4.3-6.1	22306A
		225	0.0-0.5; 0.5-2.1; 4.6-8.8; 8.8-11.1; 11.1-14.0	6.7-10.0	22505A
		226A	0.0-0.5; 0.5-2.3; 2.3-4.3; 4.3-6.4; 6.4-7.2; 7.3-9.1	5.3-6.8	22605A
		228	0.0-0.5; 0.5-1.9; 1.9-4.4; 4.4-7.4; 7.4-8.7; 8.7-10.9	5.9-8.0	22805B
		230	0.0-0.5; 0.5-1.4; 1.4-4.0; 4.0-5.6; 5.6-7.2	2.8-4.8	23005A
		231	0.0-0.5; 0.5-2.7; 2.7-5.0; 5.0-9.1; 9.1-11.0; 11.0-13.0	7.1-10.1	23105A
		234	0.0-0.5; 0.5-2.9; 2.9-4.5; 4.5-8.1; 8.1-9.8	6.3-9.0	23405B
		235	0.0-0.5; 0.5-2.2; 2.2-3.3; 3.3-4.9; 4.9-5.7; 5.7-7.2	4.1-5.3	23505A
		239	0.0-0.5; 0.5-2.3; 2.3-4.0; 4.0-7.3; 7.3-9.2; 9.2-11.8	5.7-8.2	23905A
		241	0.0-0.5; 0.5-3.5; 3.5-5.4; 5.4-8.4; 8.4-10.0; 10.0-11.9	6.9-9.2	24105A
		242	0.0-0.5; 0.5-2.6; 2.6-4.6; 4.6-10.5; 10.5-14.0; 14.0-17.3	7.5-12.2	24205A
		245	0.0-0.5; 0.5-1.5; 3.7-7.3; 7.3-9.4; 9.4-11.4	5.5-8.4	24505B
		248	0.0-0.5; 0.5-4.2; 4.2-6.1; 6.1-10.0; 10.1-12.3; 12.3-14.7	8.1-11.2	24805A
		249	0.0-0.5; 0.5-1.3; 1.3-2.8; 2.8-3.6; 3.6-4.8	2.0-3.2	24904B
		251	0.0-0.5; 0.5-4.2; 4.2-5.0; 5.0-6.5; 6.5-7.3; 7.3-8.5	5.7-6.9	25105B
		252	0.0-0.5; 0.5-2.2; 2.2-2.9; 2.9-5.7; 5.7-7.5; 7.5-9.4	4.3-6.6	25205C
		272	0.0-0.5; 0.5-2.4; 2.4-4.6; 4.6-7.3; 7.3-8.4	6.0-7.8	27205A
		274	0.0-0.5; 0.5-0.9; 0.9-2.8; 2.8-4.0; 4.0-5.1	1.8-3.4	27404A
2008 CPG Low-resolution Coring Program	2008	CLRC-092	0.0-0.8	0.7-2.7	08A-0092-B

Notes:

CPG: Cooperating Parties Group

RI: remedial investigation

Table 2-12
2,3,7,8-TCDD Concentrations and Boring Log Descriptions for 13B-0563

Sample ID	Upper Depth (ft)	Lower Depth (ft)	Length (ft)	2,3,7,8-TCDD Concentration (ng/kg)	Sediment Description
13B-0563-C2AS	0	0.5	0.5	2.4	Fine to medium sand, some silt, few organics (leaves), trace coarse sand, (10YR 2/2) very dark brown, loose, wet
13B-0563-C2BS	0.5	1.1	0.6	1.1	
13B-0563-C2CS	1.1	2.5	1.4	2,130.0	Silt, little to some clay, trace organics (leaves), (5Y 2.5/1) black, medium plasticity, soft to medium soft, wet, black staining and HC-like odor at 1.1 to 1.52 feet, becomes medium stiff with depth, organic layer (1/2 inch) at 2.5 feet
13B-0563-C2IS	7.5	8.28	0.78	3.9	Fine sand, some to little silt, (7.5YR 3/1) very dark gray, medium dense, moist, large piece of wood and slag fragments at 7.5 feet, silt layer at 7.95 to 8.1 feet

Notes:
Sediment descriptions are from boring logs reported in AECOM 2015, Appendix E.
ft: feet
HC: hydrocarbon
ng/kg: nanogram per kilogram
TCDD: tetrachlorodibenzo-p-dioxin
Y: Yellow hue on the Munsell Color System
YR: Yellow/Red intermediate hue on the Munsell Color System

Table 2-13

List of Cores with Nonstandard Layer B Segmentation Considered for Interval Adjustments in the Lower Passaic River

Study ID	Year	Location ID	River Mile	Interval (feet)		2,3,7,8-TCDD Concentration (ng/kg)		Decision	Within the Lower 8 Mile ROD Remedy Footprint?	Additional Support
				Segment 1	Segment 2	Segment 1	Segment 2			
Tierra – 1995 Remedial Investigation Sampling Program	1995	229	3.1	0.5 - 1.4	1.4 - 2.3	291	563	No adjustment	Yes	Concentration difference is within an order of magnitude.
		230	3.1	0.5 - 1.4	1.4 - 4.0	967	4330	No adjustment	Yes	Concentration difference is within an order of magnitude.
		240	4.0	0.5 - 1.2	1.2 - 1.9	8,970	12,100	No adjustment	Yes	Both segments are mostly within 0.5-1.5 interval.
		249	4.7	0.5 - 1.3	1.3 - 2.8	364	496	No adjustment	Yes	Concentration difference is less than an order of magnitude.
USEPA/MPI – Low-Resolution Sediment Coring Program	2006	G0000022	4.9	0.0 - 1.44	1.44 - 2.89	563	3,180	No adjustment	Yes	Core is lacking a Layer A segment. Therefore, the Layer B concentration will be resampled, and this core is not part of the data pool for resampling.
Tierra – 1995 Remedial Investigation Sampling Program	1995	258	5.3	0.5 - 1.4	1.4 - 2.3	414	668	No adjustment	Yes	Concentration difference is within an order of magnitude.
USEPA/MPI – Low-Resolution Sediment Coring Program	2006	G0000027	5.3	0.0 - 1.15	1.15 - 2.3	275	613	No adjustment	Yes	Core is lacking a Layer A segment. Therefore, the Layer B concentration will be resampled, and this core is not part of the data pool for resampling.
Tierra – 1999 Sediment Sampling Program	1999	PRP-99-04	6.2	0.0 - 1.0	1.0 - 3.0	810	4700	No adjustment	Yes	Core is lacking a Layer A segment. Therefore, the Layer B concentration will be resampled, and this core is not part of the data pool for resampling.
Tierra – 1995 Remedial Investigation Sampling Program	1995	270	6.3	0.5 - 1.0	1.0 - 1.8	628	2,350	No adjustment	Yes	Both segments are mostly within 0.5-1.5 interval.
		271	6.3	0.5 - 0.9	0.9 - 3.1	163	1,630	No adjustment	Yes	Concentration difference is within an order of magnitude.
		274	6.5	0.5 - 0.9	0.9 -2.8	3,740	26,500	No adjustment	Yes	Concentration difference is within an order of magnitude.
		278	6.7	0.5 - 1.2	1.2 - 1.9	4,990	27,000	No adjustment	Yes	Both segments are mostly within 0.5-1.5 interval.
Low-resolution Coring Program Supplemental Sampling Program 2	2013	13B-0563	14.5	0.5 - 1.1	1.1 - 2.5	1.1	2130	Use only the 0.5-1.1 foot segment for Layer B	No	See text: Section 2.3.1

Notes:

2,3,7,8-TCDD: 2,3,7,8-tetrachlorodibenzo-p-dioxin

ng/kg: nanogram per kilogram

ROD: Record of Decision

TCDD: tetrachlorodibenzo-p-dioxin

USEPA: U.S. Environmental Protection Agency

Table 3-1

Probing and Fine Sediment Content Data Used to Evaluate the Expansion of Silt Areas

Study Name	Year	Probing	Fine Sediment Content
Aqua Survey, Inc. – Geophysical Survey for NJDOT	2005	Yes	No
USEPA/MPI - EMBM	2007, 2008	Yes	No
Low-Resolution Coring Program	2008	Yes	Yes
Benthic Program Surface Sediment Sampling (2009)	2009	No	Yes
River Mile 10.9 Characterization	2011	No	Yes
Low-Resolution Coring Program Supplemental Sampling Program	2012	No	Yes
Low-Resolution Coring Program Supplemental Sampling Program 2	2013	Yes	Yes

Notes:

EMBM: Empirical Mass Balance Model

MPI: Malcom Pirnie, Inc.

NJDOT: New Jersey Department of Transportation

USEPA: U.S. Environmental Protection Agency

Table 5-1

Variogram Gaussian Model Parameters Used in Kriging and the Conditional Simulation for 2,3,7,8-TCDD

Name	Range	Nugget	Partial Sill*	Variance of Residuals	Type
RM 10.9 Silt Deposit	505	0.7	2.6	3.1	Base variogram
Downstream Channel and High Deposition since 1966	505	0.2	0.7	0.8	vgroup
No Deposition Since 1949 and Mixed Depositional Since 1966	505	0.8	3.2	3.7	vgroup
Left Shoal RM 0-6	505	0.1	0.2	0.3	vgroup
Left Shoal RM 6-11.3	505	1.1	4.1	4.8	vgroup
Left Shoal RM 11.3-14.4	505	0.1	0.4	0.4	vgroup
Upstream Channel	505	0.6	2.3	2.7	vgroup
Right Shoal RM 6.5-14.7	505	1.6	6.3	7.4	vgroup
Right Shoal RM 0-6.5	505	0.2	0.7	0.8**	vgroup
Silt	505	0.6	2.3	2.7	vgroup

Notes:

* The partial sill is equal to the sill minus the nugget.

** For *Right Shoal RM 0-6.5* , the variance of all the data is 2.8. The two locations with the lowest 2,3,7,8-TCDD concentrations, CLRC-002 (0.05 ng/kg) and 12A-0421 (0.77 ng/kg), were dropped prior to calculating the variance of 0.8 that was used to scale the variogram.

ng/kg: nanograms per kilogram

RM: river mile

TCDD: tetrachlorodibenzo-p-dioxin

Table 5-2

Variogram Gaussian Model Parameters Used in Kriging and the Conditional Simulation for Tetra-CB

Name	Range	Nugget	Partial Sill*	Variance of Residuals	Type
RM 10.9 Silt Deposit	390	0.35	2.0	2.3	Base variogram
Downstream Channel and High Deposition Since 1966	390	0.10	0.6	0.6	vgroup
No Deposition Since 1949 and Mixed Depositional Since 1966	390	0.29	1.7	1.9**	vgroup
Left Shoal RM 0-6	390	0.03	0.2	0.2	vgroup
Left Shoal RM 6-11.3	390	0.38	2.2	2.5	vgroup
Left Shoal RM 11.3-14.4	390	0.19	1.1	1.2	vgroup
Upstream Channel	390	0.25	1.4	1.7	vgroup
Right Shoal RM 6.5-14.7	390	0.59	3.4	3.9	vgroup
Right Shoal RM 0-6.5	390	0.11	0.6	0.7***	vgroup
Silt	390	0.33	1.9	2.2	vgroup

Notes:

* The partial sill is equal to the sill minus the nugget.

** For No Deposition Since 1949 and Mixed Depositional Since 1966, the variance of all the data is 2.9. The location with the lowest tetra-CB concentration, 12A-04552 (0.0031 mg/kg), was dropped prior to calculating the variance of 1.9 that was used to scale the variogram.

*** For Right Shoal RM 0-6.5, the variance of all the data is 1.9. The two locations with the lowest tetra-CB concentrations, CLRC-002 (0.0036 mg/kg) and 12A-0421 (0.00026 mg/kg), were dropped prior to calculating the variance of 0.7 that was used to scale the variogram.

mg/kg: milligrams per kilogram

RM: river mile

tetra-CB: tetrachlorobiphenyl

Table 5-3
Summary of Capping and Bottoming-Out for the 2,3,7,8-TCDD Conditional Simulation

	2,3,7,8-TCDD Concentration (ng/kg)					Simulation 37						Statistics for All 100 Simulations											
	Measured Data			Bottom-Out Value	Cap	2,3,7,8-TCDD Concentration (ng/kg)		Acres		Percent of Area		2,3,7,8-TCDD Concentration (ng/kg)				Acres				Percent of Area			
			Was Min Detected?			Smallest Simulated Value	Largest Simulated Value	Bottomed-Out	Capped	Bottomed-Out	Capped	Smallest Simulated Value		Largest Simulated Value		Bottomed-Out		Capped		Bottomed-Out		Capped	
Vgroup	Min	Max										Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Channel_HD	16.3	2,660	Y	8.1	5,320	6.2	7,684	0.02	0.06	0.01	0.03	2.1	12	3,849	27,205	0	0.3	0	0.4	0	0.2	0	0.2
G_2_3	3.29	21,900	Y	1.6	43,800	0.27	1,036,831	0.2	0.9	0.3	1.3	0.0091	0.55	130,830	3,947,679	0.1	2.5	0.1	2.4	0.2	3.6	0.2	3.5
LS_RM_00_6	110	1,340	Y	55	2,680	42	2,300	0.04	NA	0.04	NA	19	66	1,311	5,056	0	1.7	0	0.2	0	1.9	0	0.2
LS_RM_06_11p3	10.3	28,200	Y	5.2	51,100	0.10	178,105	0.9	0.3	2.6	0.9	0.031	1.9	135,272	10,487,424	0.1	2.1	0.1	1.5	0.3	6.1	0.2	4.2
LS_RM_11p3_14p4	54	465	Y	27	930	19	1,526	0.04	0.1	0.2	0.7	6.5	34	628	2,098	0	0.7	0	0.3	0	4.4	0	2.2
NS_UP	0.53	7,590	Y	0.27	15,180	0.012	12,154	1.1	NA	0.8	NA	0.0031	0.090	7,488	597,878	0.5	3.5	0	0.7	0.4	2.5	0	0.5
RS_above_6p5	0.445	51,100	Y	0.22	51,100	0.0080	1,125,834	1.5	1.5	2.9	2.9	0.00012	0.041	379,306	236,410,333	0.1	2.6	0.6	5.4	0.1	4.9	1.1	10.2
RS_below_6p5	0.045	2,600	Y	0.023	5,200	0.081	10,412	NA	0.1	NA	0.05	0.052	0.39	3,718	16,504	0	0	0	0.3	0	0	0	0.1
Silt	0.416	21,600	Y	0.21	43,200	0.65	108,552	NA	0.3	NA	0.5	0.064	1.7	50,869	954,549	0	0.03	0.01	0.8	0	0.05	0.0	1.4

Notes:

NA: not applicable

ng/kg: nanogram per kilogram

TCDD: tetrachlorodibenzo-p-dioxin

Table 5-4
Summary of Capping and Bottoming-Out for the Tetra-CB Conditional Simulation

	Tetra-CB Concentration (mg/kg)					Simulation 37						Statistics for All 100 Simulations											
	Measured Data					Tetra-CB (mg/kg)		Acres		Percent of Area		Tetra-CB (mg/kg)				Acres				Percent of Area			
												Smallest Simulated Value		Largest Simulated Value		Bottomed-Out		Capped		Bottomed-Out		Capped	
Vgroup	Min	Max	Was Min Detected?	Bottom-Out Value	Cap	Smallest Simulated Value	Largest Simulated Value	Bottomed-Out	Capped	Bottomed-Out	Capped	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Channel_HD	0.02	3.15	Y	0.01095	6.3	0.013	5.7	NA	NA	NA	NA	0.0062	0.021	3.4	16	0	0.1	0	0.2	0	0.04	0	0.1
G_2_3	0.003	10.8	Y	0.00155	10.8	0.0011	60.9	0.00001	16	0.00002	23	0.00008	0.0020	24	268	0	0.9	0.2	2.4	0	1.3	0.4	3.4
LS_RM_00_6	0.11	0.9985	Y	0.055	1.997	0.060	1.6	NA	NA	NA	NA	0.028	0.074	1.0	2.1	0	0.5	0	0.02	0	0.5	0	0.02
LS_RM_06_11p3	0.01	4.23	Y	0.0042	8.46	0.00066	35.5	0.0008	8.5	0.002	24	0.00020	0.0045	18	390	0	0.5	0.1	2.0	0	1.5	0.4	5.8
LS_RM_11p3_14p4	0.05	1.93	Y	0.026	3.86	0.011	8.5	0.009	0.9	0.05	5.7	0.0024	0.016	2.3	24	0.1	1.3	0	0.3	0.5	8.3	0	2.0
NS_UP	0.002	2.95	Y	0.00085	5.9	0.00025	5.4	0.0001	NA	0.0001	NA	0.00007	0.0013	3.3	66	0	0.8	0	0.5	0	0.6	0	0.4
RS_above_6p5	0.003	7.85	Y	0.00134	10.8	0.00010	85.1	0.0004	33	0.0008	62	0.00003	0.0011	41	2433	0.01	1.0	0.4	4.6	0.02	1.8	0.8	8.7
RS_below_6p5	0.0003	2.28	N	0.00013	4.56	0.00069	5.1	NA	0.09	NA	0.04	0.00017	0.0011	3.2	11	0	0	0	0.2	0	0	0	0.1
Silt	0.0004	10.3	Y	0.00019	10.8	0.00056	41.4	NA	7.7	NA	14	0.00005	0.0007	23	213	0	0.05	0.1	1.3	0	0.1	0.2	2.2

Notes:

mg/kg: milligram per kilogram

NA: not applicable

Tetra-CB: Tetrachlorobiphenyl

Table 6-1
Layer A Concentration Bins Used for Layer B Resampling

Bins Breaks	2,3,7,8-TCDD (ng/kg)	Tetra-CB (mg/kg)	1,2,3,4,6,7,8-HPCDF (ng/kg)	1,2,3,7,8-PeCDD (ng/kg)	2,3,4,7,8-PeCDF (ng/kg)	PCB-126 (ng/kg)	PCB-167 (ng/kg)	Total 4,4'-DDx (mg/kg)	Mercury (mg/kg)
Break 1	10	0.01	10	0.3	0.3	3	10	0.003	0.1
Break 2	100	0.1	100	1	1.0	10	100	0.01	0.3
Break 3	300	0.3	300	3	10	100	300	0.03	1
Break 4	1,000	1	1000	10.0	20	1000	1,000	0.1	3
Break 5	10,000	NA	NA	NA	50	NA	10,000	0.3	10
Break 6	NA	NA	NA	NA	200	NA	NA	NA	NA

Notes:

HPCDF: Heptachlorodibenzofuran

mg/kg: miligram per kilogram

NA: not applicable

ng/kg: nanogram per kilogram

PCB: polychlorinated biphenyl

PeCDD: Pentachlorodibenzo-p-dioxin

PeCDF: Pentachlorodibenzofuran

TCDD: tetrachlorodibenzo-p-dioxin

tetra-CB: tetrachlorobiphenyl

Table 6-2

Datasets and Layer A Surfaces Used for Layer B Resampling

River Miles	1995		2010	
	Dataset	Layer A Surface	Dataset	Layer A Surface
0-1	NA - Use 2010 thiessen resampling*		Pooled: 1995 dataset RM 1-7 2010 dataset RM 0-7.8	Resample: CS for 2,3,7,8-TCDD and tetra-CB Thiessens for other COPCs
1-7	Pooled: 1995 dataset RM 1-7 2010 dataset RM 1-7	Resample 1995 thiessens		
7-7.8	NA – Use 2010 thiessen resampling*			
7.8-14.7	NA – Use 2010 thiessen resampling*		2010 dataset RM 7.8-14.7	Resample: CS for 2,3,7,8-TCDD and tetra-CB Thiessens for other COPCs

Notes:

* Regarding the 1995 mapping outside of RM 1-7, for all COPCs with the exception of 2,3,7,8-TCDD and tetra-CB, the 2010 layer A mapping was based on thiessen polygons and the layer B resampling of these thiessens was also used to represent 1995. For 2,3,7,8-TCDD and tetra-CB, the 2010 layer A mapping was based on the conditional simulation. To represent 1995 layer A for these two COPCs, a separate thiessen polygon interpolation was performed based on the 2010 data. This layer A thiessen polygon surface was resampled to get a layer B surface.

NA: not applicable

COPC: chemical of potential concern

CS: conditional simulation

RM: river mile

TCDD: tetrachlorodibenzo-p-dioxin

tetra-CB: tetrachlorobiphenyl

Table 7-1
Comparison of Layer B vs. Layer A in Measured Data and Mapped Surfaces in the Lower Passaic River Between RM 0 to RM 14.7

Description				Figure Number	
Interpolation Type	COPC	IC Year	RM	Data Comparison*	Mapped Surface Comparison**
Thiessen Polygon	2,3,7,8-TCDD	1995	1 - 7	Figure 6-4	Figure 7-13
		1995	Outside RM 1-7	Figure 6-3	Figure 7-14
Conditional Simulation		2010	0 - 14.7		Figure 7-12
Thiessen Polygon	Tetra-CB	1995	1 - 7	Attachment 2, Figure 9	Attachment 3, Figure 9
		1995	Outside RM 1-7	Attachment 2, Figure 1	Attachment 3, Figure 17
Conditional Simulation		2010	0 - 14.7		Attachment 3, Figure 1
Thiessen Polygon	1,2,3,4,6,7,8-HPCDF	1995	1 - 7	Attachment 2, Figure 10	Attachment 3, Figure 10
		1995	Outside RM 1-7	Attachment 2, Figure 2	Attachment 3, Figure 2
		2010	0 - 14.7		
	1,2,3,7,8-PeCDD	1995	1 - 7	Attachment 2, Figure 11	Attachment 3, Figure 11
		1995	Outside RM 1-7	Attachment 2, Figure 3	Attachment 3, Figure 3
		2010	0 - 14.7		
	2,3,4,7,8-PeCDF	1995	1 - 7	Attachment 2, Figure 12	Attachment 3, Figure 12
		1995	Outside RM 1-7	Attachment 2, Figure 4	Attachment 3, Figure 4
		2010	0 - 14.7		
	PCB-126	1995	1 - 7	Attachment 2, Figure 13	Attachment 3, Figure 13
		1995	Outside RM 1-7	Attachment 2, Figure 5	Attachment 3, Figure 5
		2010	0 - 14.7		
	PCB-167	1995	1 - 7	Attachment 2, Figure 14	Attachment 3, Figure 14
		1995	Outside RM 1-7	Attachment 2, Figure 6	Attachment 3, Figure 6
		2010	0 - 14.7		
	Total 4,4'-DDx	1995	1 - 7	Attachment 2, Figure 15	Attachment 3, Figure 15
		1995	Outside RM 1-7	Attachment 2, Figure 7	Attachment 3, Figure 7
		2010	0 - 14.7		
	Mercury	1995	1 - 7	Attachment 2, Figure 16	Attachment 3, Figure 16
		1995	Outside RM 1-7	Attachment 2, Figure 8	Attachment 3, Figure 8
		2010	0 - 14.7		

Notes:
*Note that the datasets used for resampling for 2010 RM 0 - 14.7 and 1995 outside RM 1 - 7 are the same.
**For COPCs other than 2,3,7,8-TCDD and tetra-CB, the mappings for 2010 RM 0 - 14.7 and 1995 outside RM 1 - 7 are the same.
1,2,3,4,6,7,8-HPCDF: 1,2,3,4,6,7,8-heptachlorodibenzofuran
2,3,7,8-TCDD: 2,3,7,8-tetrachlorodibenzo-p-dioxin
COPC: chemical of potential concern
IC: initial condition
PCB: polychlorinated biphenyl
PeCDD: Pentachlorodibenzo-p-dioxin
PeCDF: Pentachlorodibenzofuran
RM: river mile
tetra-CB: tetrachlorobiphenyl

Figures

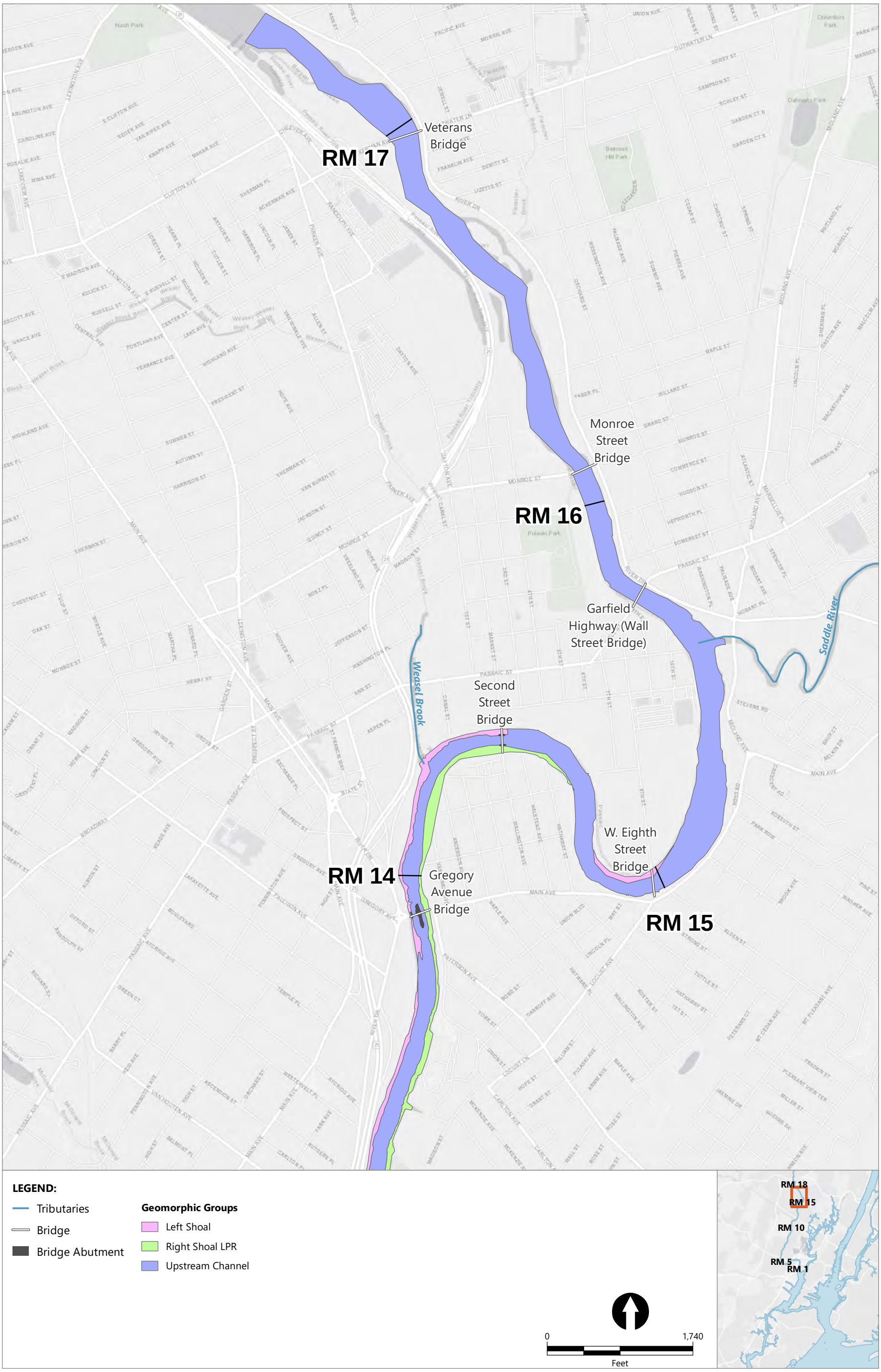

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Figure 3-1a
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

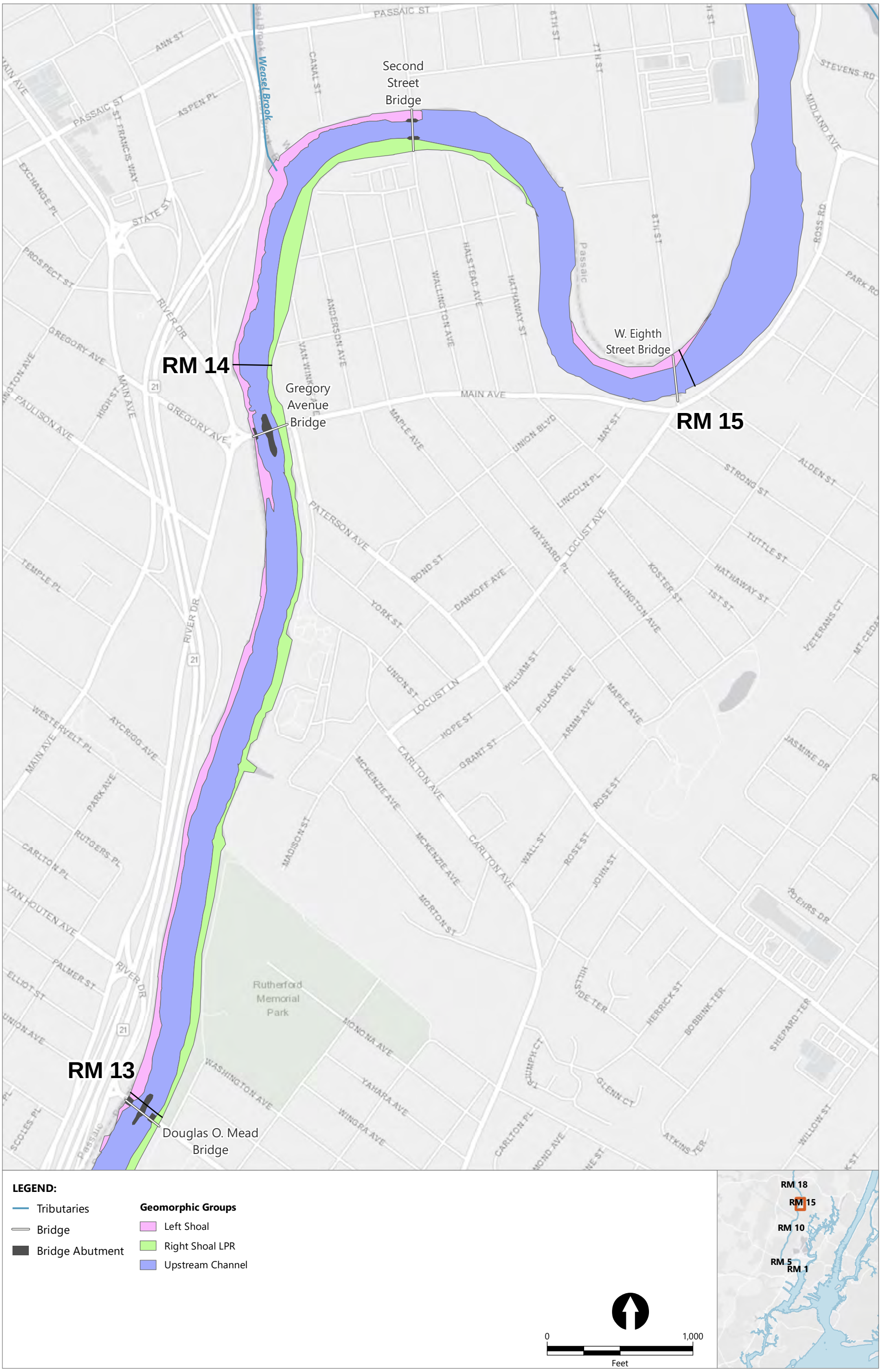

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Figure 3-1b
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

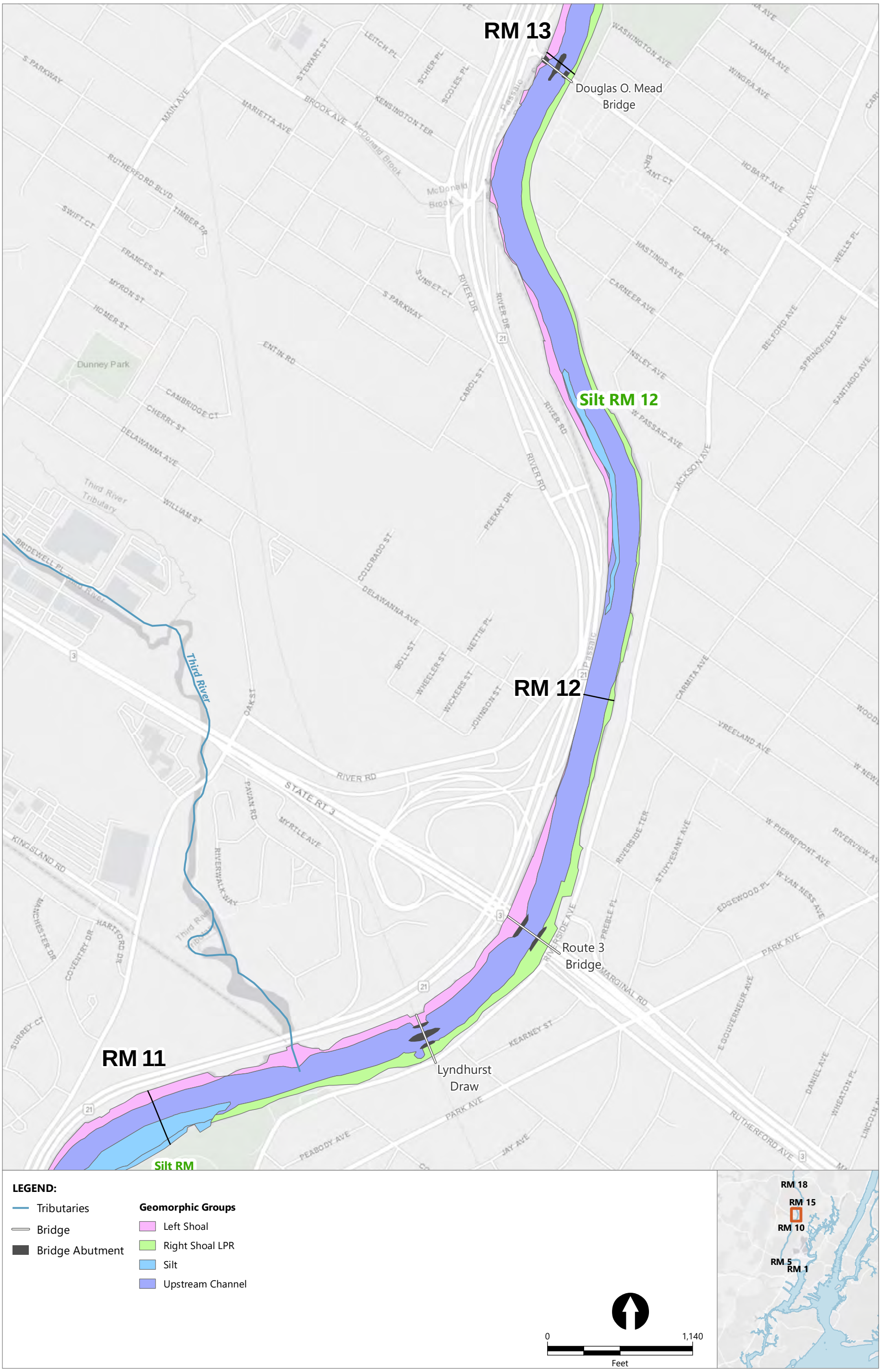

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Figure 3-1c
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

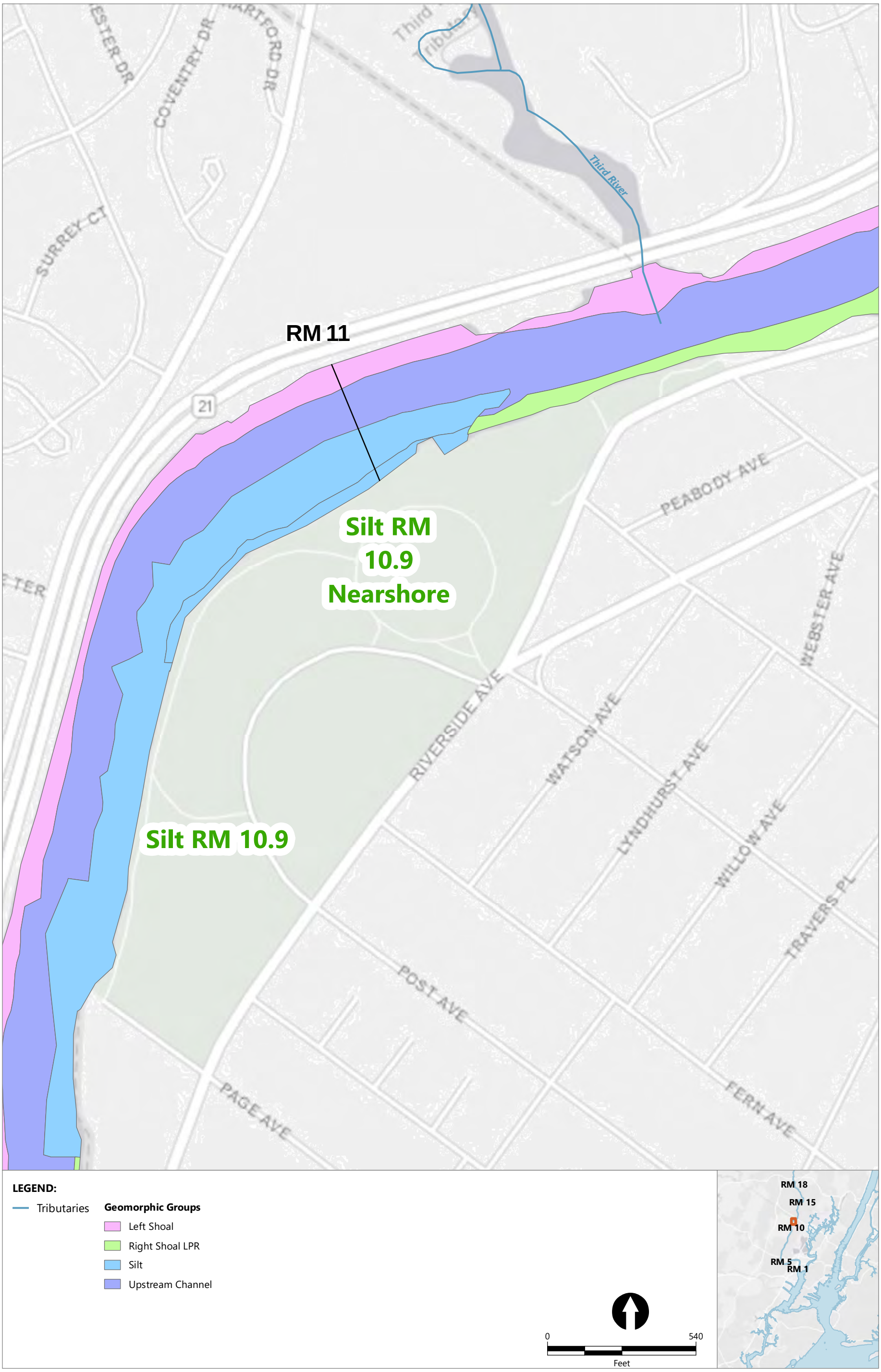

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Figure 3-1d
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-1e
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

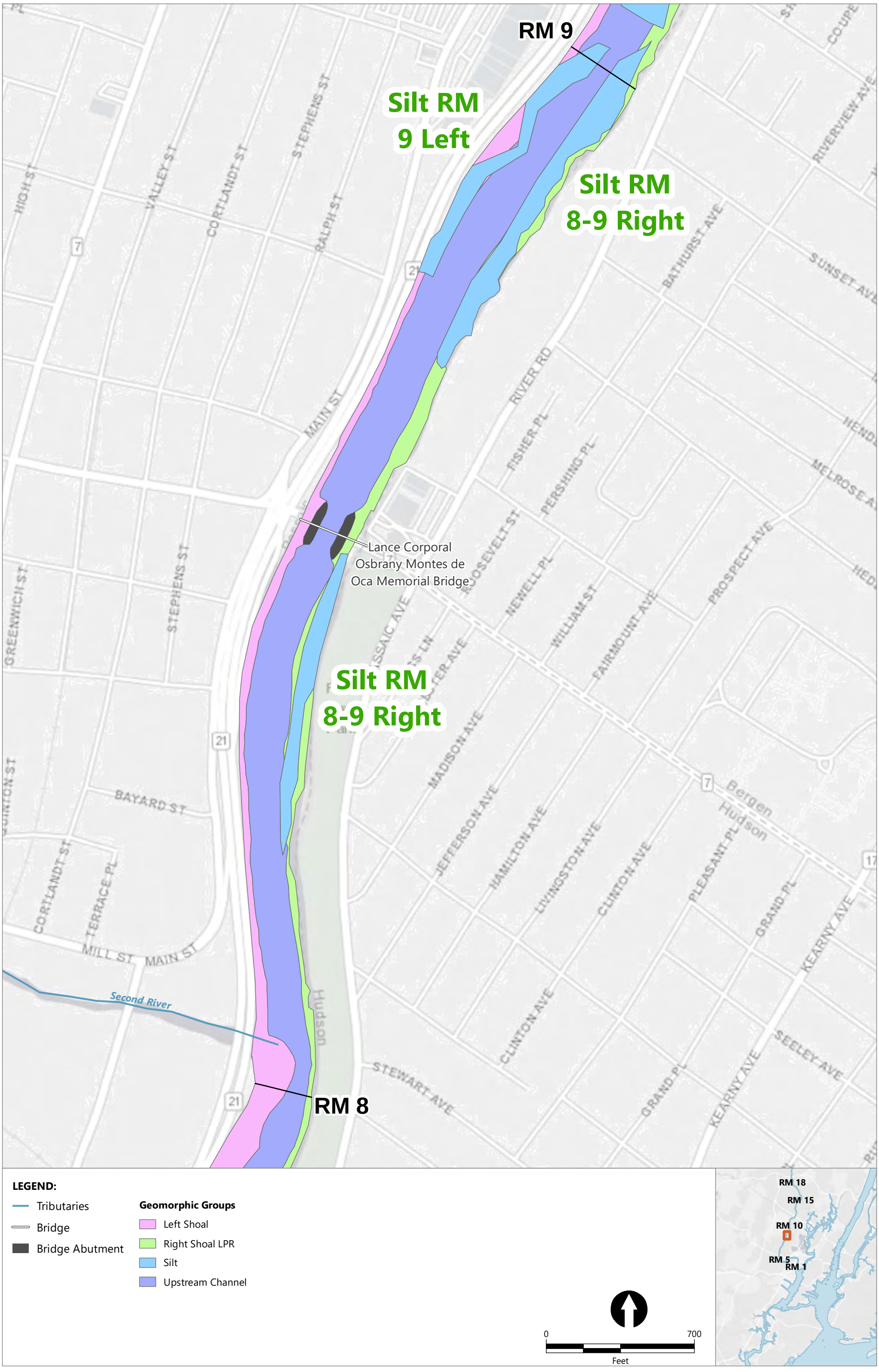

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Figure 3-1f
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

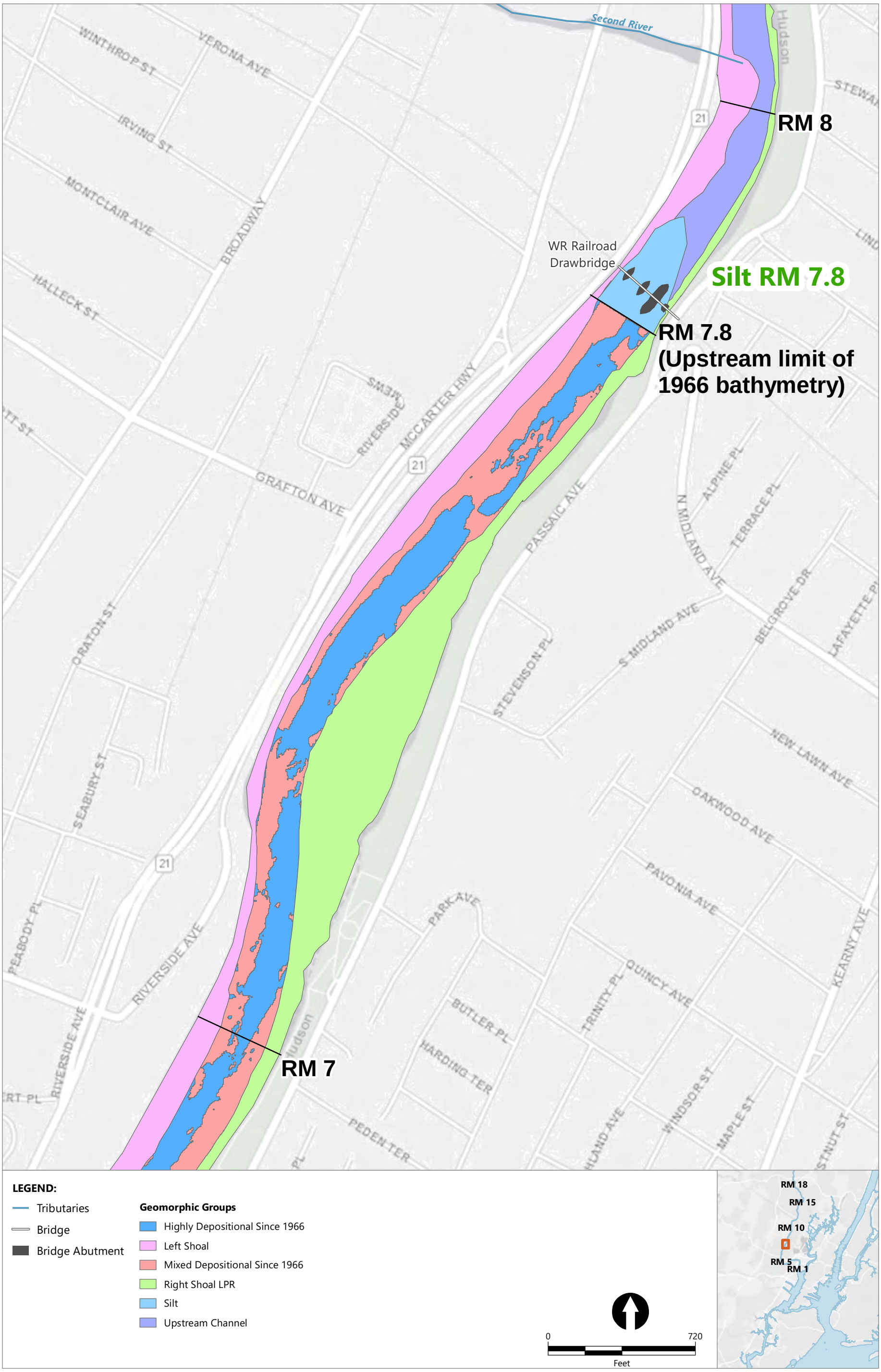

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Figure 3-1g
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

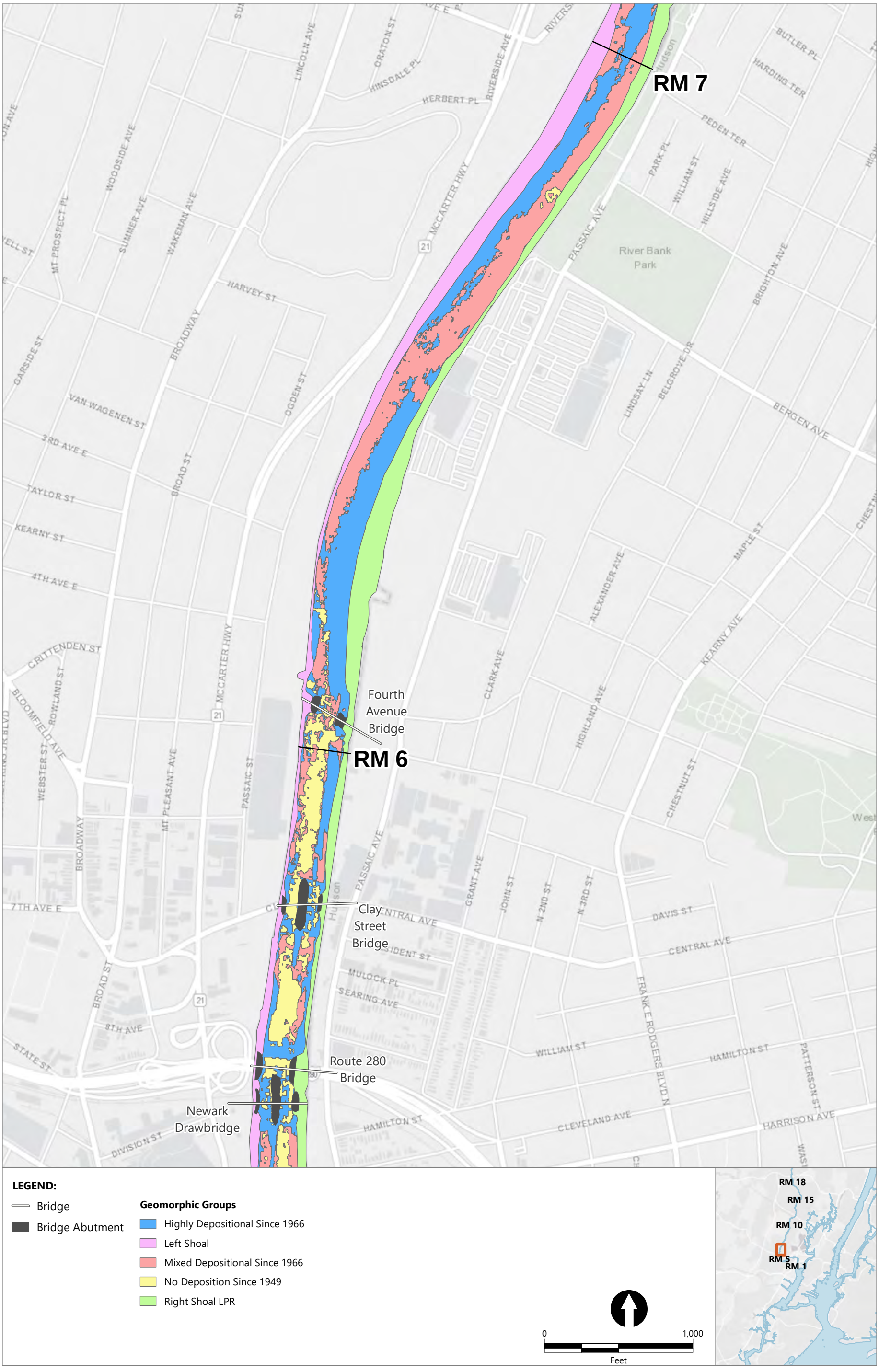

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Figure 3-1h
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

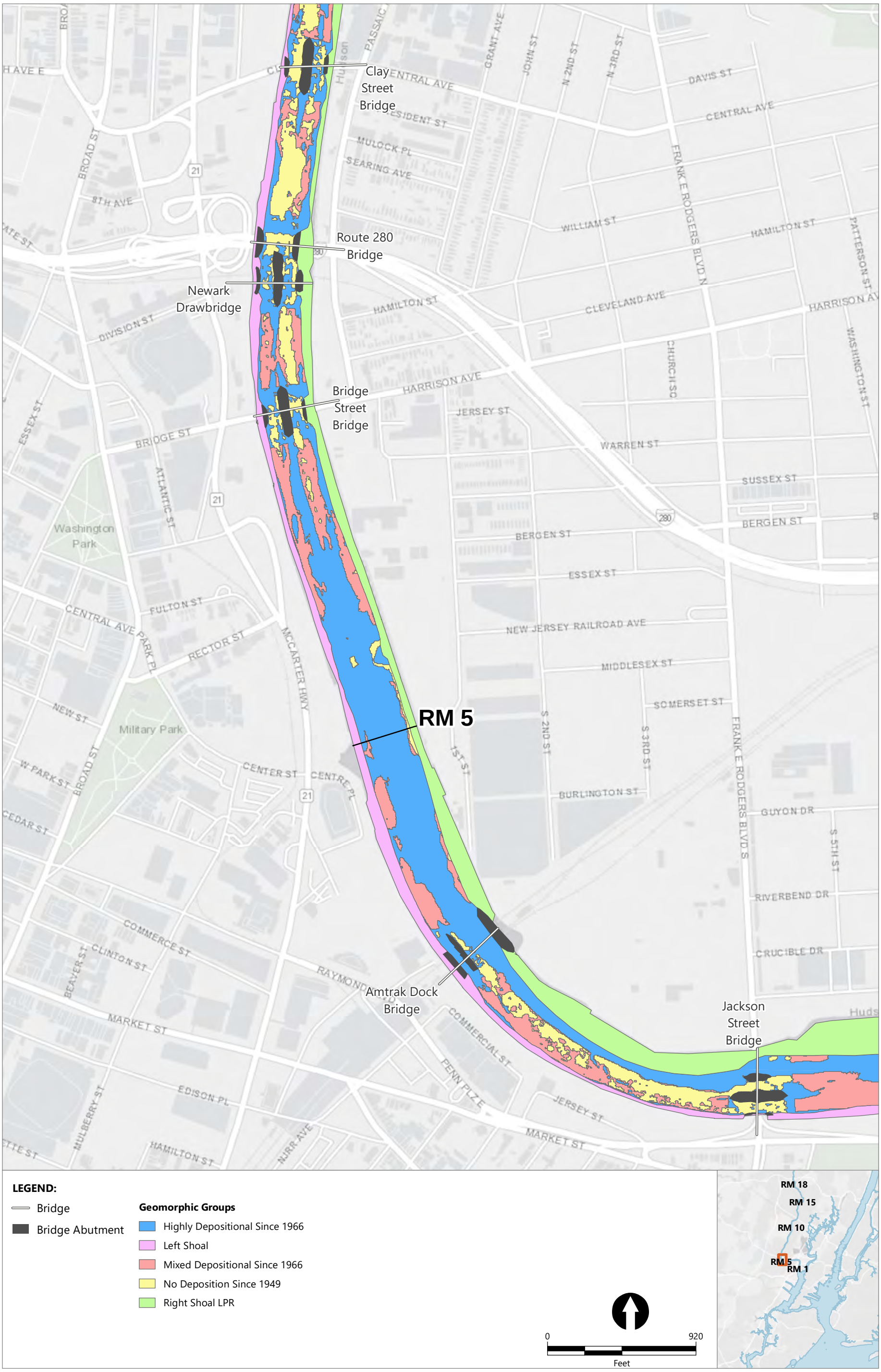

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Figure 3-1i
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

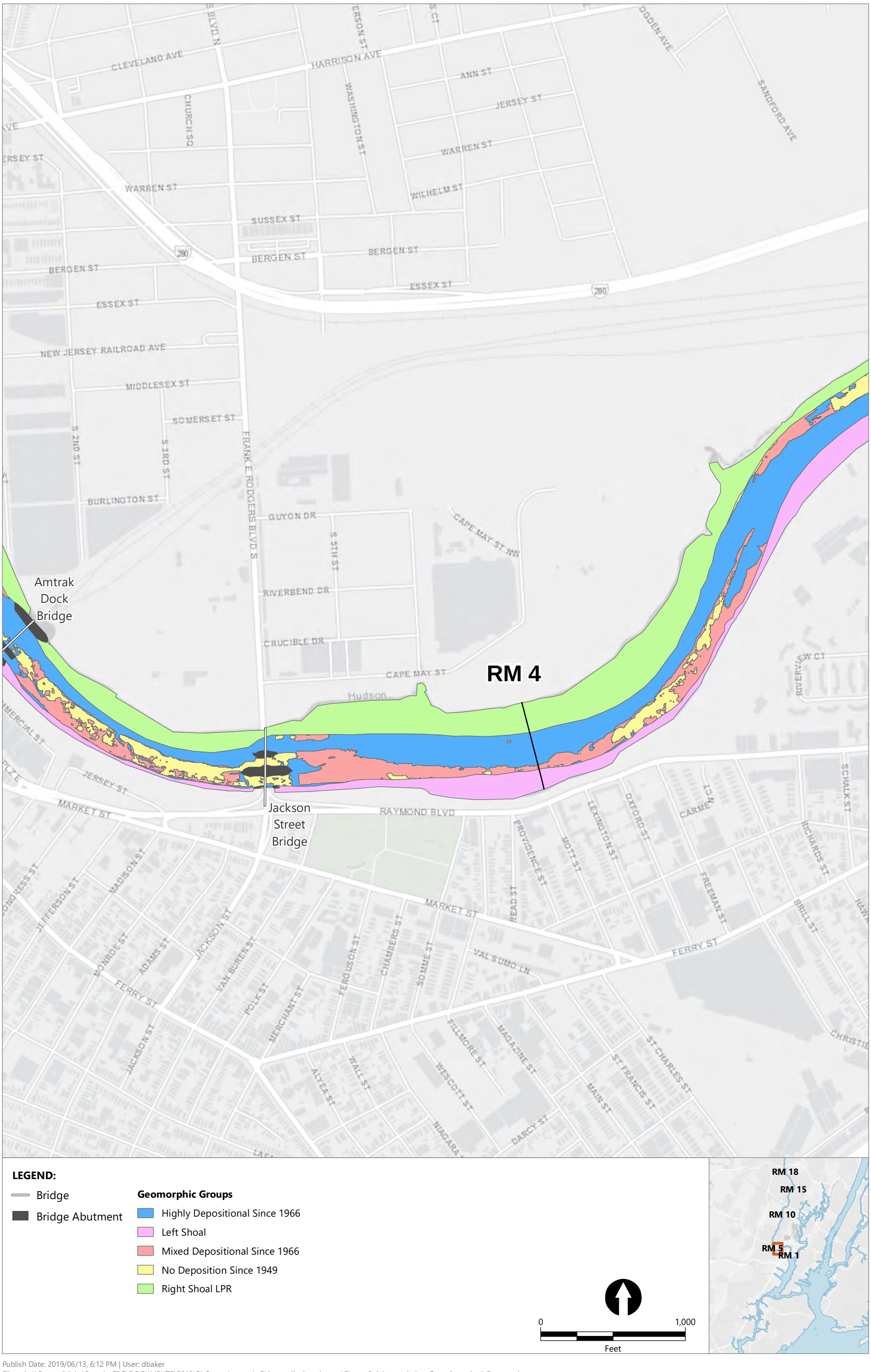

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Figure 3-1j
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

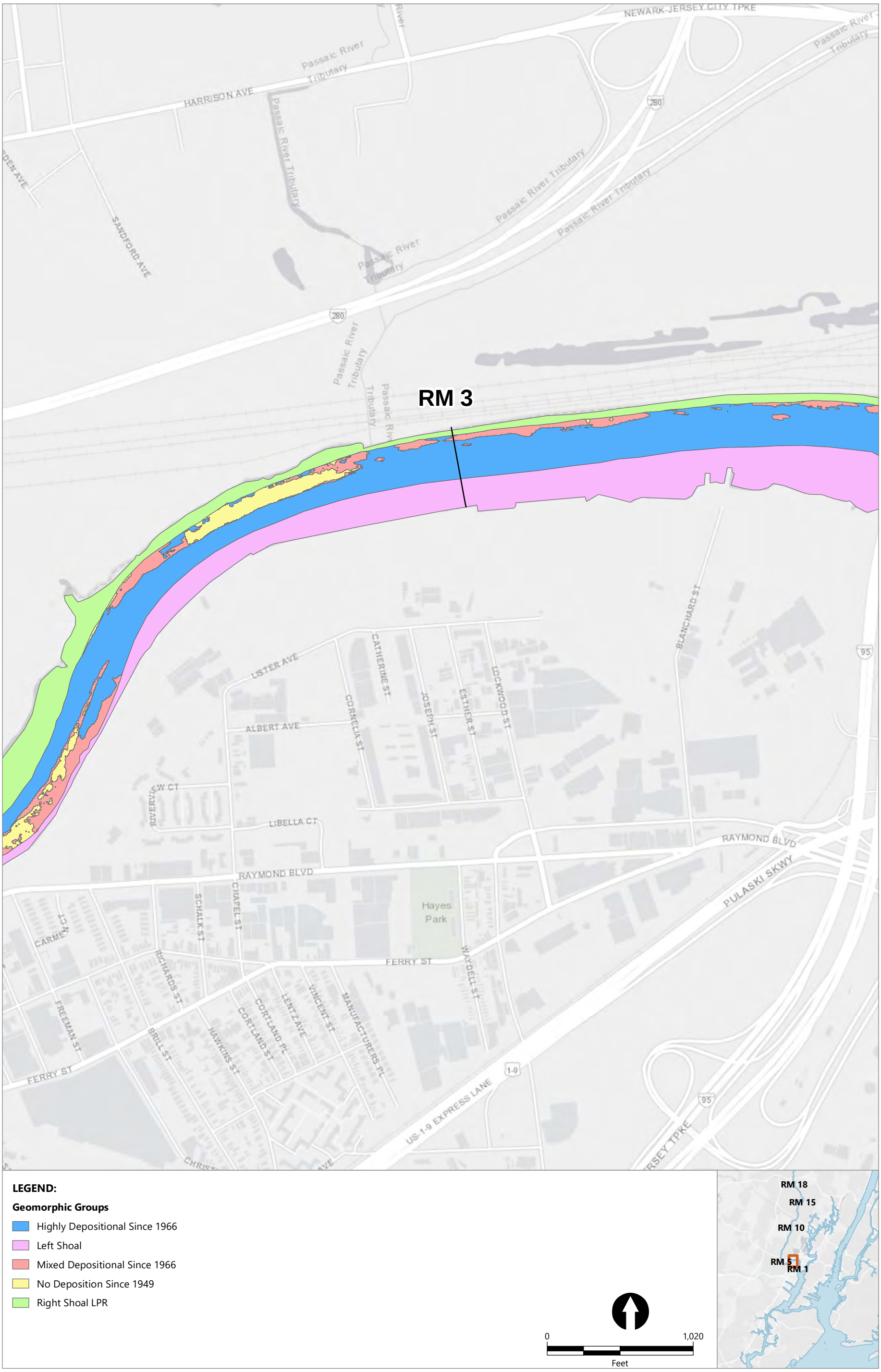

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Figure 3-1k
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

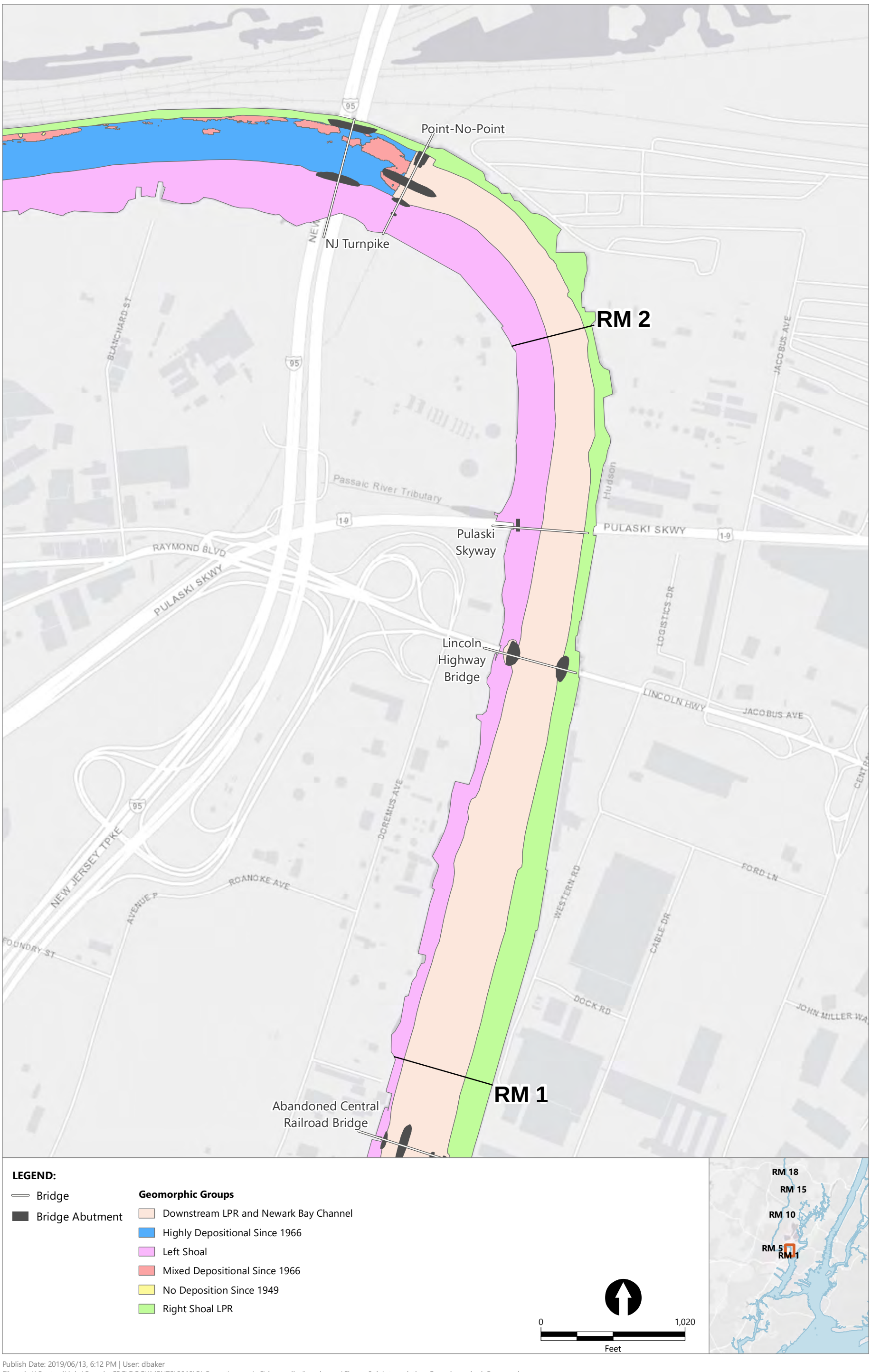

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Figure 3-1l
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-1m
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

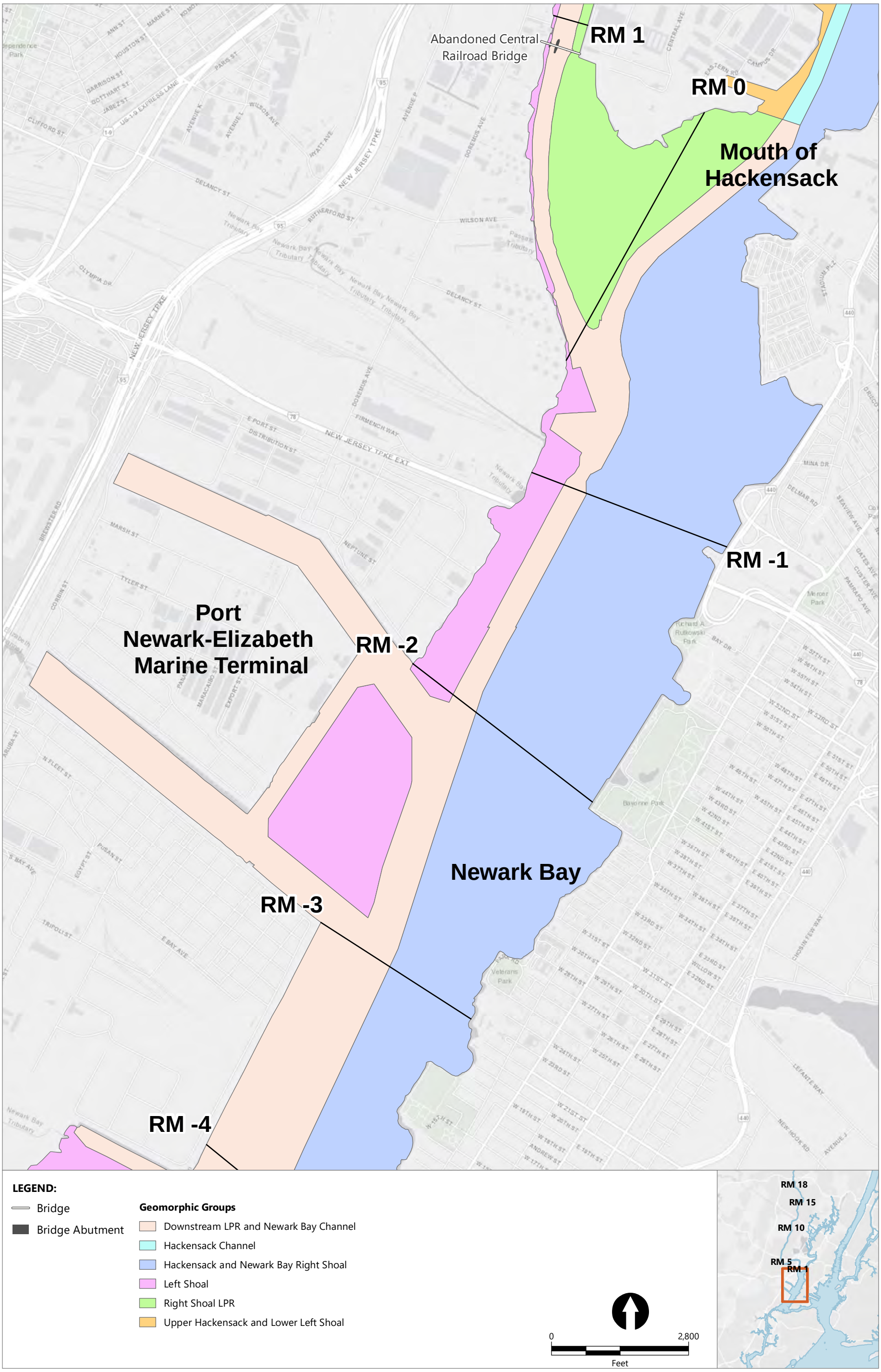

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Figure 3-1n
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

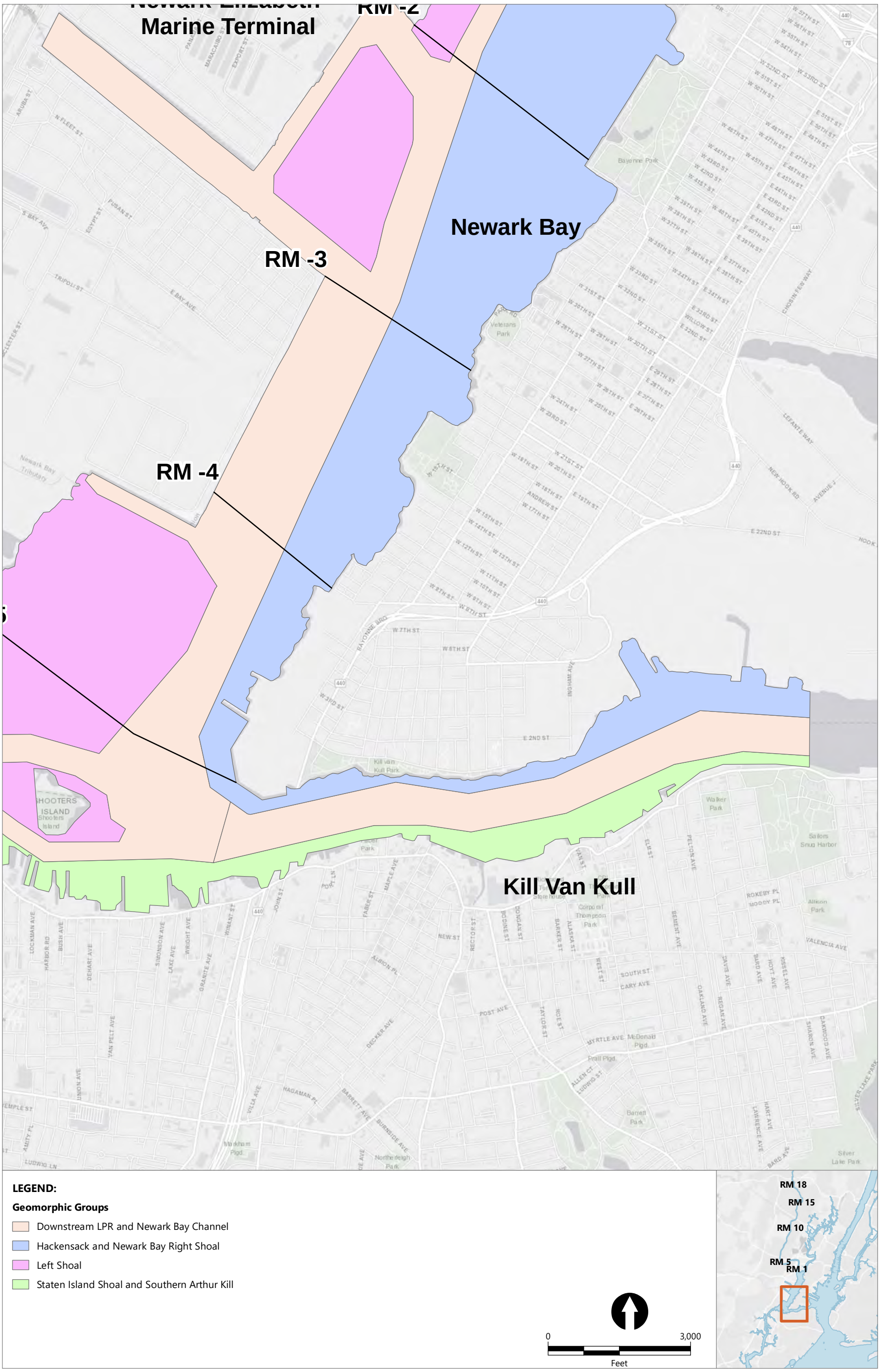

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Figure 3-1o
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

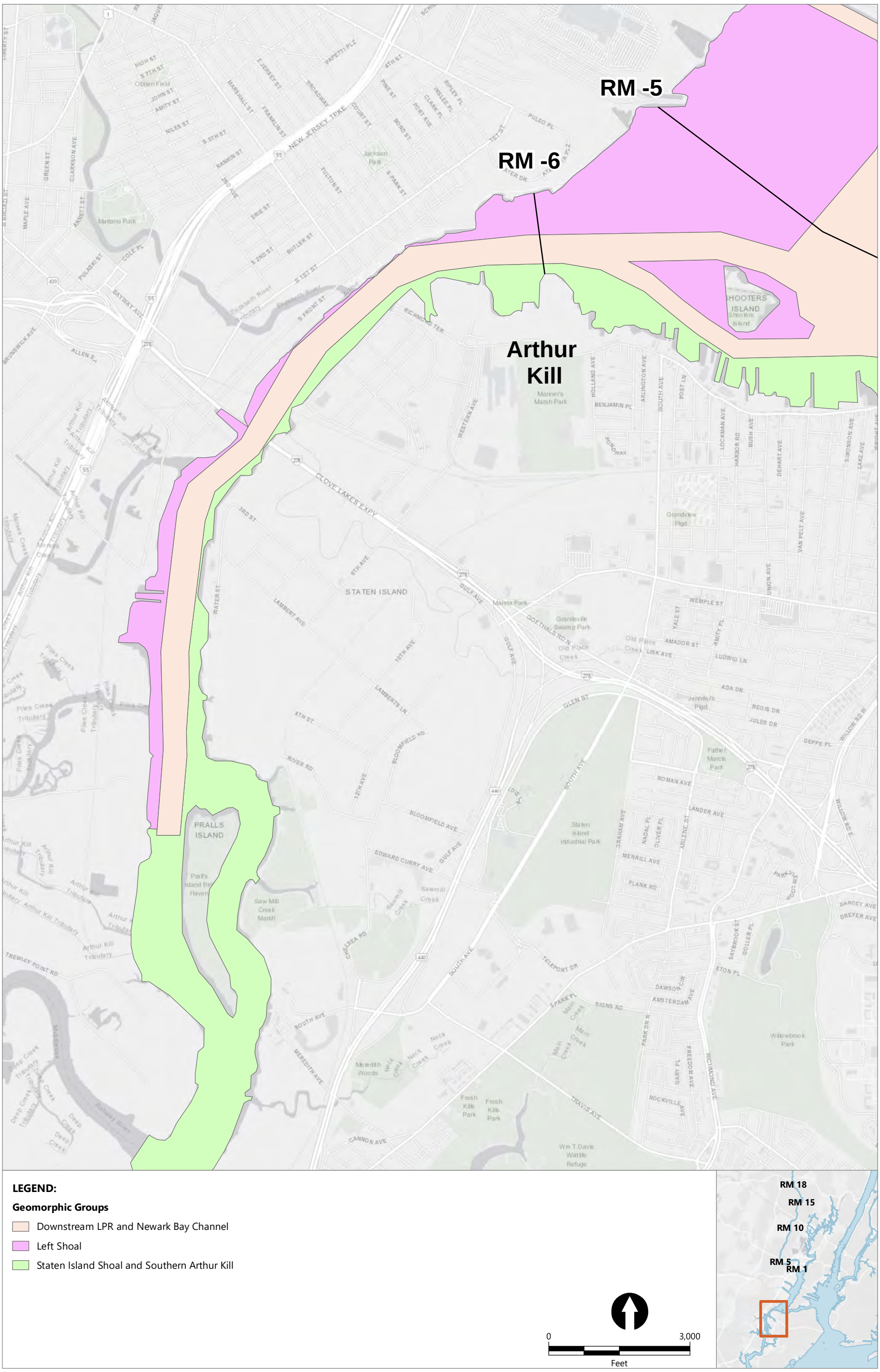

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Figure 3-1p
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

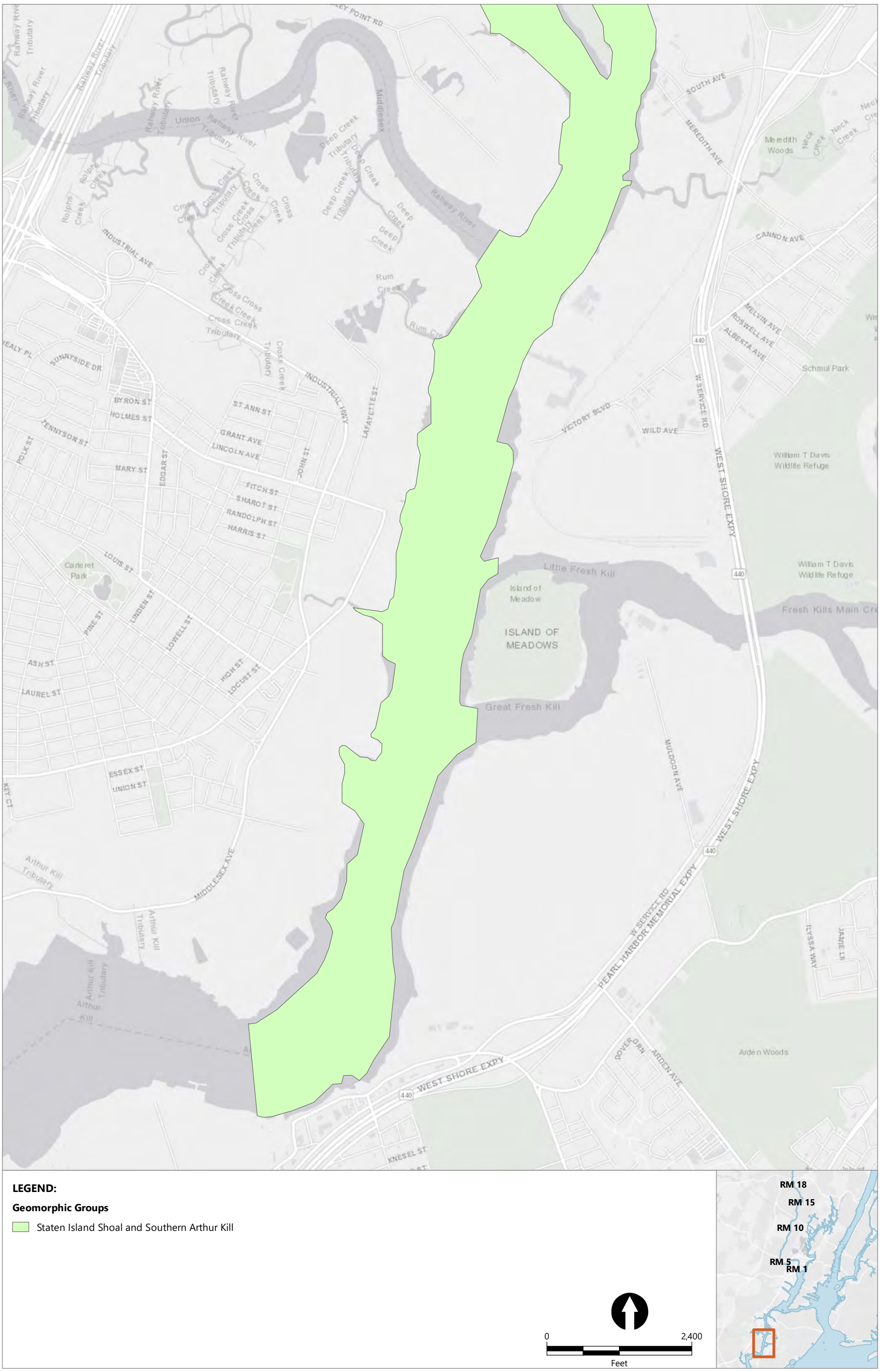

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Figure 3-1q
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

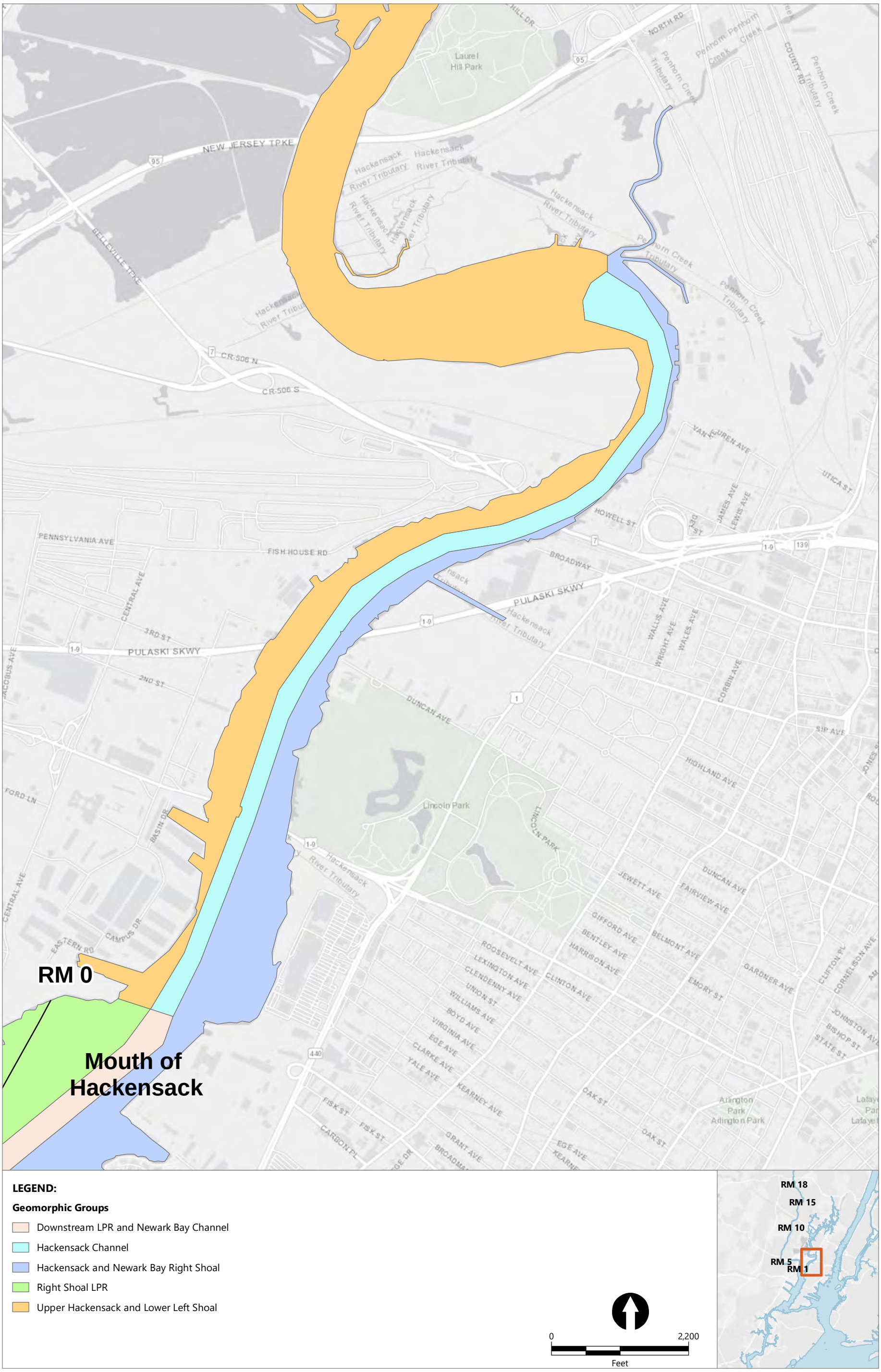

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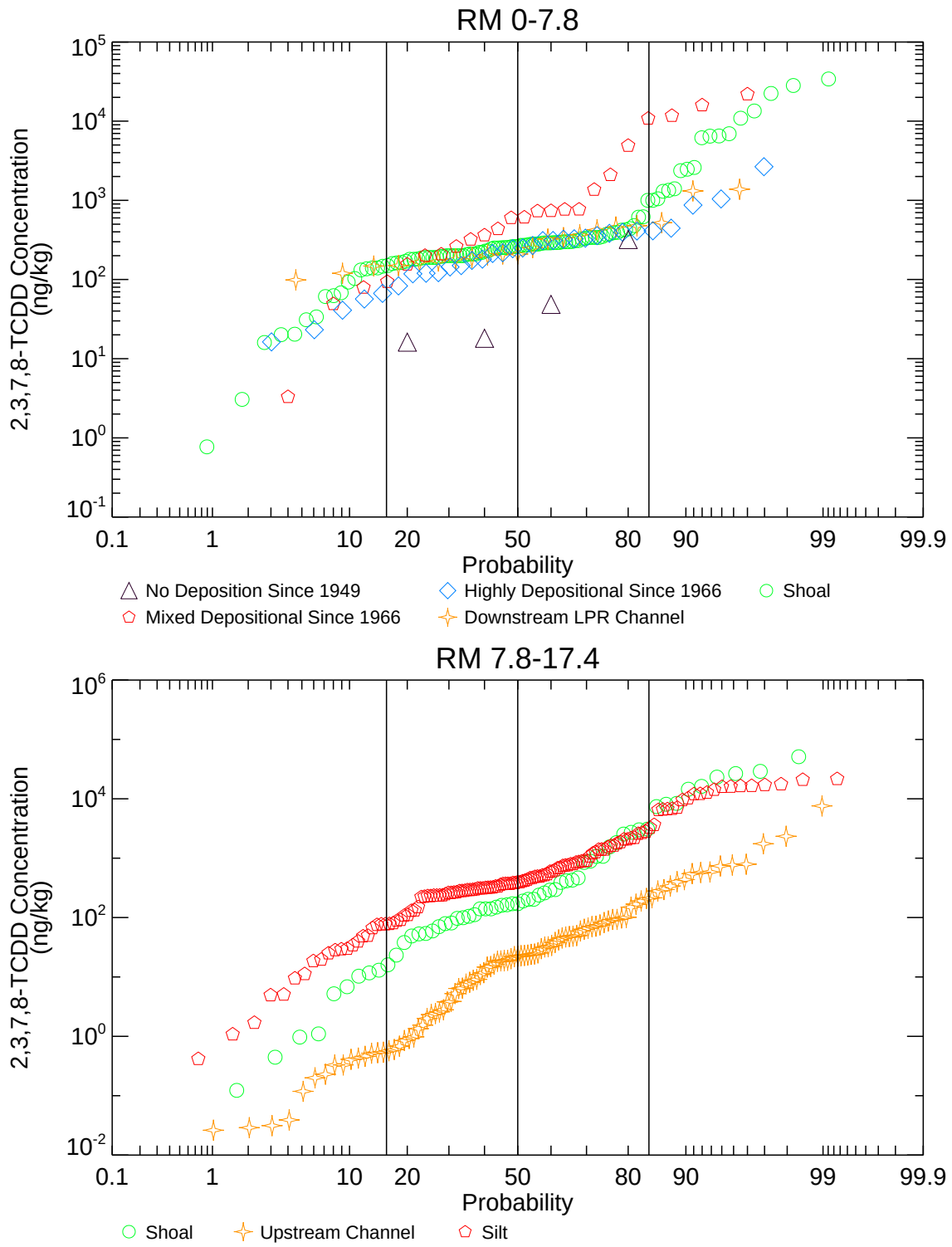
Figure 3-1r
Geomorphic Groups
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

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Figure 3-2

Distribution of Surface Sediment 2,3,7,8-TCDD Concentration Between RM 0 and 17.4 by Geomorphic Group

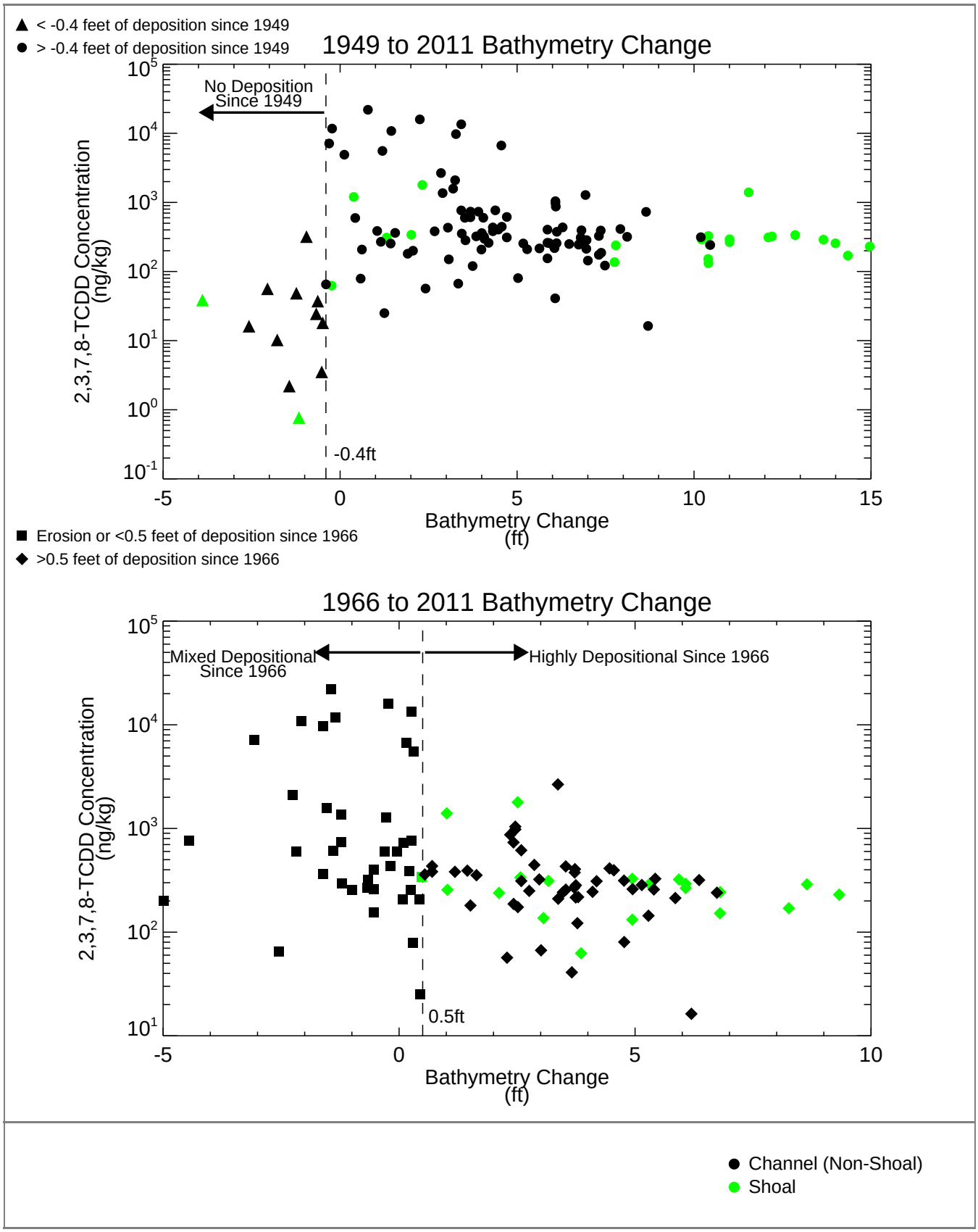

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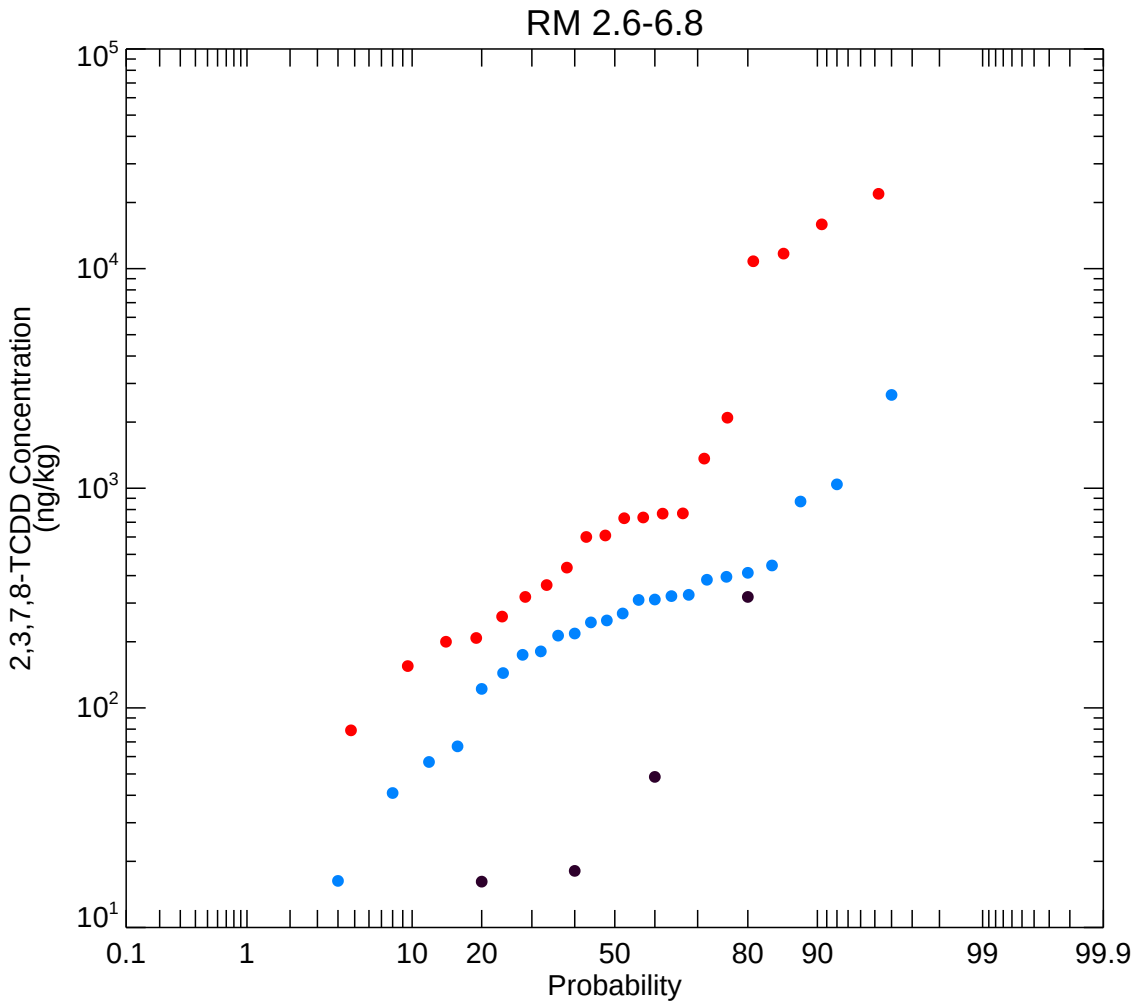
Figure 3-3

2,3,7,8-TCDD Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Excludes data in the shoals

- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/18/2019 17:20 | User: sm/ch
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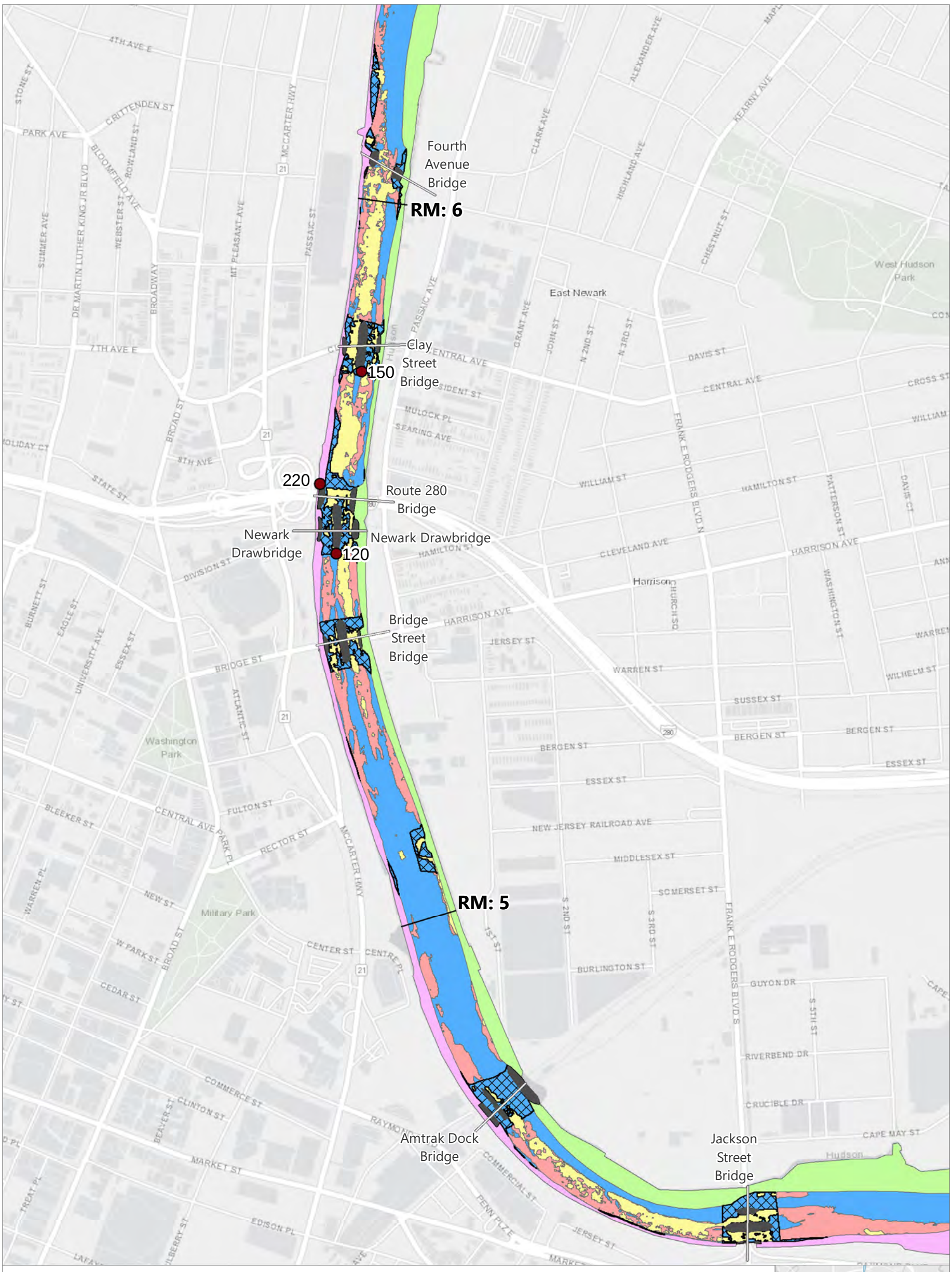
Figure 3-4

Distribution of Surface 2,3,7,8-TCDD Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8



LEGEND:

- Sample Location (ng/kg)
- Bridge
- Bridge Abutment
- Area without 1966 to 2011 Bathymetry Difference

Geomorphic Group

- Left Shoal
- Right Shoal LPR
- Highly Depositional Since 1966
- Mixed Depositional Since 1966
- No Deposition Since 1949
- Downstream LPR and Newark Bay Channel

NOTE(S):
Only samples within the highlighted areas with no bathymetry difference between 1966-2011 were shown above.
Sample locations were labeled with surface 2,3,7,8-TCDD concentrations in ng/kg.
Samples collected between 1995-2013.

0 1,050
Feet

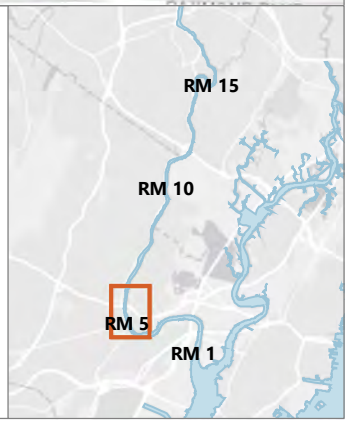


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Figure 3-5a
Areas Without 1966 to 2011 Bathymetry Difference, Which Were Assigned to "Highly Depositional Since 1966"
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

LEGEND:

- Sample Location (ng/kg)
- Bridge
- Bridge Abutment
- Area without 1966 to 2011 Bathymetry Difference

Geomorphic Group

- Left Shoal
- Right Shoal LPR
- Highly Depositional Since 1966
- Mixed Depositional Since 1966
- No Deposition Since 1949
- Downstream LPR and Newark Bay Channel

NOTE(S):
Only samples within the highlighted areas with no bathymetry difference between 1966-2011 were shown above.
Sample locations were labeled with surface 2,3,7,8-TCDD concentrations in ng/kg.
Samples collected between 1995-2013.

0 900
Feet

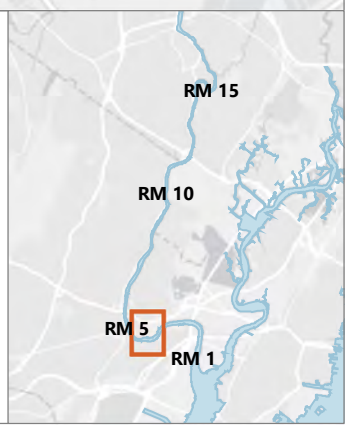

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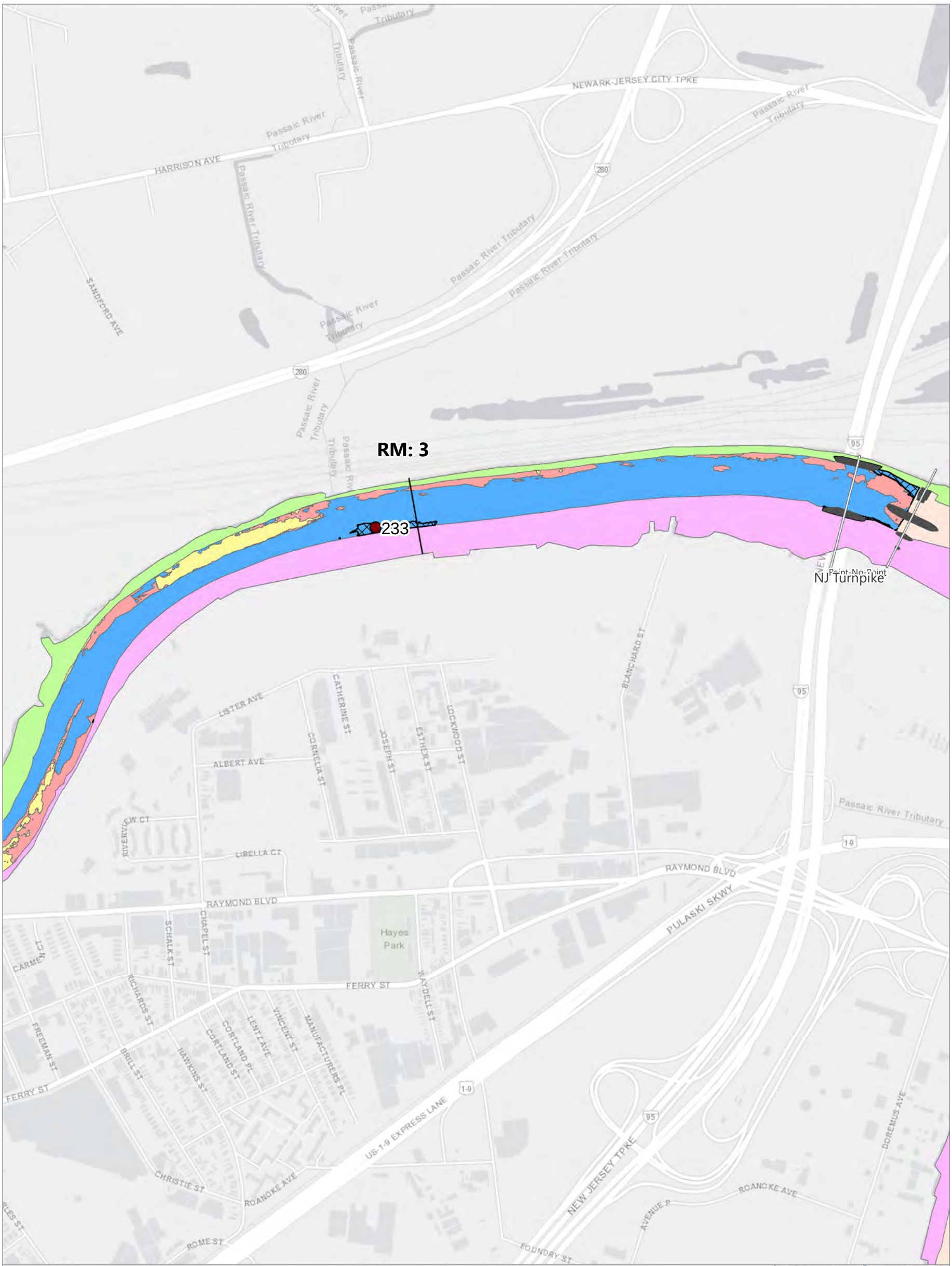
Figure 3-5b
Areas Without 1966 to 2011 Bathymetry Difference, Which Were Assigned to "Highly Depositional Since 1966"
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



LEGEND:

- Sample Location (ng/kg)
- Bridge
- Bridge Abutment
- Area without 1966 to 2011 Bathymetry Difference

Geomorphic Group

- Left Shoal
- Right Shoal LPR
- Highly Depositional Since 1966
- Mixed Depositional Since 1966
- No Deposition Since 1949
- Downstream LPR and Newark Bay Channel

NOTE(S):
Only samples within the highlighted areas with no bathymetry difference between 1966-2011 were shown above.
Sample locations were labeled with surface 2,3,7,8-TCDD concentrations in ng/kg.
Samples collected between 1995-2013.

0 1,060
Feet

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Figure 3-5c
Areas Without 1966 to 2011 Bathymetry Difference, Which Were Assigned to "Highly Depositional Since 1966"
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

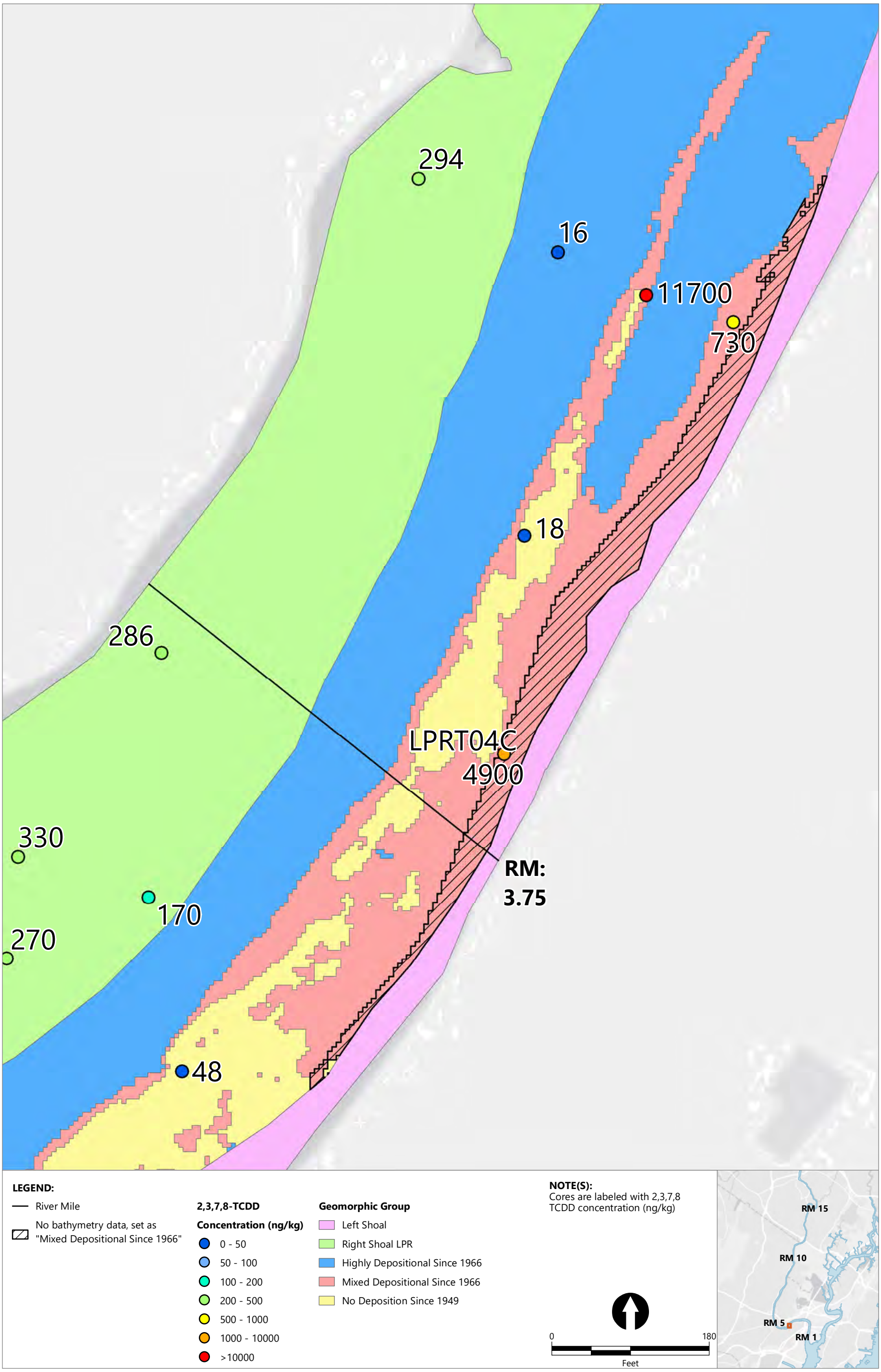

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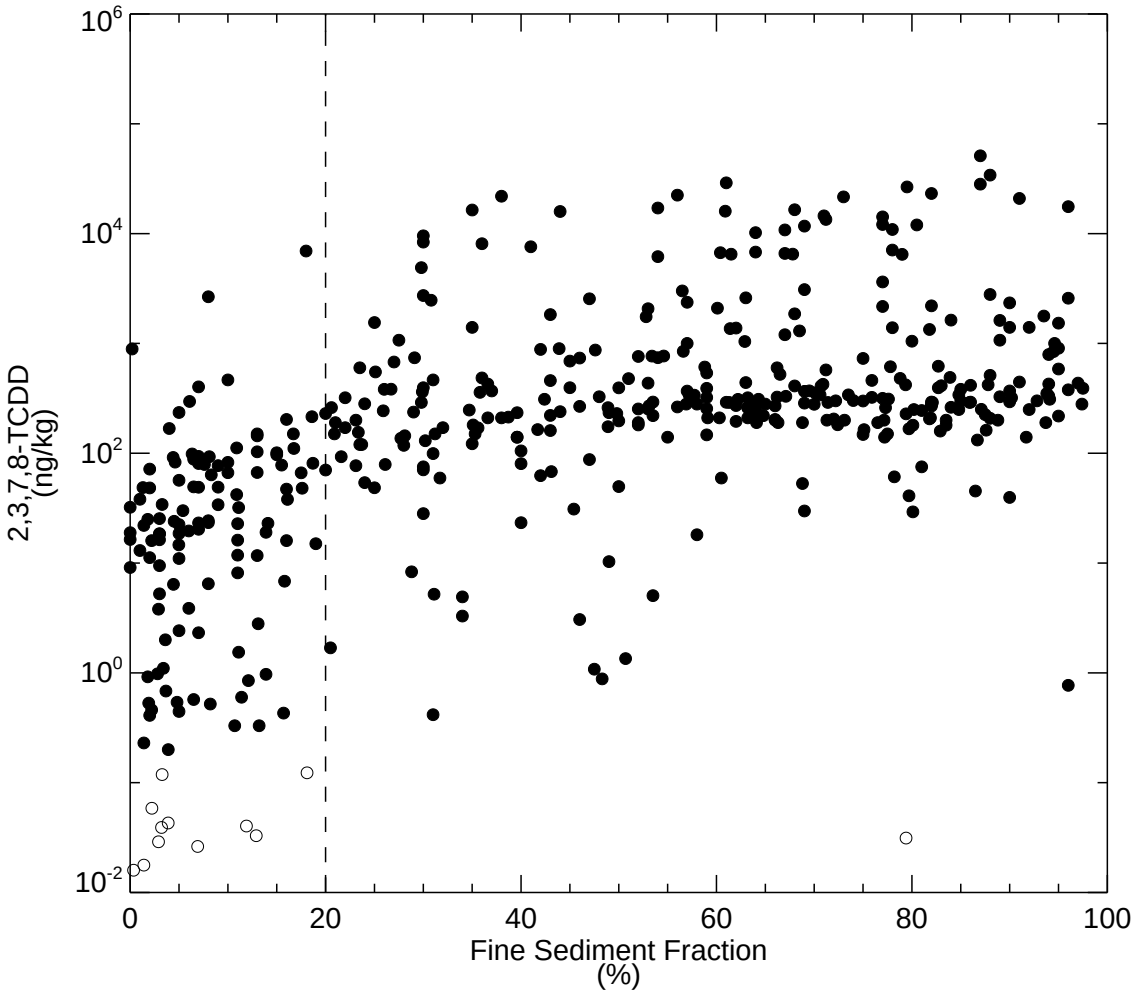
Figure 3-6

Area Without Historical 1966 Bathymetry Data, Which Was Assigned to "Mixed Depositional Since 1966"

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013 between RM 0 and RM 17.4.Surface sediments have bottom depths less than 6 inches.
Non-detect 2,3,7,8-TCDD concentrations plotted as unfilled circles.

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Figure 3-7

2,3,7,8-TCDD Concentrations in Surface Sediments Versus Fine Sediment Content

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-8a

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

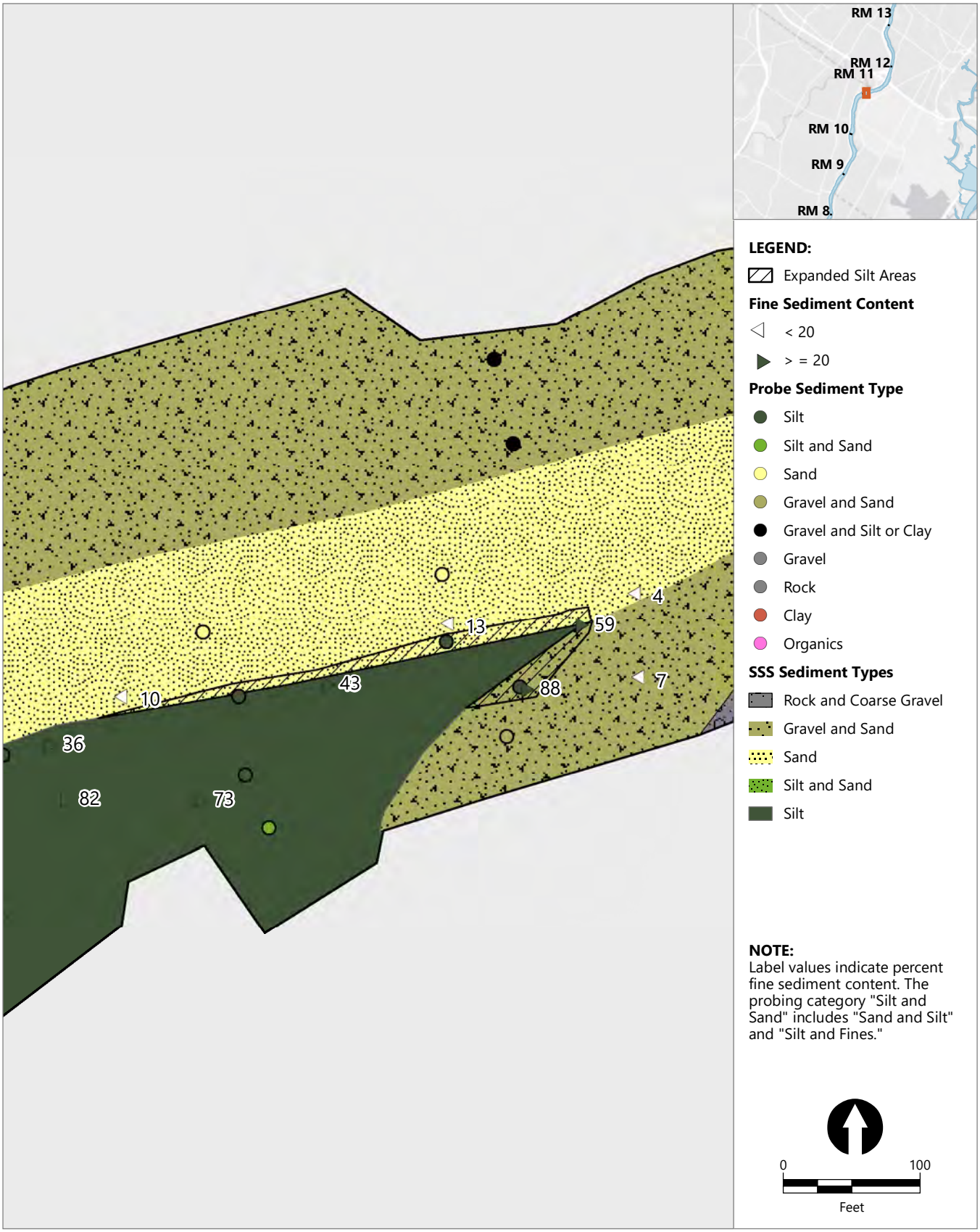

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Figure 3-8b
Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

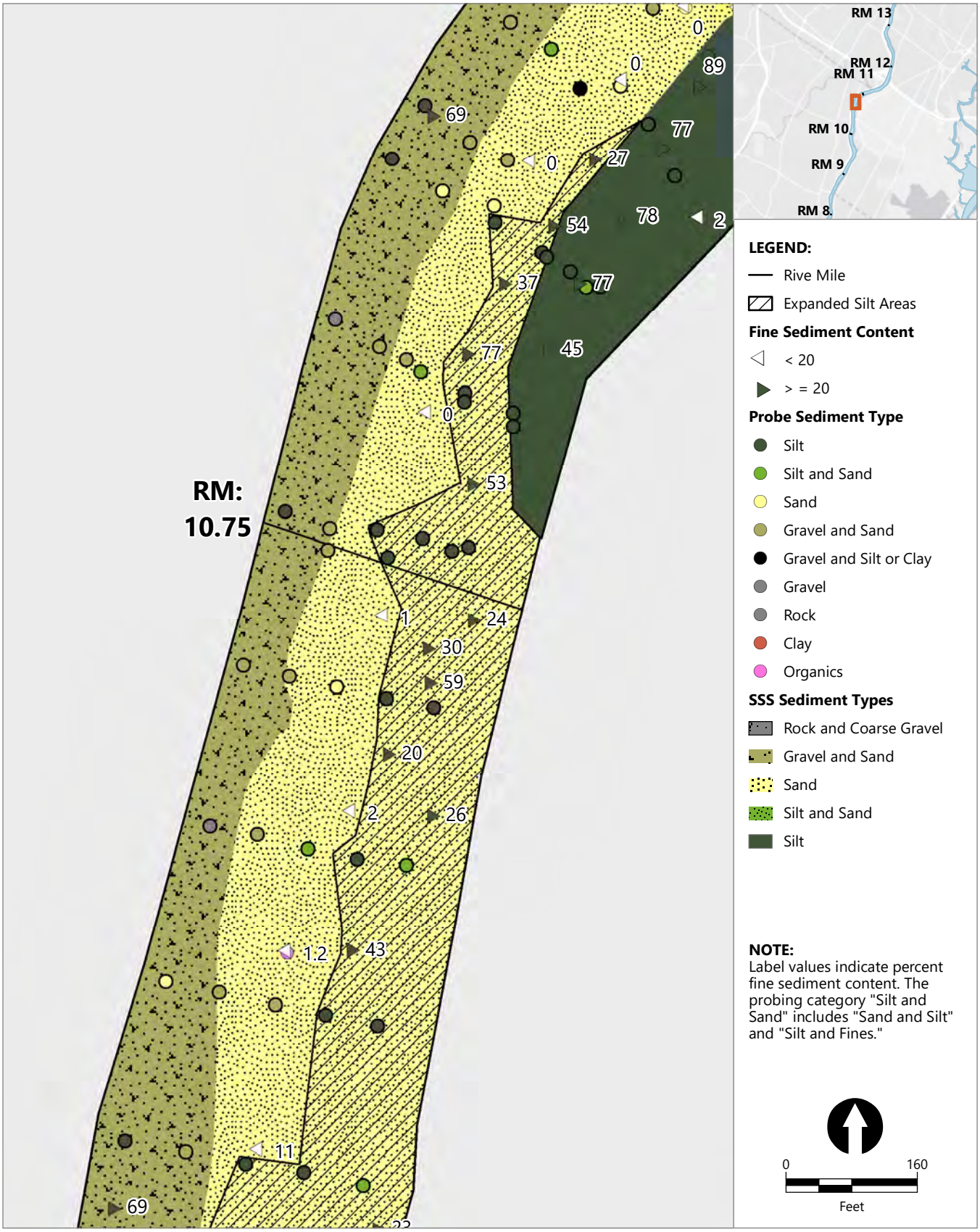

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Figure 3-8c

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

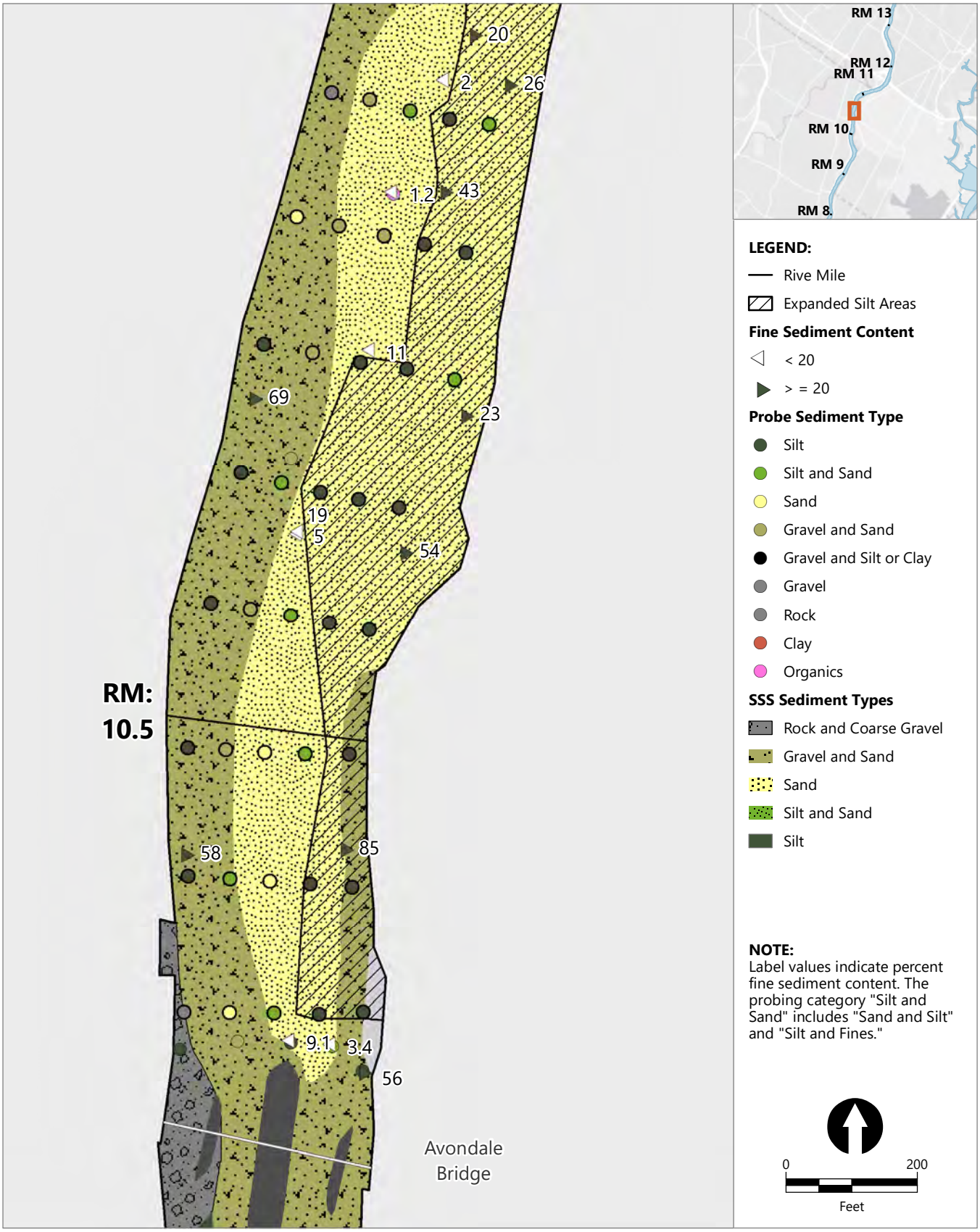

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Figure 3-8d

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

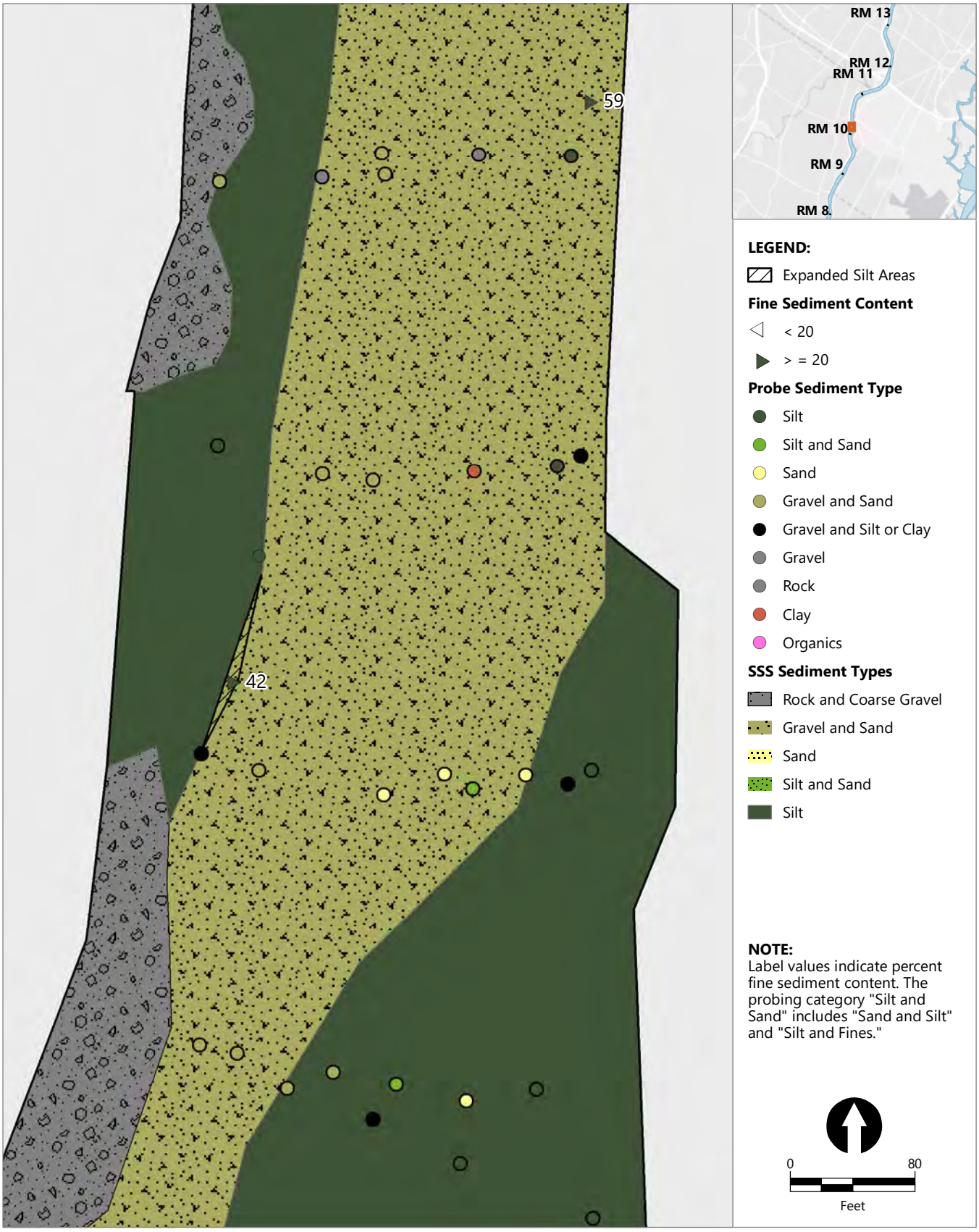

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Figure 3-8e

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-8f

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

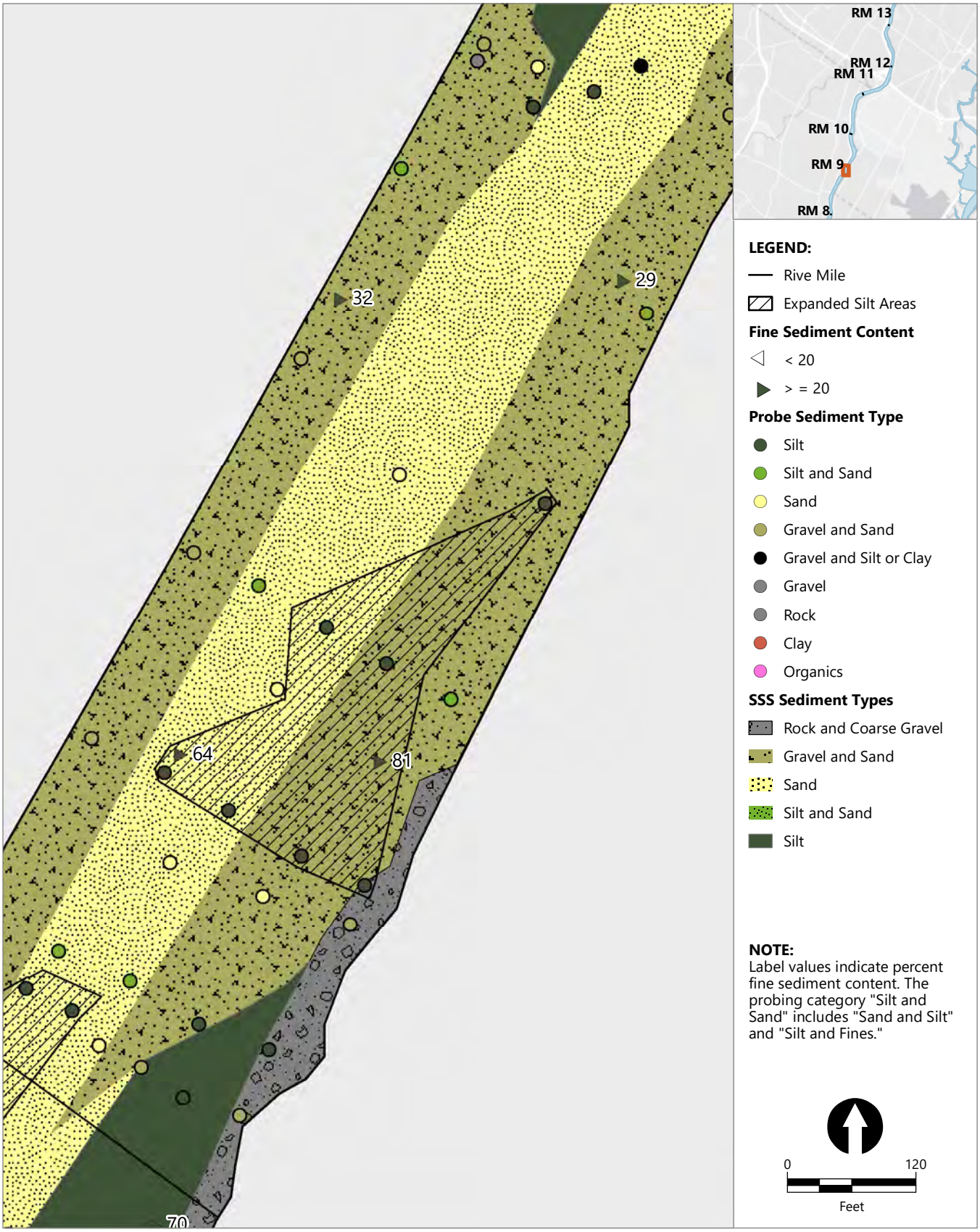

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Figure 3-8g

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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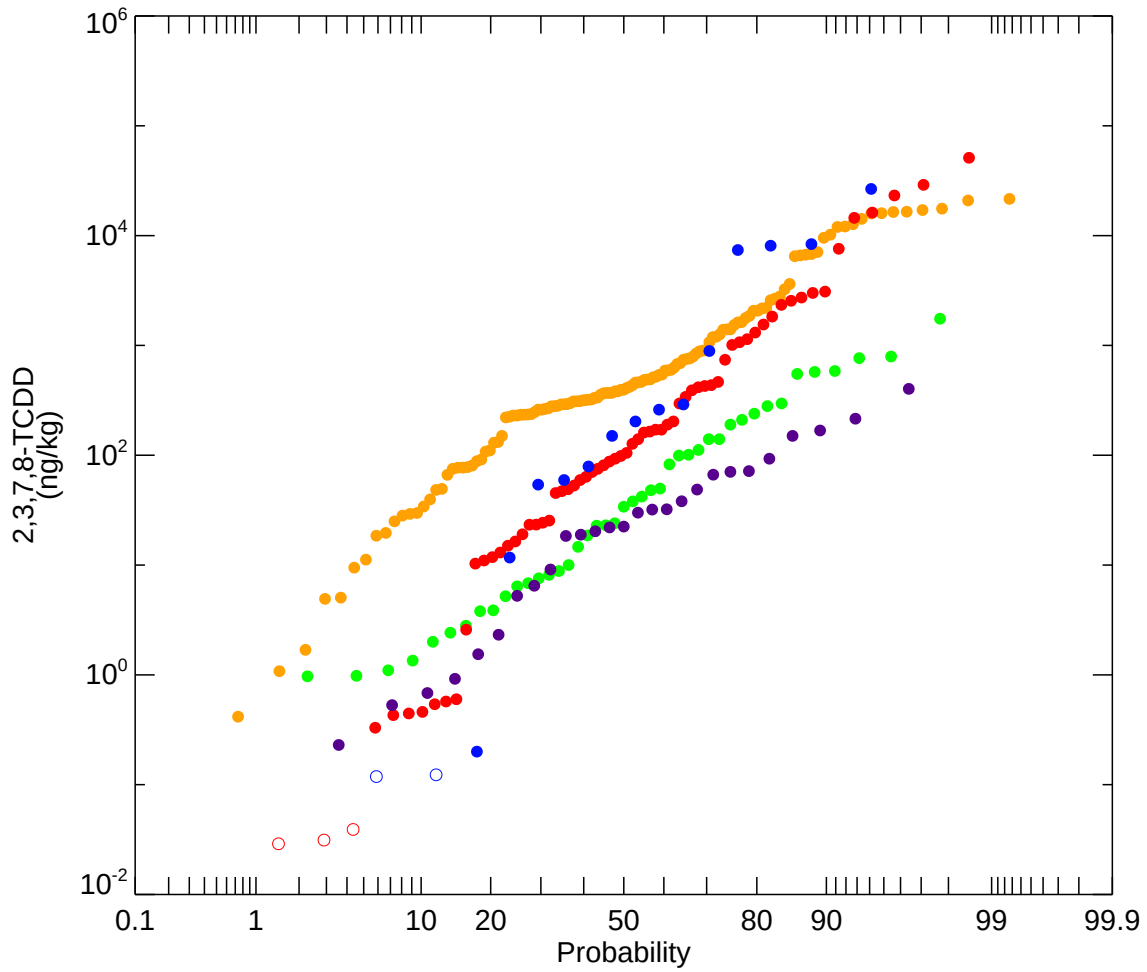
Figure 3-8h

Silt Areas Delineated/Expanded Based on Probing and Fine Sediment Content Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Sediment types based on expanded silt areas and 2005 SSS survey. Includes data from 2005-2013.
Hollow circles denote non-detect concentrations.

- Silt
- Silt and Sand
- Gravel and Sand
- Rock and Coarse Gravel
- Sand

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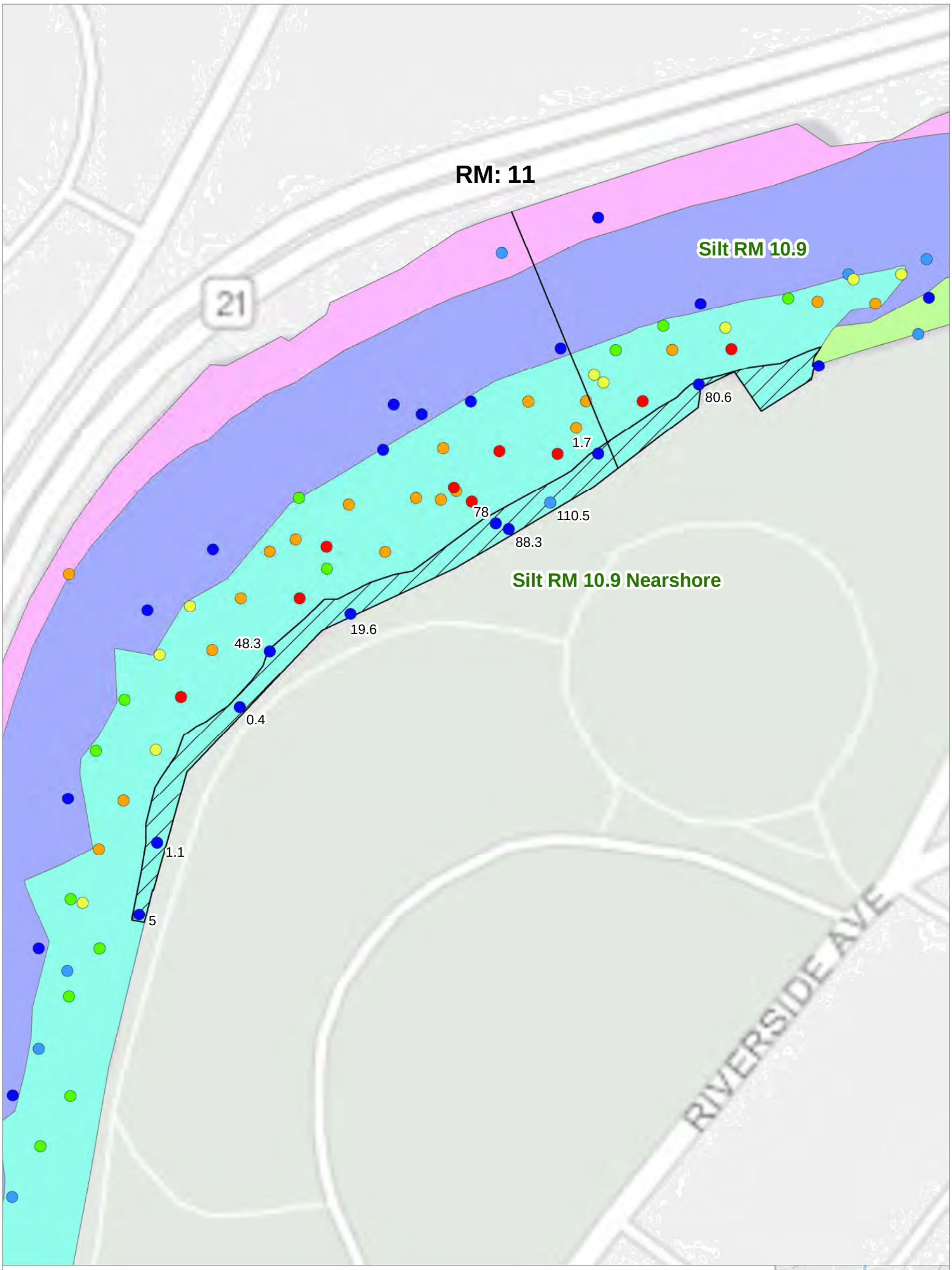
Figure 3-9

Distribution of Surface Sediment 2,3,7,8-TCDD Concentrations by Sediment Type: RM 17.4 to RM 7.8



LEGEND:

River Miles

2,3,7,8 TCDD (ng/kg)

- 0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- 10,001 - 51,100

Silt Nearshore

Geomorphic Groups

- Upstream Channel
- Left Shoal
- Right Shoal LPR
- Silt

NOTE:
Samples in the Silt Nearshore are labeled with 2,3,7,8-TCDD concentrations in ng/kg.

0 200
Feet

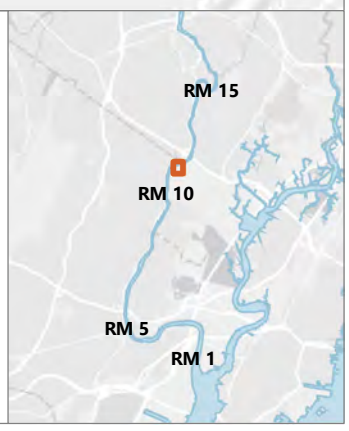


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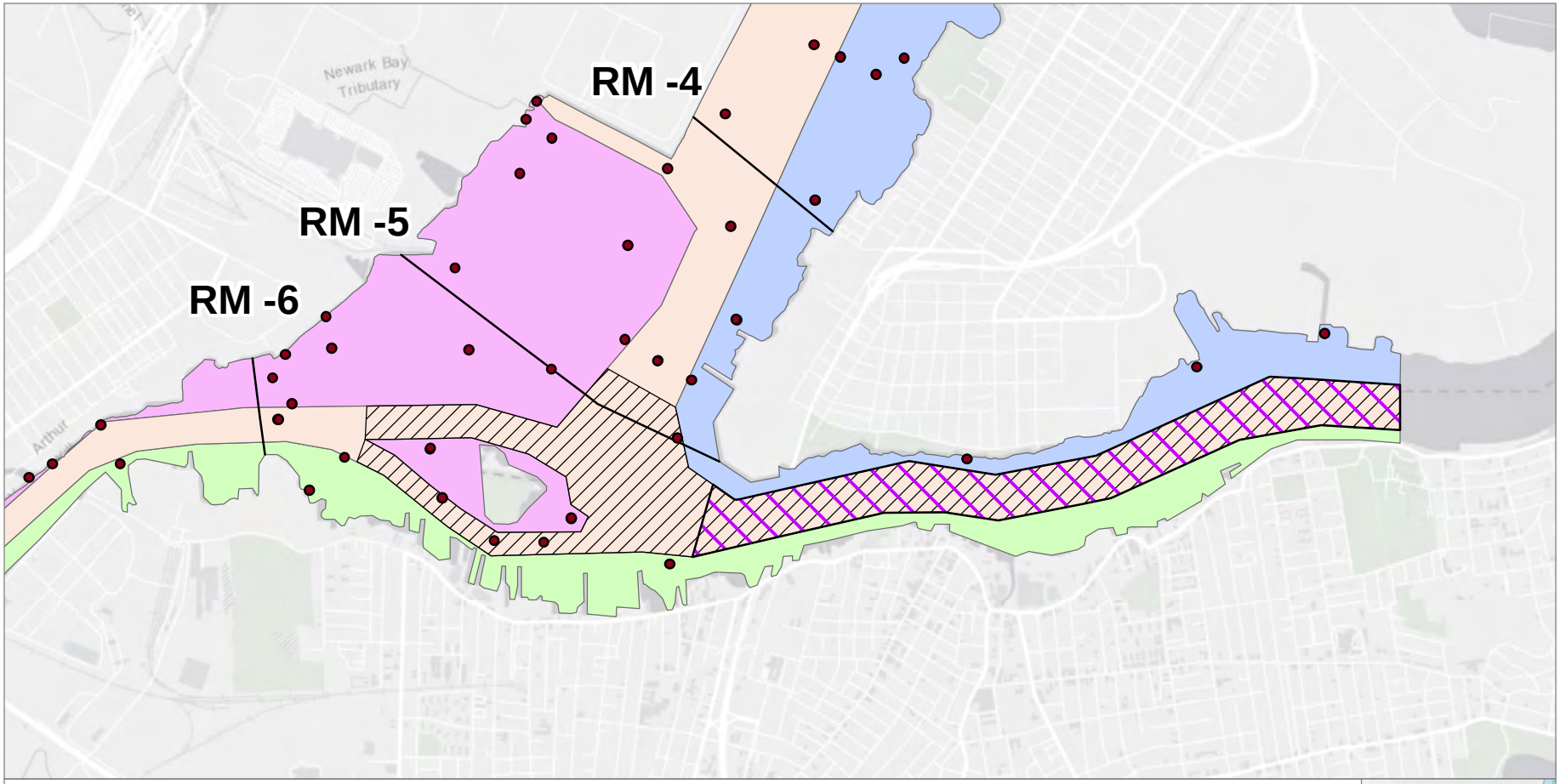
Figure 3-10
Surface Sediment 2,3,7,8-TCDD Data in the Nearshore Portion of the RM 10.9 Silt Deposit
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



LEGEND:

- Sampling Locations (2,3,7,8-TCDD Layer A 2010)
- River Mile
- Applied Area
- Averaging Area

Geomorphic Groups

- Downstream LPR and Newark Bay Channel
- Hackensack and Newark Bay Right Shoal
- Left Shoal
- Staten Island Shoal and Southern Arthur Kill

NOTE: No data were available in the Kill Van Kull Channel. Samples within the "Averaging Area" (depicted with the black lined pattern) were arithmetically averaged. The average concentration was applied to the "Applied Area" (depicted with the magenta lined pattern).

0 1,500 3,000 4,500 6,000
Feet

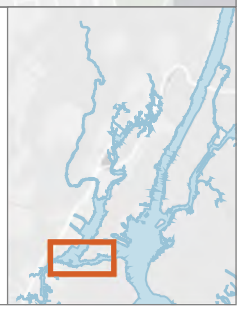


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Figure 3-11
Kill Van Kull Channel Averaging
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

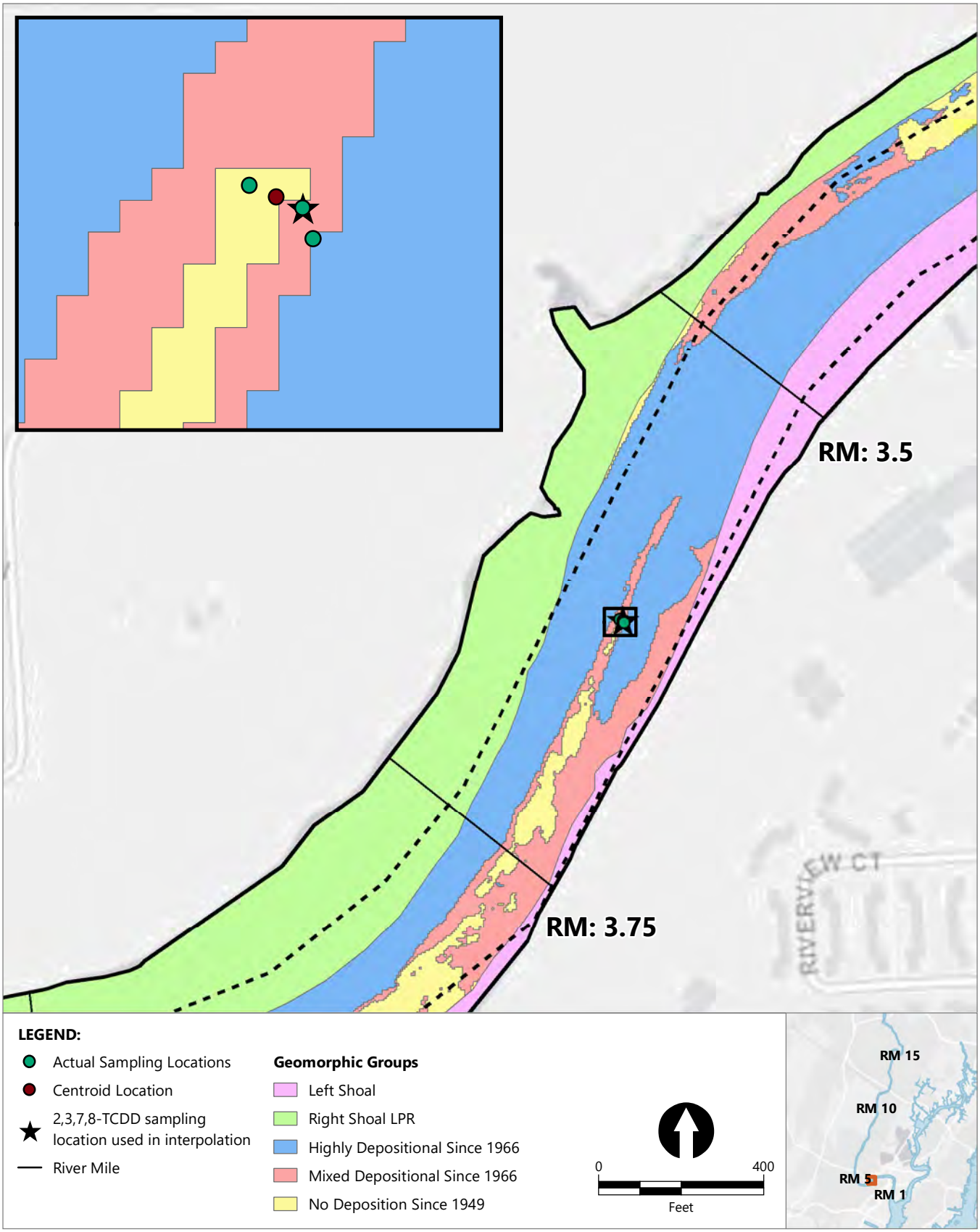

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Figure 3-12
Location Used for Core 12A-0427 in Mapping
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

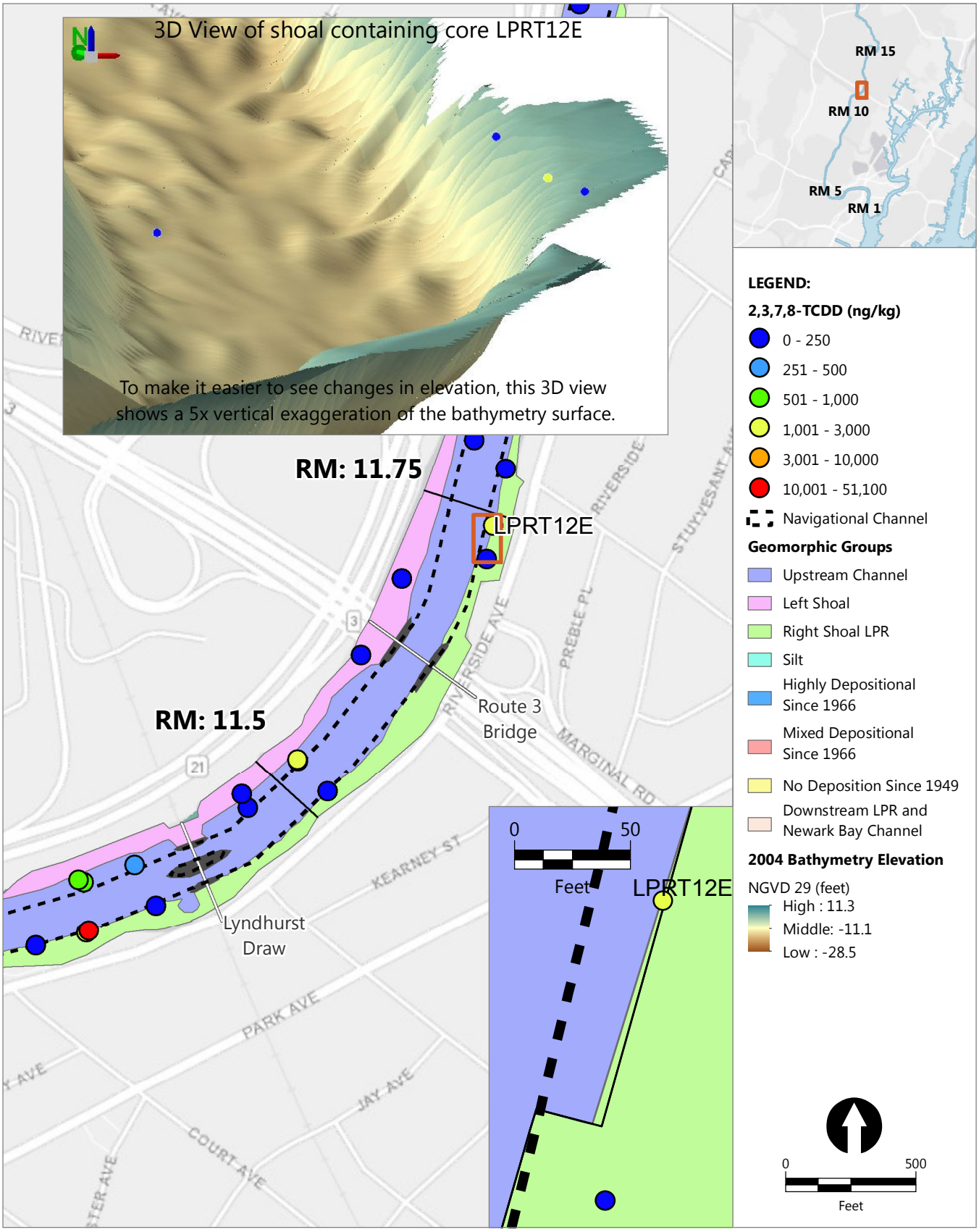

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Figure 3-13
Adjustment to Shoal Boundary Near RM 11.75
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14a
Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14b
Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14c

Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14d

Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14e

Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14f

Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

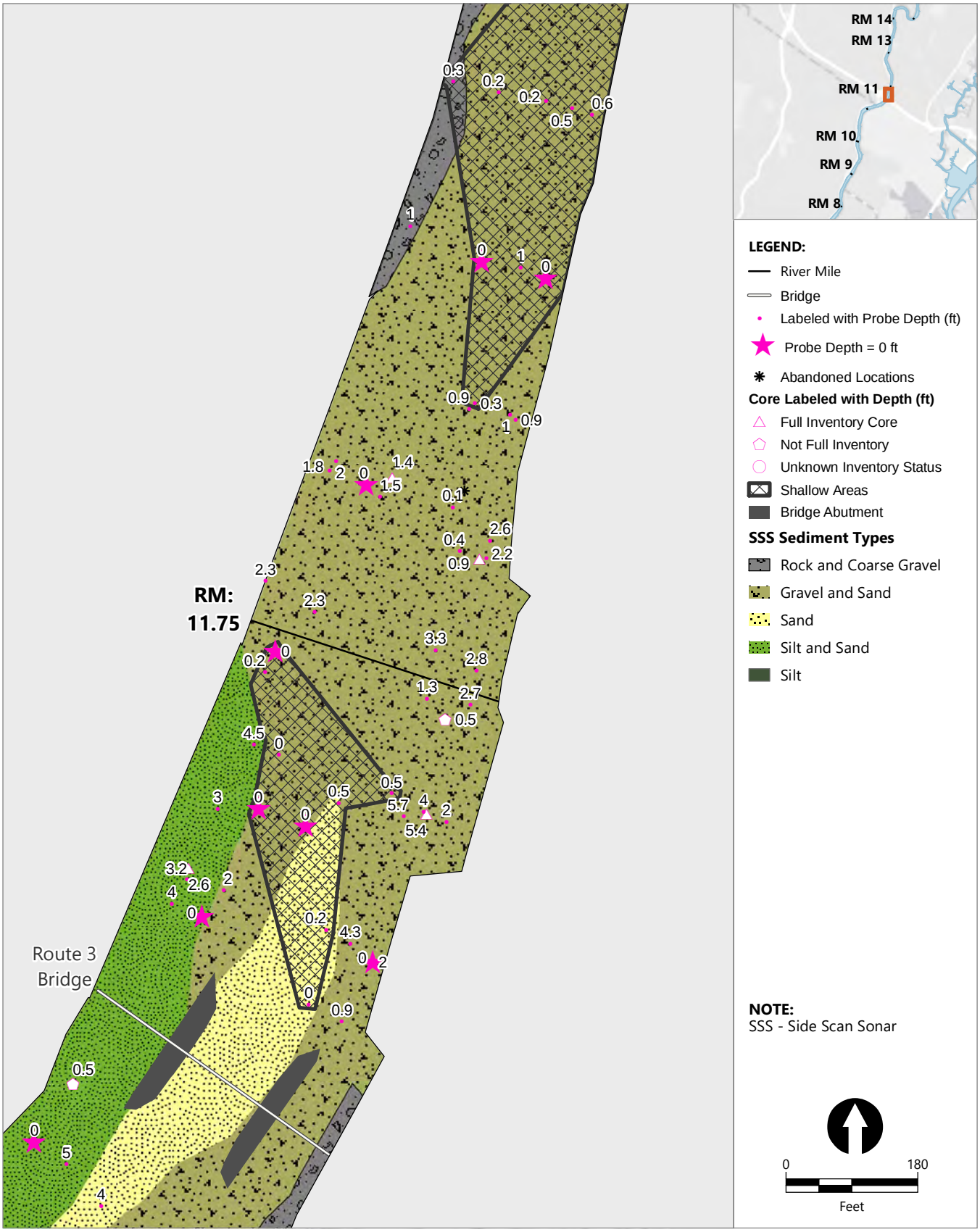

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Figure 3-14g
Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14h

Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 3-14i

Shallow Sediment Areas Delineated Based on Probing Depth and Core Depth Data

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

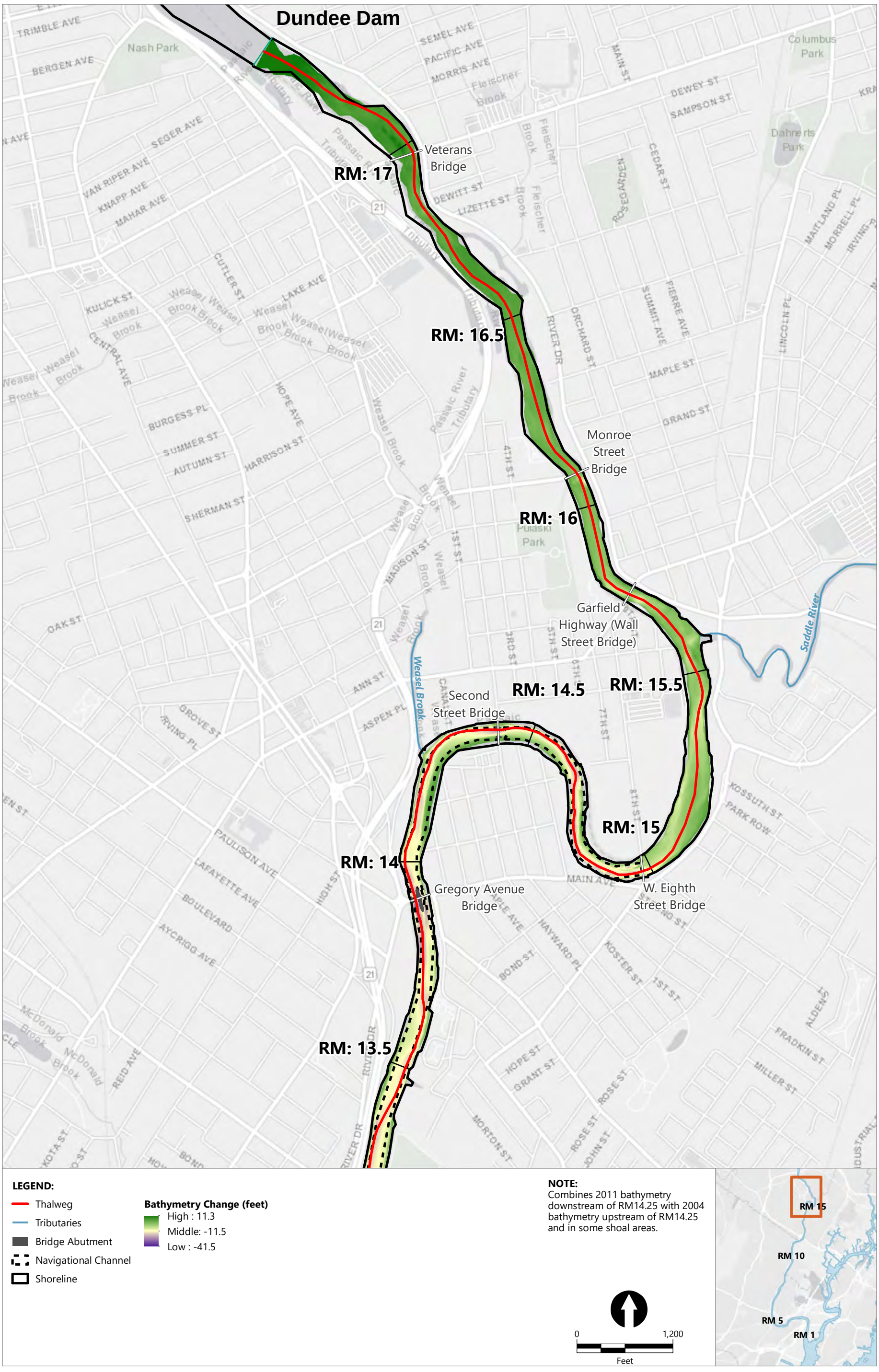

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Figure 5-1a
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

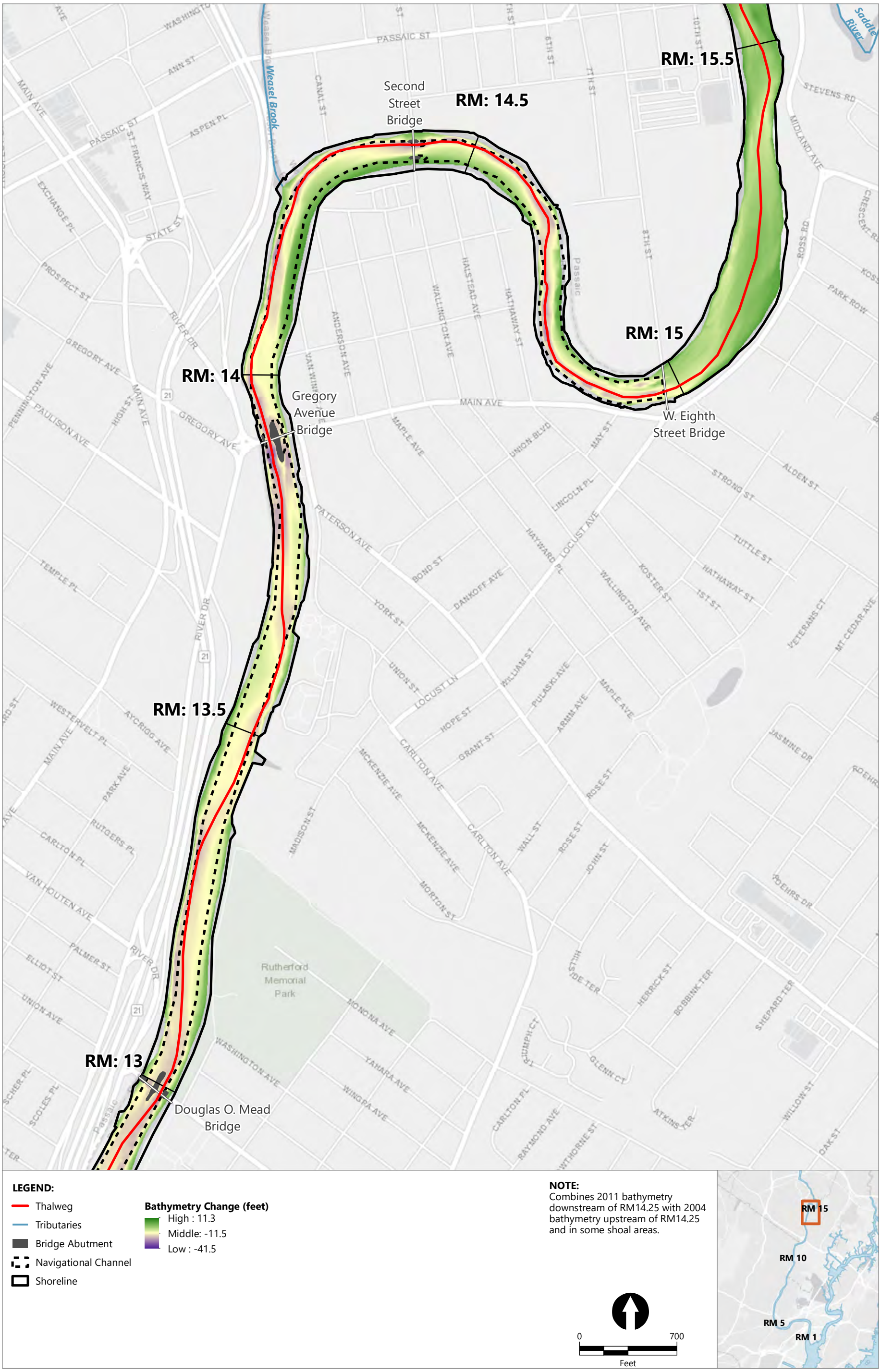

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Figure 5-1b
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

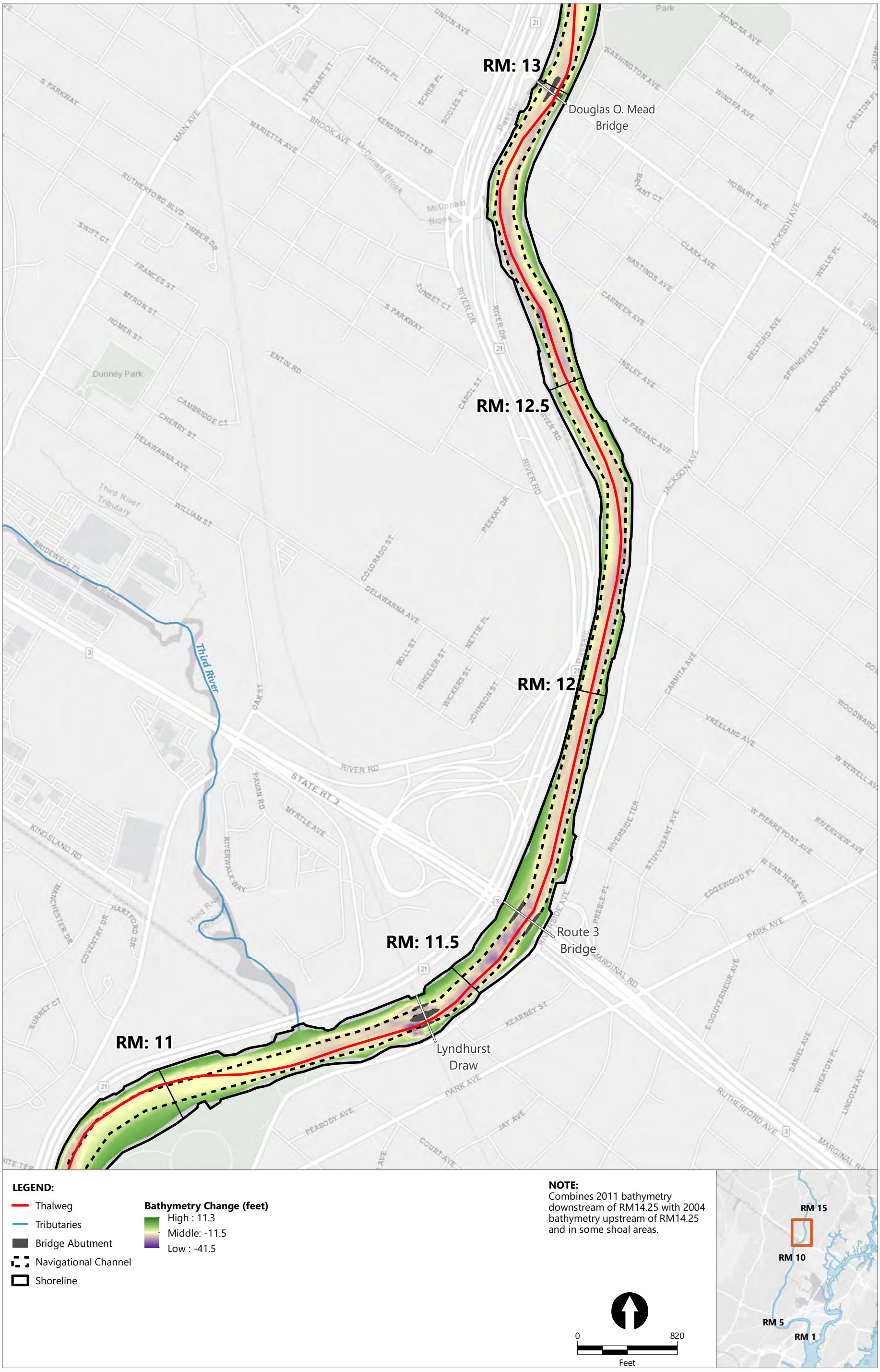

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Figure 5-1c
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

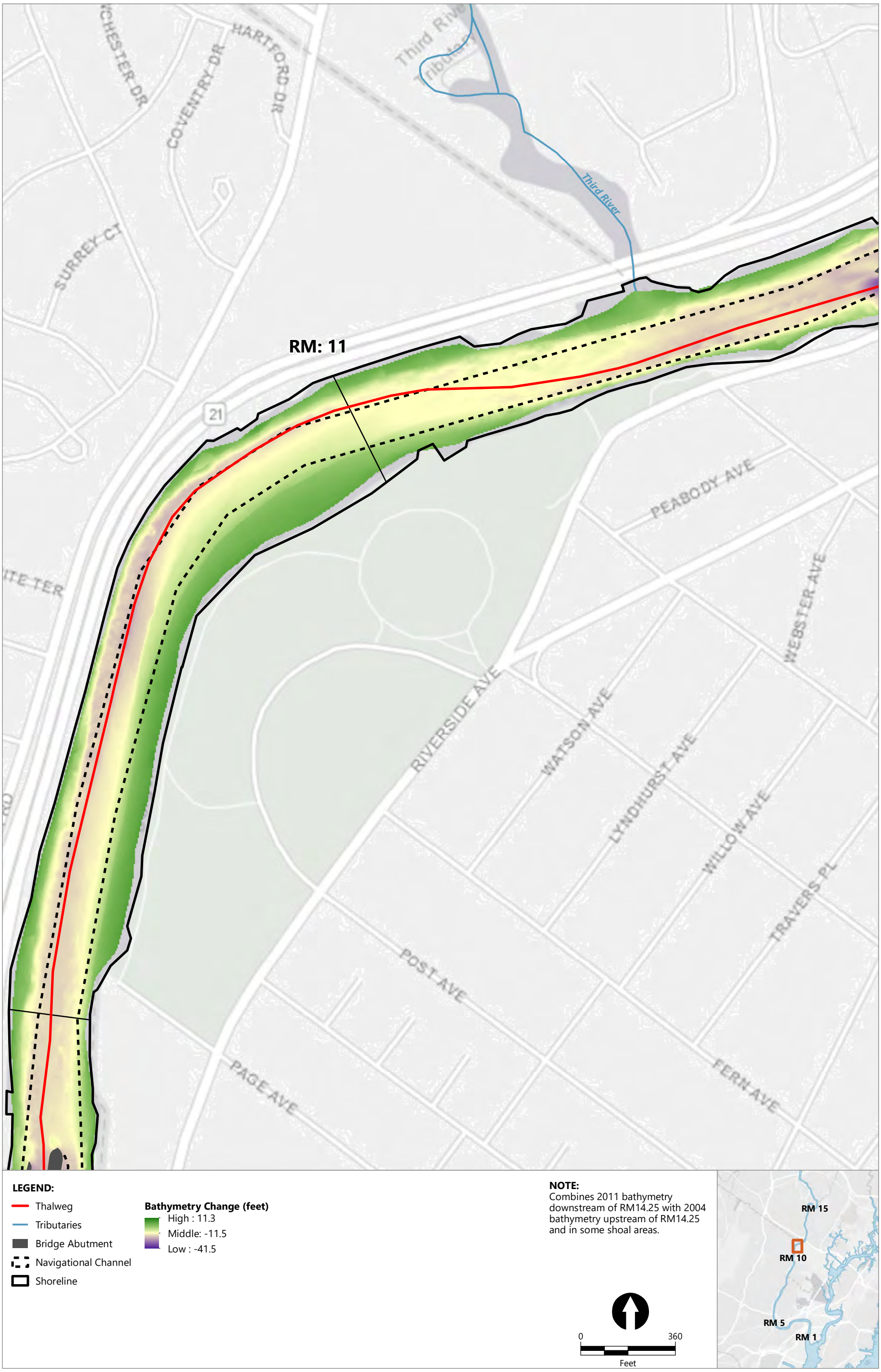

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Figure 5-1d
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

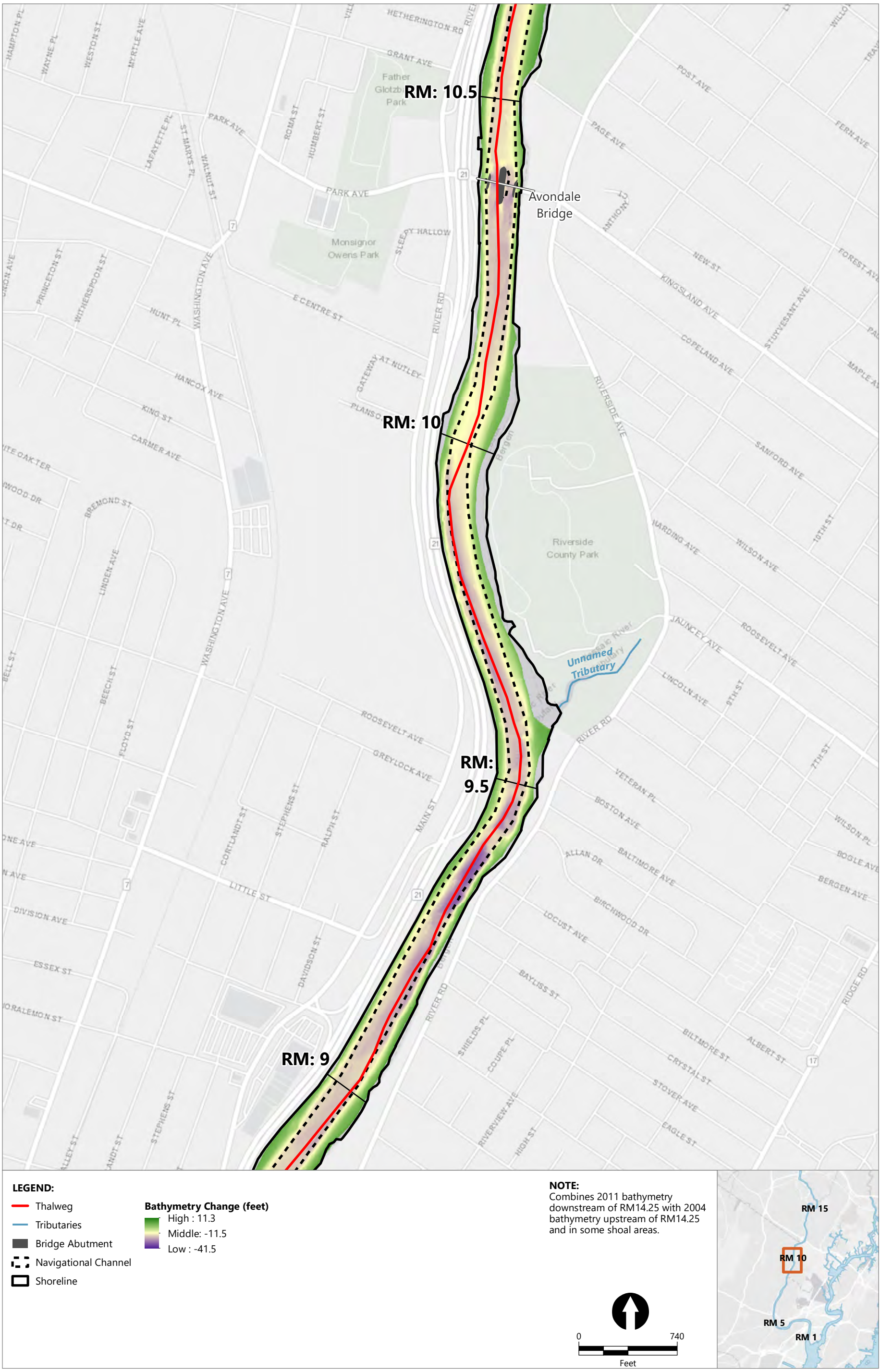

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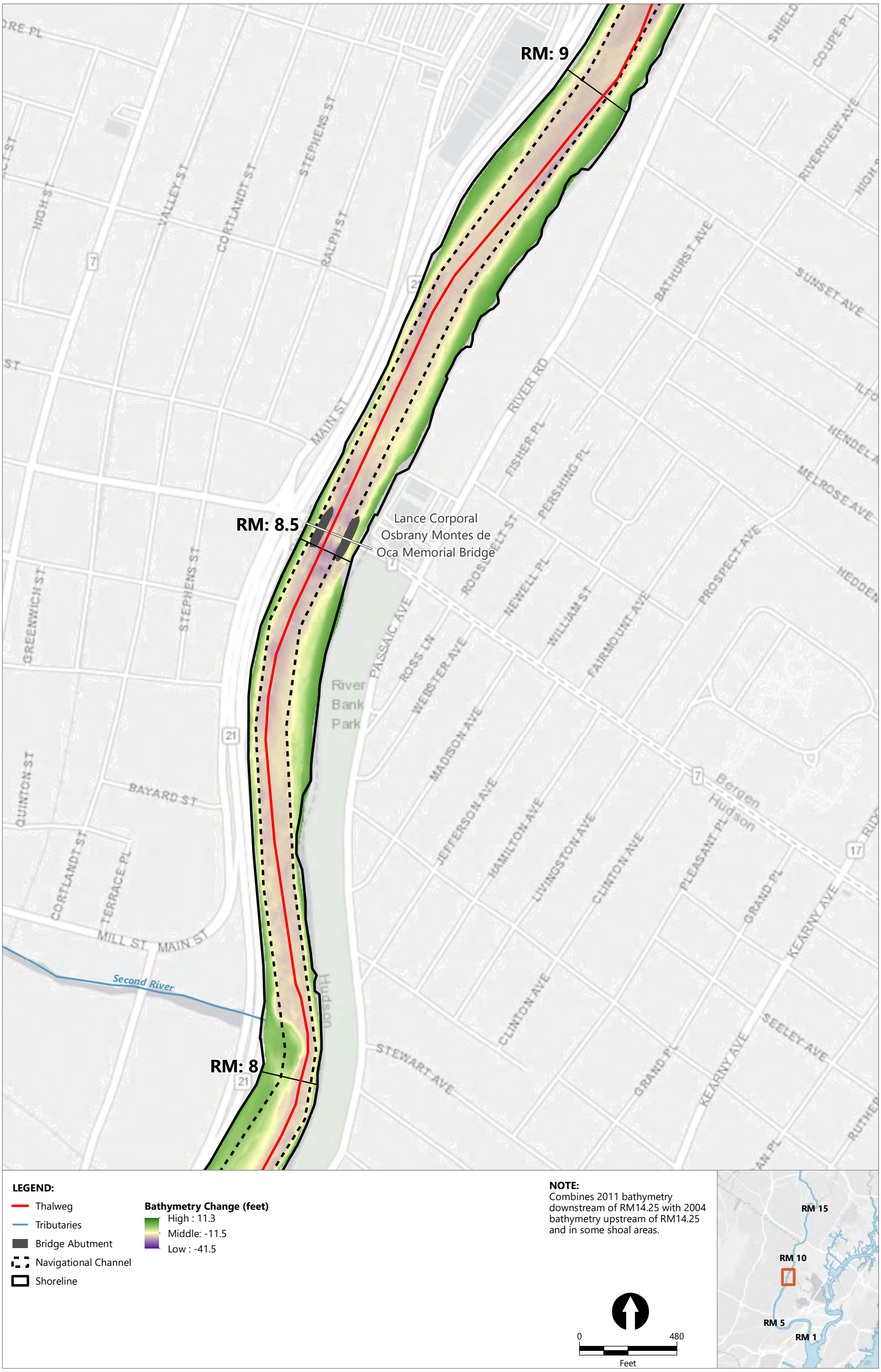
Figure 5-1e
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



LEGEND:

- Thalweg
- Tributaries
- Bridge Abutment
- Navigational Channel
- Shoreline

Bathymetry Change (feet)

High : 11.3
Middle: -11.5
Low : -41.5

NOTE:
Combines 2011 bathymetry downstream of RM14.25 with 2004 bathymetry upstream of RM14.25 and in some shoal areas.

0 480
Feet

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Figure 5-1f
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 5-1g
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

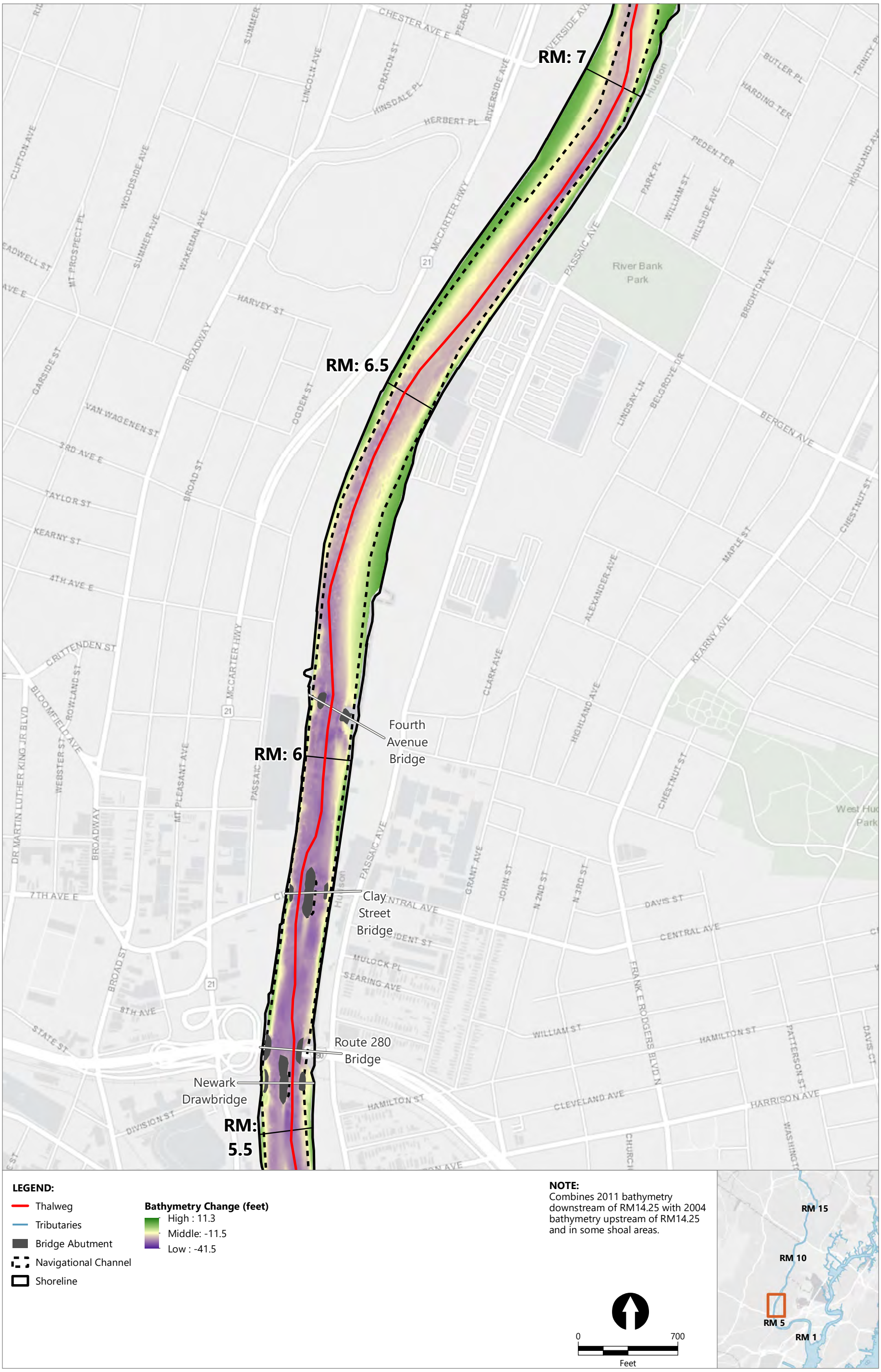

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Figure 5-1h
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

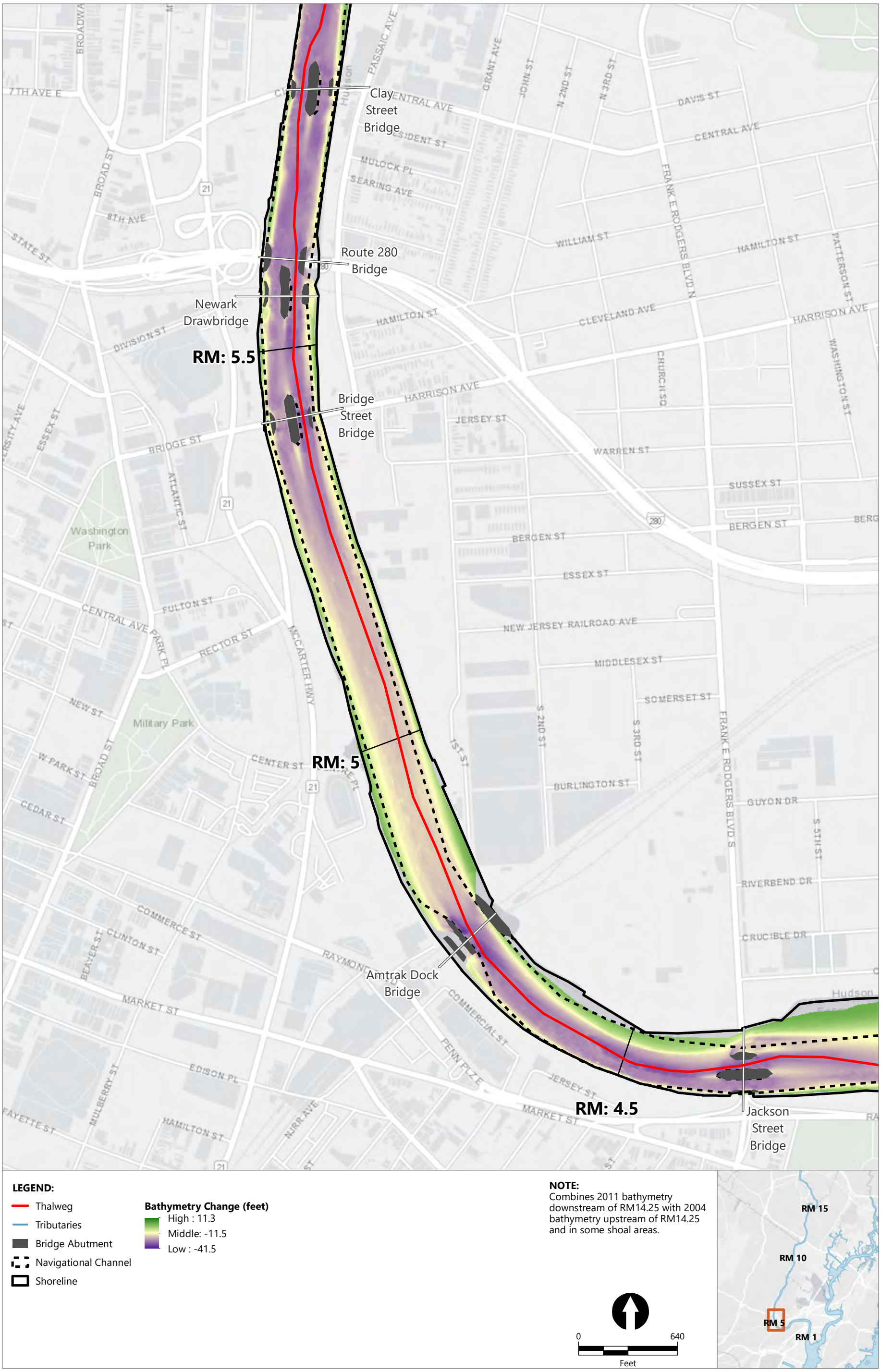

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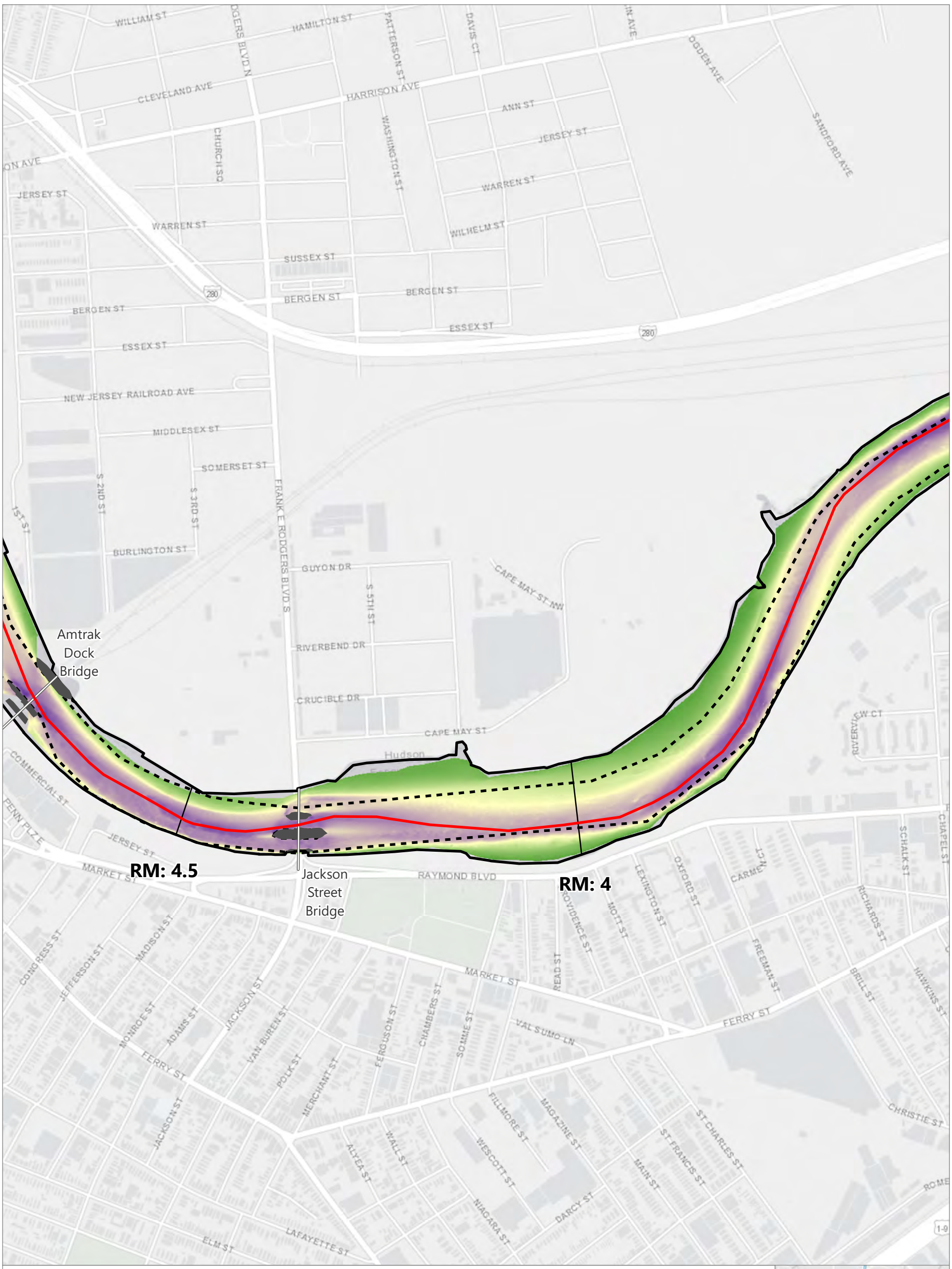
Figure 5-1i
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



LEGEND:

- Thalweg
- Tributaries
- Bridge Abutment
- Navigational Channel
- Shoreline

Bathymetry Change (feet)

High : 11.3
Middle: -11.5
Low : -41.5

NOTE:
Combines 2011 bathymetry downstream of RM14.25 with 2004 bathymetry upstream of RM14.25 and in some shoal areas.

0 700
Feet

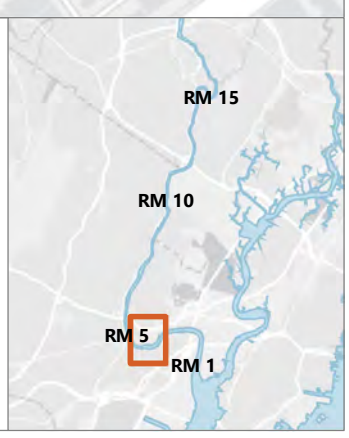


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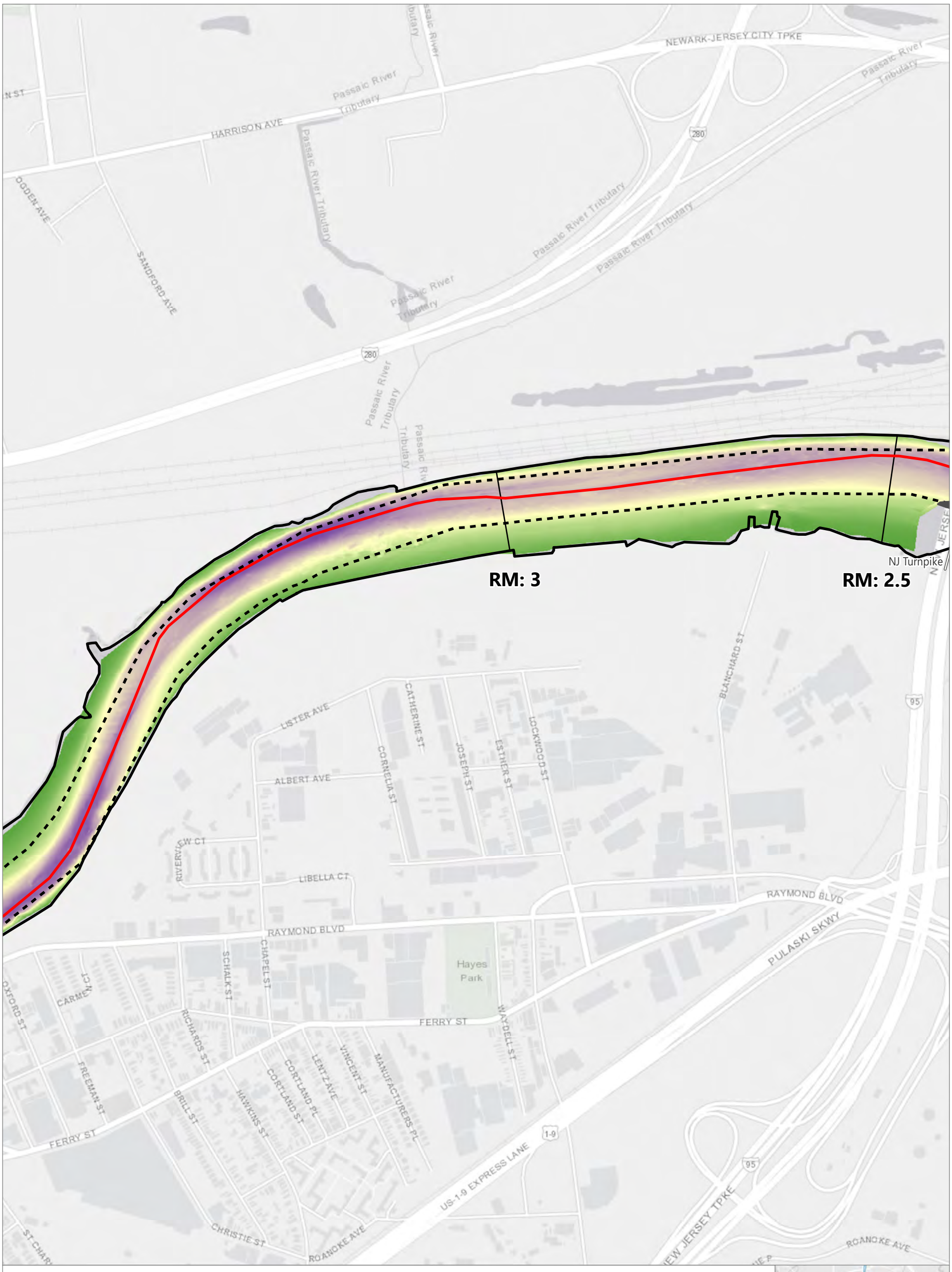
Figure 5-1j
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



LEGEND:

- Thalweg
- Tributaries
- Bridge Abutment
- Navigational Channel
- Shoreline

Bathymetry Change (feet)

High : 11.3
Middle: -11.5
Low : -41.5

NOTE:
Combines 2011 bathymetry downstream of RM14.25 with 2004 bathymetry upstream of RM14.25 and in some shoal areas.

0 720
Feet

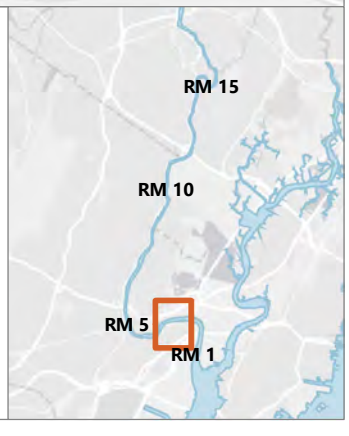


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Figure 5-1k
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

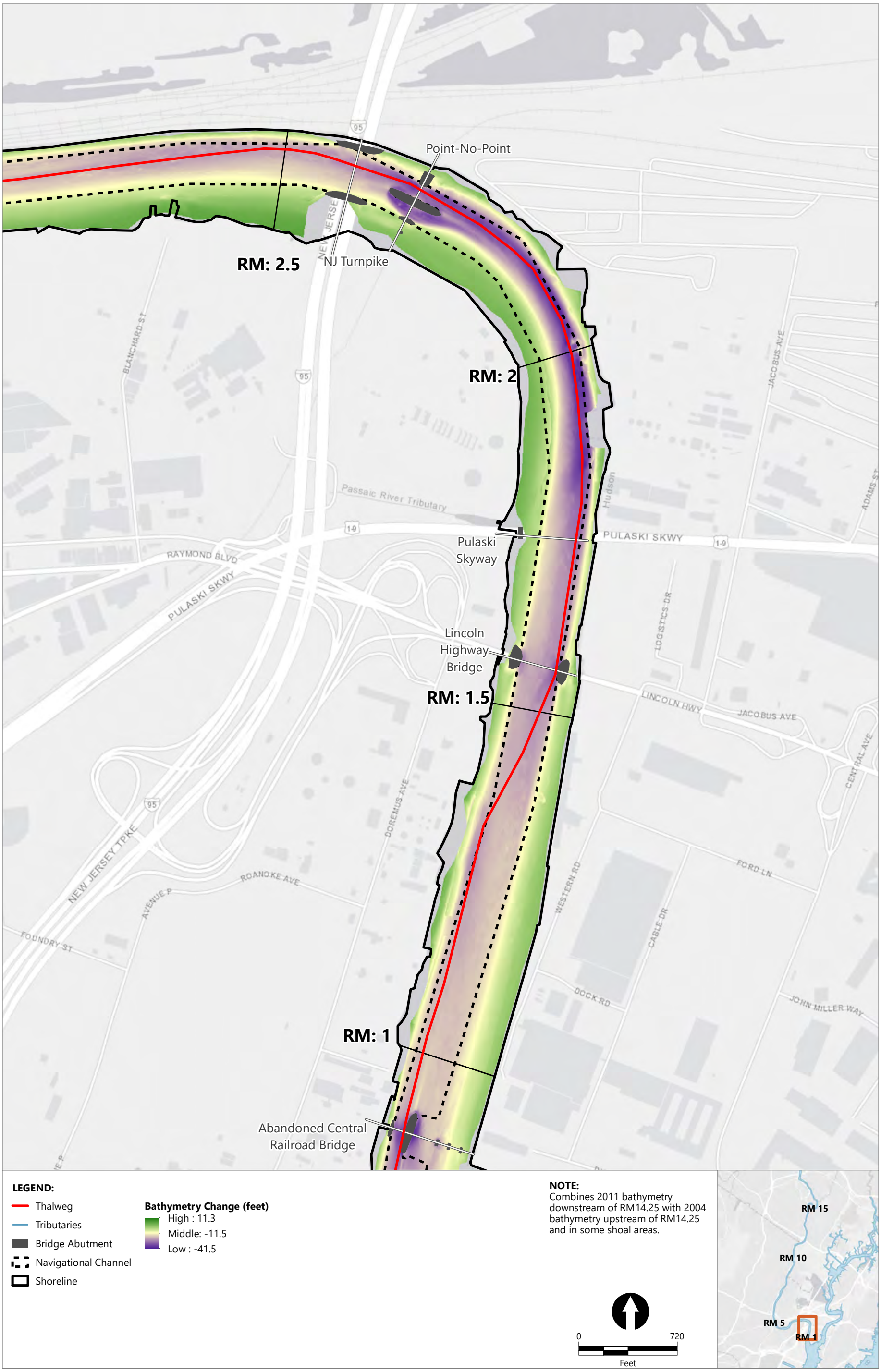

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Figure 5-1I
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

LEGEND:

- Thalweg
- Tributaries
- Bridge Abutment
- Navigational Channel
- Shoreline

Bathymetry Change (feet)

High : 11.3
Middle: -11.5
Low : -41.5

NOTE:
Combines 2011 bathymetry downstream of RM14.25 with 2004 bathymetry upstream of RM14.25 and in some shoal areas.

0 720
Feet

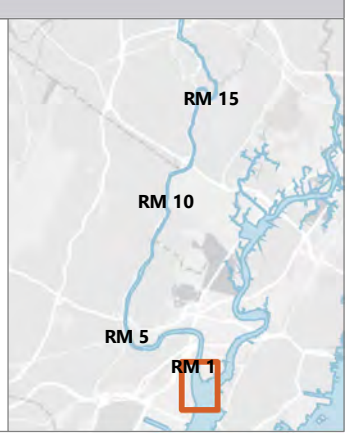

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Figure 5-1m
2004/2011 Bathymetry with Thalwag
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 5-2a
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

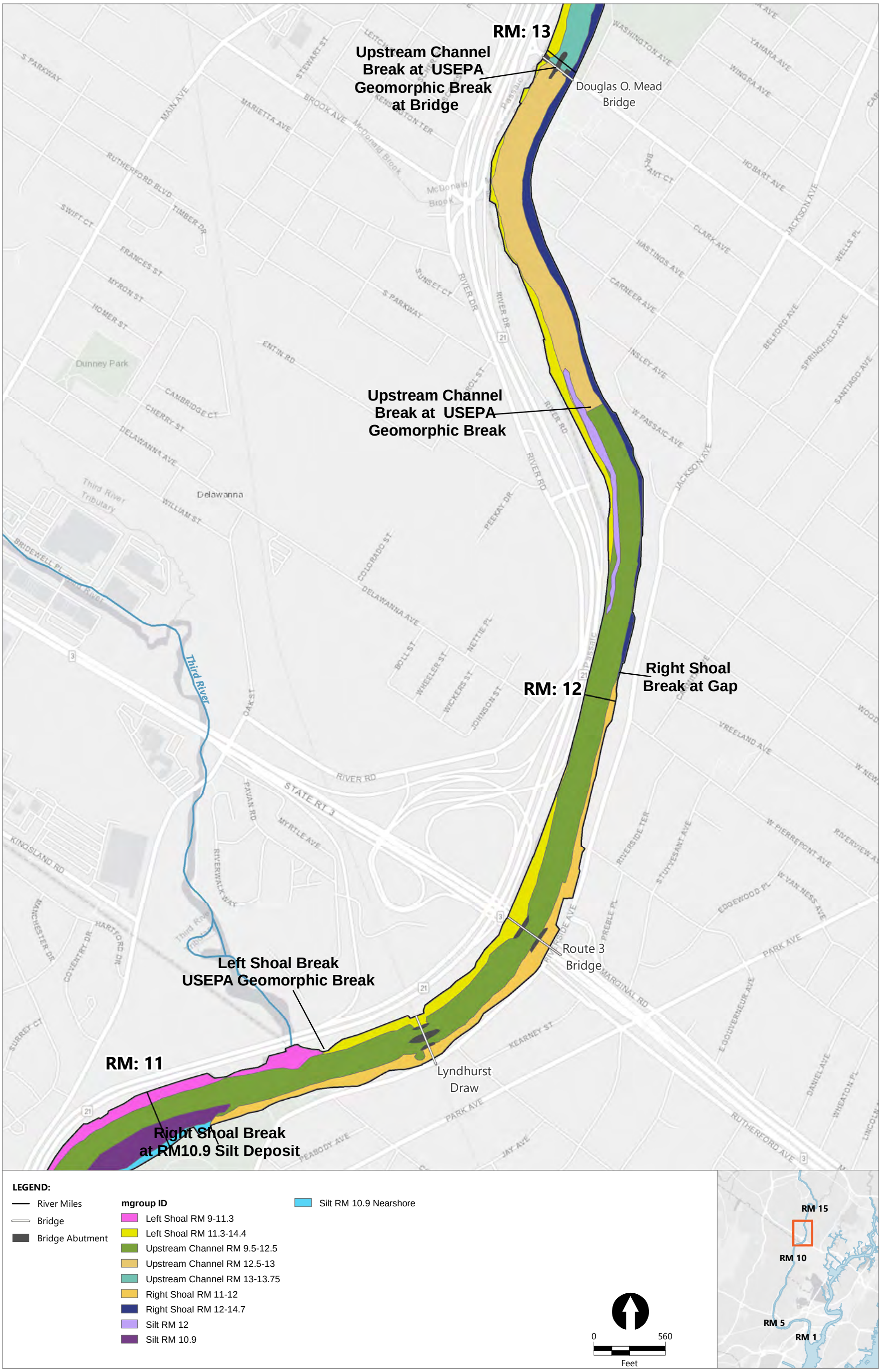

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Figure 5-2b
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 5-2c
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 5-2d
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

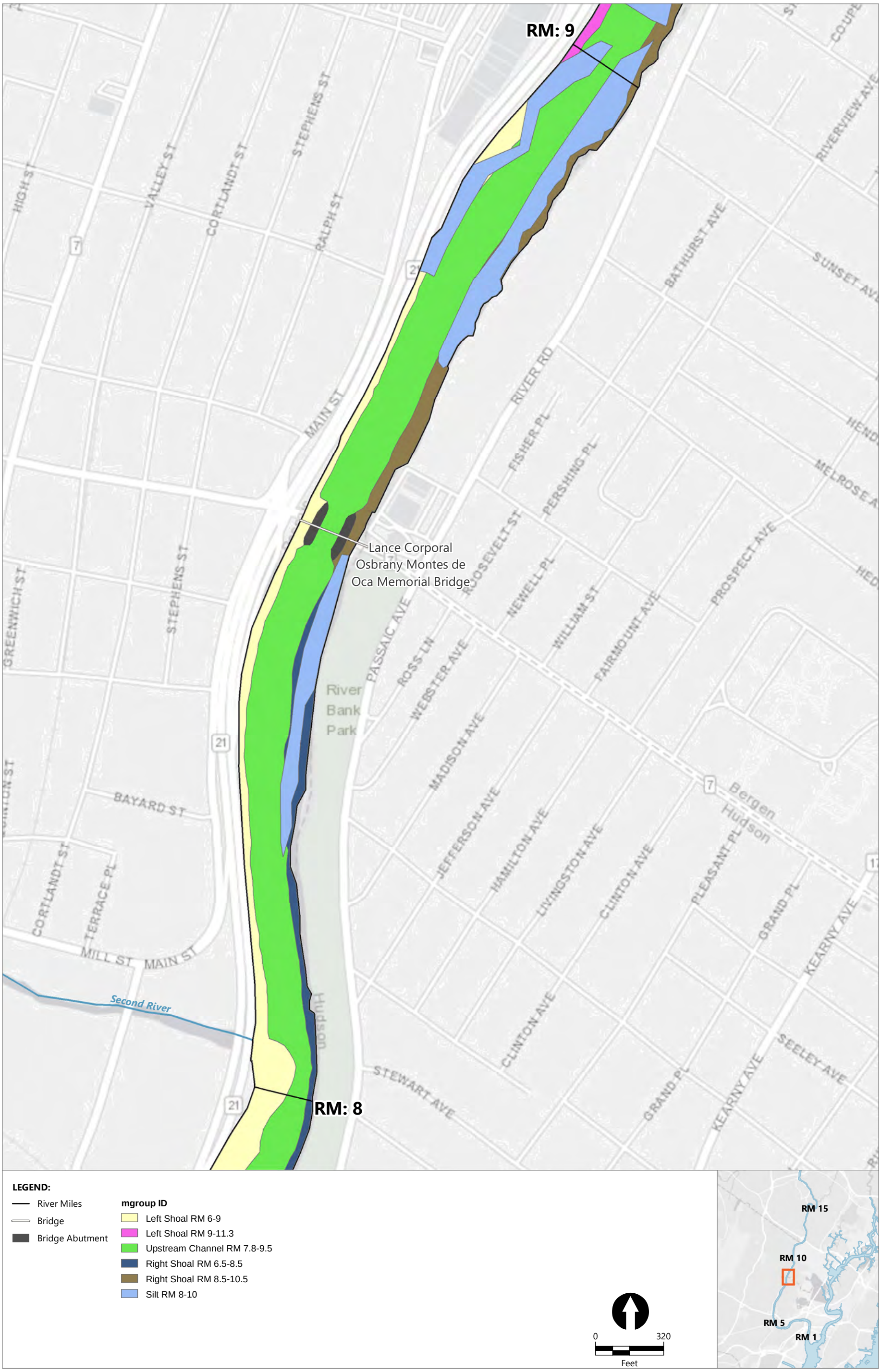

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Figure 5-2e
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

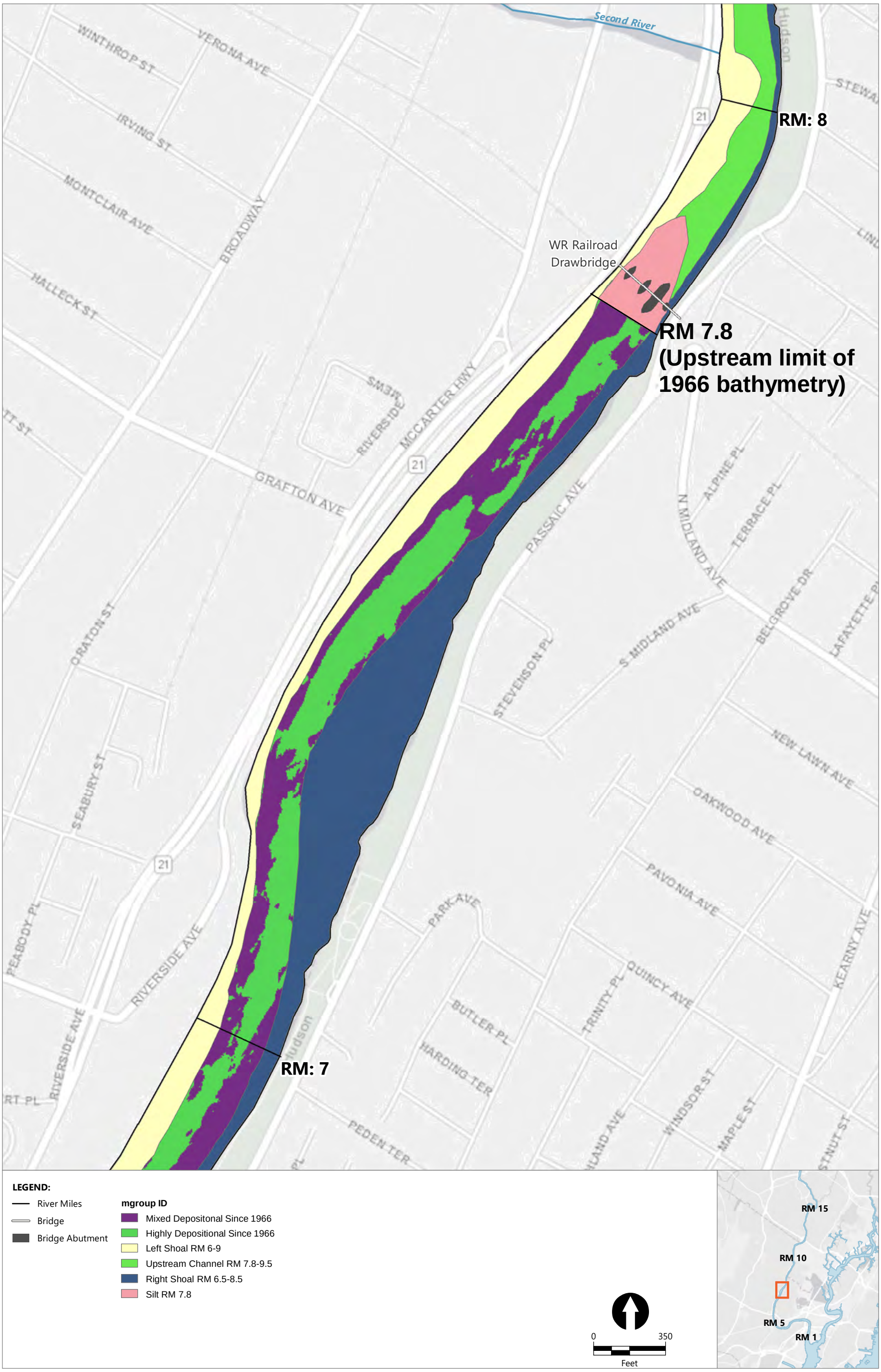

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Figure 5-2f
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

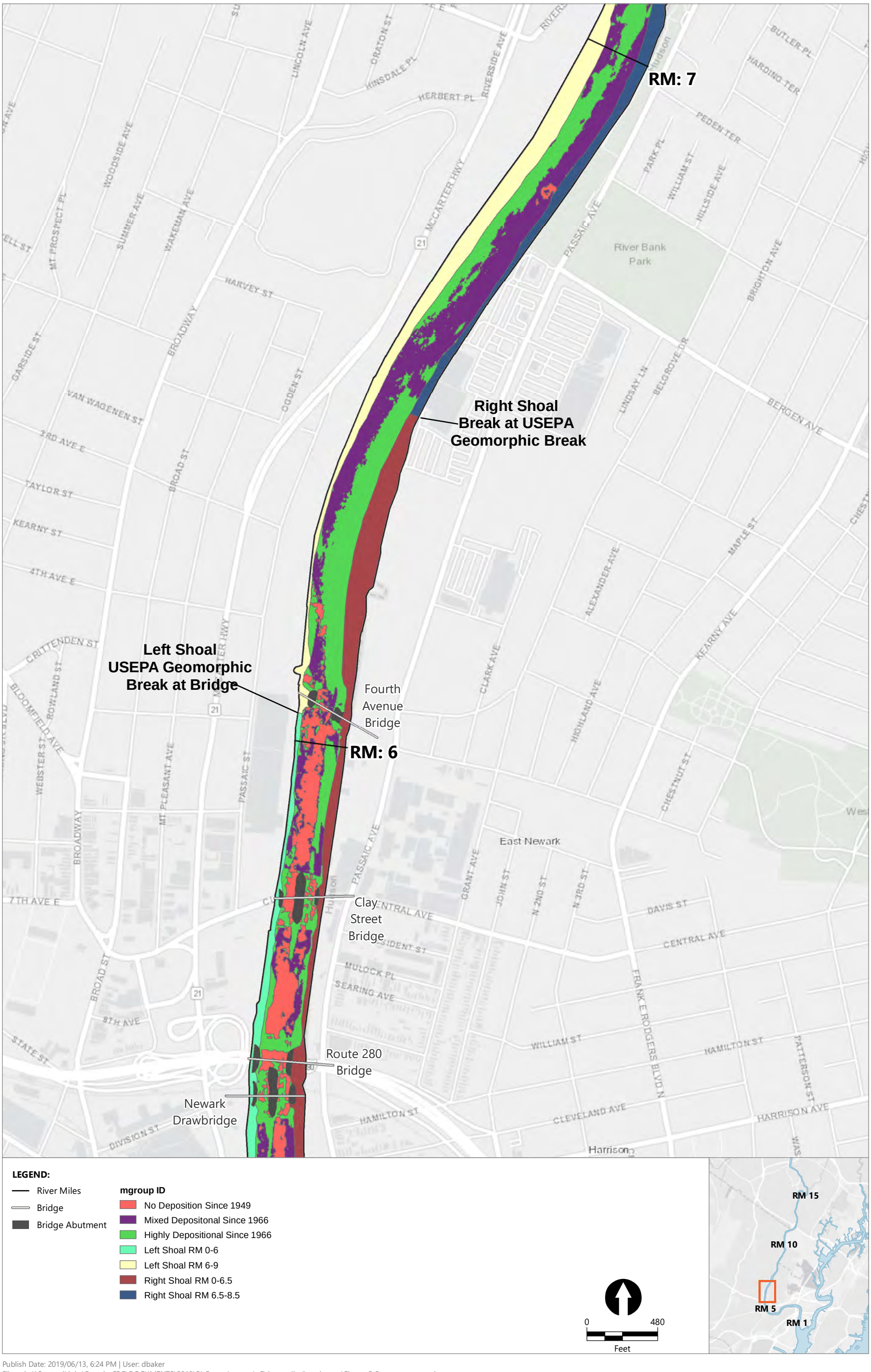

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Figure 5-2g
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

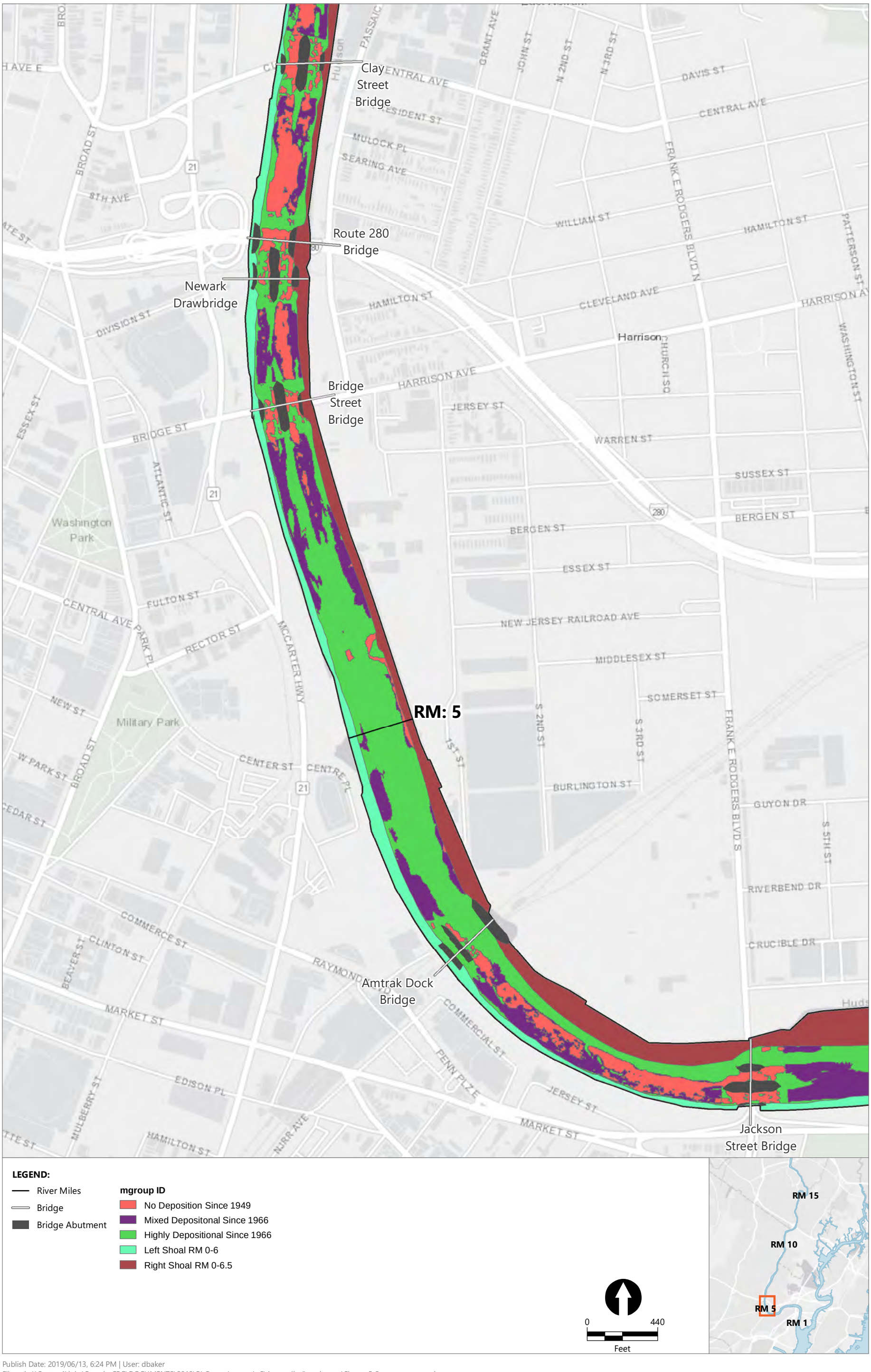

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Figure 5-2h
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

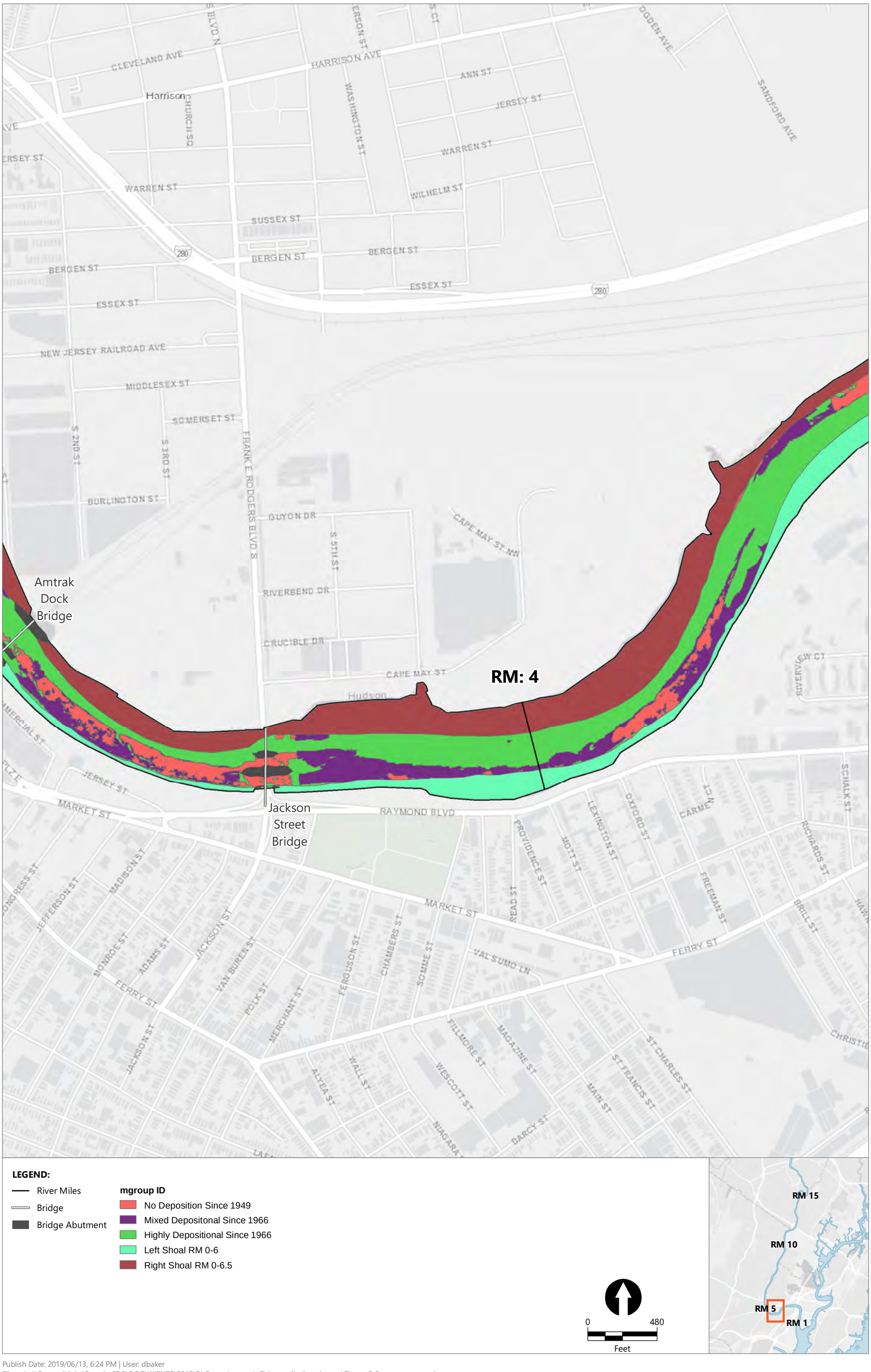

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Figure 5-2i
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

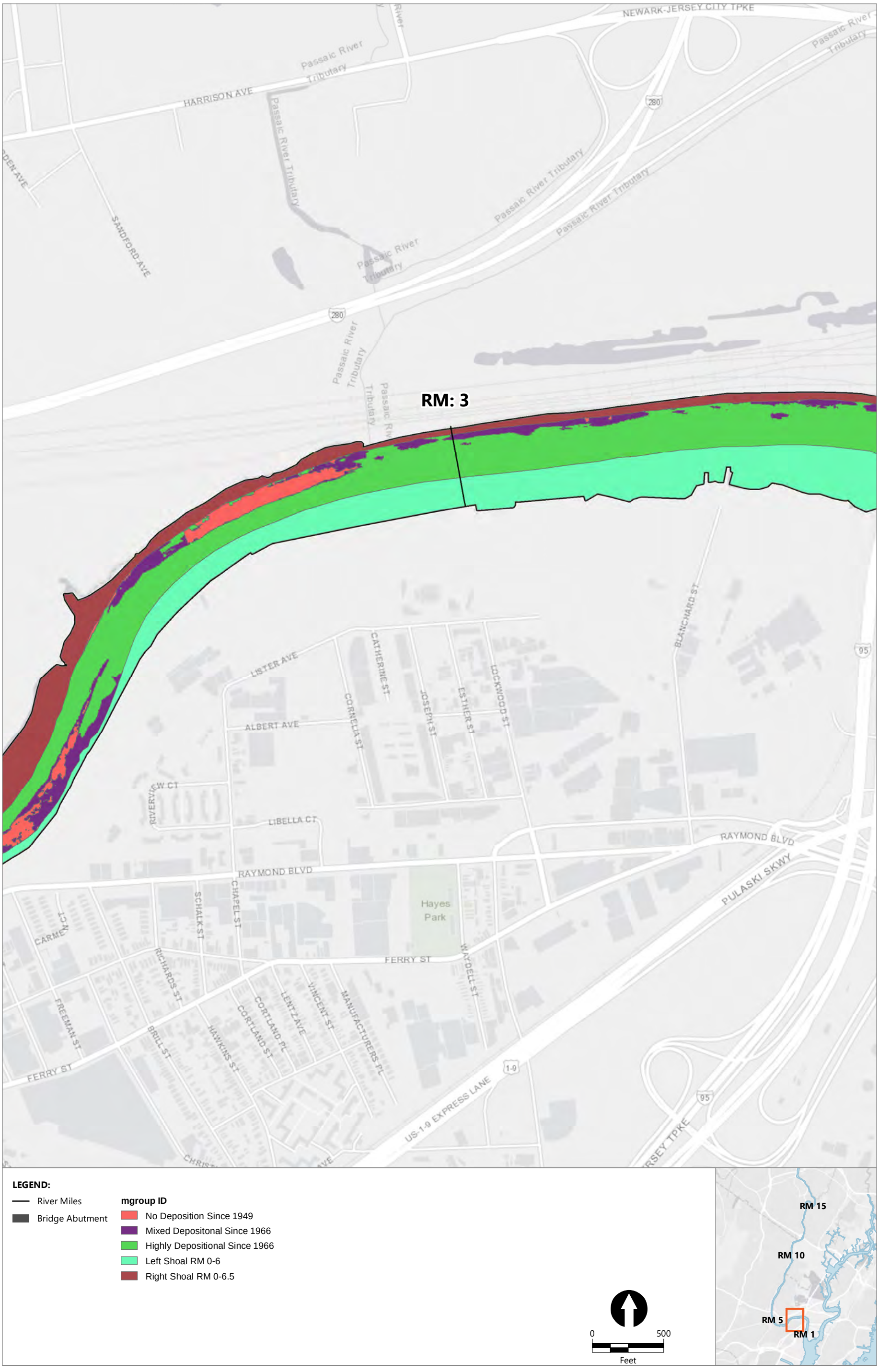

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Figure 5-2j
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

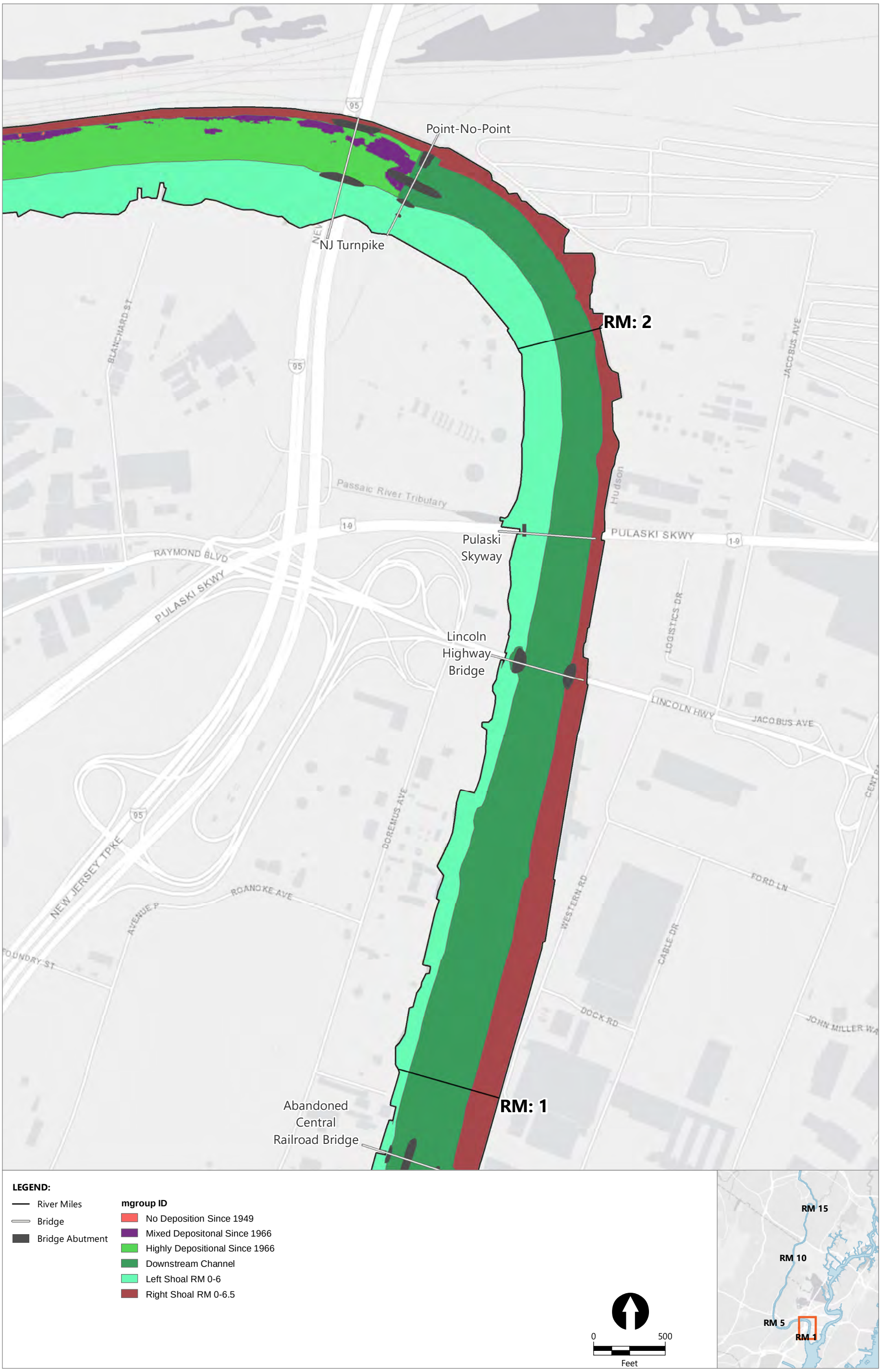

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Figure 5-2k
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

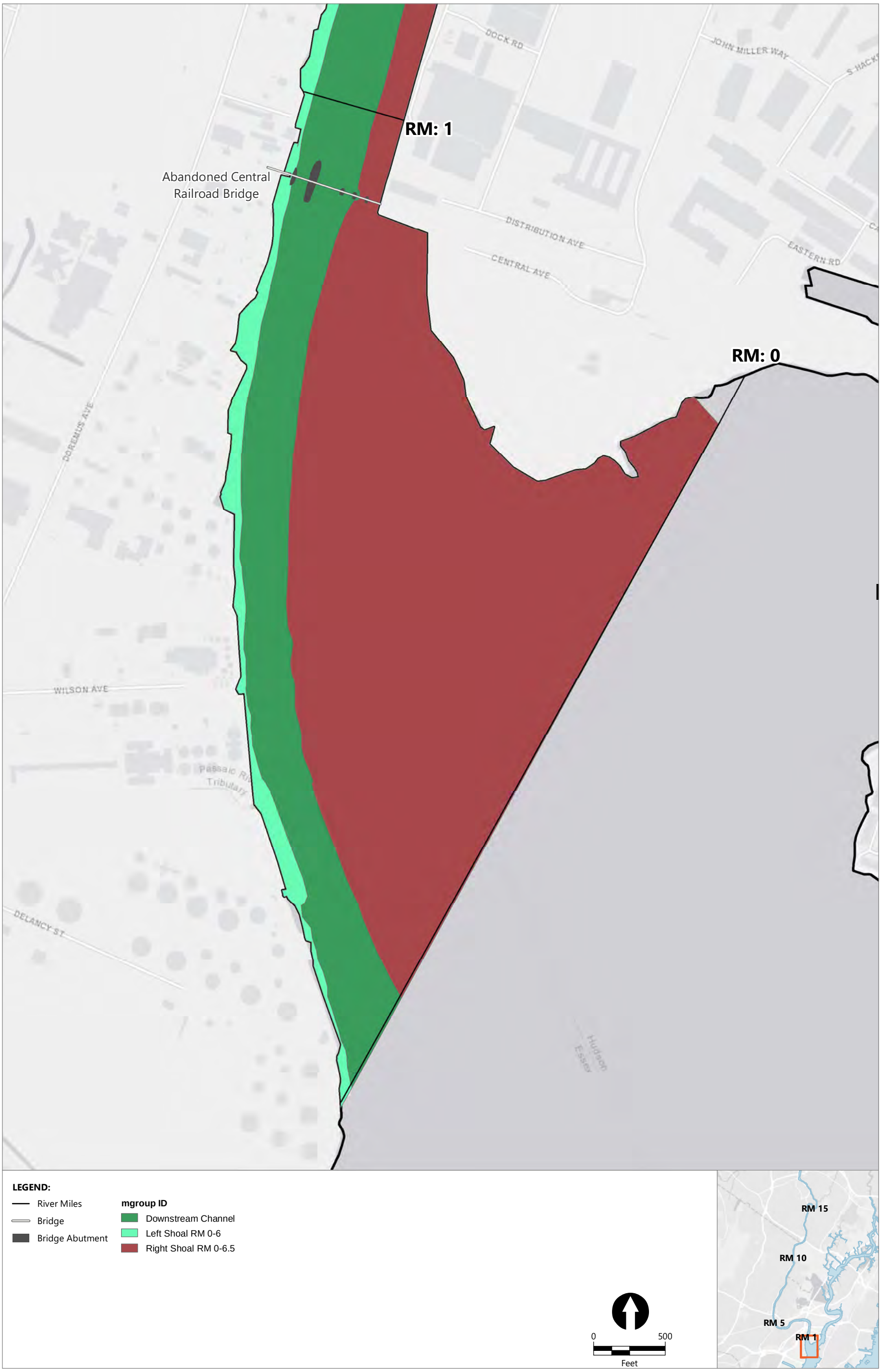

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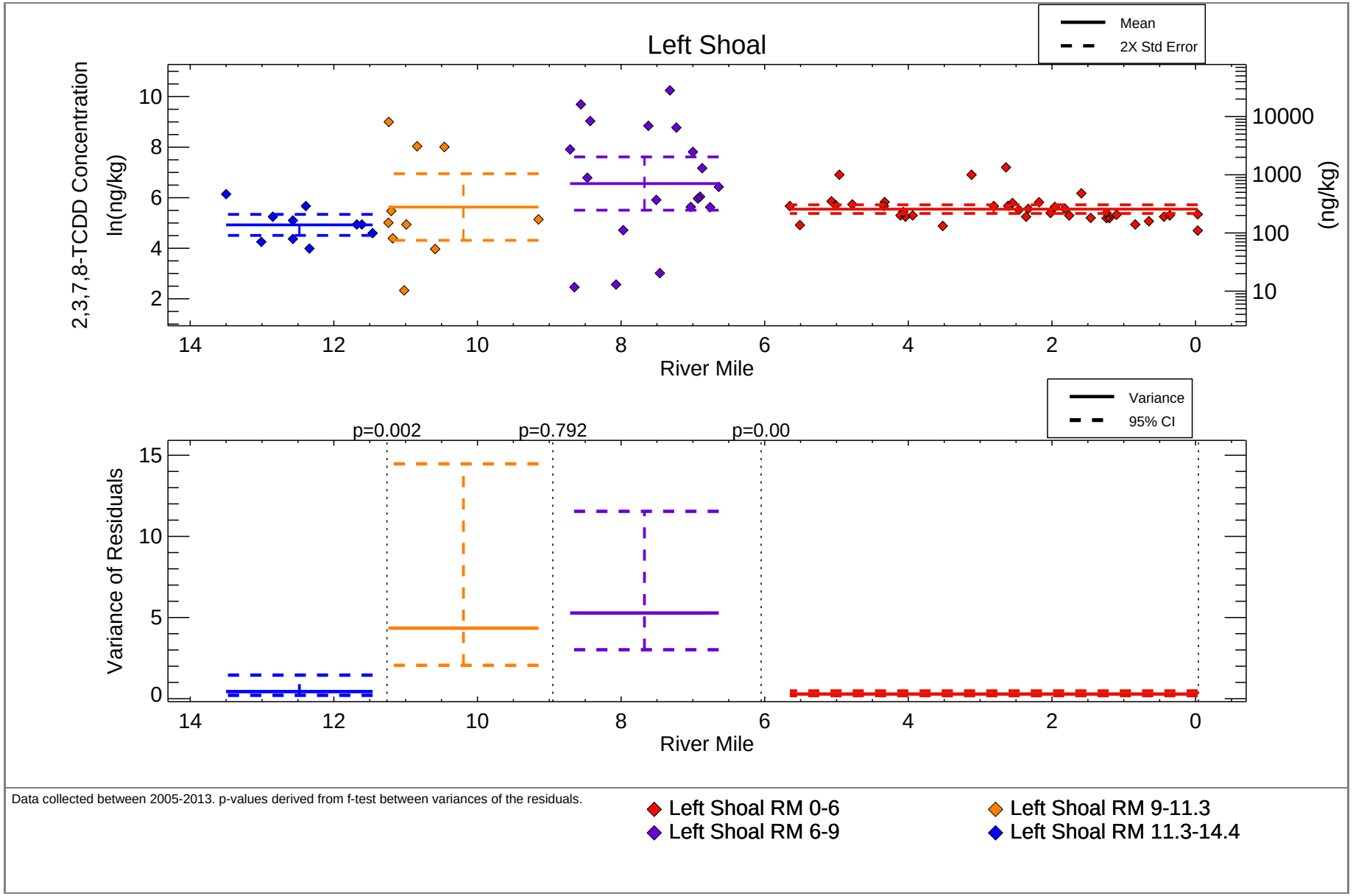
Figure 5-2l
Data Groups (mgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

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Figure 5-3a

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

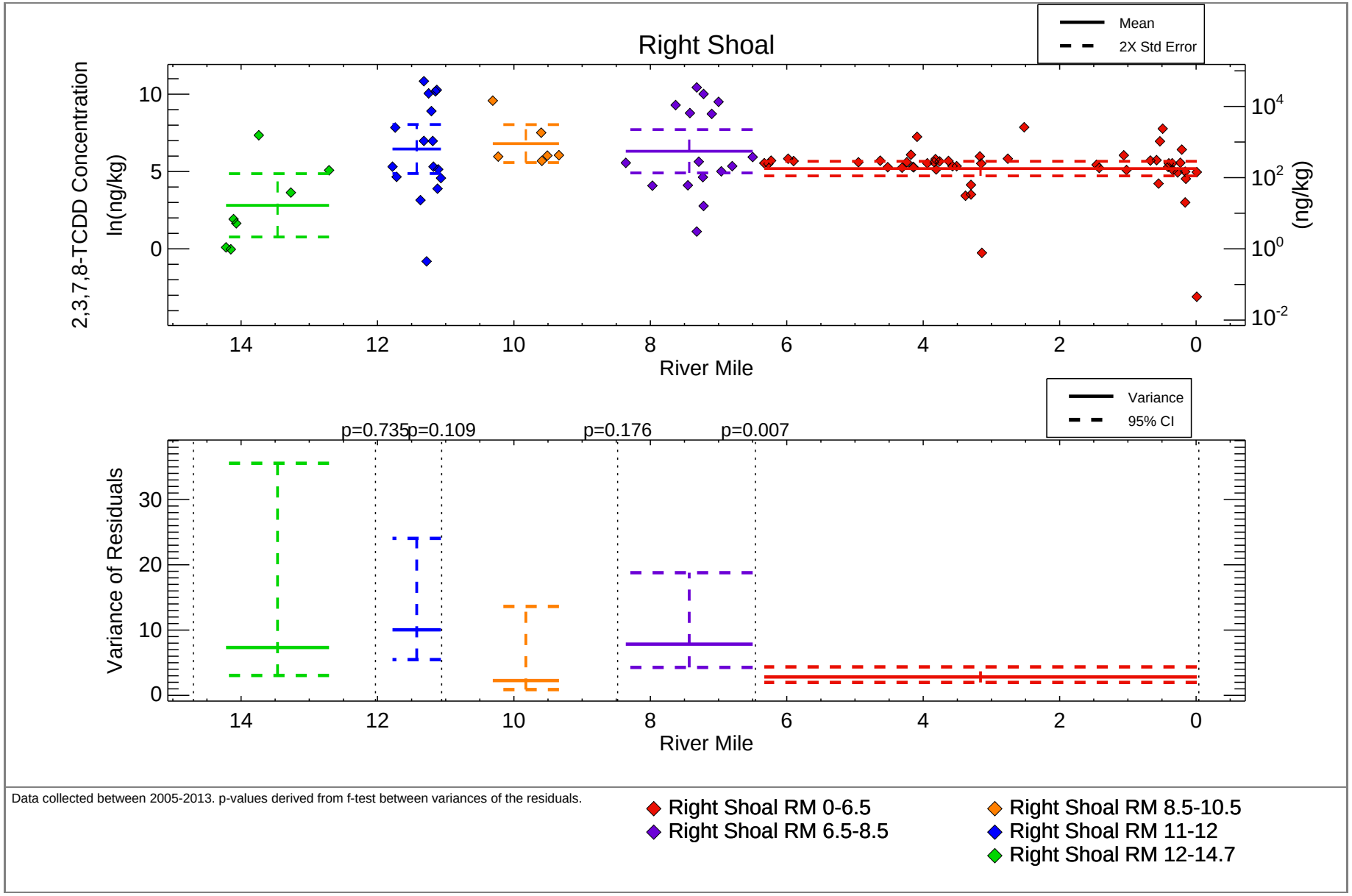

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Figure 5-3b

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

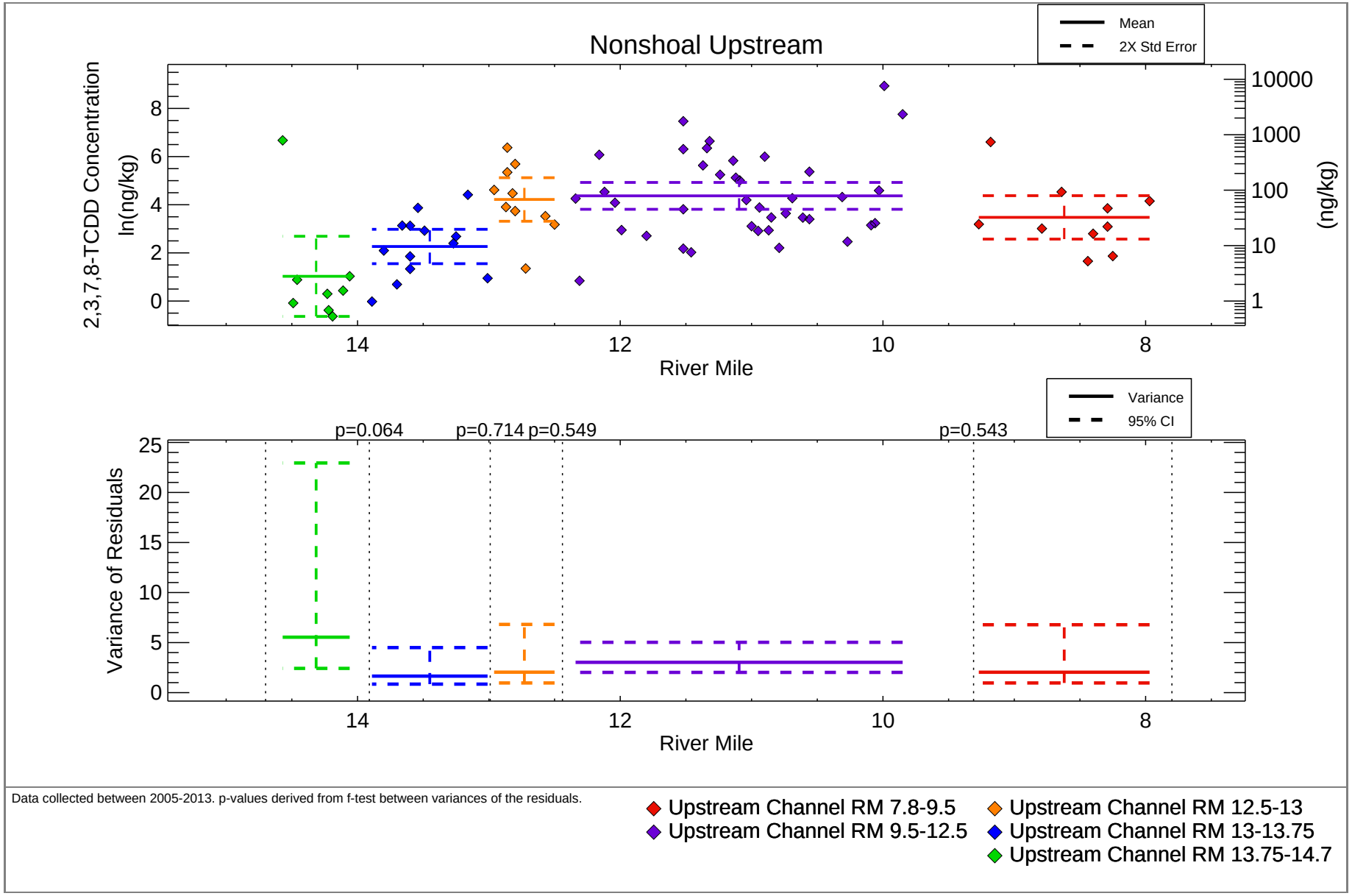

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Figure 5-3c

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

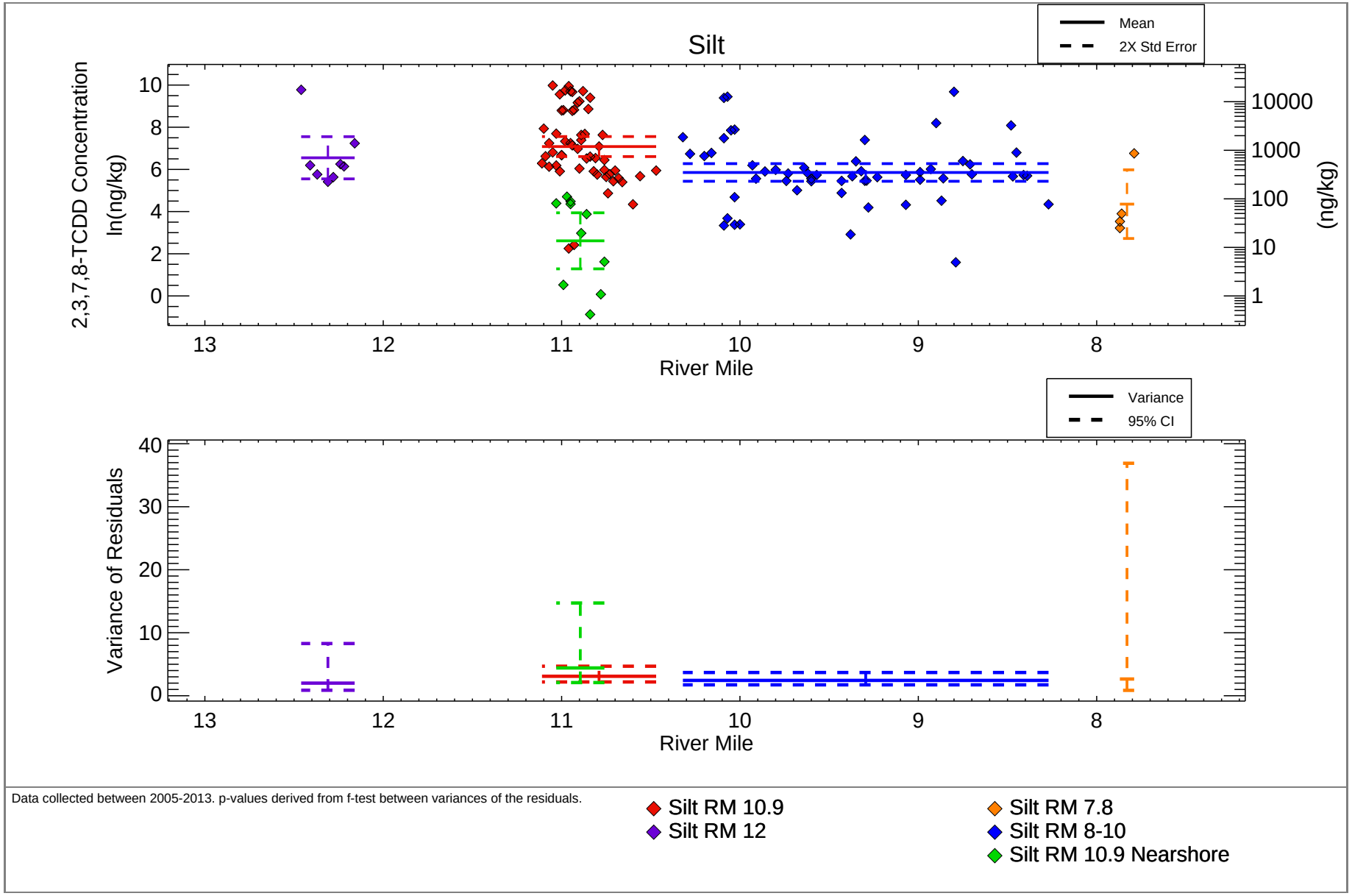

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Figure 5-3d

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

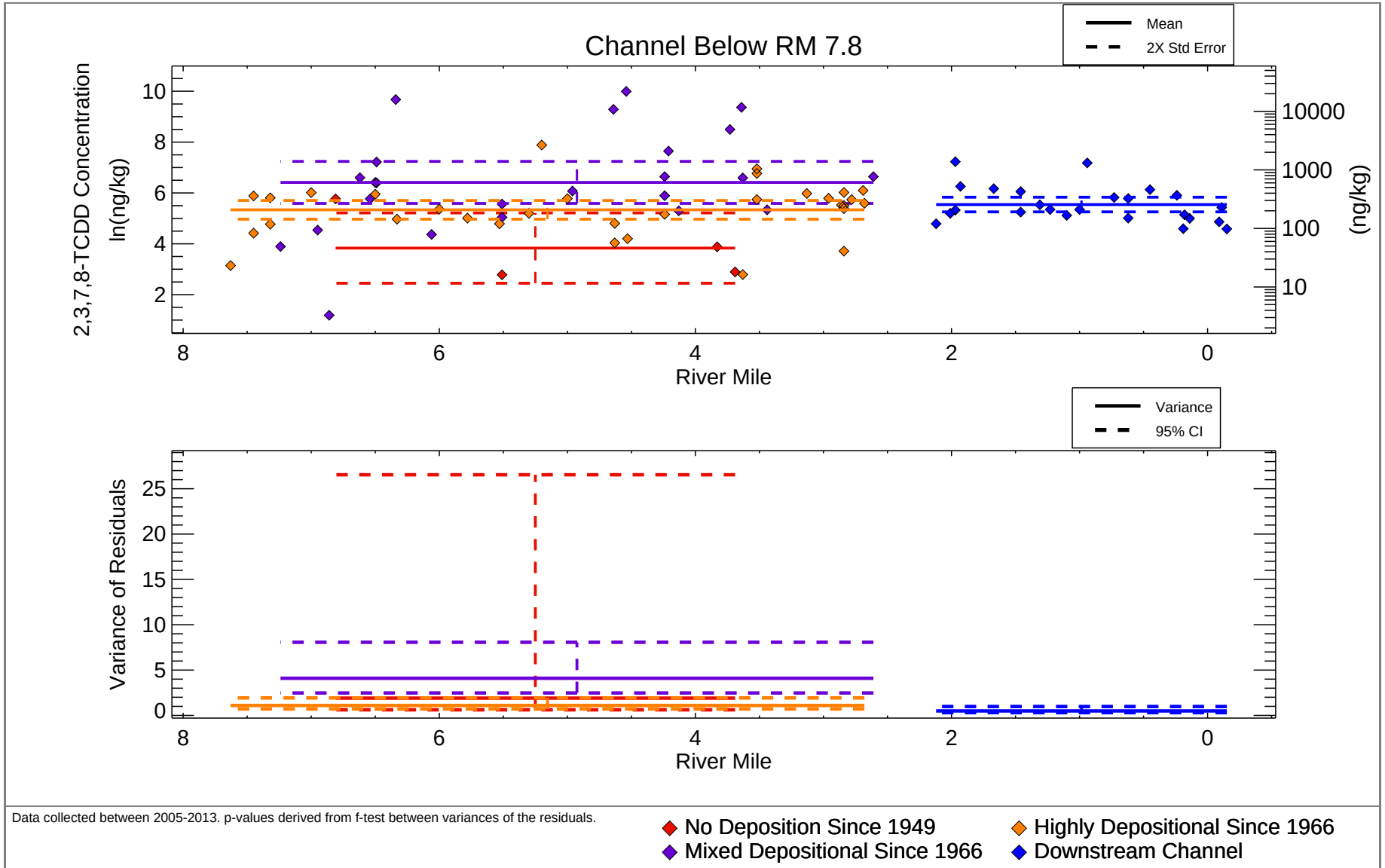

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Figure 5-3e

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

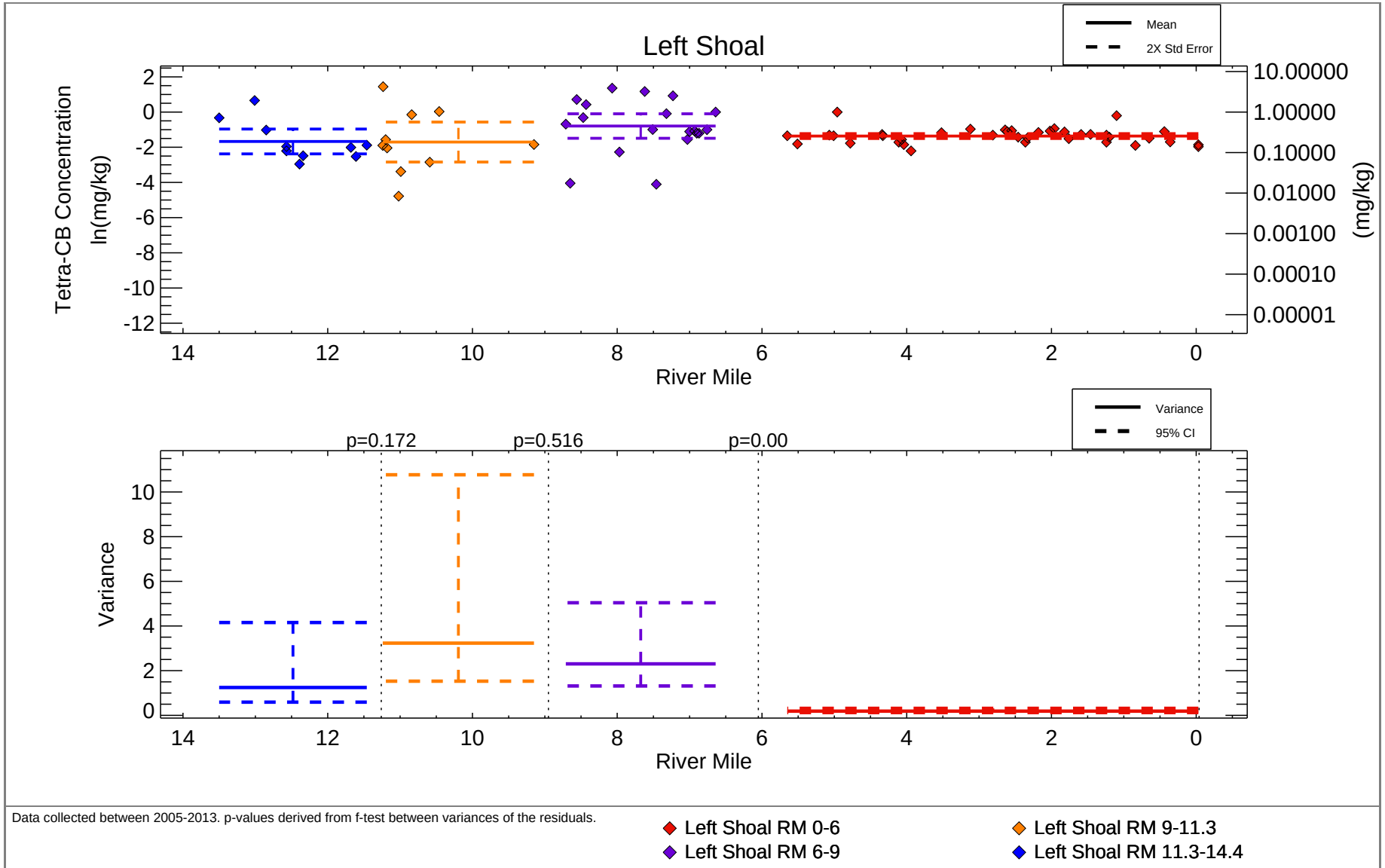

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Figure 5-4a

Surface Sediment Tetra-CB Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

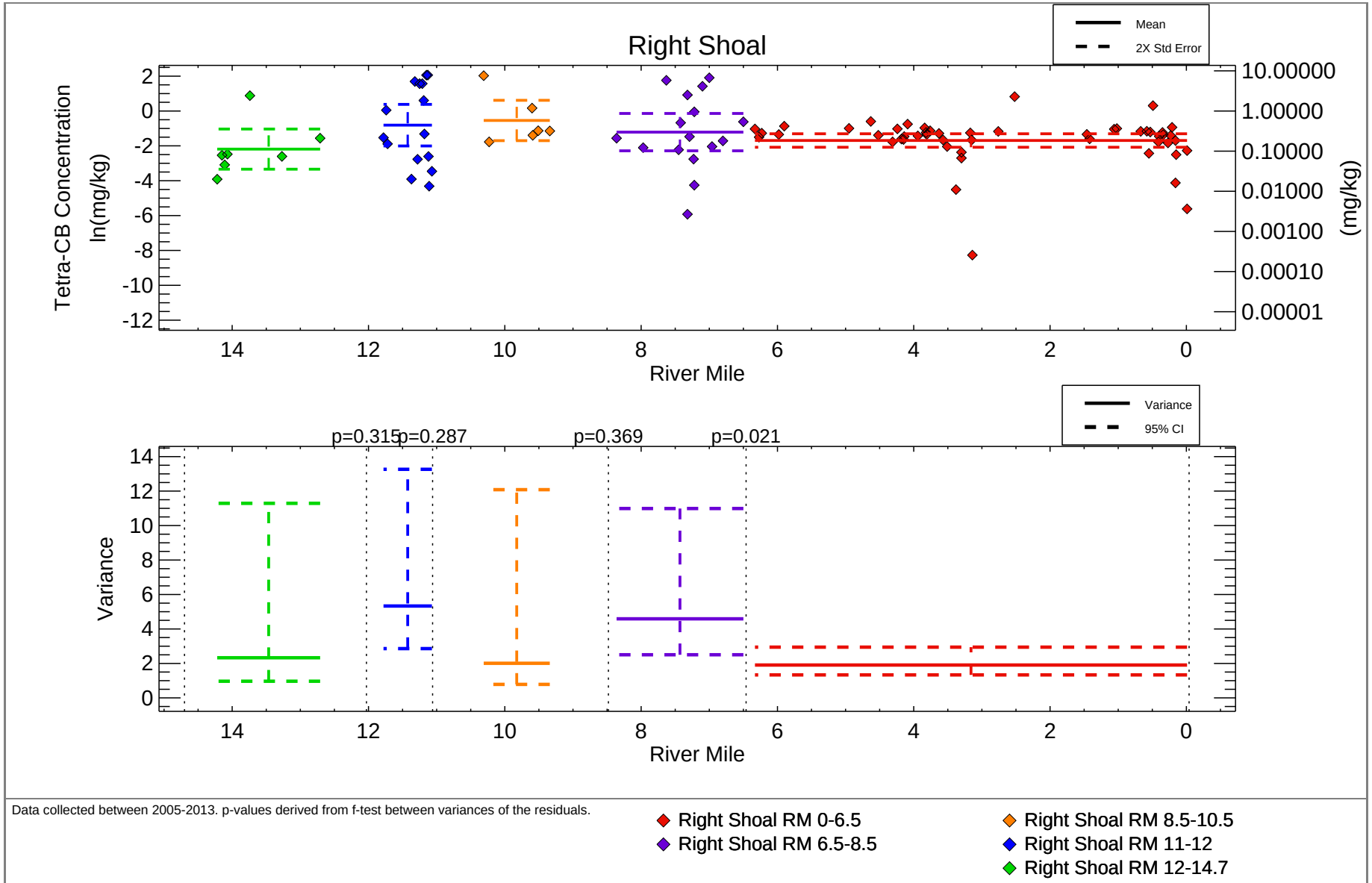

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Figure 5-4b

Surface Sediment Tetra-CB Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

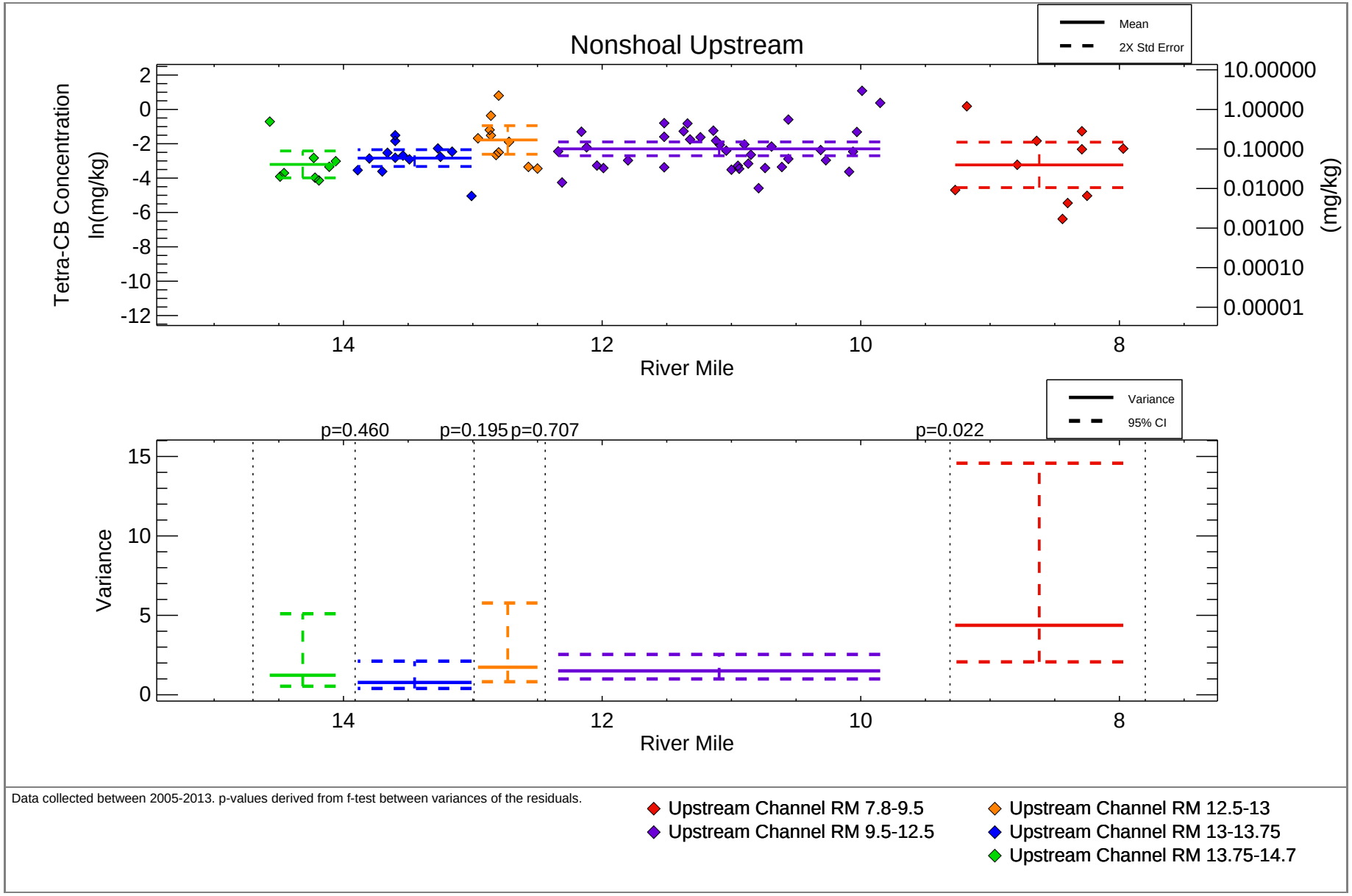

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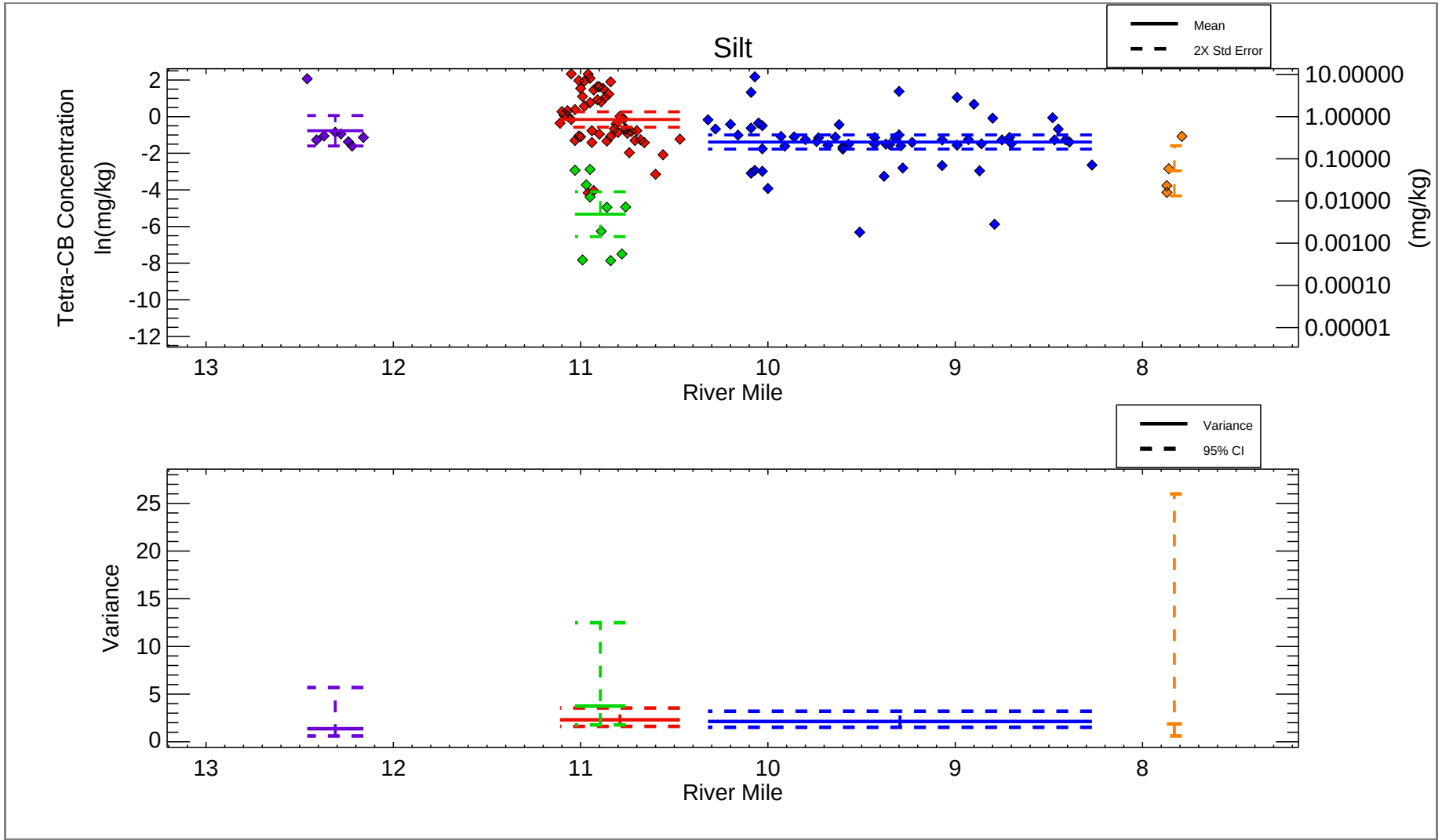
Figure 5-4c

Surface Sediment Tetra-CB Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

- Silt RM 10.9
- Silt RM 12
- Silt RM 7.8
- Silt RM 8-10
- Silt RM 10.9 Nearshore

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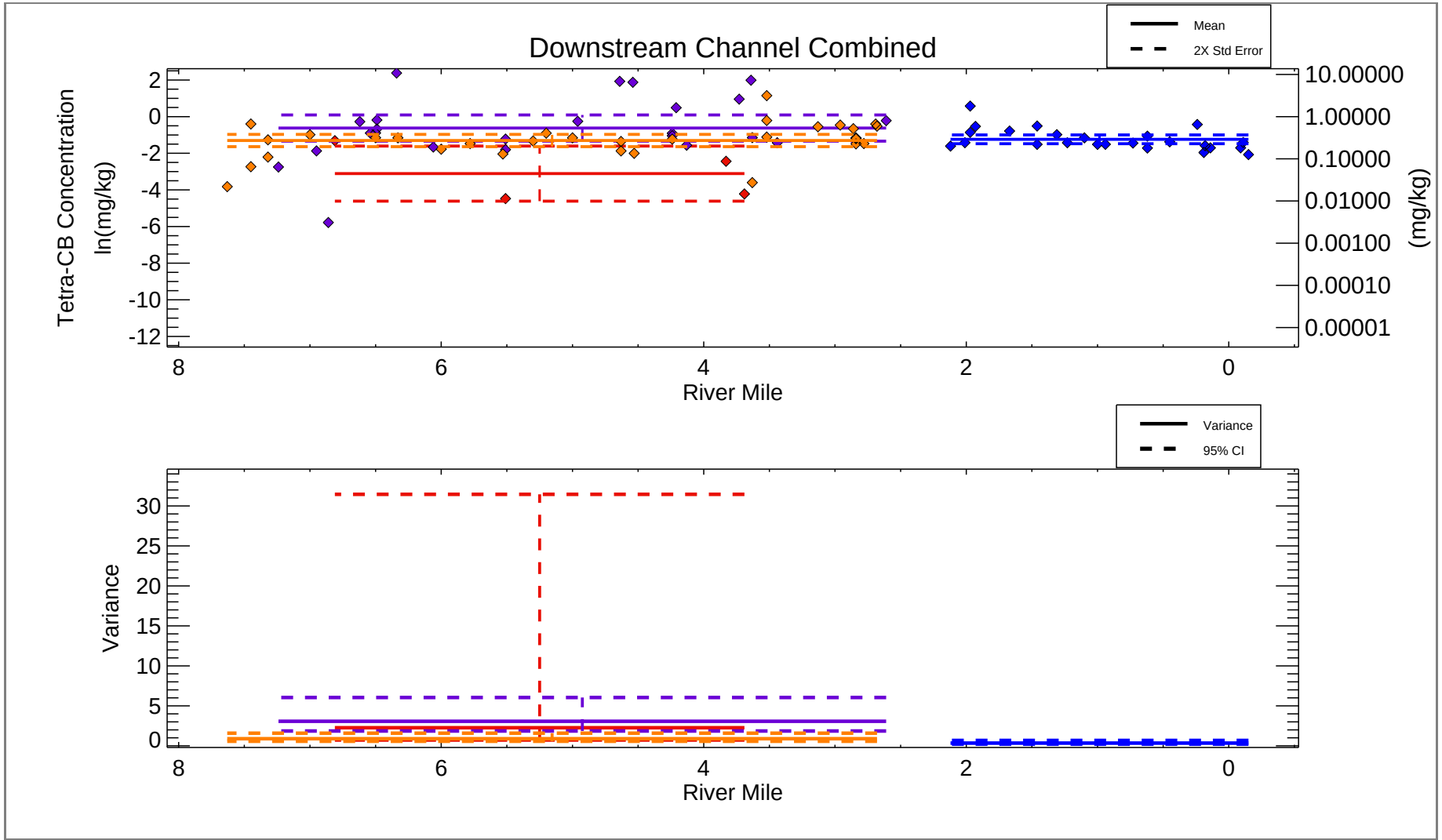
Figure 5-4d

Surface Sediment Tetra-CB Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

- No Deposition Since 1949
- Highly Depositional Since 1966
- Mixed Depositional Since 1966
- Downstream Channel

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Figure 5-4e

Surface Sediment Tetra-CB Concentration vs River Mile by Data Group (mgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 5-5a
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

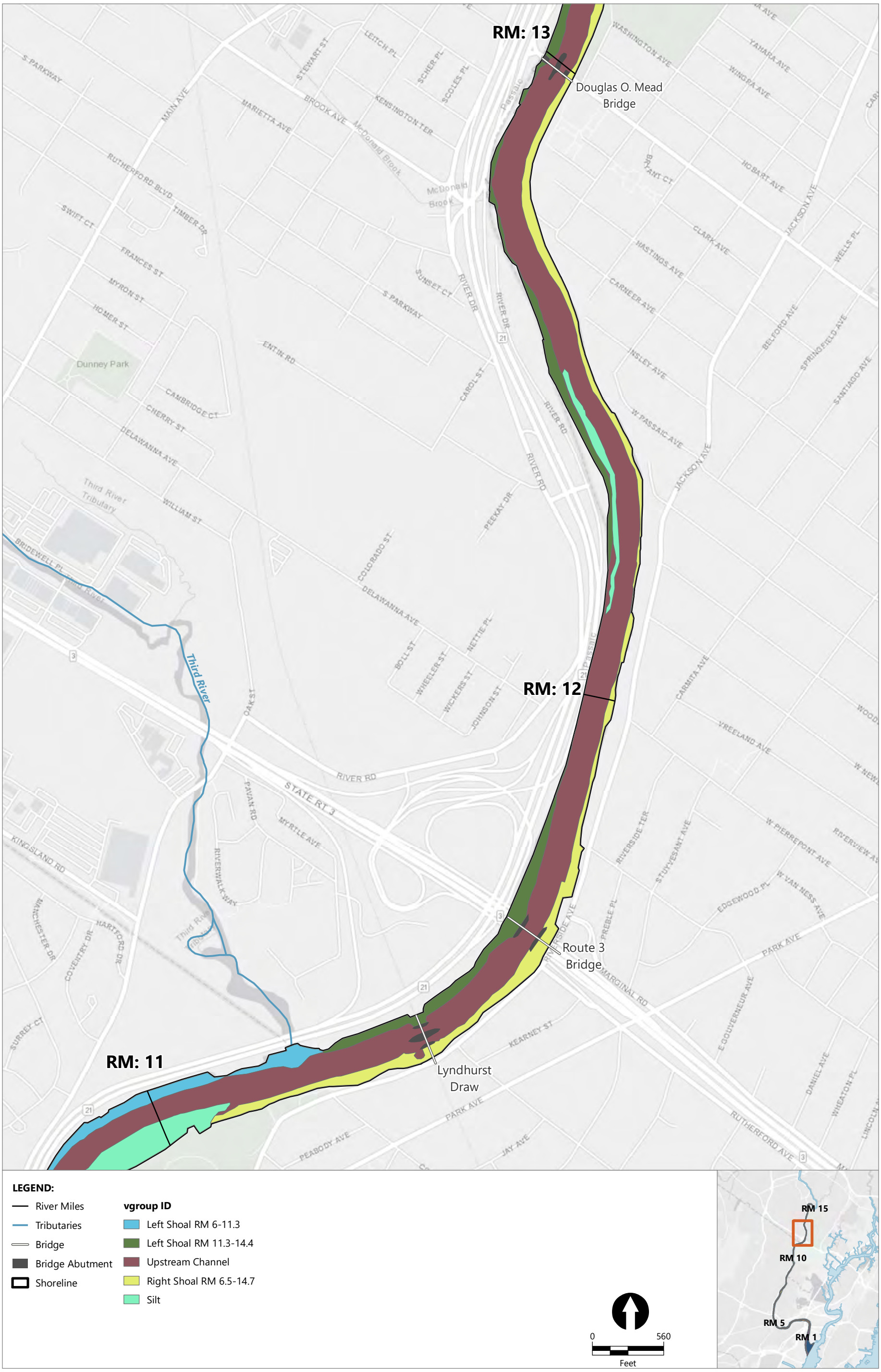

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Figure 5-5b
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

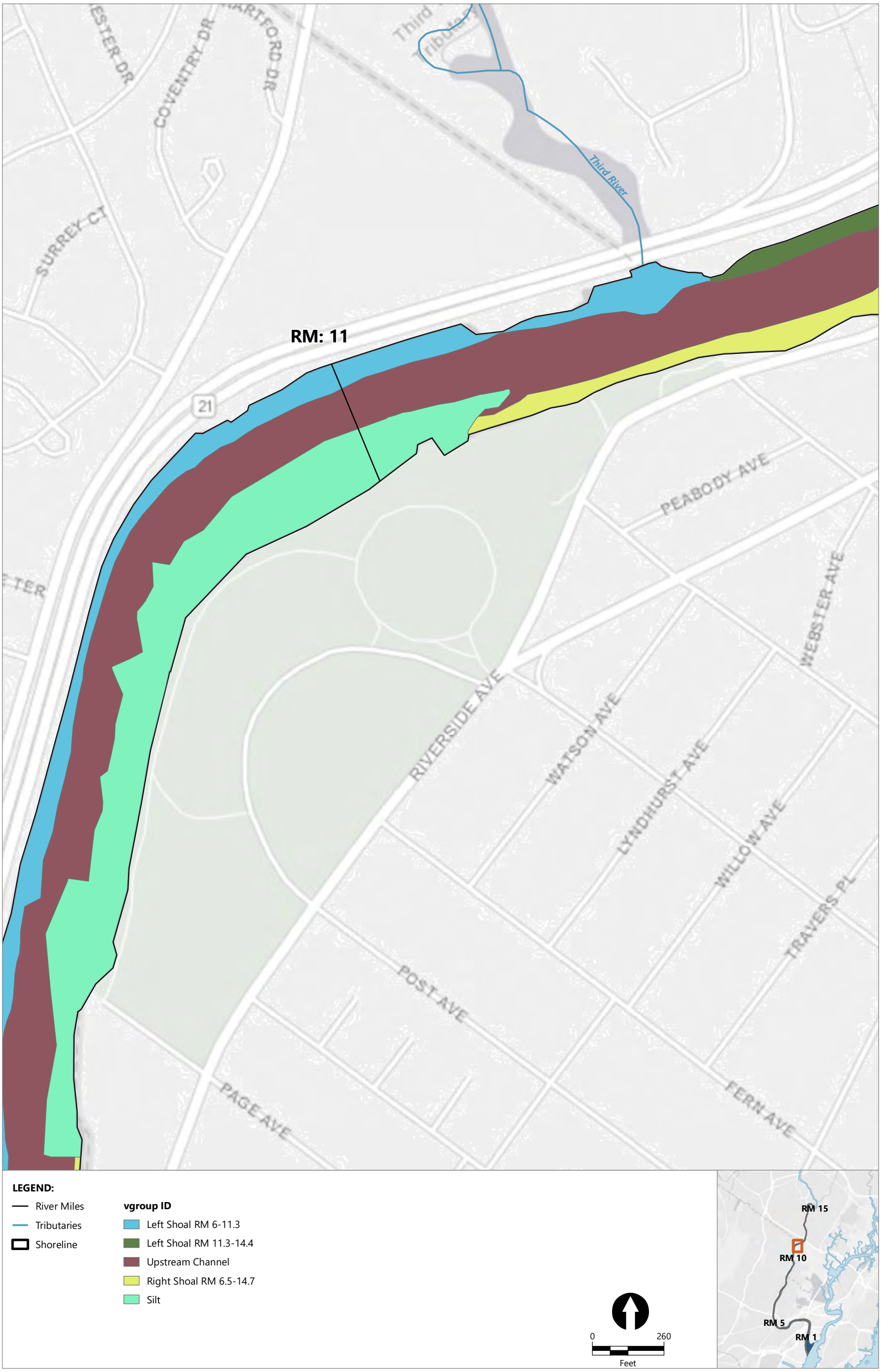

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Figure 5-5c
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

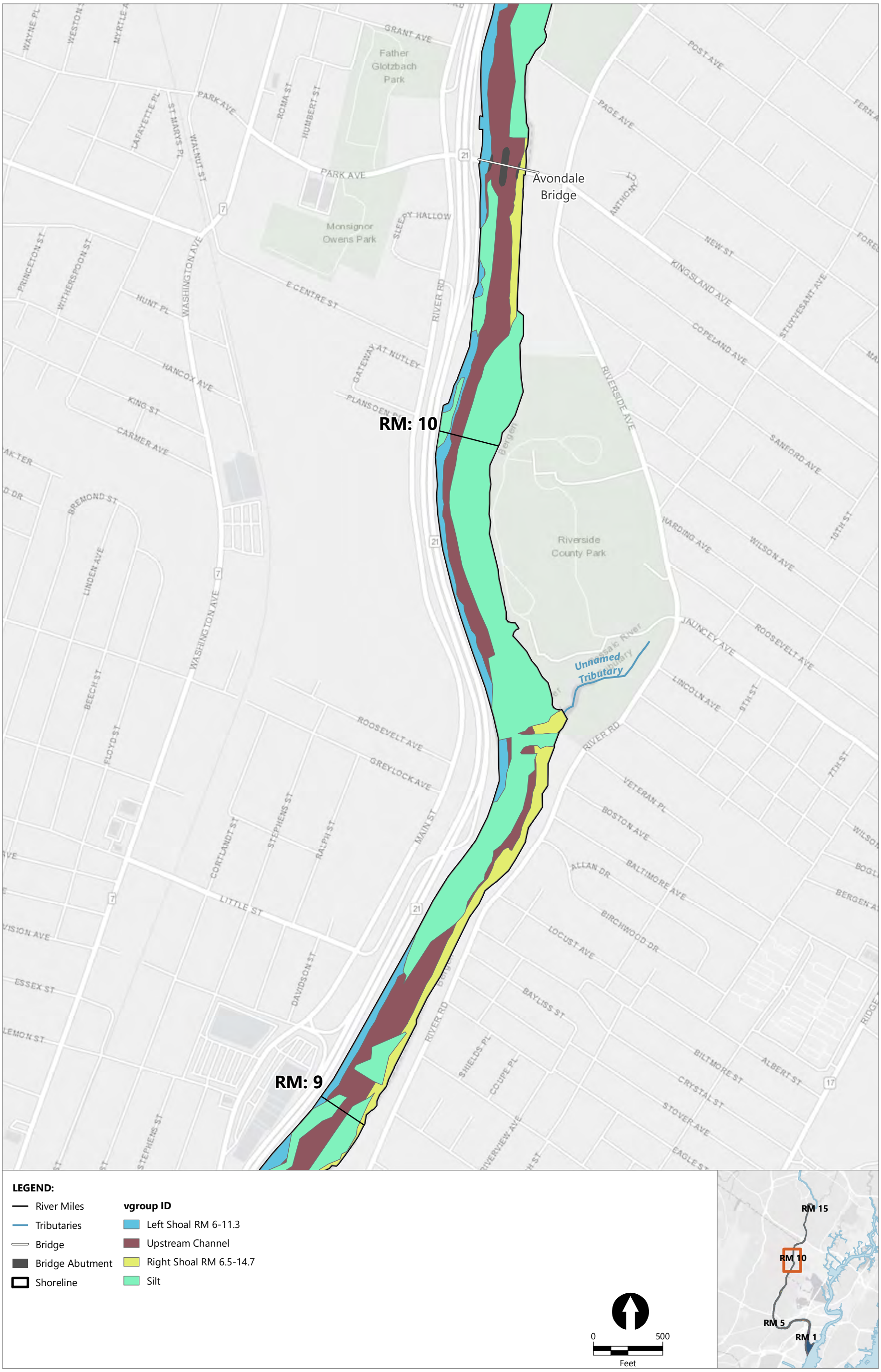

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Figure 5-5d
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

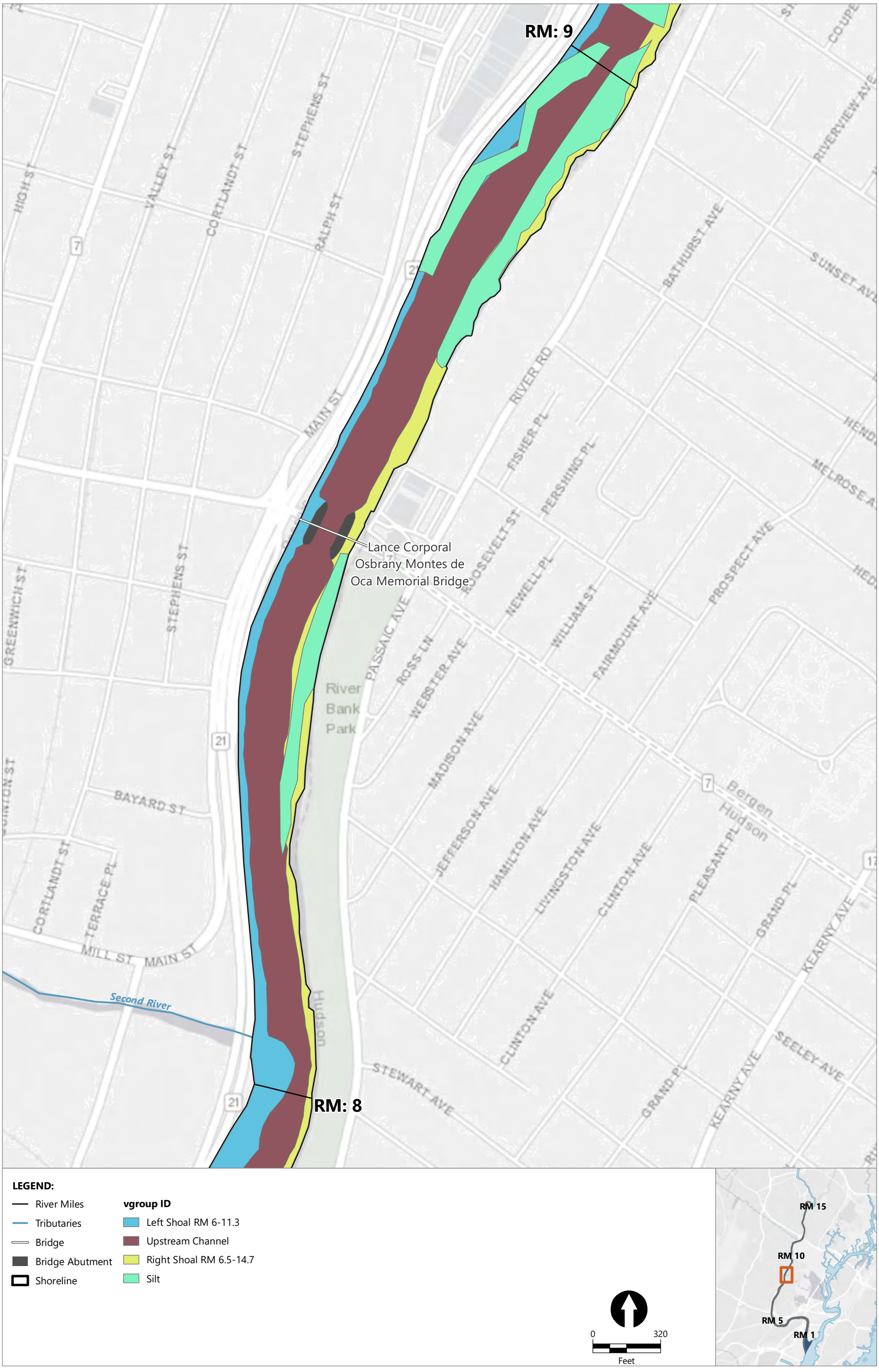

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Figure 5-5e
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

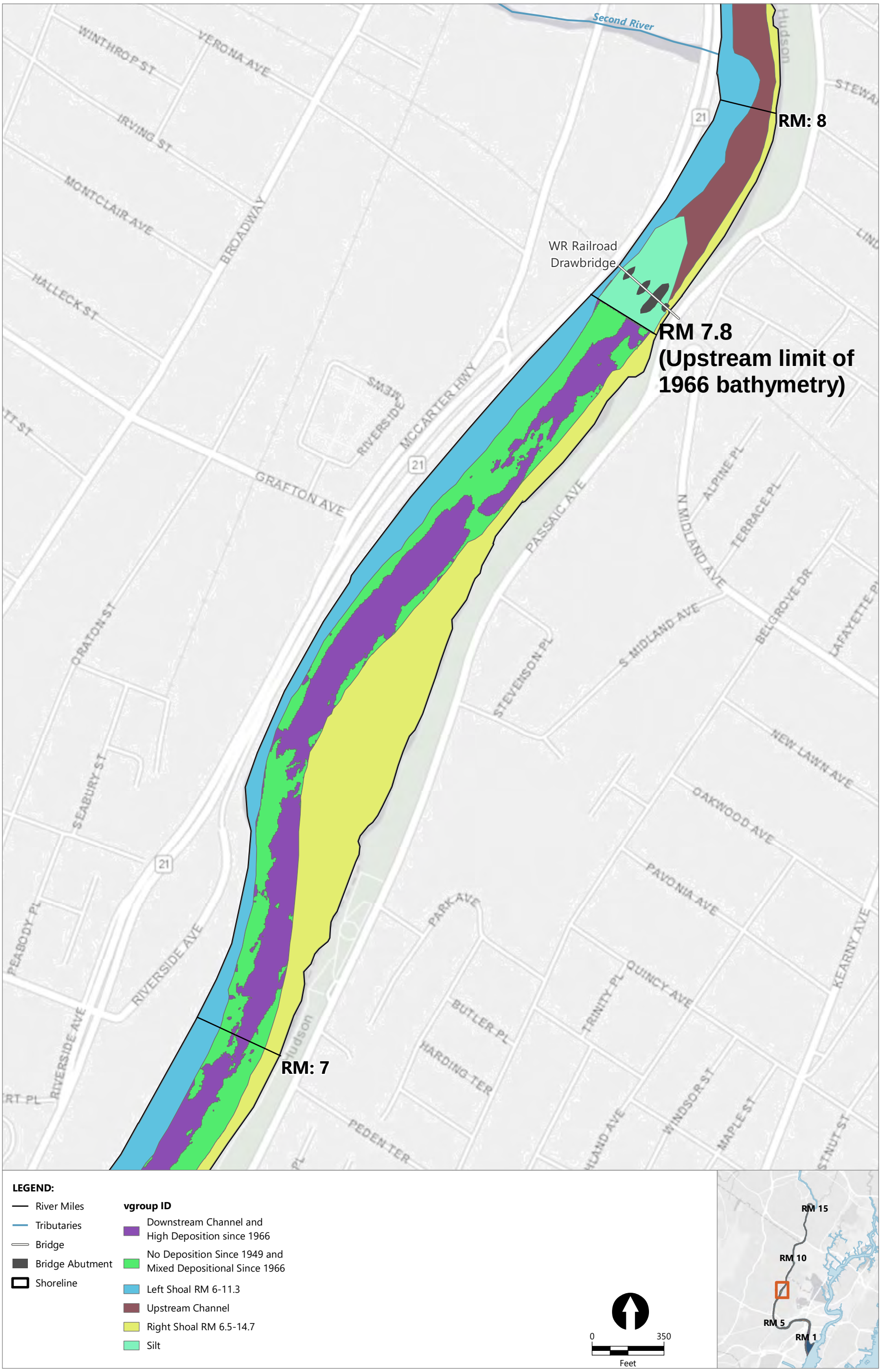

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Figure 5-5f
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 5-5g
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

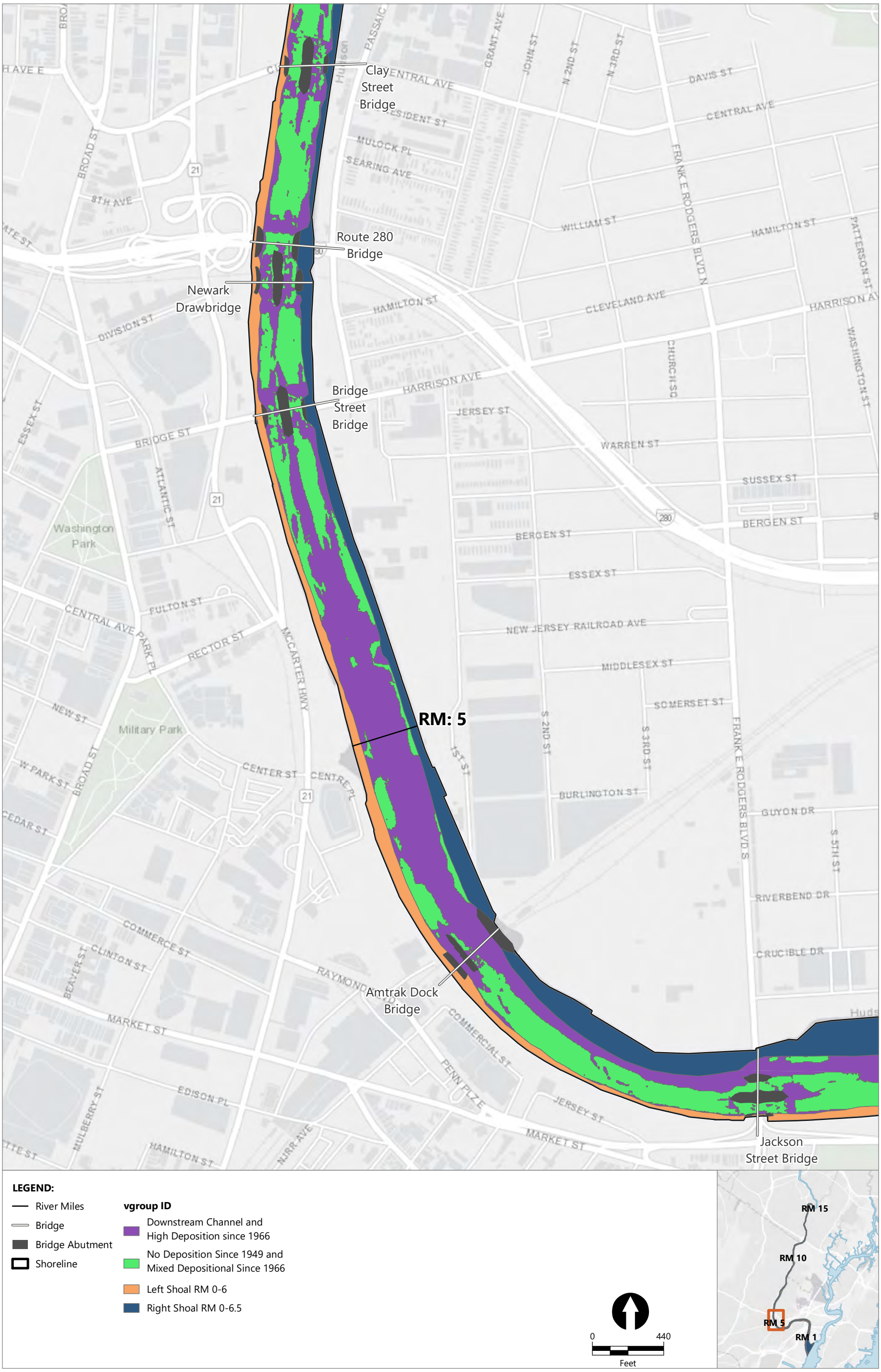

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Figure 5-5h
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

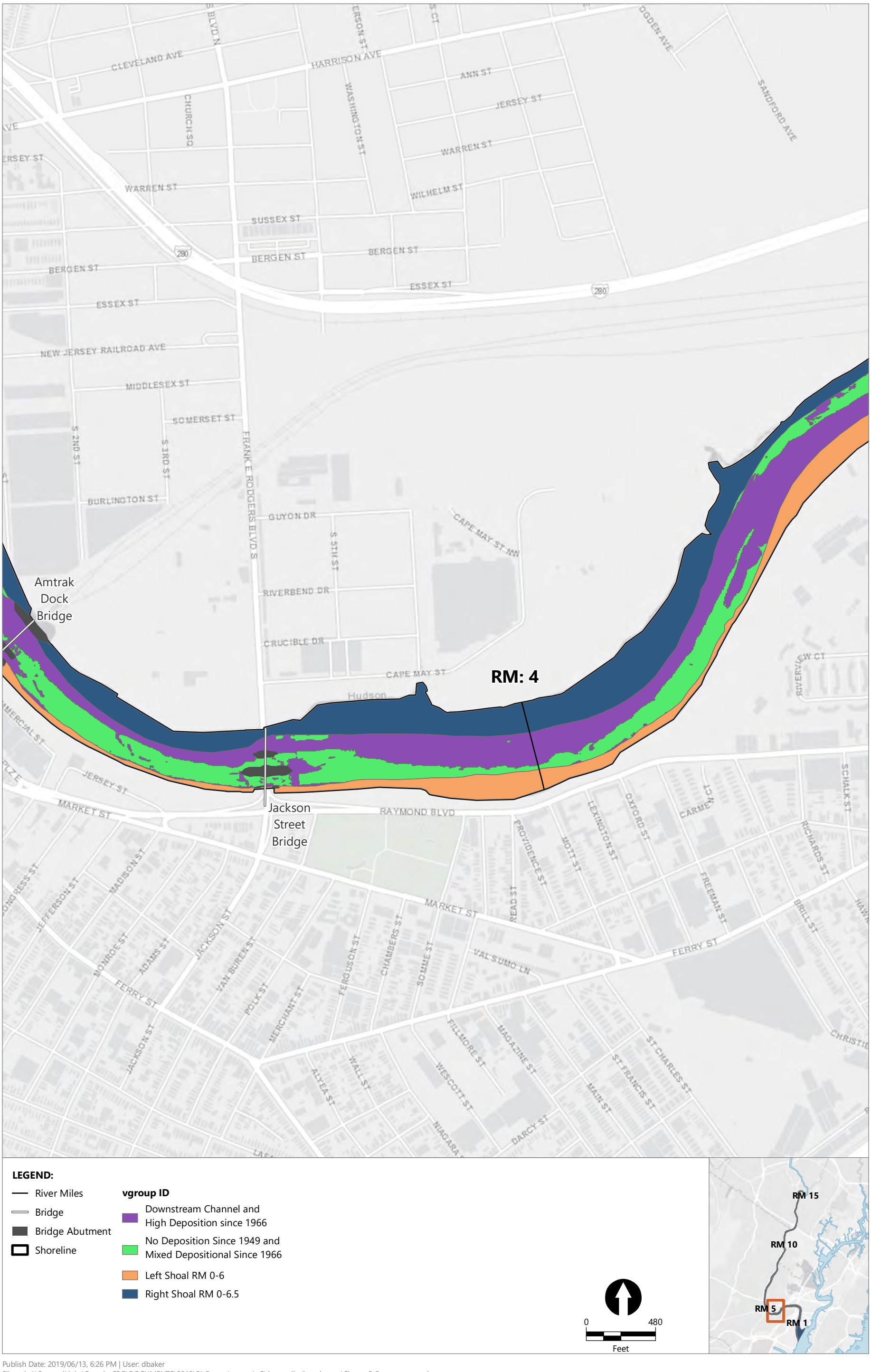

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Figure 5-5i
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

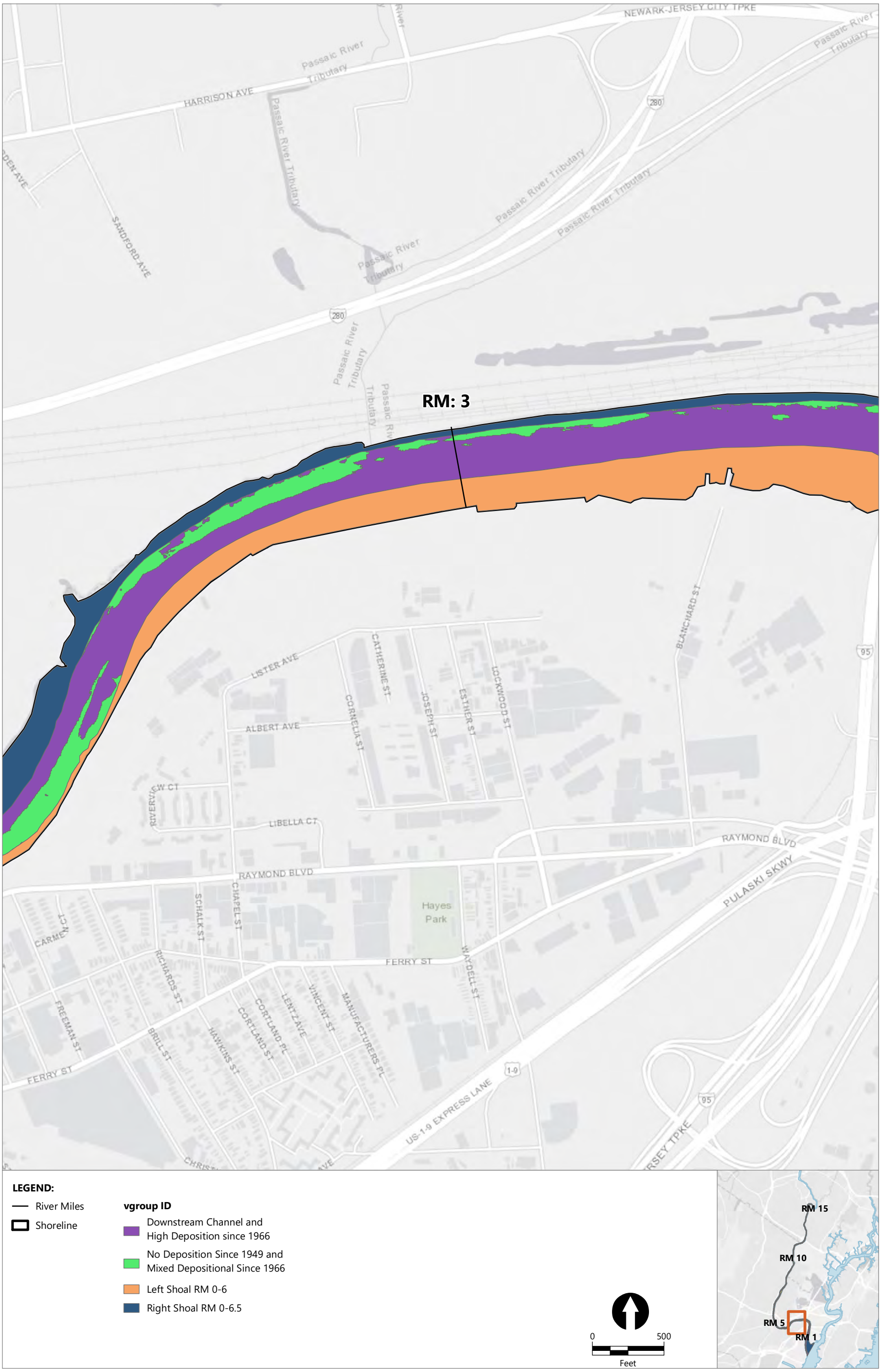

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Figure 5-5j
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

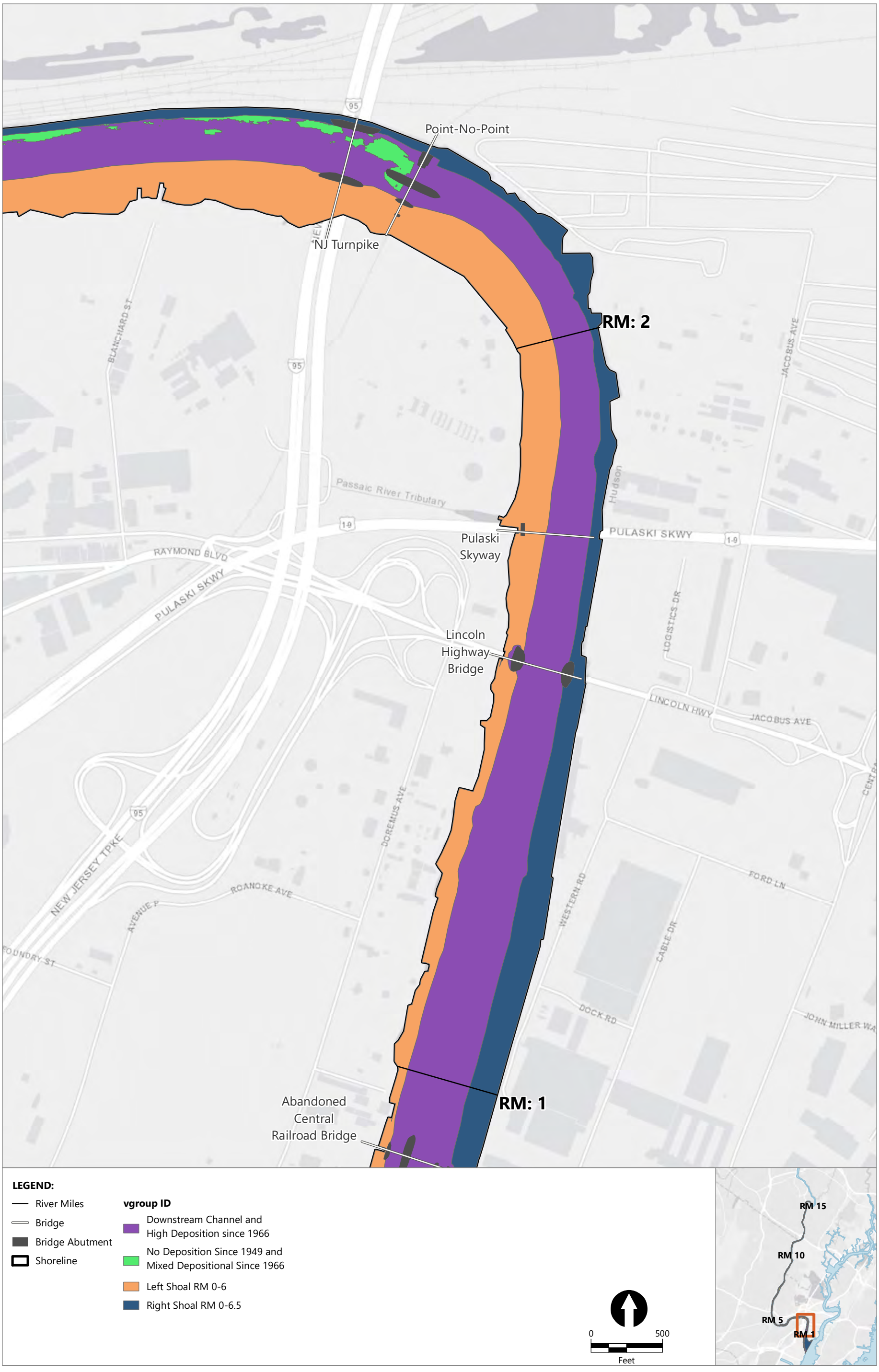

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Figure 5-5k
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

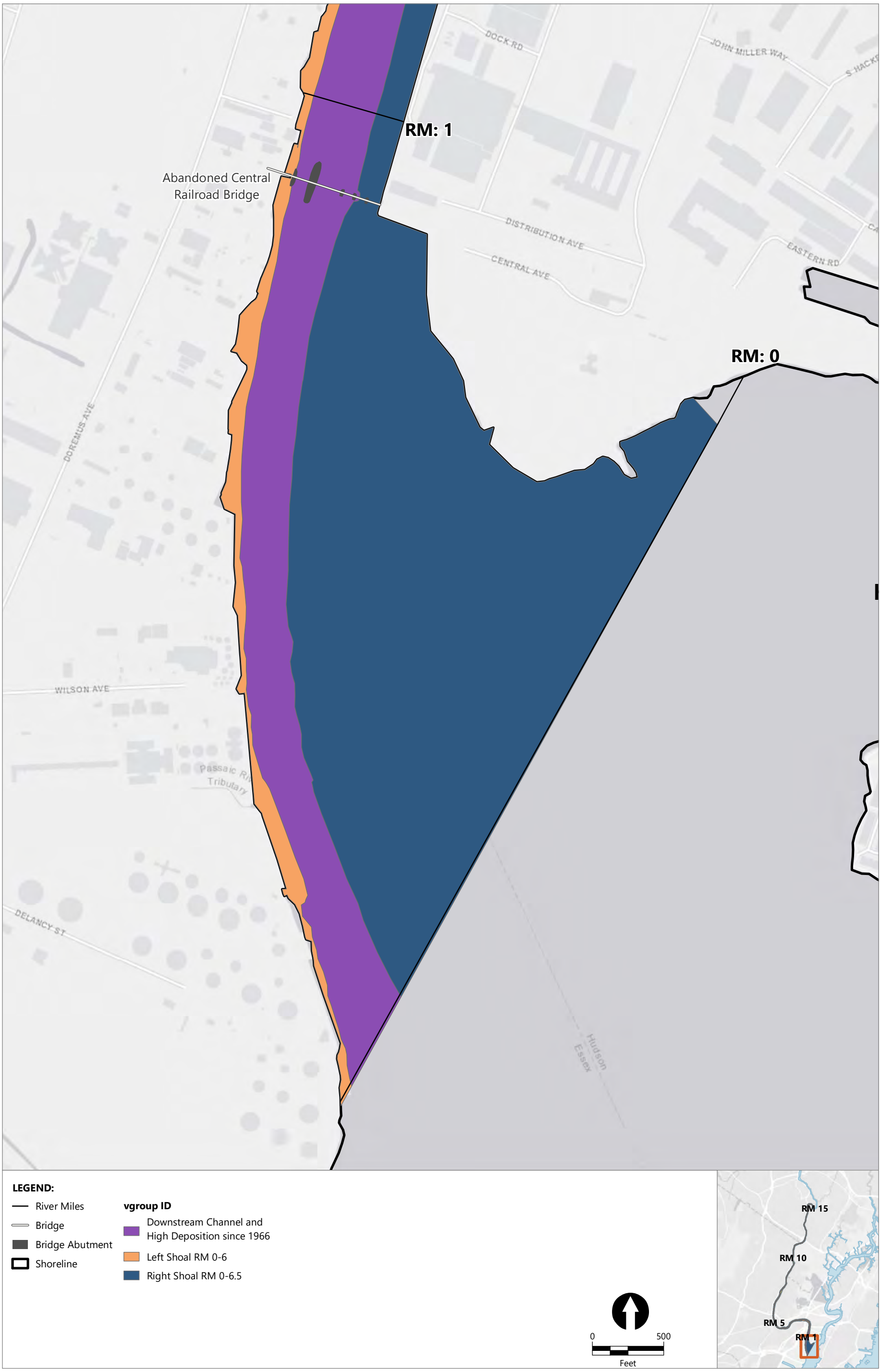

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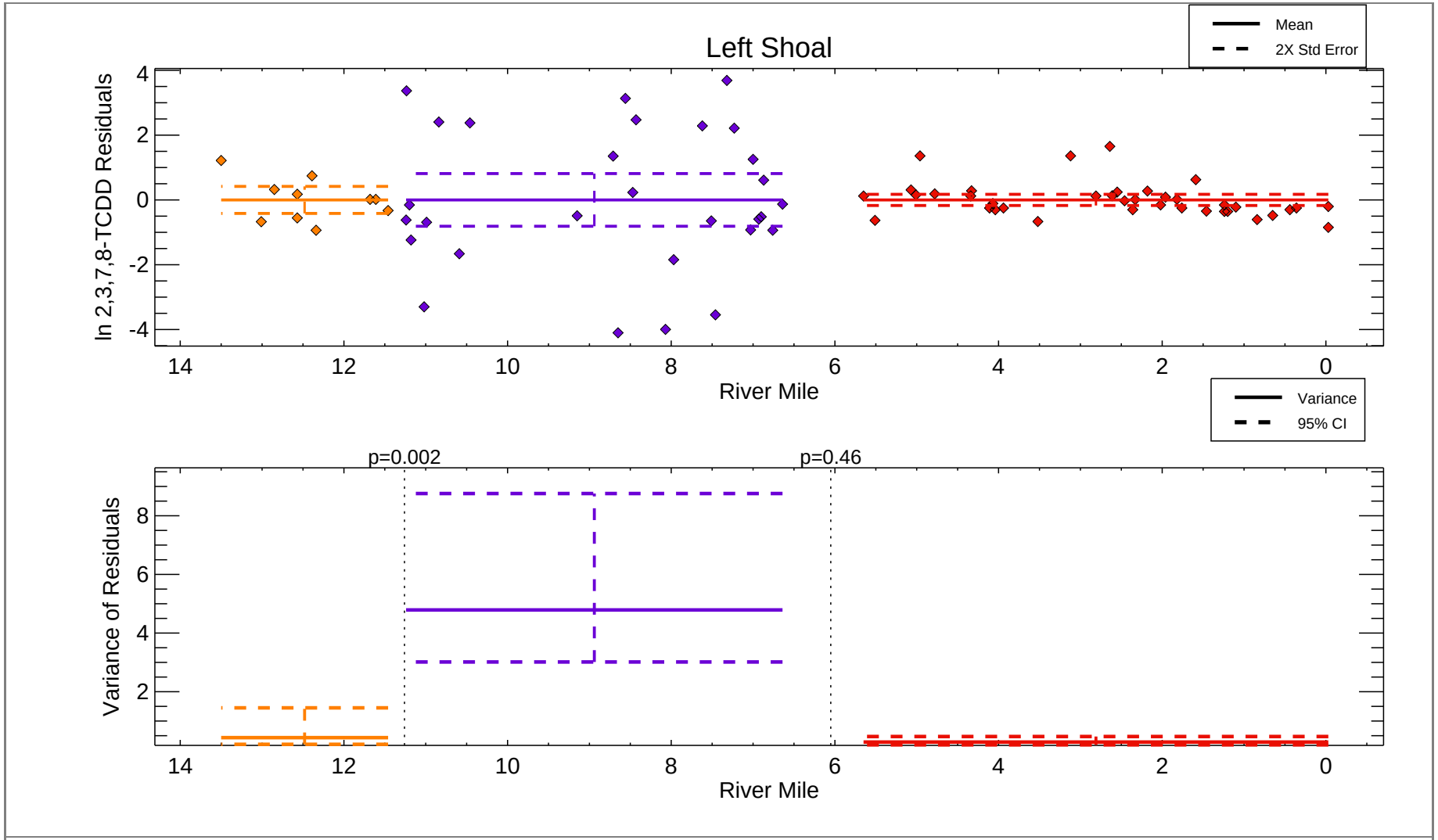
Figure 5-5l
Kriging Groups (vgroups) Used in the Conditional Simulation Approach
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

- Left Shoal RM 0-6
- Left Shoal RM 6-11.3
- Left Shoal RM 11.3-14.4

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Figure 5-6a

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

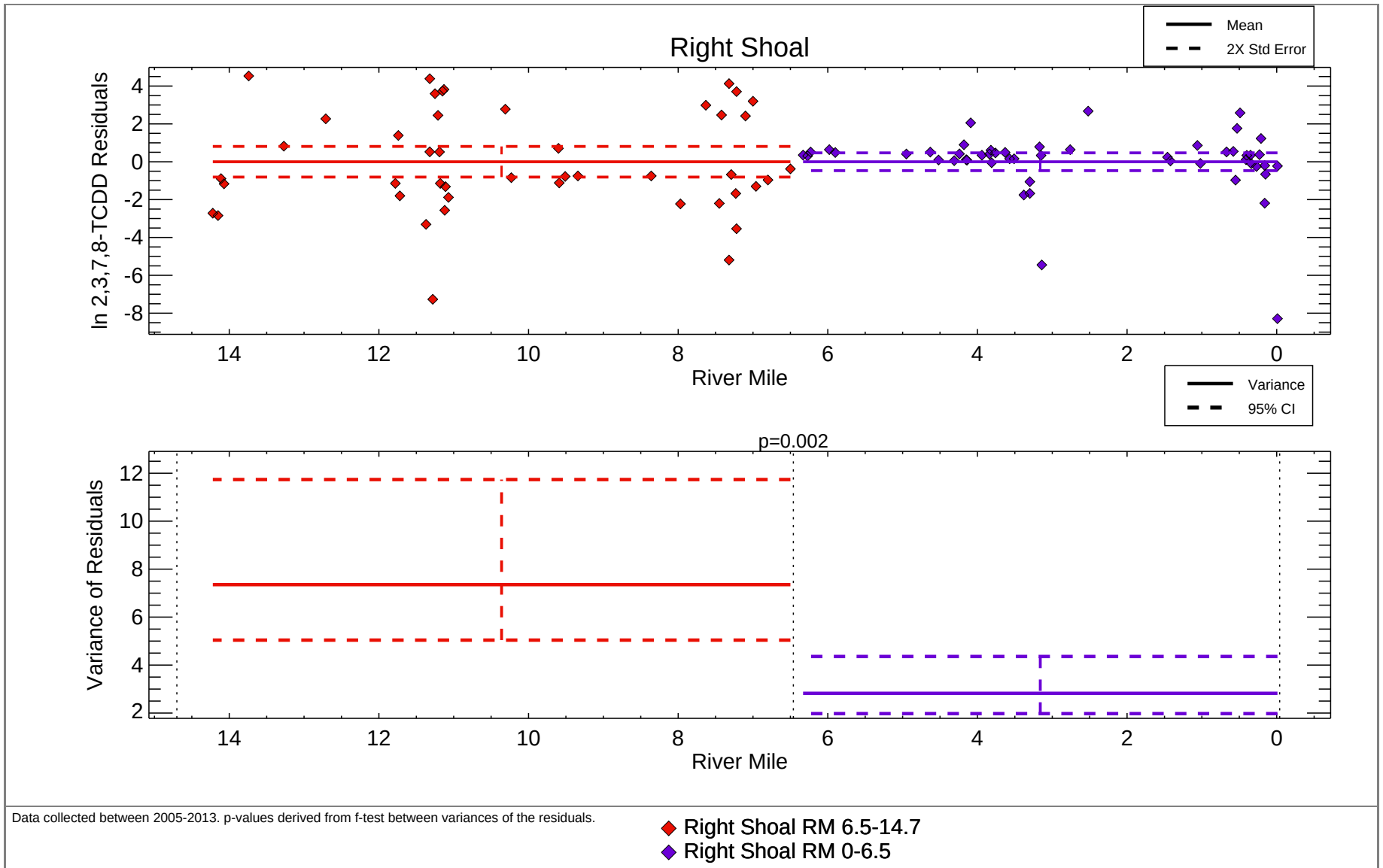

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Figure 5-6b

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

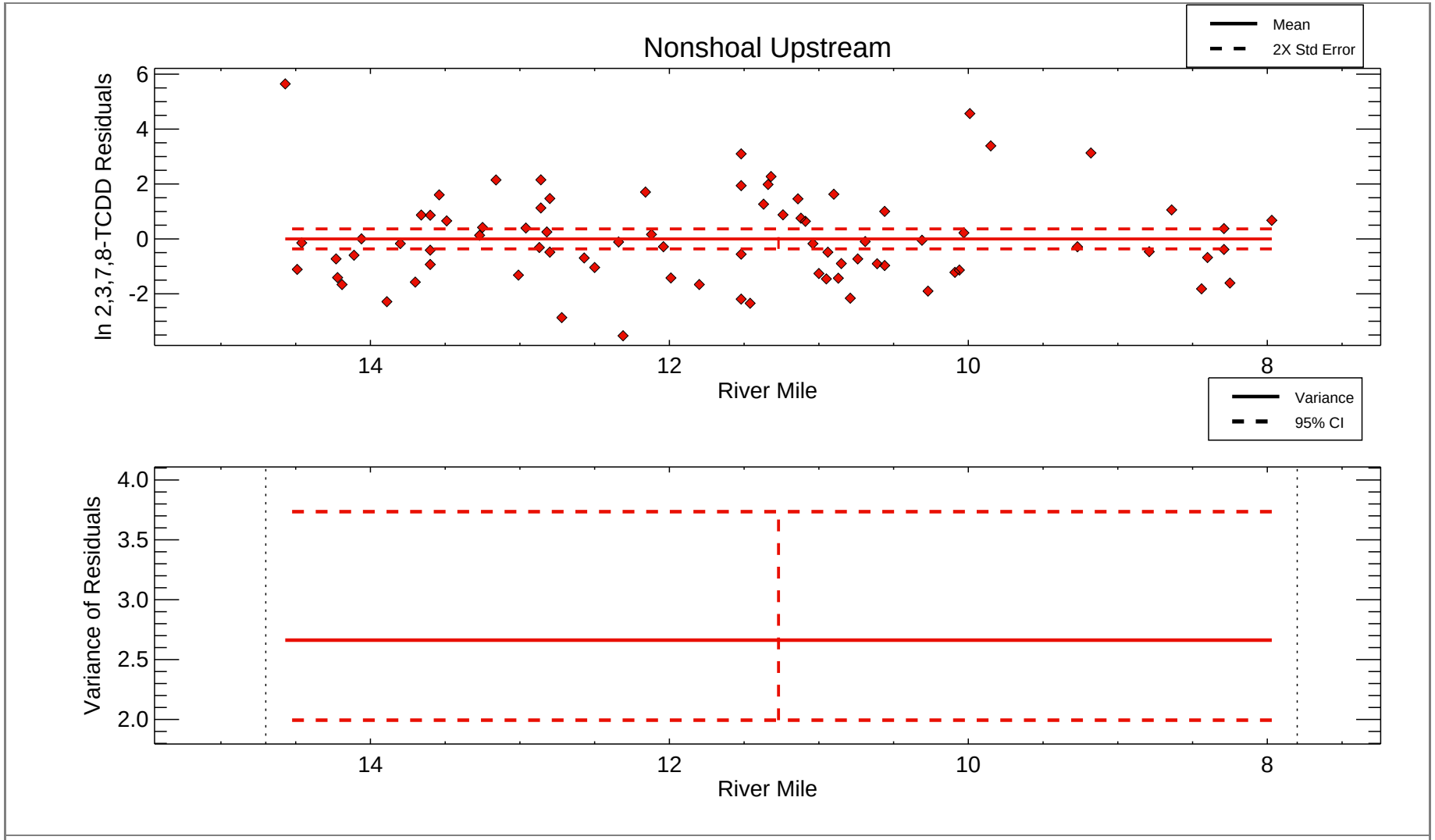

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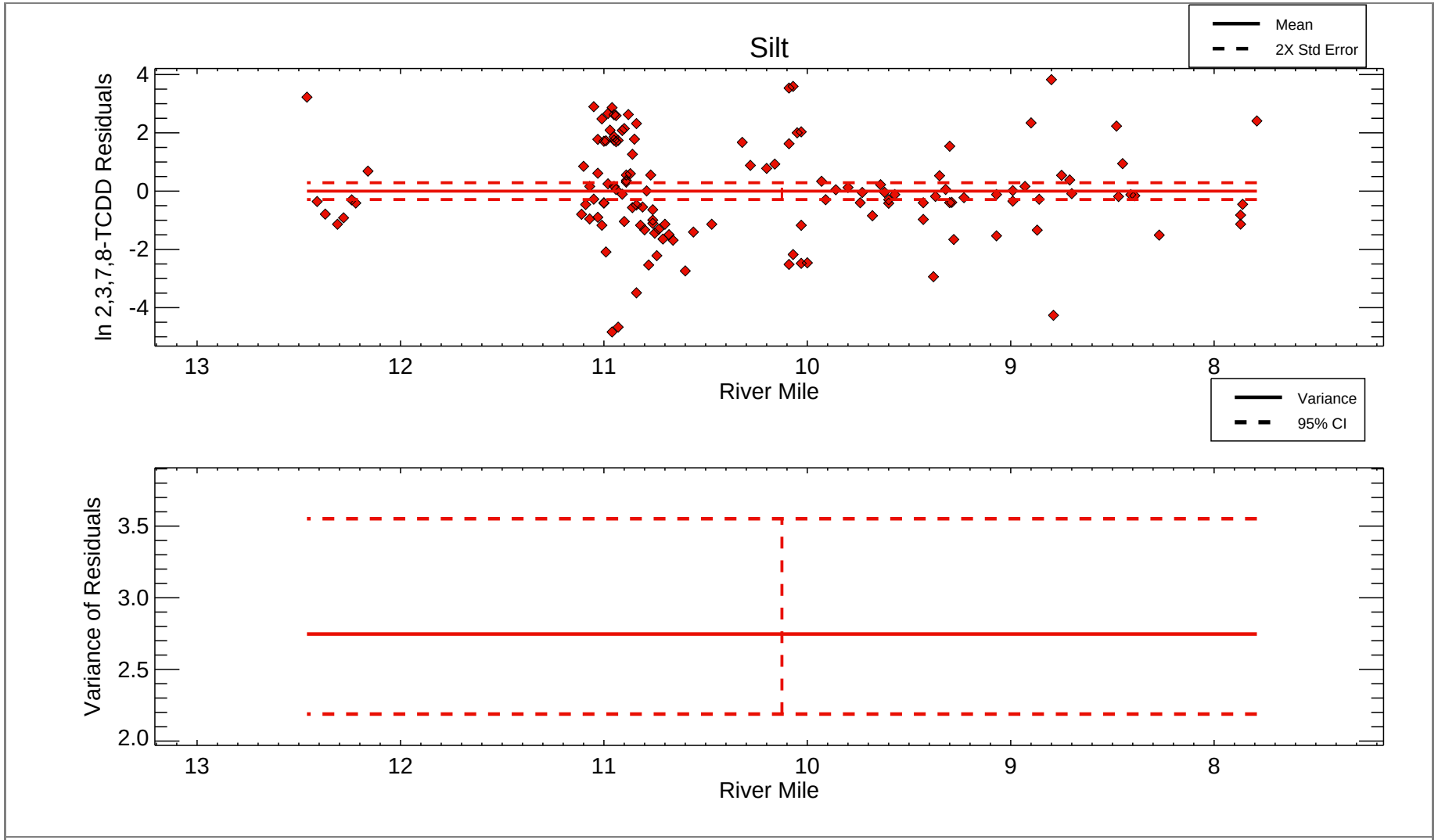
Figure 5-6c

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

◆ Silt

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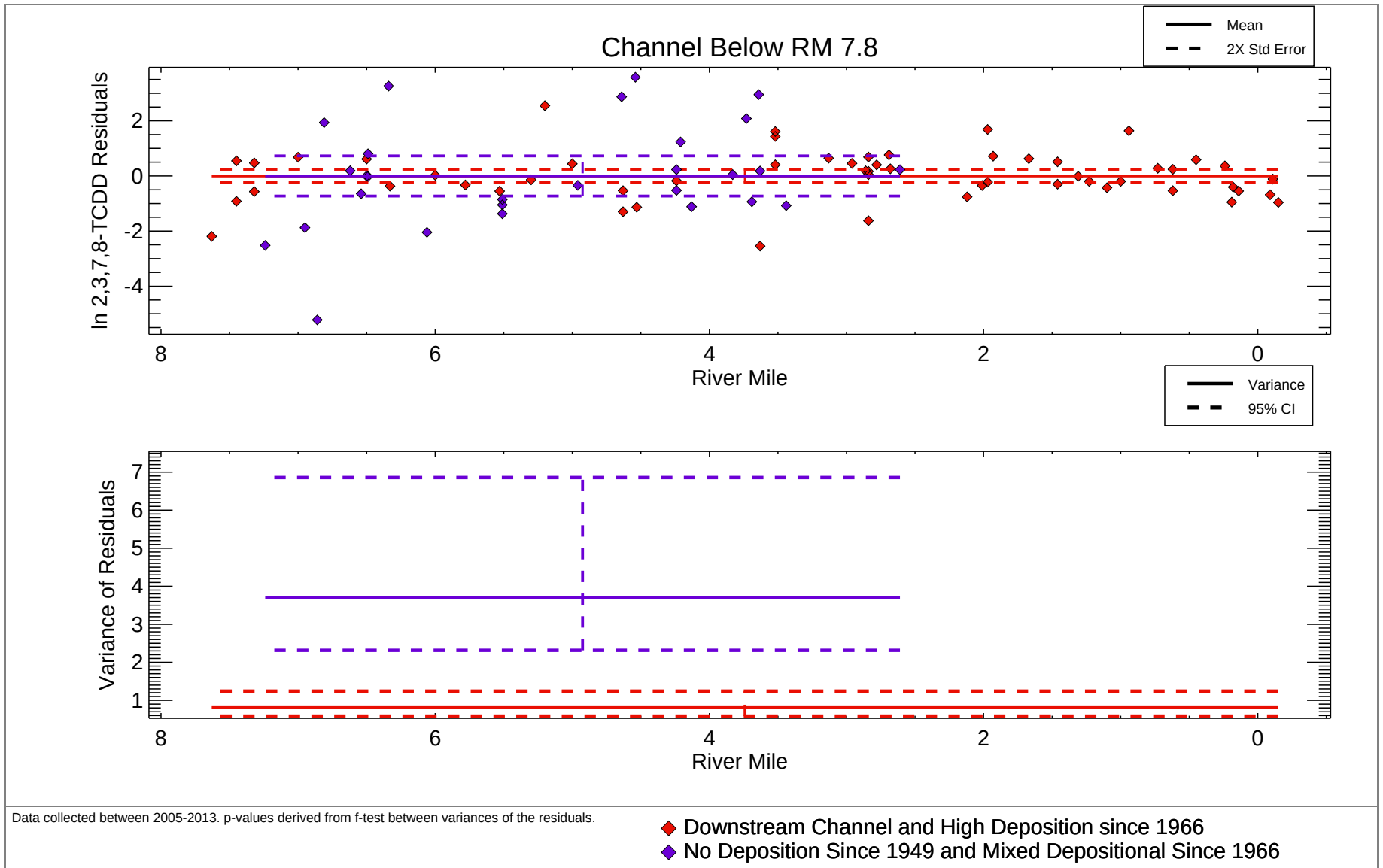
Figure 5-6d

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

◆ Downstream Channel and High Deposition since 1966
◆ No Deposition Since 1949 and Mixed Depositional Since 1966

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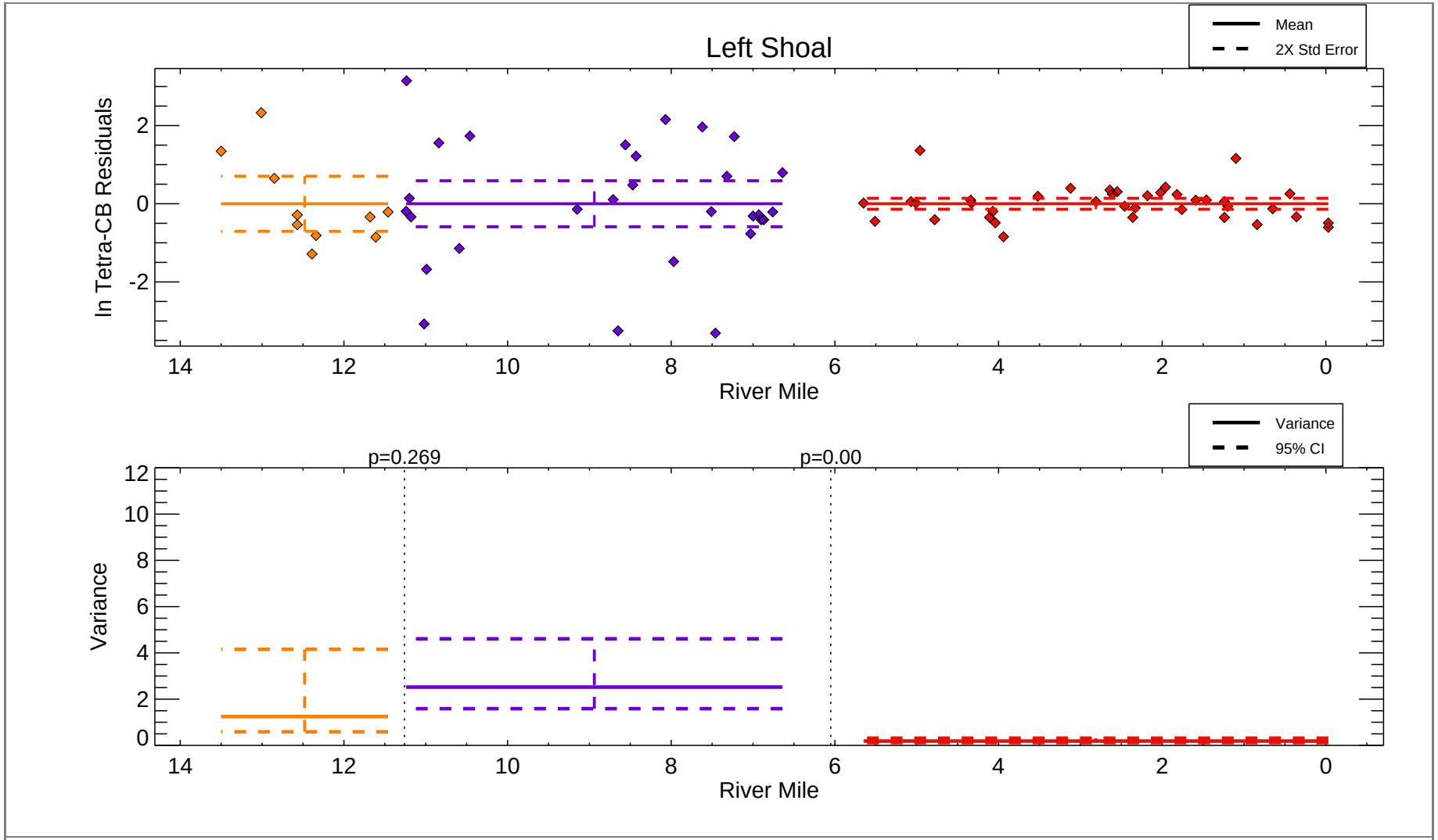
Figure 5-6e

Surface Sediment 2,3,7,8-TCDD Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

- Left Shoal RM 0-6
- Left Shoal RM 6-11.3
- Left Shoal RM 11.3-14.4

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Figure 5-7a

Surface Sediment Tetra-CB Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

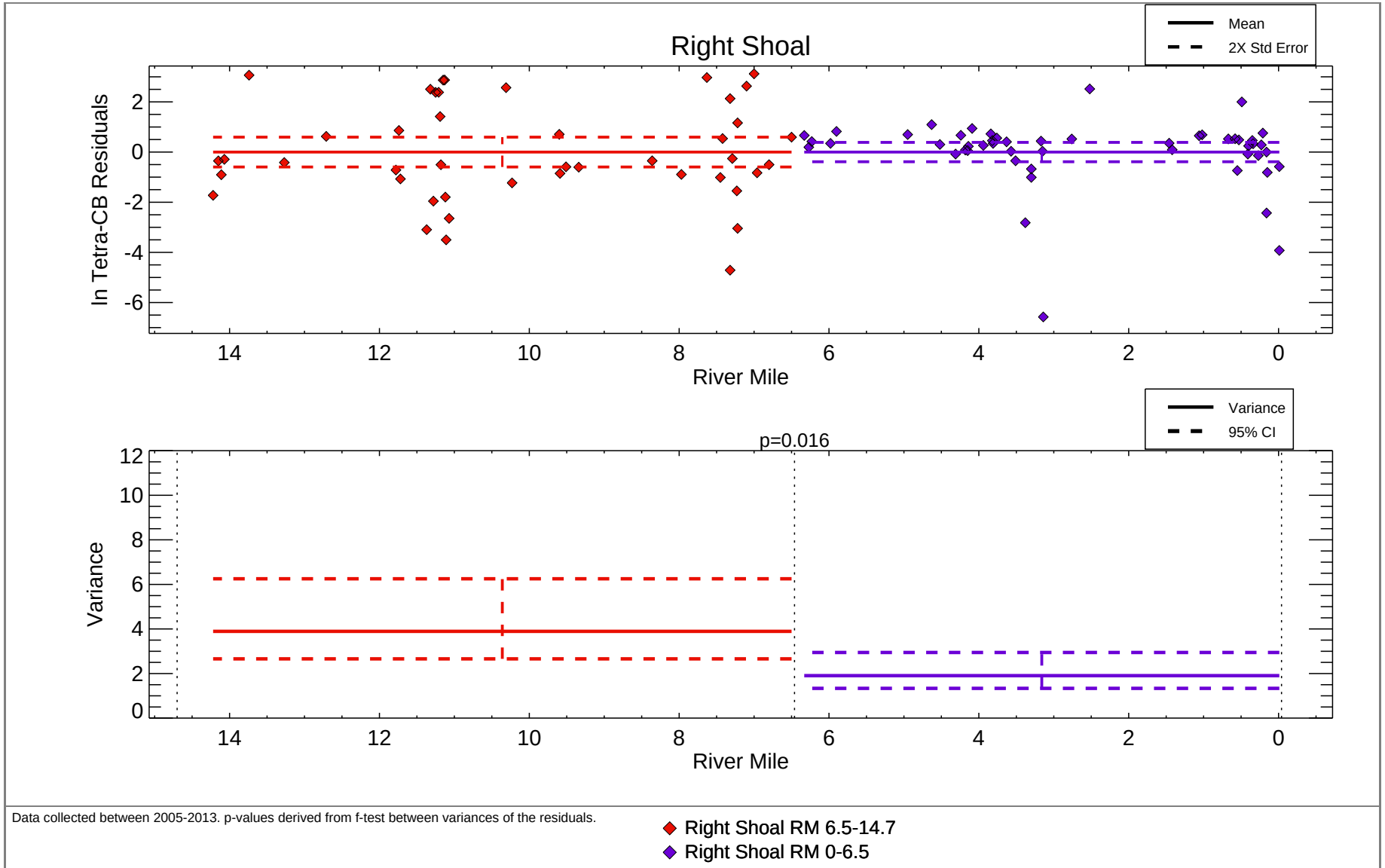

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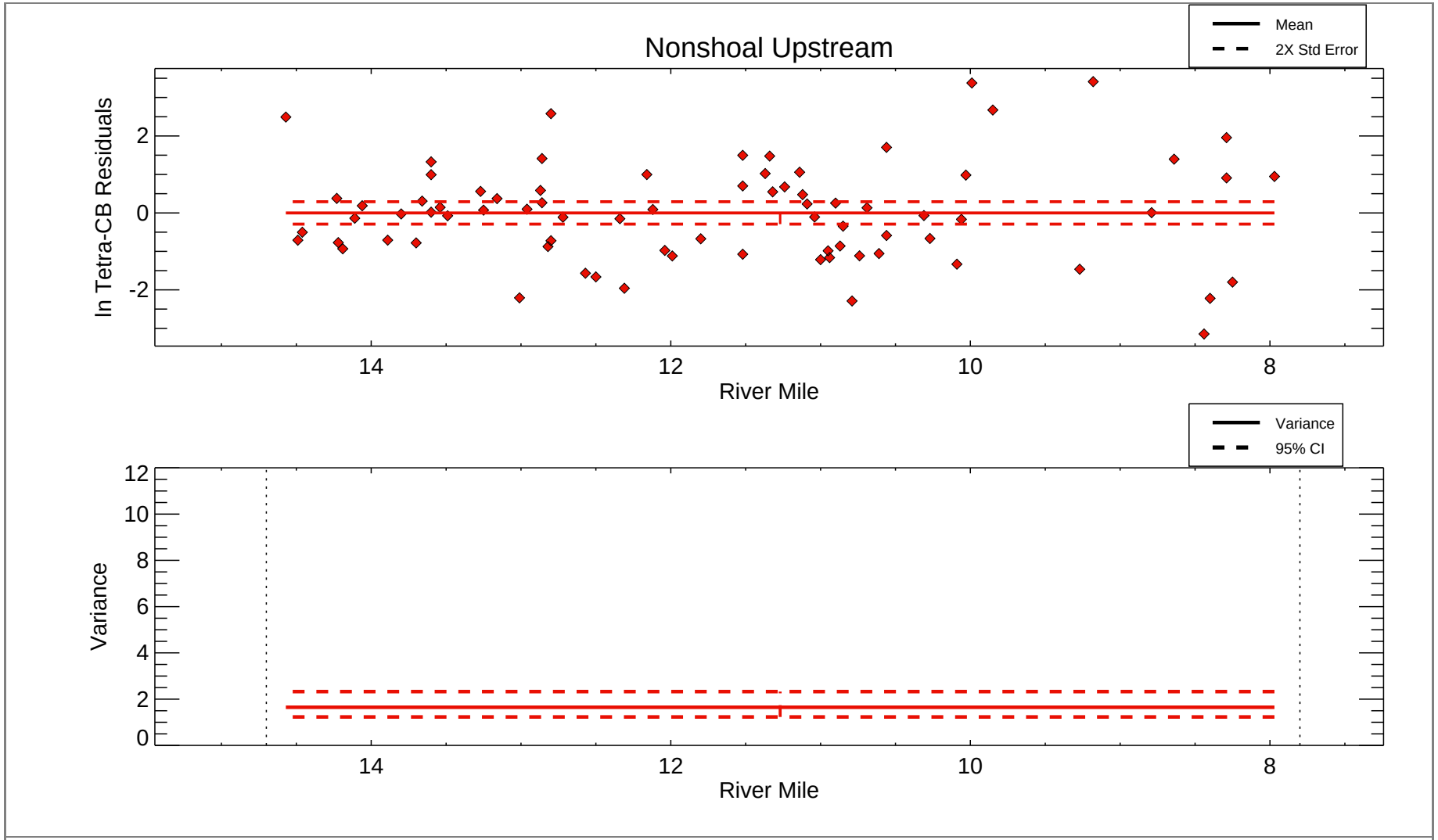
Figure 5-7b

Surface Sediment Tetra-CB Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

Upstream Channel

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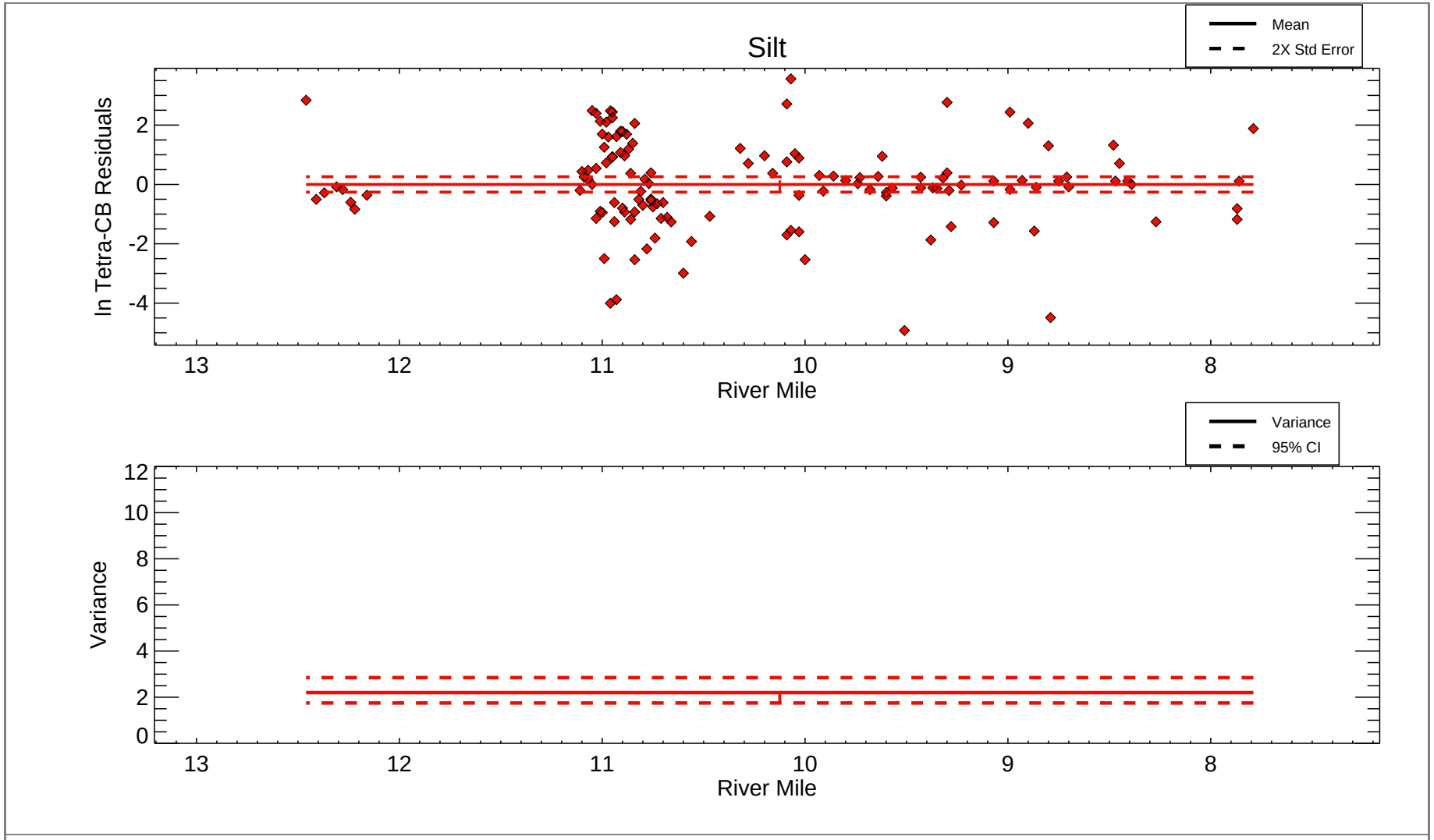
File Path: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_5_7_plot_te_pcb_spatials_by_vgroups.pro

Figure 5-7c

Surface Sediment Tetra-CB Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

◆ Silt

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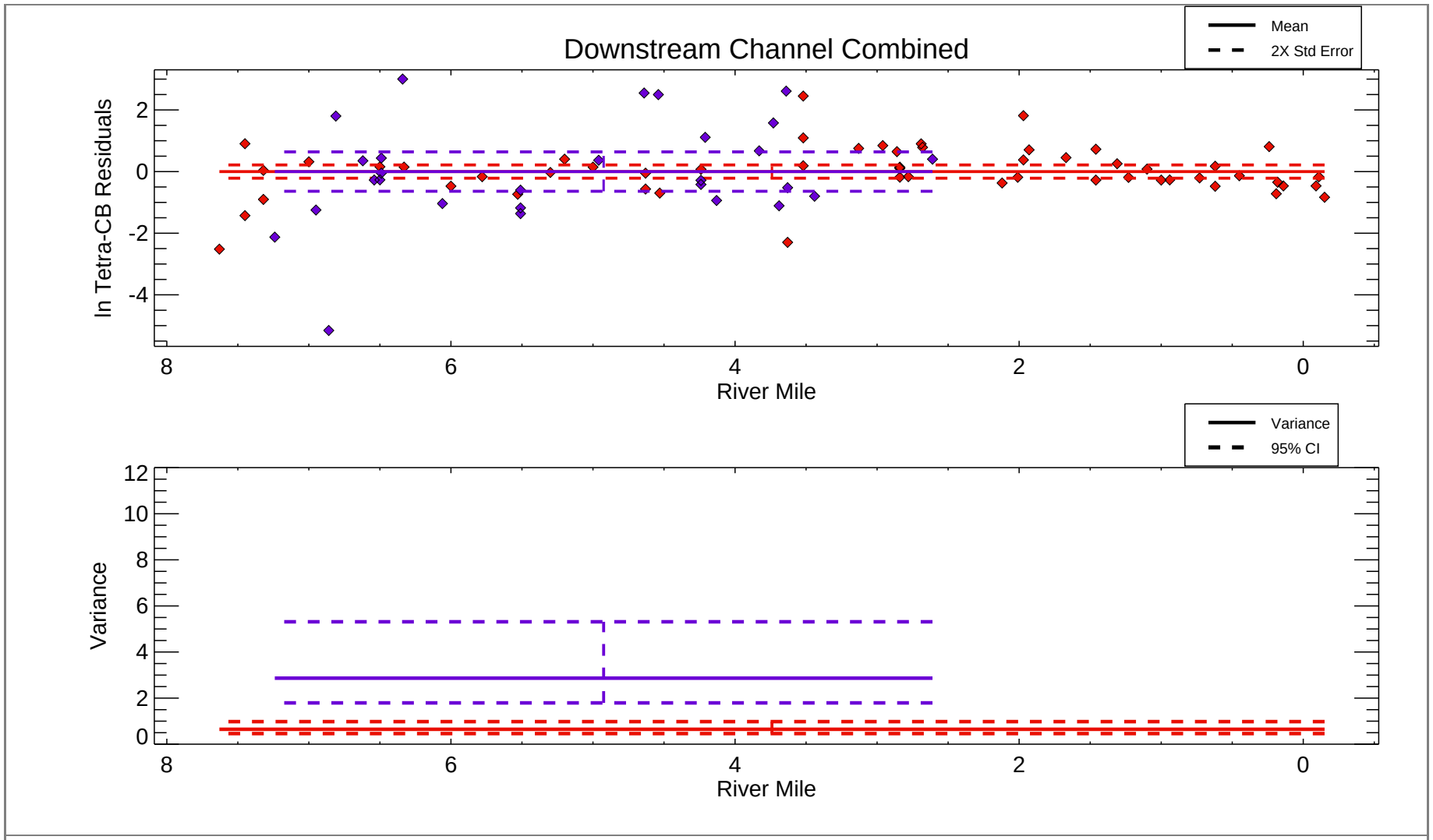
Figure 5-7d

Surface Sediment Tetra-CB Concentration vs River Mile by Kriging Group (vgroup)

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Data collected between 2005-2013. p-values derived from f-test between variances of the residuals.

◆ Downstream Channel and High Deposition since 1966
◆ No Deposition Since 1949 and Mixed Depositional Since 1966

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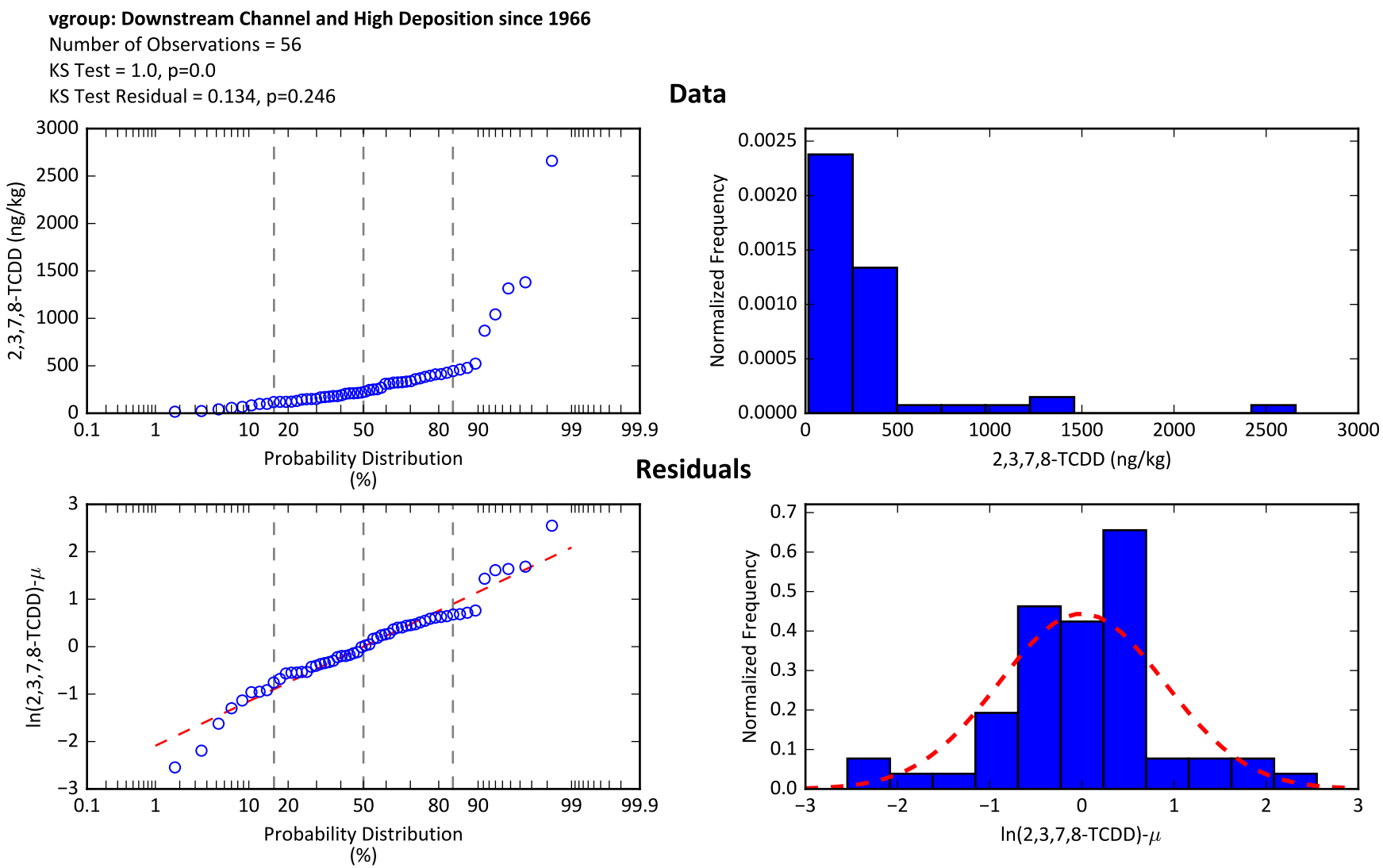
Figure 5-7e

Surface Sediment Tetra-CB Concentration vs River Mile by Kriging Group (vgroup)

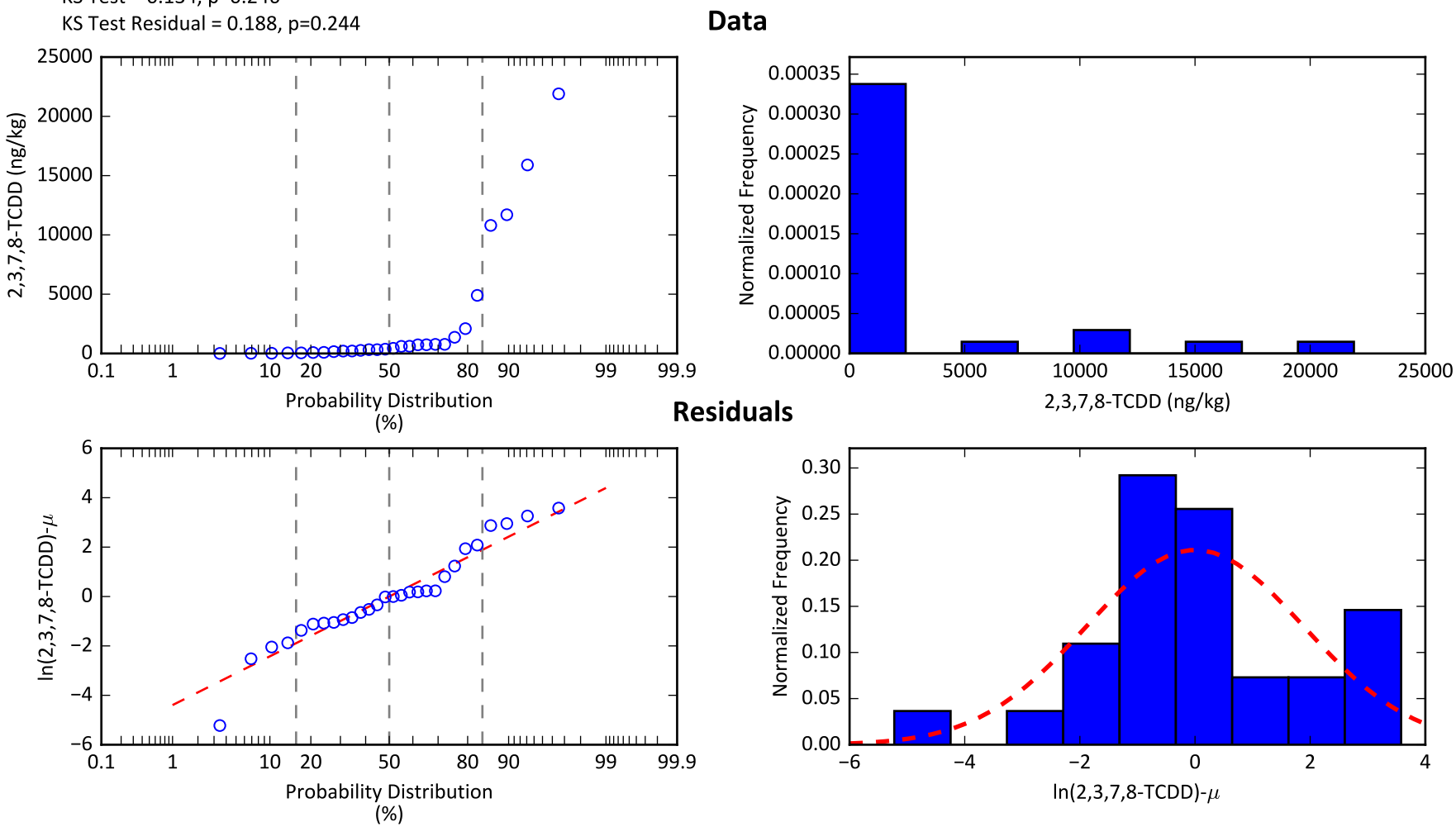
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

Publish Date: 06/19/2019 10:46 AM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-8_ProbPlot_Hist_Data_Residuals.py

Figure 5-8a
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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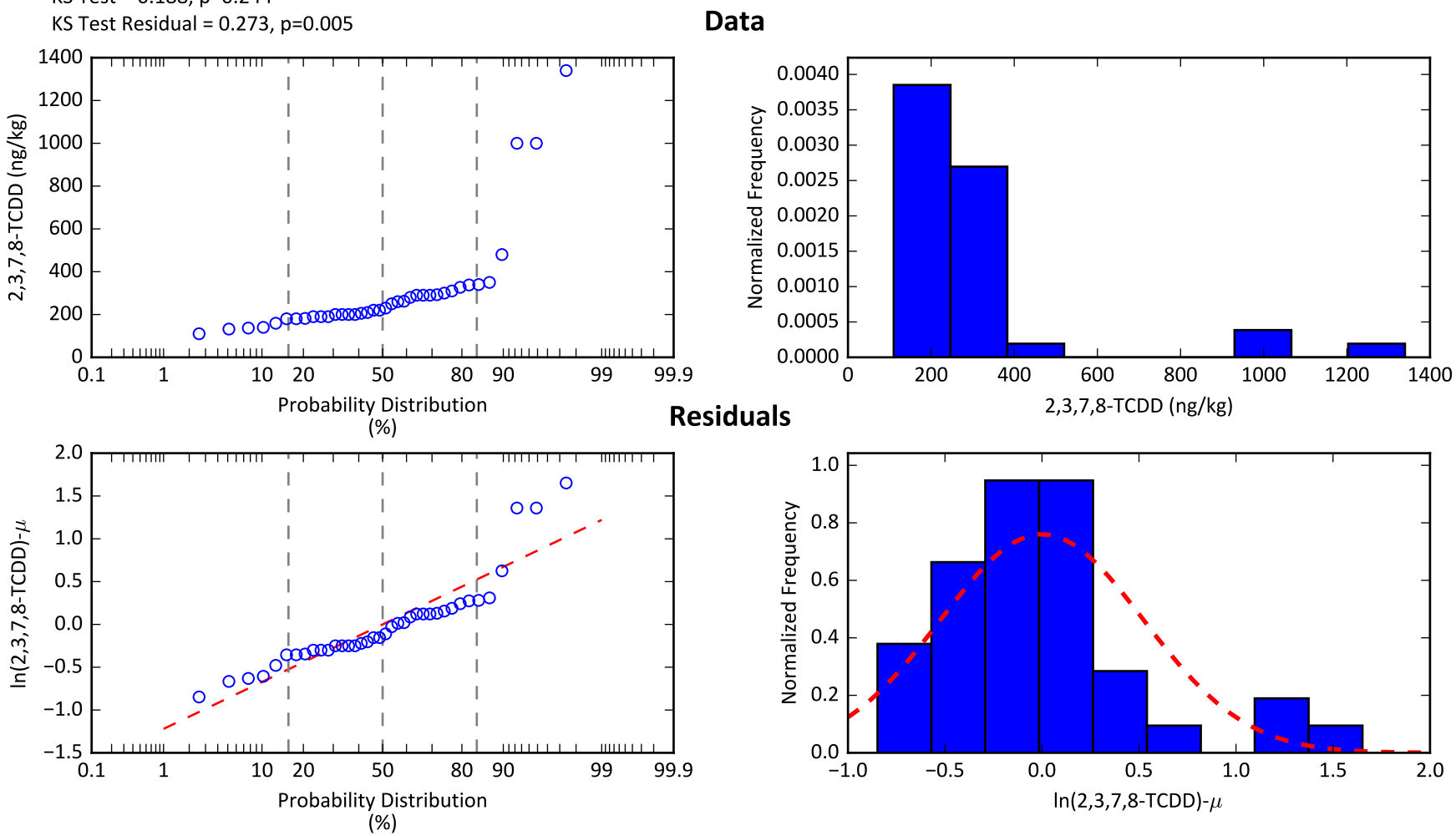
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-8_ProbPlot_Hist_Data_Residuals.py

Figure 5-8b
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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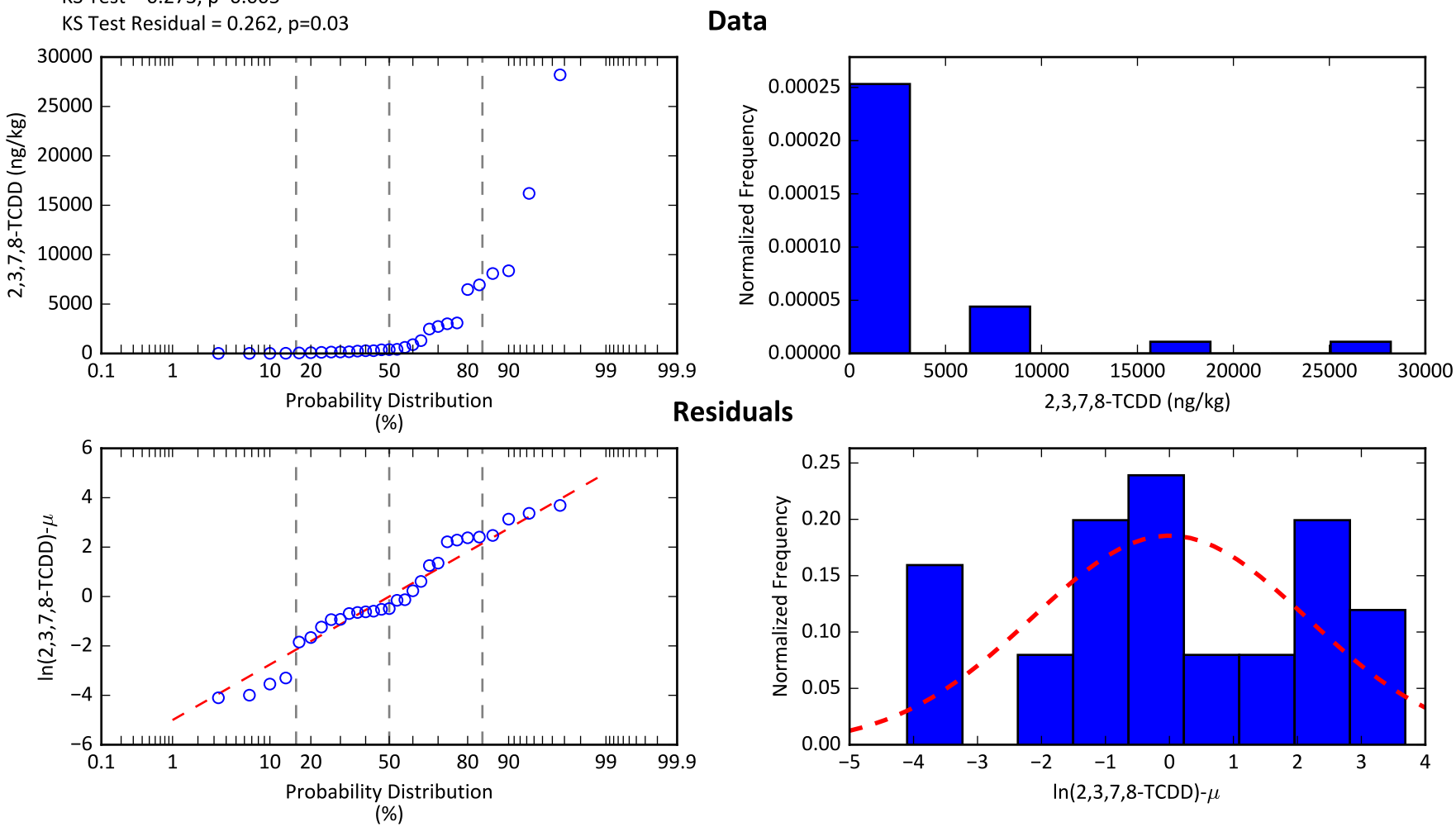
Figure 5-8c
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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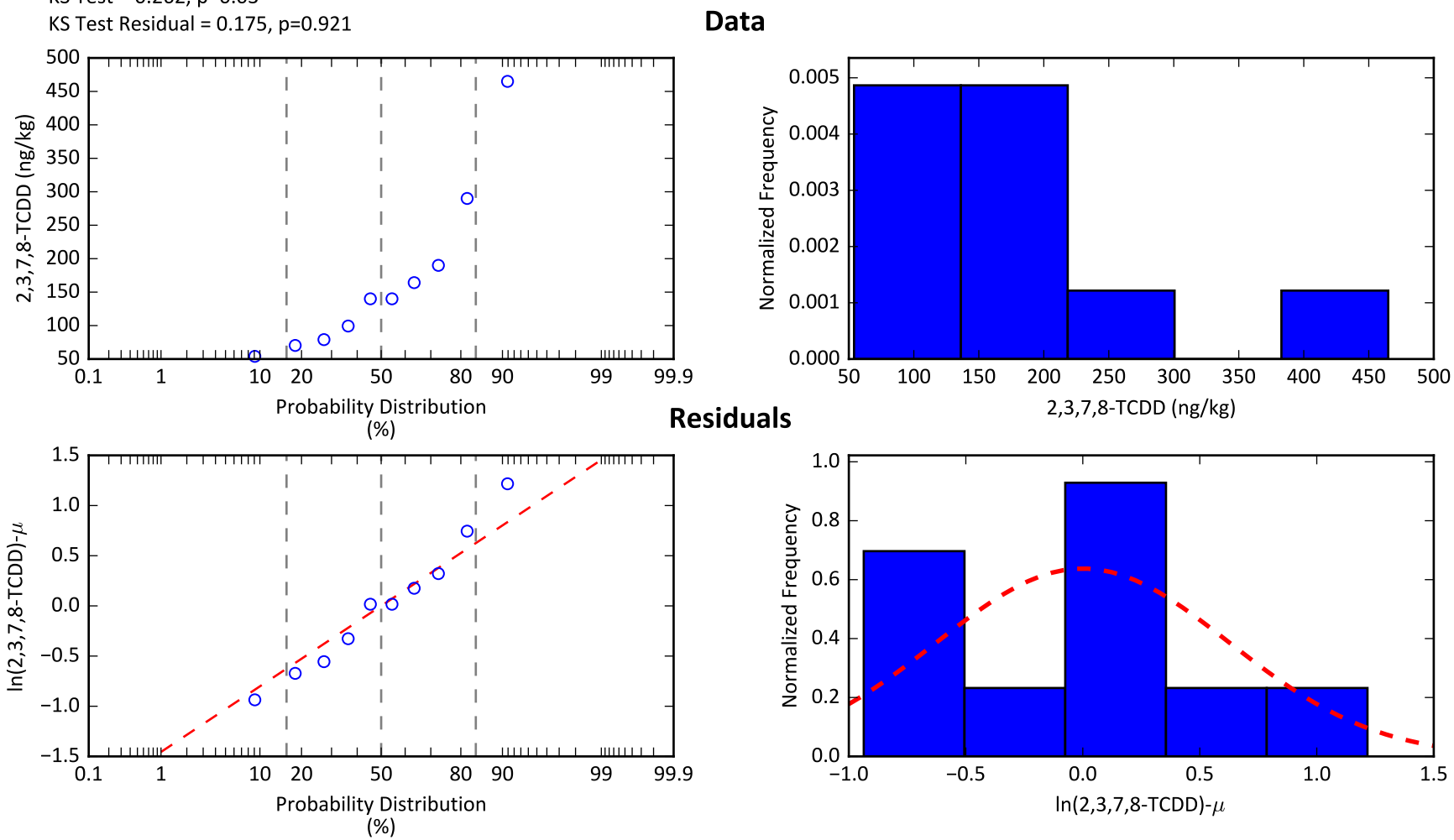
Figure 5-8d
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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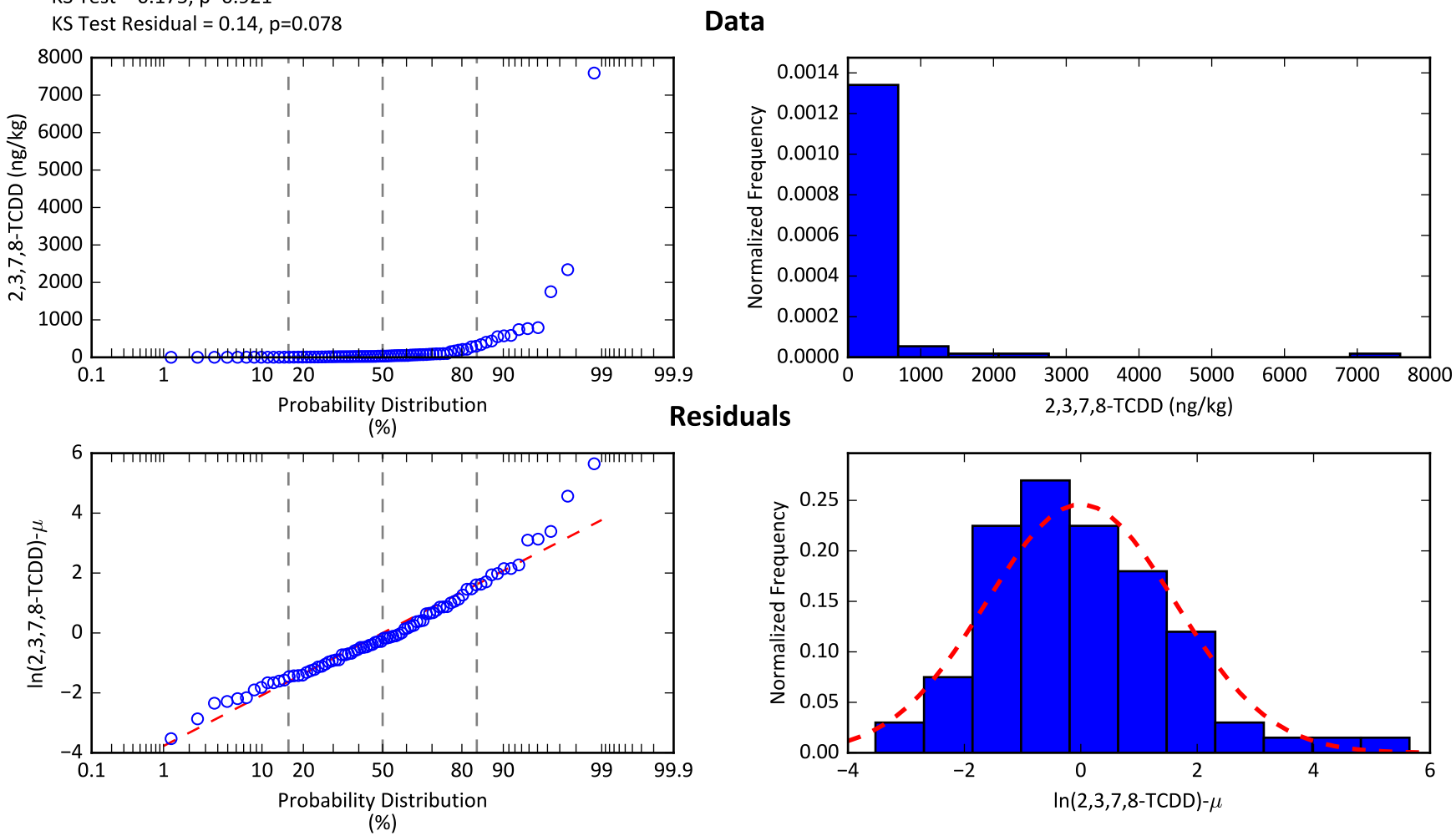
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-8_ProbPlot_Hist_Data_Residuals.py

Figure 5-8e
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

Publish Date: 06/19/2019 10:46 AM | User: GD
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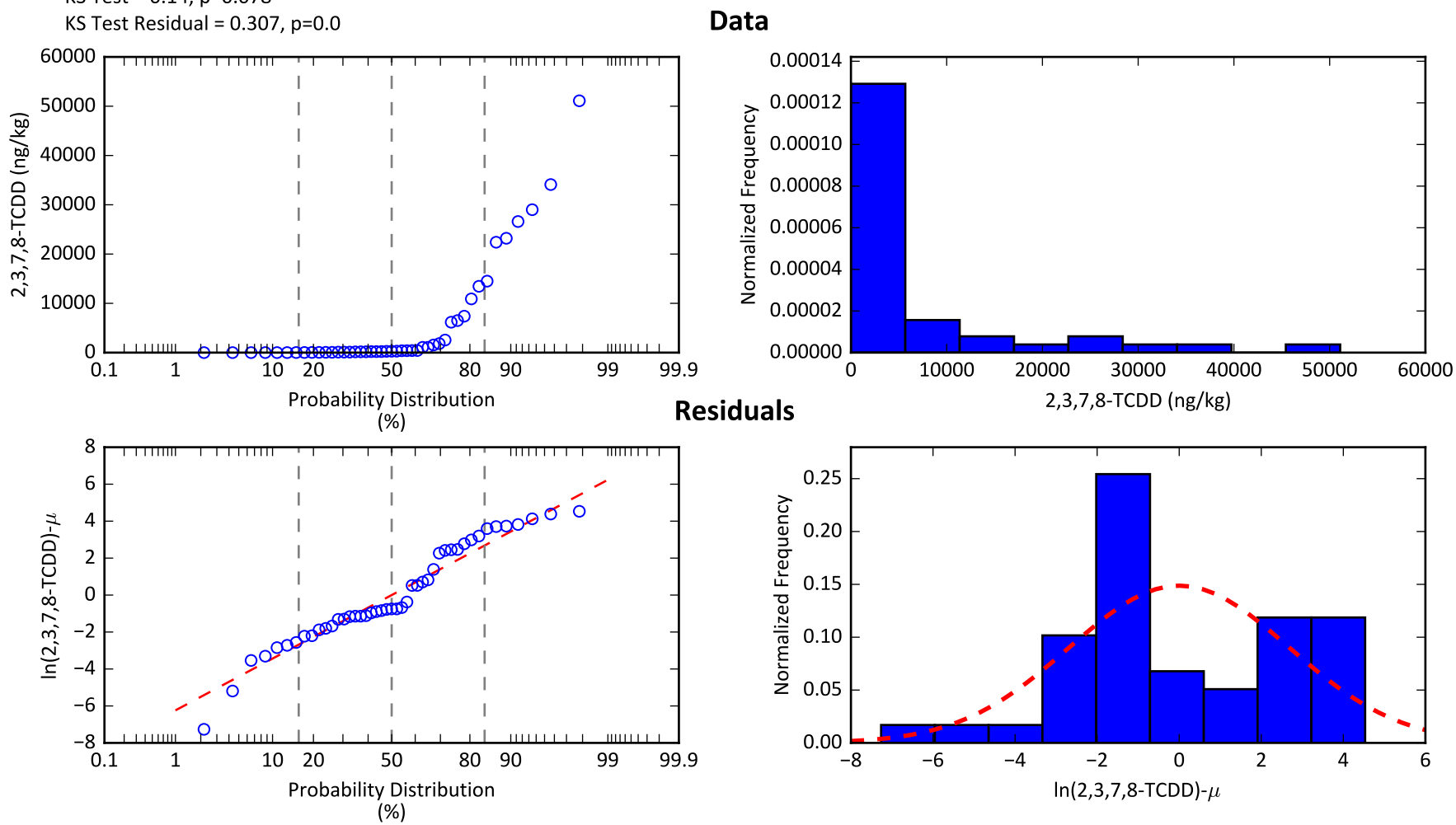
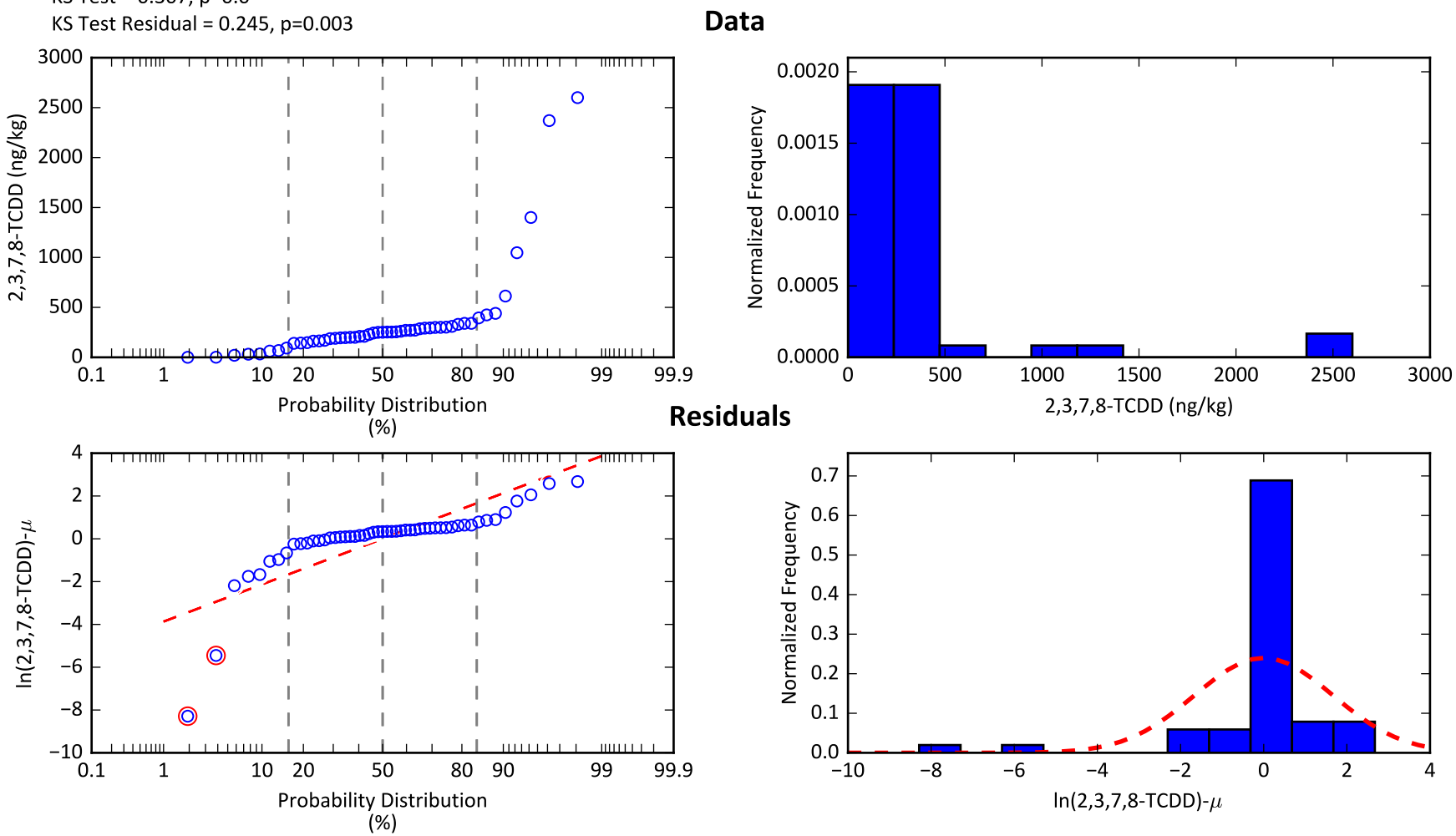
Figure 5-8f
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

Publish Date: 06/19/2019 10:46 AM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-8_ProbPlot_Hist_Data_Residuals.py

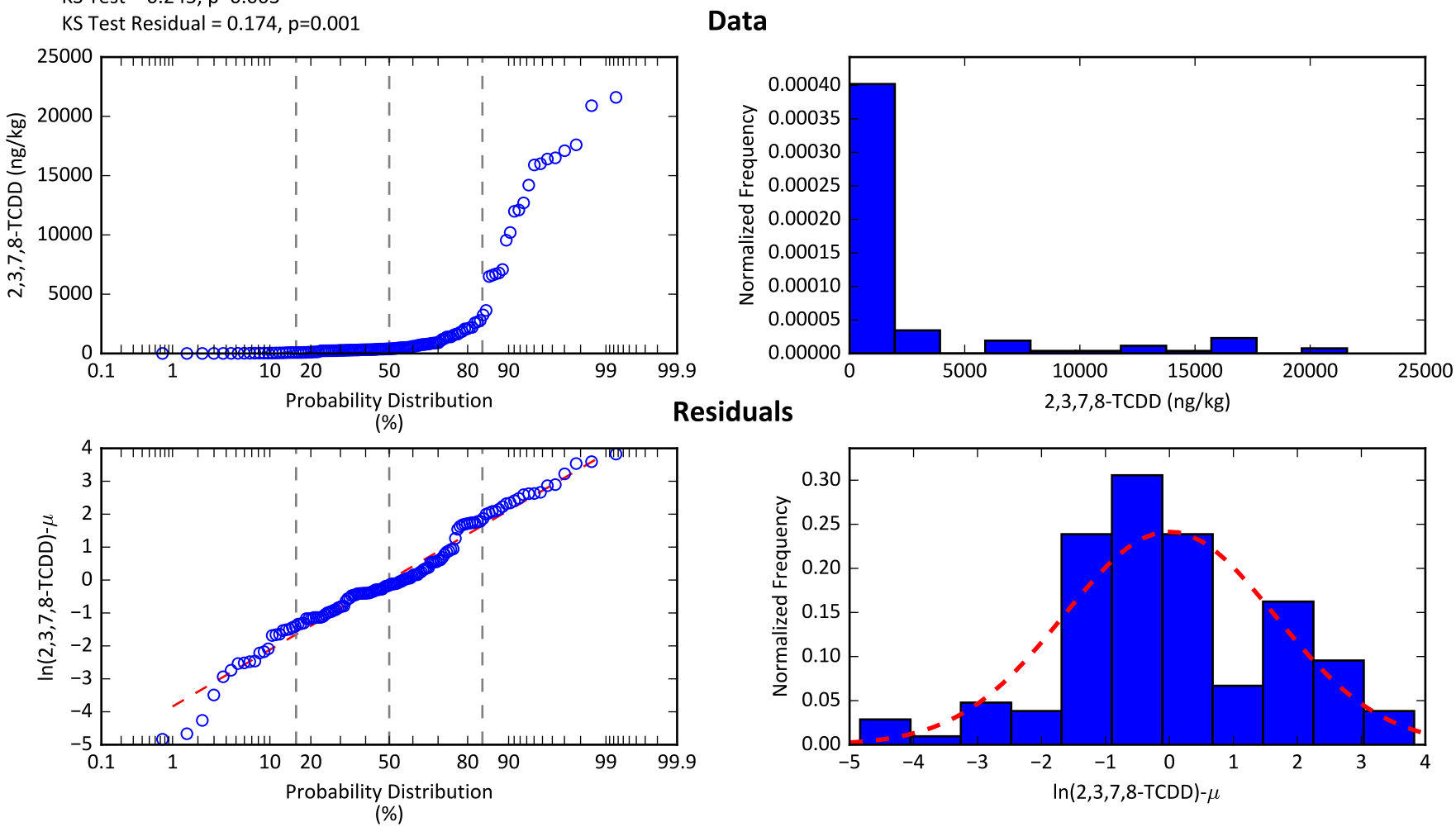
Figure 5-8g
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: The two circled points (CLRC-002 and 12A-0421) were removed from the distribution prior to calculating the variance that was used to scale the variogram.
Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

Publish Date: 06/19/2019 10:47 AM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-8_ProbPlot_Hist_Data_Residuals.py

Figure 5-8h
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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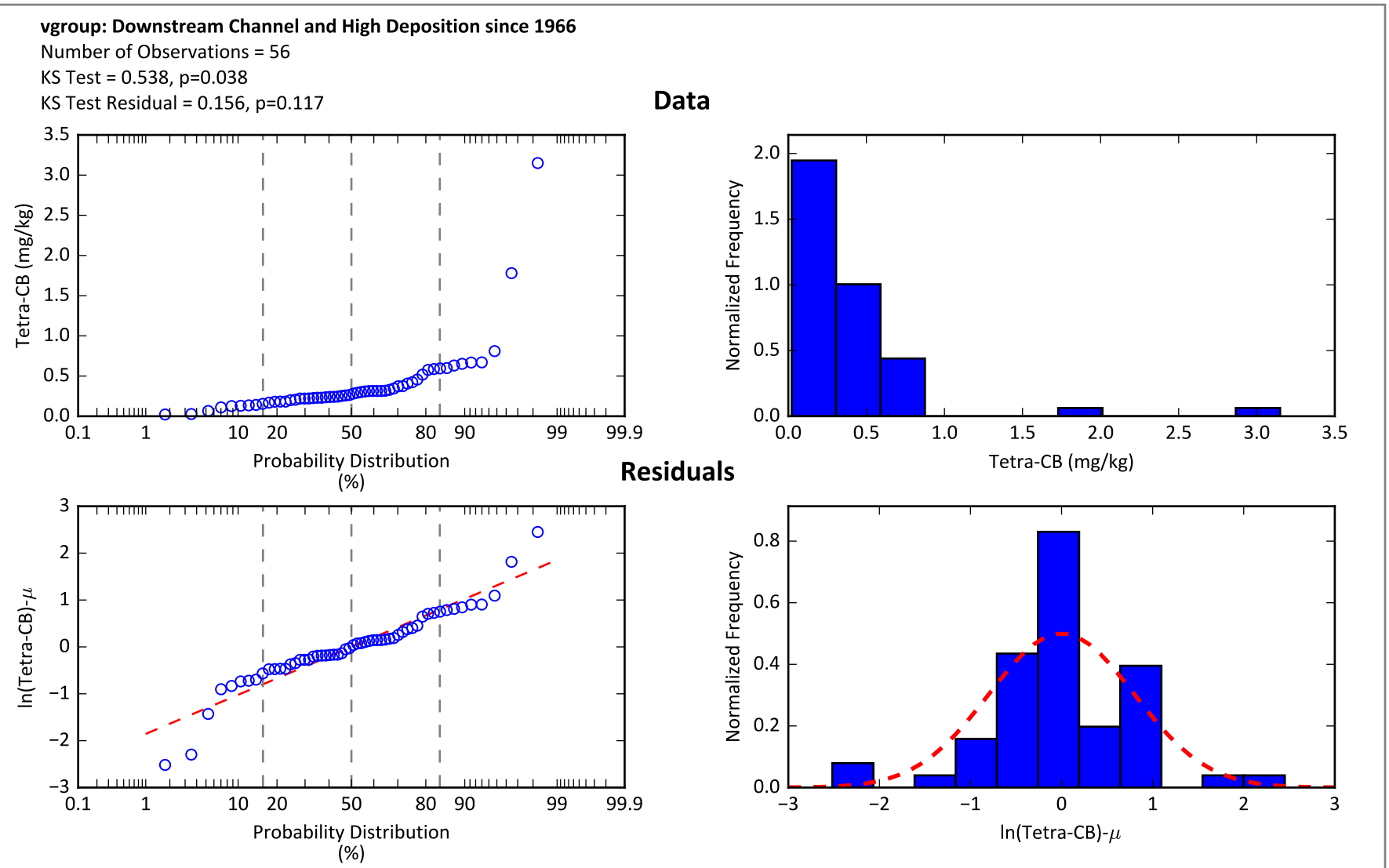
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-8_ProbPlot_Hist_Data_Residuals.py

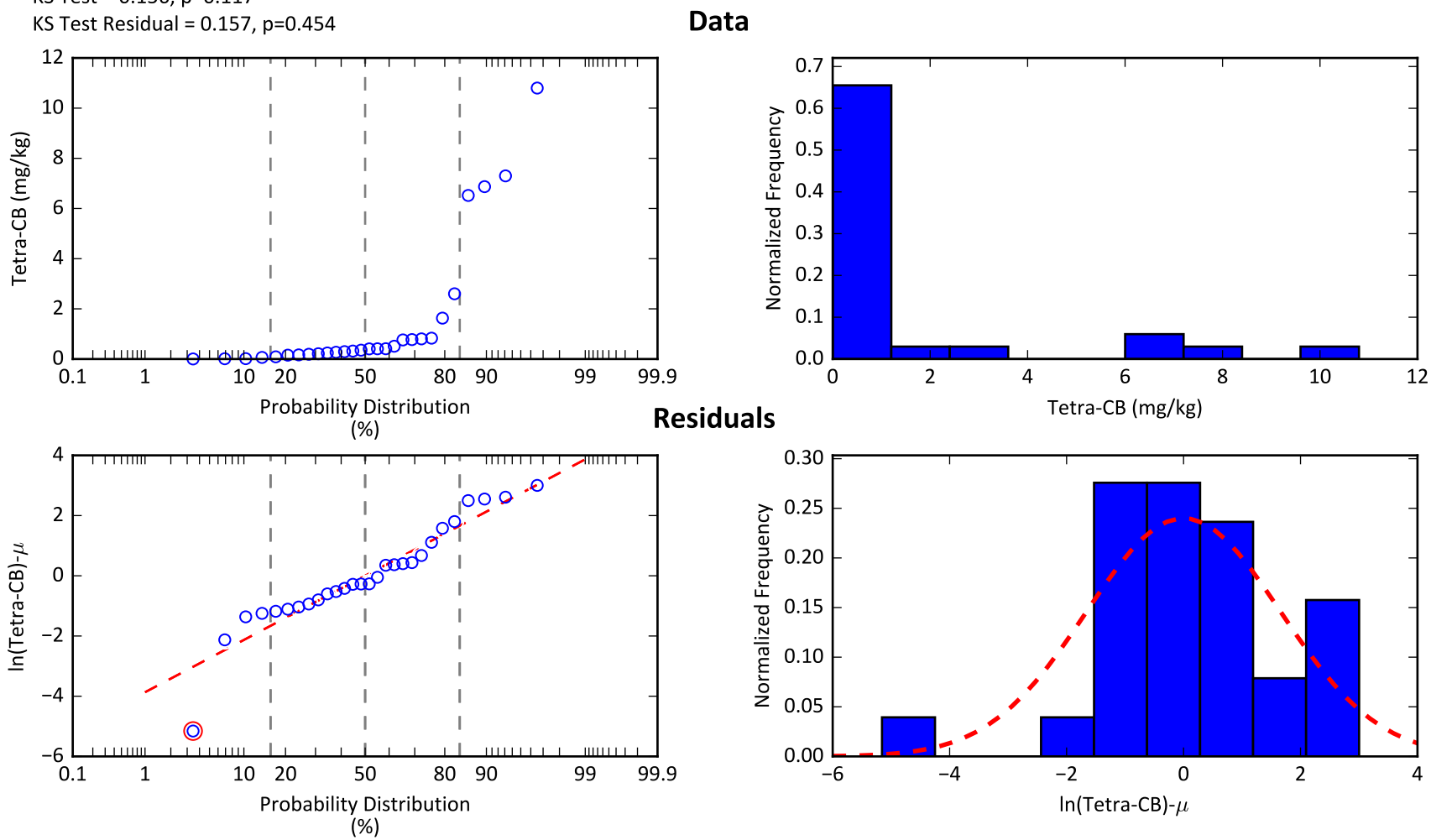
Figure 5-8i
Distribution of 2,3,7,8-TCDD by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

Publish Date: 06/19/2019 11:05 AM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-9_TePCB_ProbPlot_Hist_Data_Residuals.py

Figure 5-9a
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: The circled point (12A-0455) was removed from the distribution prior to calculating the variance that was used to scale the variogram.
Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

Publish Date: 06/19/2019 11:05 AM | User: GD
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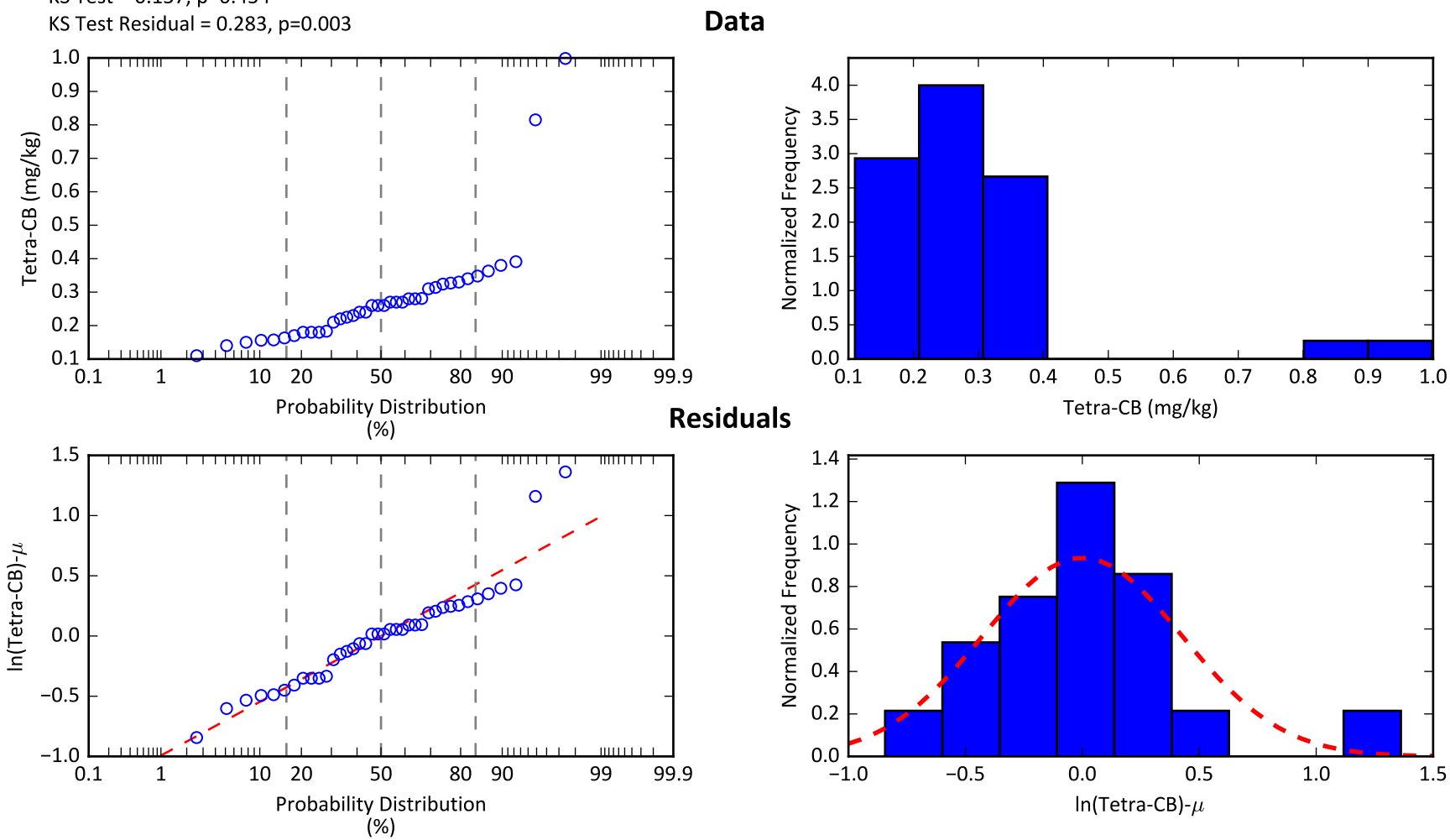
Figure 5-9b
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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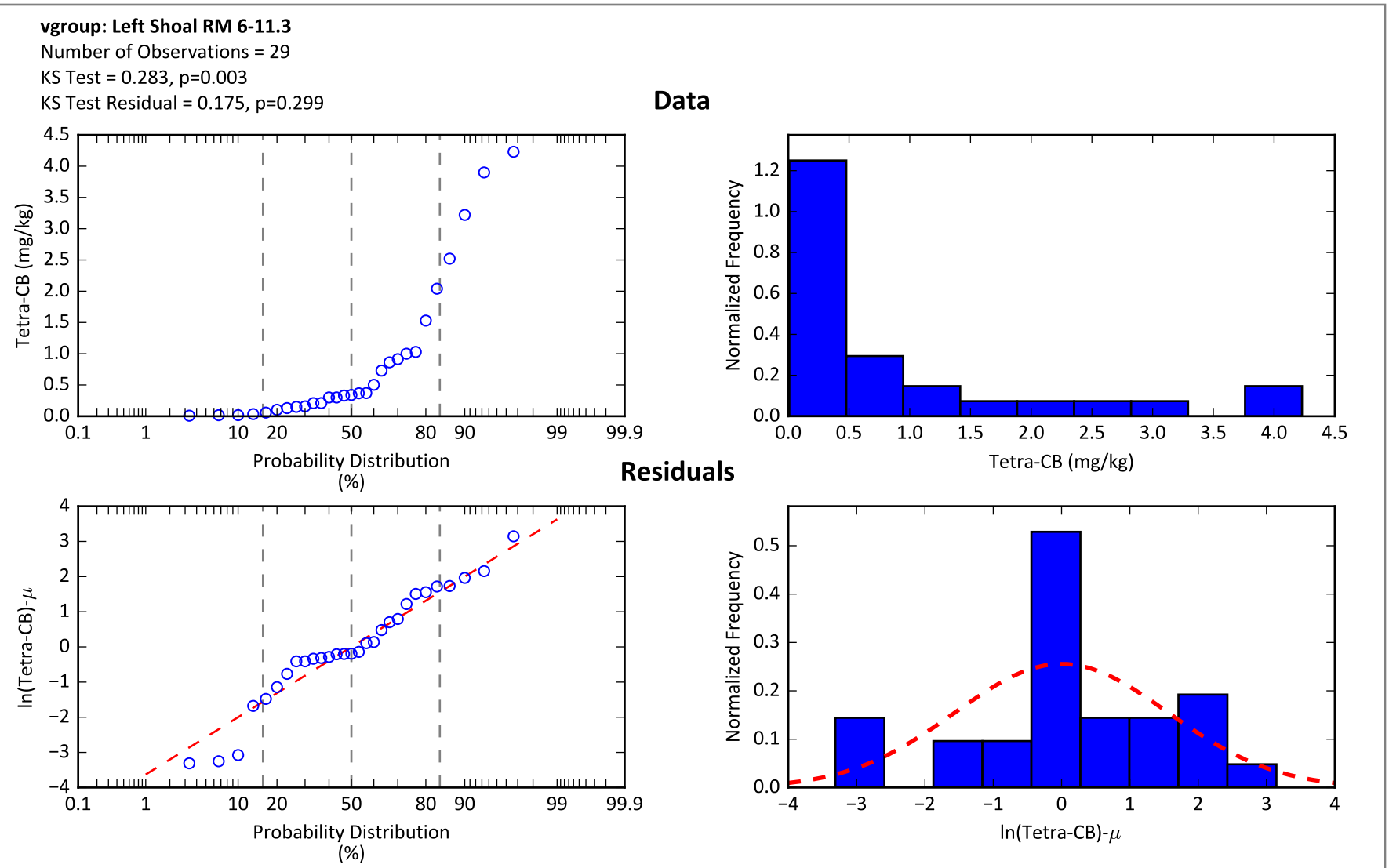
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_5-9_TePCB_ProbPlot_Hist_Data_Residuals.py

Figure 5-9c
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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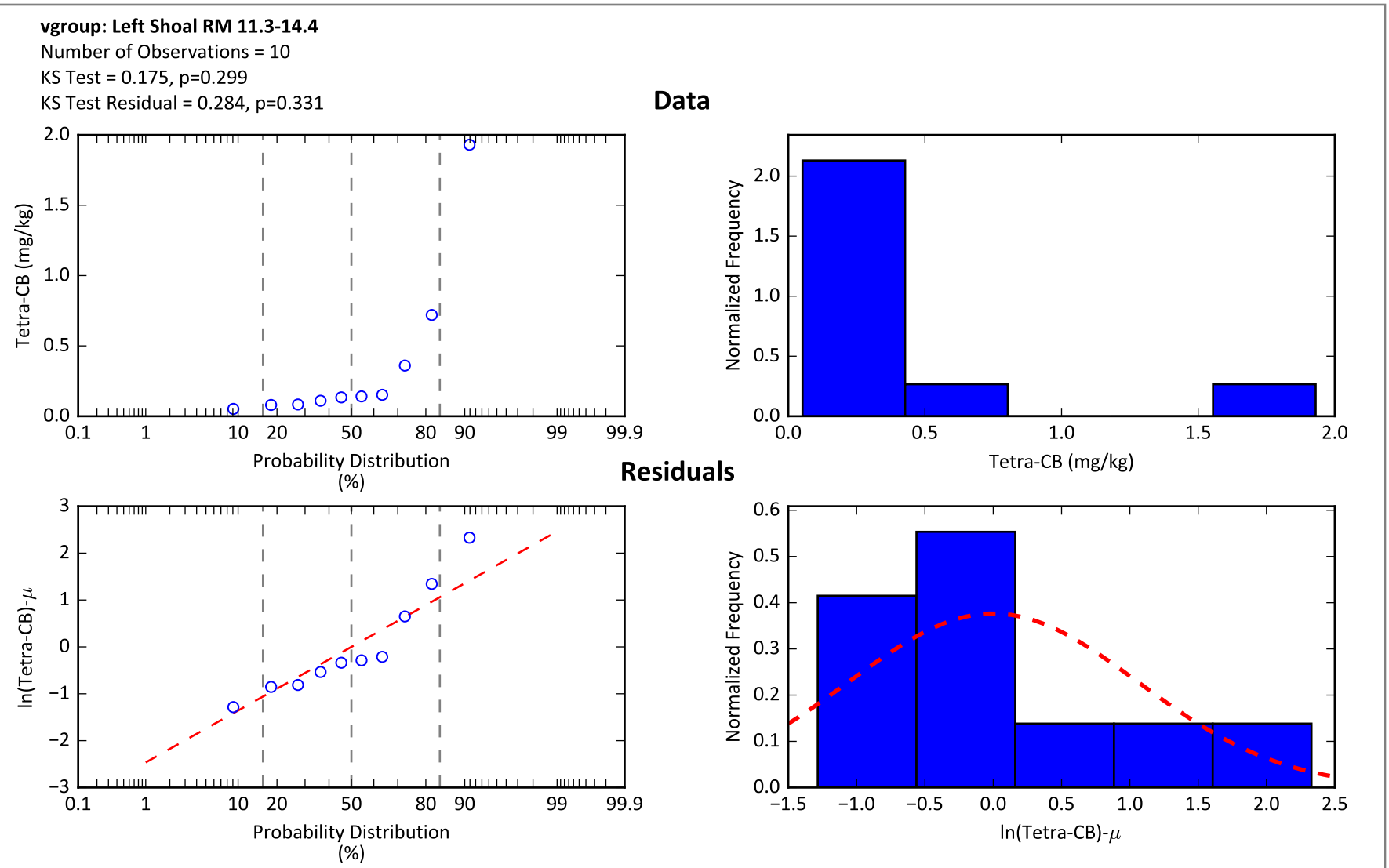
Figure 5-9d
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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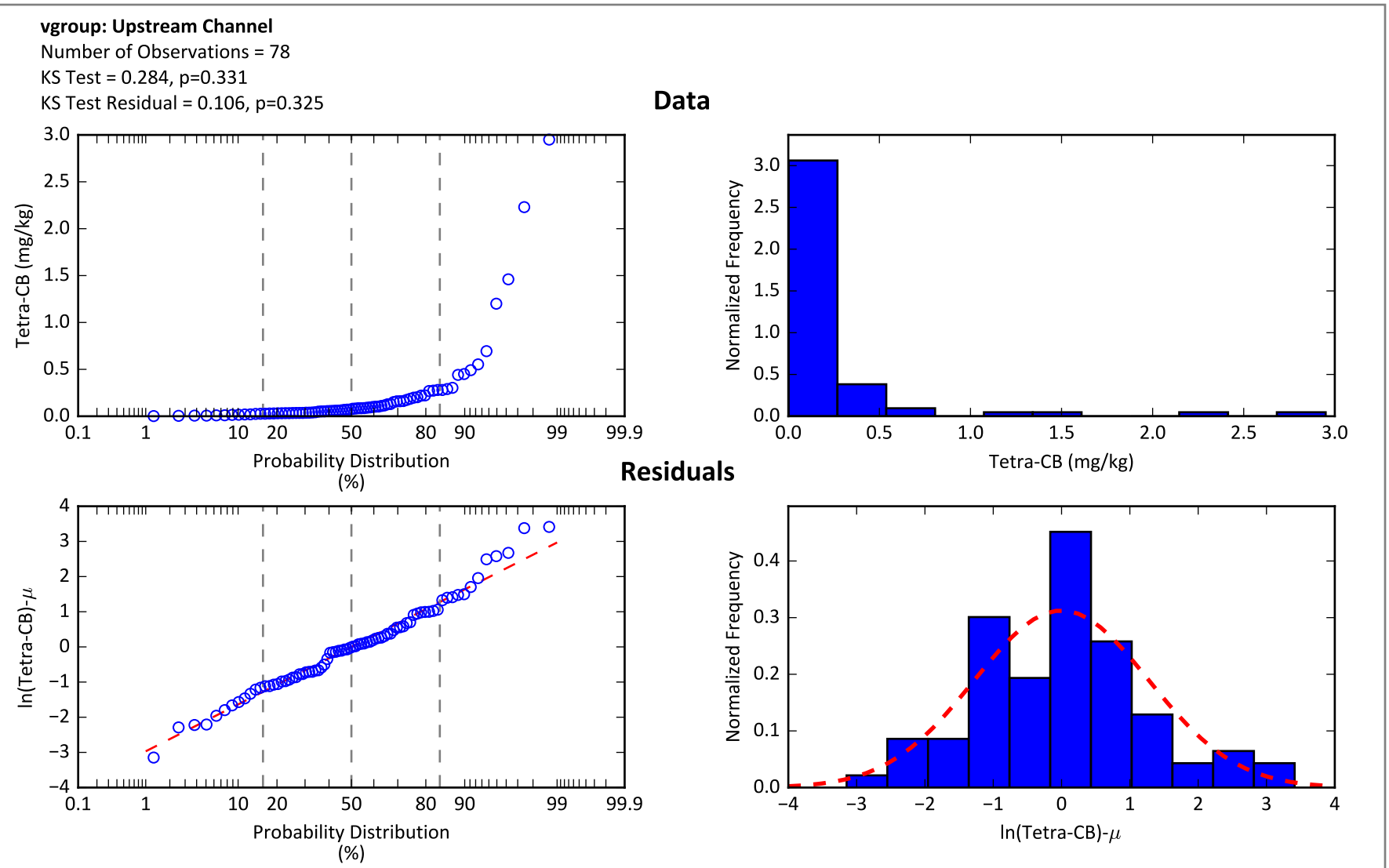
Figure 5-9e
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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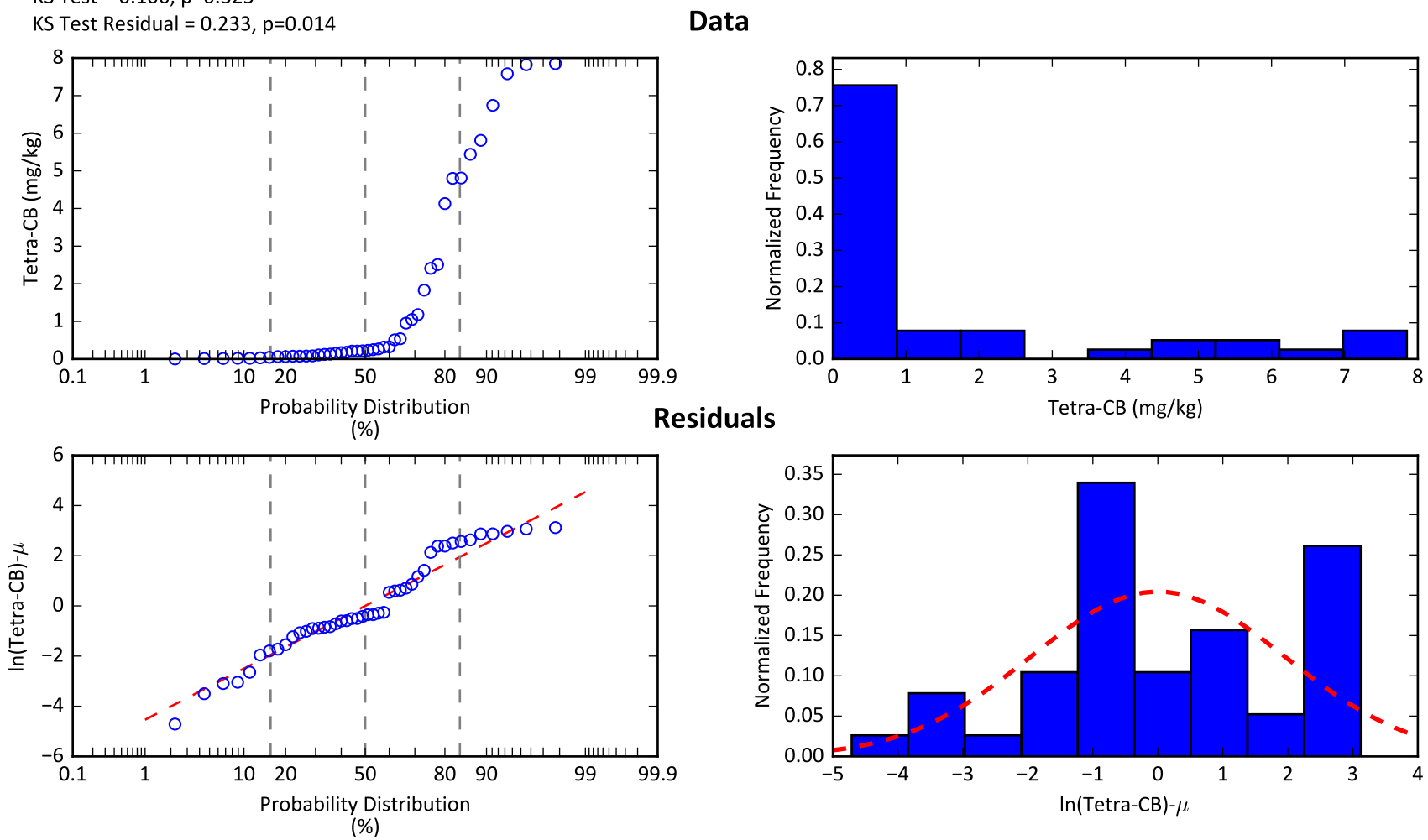
Figure 5-9f
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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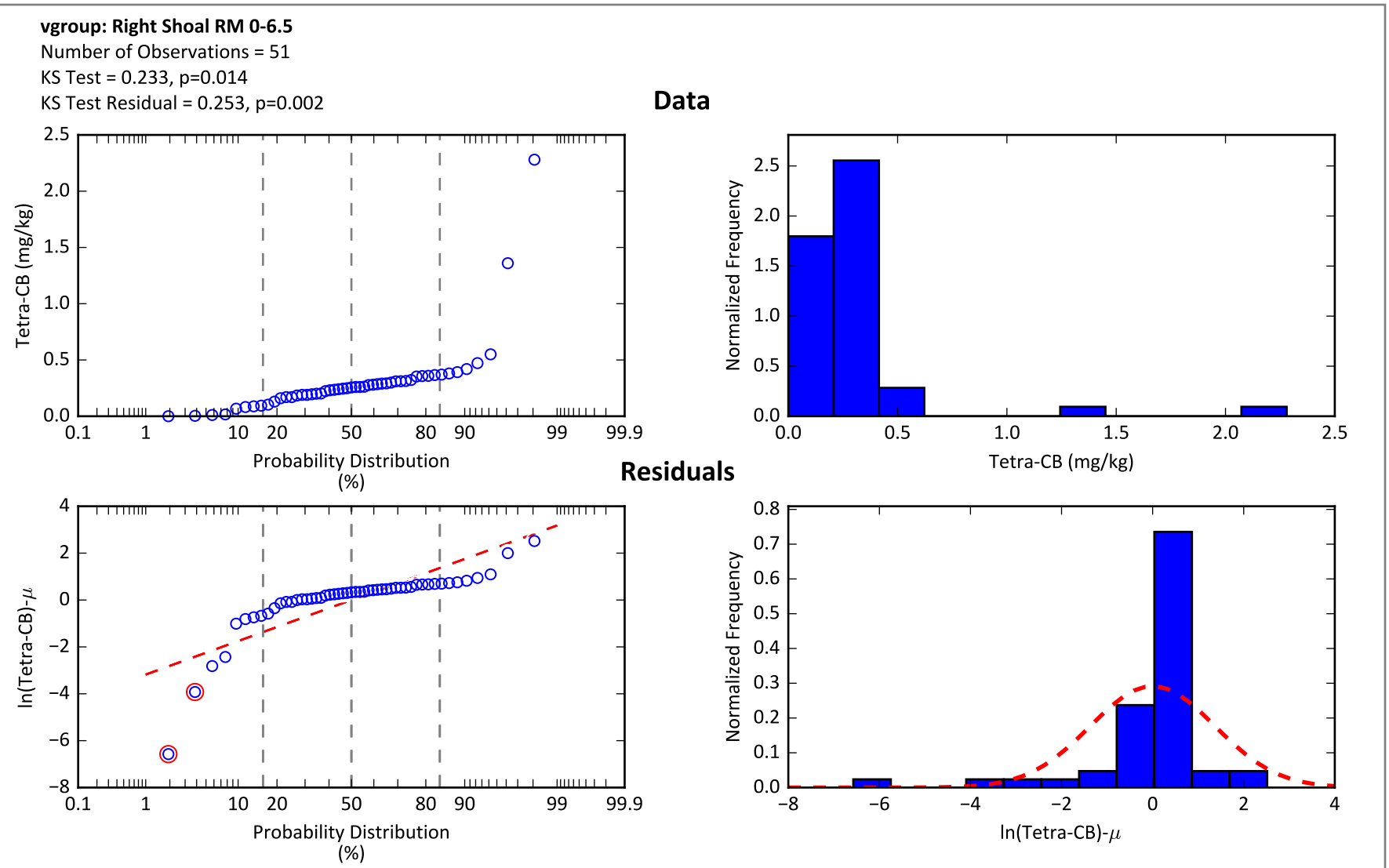
Figure 5-9g
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes: The two circled points (CLRC-002 and 12A-0421) were removed from the distribution prior to calculating the variance that was used to scale the variogram.
Red dashed line represents a normal distribution with the same mean and standard deviation as the residuals.
μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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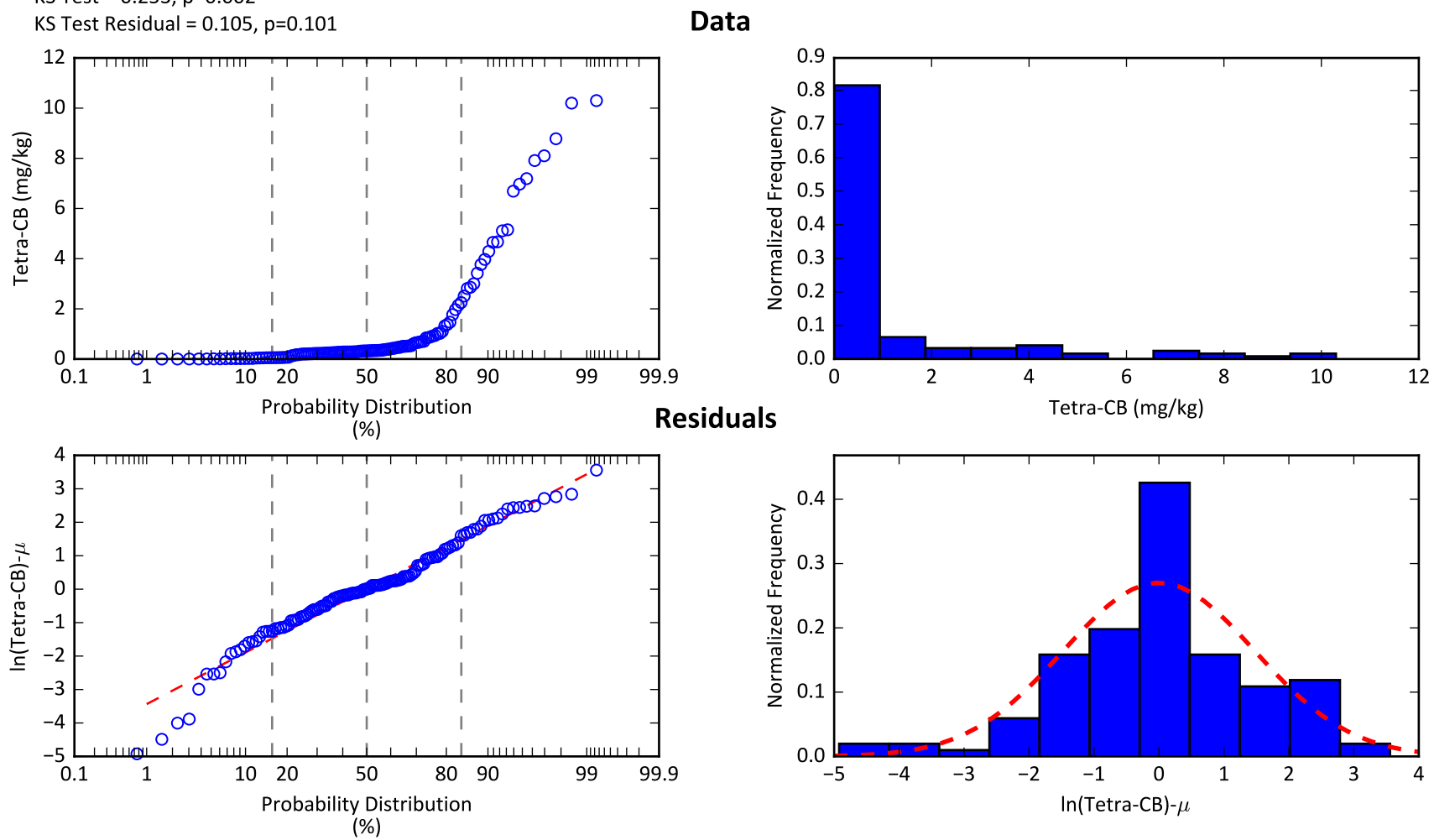
Figure 5-9h
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



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μ is the mean log concentration of the mgroup for each data point. KS Test = Kolmogorov-Smirnov Test

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Figure 5-9i
Distribution of Tetra-CB by vgroup
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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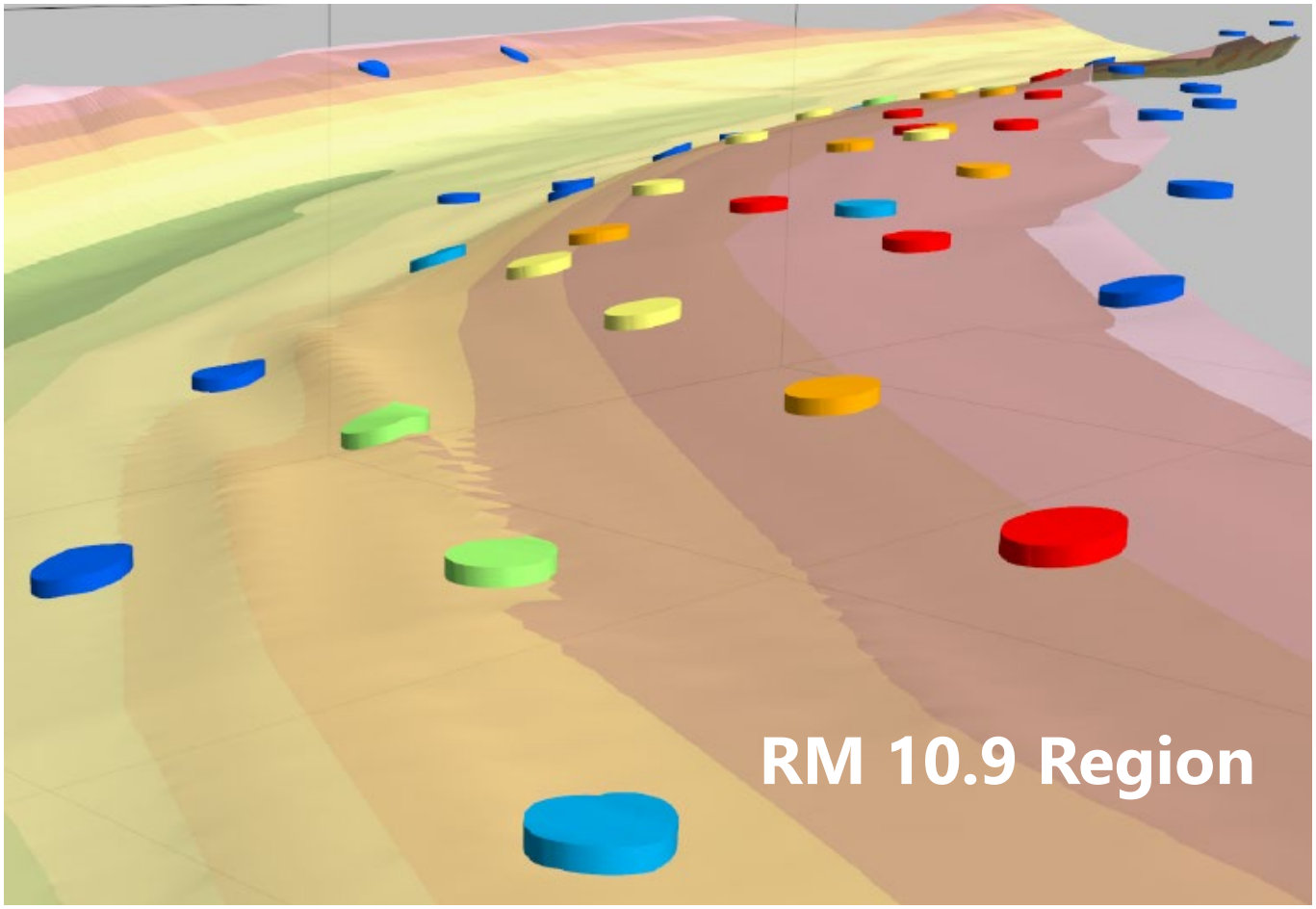
Figure 5-10
Surface Sediment 2,3,7,8-TCDD Data Used in RM 10.9 Silt Deposit Variogram
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

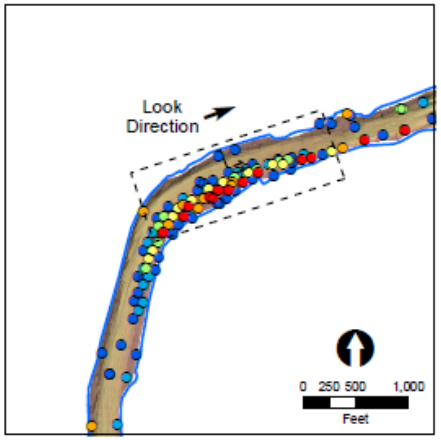


2,3,7,8-TCDD Concentrations (ng/kg)

- 0 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 3,000
- 3,001 - 10,000
- > 10,000

2004 Bathymetry in feet (NGVD29)

- 2.1 - 4
- 0.1 - 2
- -1.9 - 0
- -3.9 - -2
- -5.9 - -4
- -7.9 - -6
- -9.9 - -8
- -11.9 - -10
- -13.9 - -12
- -15.9 - -14
- -17.8 - -16



Vertical Exaggeration: 3X

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Figure 5-11a
Surface Sediment 2,3,7,8-TCDD Concentration and LPR Bathymetry
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

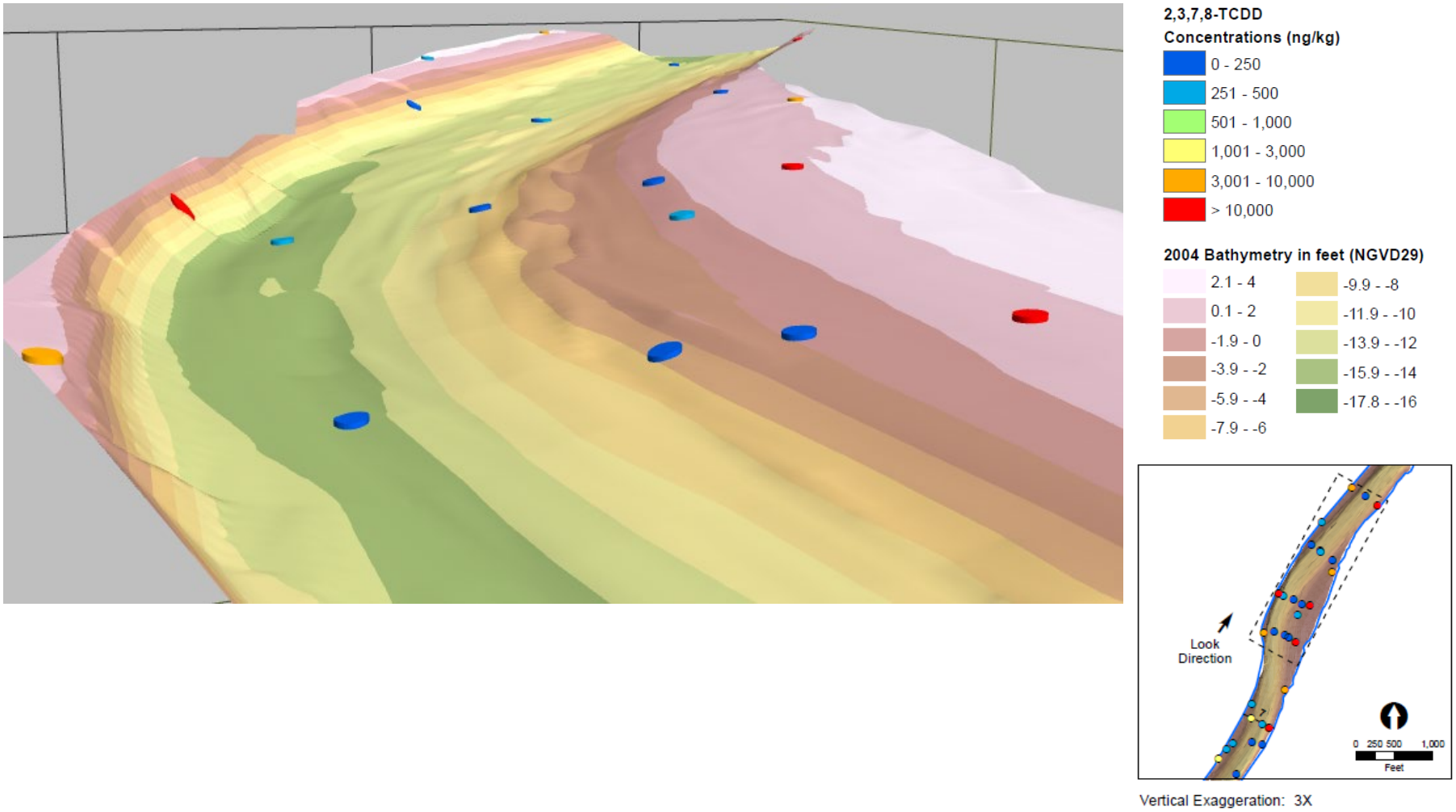

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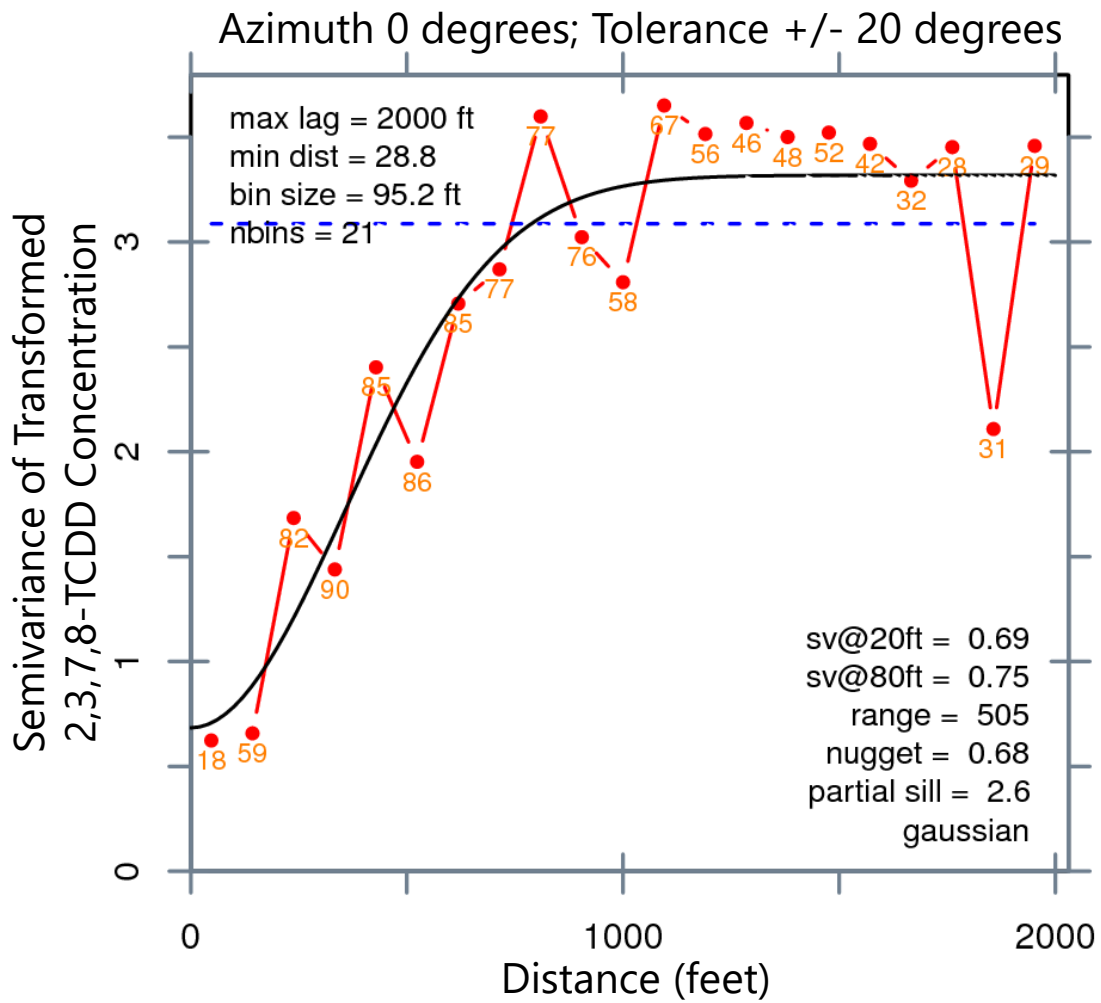
Figure 5-11b
Surface Sediment 2,3,7,8-TCDD Concentration and LPR Bathymetry
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Notes:
The black line is a model fit through the data (Gaussian model parameters are printed on the bottom right of the panel).
The red points are the binned experimental variogram (based on surface sediment 2,3,7,8-TCDD data collected from 2005 to 2013).
Data are log-transformed prior to variogram generation to normalize the data distribution.
Each point is labeled with the number of pairs in the bin.
The blue dashed line is the population variance.

Key:
max lag = maximum lag length used in variogram
min dist = minimum separation between pairs
bin size = size of bins
nbins = number of bins shown on variogram
partial sill = sill - nugget

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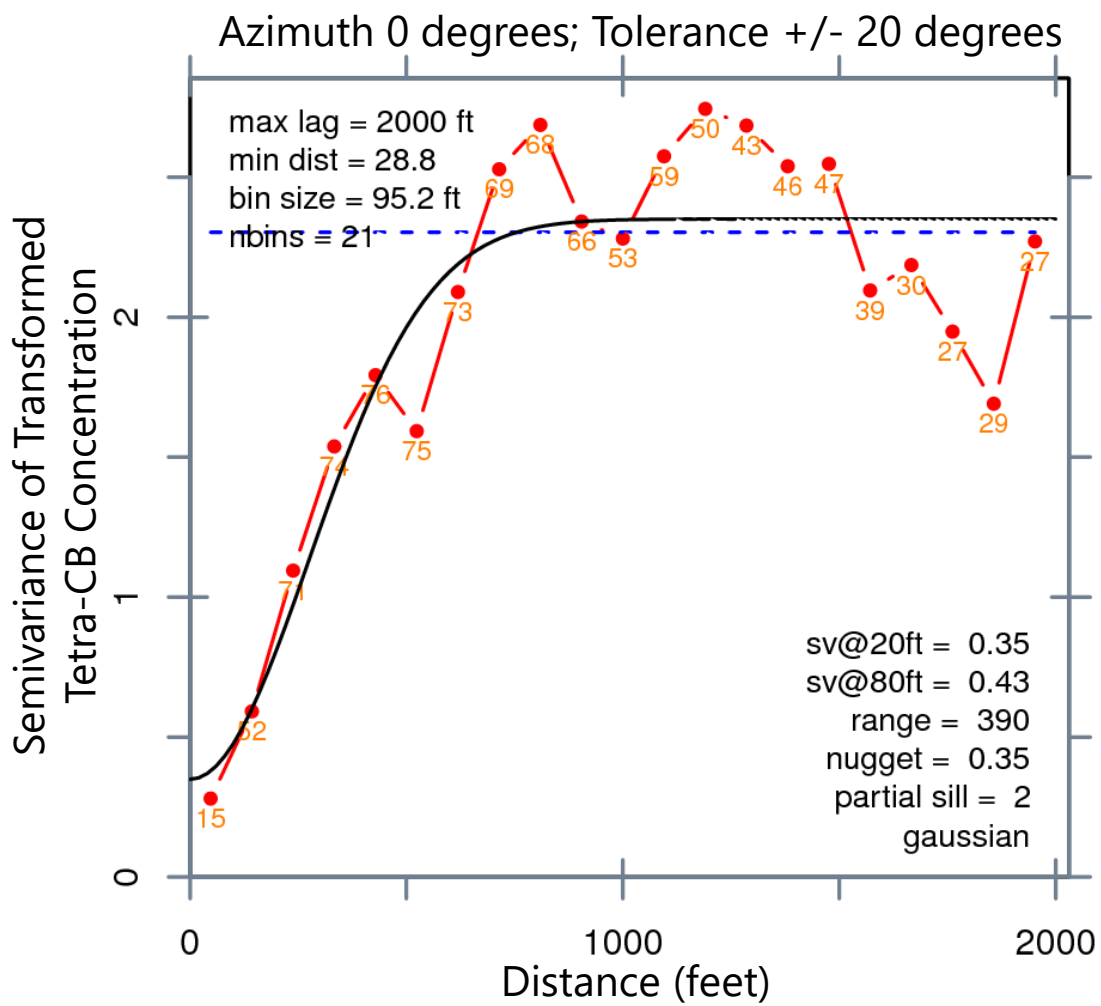
Figure 5-12
Along-flow Variogram for Surface Sediment 2,3,7,8-TCDD in the RM 10.9 Silt Deposit



Notes:
The black line is a model fit through the data (Gaussian model parameters are printed on the bottom right of the panel).
The red points are the binned experimental variogram (based on surface sediment 2,3,7,8-TCDD data collected from 2005 to 2013).
Data are log-transformed prior to variogram generation to normalize the data distribution.
Each point is labeled with the number of pairs in the bin.
The blue dashed line is the population variance.

Key:
max lag = maximum lag length used in variogram
min dist = minimum separation between pairs
bin size = size of bins
nbins = number of bins shown on variogram
partial sill = sill - nugget

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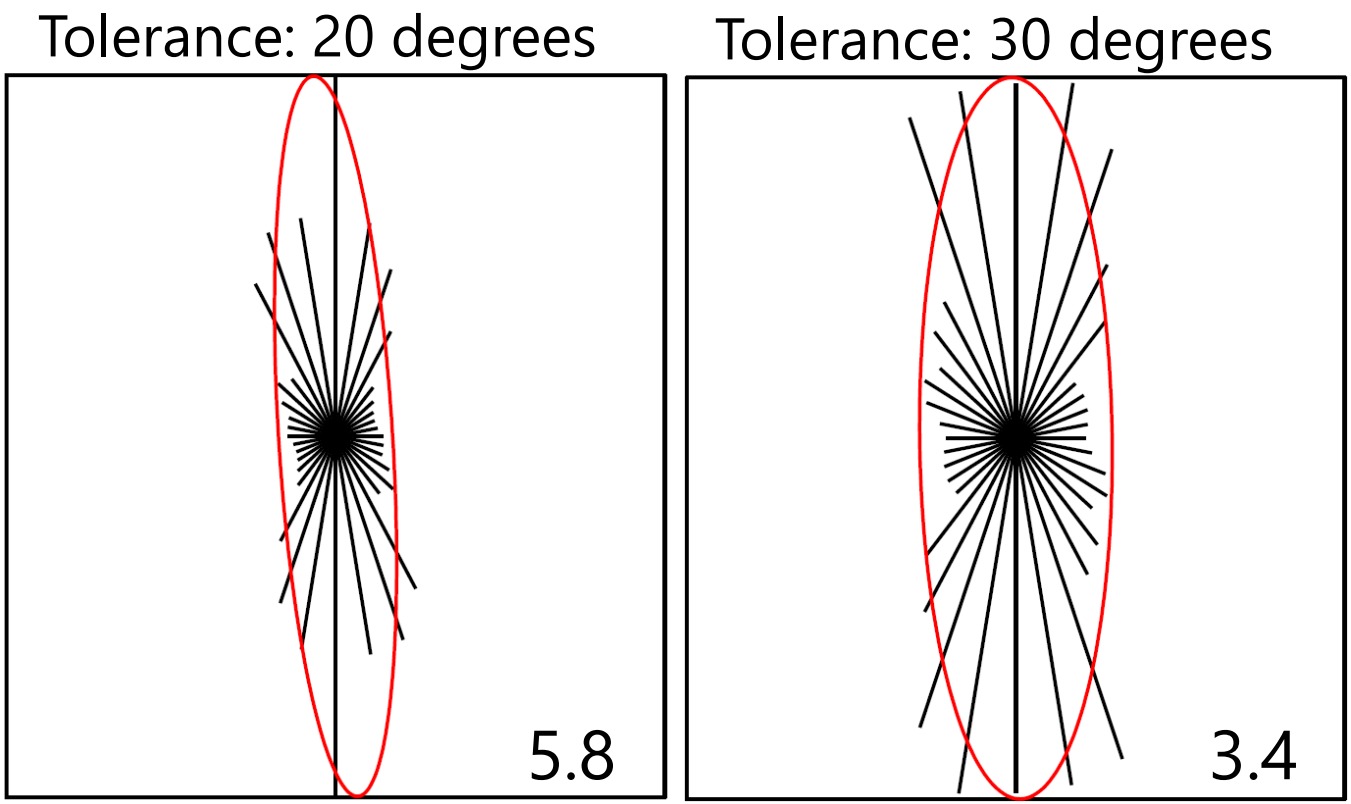
\\Iris\Woodcliff\Projects\Passaic_CPG\ANALYSIS\Sed_Char\interpolations\k20170821_tetra\COPCs\te_pcb_silt_10p9_gaussian\flow_dir_te_pcb_variograms.ps

Figure 5-13
Along-flow Variogram for Surface Sediment Tetra-CB in the RM 10.9 Silt Deposit



Anisotropy ratio is labeled on the lower right corner of each panel.

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Figure 5-14
Anisotropy Ratio – Rose Diagrams Based on Surface Sediment 2,3,7,8-TCDD Between RM 10.4 – 11.5

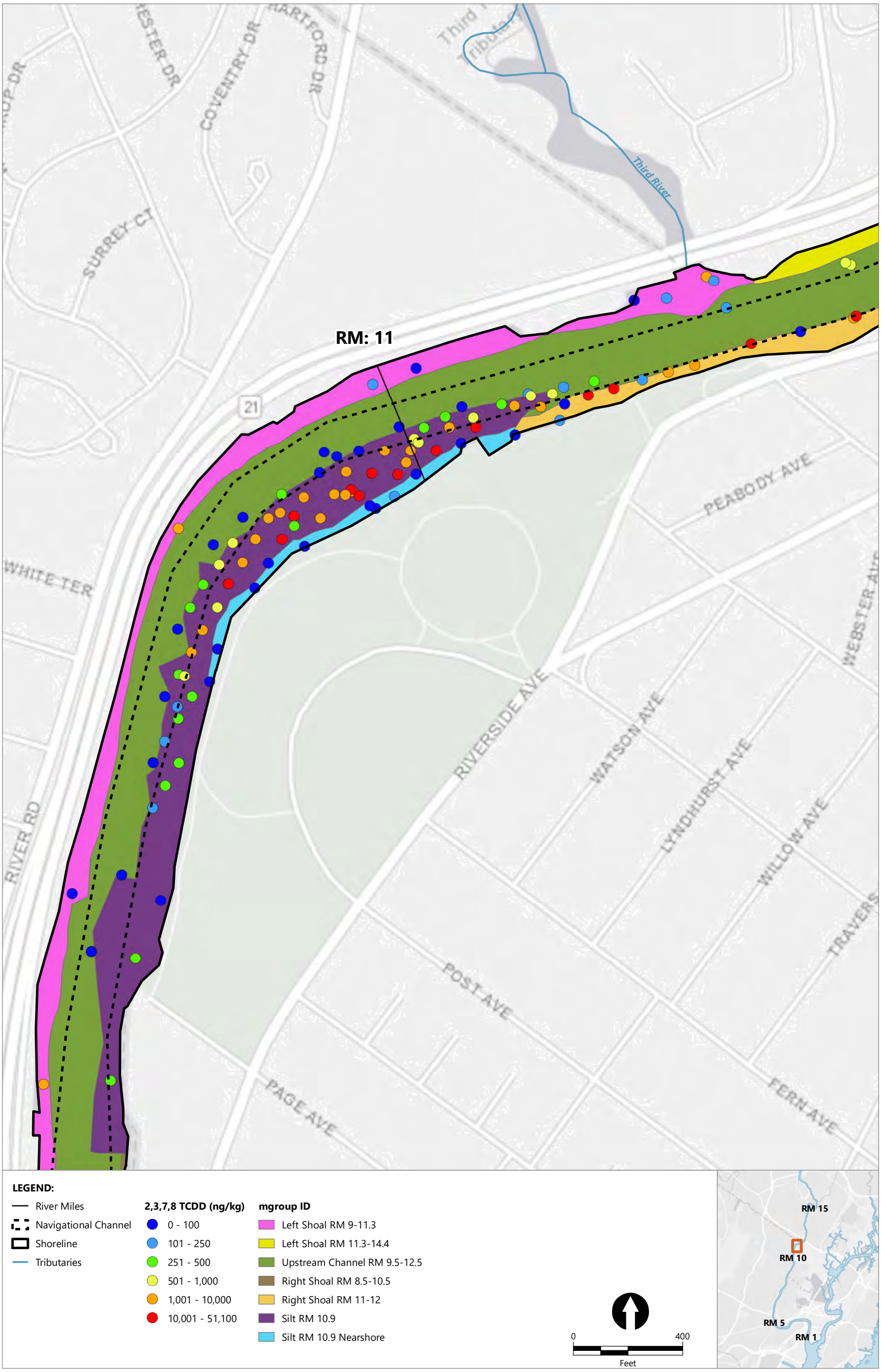

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Figure 5-15
Surface Sediment 2,3,7,8-TCDD Data Used in Rose Diagram
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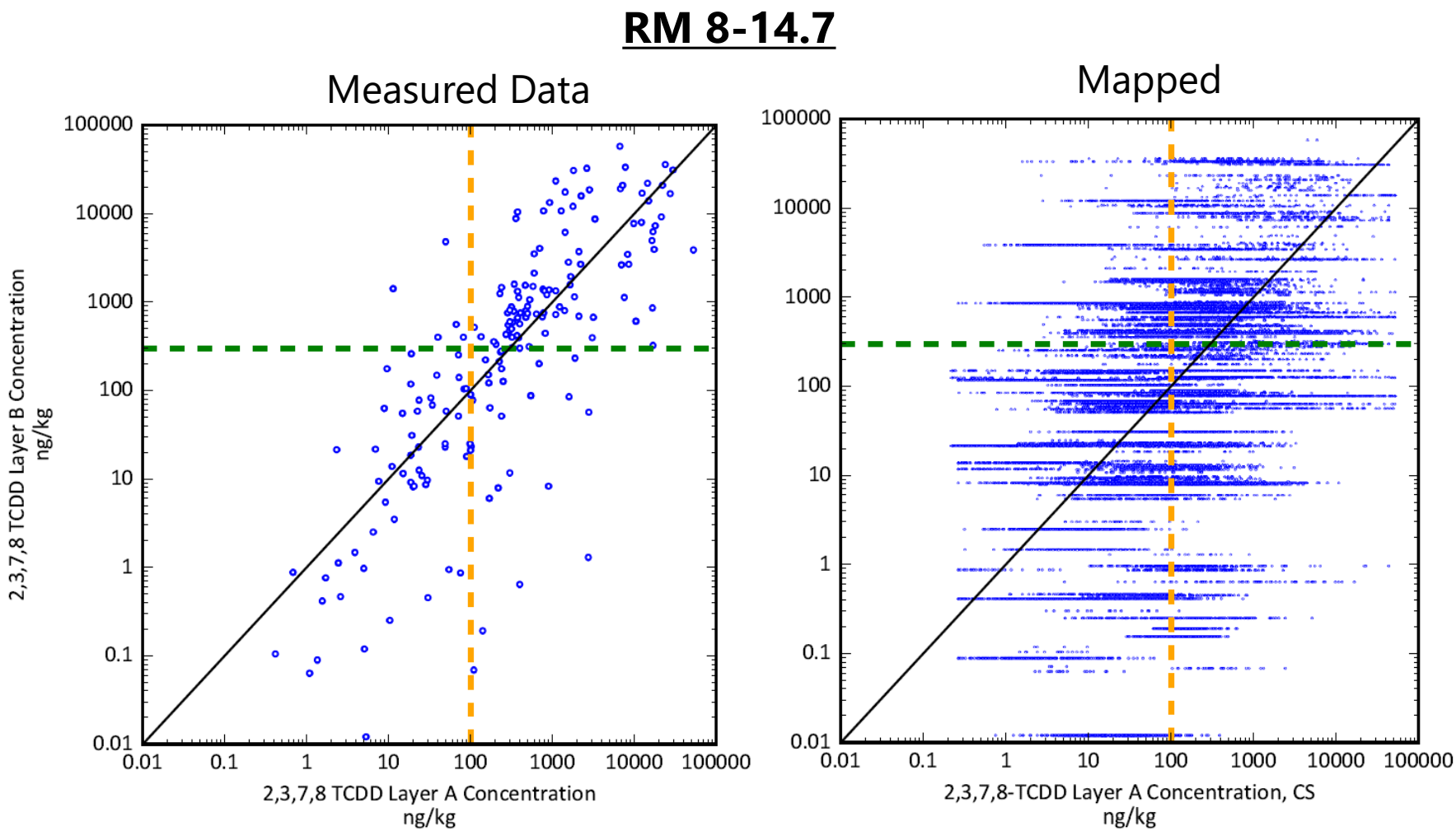

2010 mapping is based on the conditional simulation for Layer A and Thiessen polygons for layer B.

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Figure 6-1

Comparison of Layer A and Layer B 2,3,7,8-TCDD Concentrations for Measured and Mapped Data

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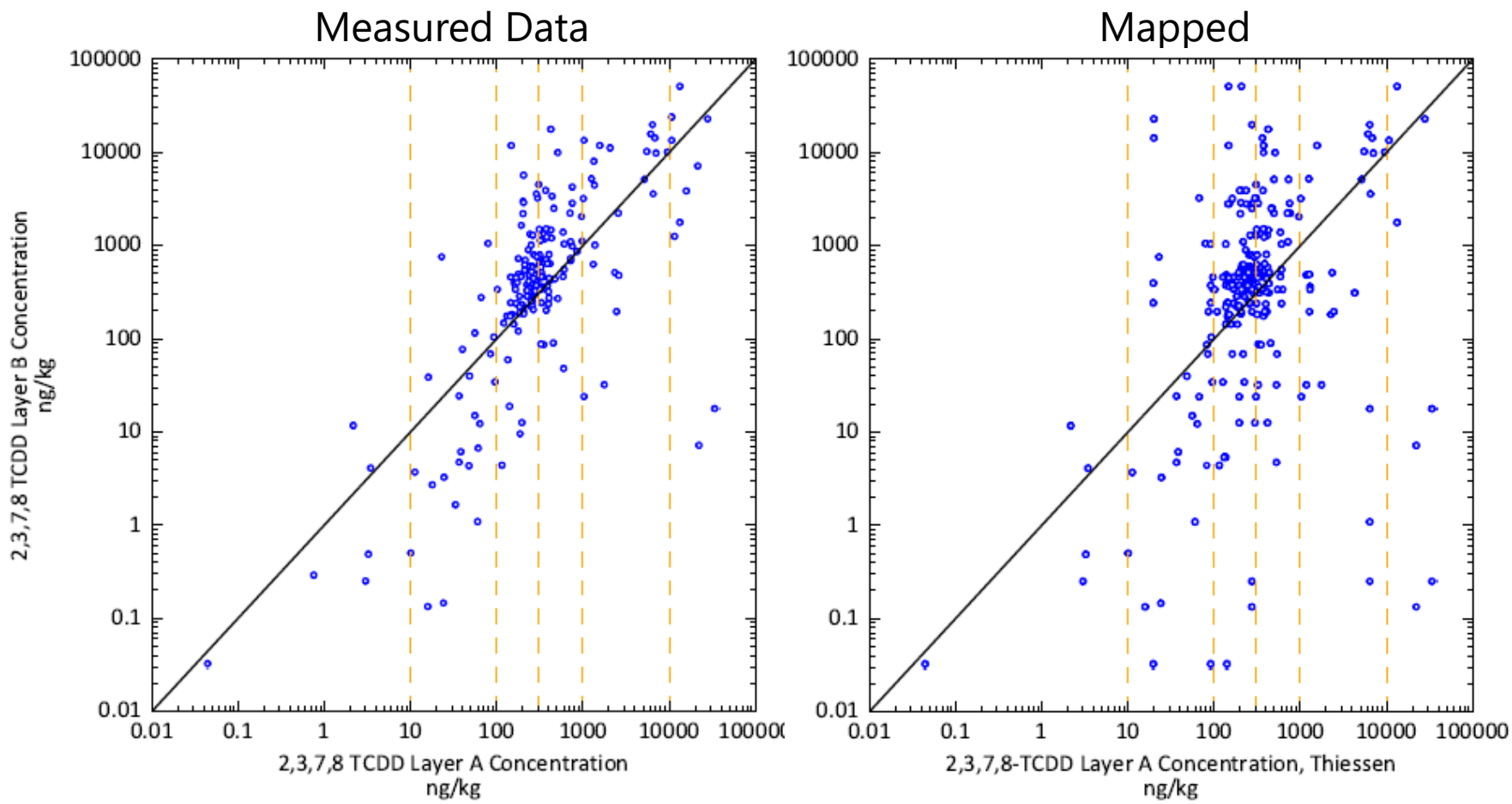

1995 mapping is based on the Thiessen polygons for layer A and layer B.

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Path for code used in figures : \\boston1\Jobs\Passaic_CPG\ANALYSIS\Sed_Char\Interpolations\resampled_B\code\Diagnostics\ - crossplot_Data_v2.py and crossplot_ThiesvsThies_V2.py

Figure 6-2

Comparison of Layer A and Layer B 2,3,7,8-TCDD Concentrations for Measured and Mapped Data

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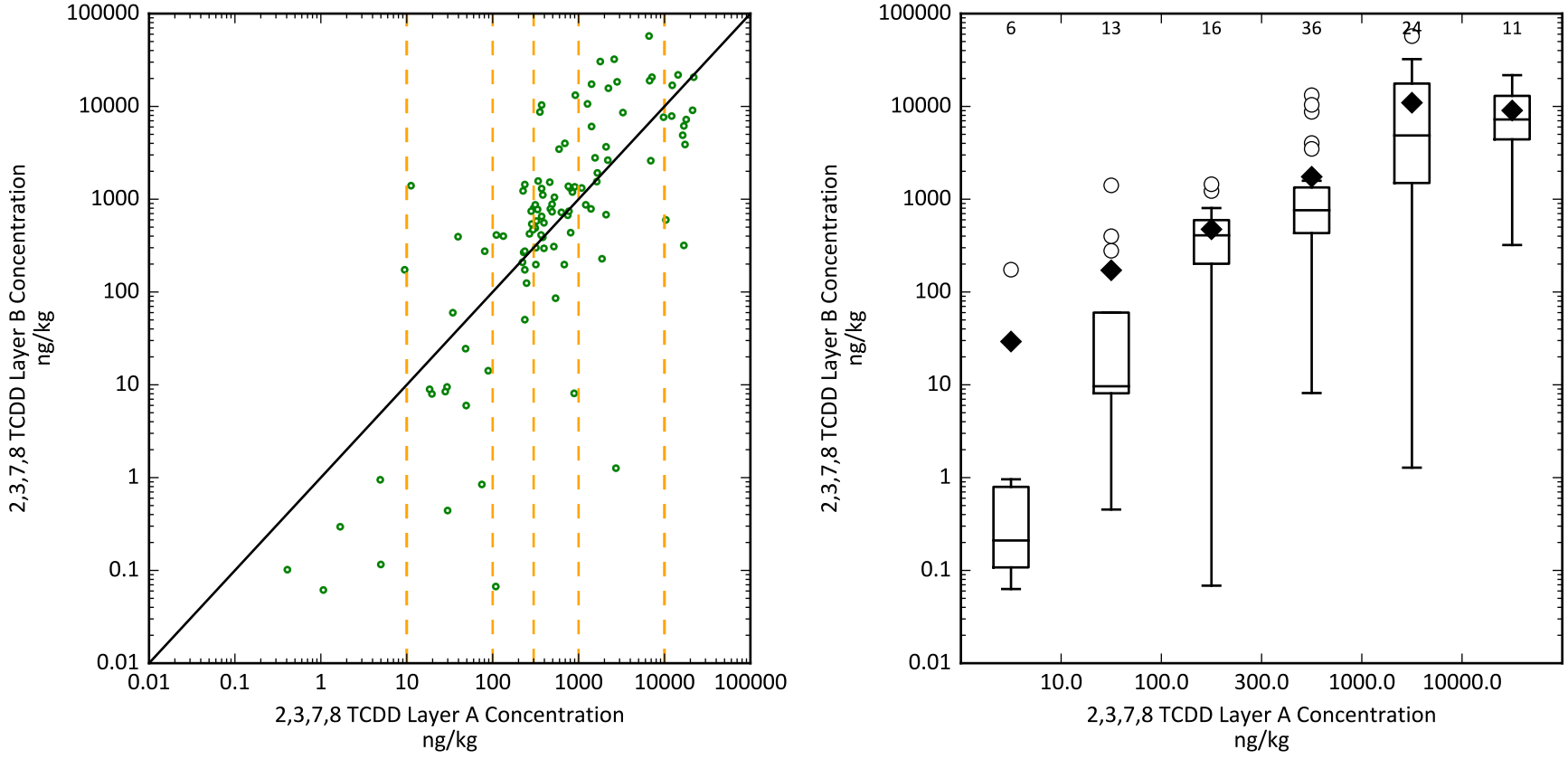

Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

Publish Date: 06/19/2019 15:32 PM | User: DB
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Figure 6-3a

2,3,7,8 TCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

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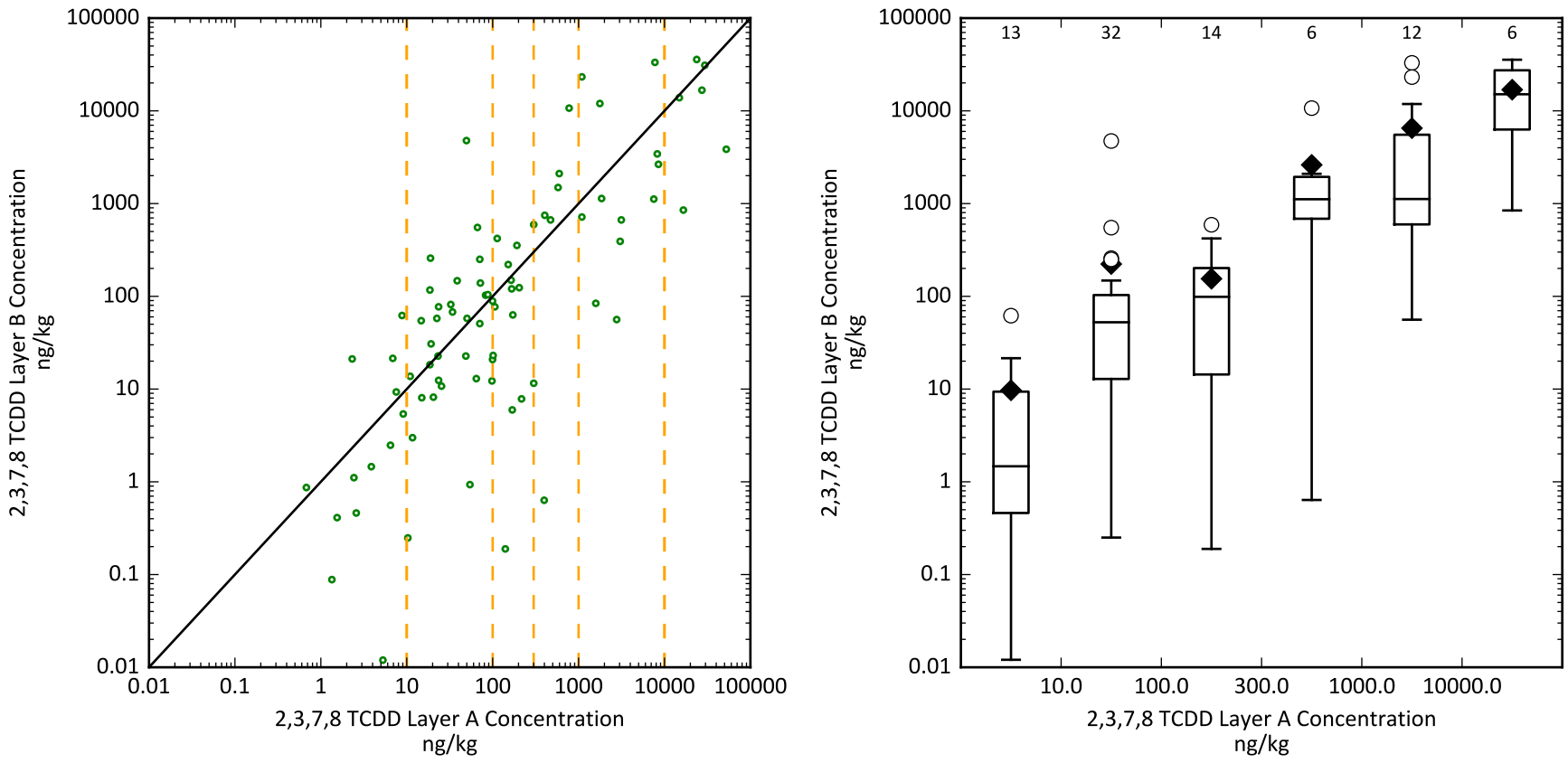

Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

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Figure 6-3b

2,3,7,8 TCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

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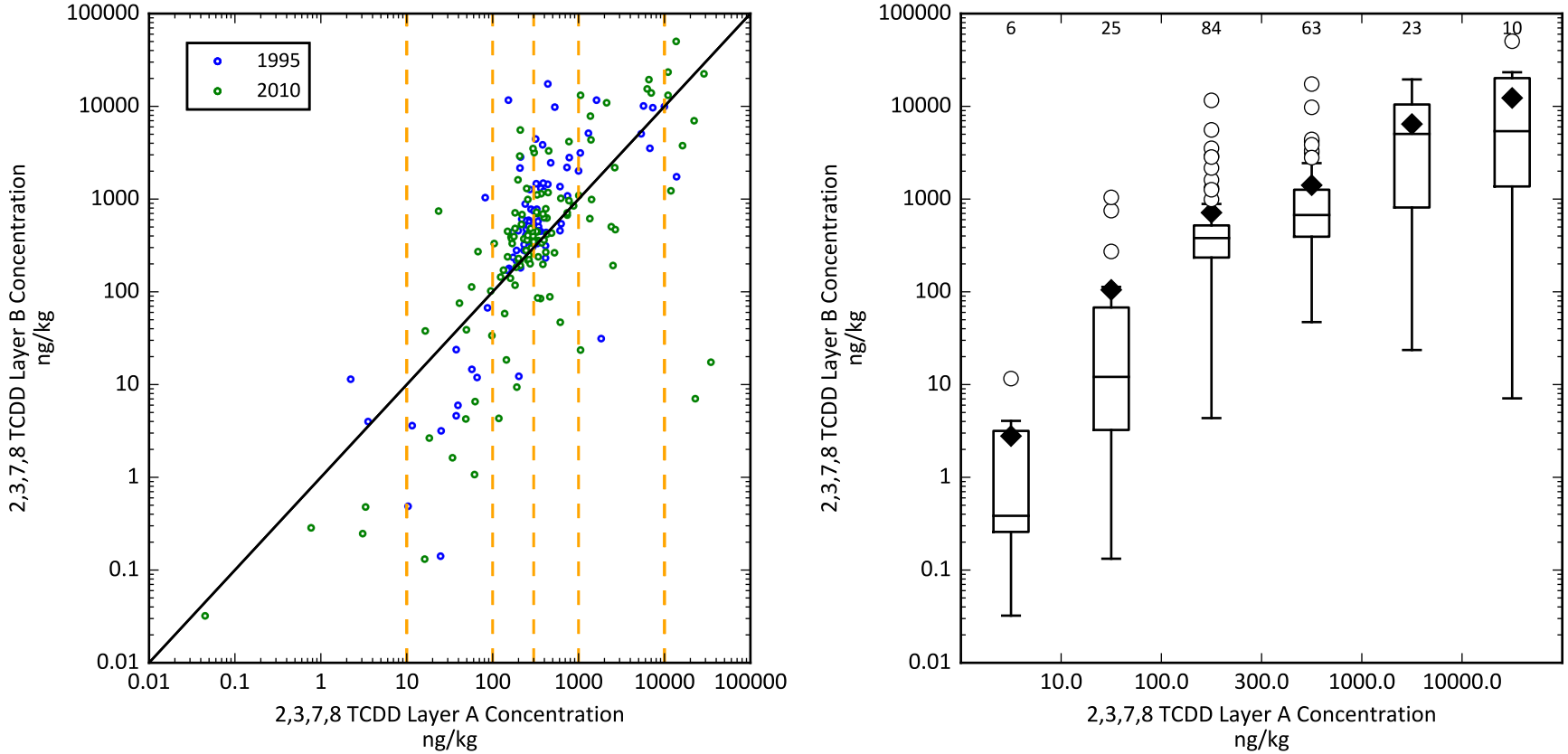

Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

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File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 6-3c

2,3,7,8 TCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

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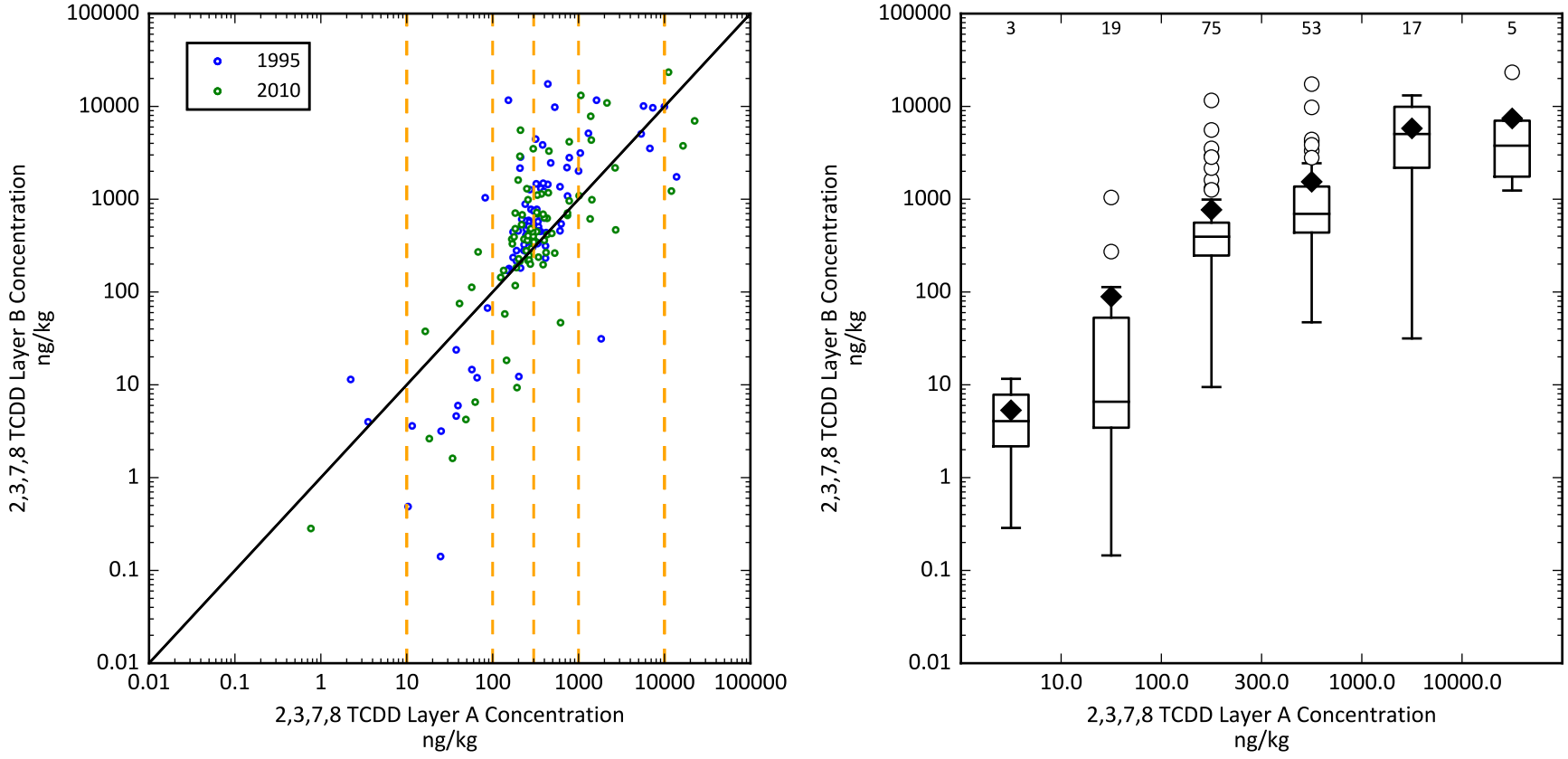

Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

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File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 6-4

2,3,7,8 TCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

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Figure 7-1a
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

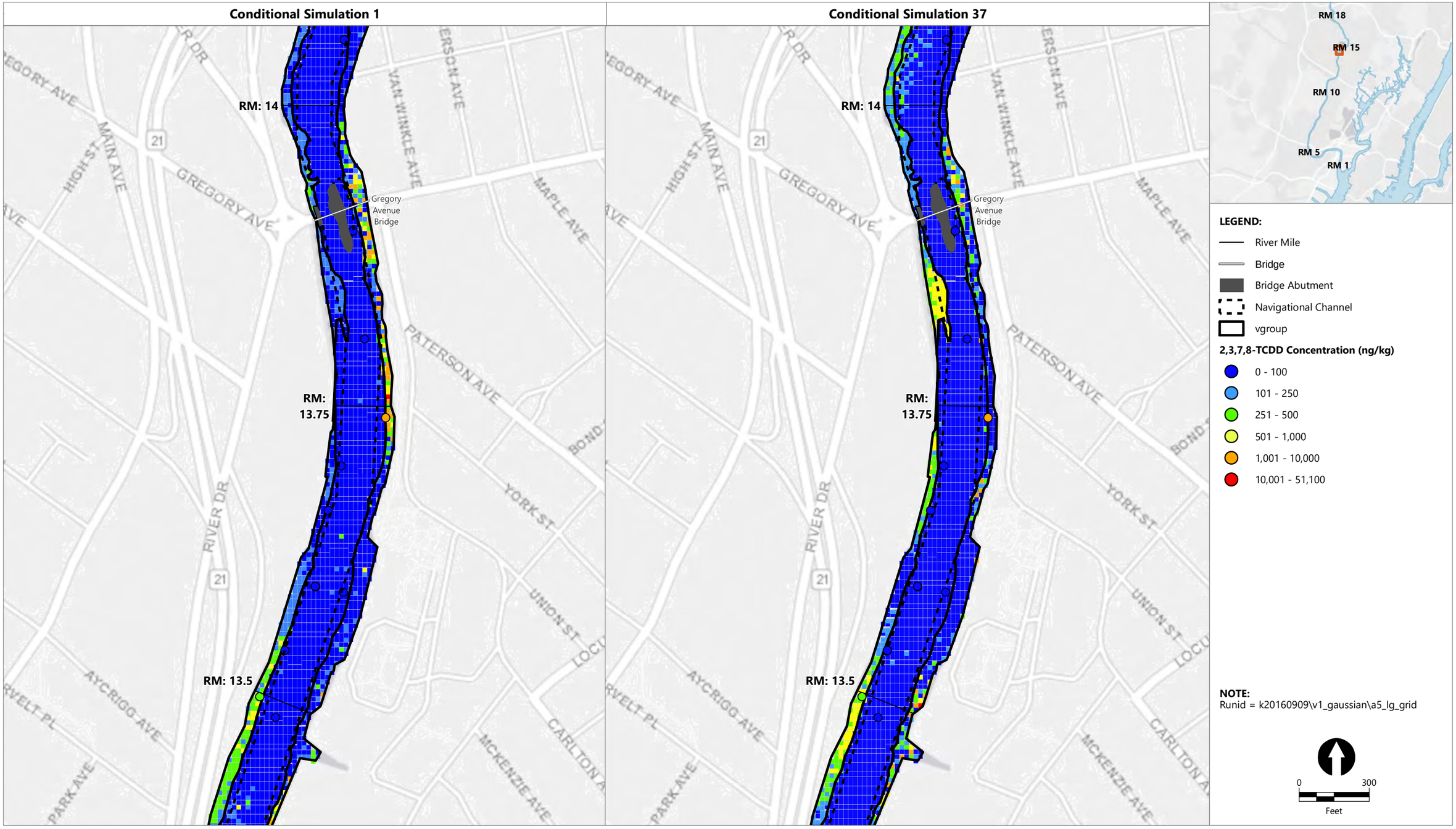

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Figure 7-1b

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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Figure 7-1c

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

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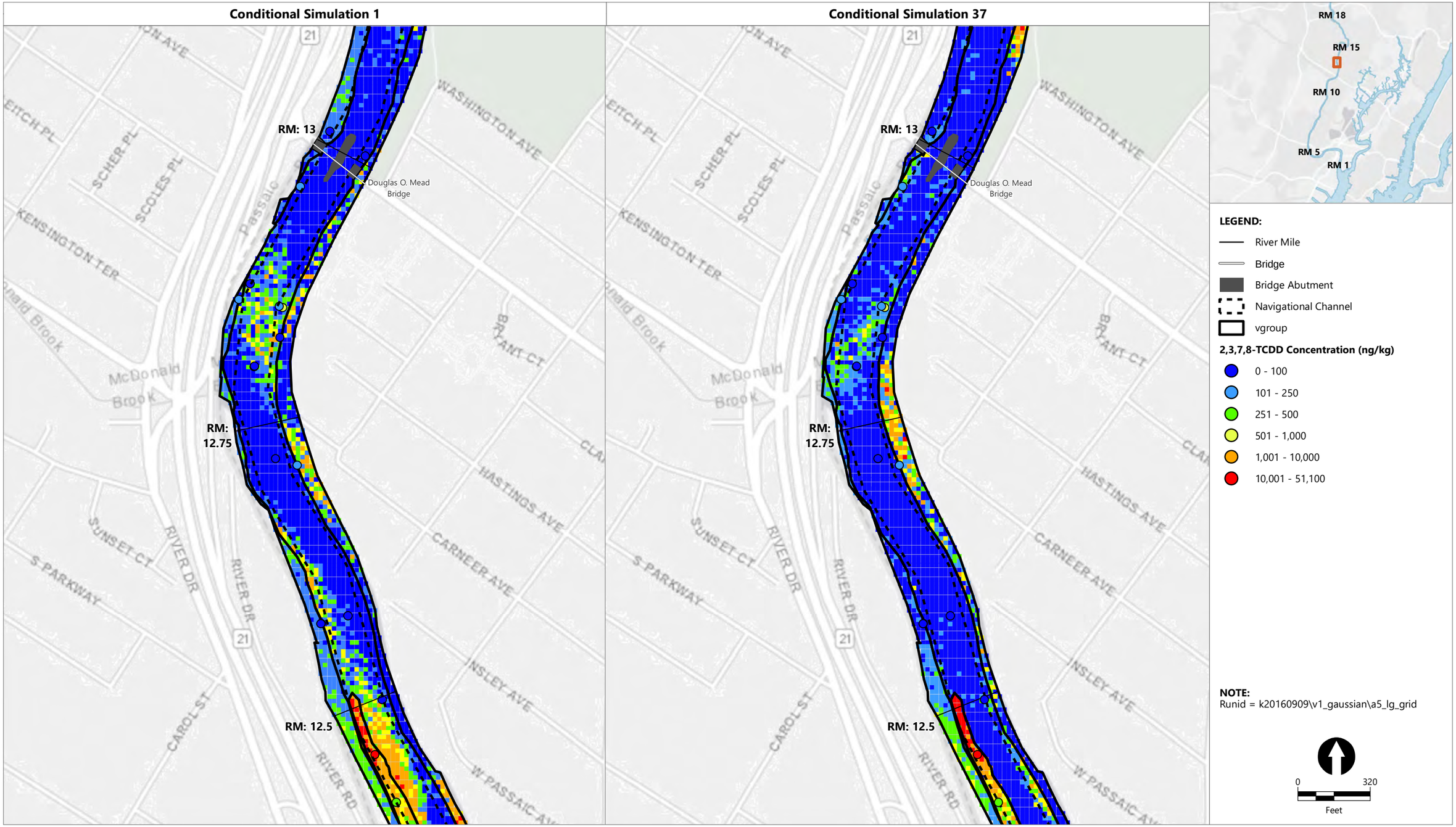

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Figure 7-1d
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

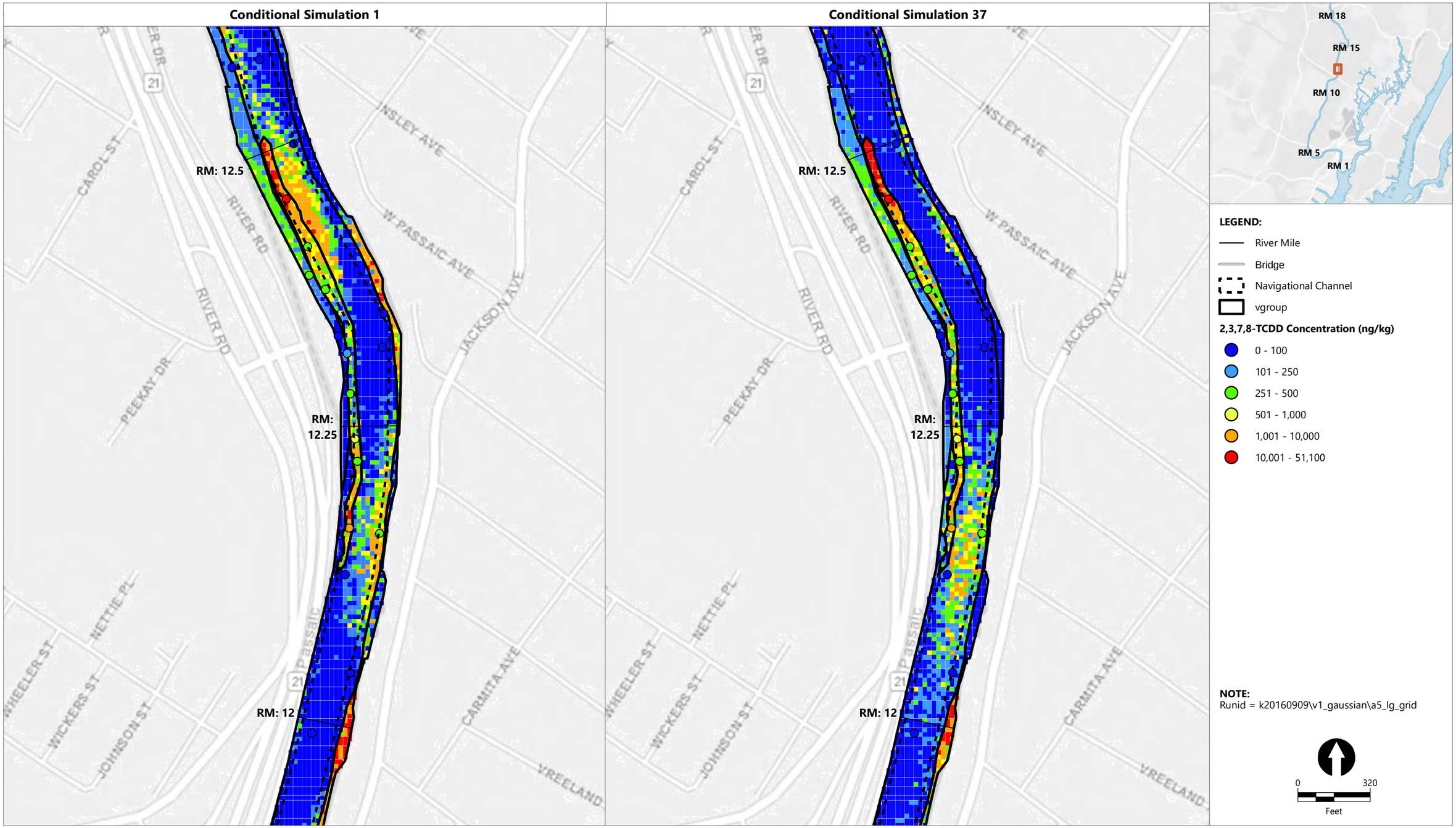

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Figure 7-1e
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
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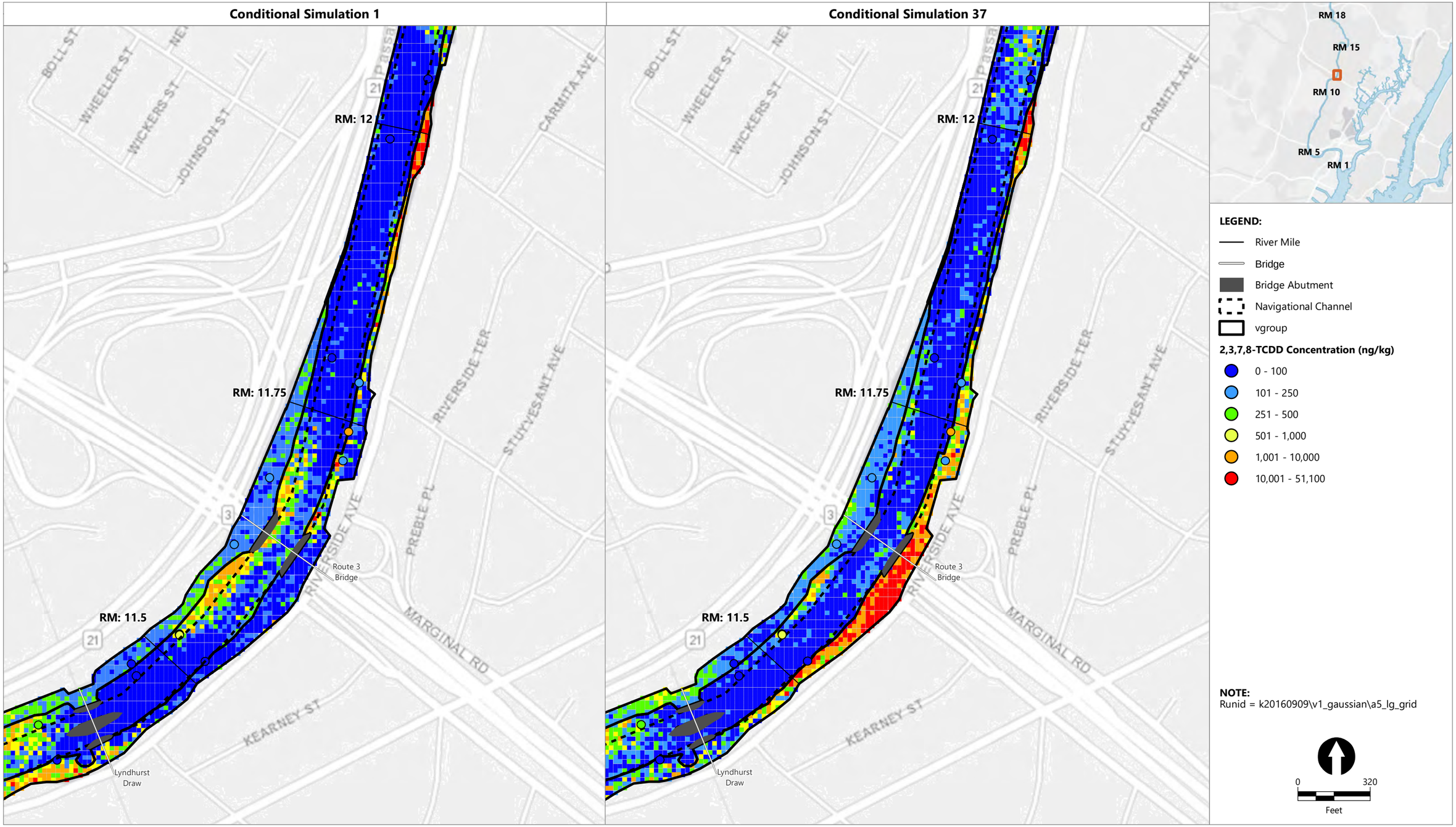

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Figure 7-1f
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
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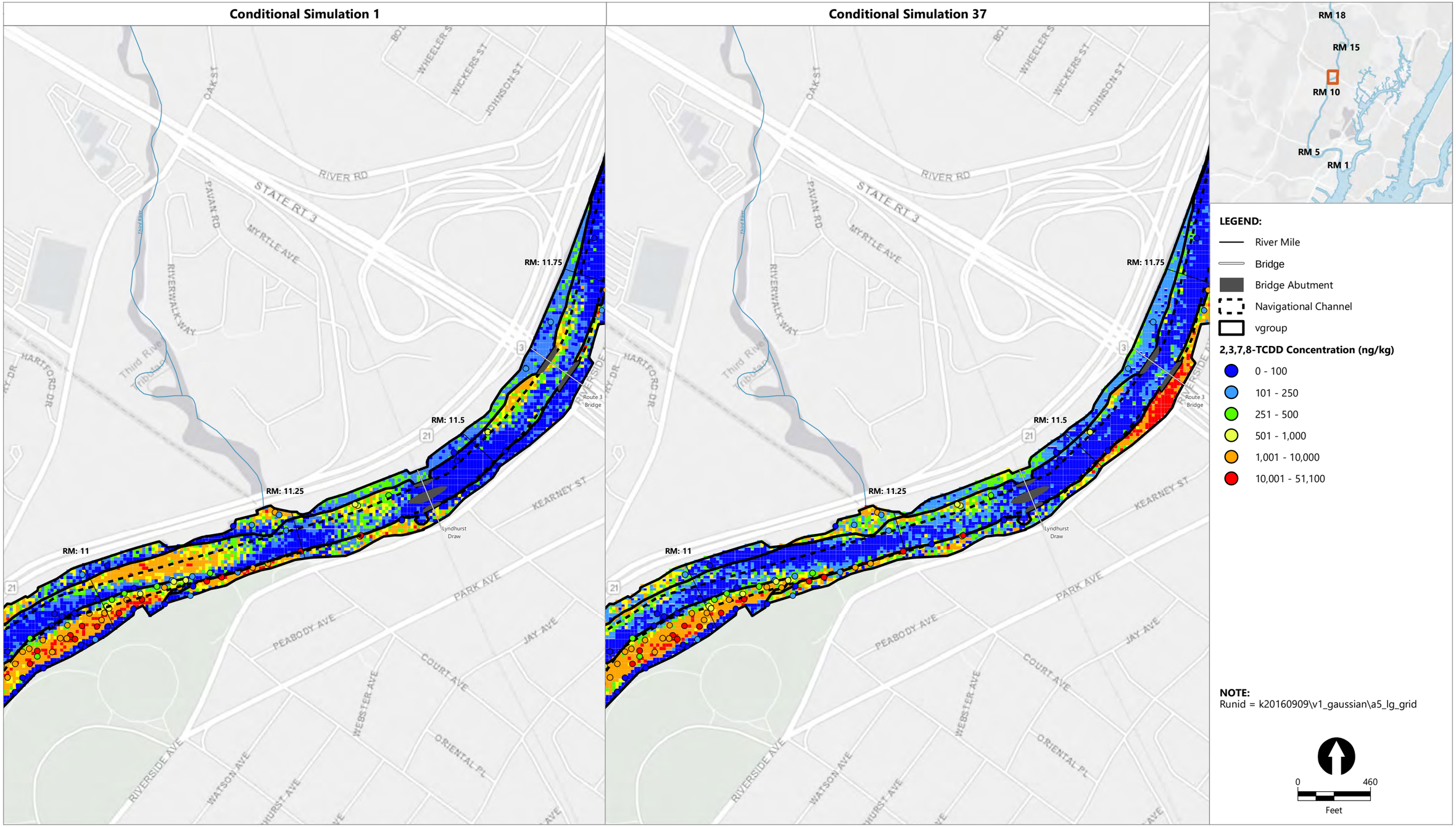

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Figure 7-1g
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

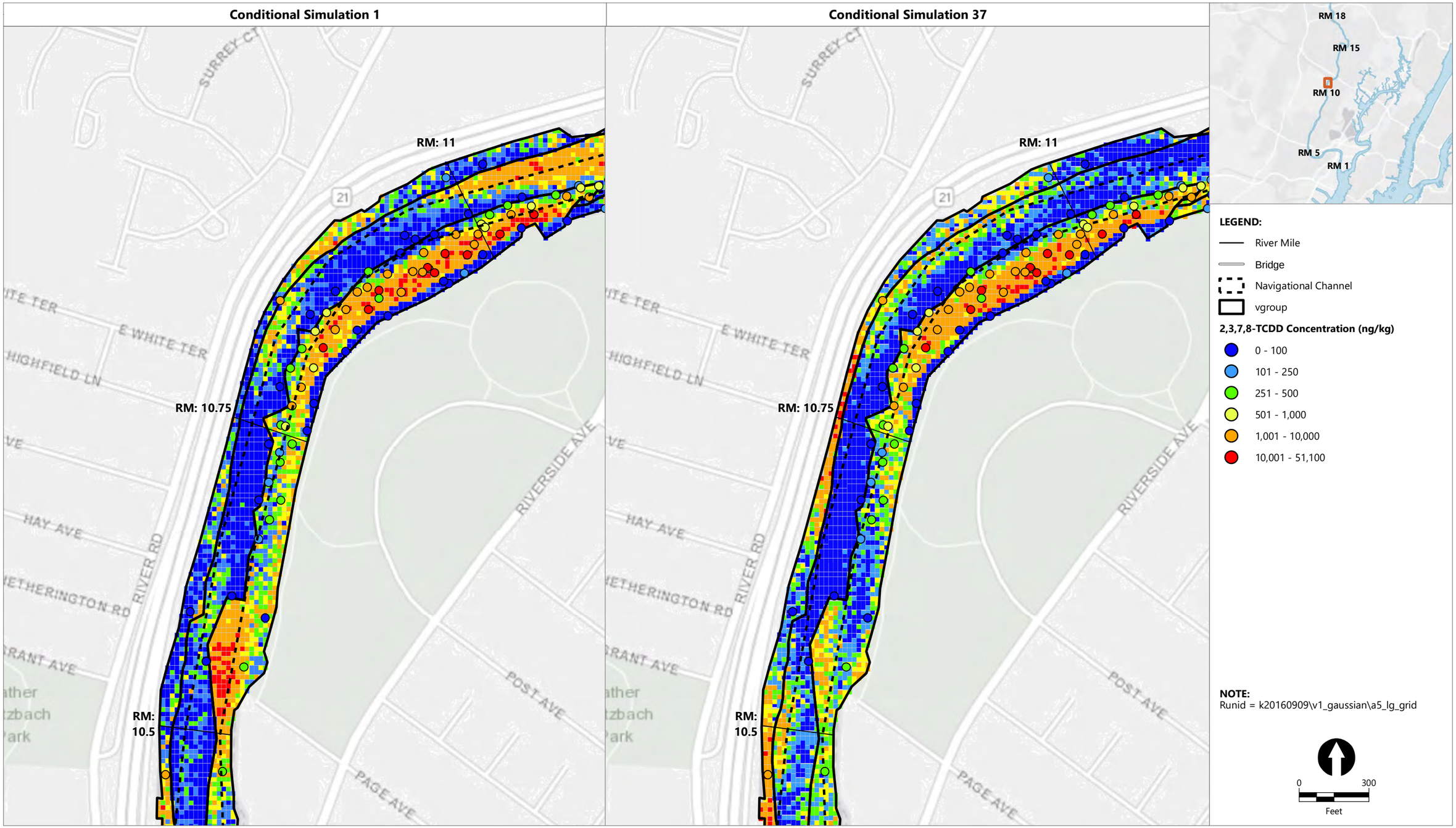

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Figure 7-1h

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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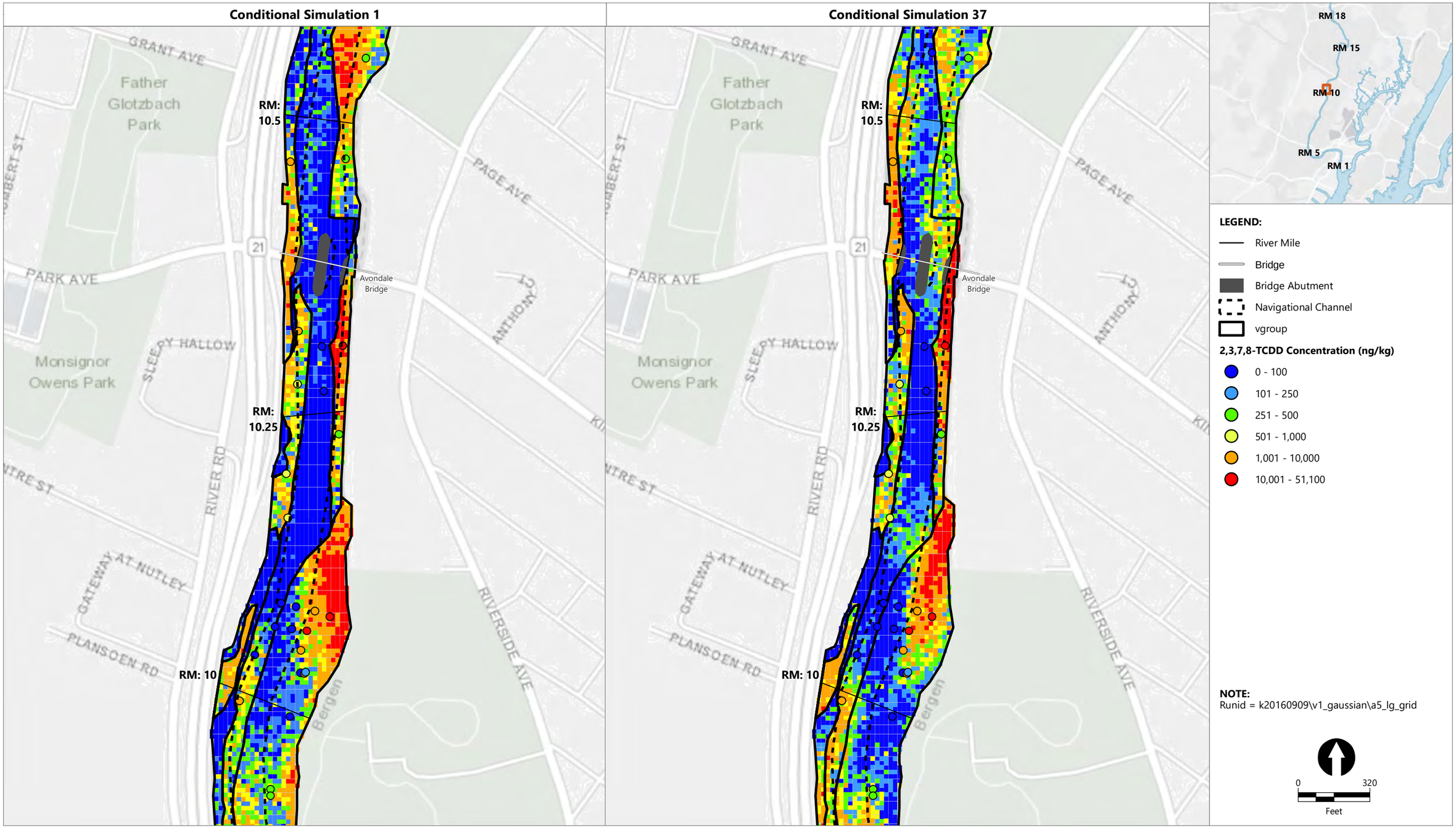

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Figure 7-1i

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

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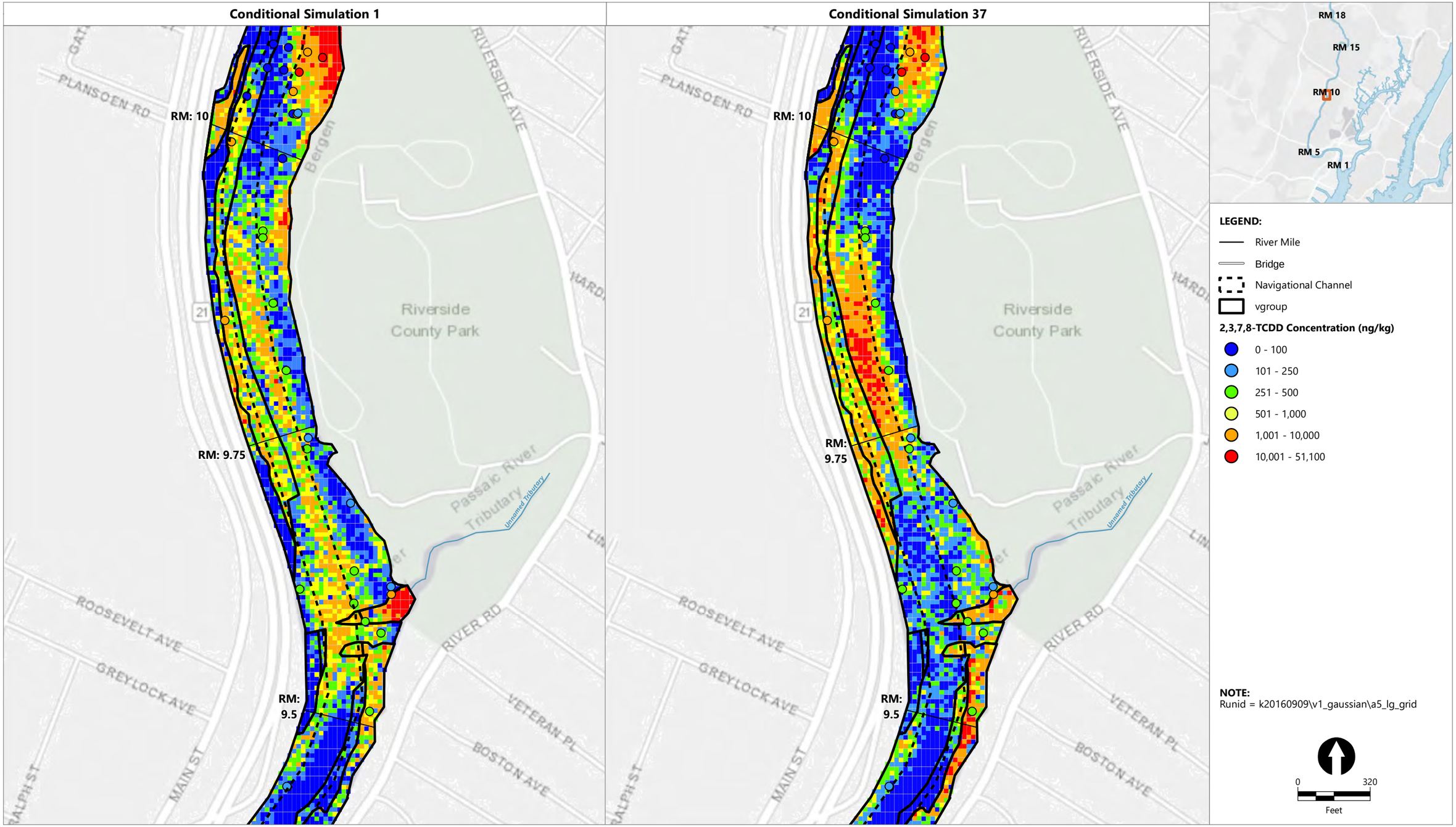

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Figure 7-1j
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

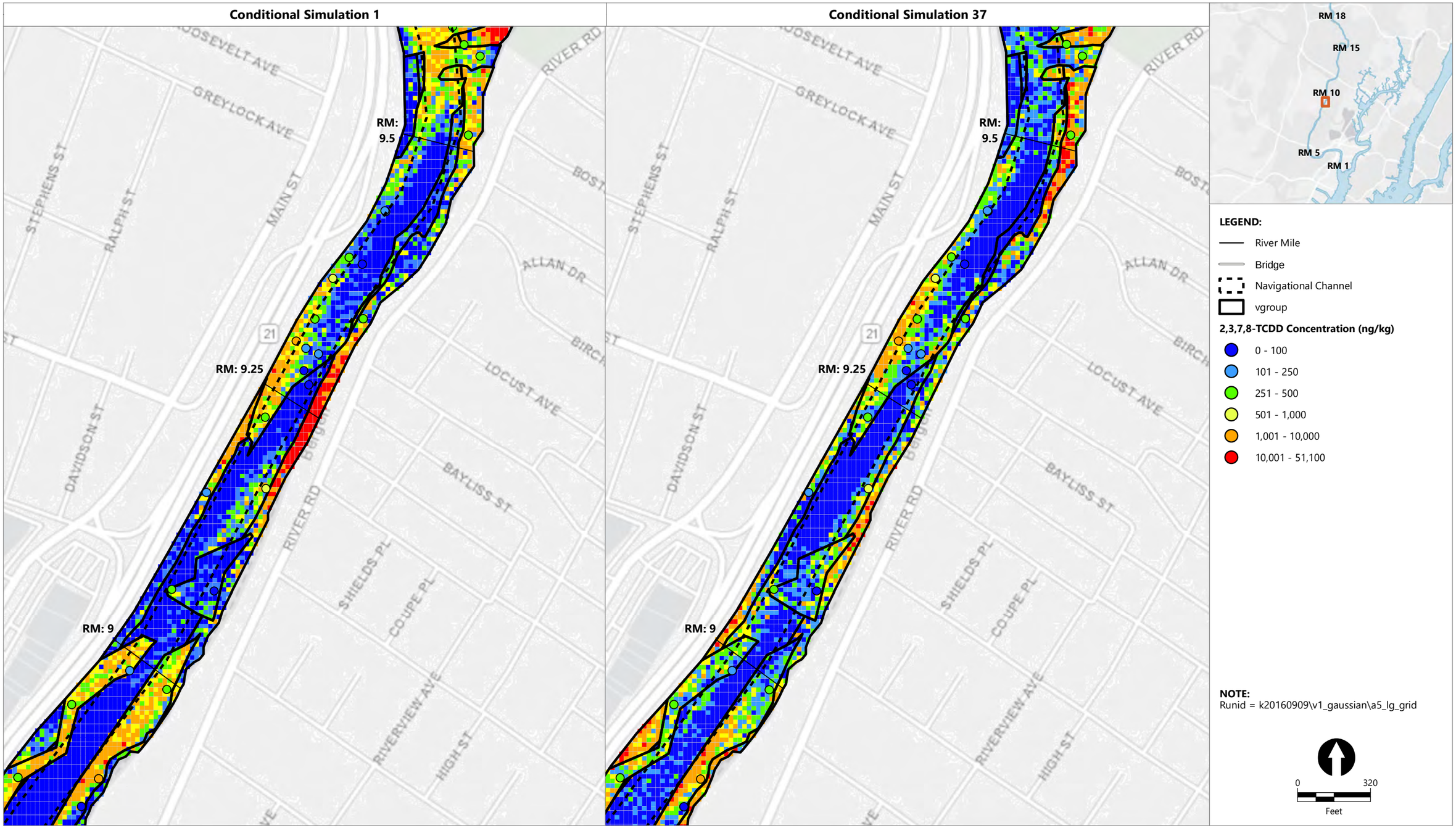

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Figure 7-1k
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

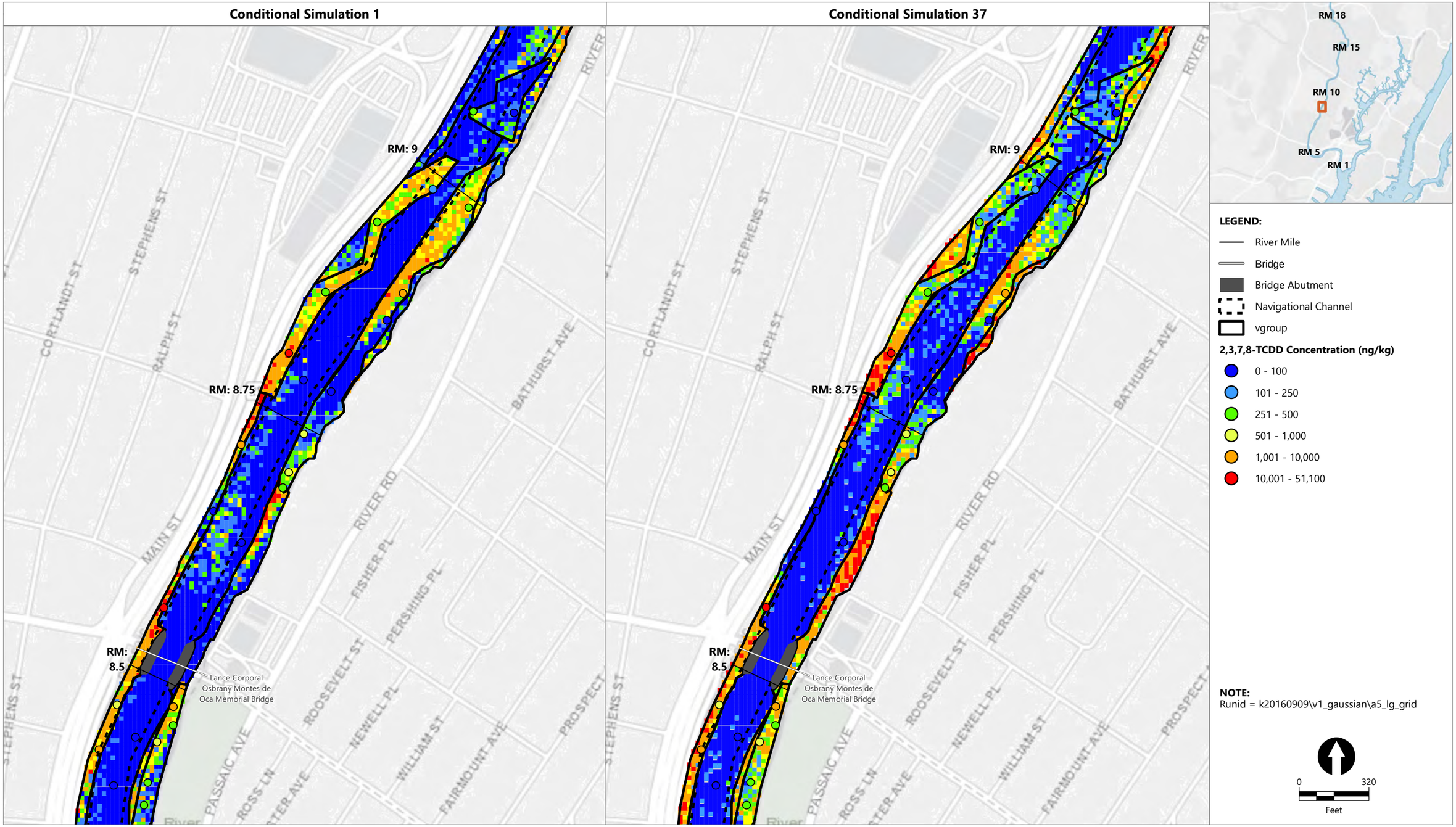

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Figure 7-1l

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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Figure 7-1m

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

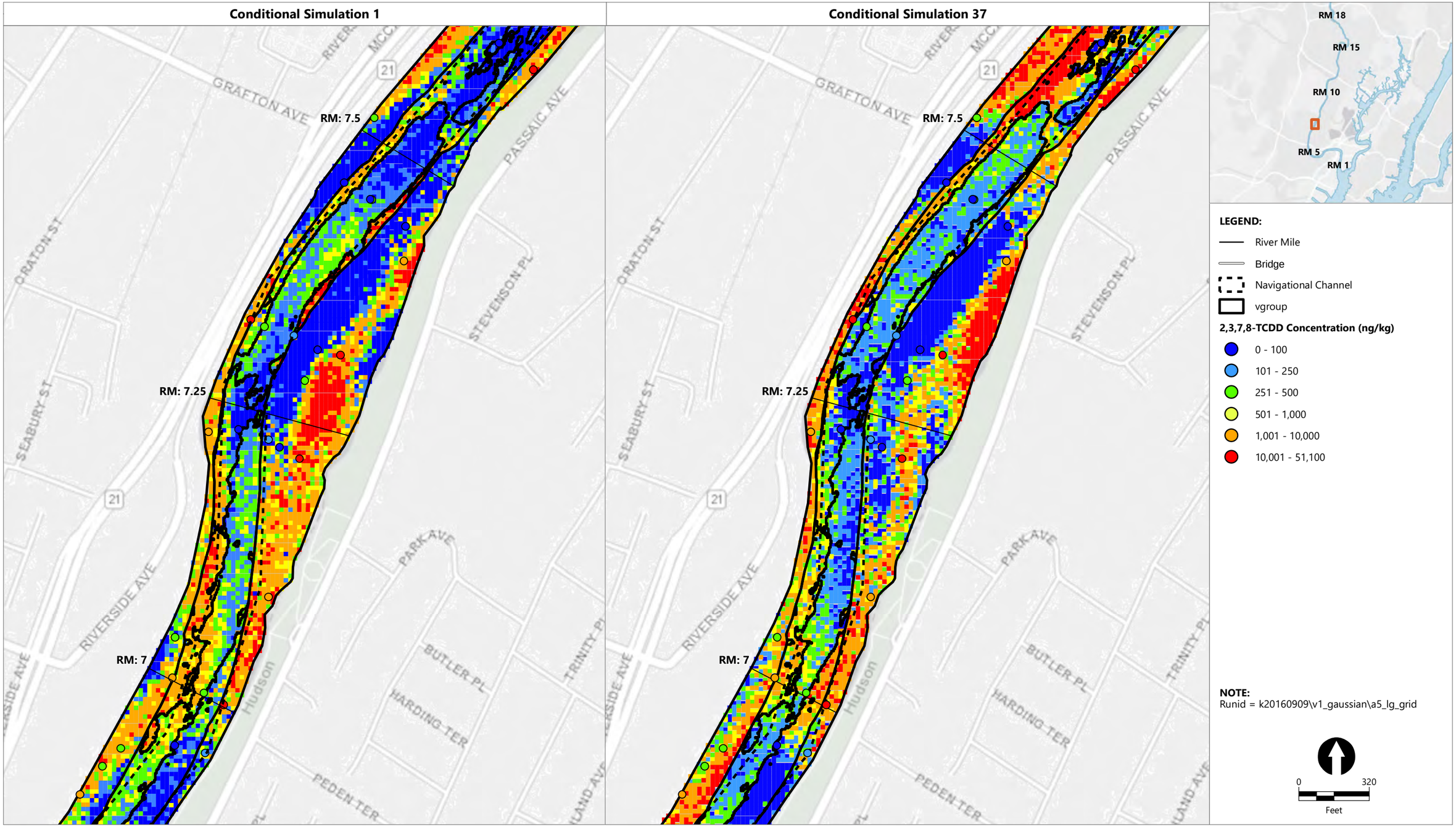

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Figure 7-1n

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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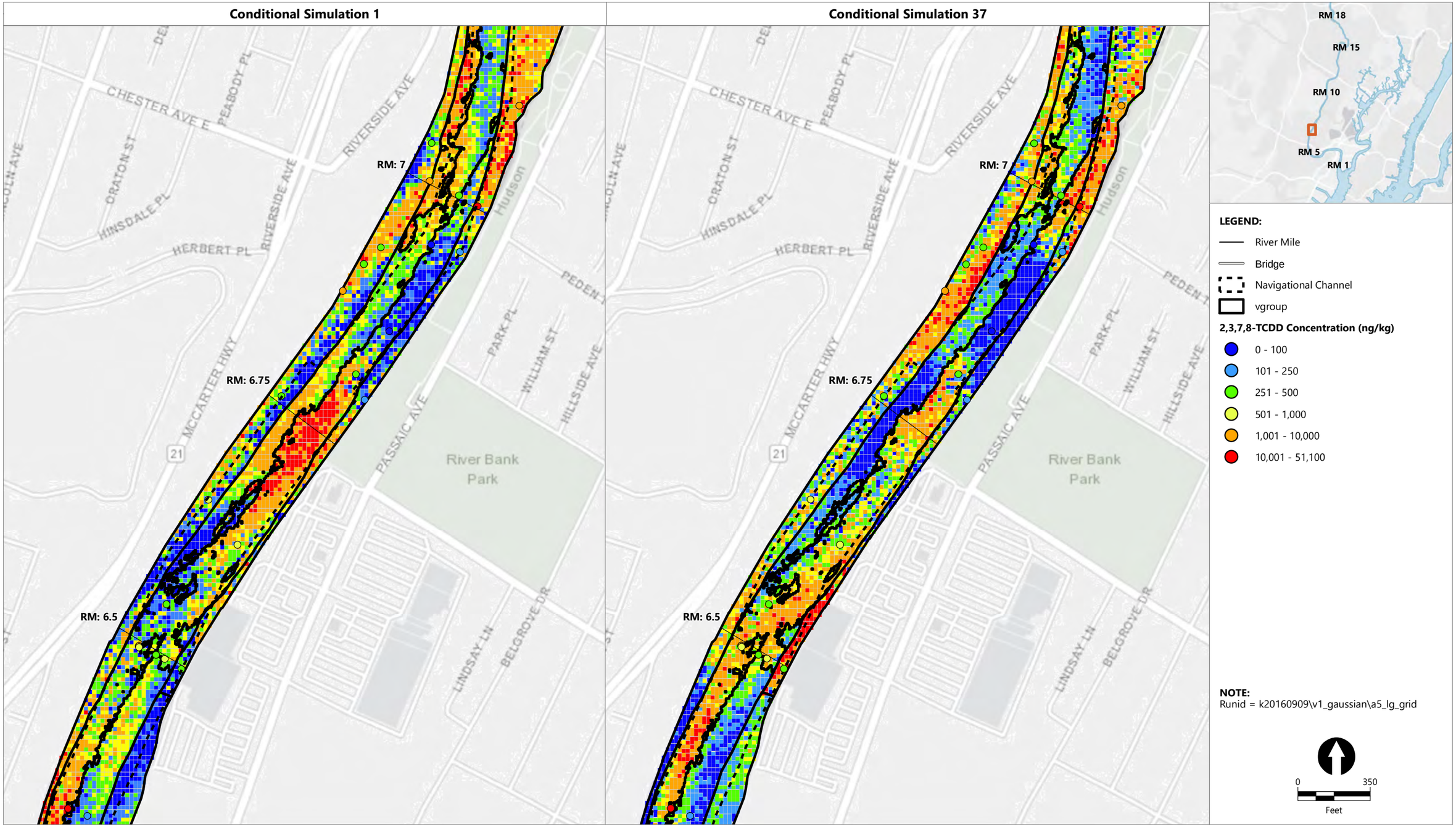

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Figure 7-1o
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

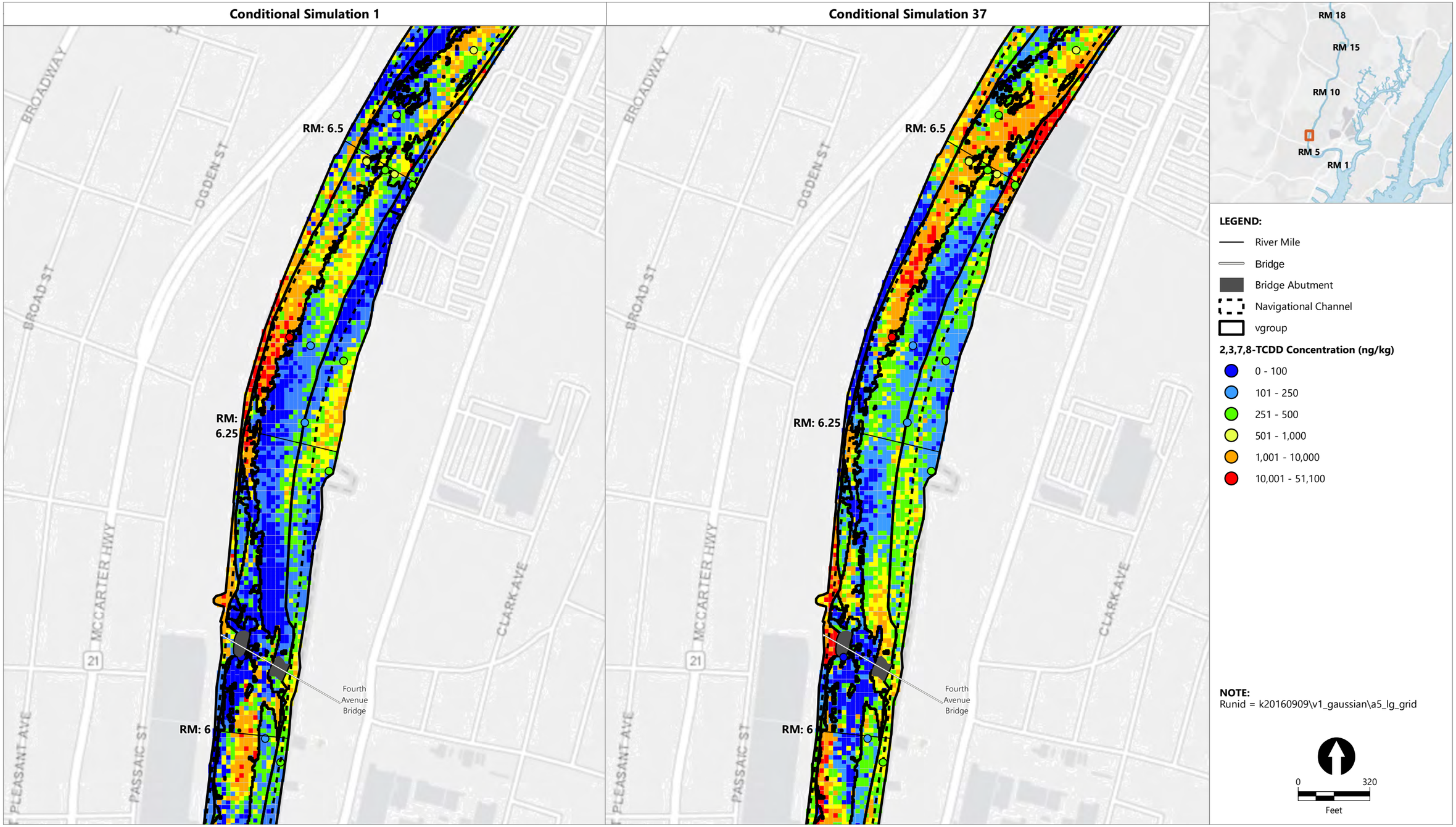

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Figure 7-1p

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

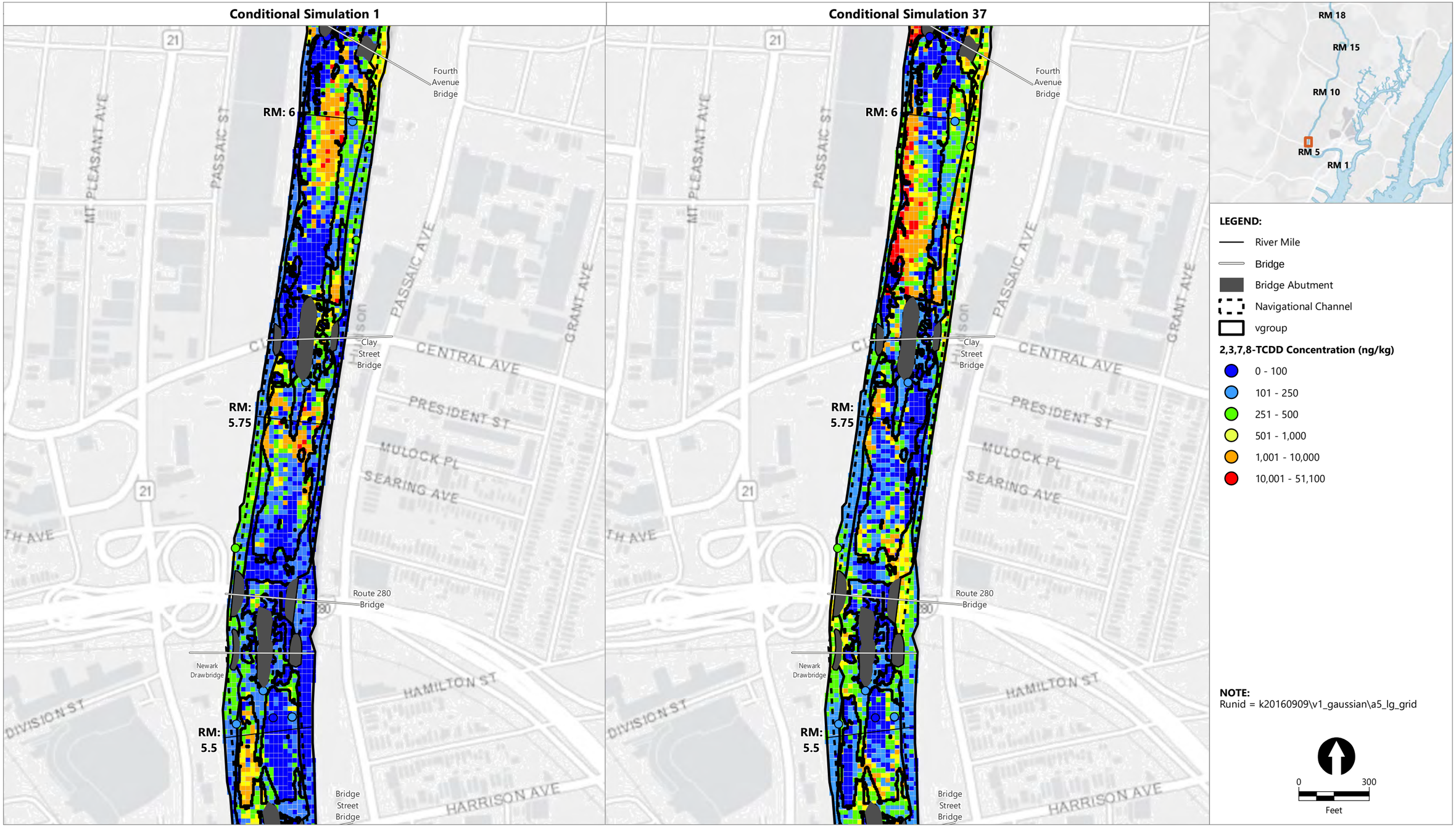

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Figure 7-1q

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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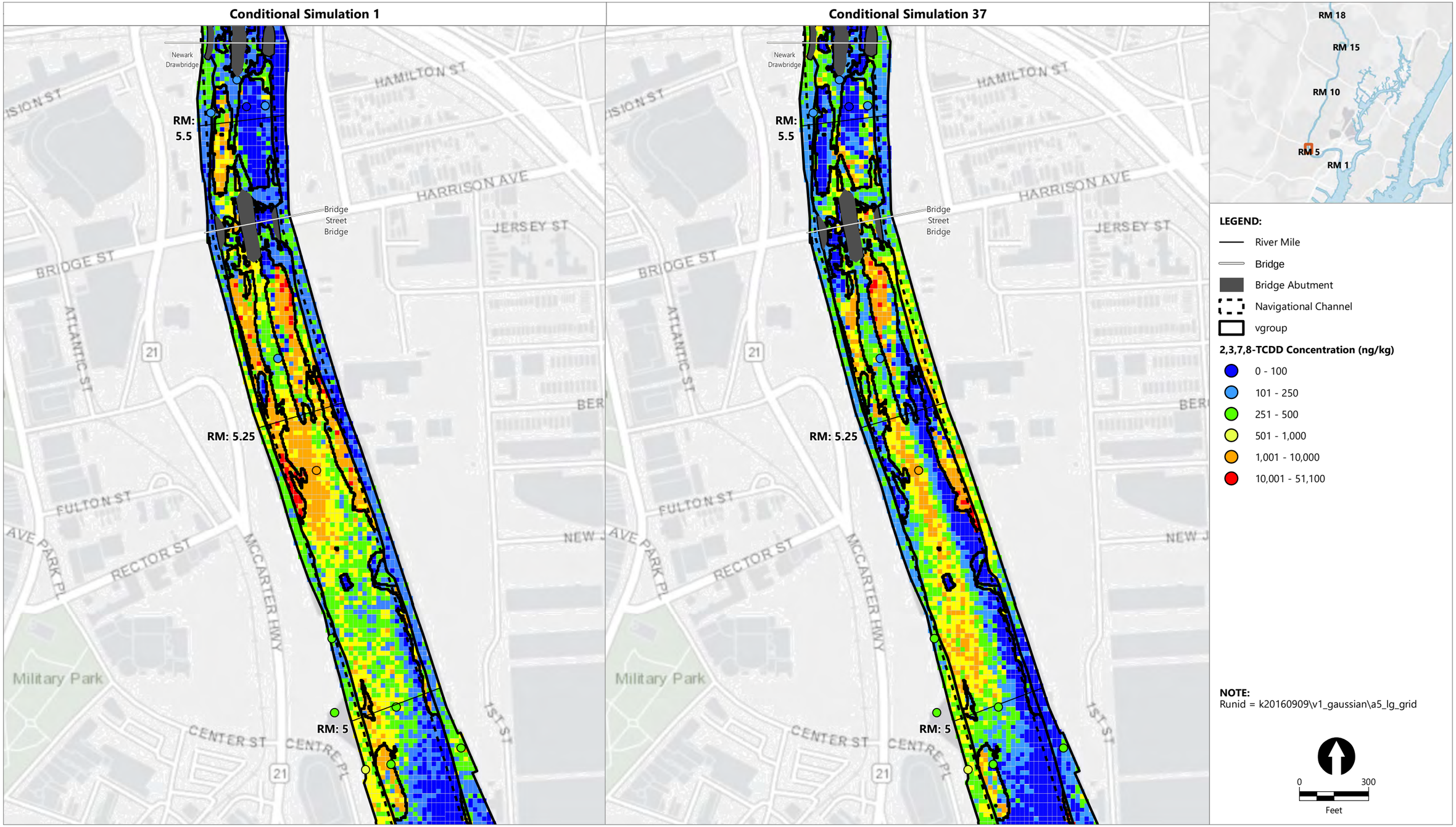

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Figure 7-1r
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

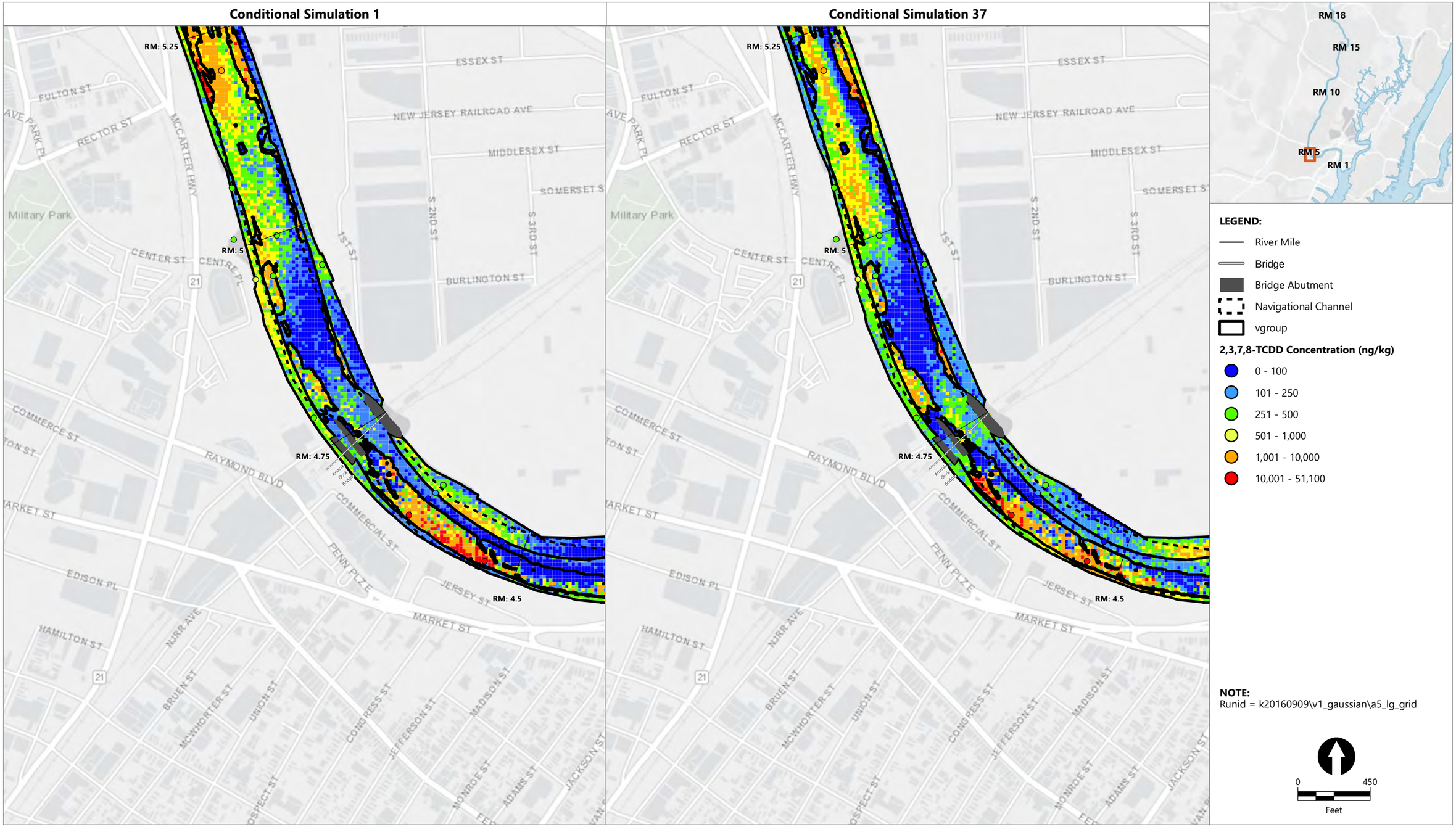

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Figure 7-1s
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
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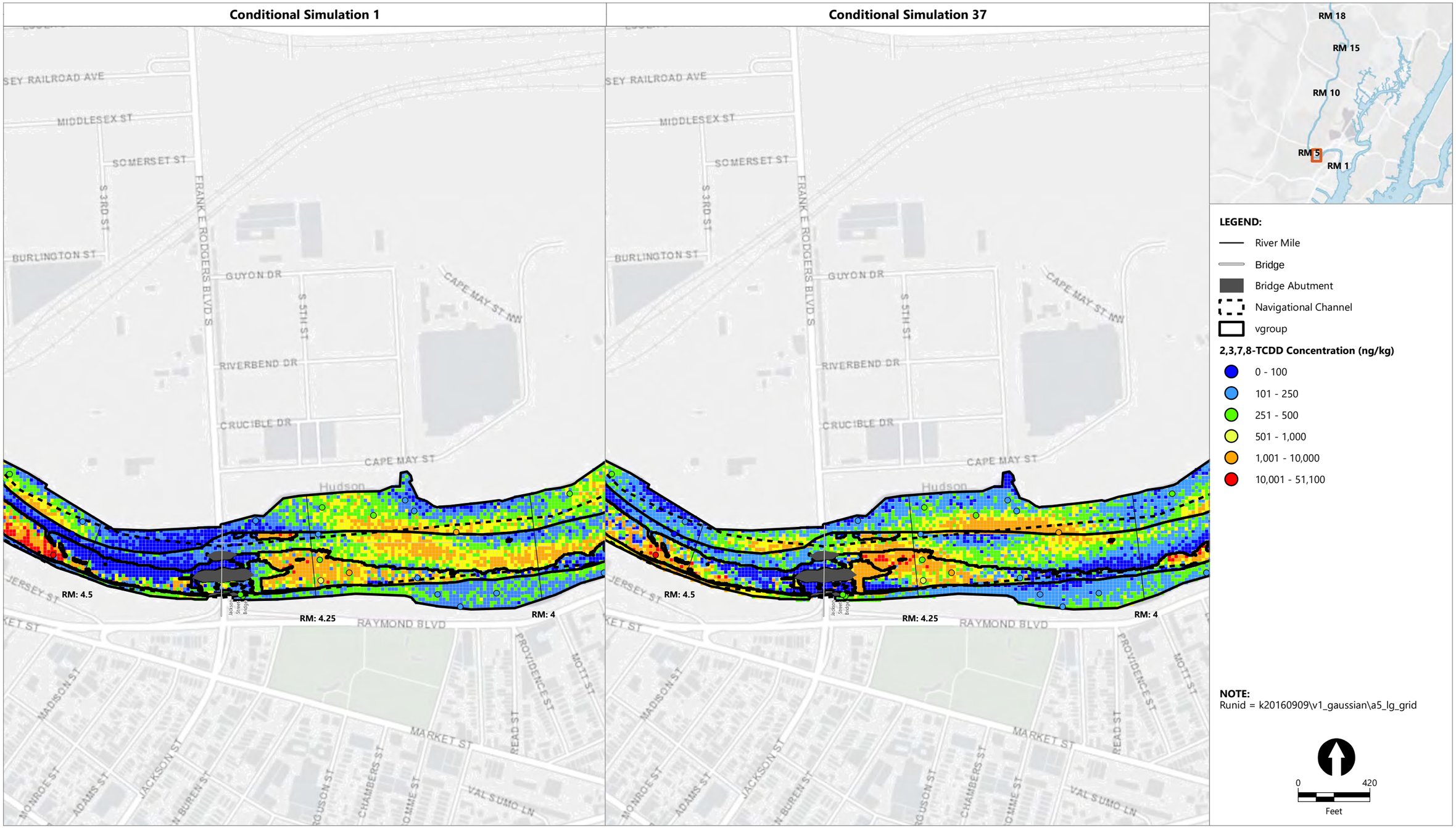

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Figure 7-1t

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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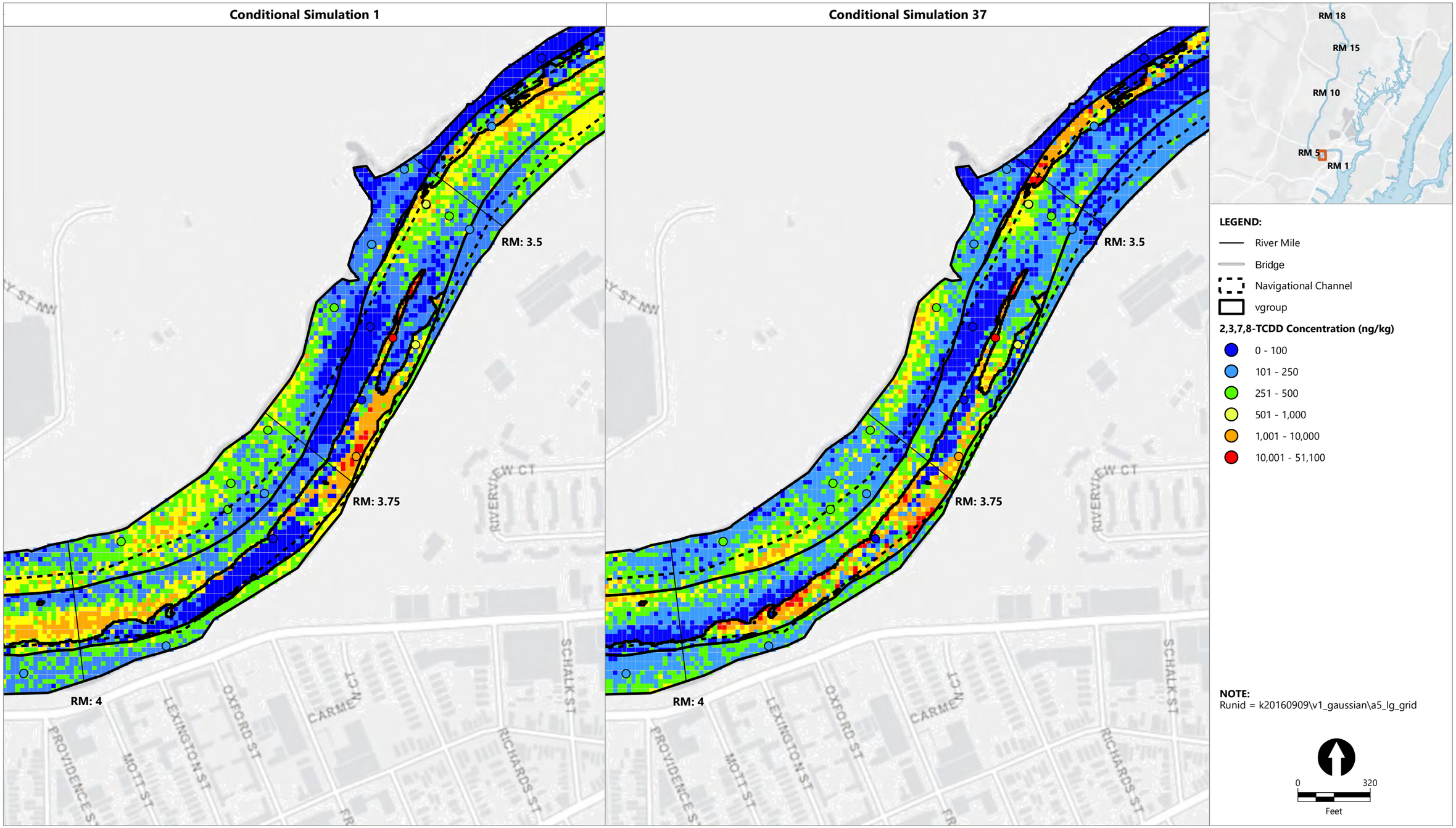

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Figure 7-1u
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

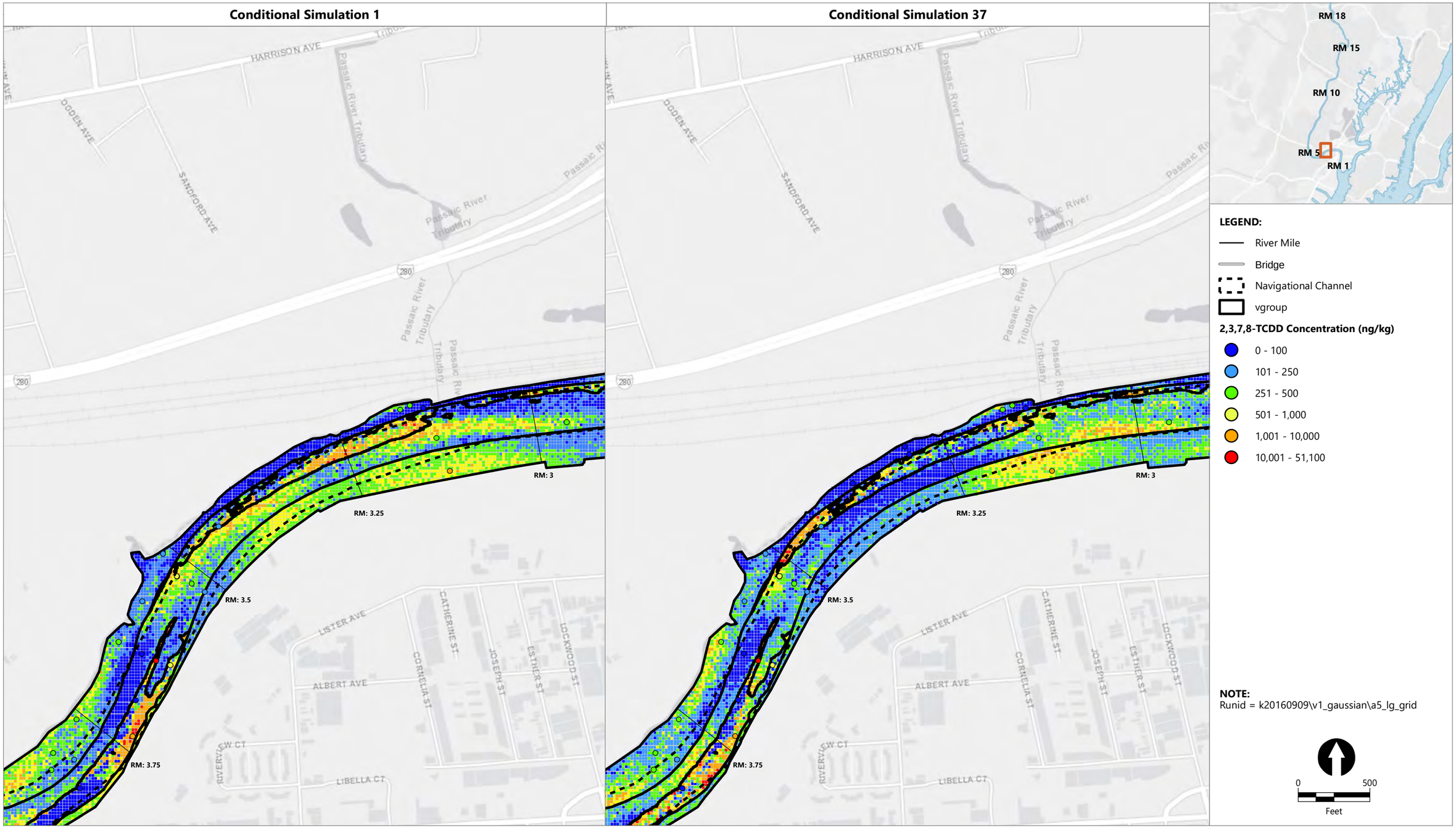

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Figure 7-1v

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

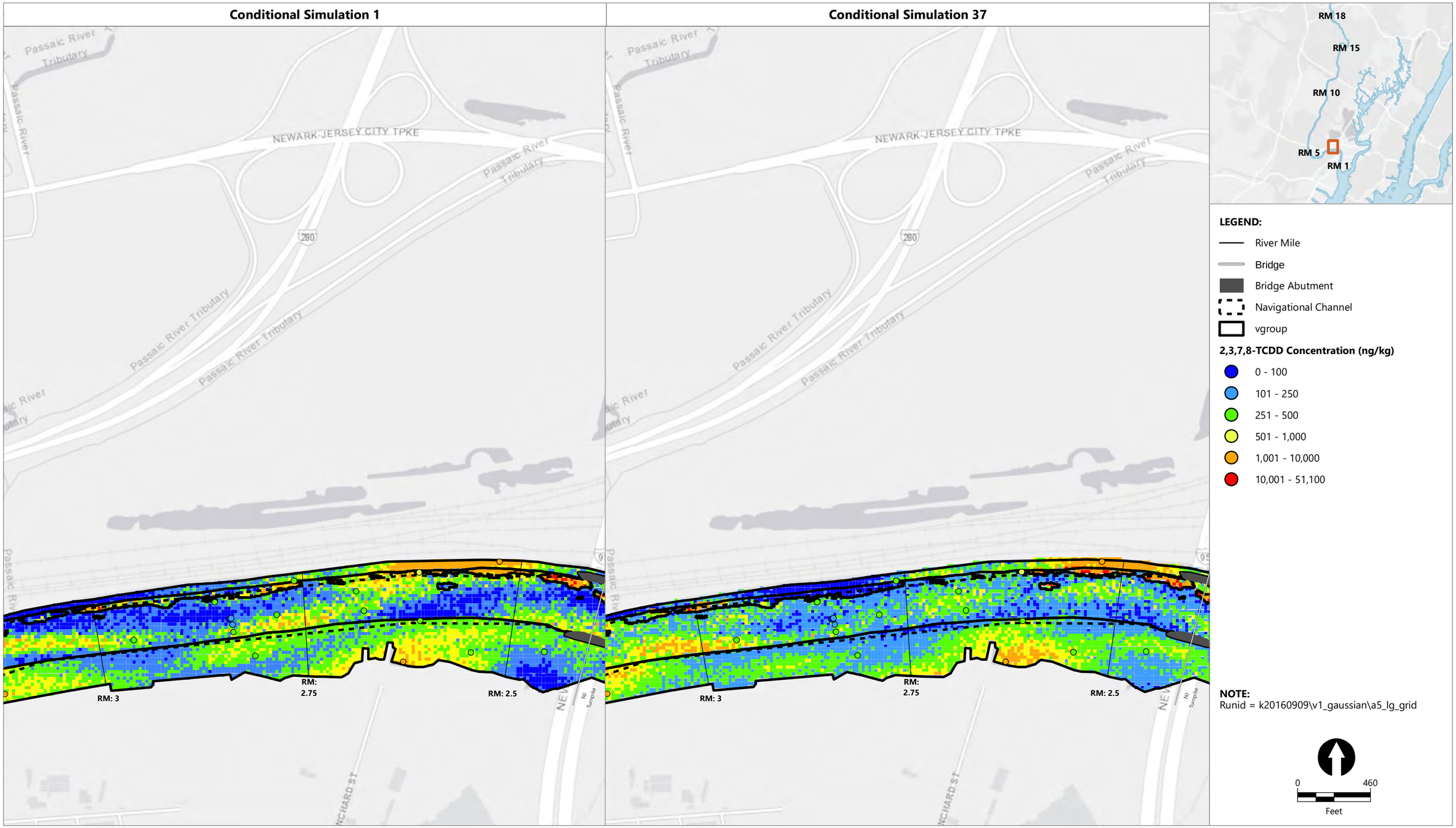

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Figure 7-1w

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

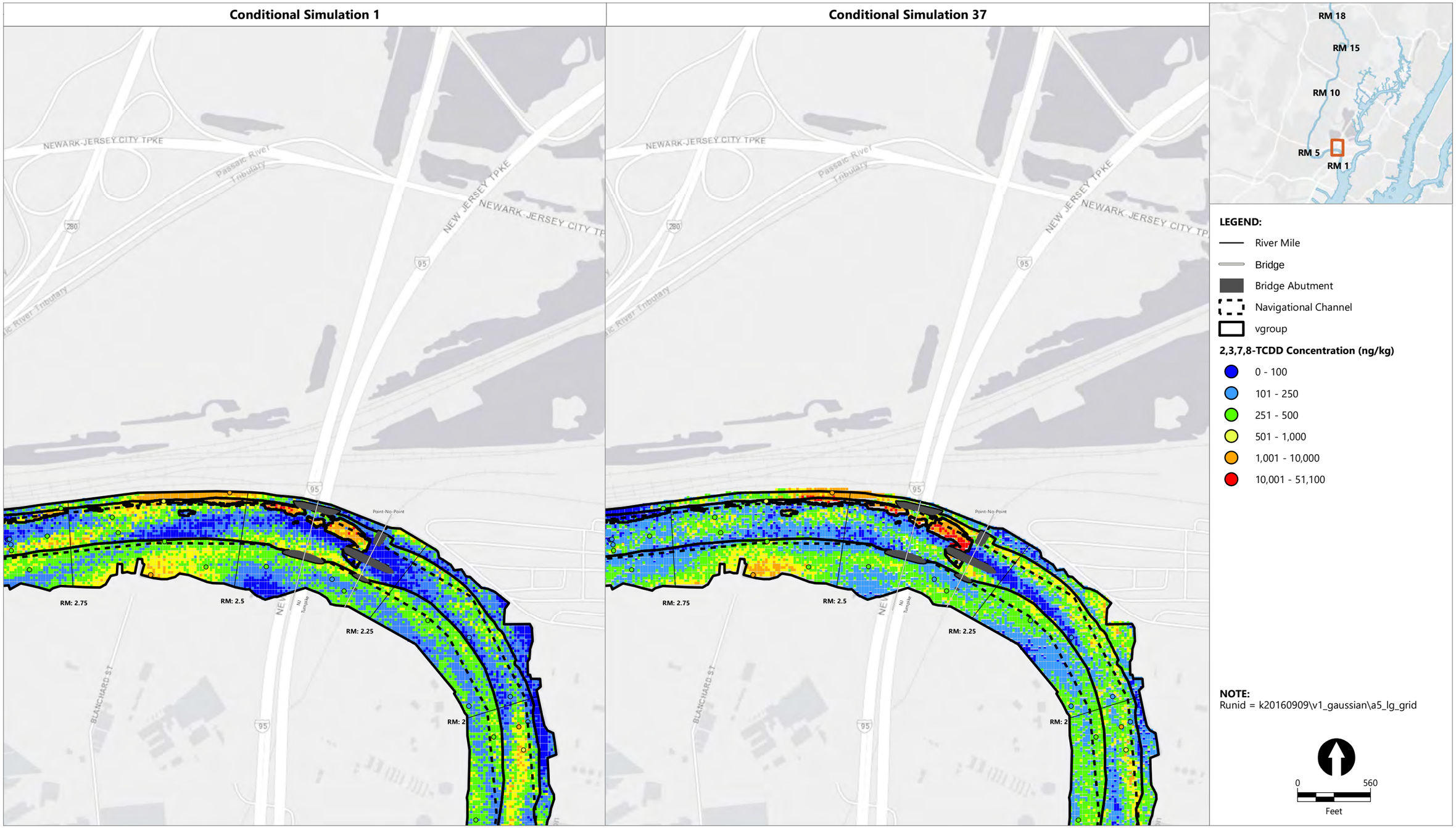

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Figure 7-1x
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

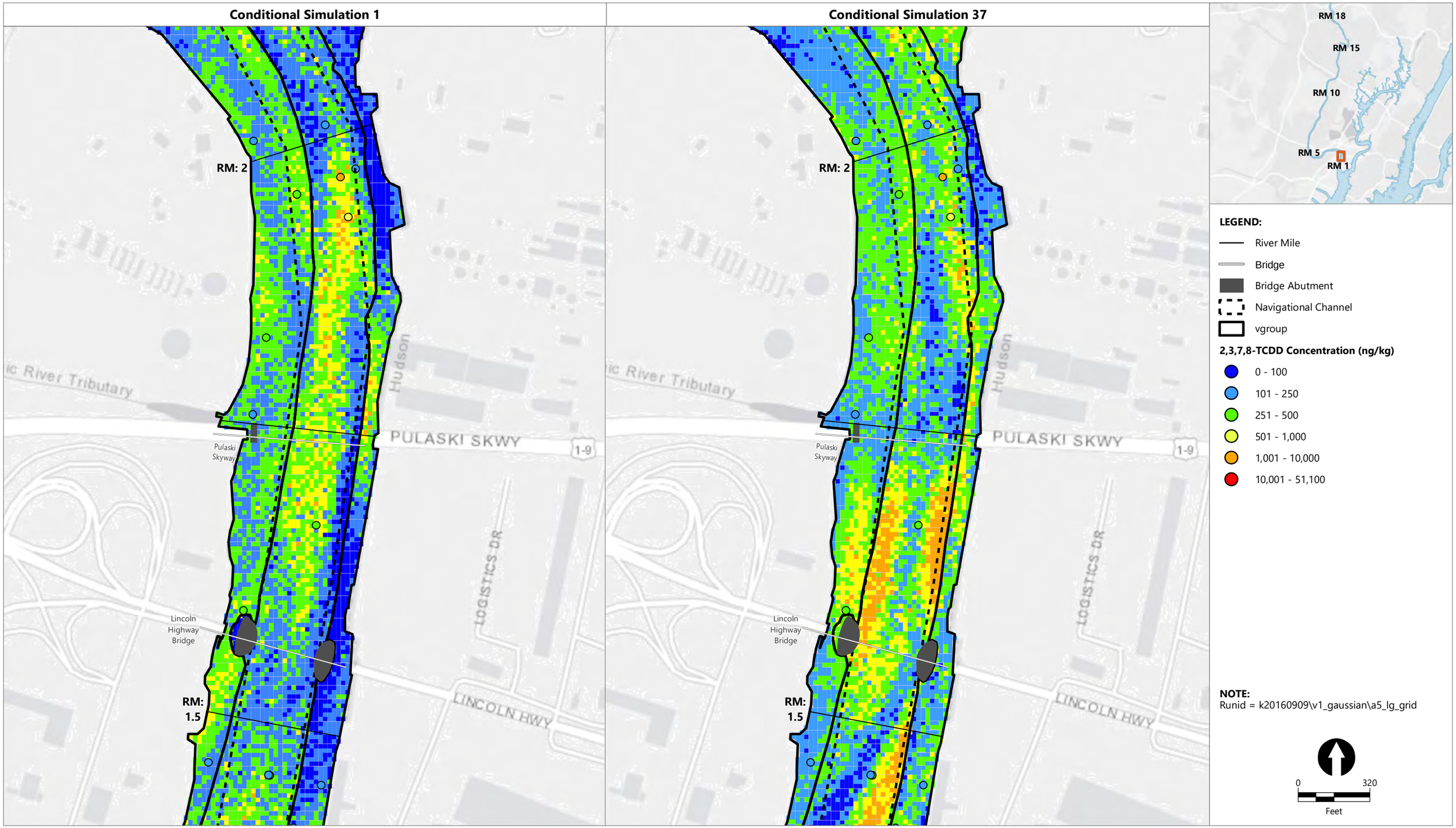

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Figure 7-1y
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

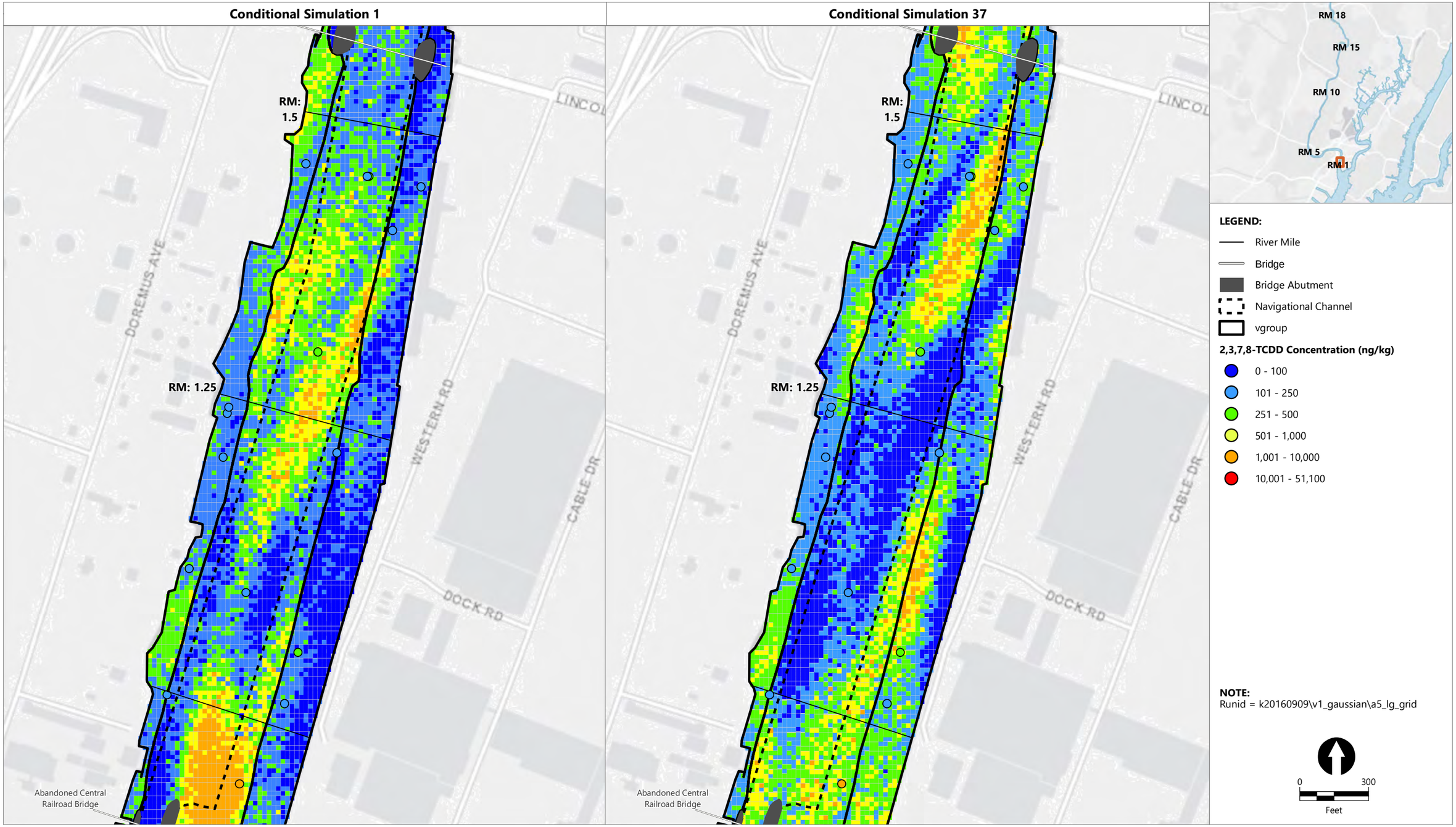

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Figure 7-1z

Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

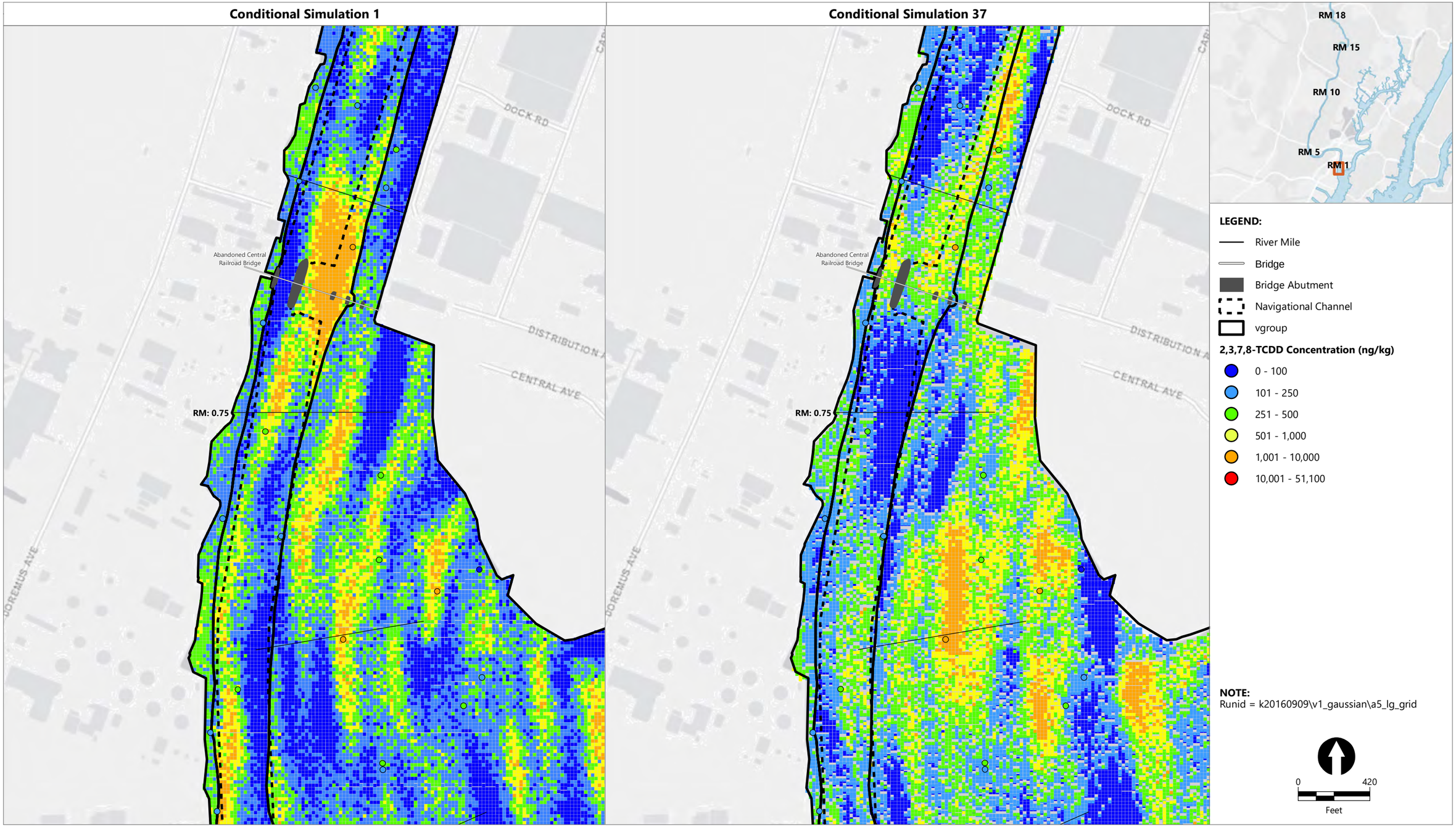

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Figure 7-1aa
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

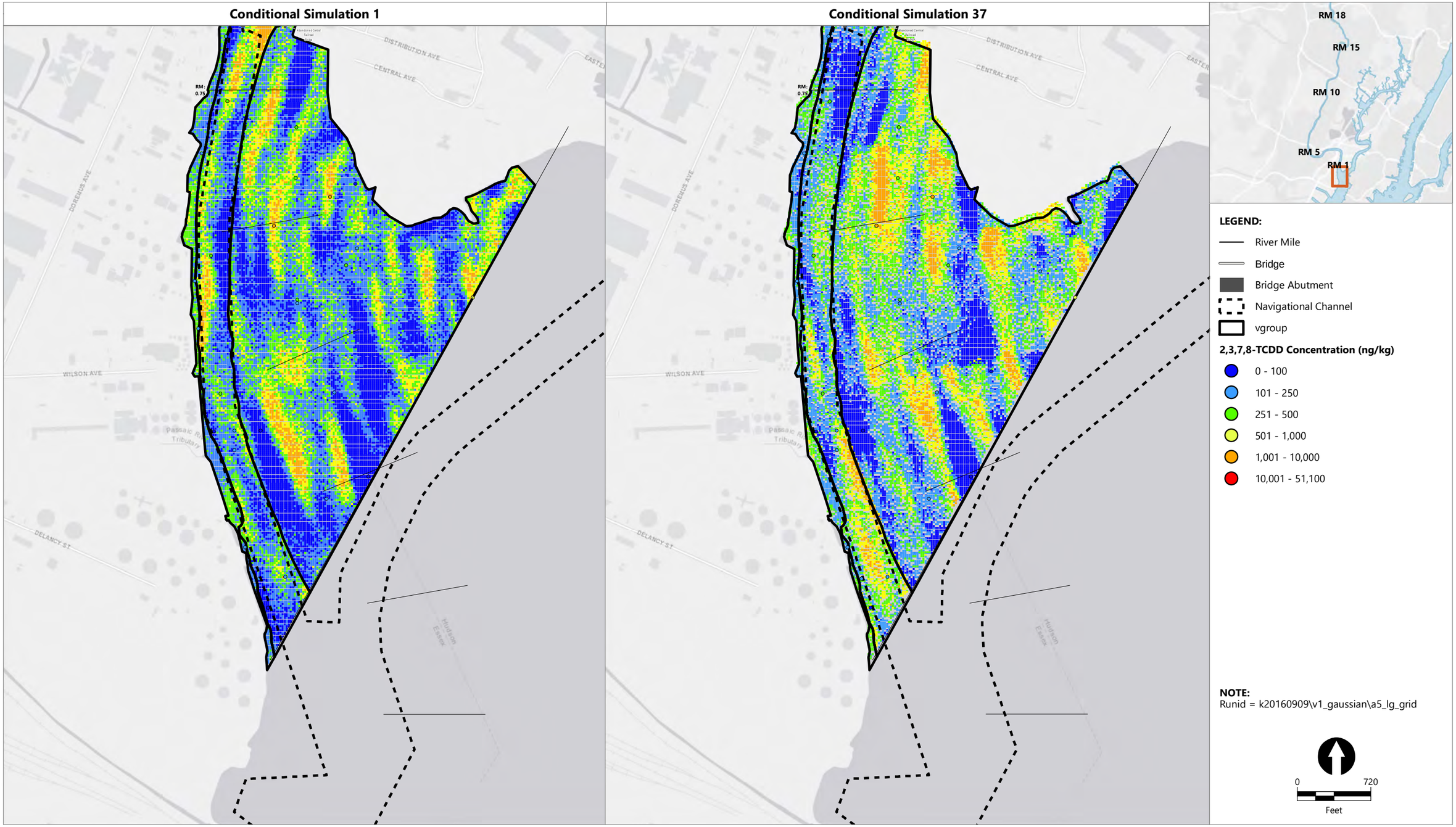

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Figure 7-1ab
Sample 2,3,7,8-TCDD Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
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Figure 7-2a

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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Lower Passaic River Study Remedial Investigation/Feasibility Study

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Figure 7-2b

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

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Figure 7-2c

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

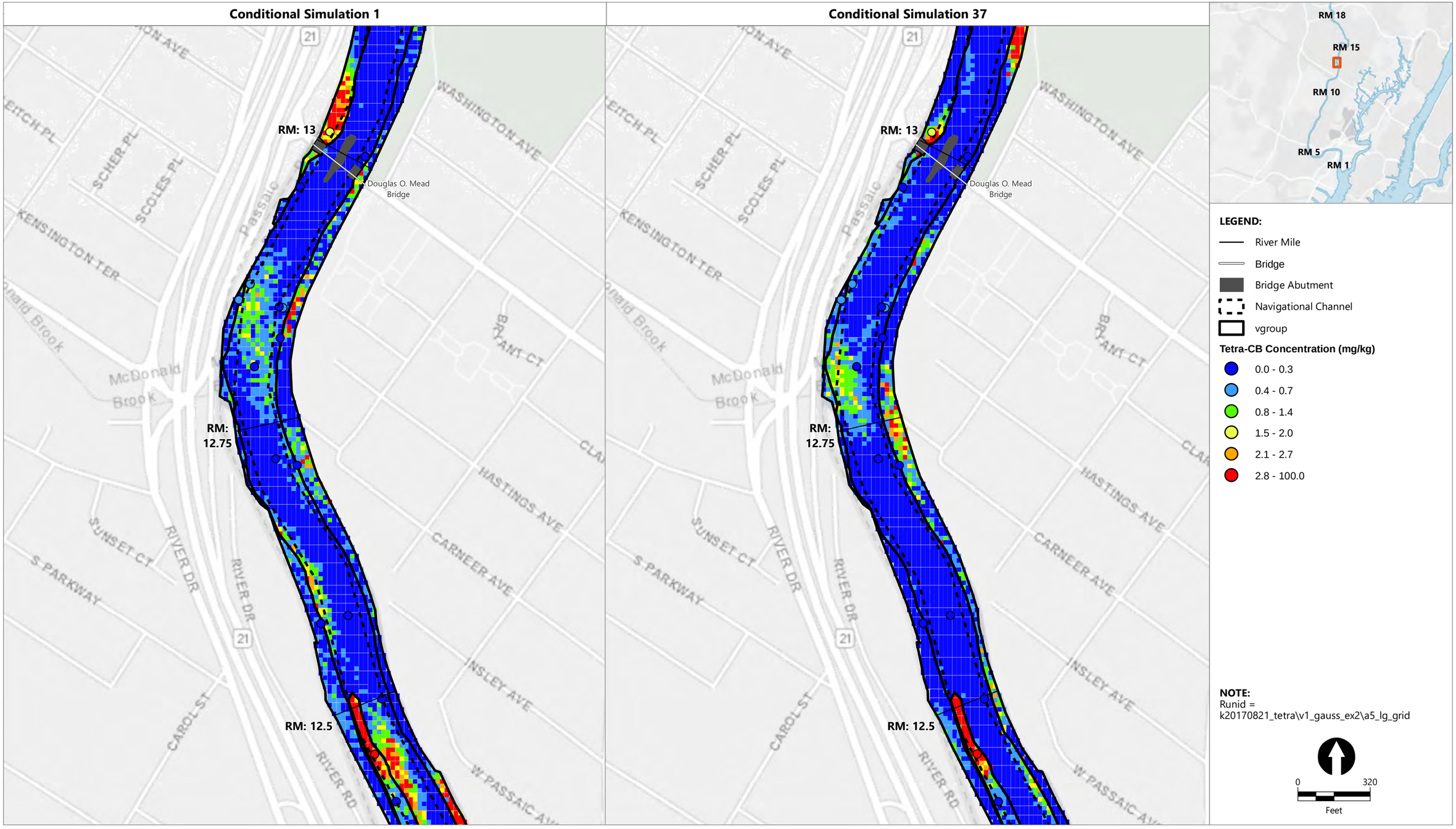

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Figure 7-2d

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

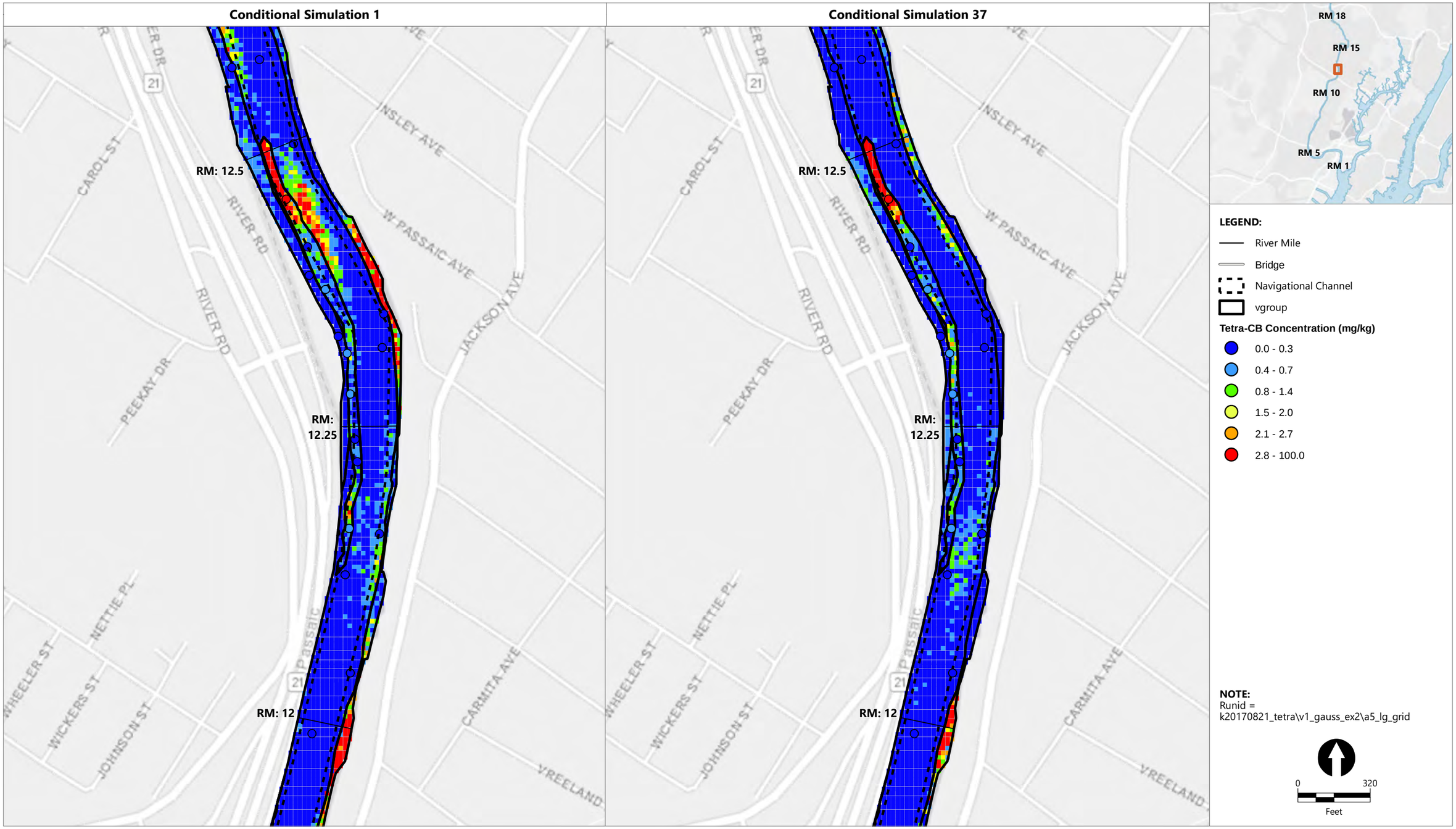

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Figure 7-2e

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

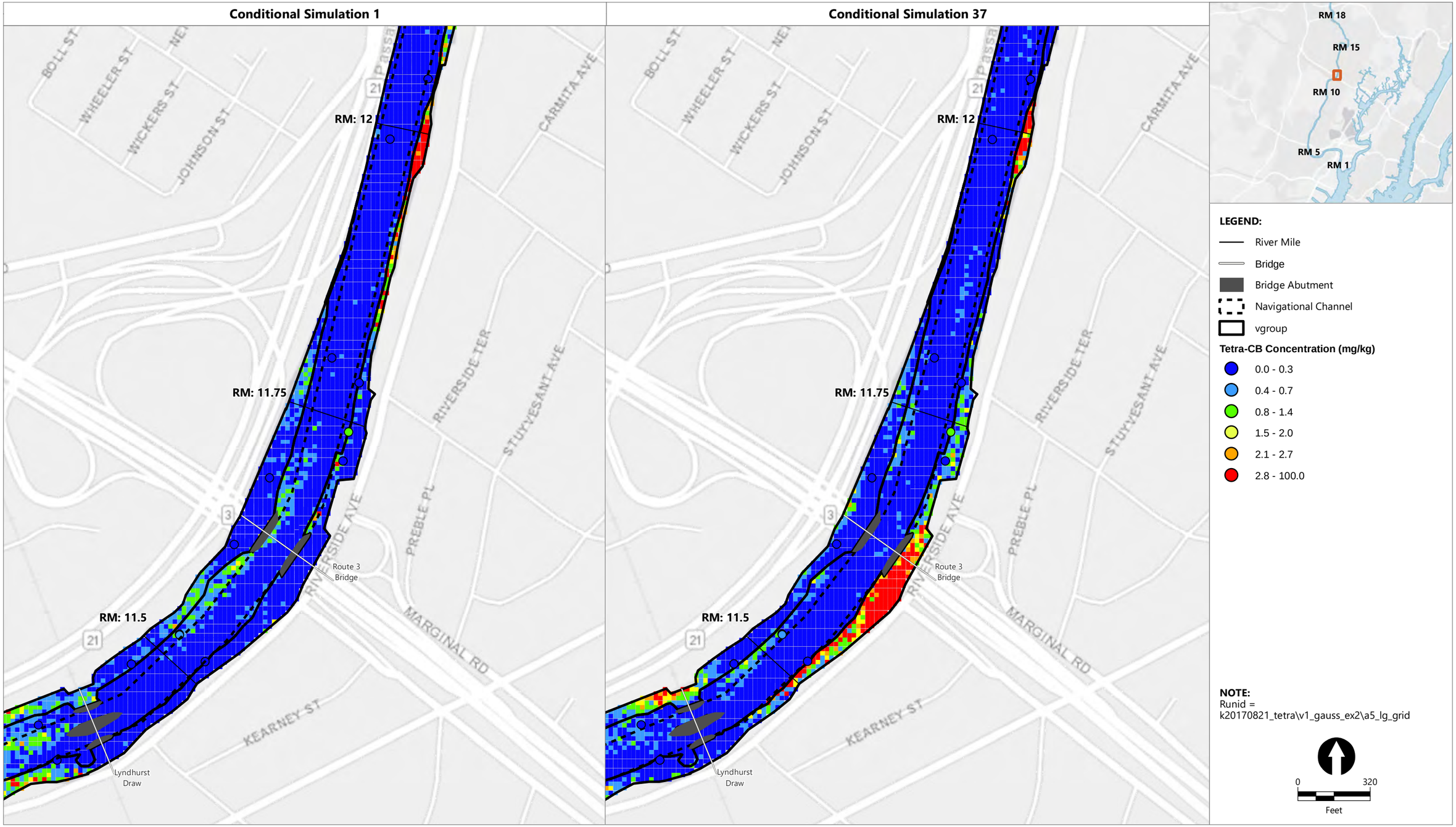

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Figure 7-2f
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

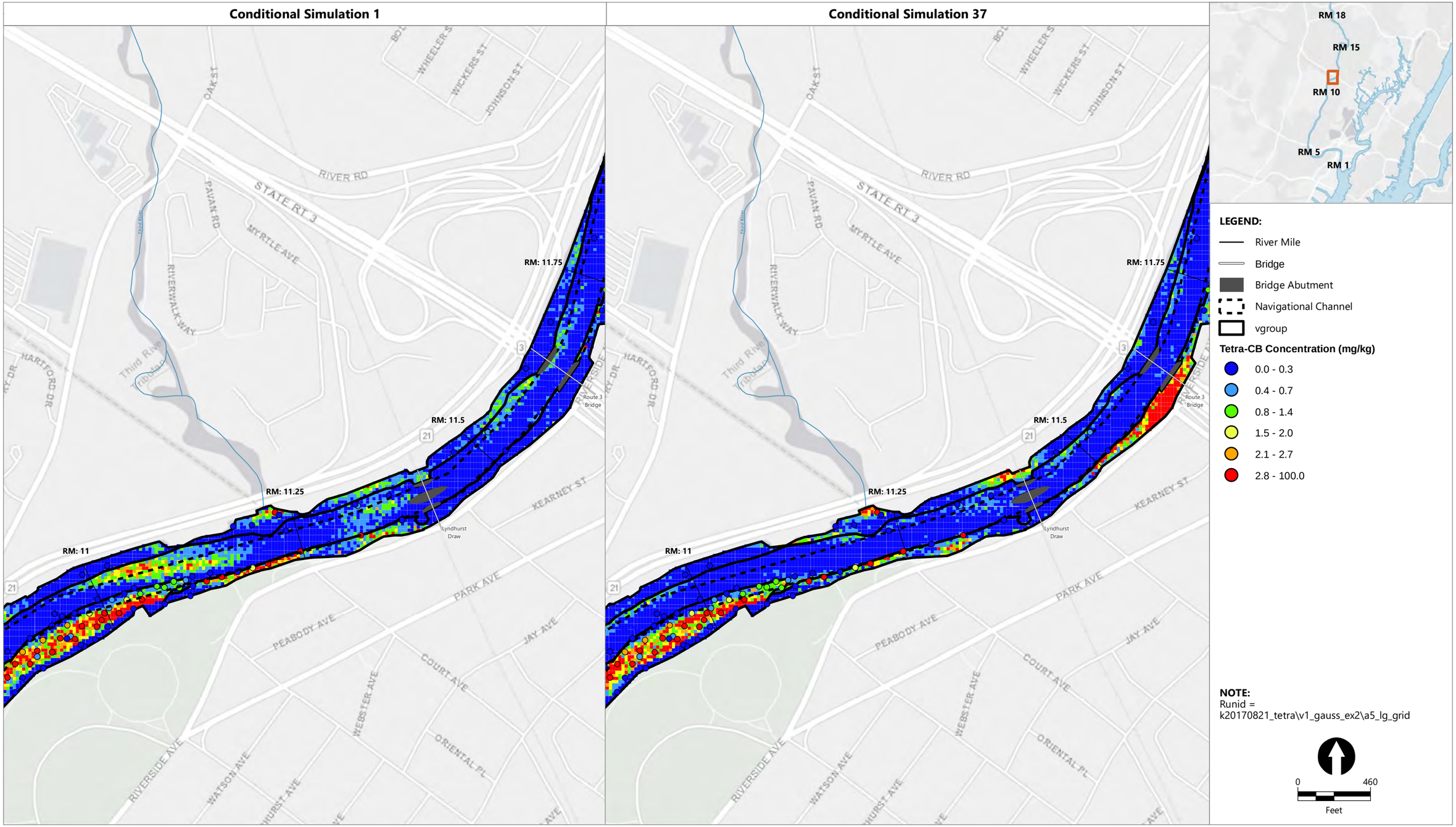

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Figure 7-2g
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

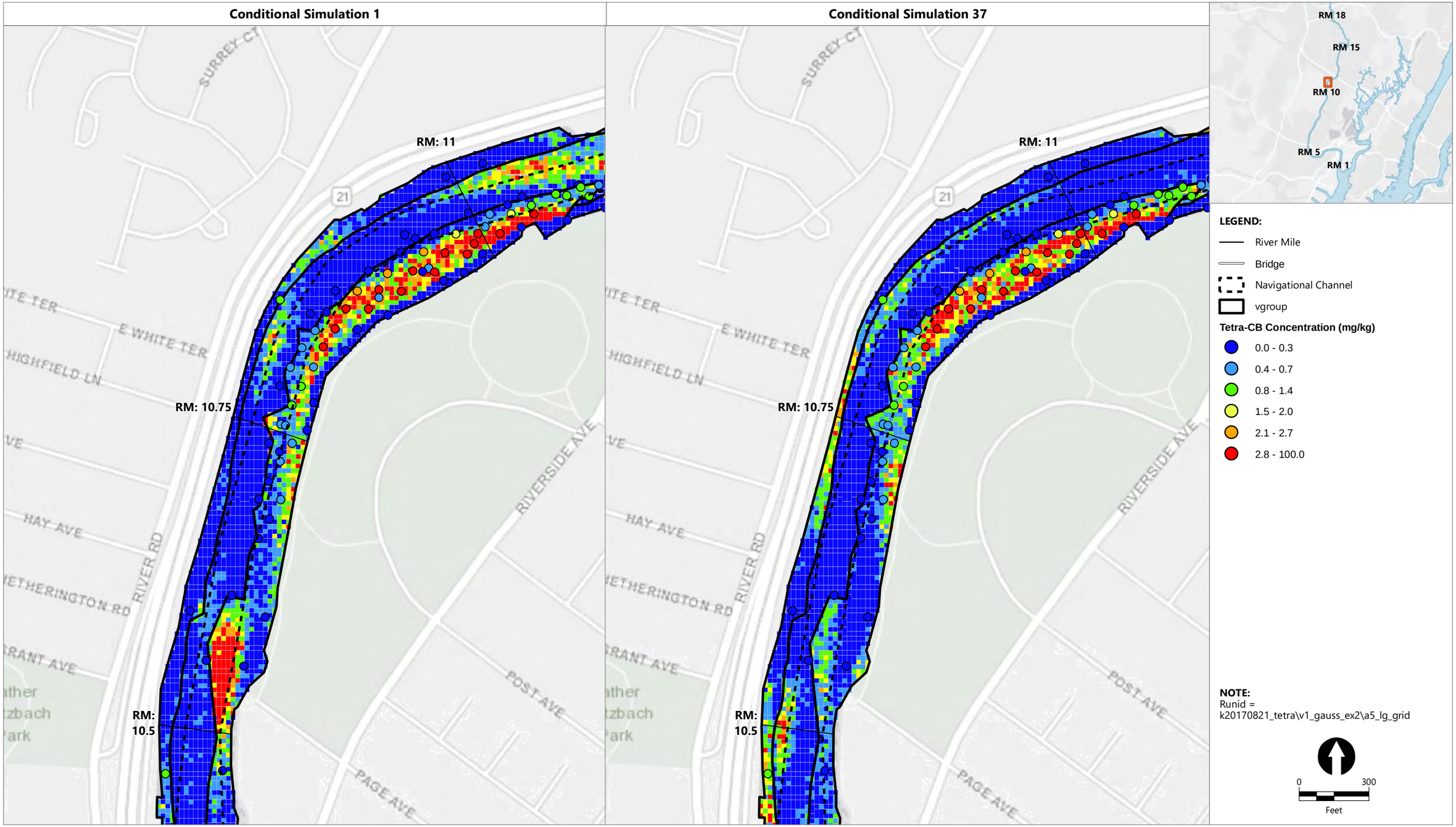

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Figure 7-2h
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

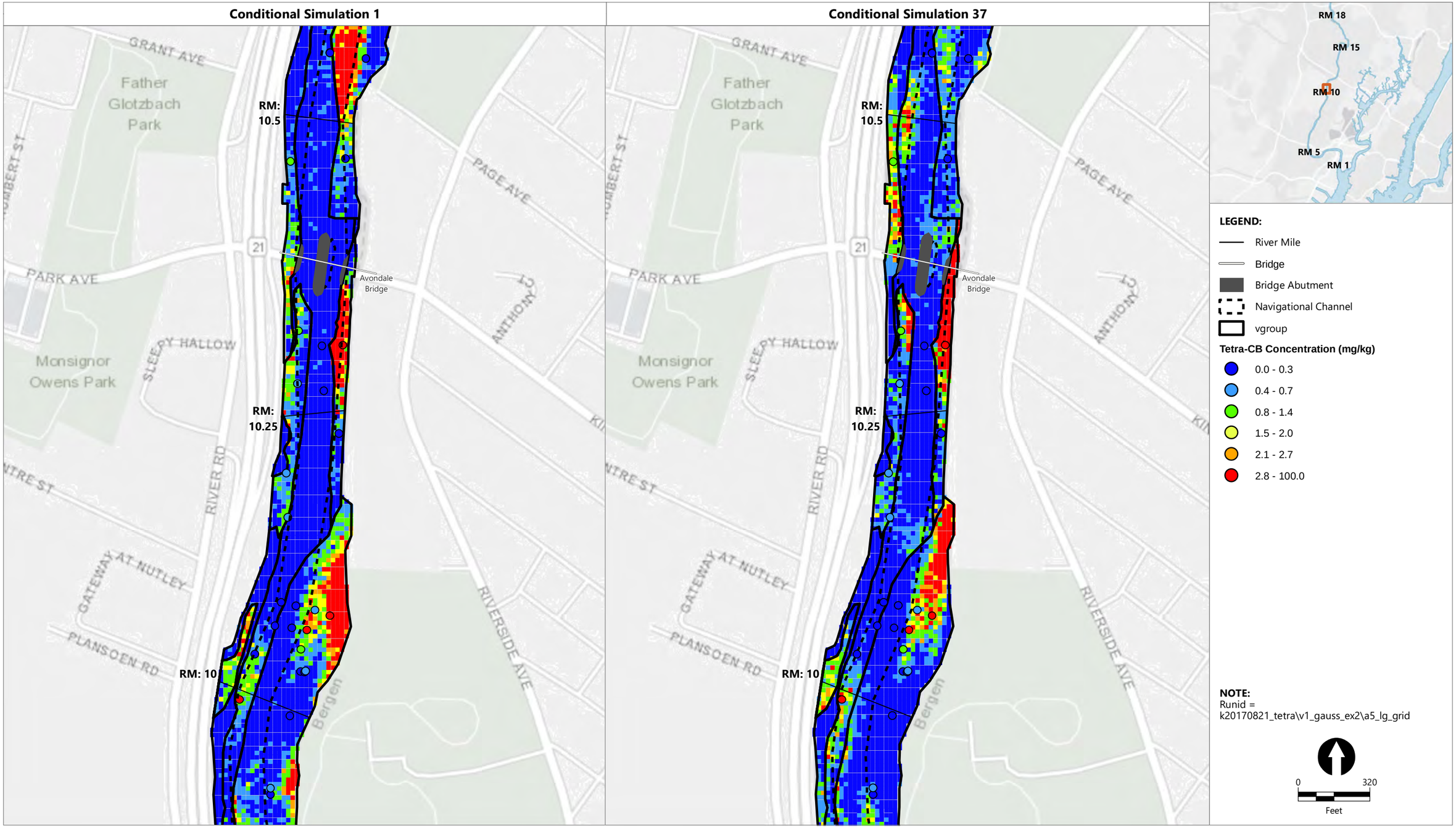

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Figure 7-2i

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

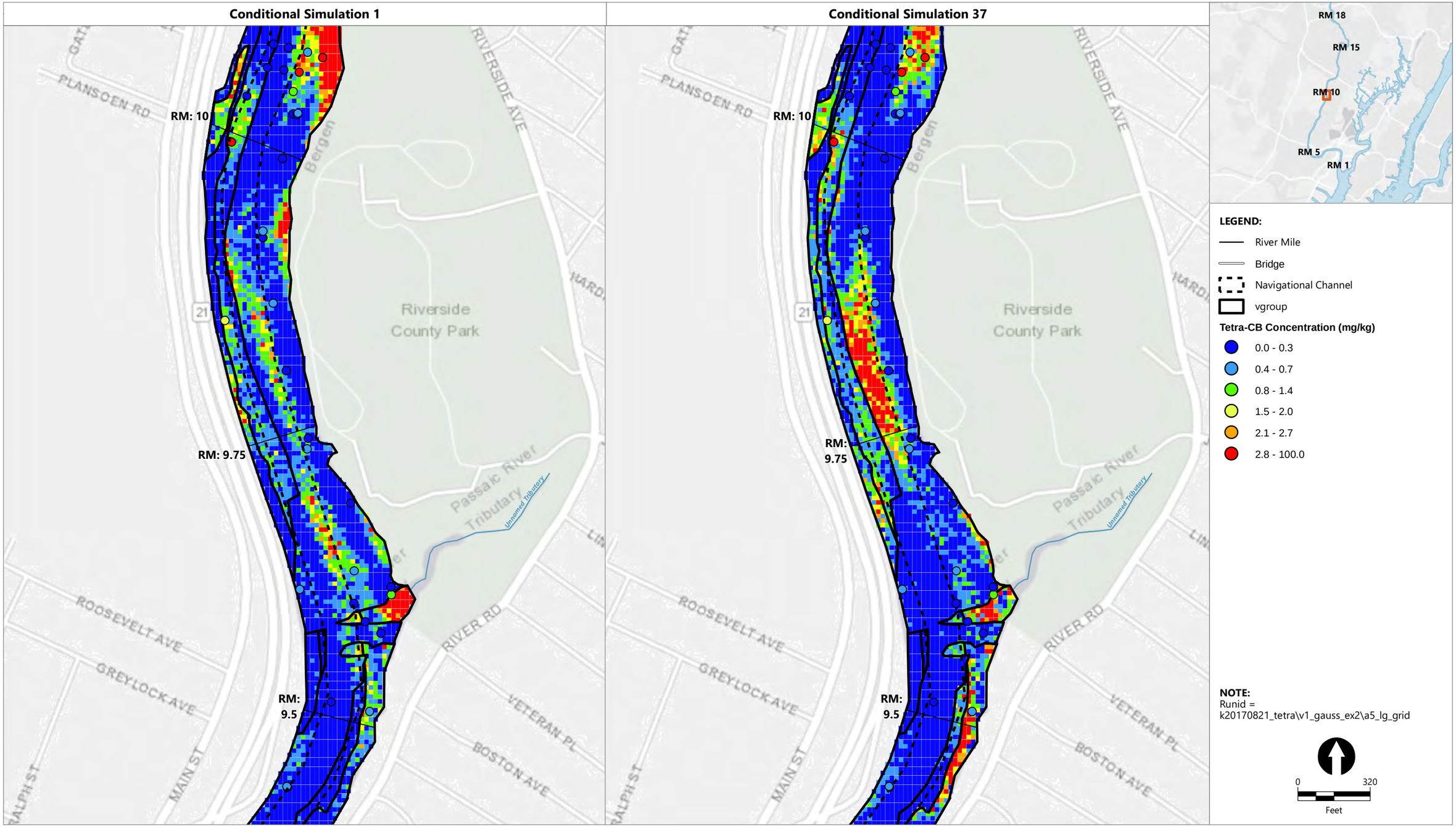

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Figure 7-2j
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

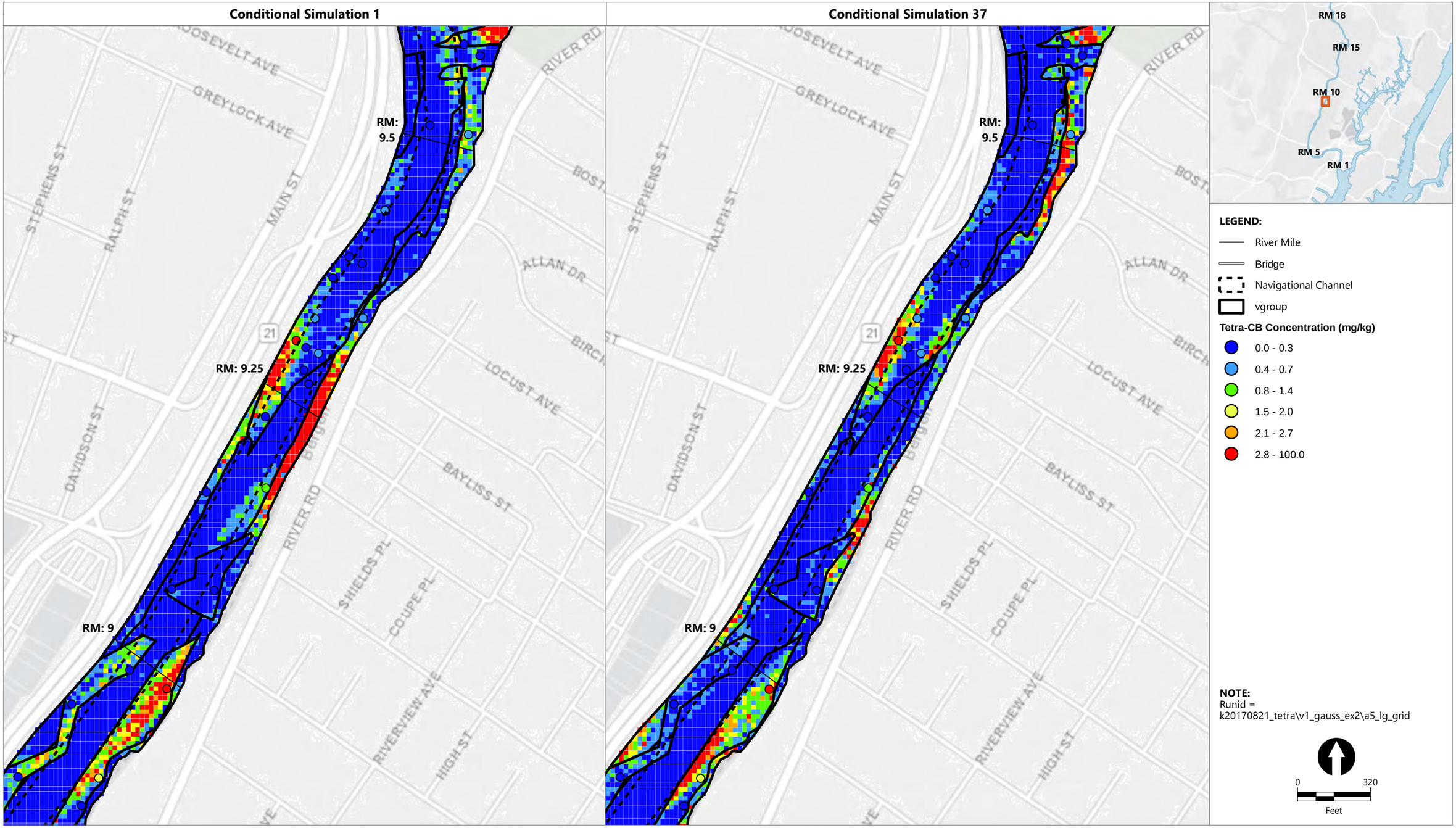

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Figure 7-2k

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

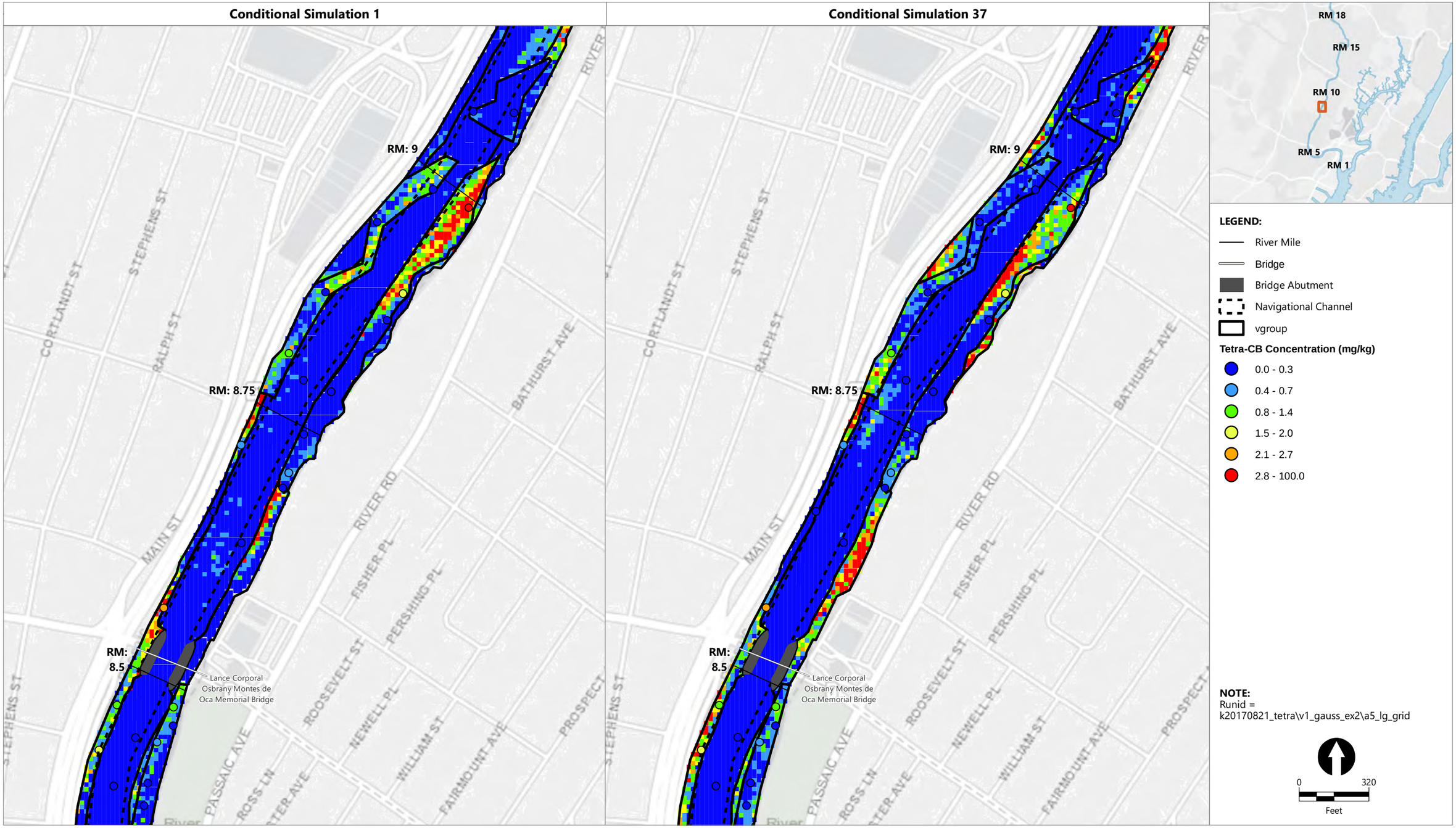

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Figure 7-2l

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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Lower Passaic River Study Remedial Investigation/Feasibility Study

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Figure 7-2m

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

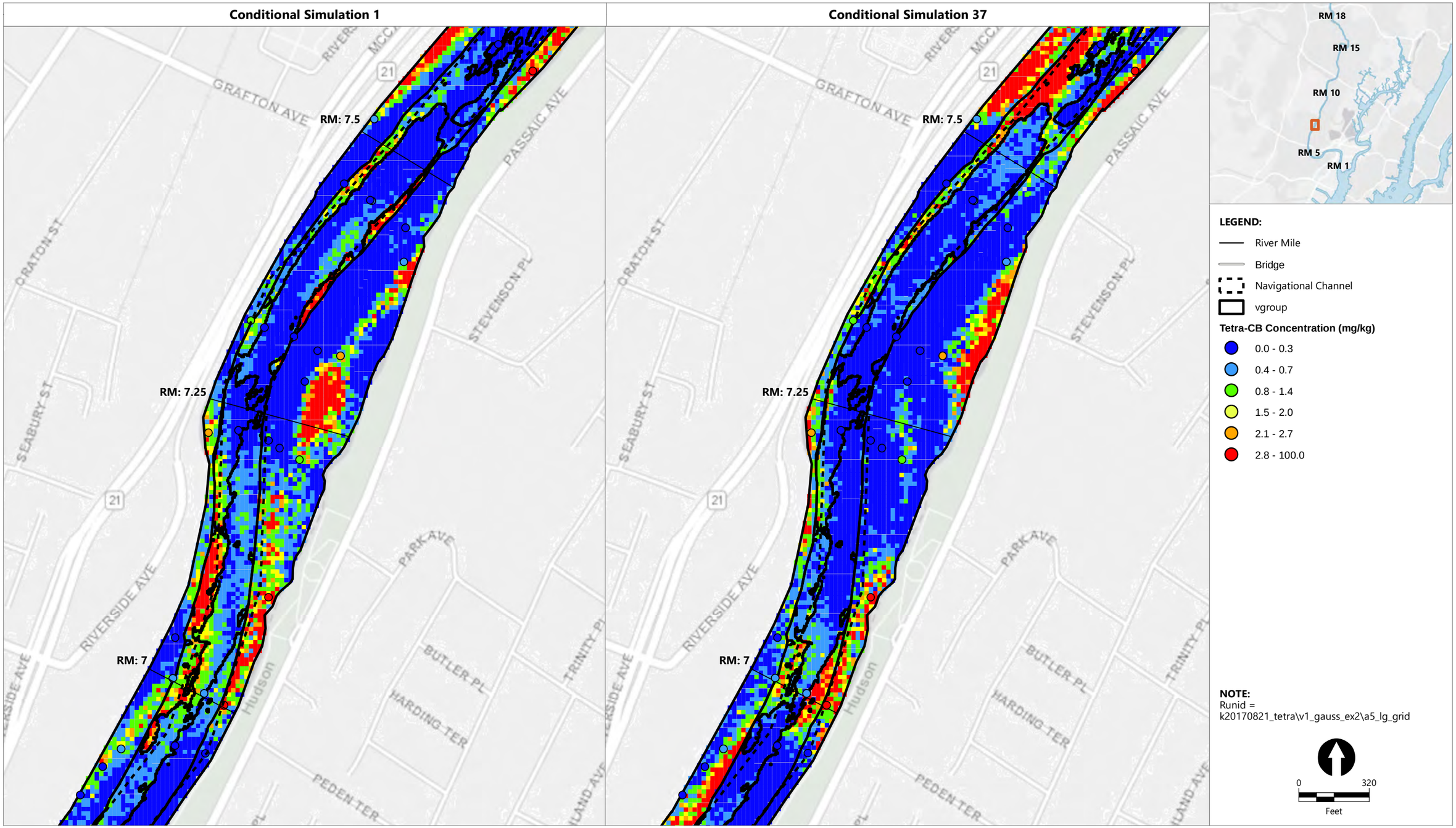

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Figure 7-2n

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

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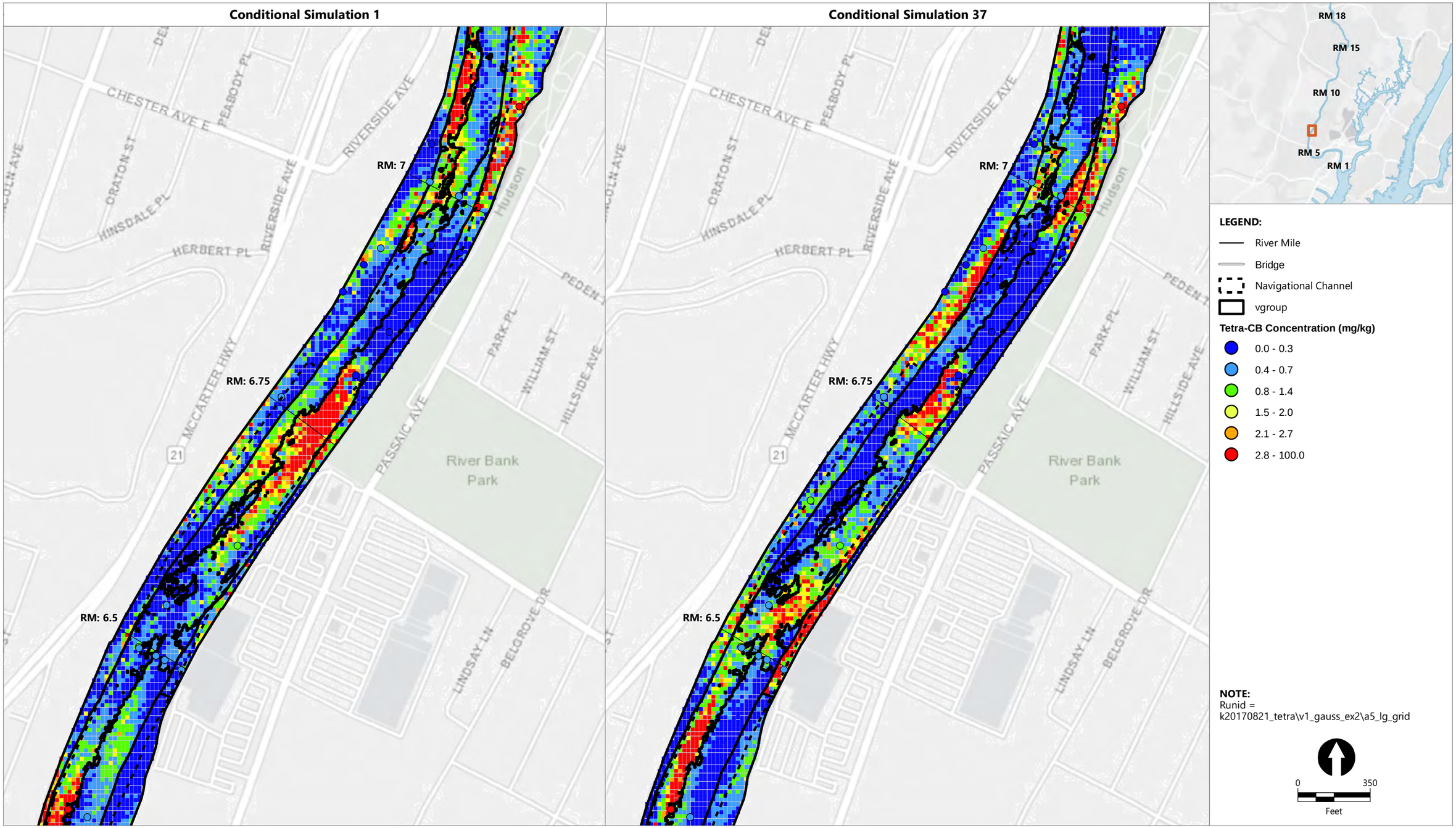

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Figure 7-2o
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

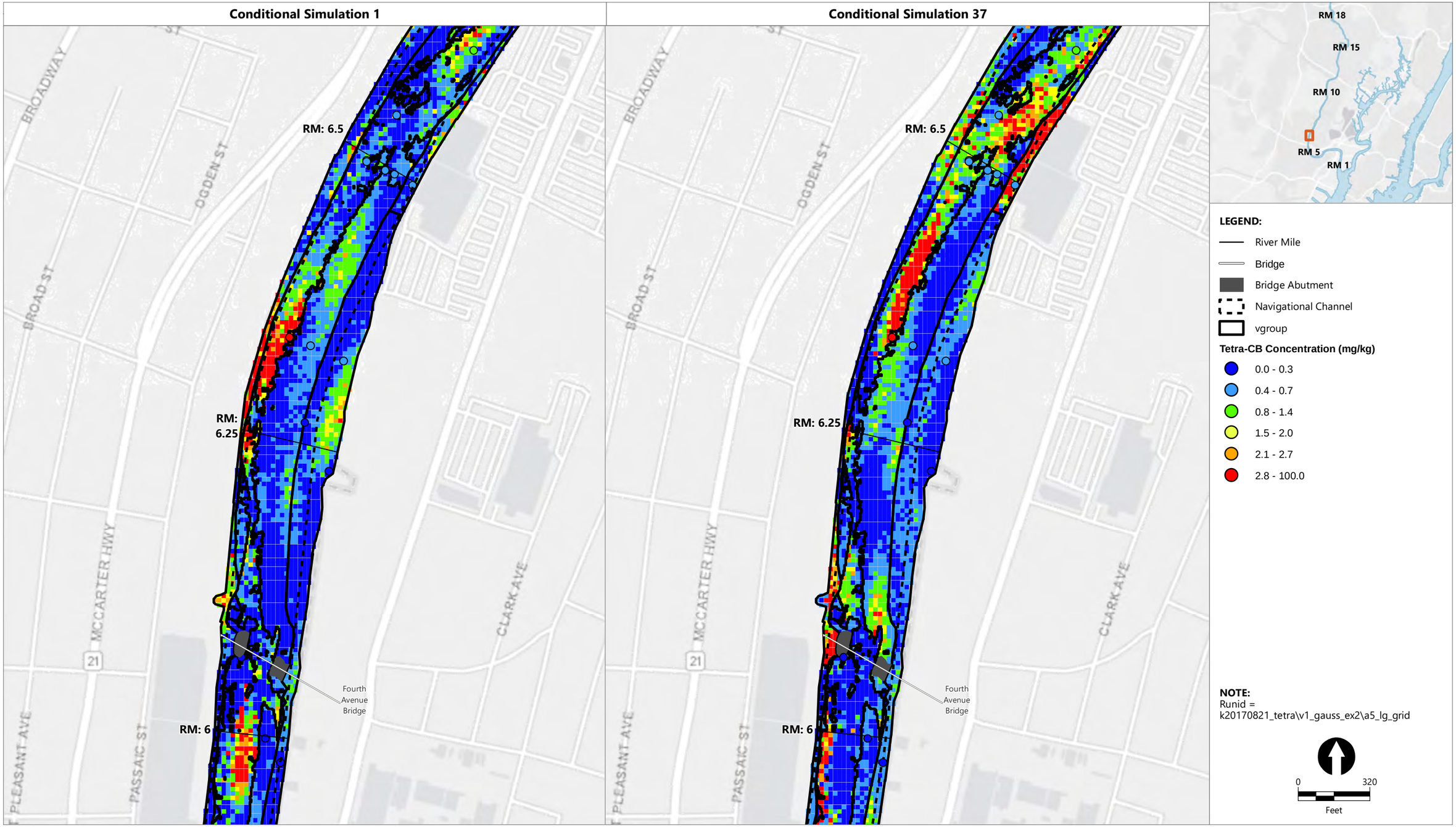

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Figure 7-2p

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

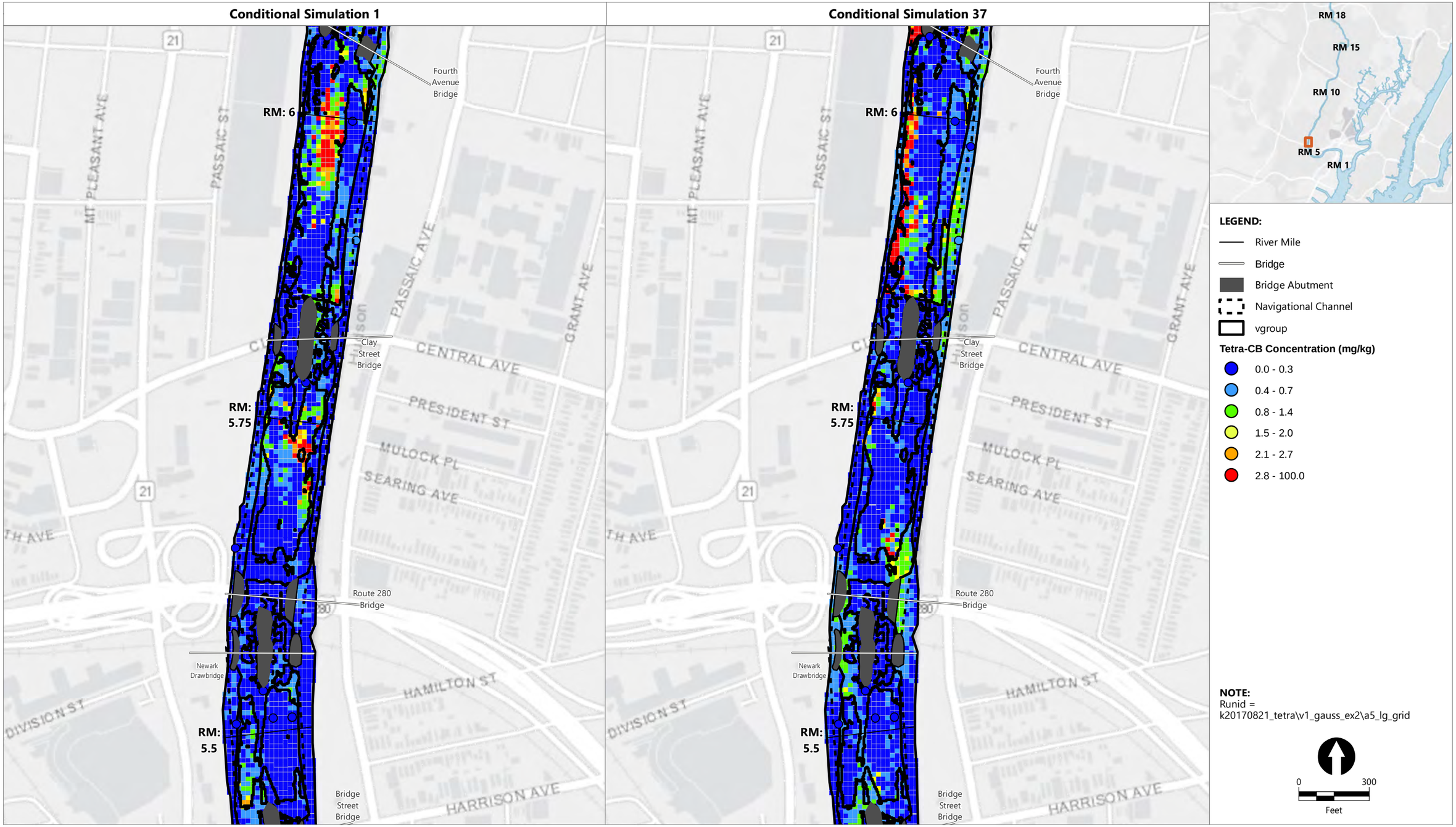

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Figure 7-2q
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

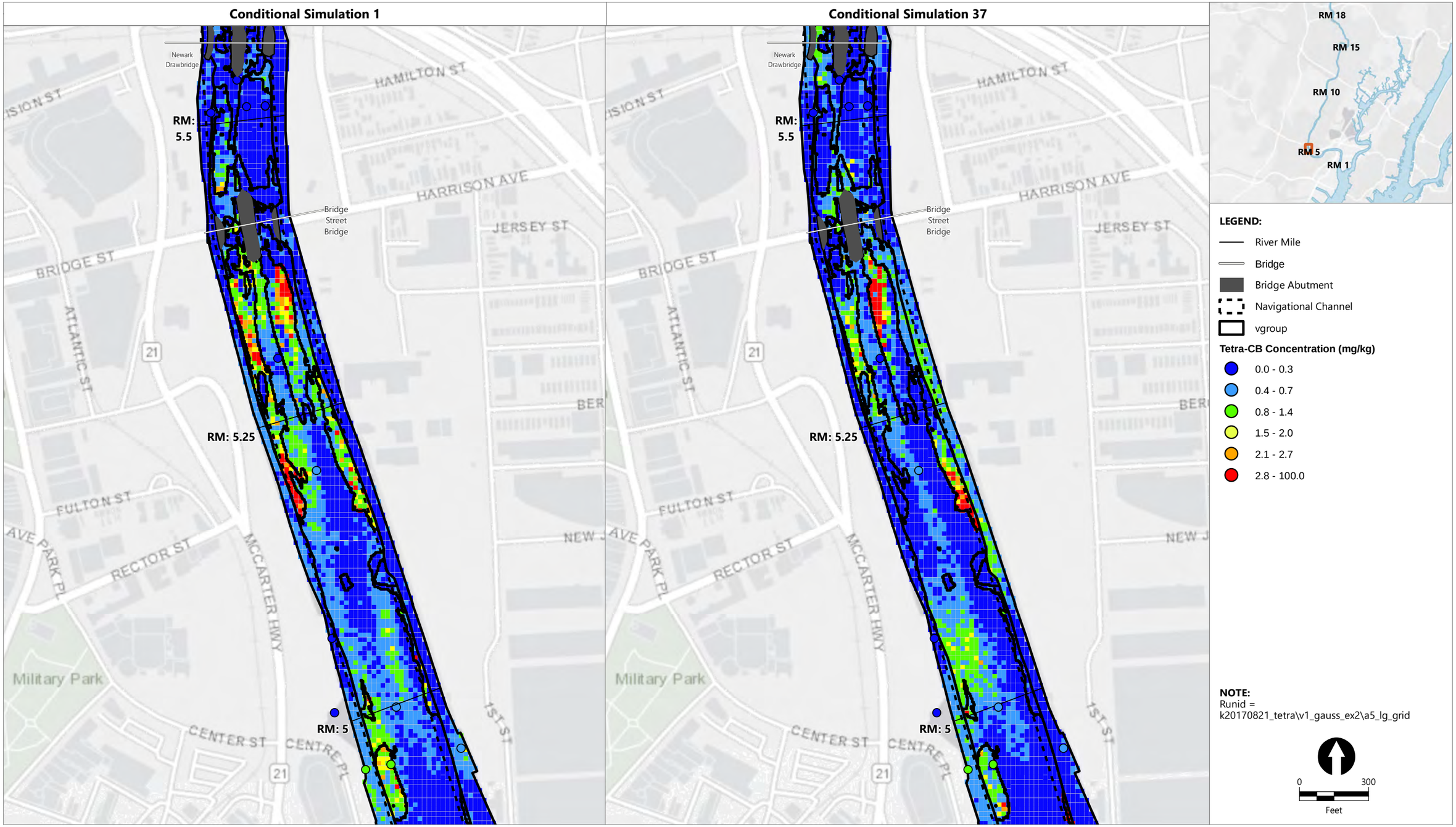

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Figure 7-2r

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

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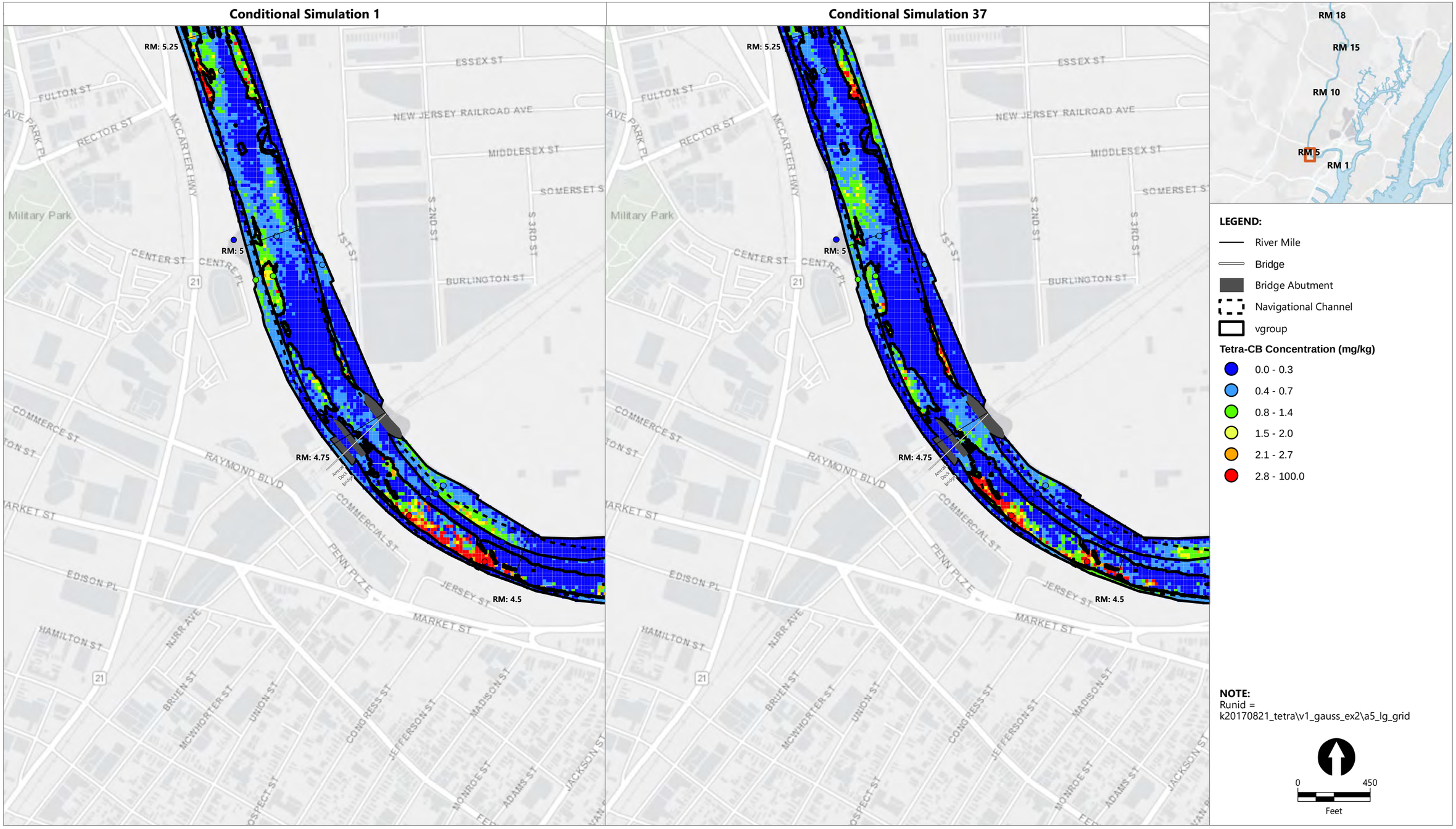

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Figure 7-2s
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

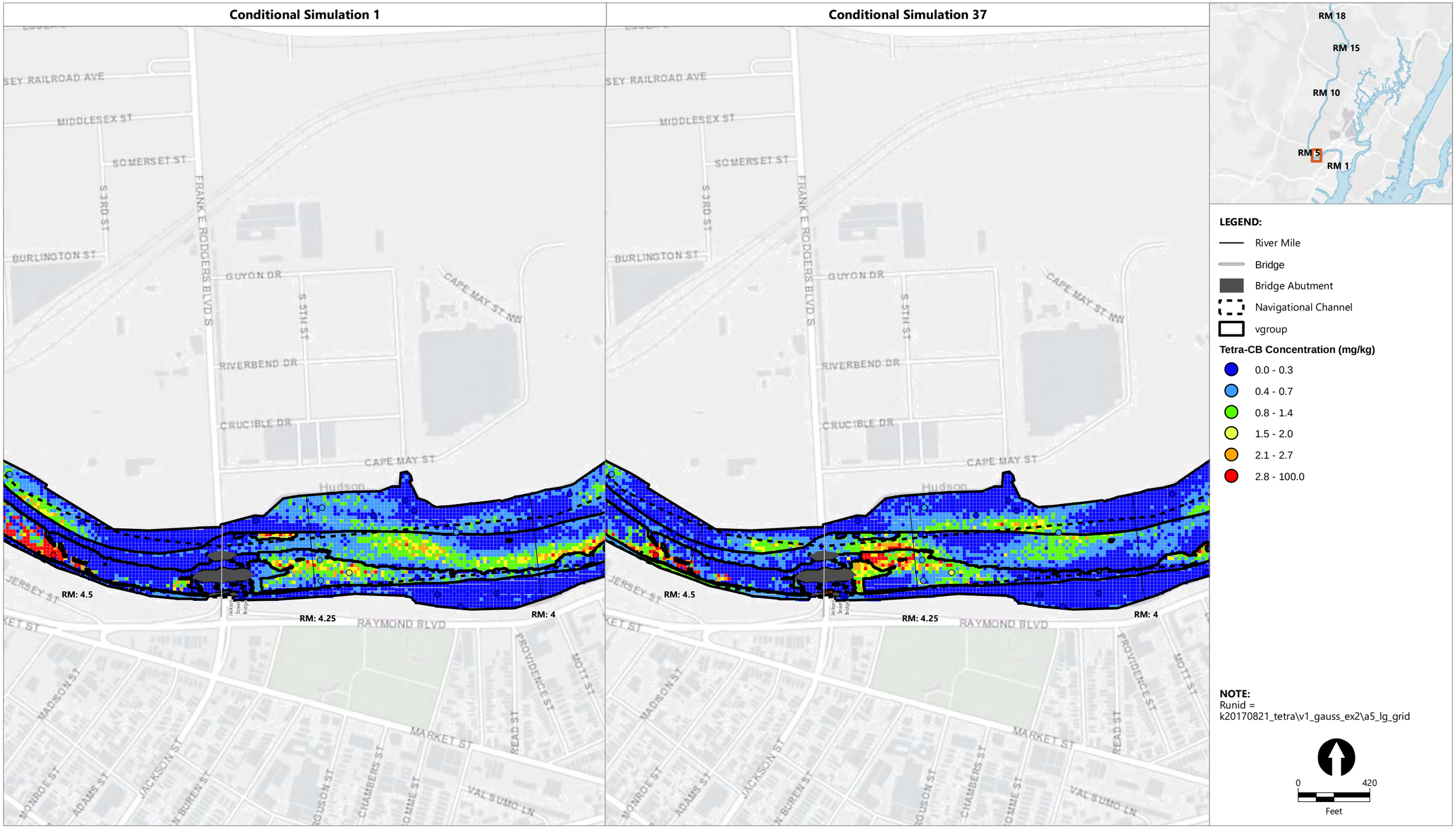

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Figure 7-2t

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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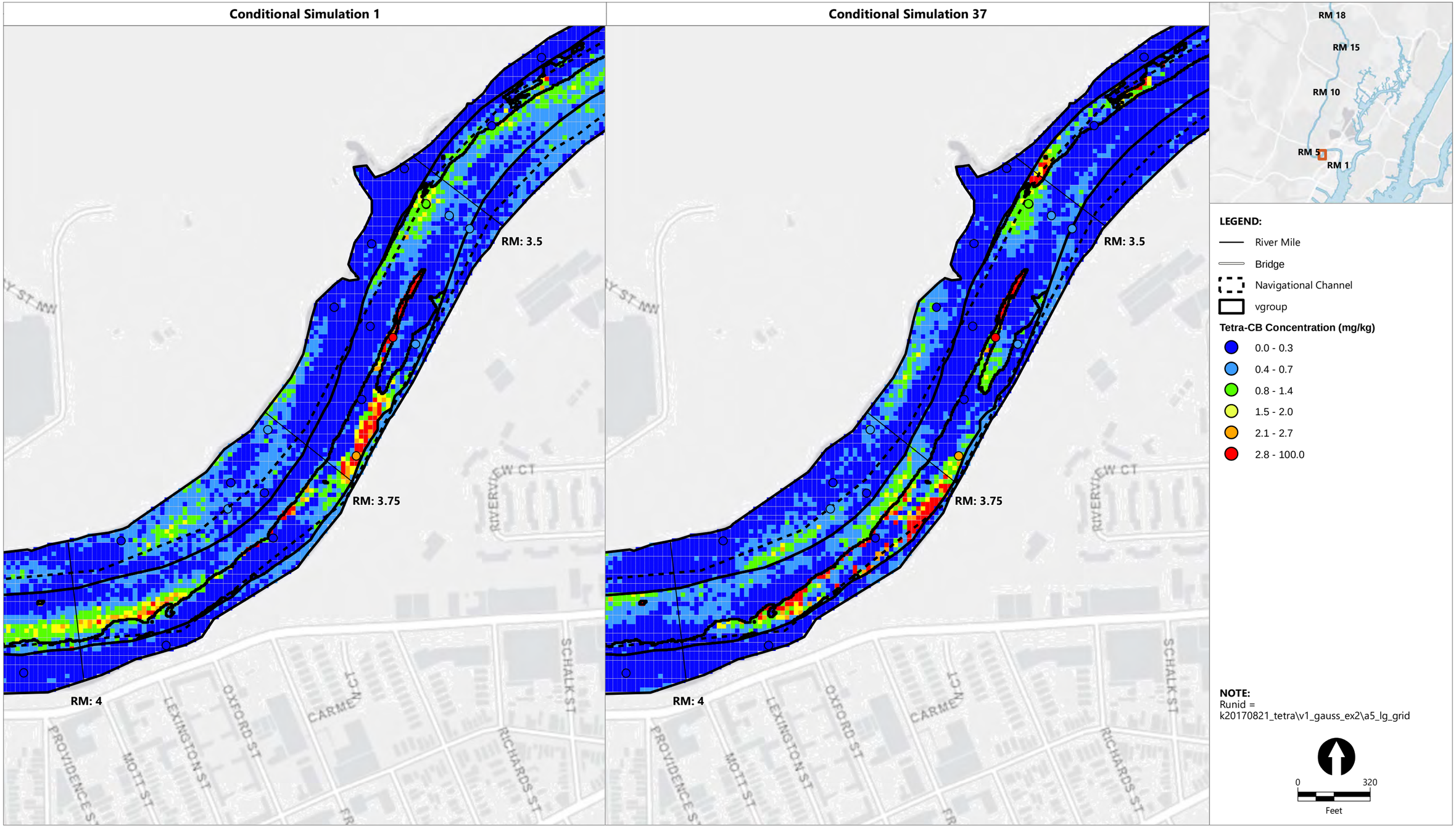

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Figure 7-2u
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

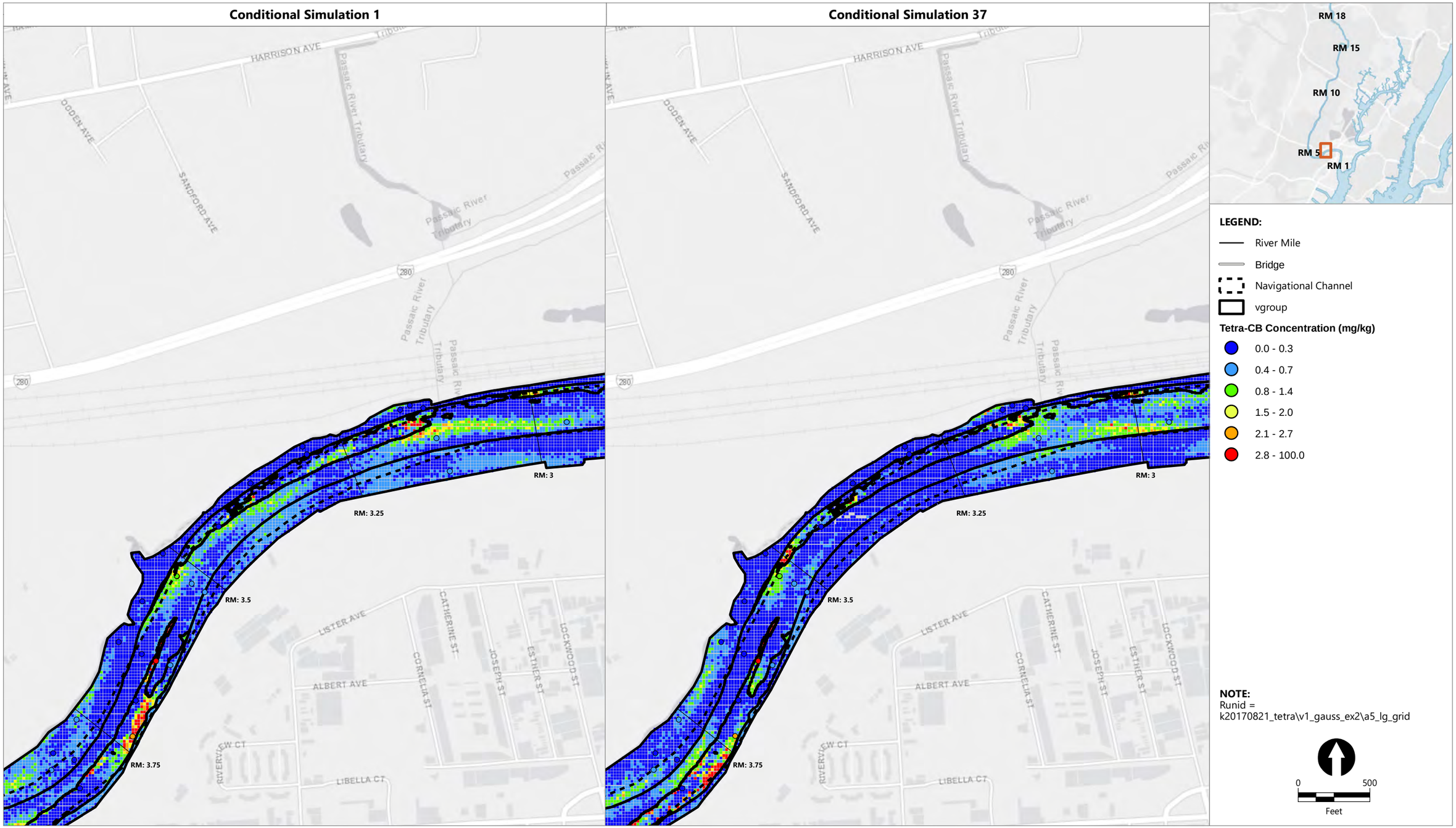

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Figure 7-2v
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

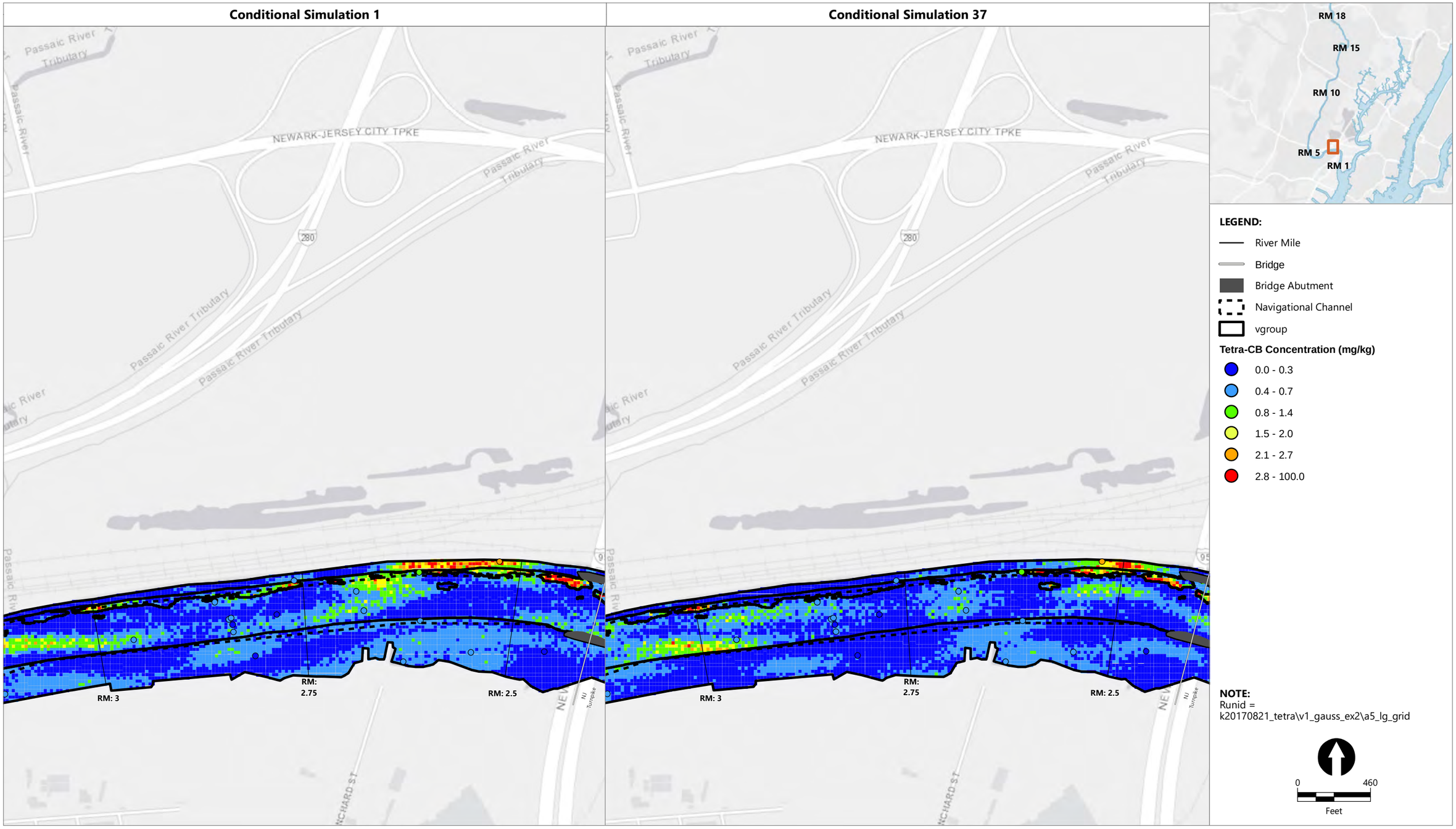

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Figure 7-2w

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

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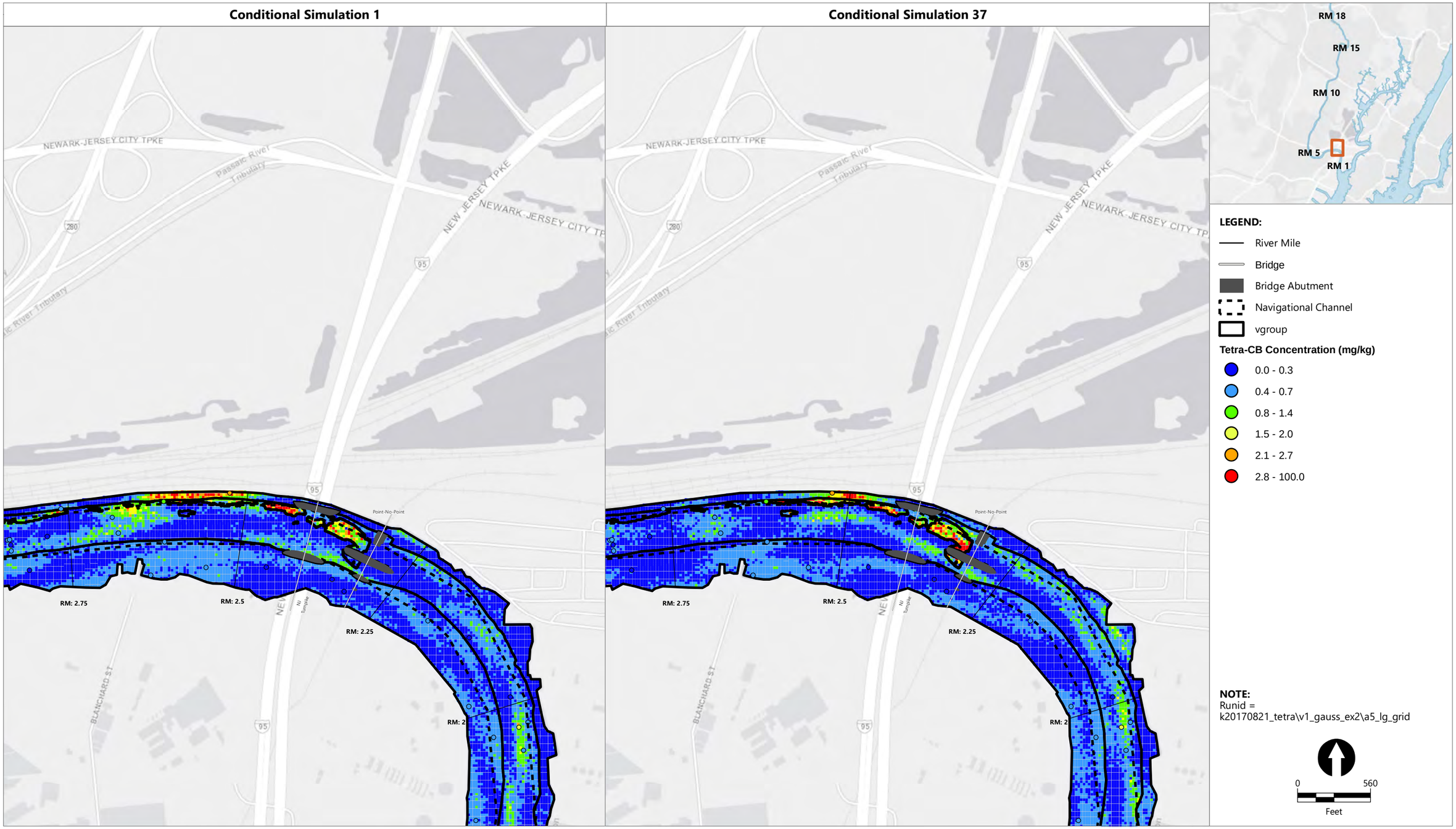

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Figure 7-2x

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

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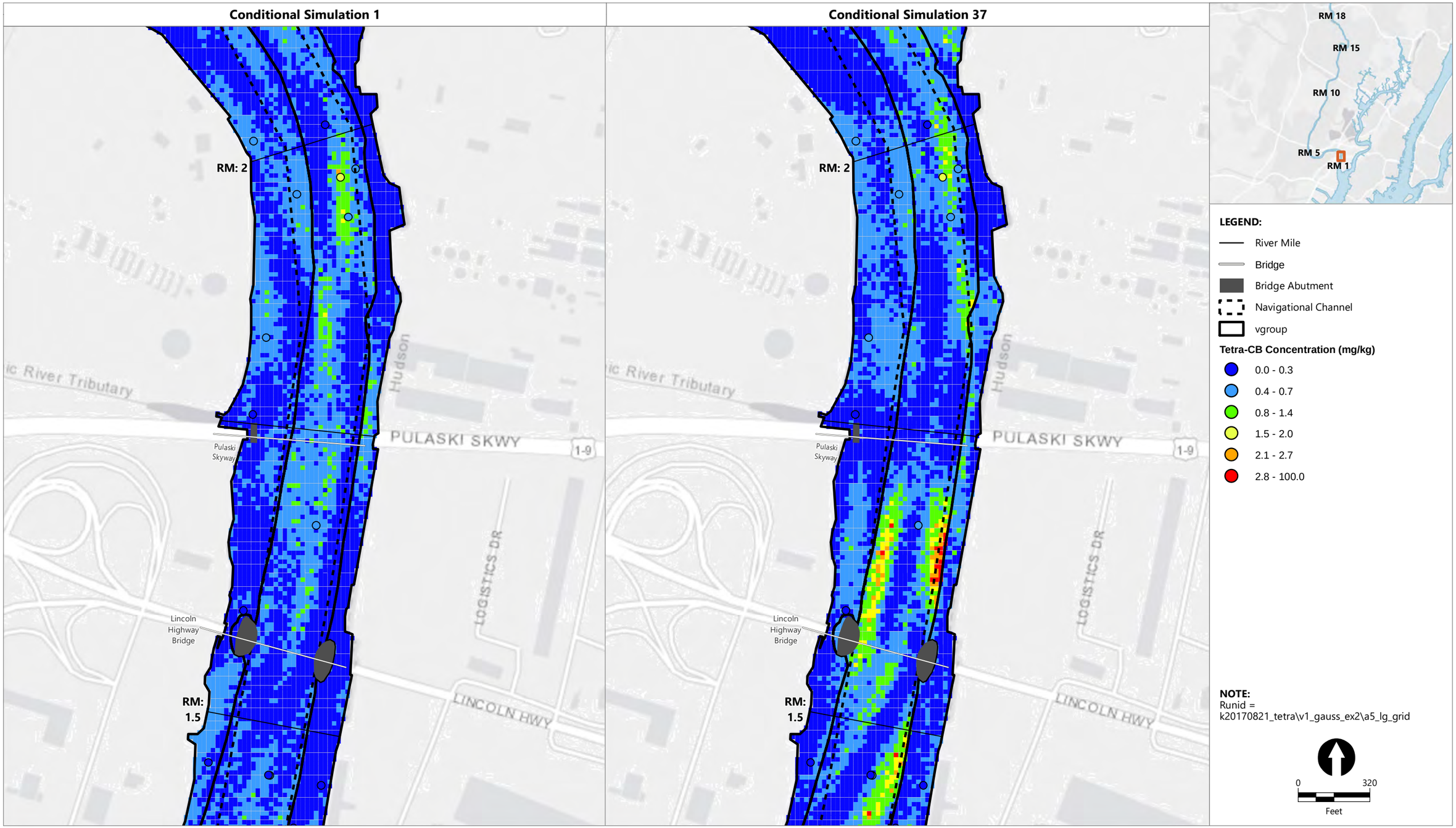

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Figure 7-2y
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

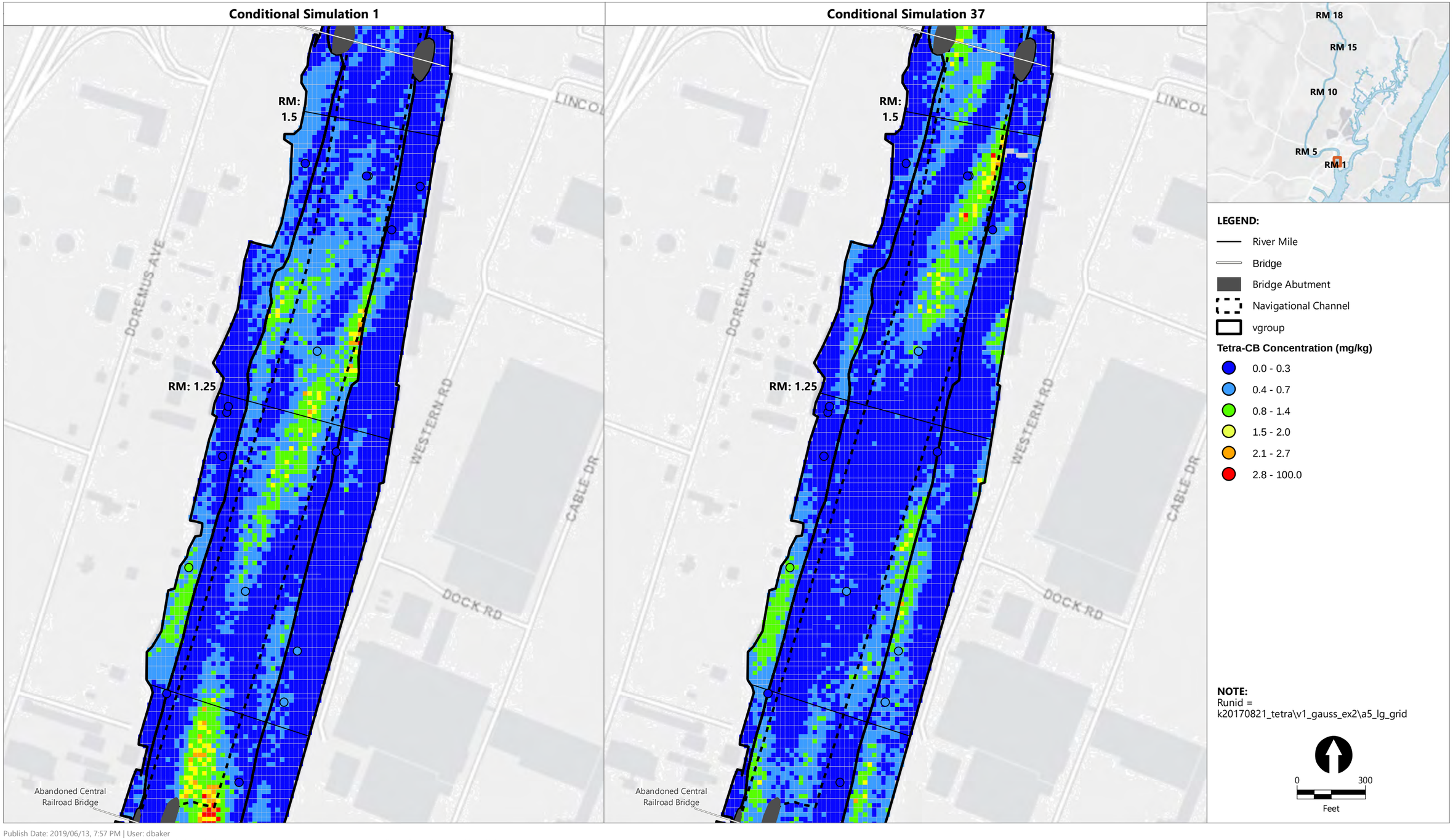

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Figure 7-2z

Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

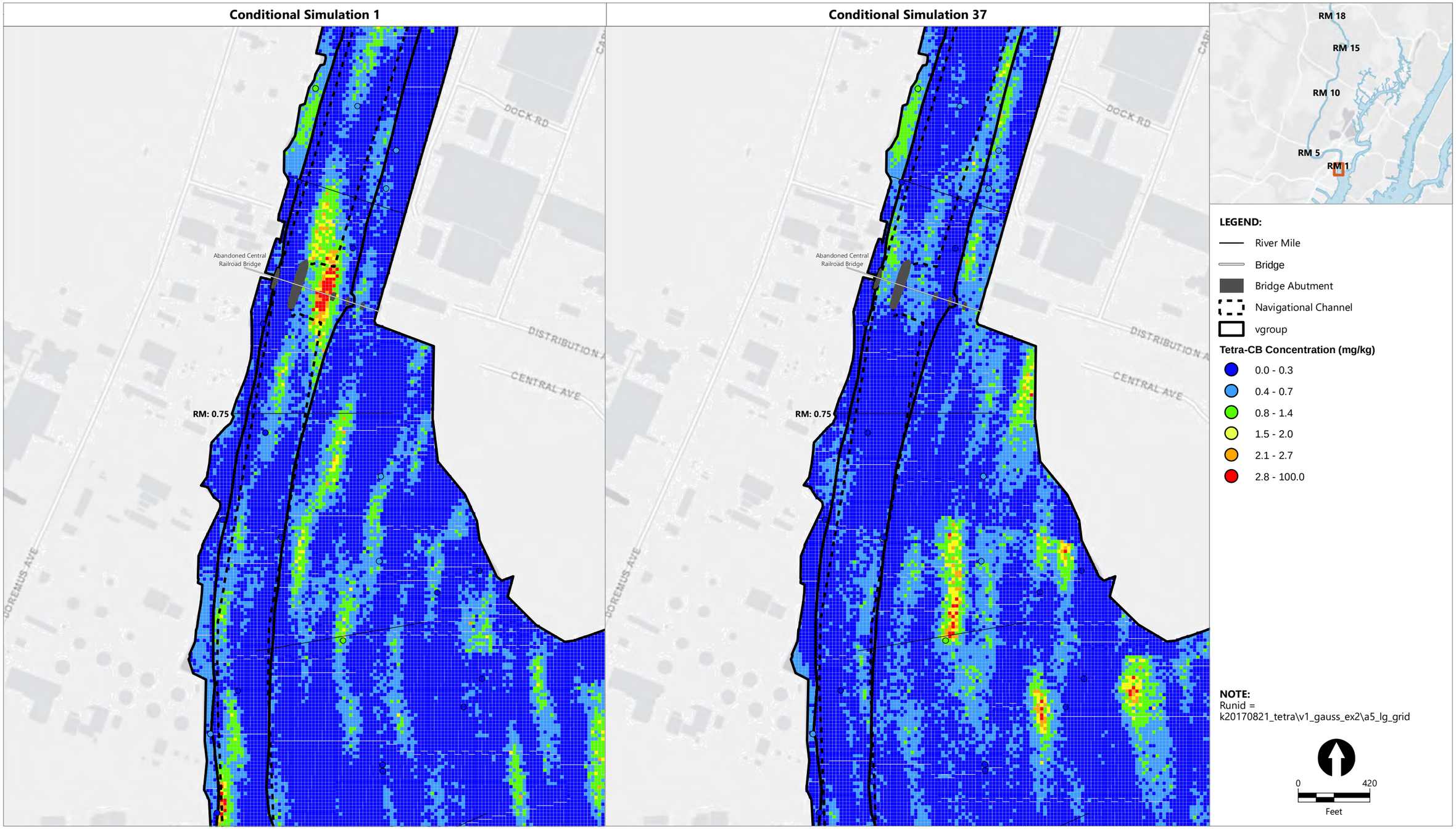

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Figure 7-2aa
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

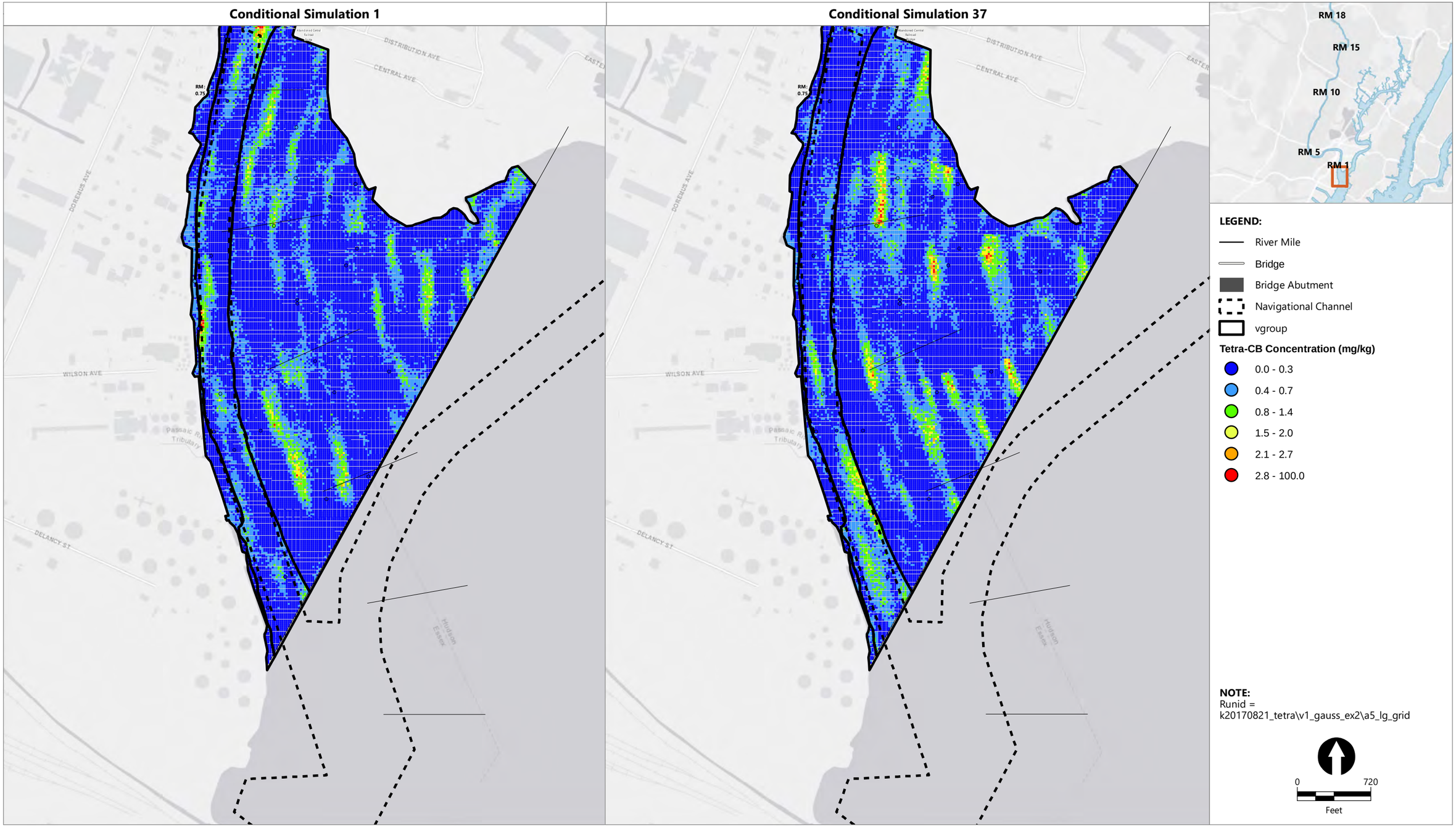

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Figure 7-2ab
Sample Tetra-CB Conditional Simulation Output (on 20-foot Grid; Capped and Back-Transformed)
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study

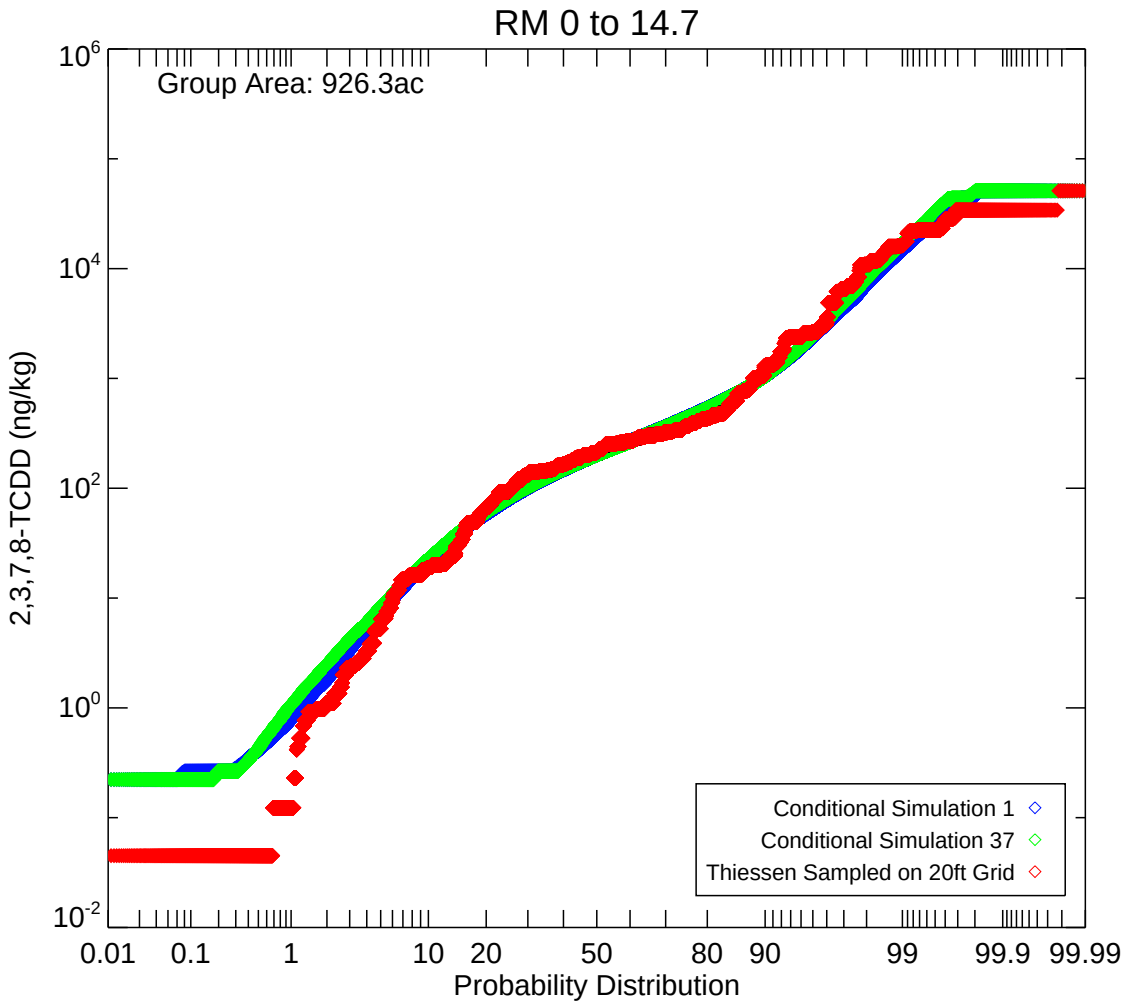

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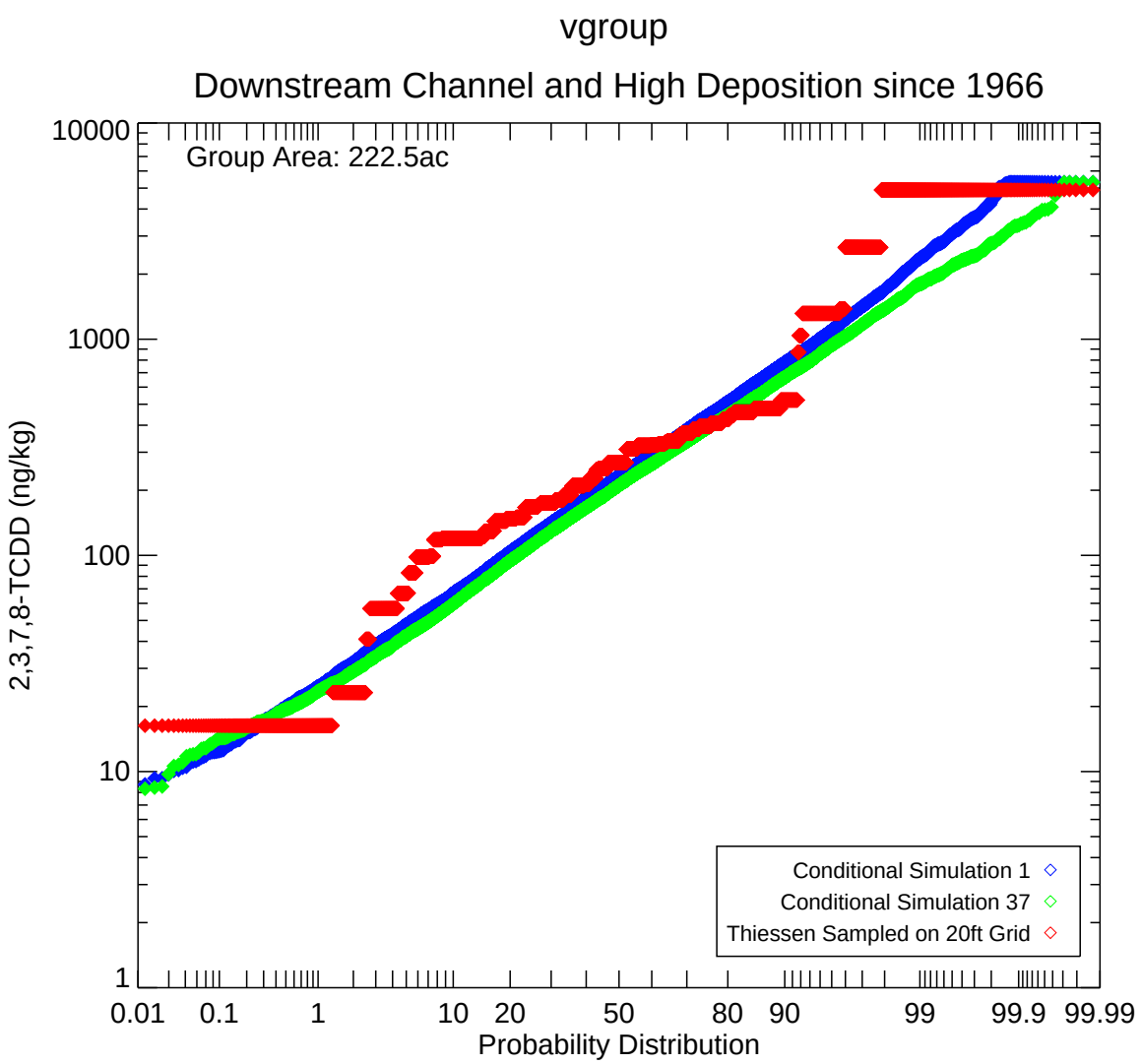
Figure 7-3a

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)



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File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_7_3_probplot_CS_Thies.pro

Figure 7-3b

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)

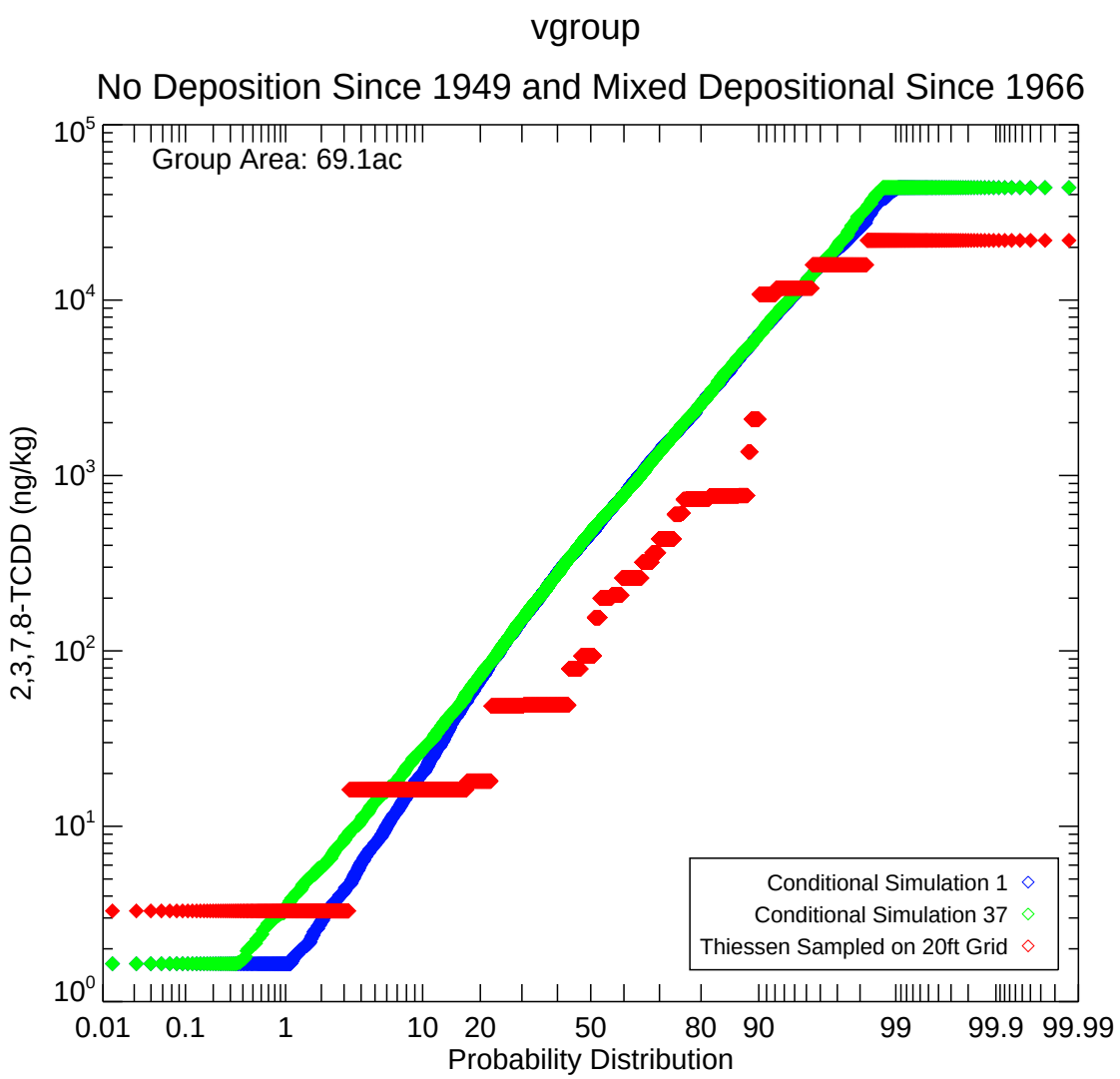

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Figure 7-3c

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)

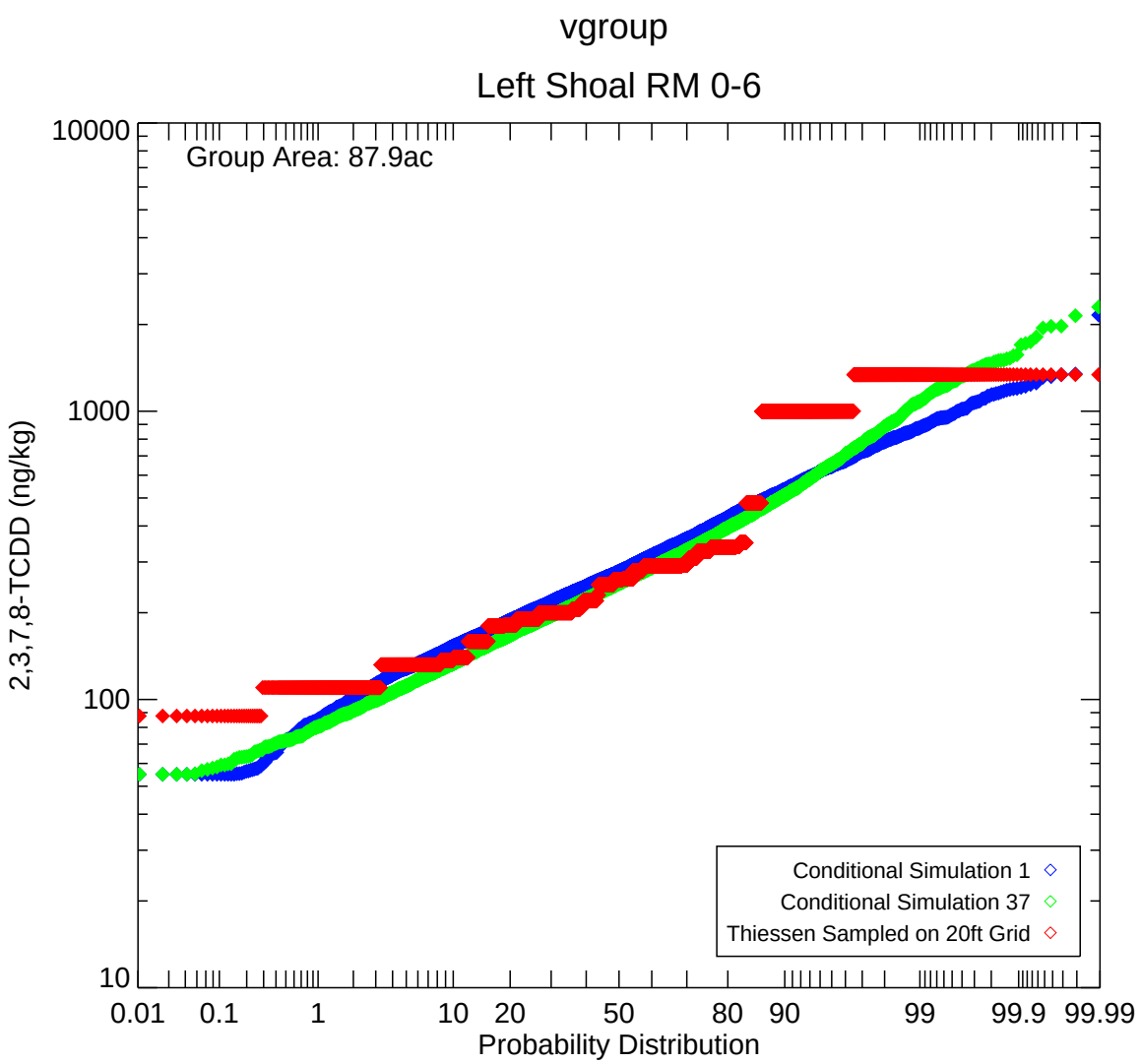

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Figure 7-3d

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)

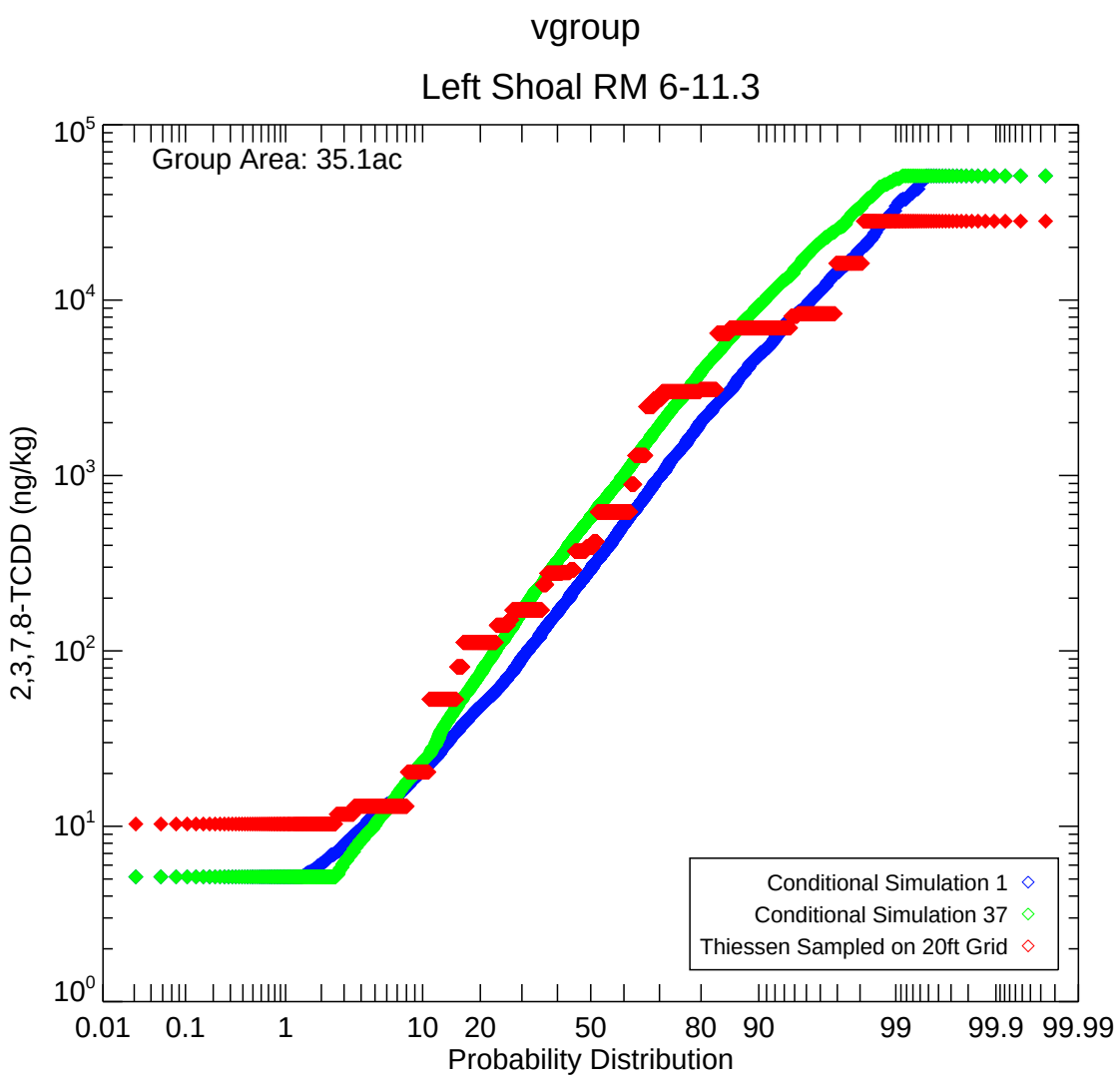

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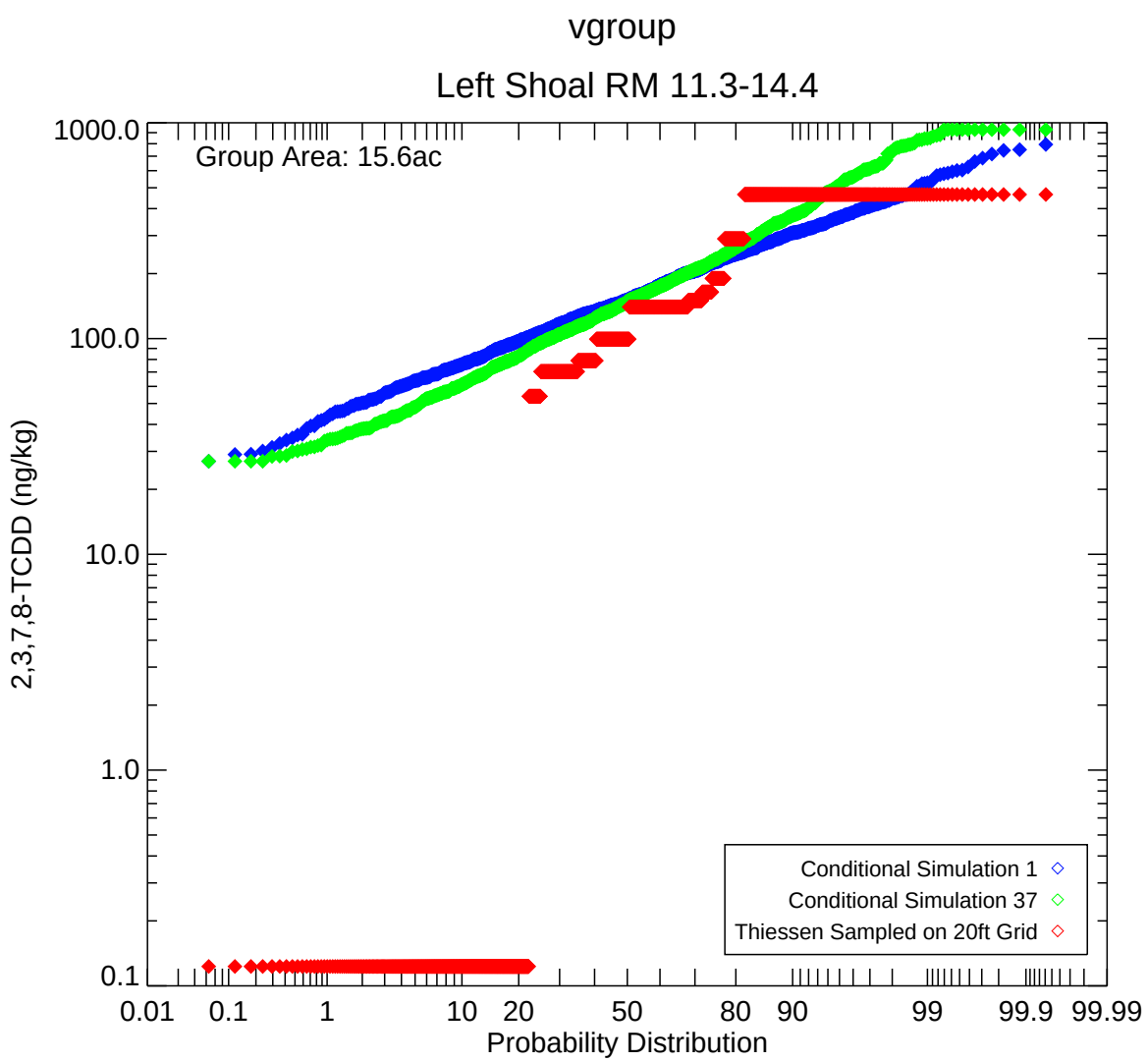
Figure 7-3e

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)



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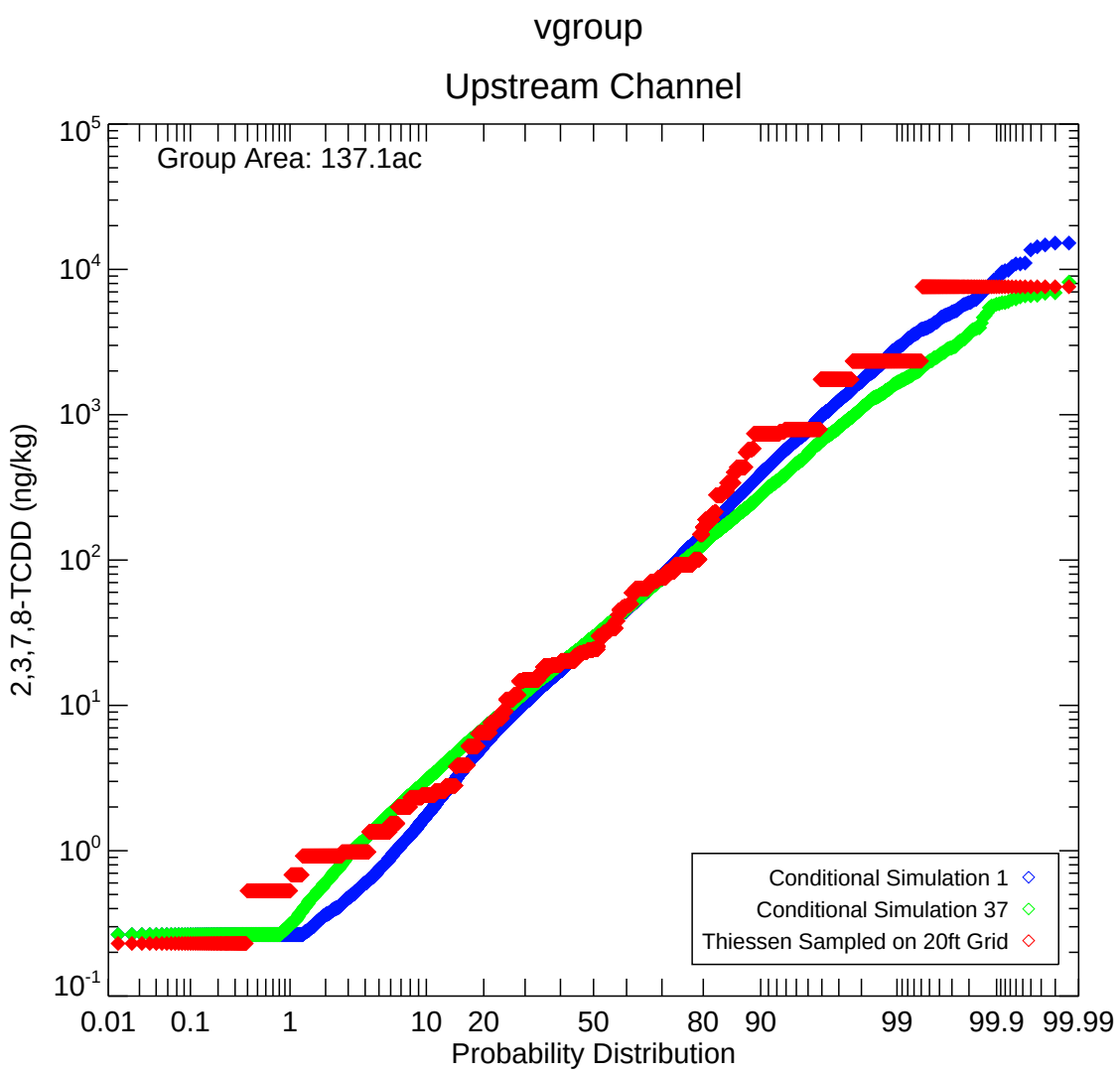
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_7_3_probplot_CS_Thies.pro

Figure 7-3f

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)



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File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_7_3_probplot_CS_Thies.pro

Figure 7-3g

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)

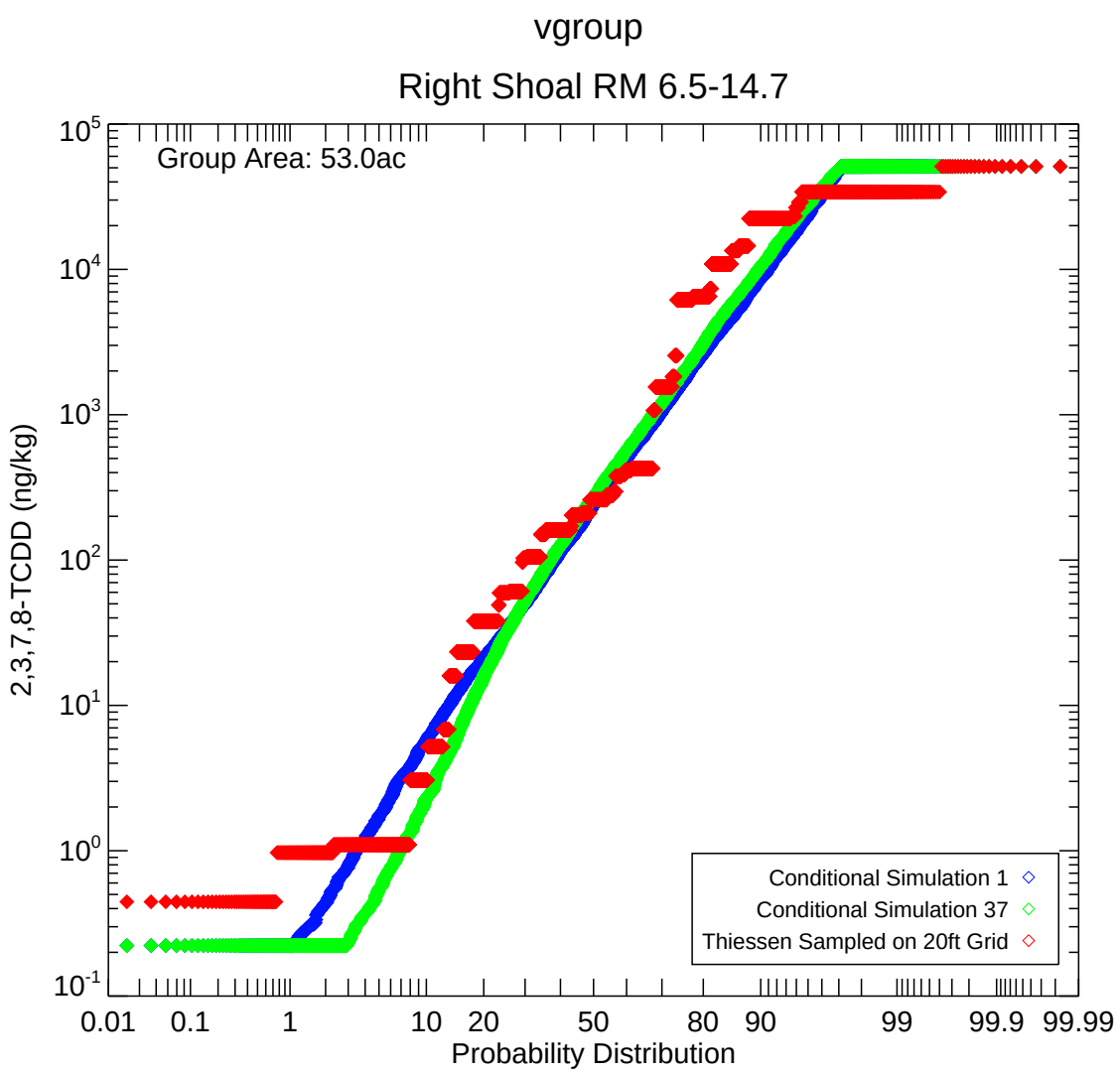

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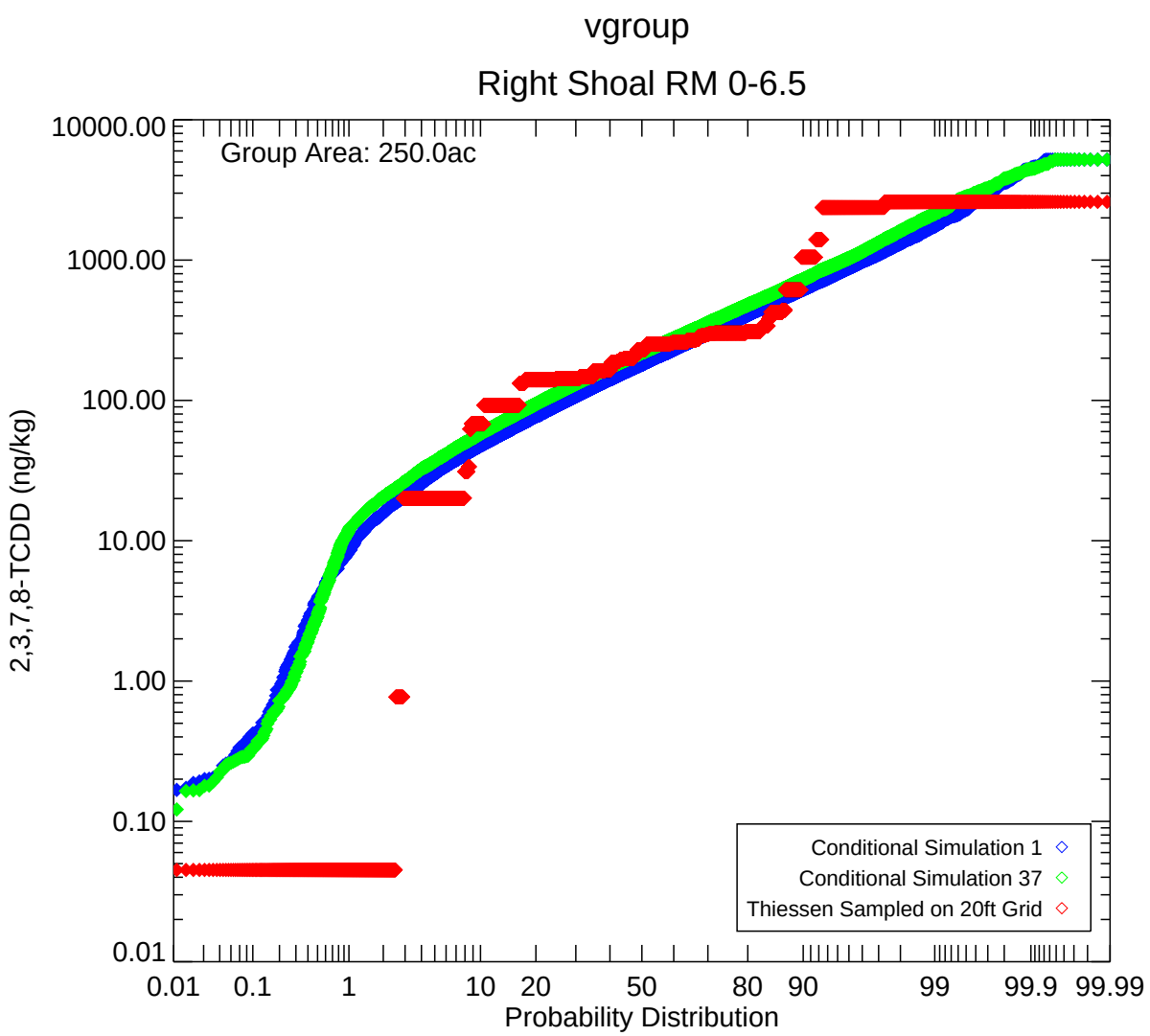
Figure 7-3h

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)



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File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_7_3_probplot_CS_Thies.pro

Figure 7-3i

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)

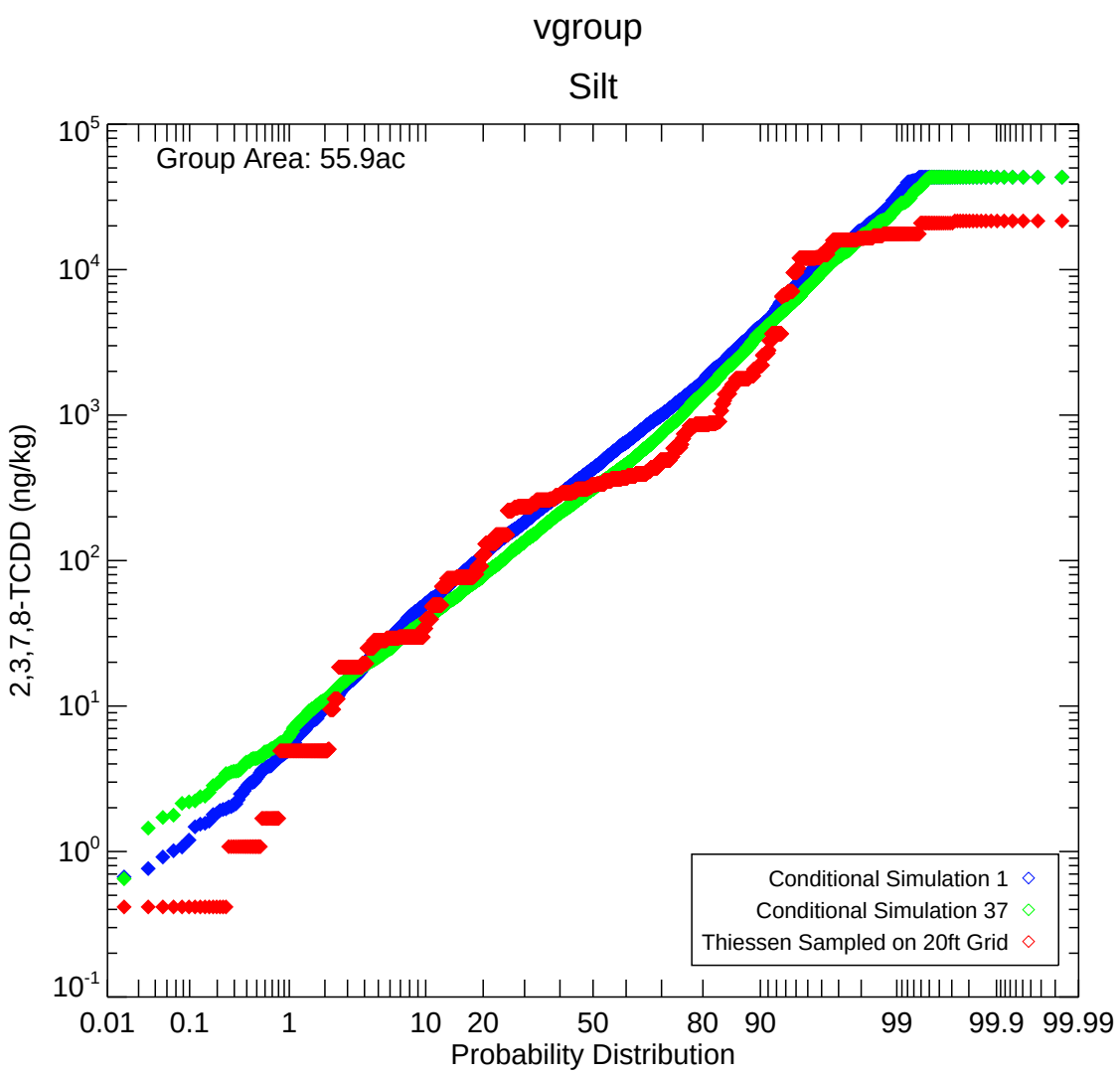

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Figure 7-3j

Comparison of 2,3,7,8-TCDD Simulation Results and De-clustered Data (Thiessen polygons)

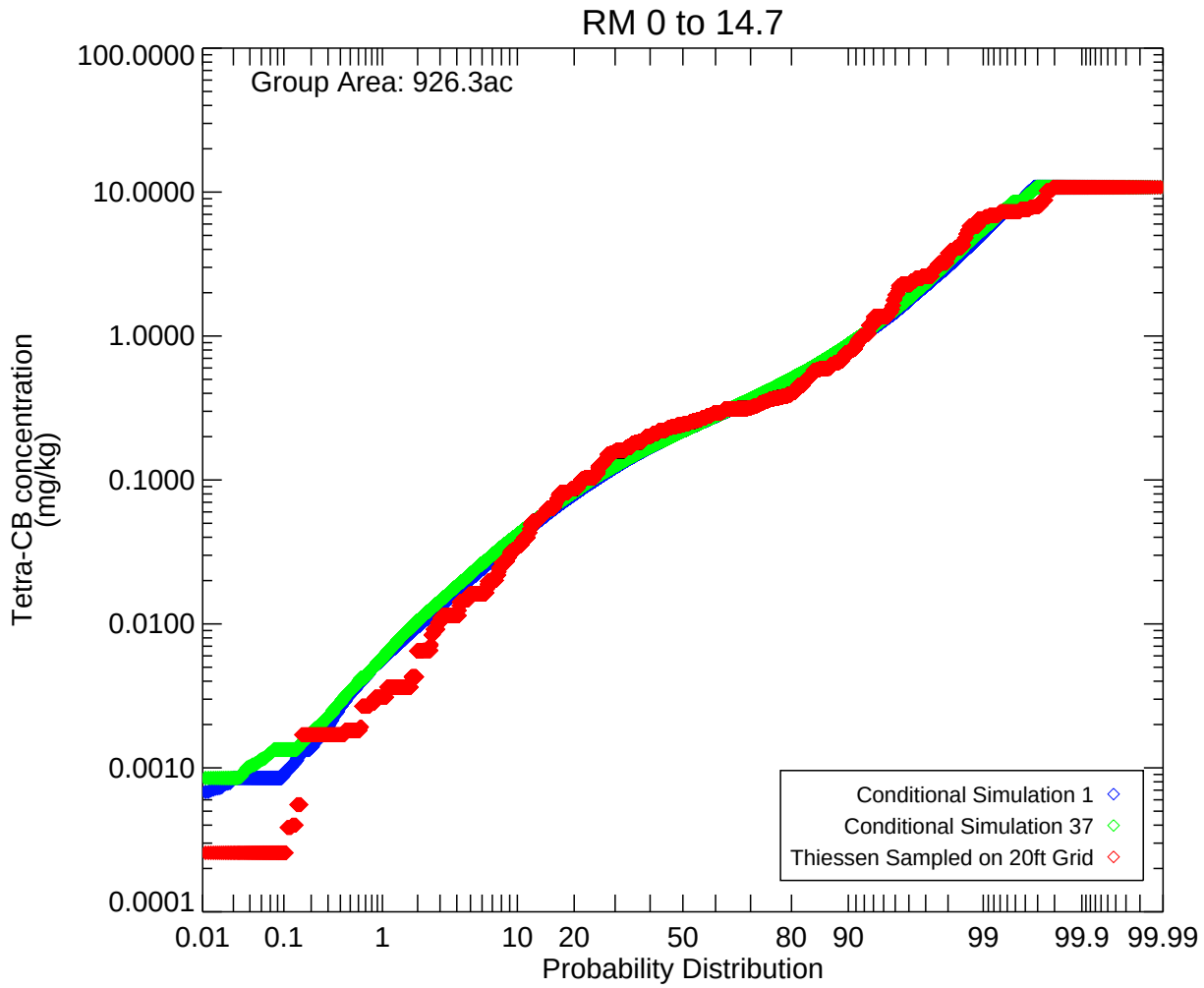

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Figure 7-4a

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

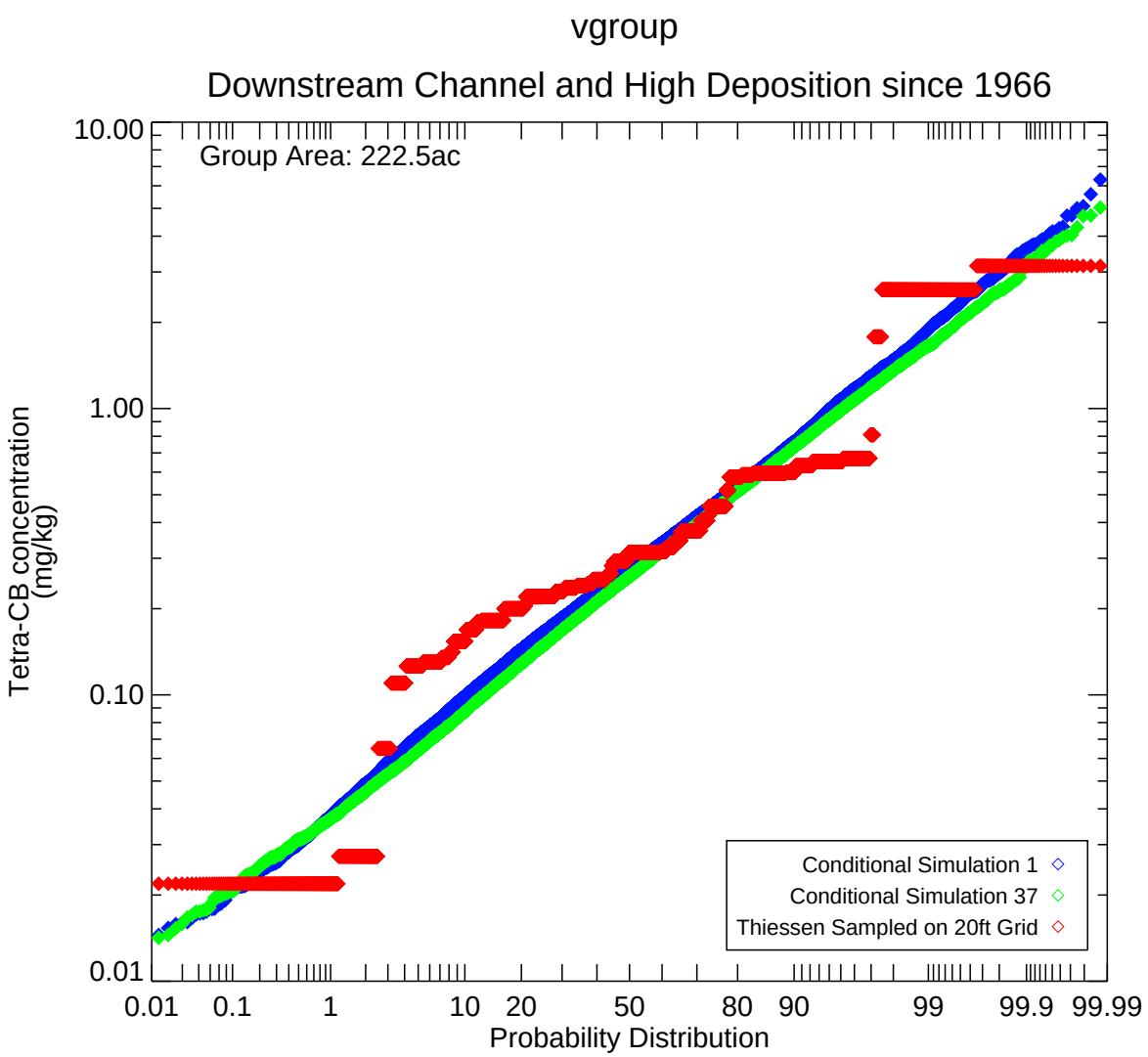

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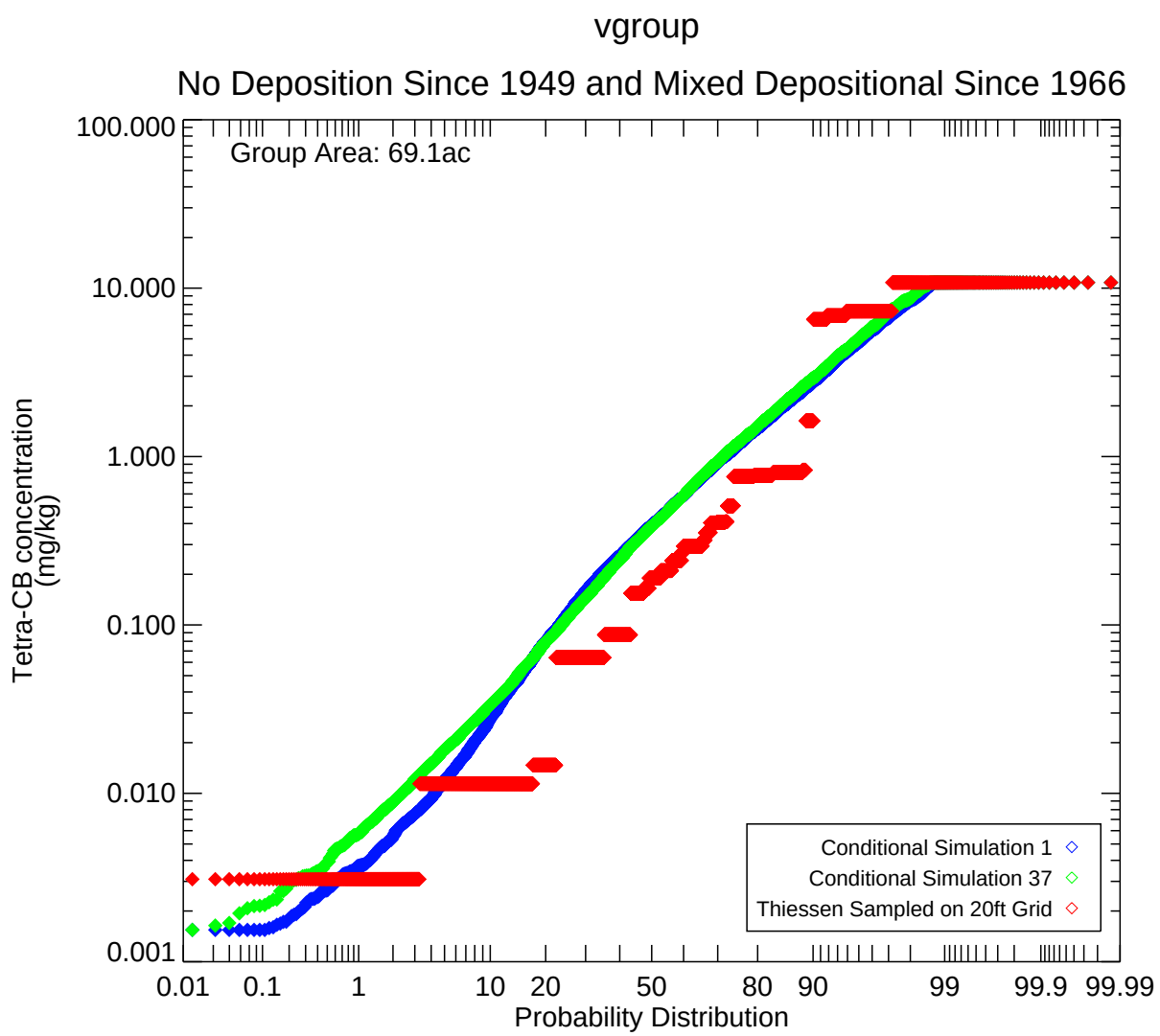
Figure 7-4b

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)



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File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_7_4_probplot_CS_Thies.pro

Figure 7-4c

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

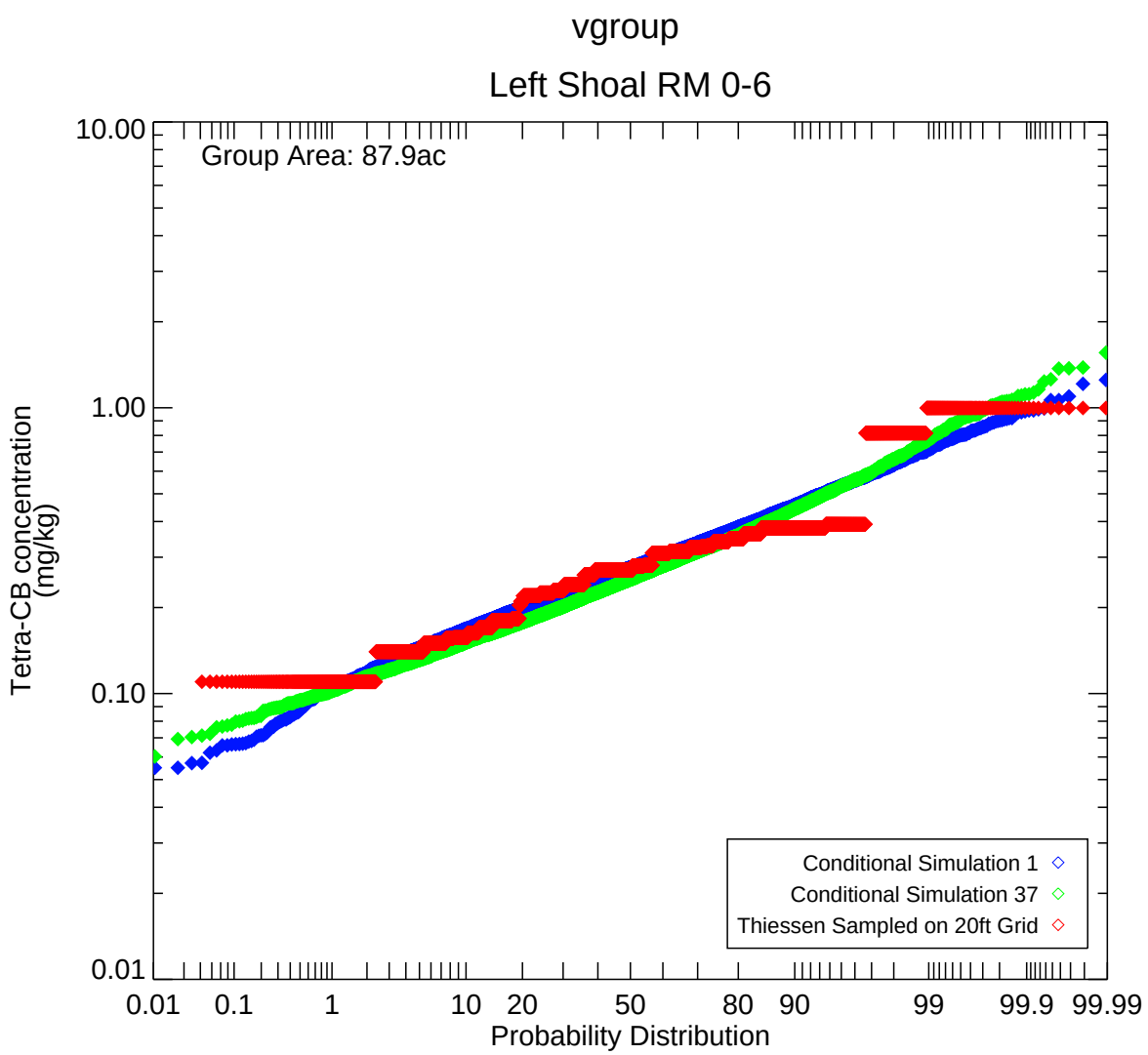

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Figure 7-4d

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

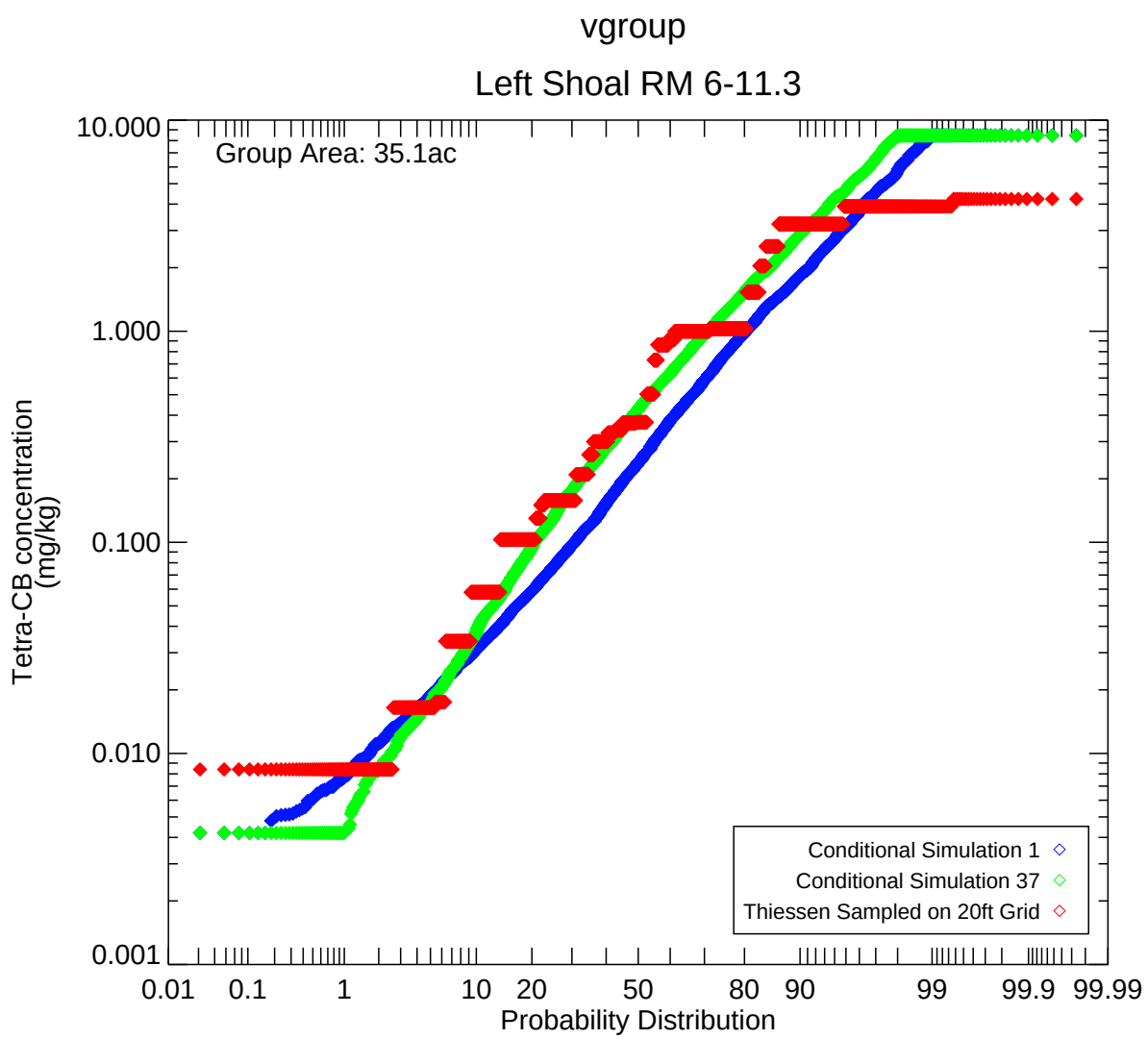

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Figure 7-4e

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

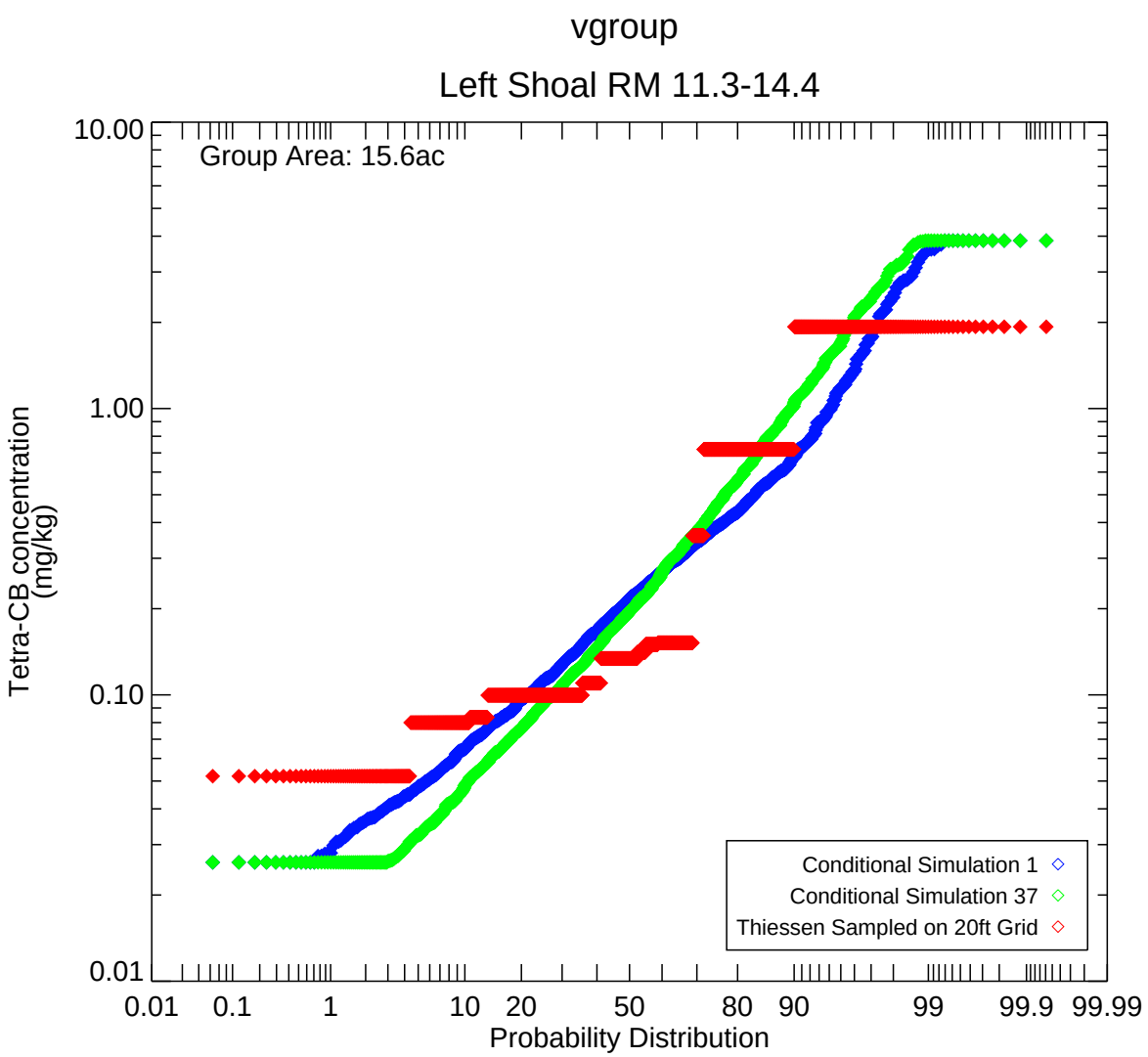

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Figure 7-4f

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

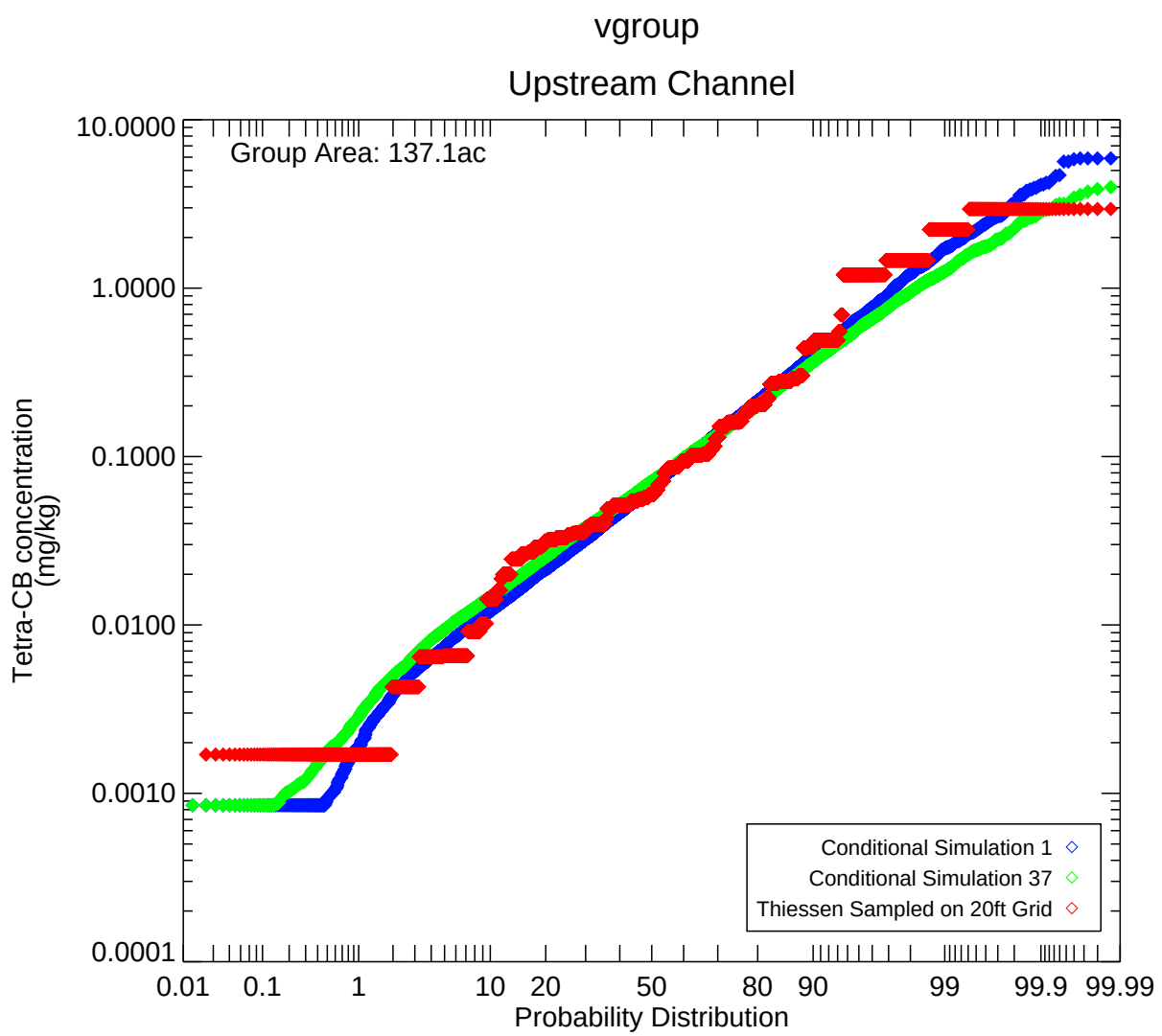

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Figure 7-4g

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

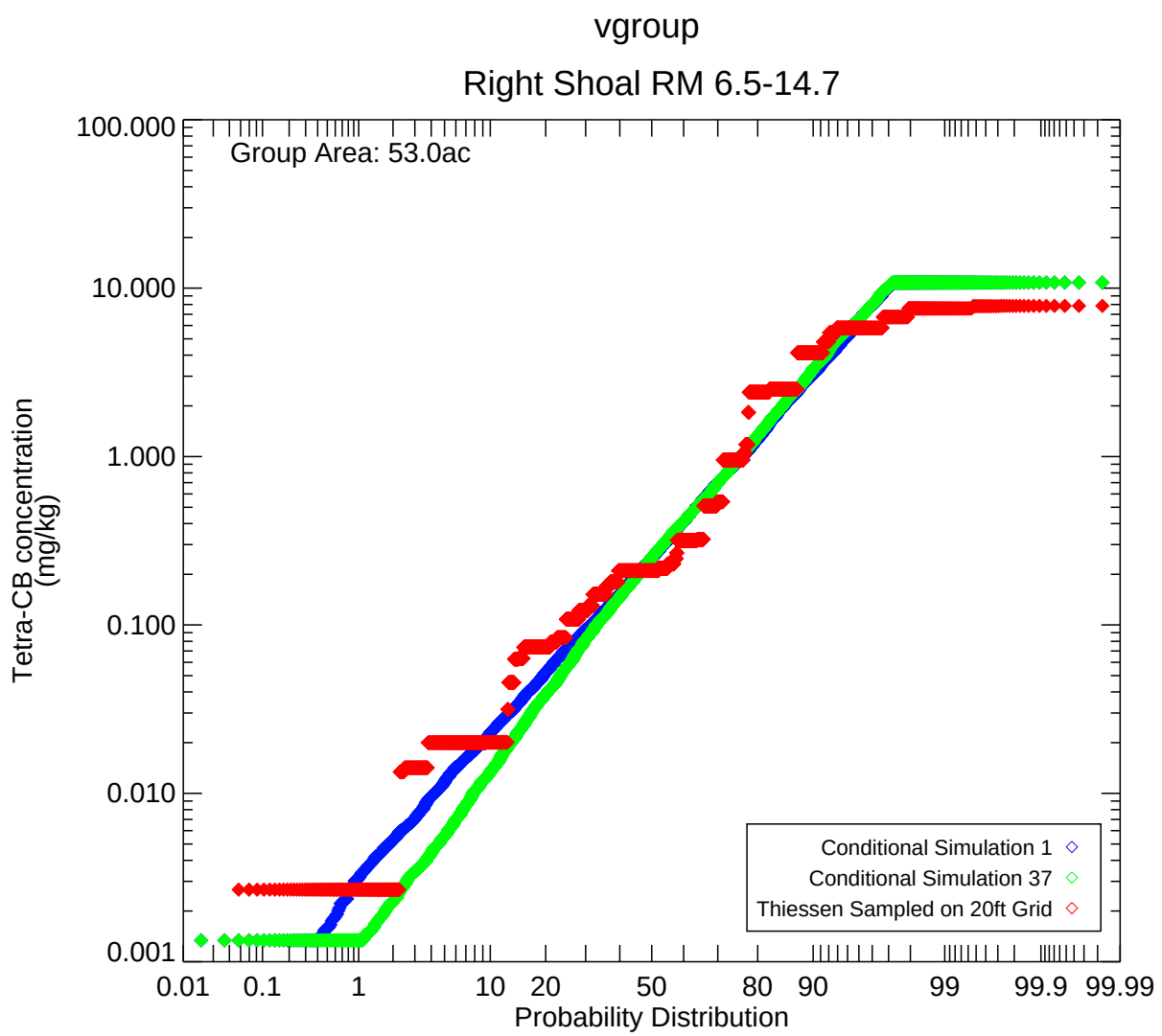

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Figure 7-4h

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

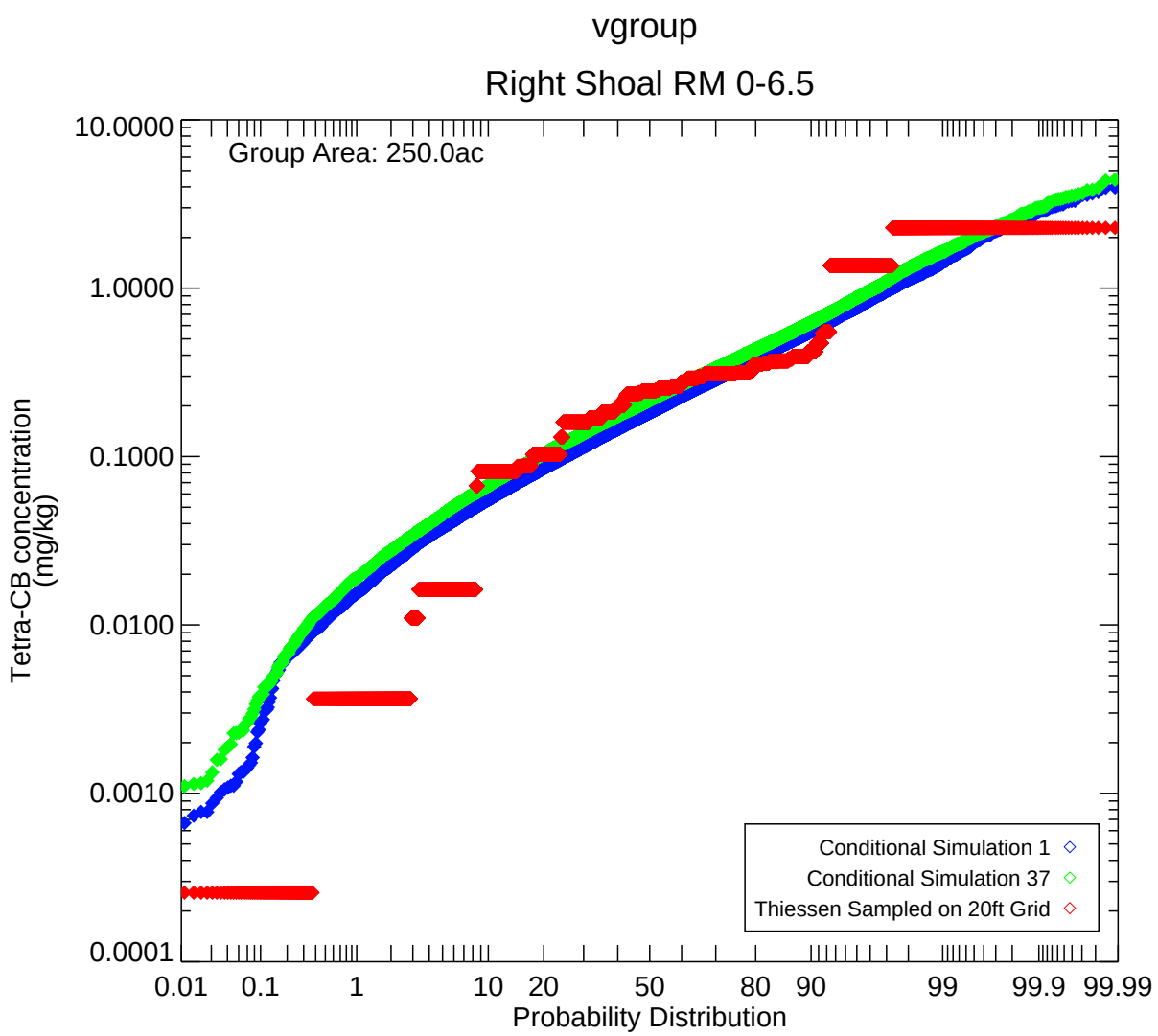

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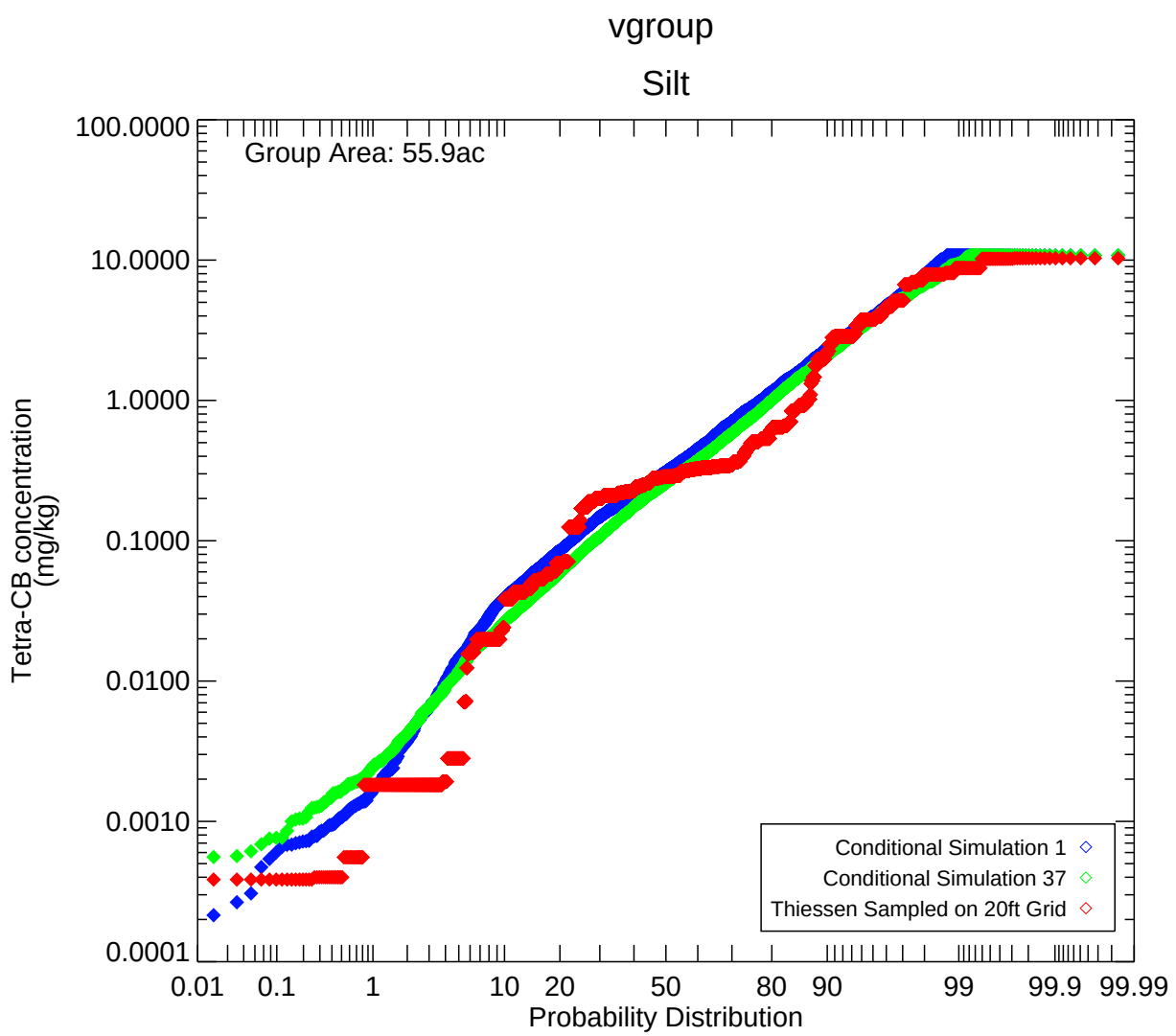
Figure 7-4i

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)



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File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_7_4_probplot_CS_Thies.pro

Figure 7-4j

Comparison of Tetra-CB Simulation Results and De-clustered Data (Thiessen polygons)

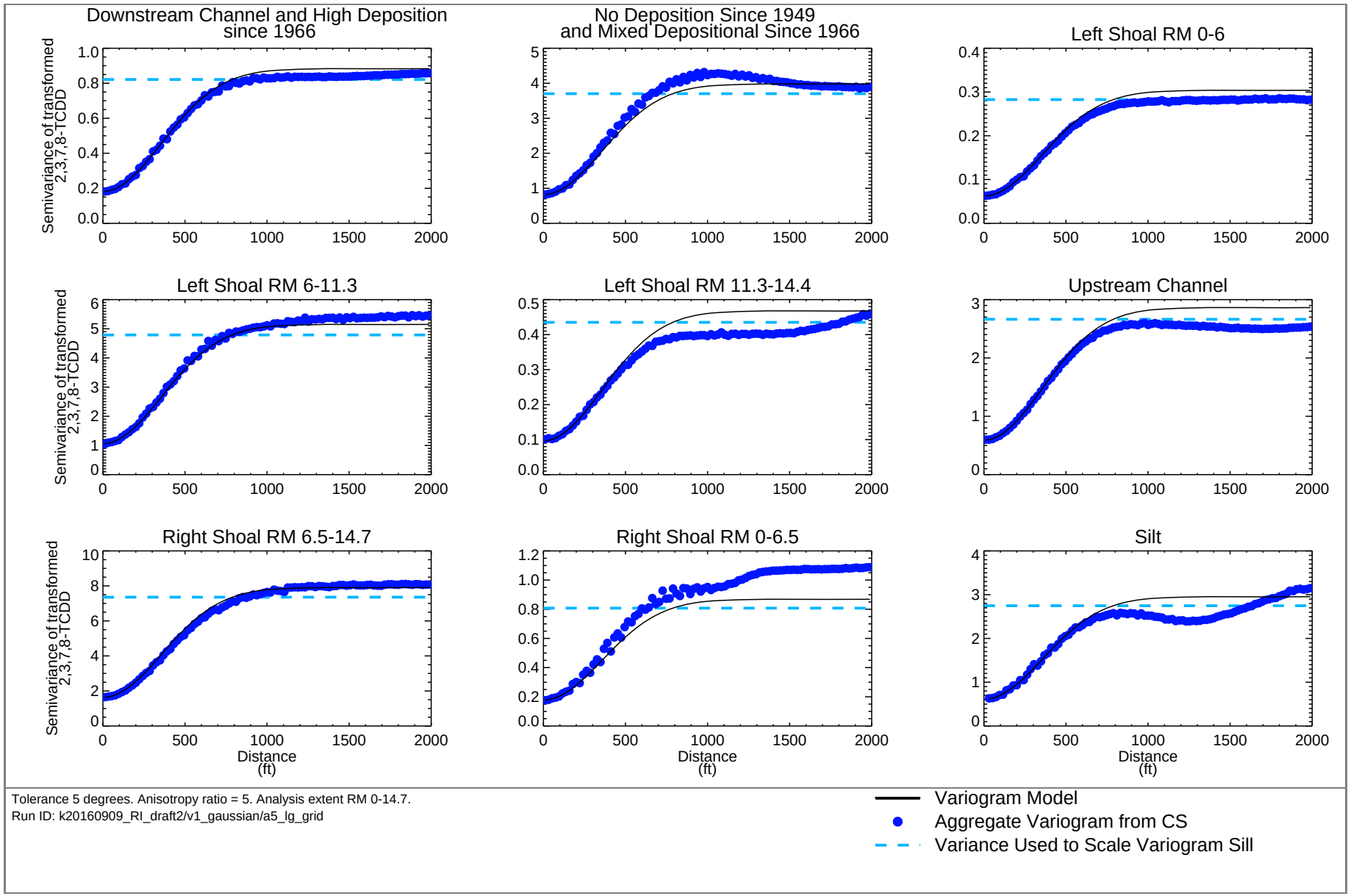

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Figure 7-5

Aggregate Variogram Recovery by vgroup for 2,3,7,8-TCDD Based on 100 Conditional Simulations

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

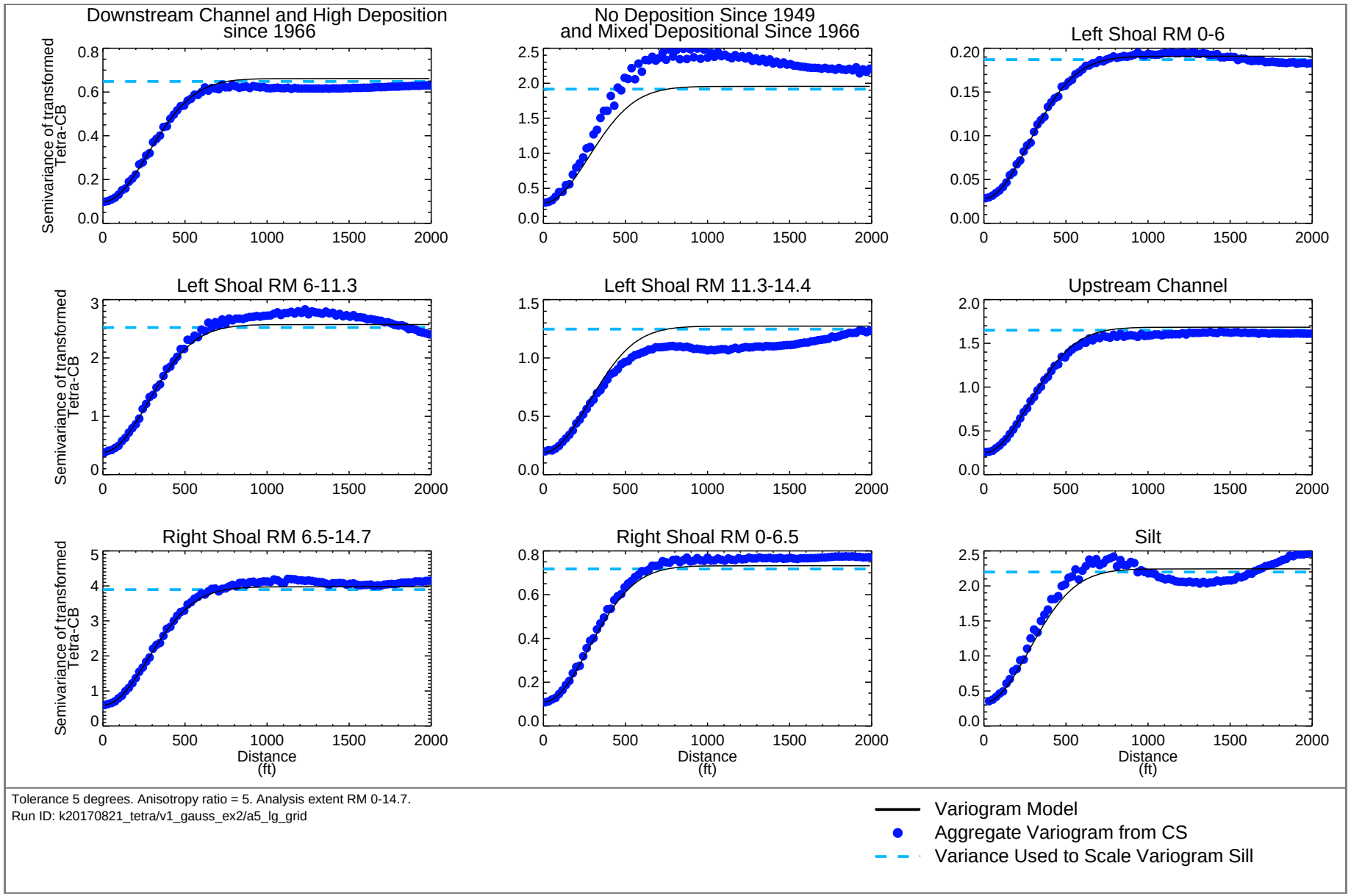

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Figure 7-6

Aggregate Variogram Recovery by vgroup for Tetra-CB Based on 100 Conditional Simulations

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

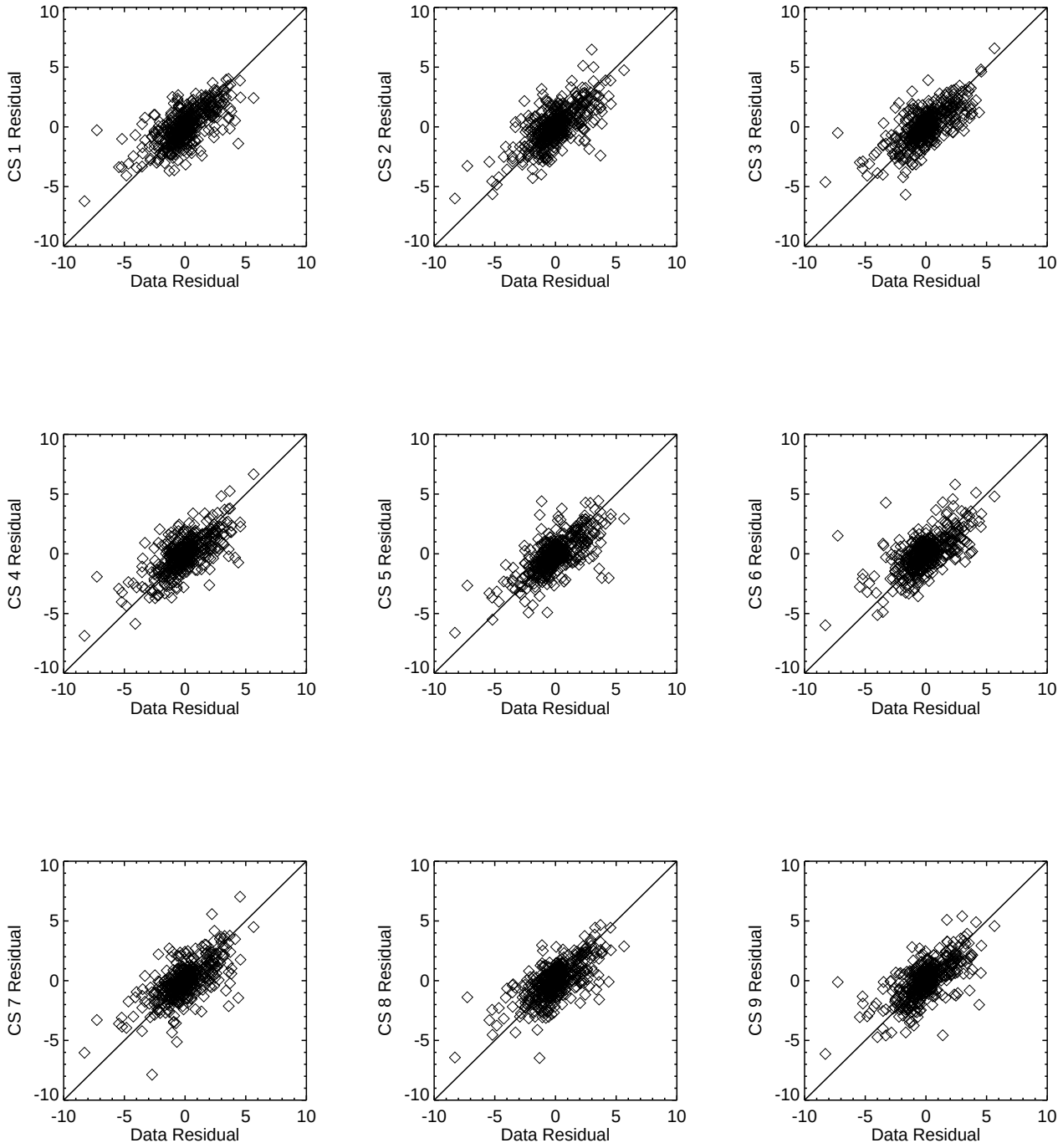

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Figure 7-7

2,3,7,8-TCDD Conditional Simulation Residuals Versus Data Residuals

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

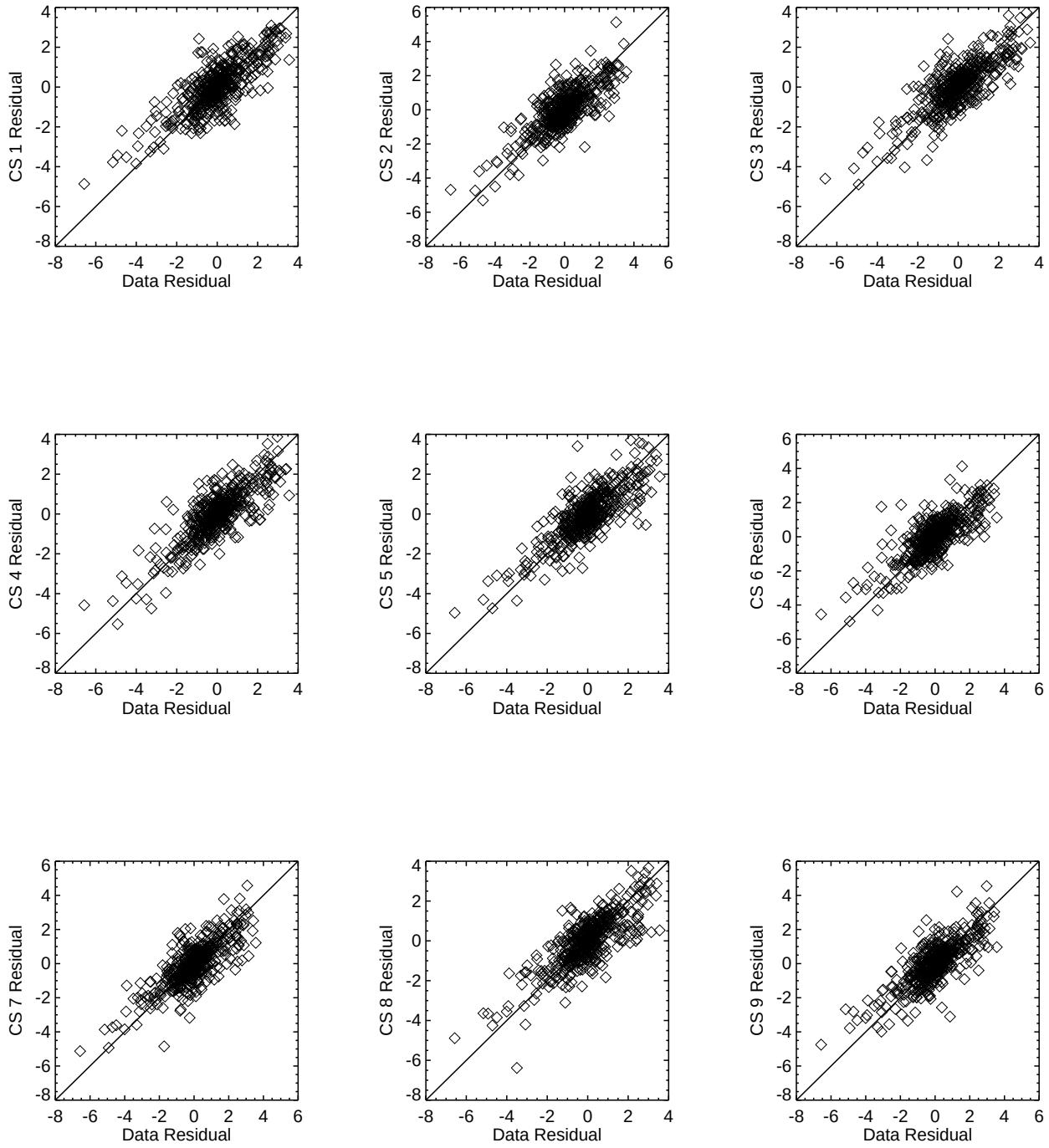

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Figure 7-8

Tetra-CB Conditional Simulation Residuals Versus Data Residuals

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

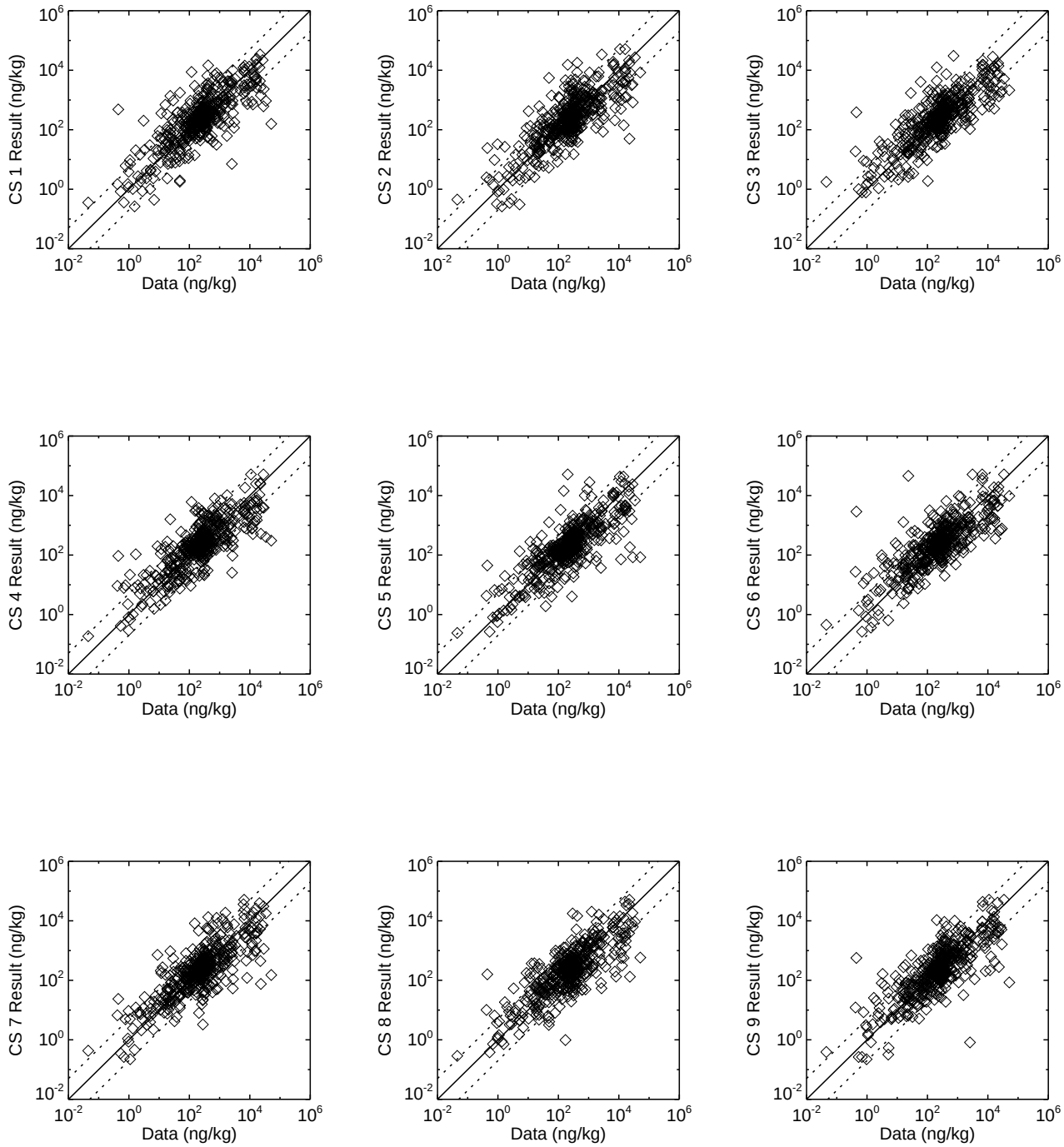

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Figure 7-9

2,3,7,8-TCDD Conditional Simulation Results Versus Data

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

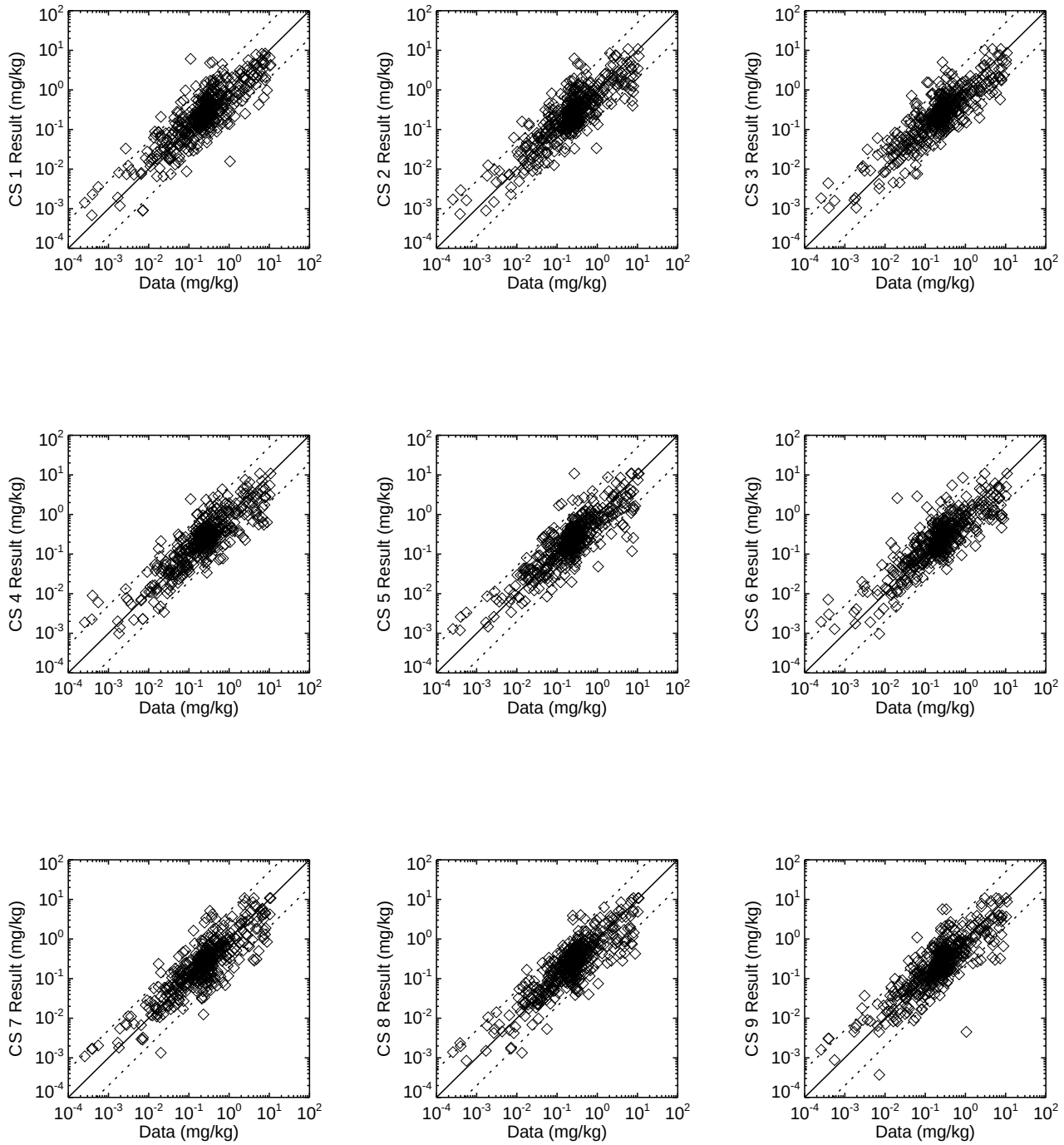

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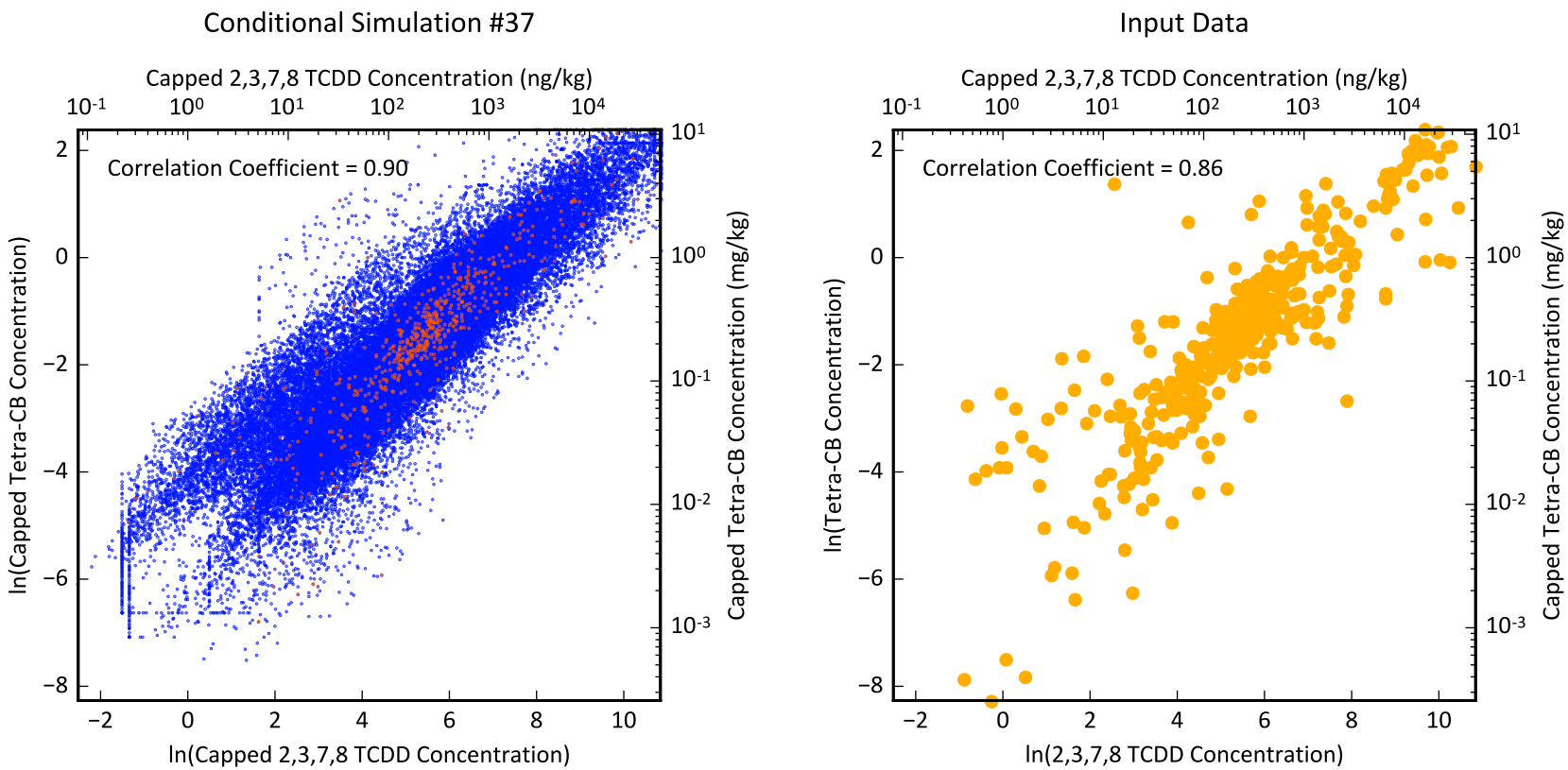
Figure 7-10

Tetra-CB Conditional Simulation Results Versus Data

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

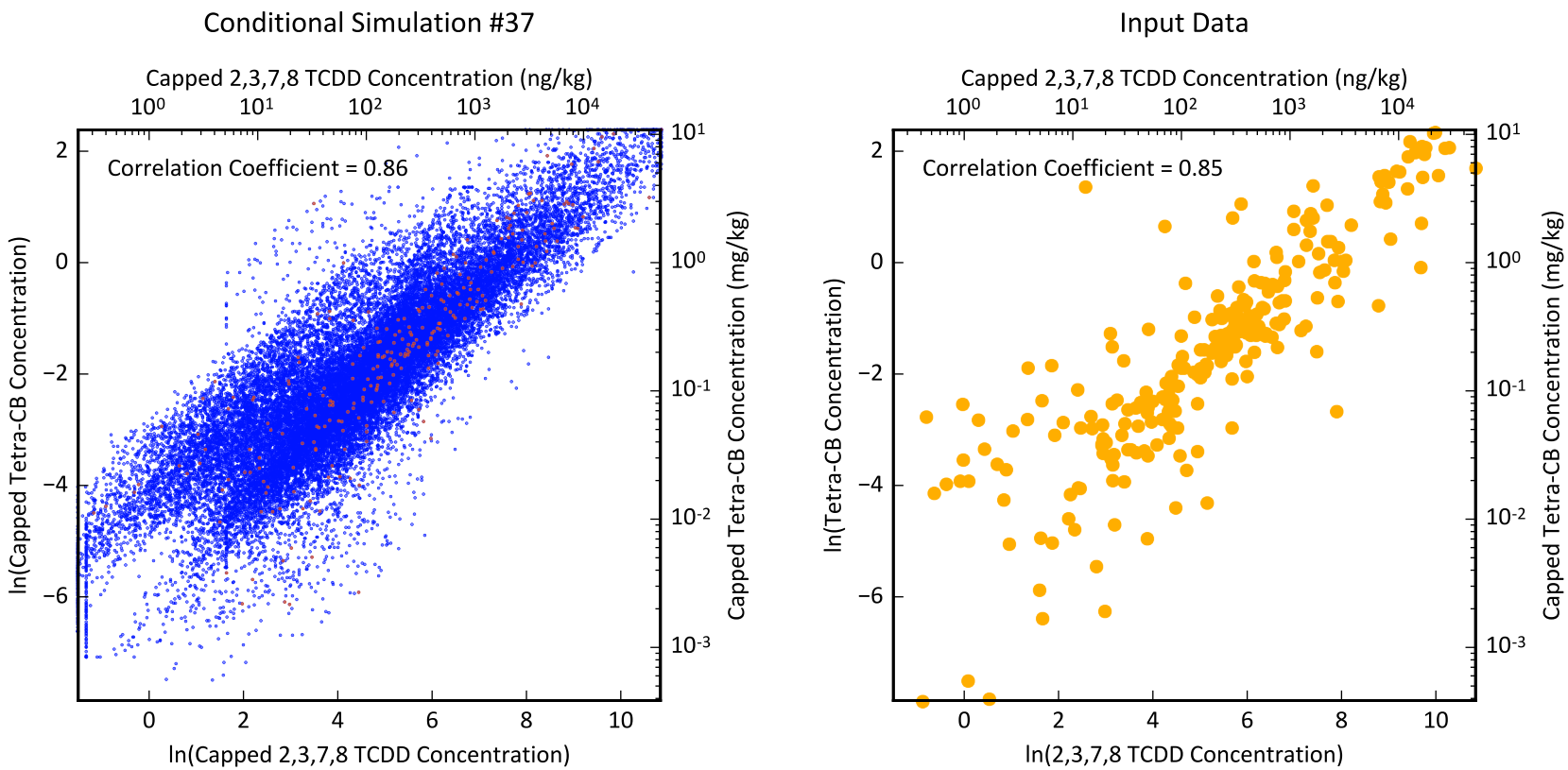


The correlation was calculated in capped_log space.
Data outside of VGROUPs are not included.

- Kriging grid
- Kriging grid colocated with input data
- Input data

Publish Date: 06/19/2019 15:16 PM | User: zl\ep
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_11_bivariate_correlation_prob_plot_v2.py

Figure 7-11a
Cross Plot of Tetra-CB and 2,3,7,8 TCDD: Whole River
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

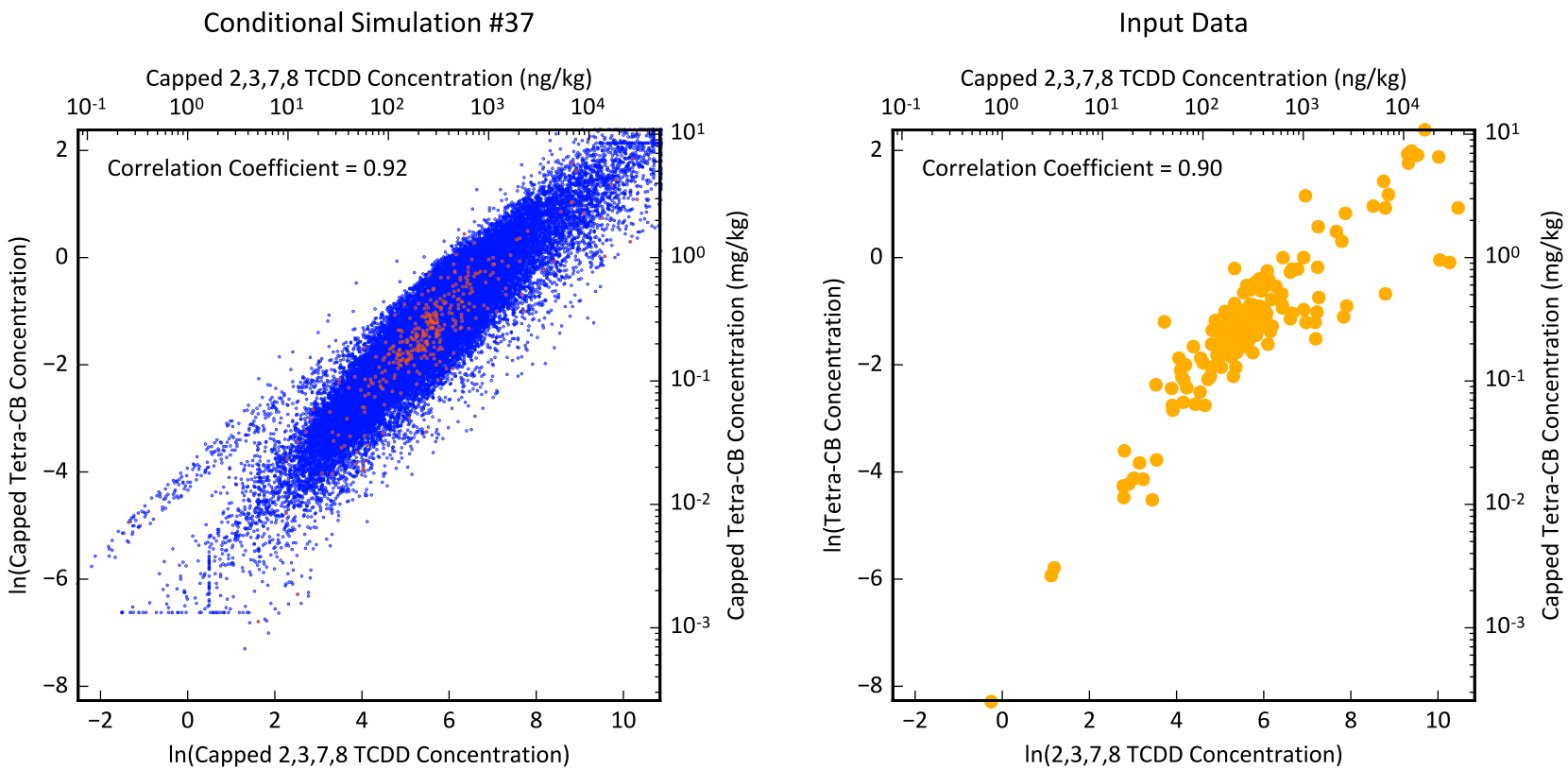


The correlation was calculated in capped_log space.
Data outside of VGROUPs are not included.

- Kriging grid
- Kriging grid colocated with input data
- Input data

Publish Date: 06/19/2019 15:16 PM | User: zl\ep
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_11_bivariate_correlation_prob_plot_v2.py

Figure 7-11b
Cross Plot of Tetra-CB and 2,3,7,8 TCDD: Above RM8
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

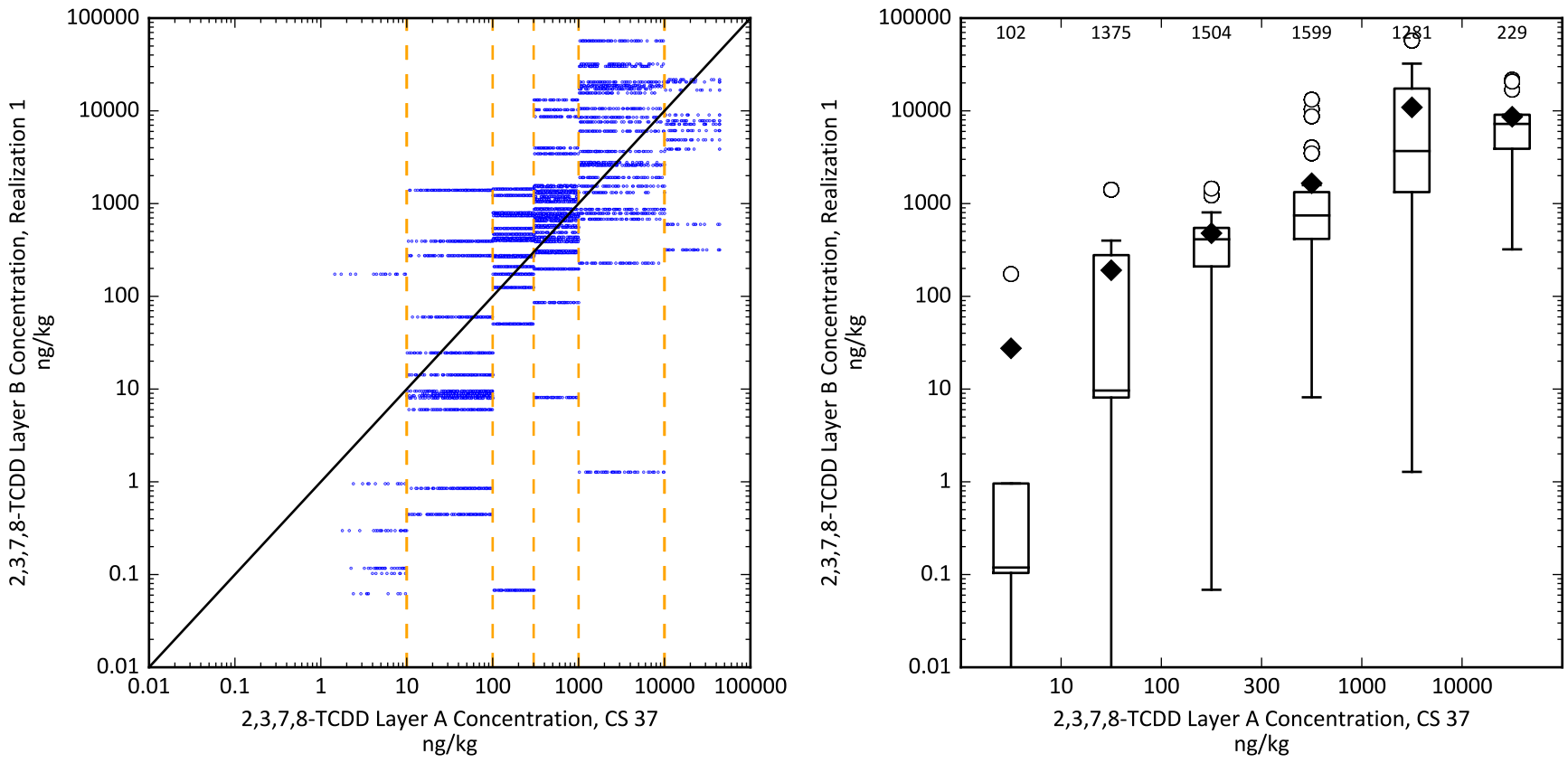


The correlation was calculated in capped_log space.
Data outside of VGROUPs are not included.

- Kriging grid
- Kriging grid colocated with input data
- Input data

Publish Date: 06/19/2019 15:17 PM | User: zl\ep
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_11_bivariate_correlation_prob_plot_v2.py

Figure 7-11c
Cross Plot of Tetra-CB and 2,3,7,8 TCDD: Below RM8
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions. Data is from the 2010 dataset.
The Conditional Simulation was sampled on a 20 x 20 ft grid.

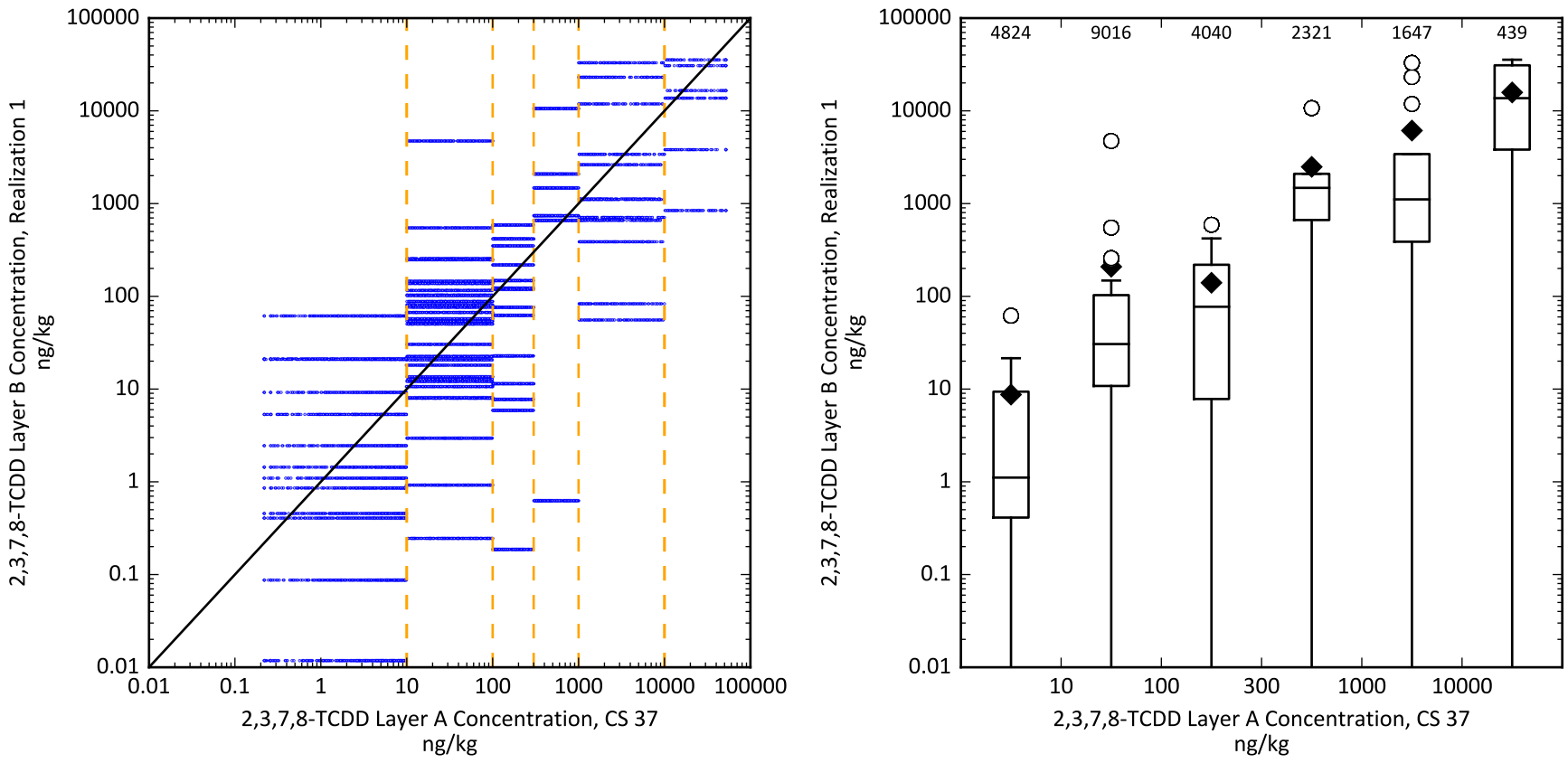
Publish Date: 06/19/2019 15:18 PM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_12_crossplot_CS_LayerB_Resample.py

Figure 7-12a

2,3,7,8-TCDD 2010 Mapped Conditional Simulation Layer A and Layer Resampled B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions. Data is from the 2010 dataset.
The Conditional Simulation was sampled on a 20 x 20 ft grid.

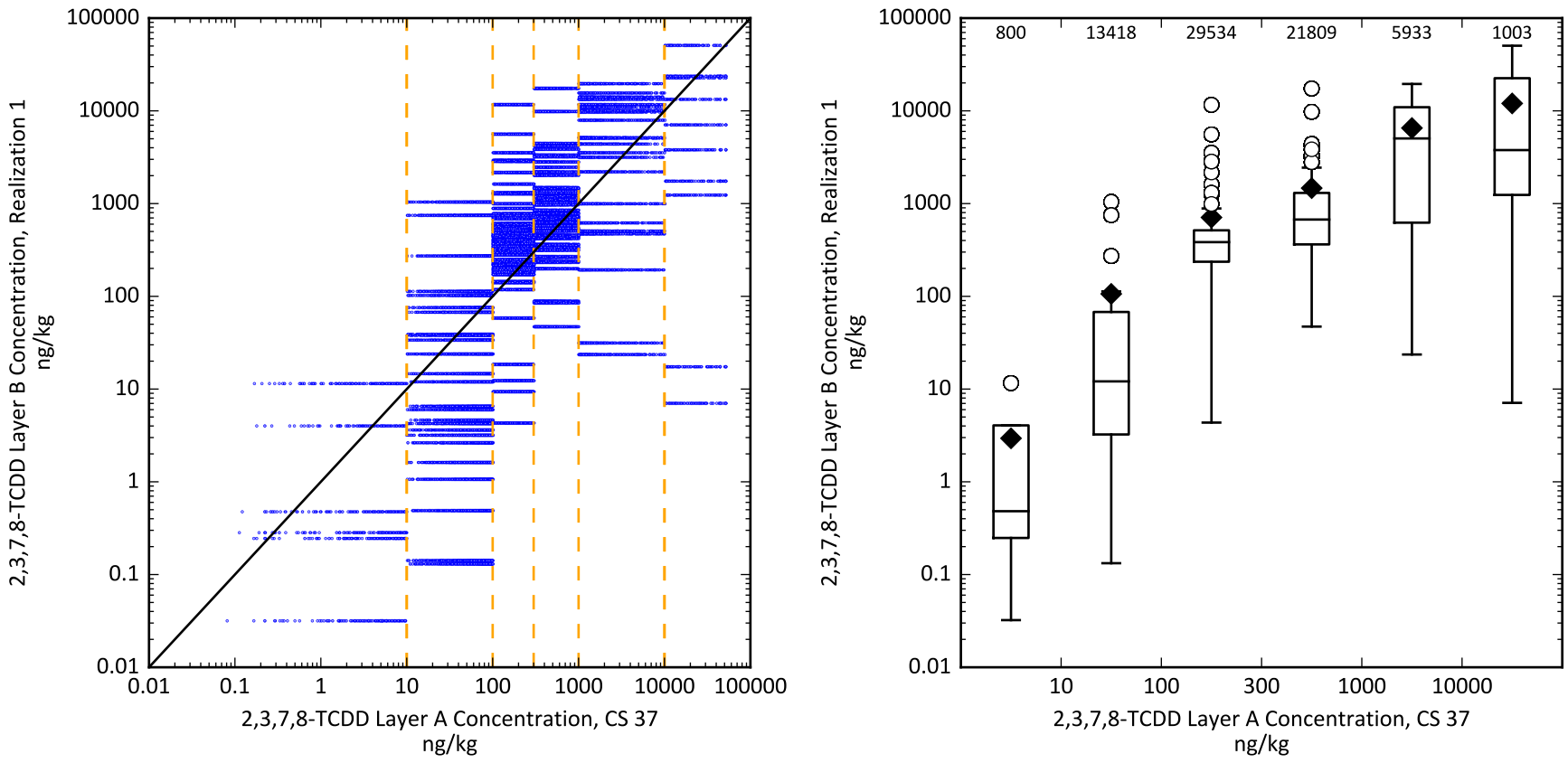
Publish Date: 06/19/2019 15:18 PM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_12_crossplot_CS_LayerB_Resample.py

Figure 7-12b

2,3,7,8-TCDD 2010 Mapped Conditional Simulation Layer A and Layer Resampled B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions. Data is from the pooled 1995 and 2010 dataset.
The Conditional Simulation was sampled on a 20 x 20 ft grid.

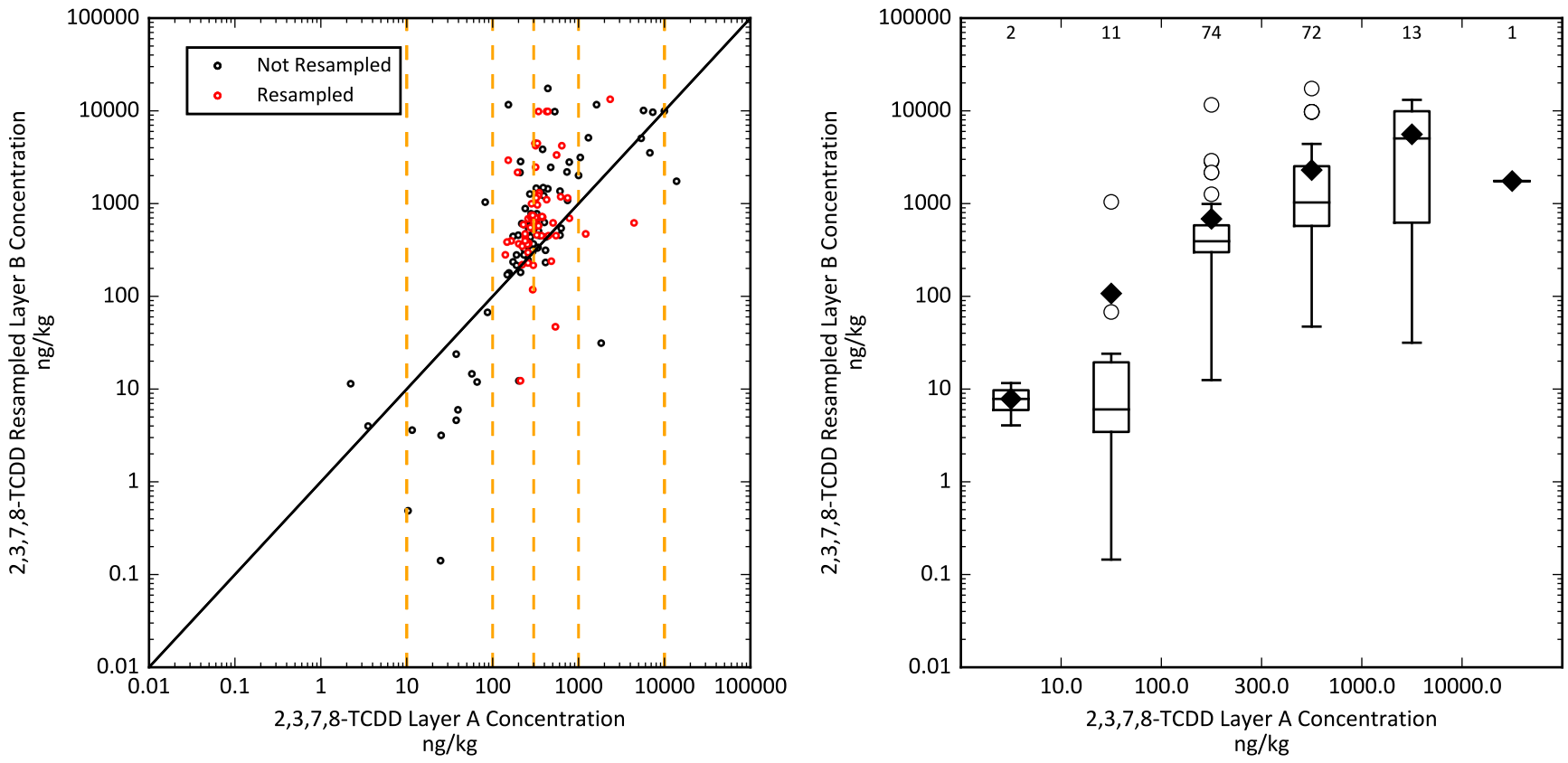
Publish Date: 06/19/2019 15:18 PM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_12_crossplot_CS_LayerB_Resample.py

Figure 7-12c

2,3,7,8-TCDD 2010 Mapped Conditional Simulation Layer A and Layer Resampled B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

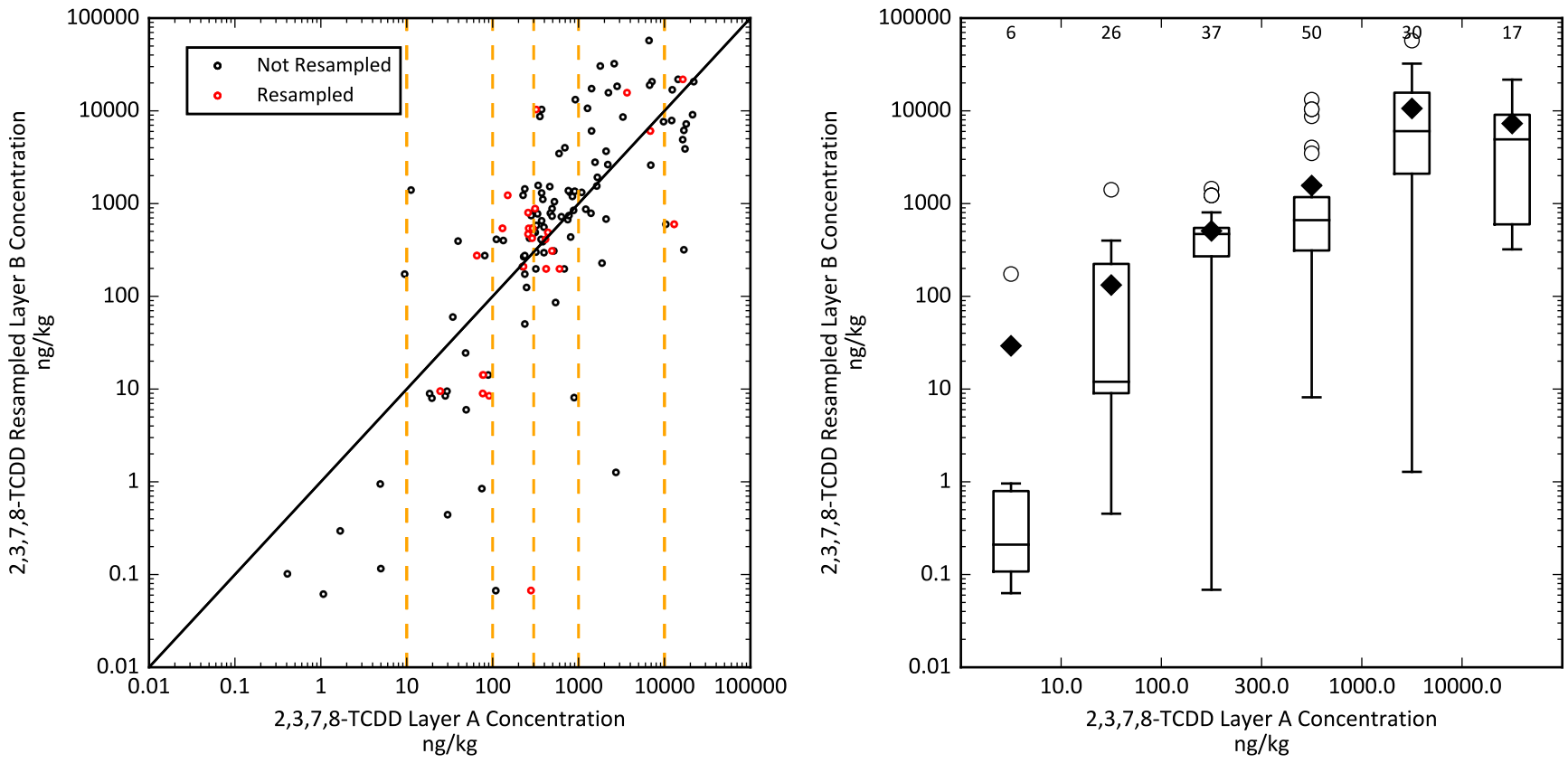
Publish Date: 06/19/2019 15:21 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 7-13

2,3,7,8-TCDD 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 2010 dataset.
2 Layer B concentrations with a value of zero are not shown.

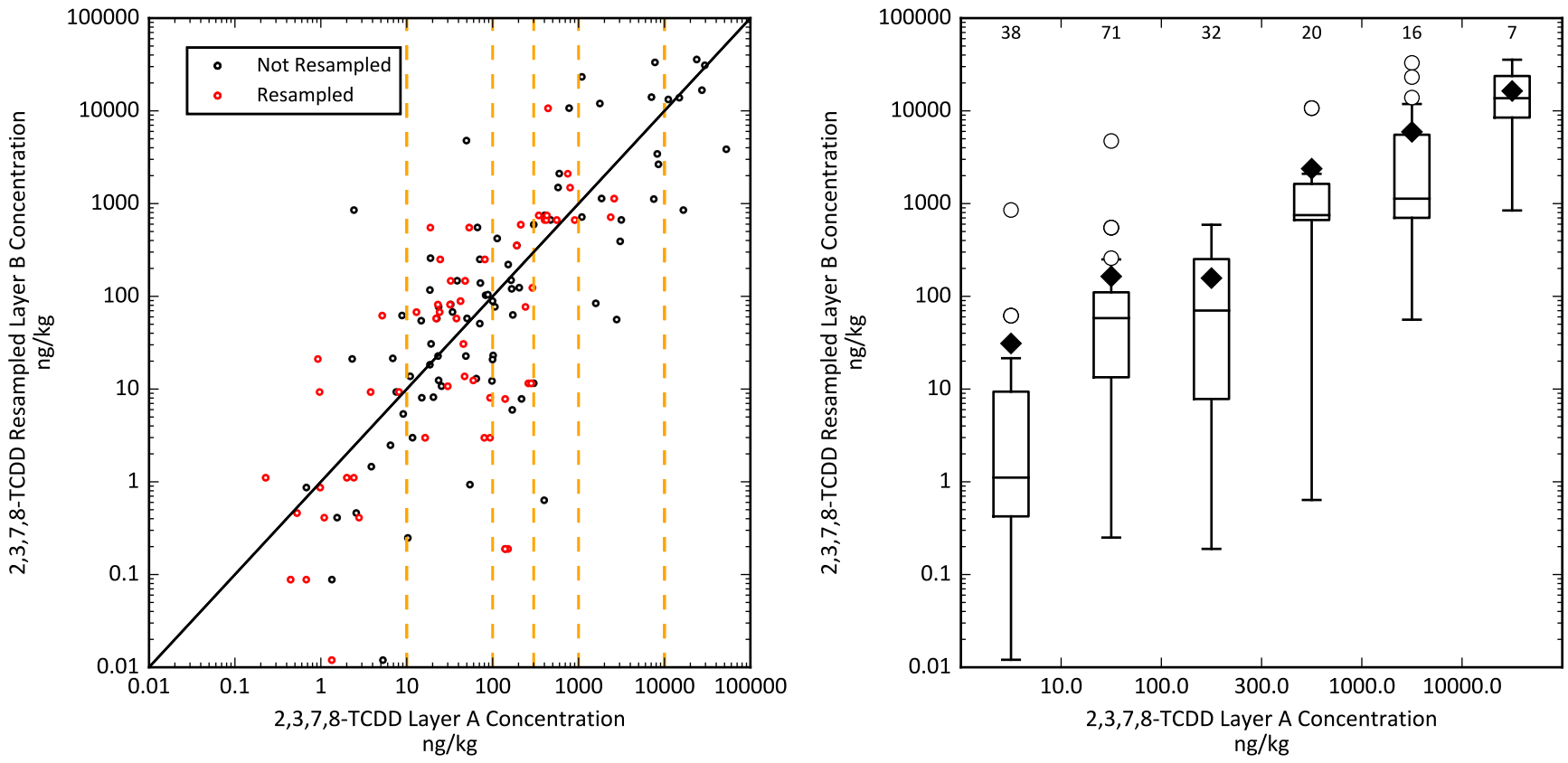
Publish Date: 06/19/2019 15:22 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 7-14a

2,3,7,8-TCDD 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

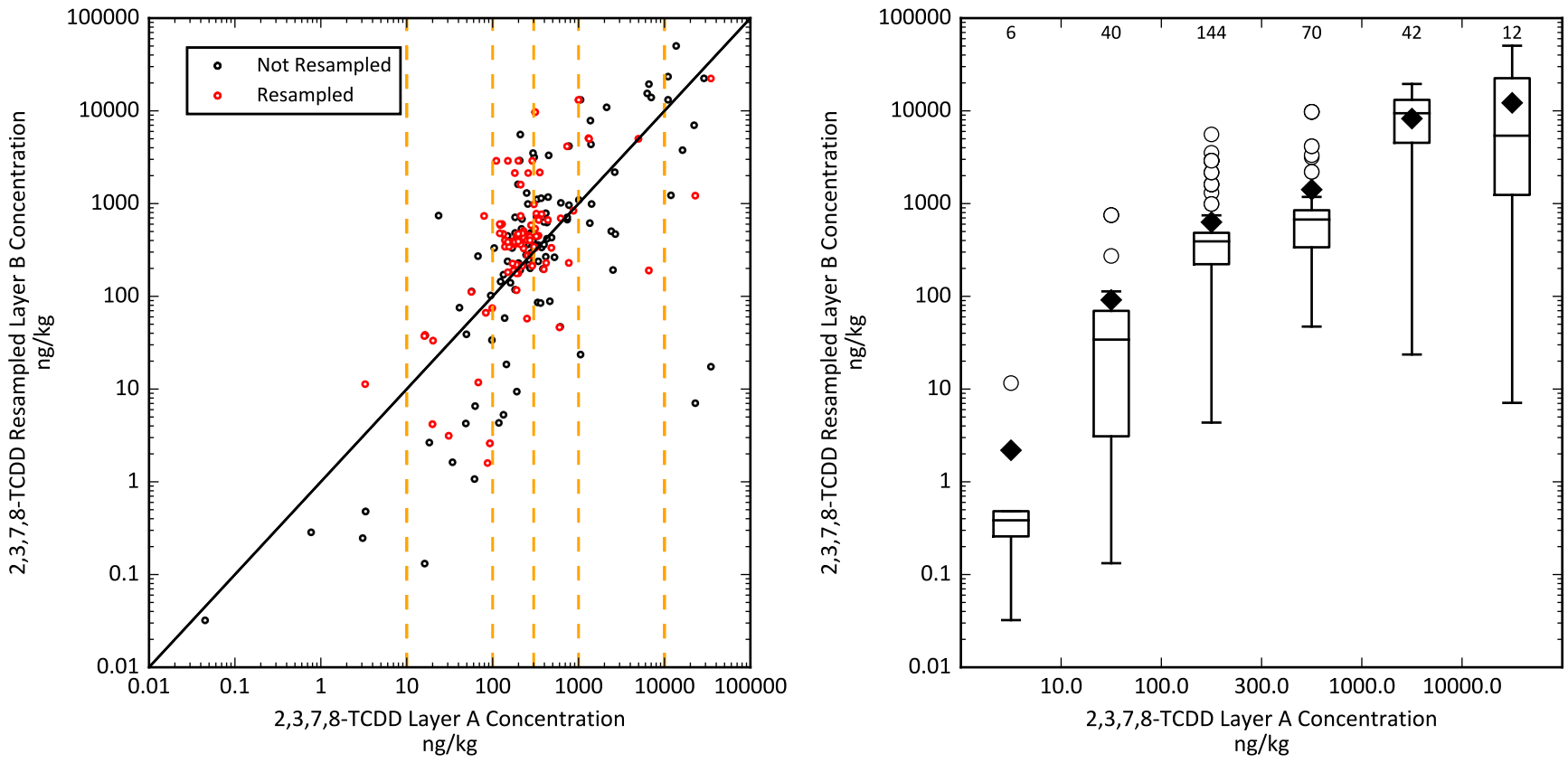
Publish Date: 06/19/2019 15:22 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 7-14b

2,3,7,8-TCDD 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

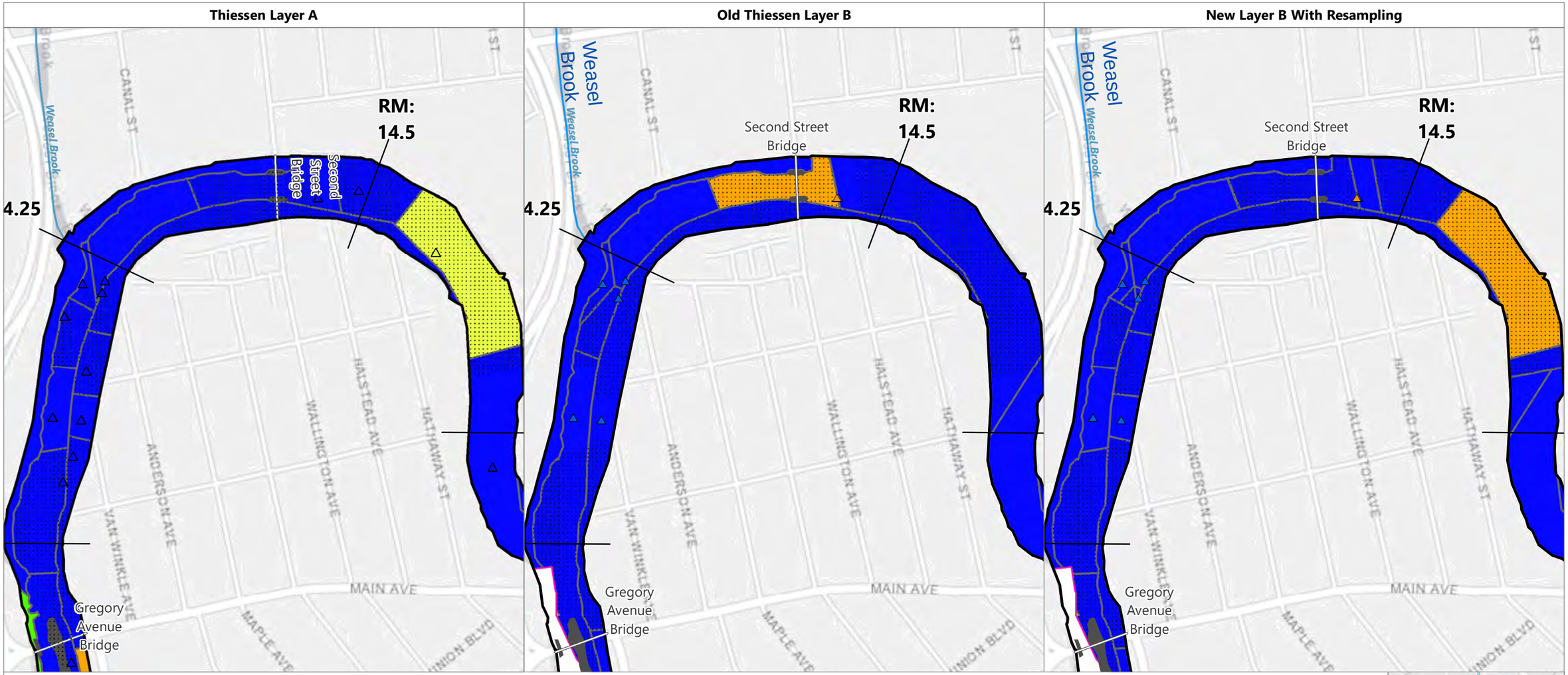
Publish Date: 06/19/2019 15:22 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 7-14c

2,3,7,8-TCDD 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Legend:

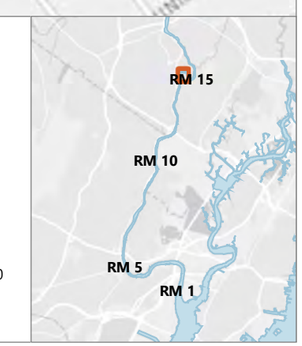
- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 450
Feet



Publish Date: 2019/06/13, 7:06 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

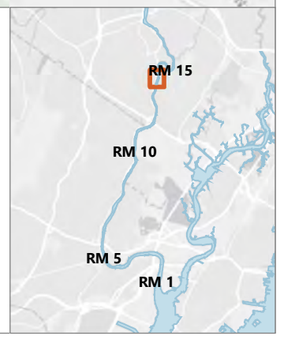
Figure 7-15a
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

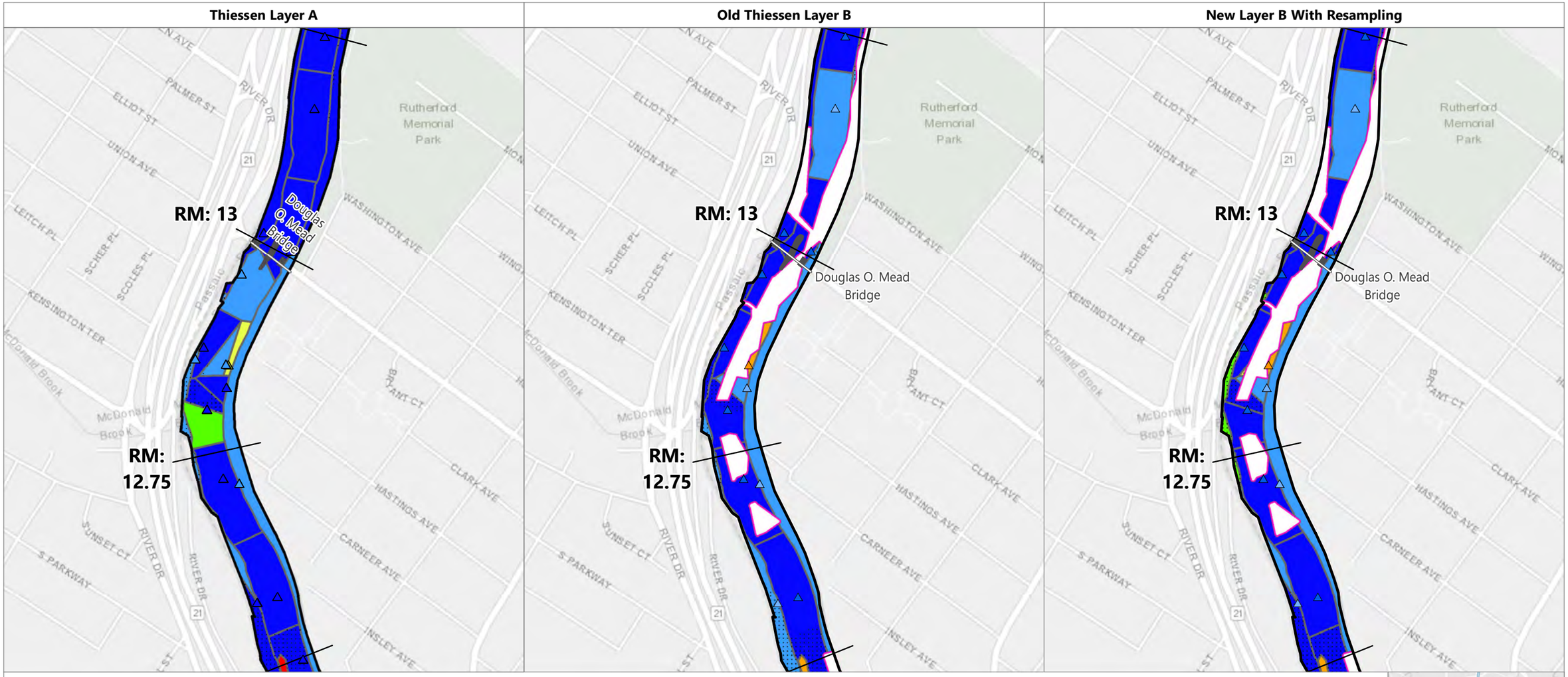
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 580
Feet



Publish Date: 2019/06/13, 7:06 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15b
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

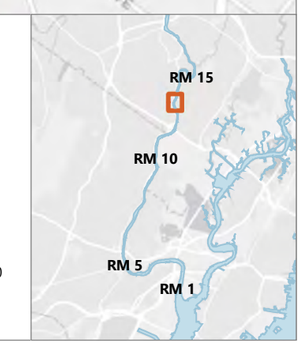


Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

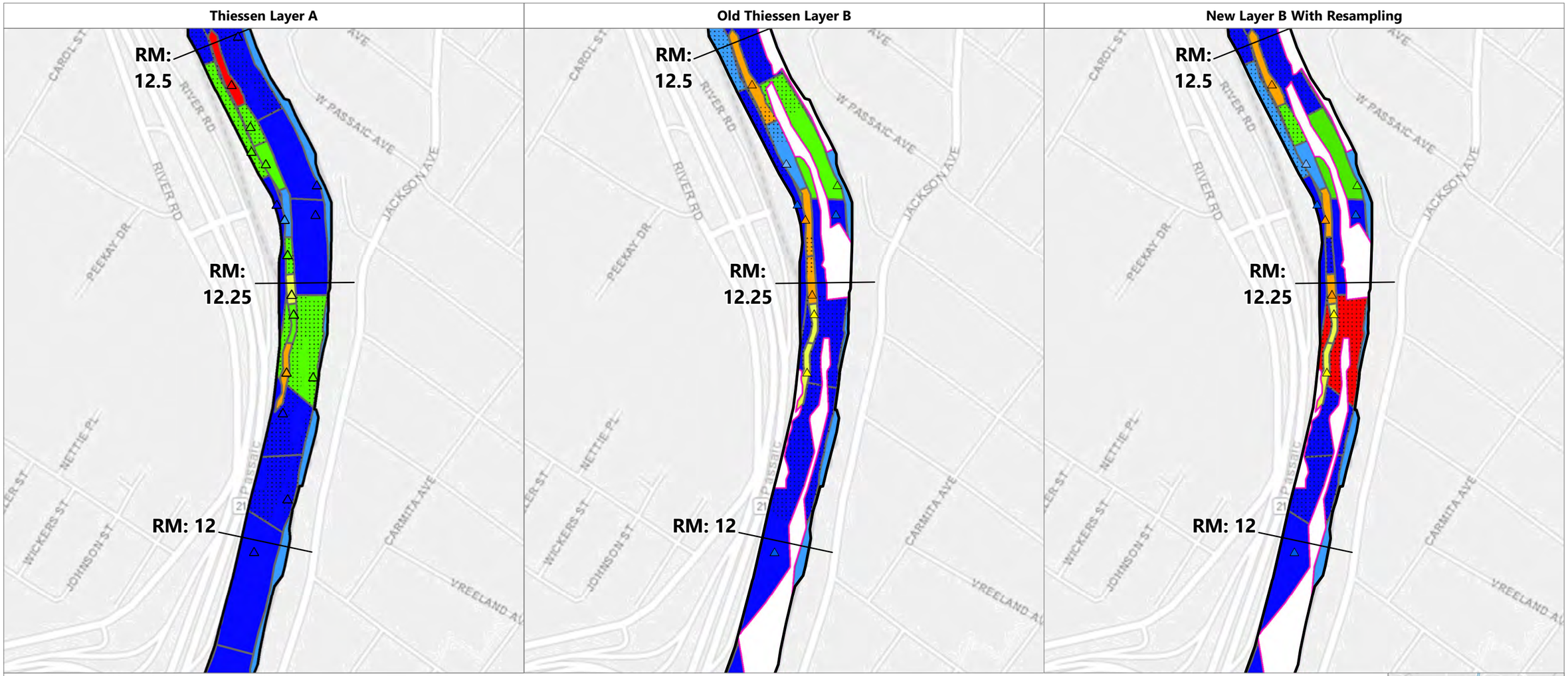
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 580
Feet



Publish Date: 2019/06/13, 7:07 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15c
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

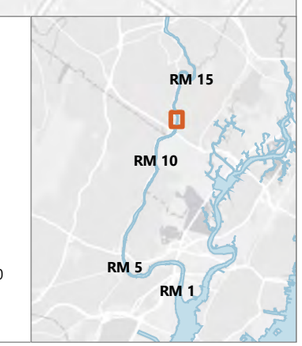


Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

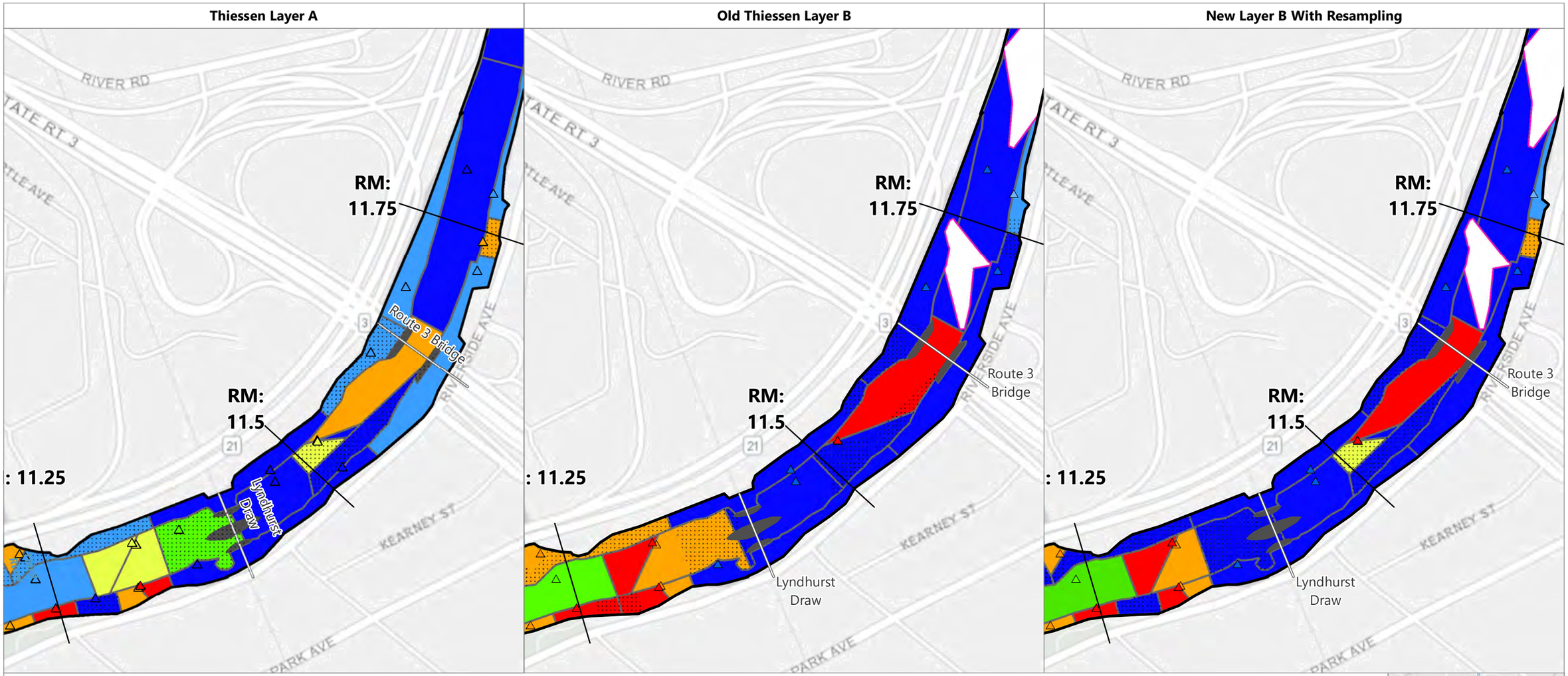
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 500
Feet



Publish Date: 2019/06/13, 7:07 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15d
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

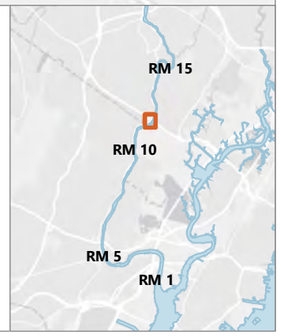


Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

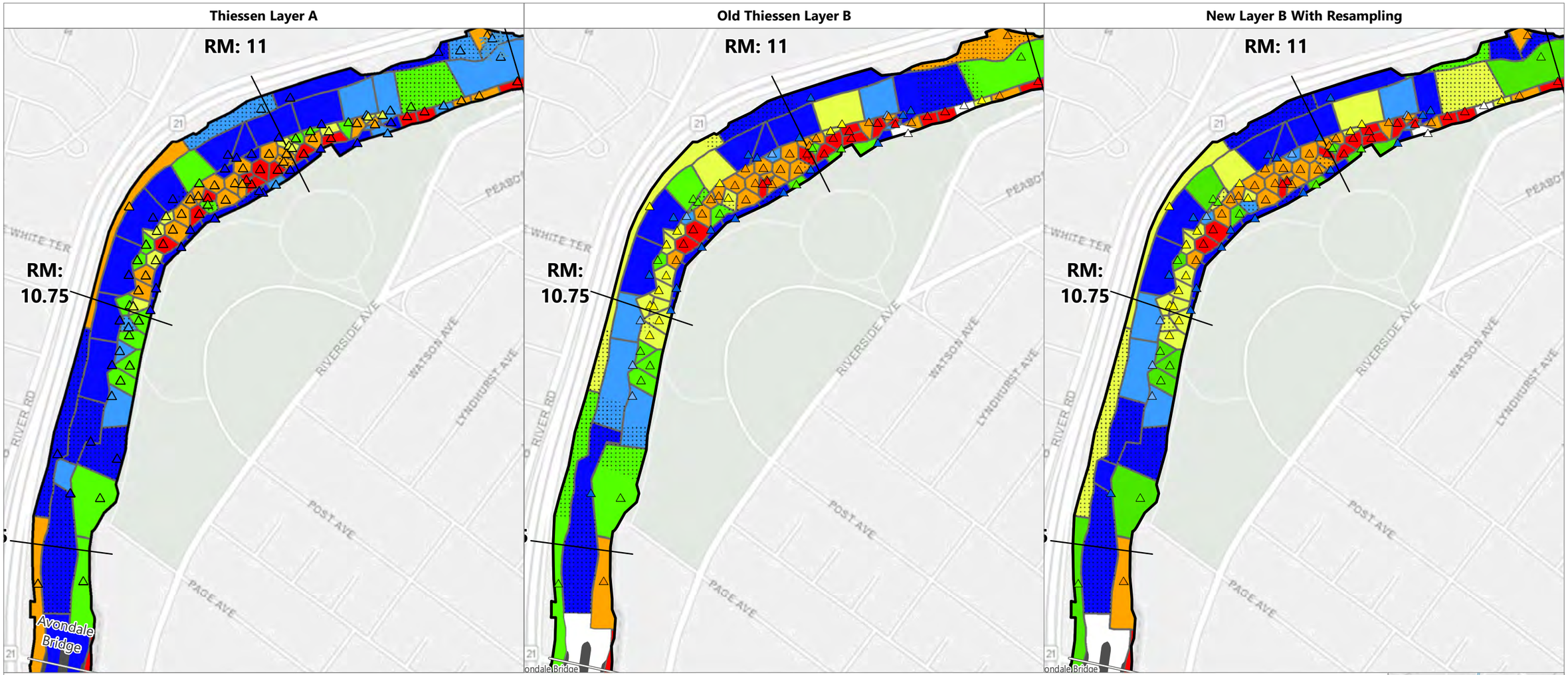
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 450
Feet



Publish Date: 2019/06/13, 7:07 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15e
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

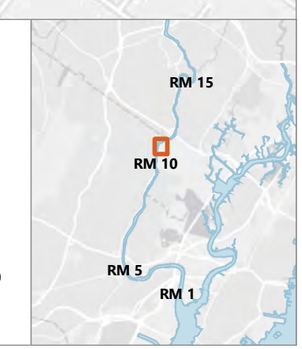


Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 520
Feet



Publish Date: 2019/06/13, 7:08 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15f
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

Legend:

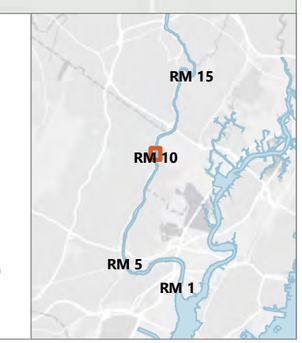
- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 400
Feet



Publish Date: 2019/06/13, 7:08 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15g
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

Legend:

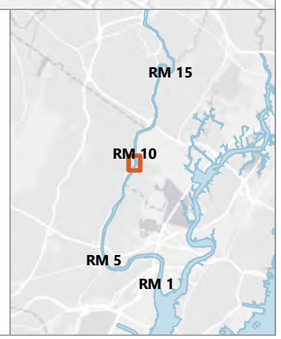
- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

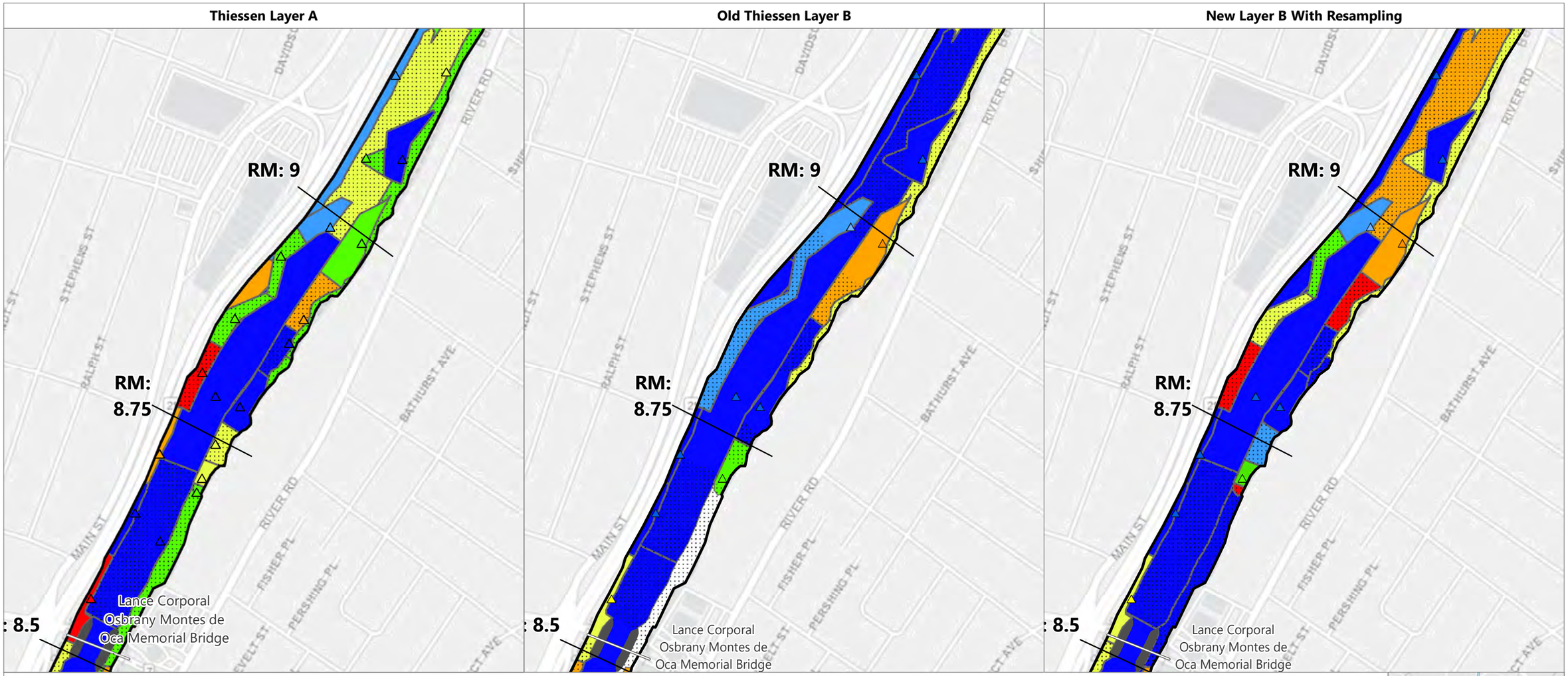
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 500
Feet



Publish Date: 2019/06/13, 7:08 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15h
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

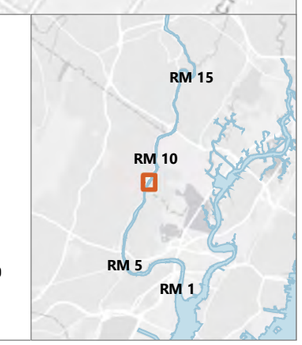


Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

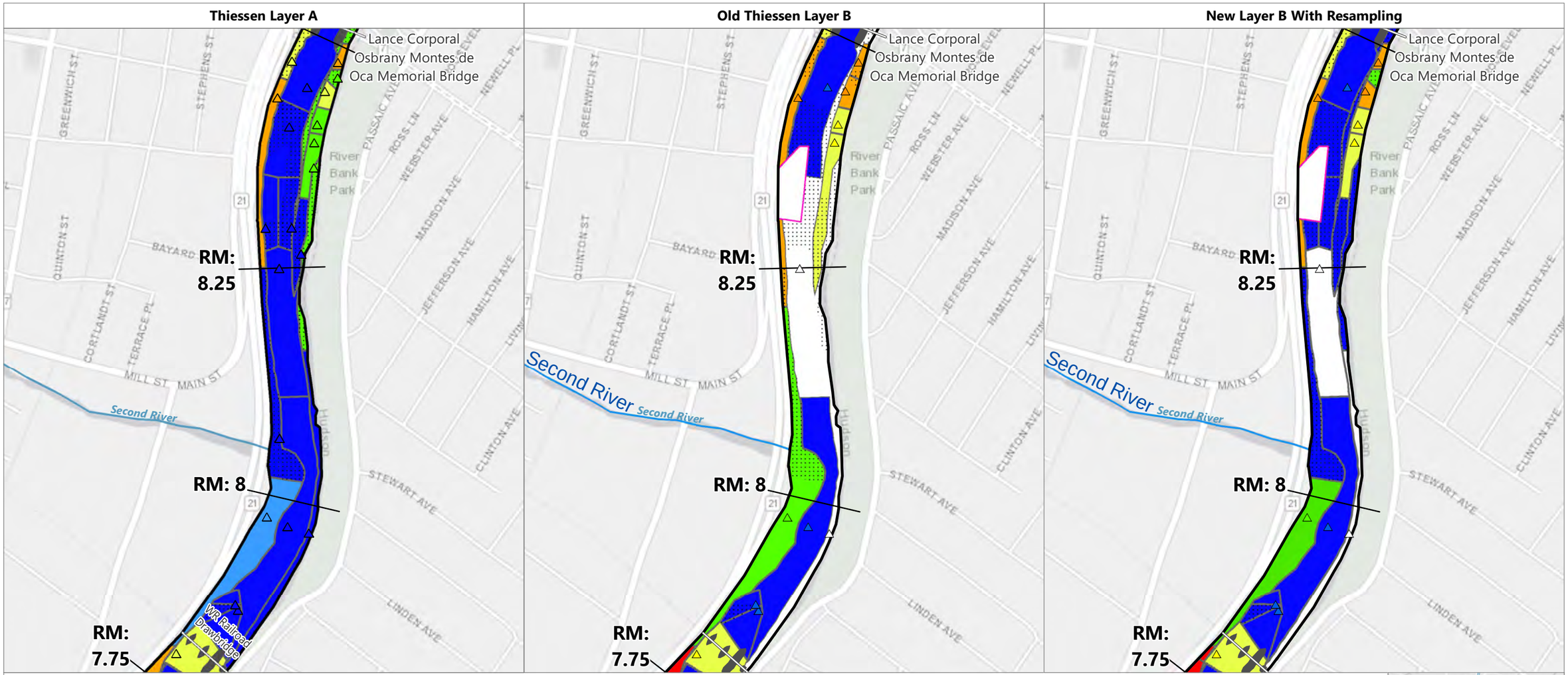
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 500
Feet



Publish Date: 2019/06/13, 7:09 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15i
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

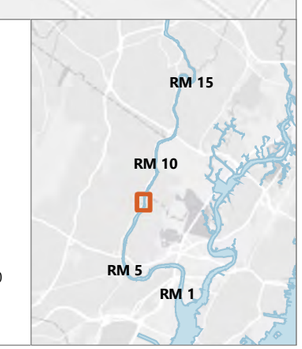


Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

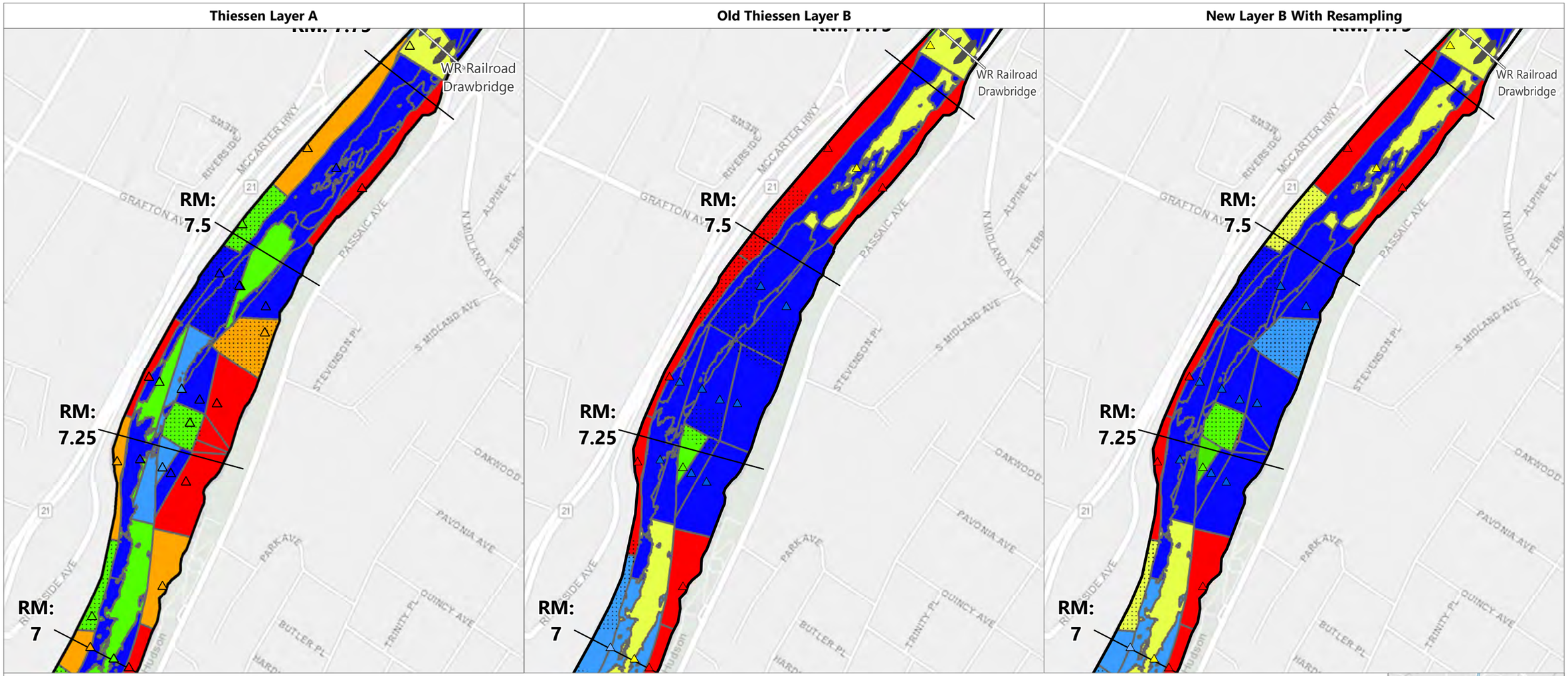
NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 550
Feet



Publish Date: 2019/06/13, 7:09 PM | User: dbaker
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15j
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 580
Feet

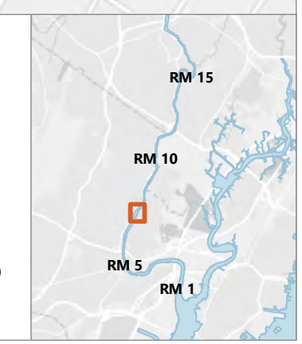


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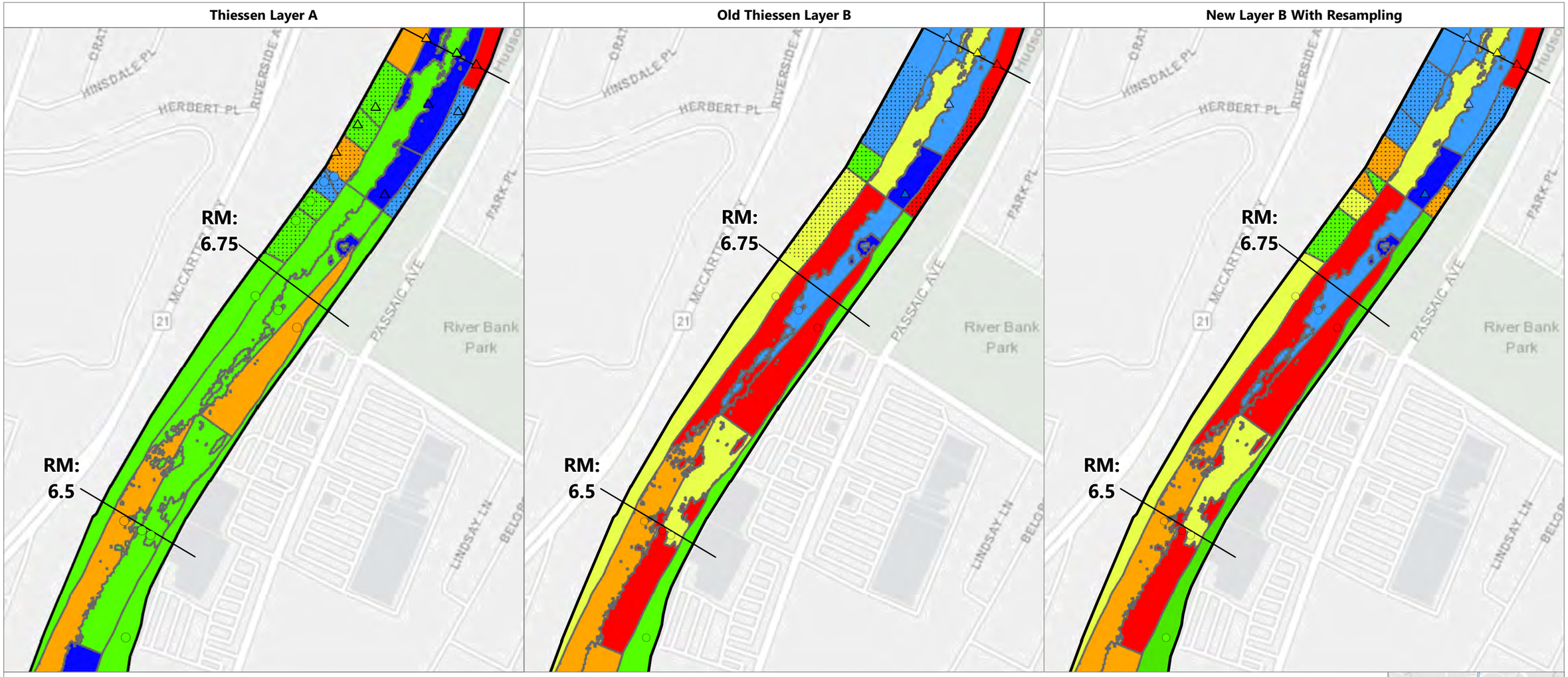
Figure 7-15k
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 460
Feet

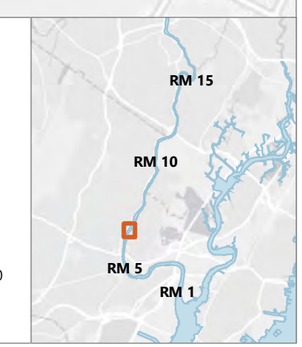


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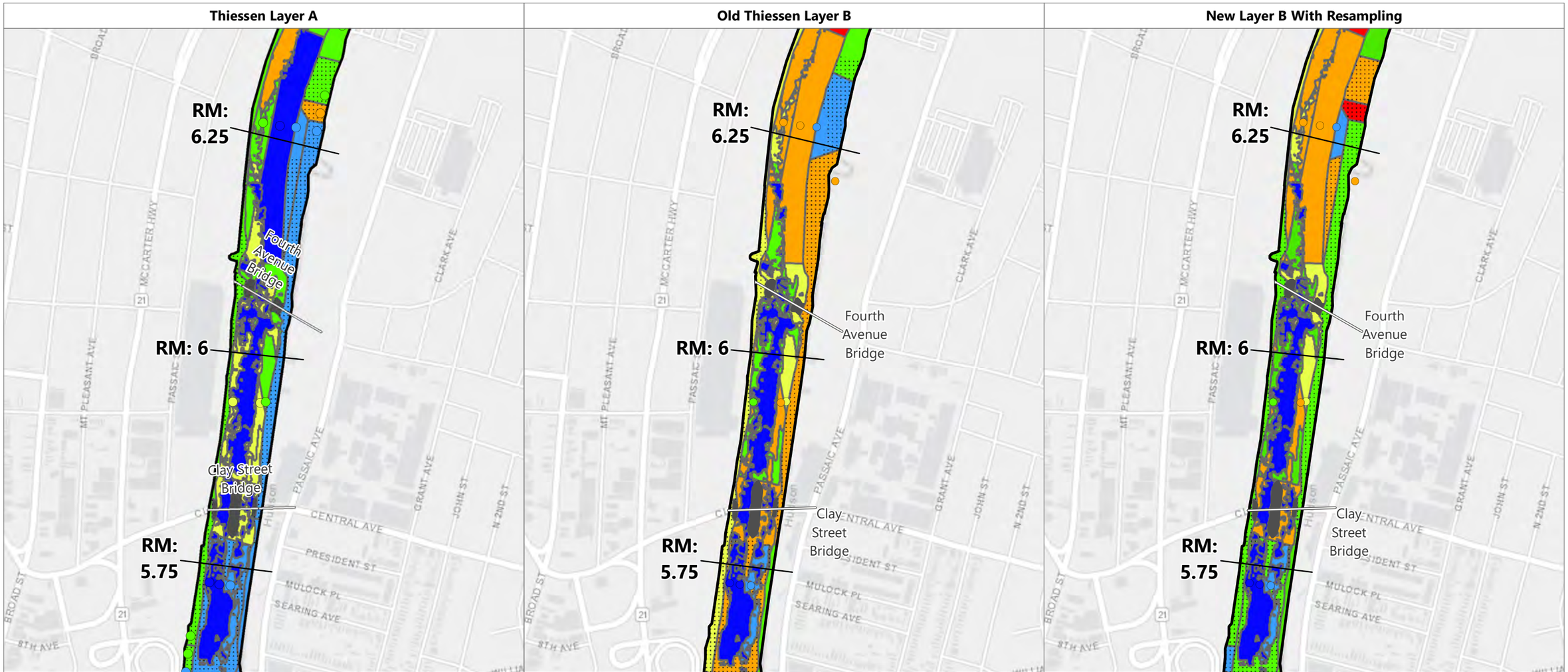
Figure 7-15I
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

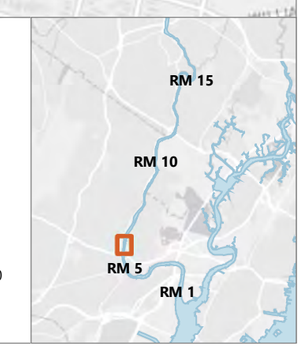
- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 600
Feet



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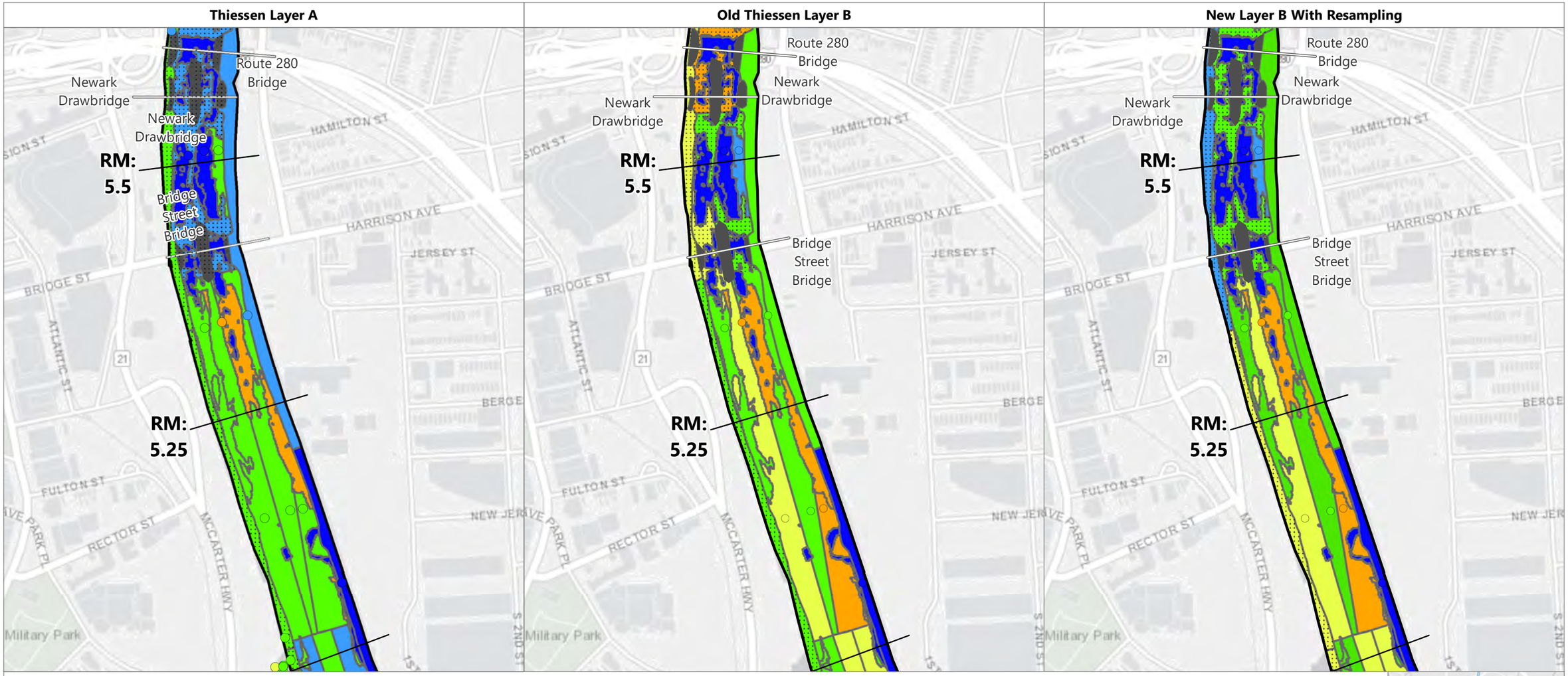
Filepath: \\Boston1\jobs\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\mxds_new\Figure_7-15_3Panel_Interp_Comparison_1995_.mxd

Figure 7-15m
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 500
Feet

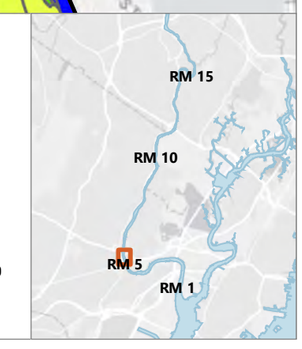


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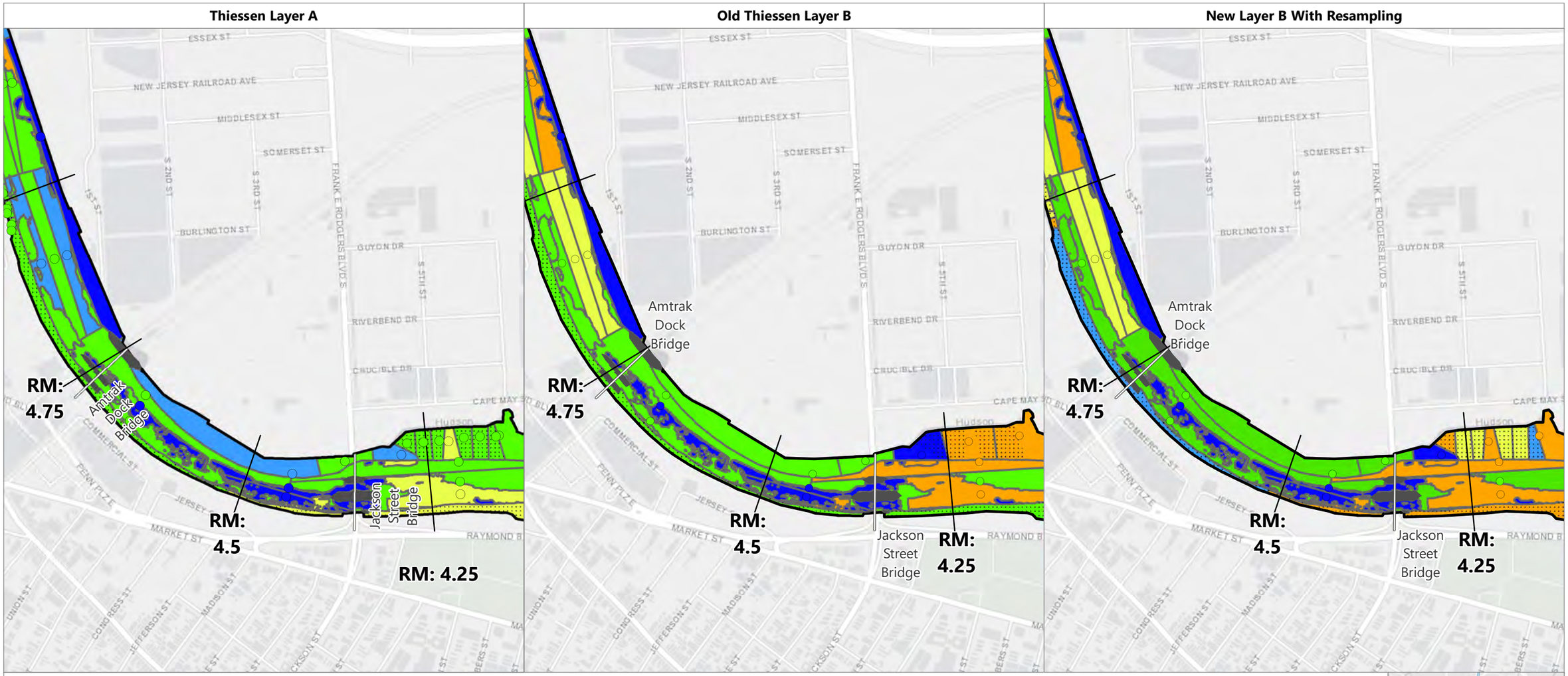
Figure 7-15n
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 700
Feet

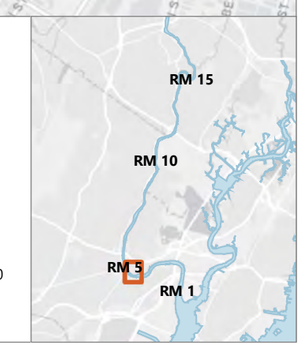


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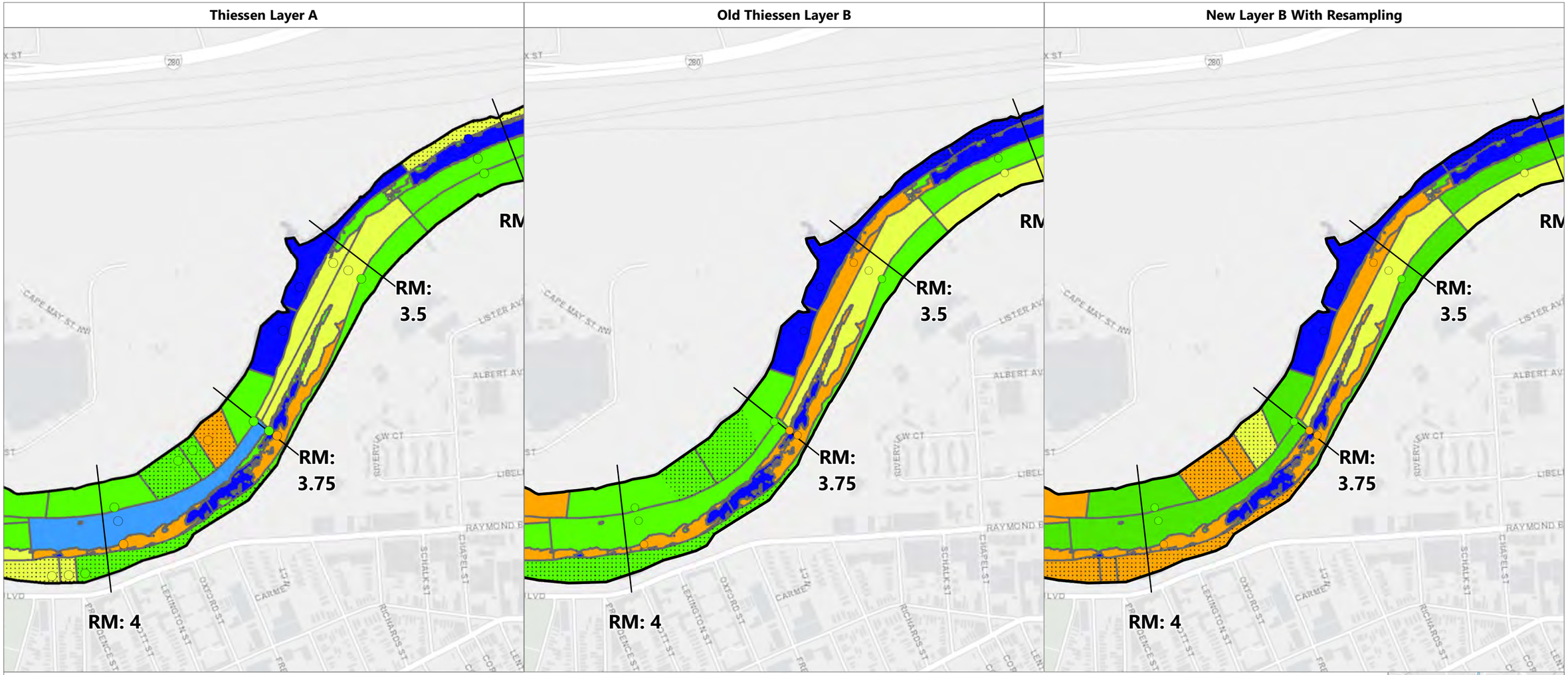
Figure 7-15o
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 660
Feet

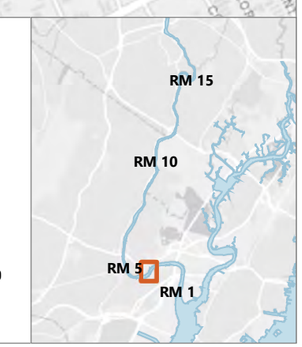


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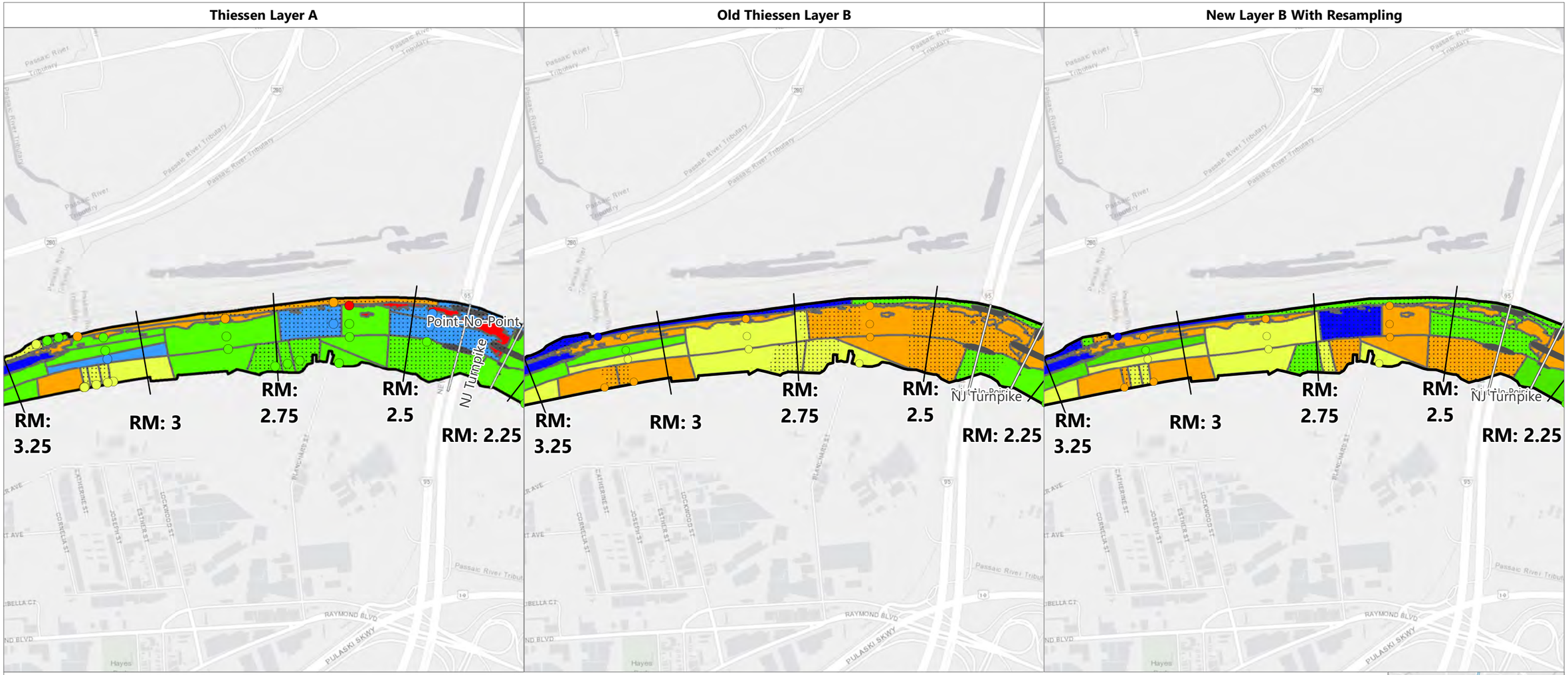
Figure 7-15p
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 960
Feet

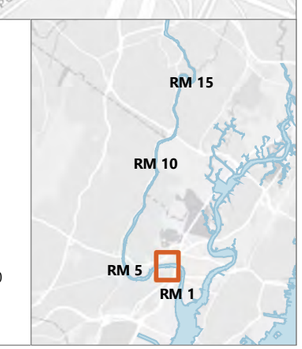


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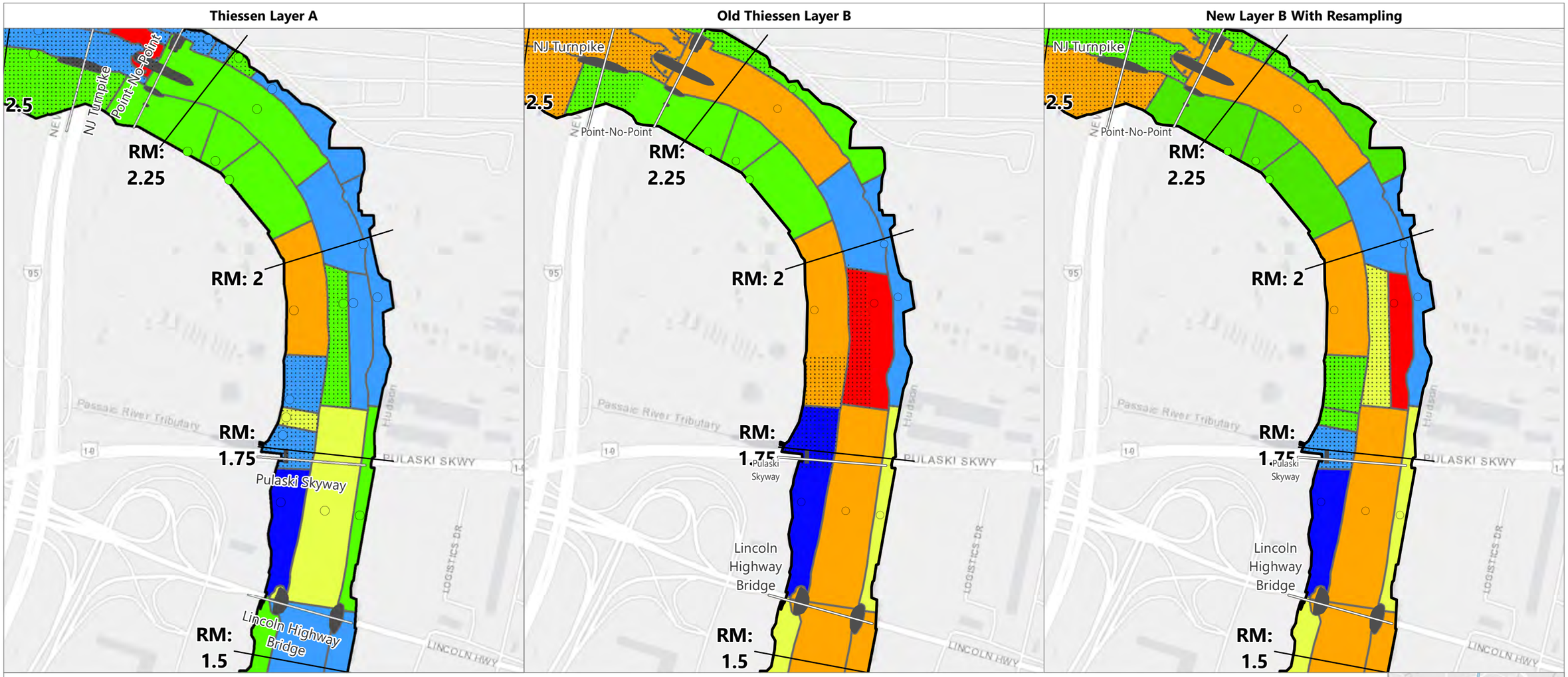
Figure 7-15q
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

- 1995 Dataset
- 2010 Dataset
- Layer B Resampled
- Shallow Areas
- Bridge Abutment
- Shoreline

2,3,7,8-TCDD Concentration (ng/kg)

- 0
- >0 - 100
- 101 - 250
- 251 - 500
- 501 - 1,000
- 1,001 - 10,000
- >10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 620
Feet

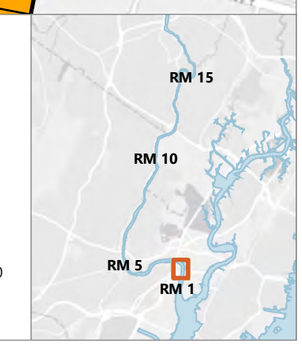


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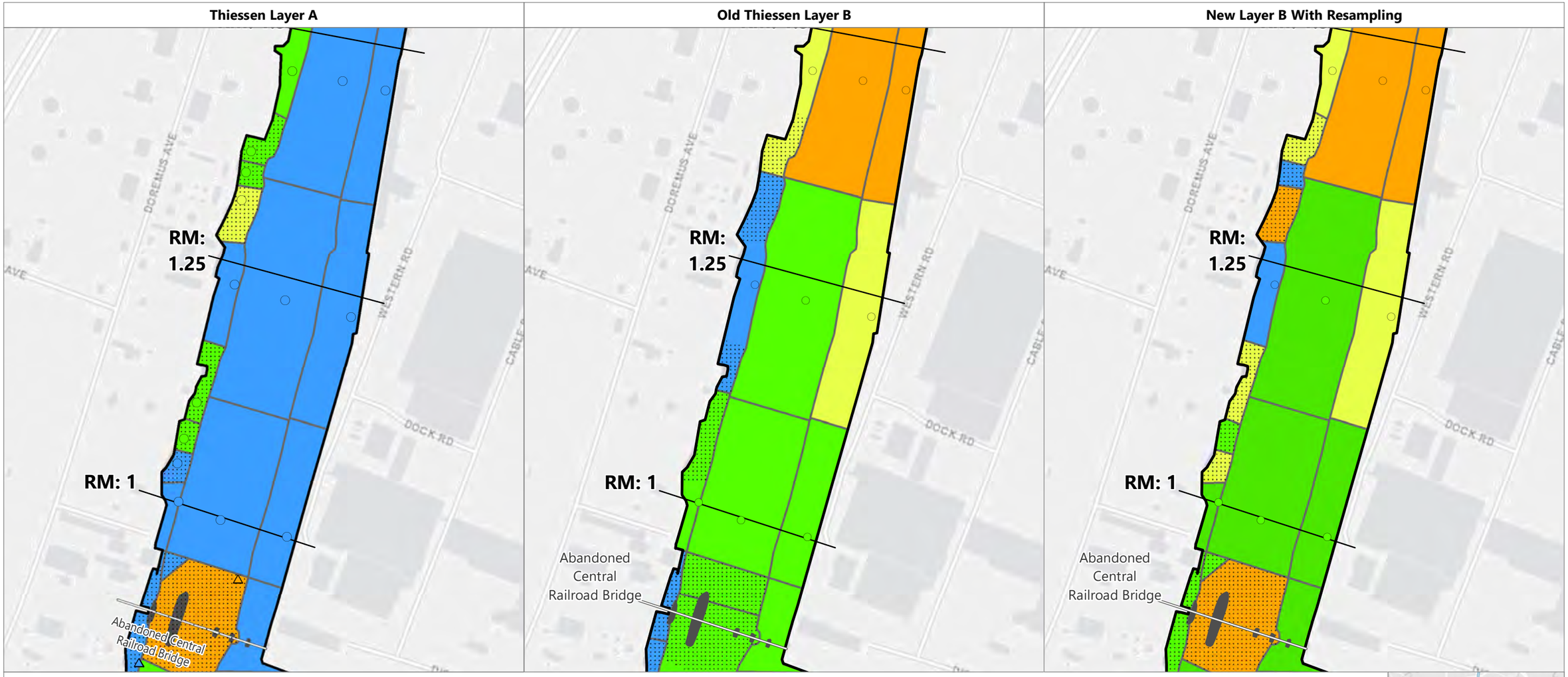
Figure 7-15r
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 520
Feet

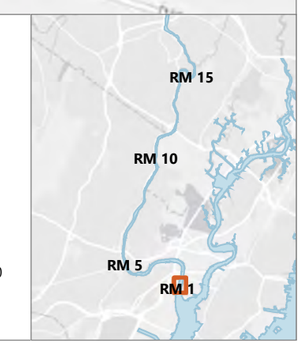


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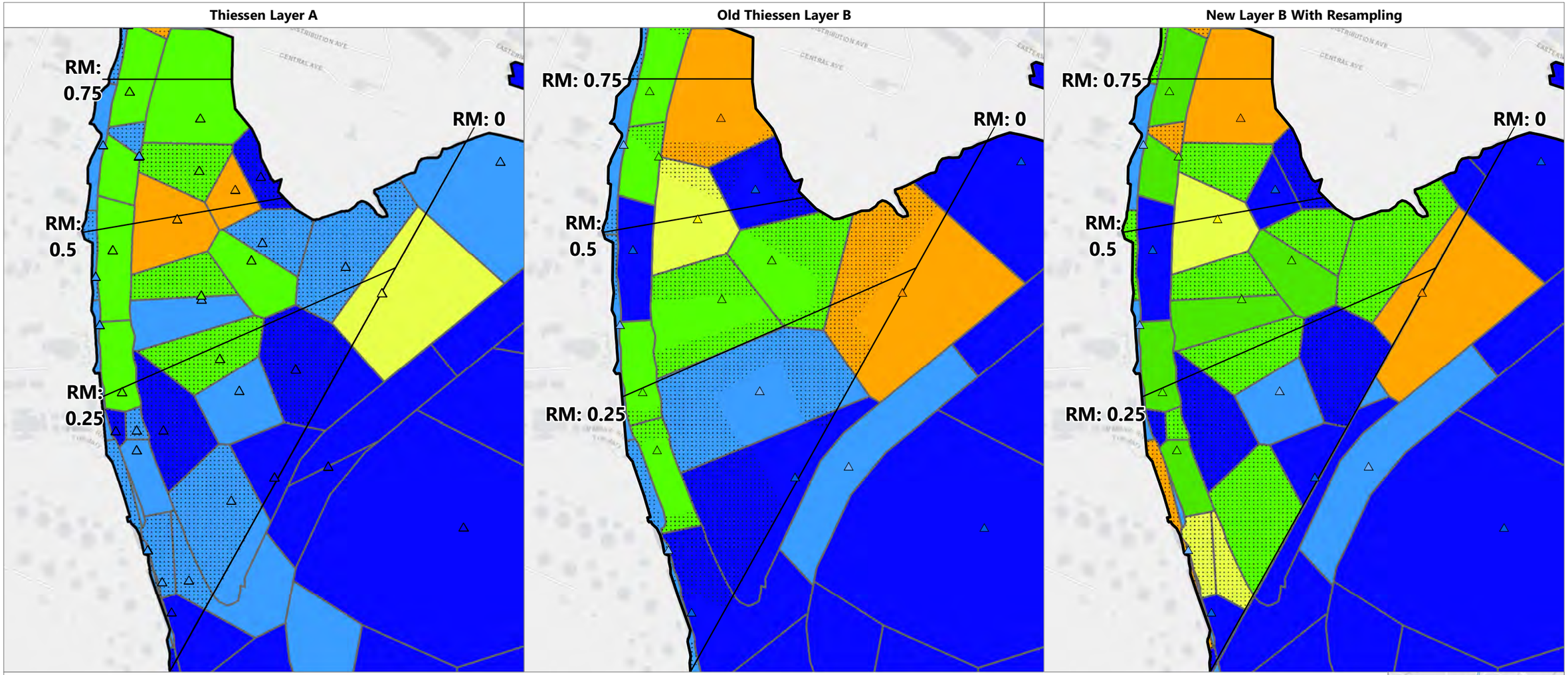
Figure 7-15s
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Legend:

1995 Dataset	2,3,7,8-TCDD Concentration (ng/kg)
2010 Dataset	0
Layer B Resampled	>0 - 100
Shallow Areas	101 - 250
Bridge Abutment	251 - 500
Shoreline	501 - 1,000
	1,001 - 10,000
	>10,000

NOTE:
Areas where layer B was resampled are shown for illustrative purposes on all three panels.

0 940
Feet

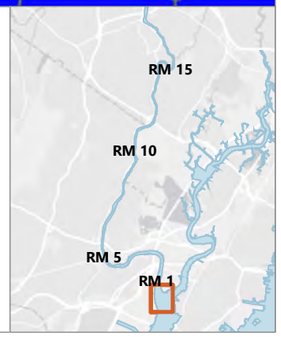


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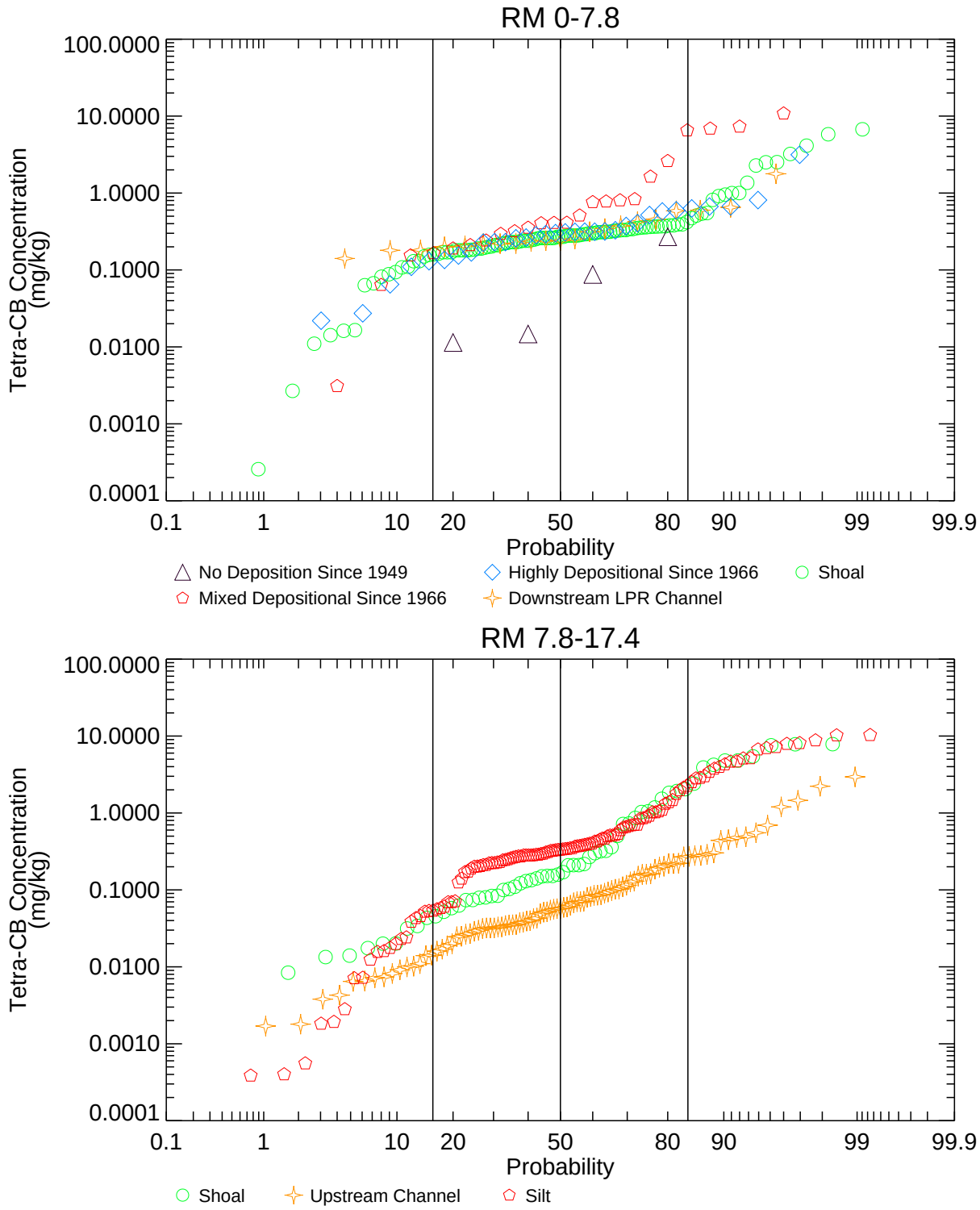
Figure 7-15t
1995 Mapping Comparison: Layer A and Old and New Layer B
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

Attachment 1
Support for Geomorphic Groups for Additional Mapped COPCs



Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

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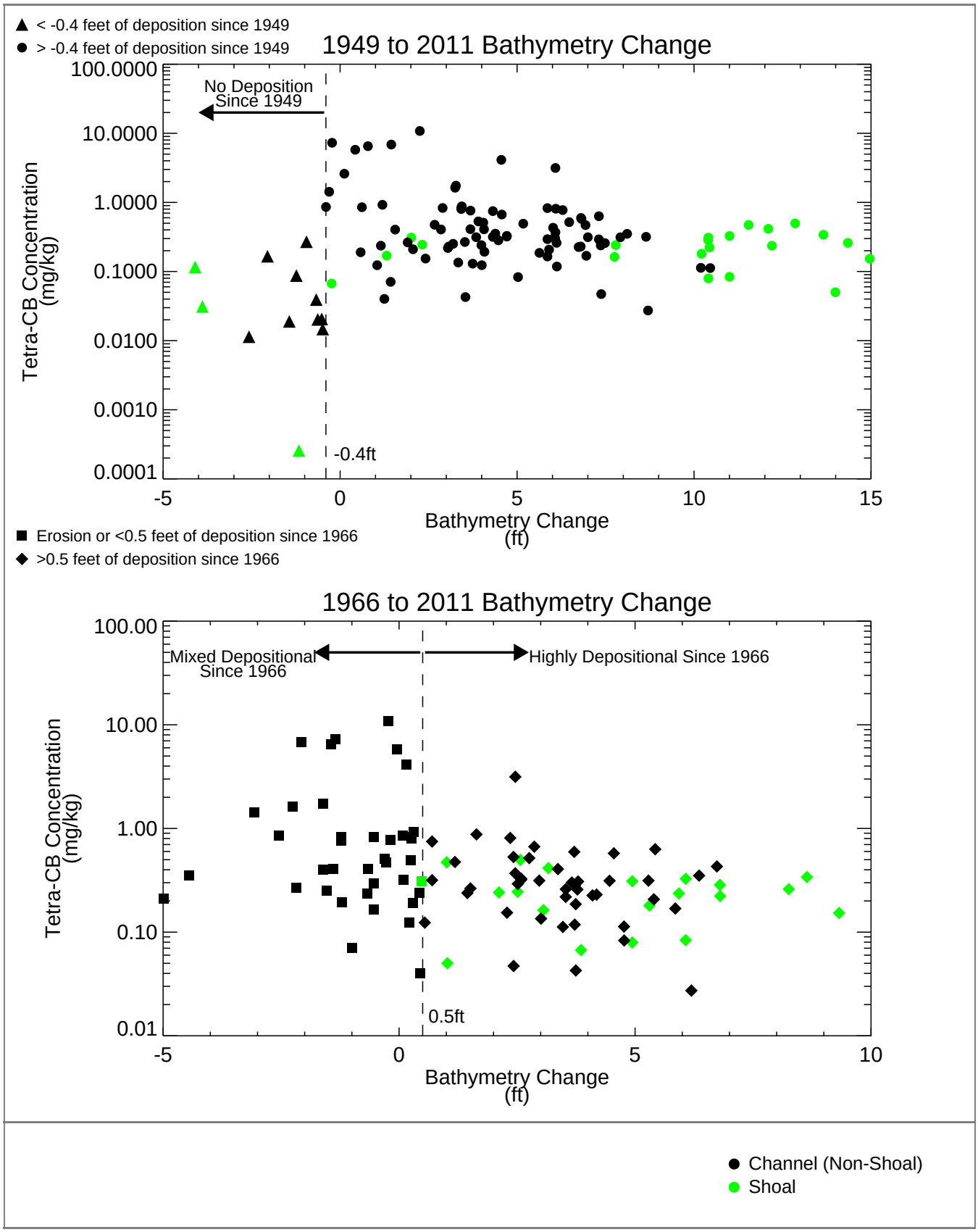
Figure 1

Distribution of Surface Sediment Tetra-CB Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



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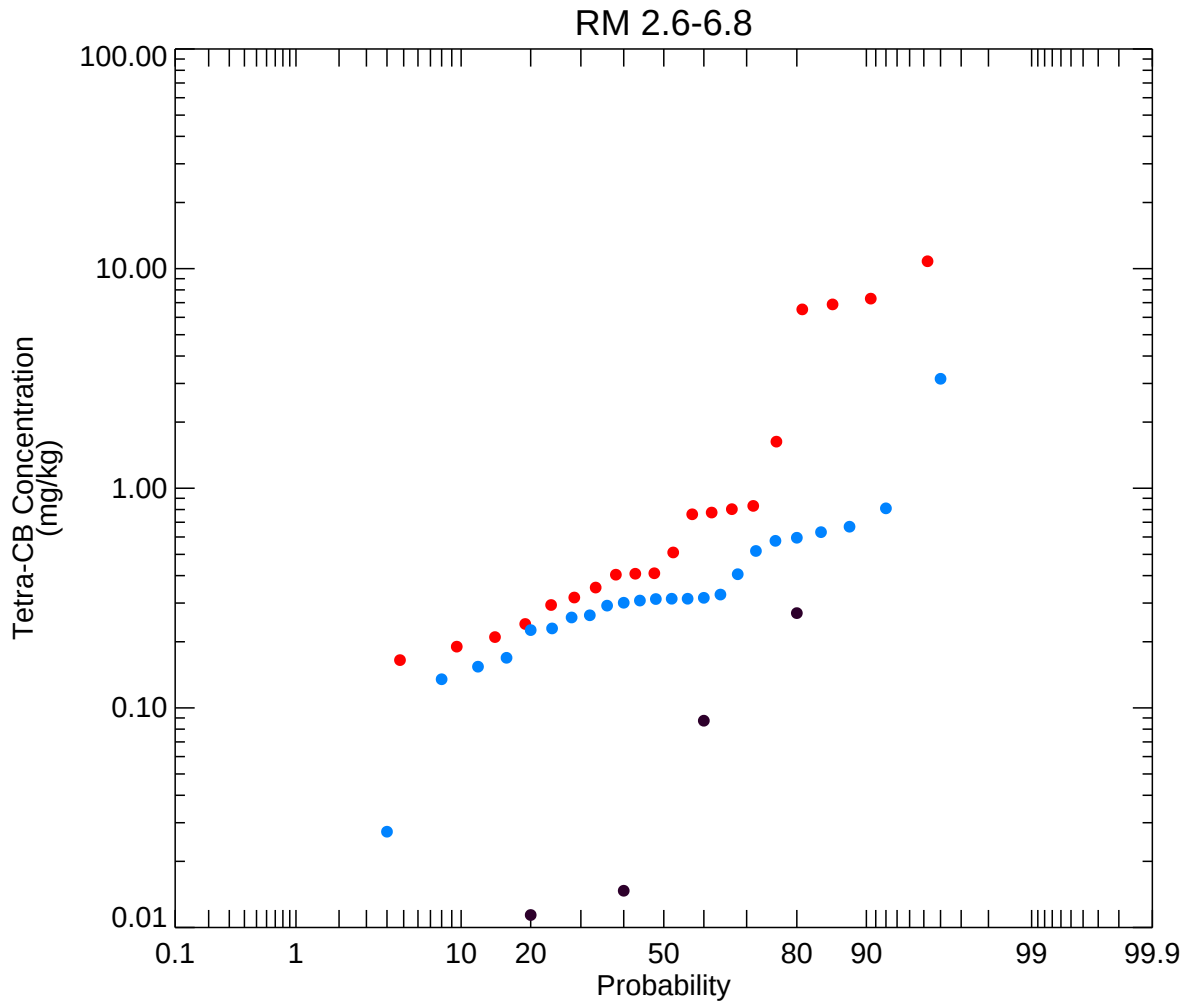
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 2

Tetra-CB Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Excludes data in the shoals

- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
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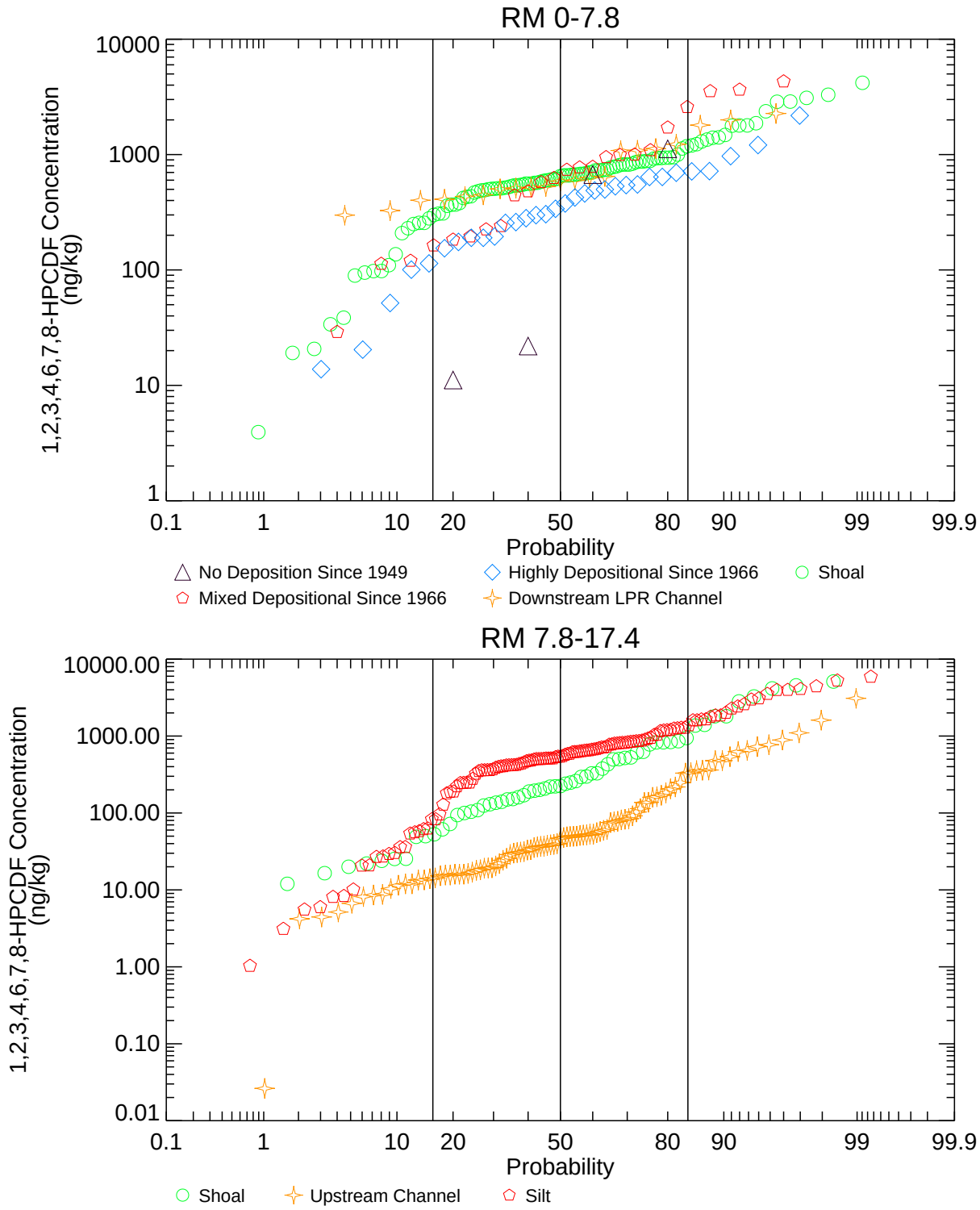
Figure 3

Distribution of Surface Tetra-CB Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

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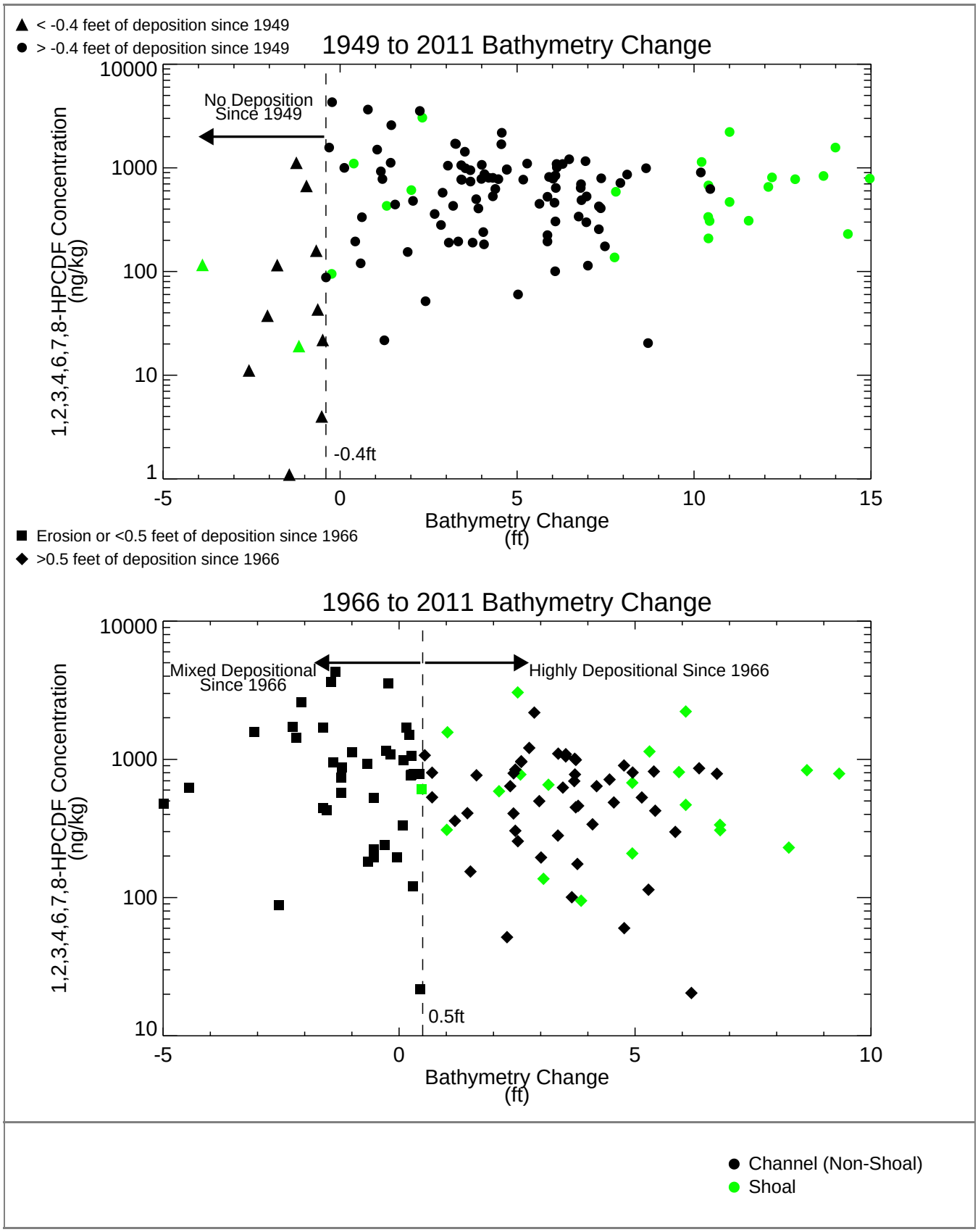
Figure 4

Distribution of Surface Sediment 1,2,3,4,6,7,8-HPCDF Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



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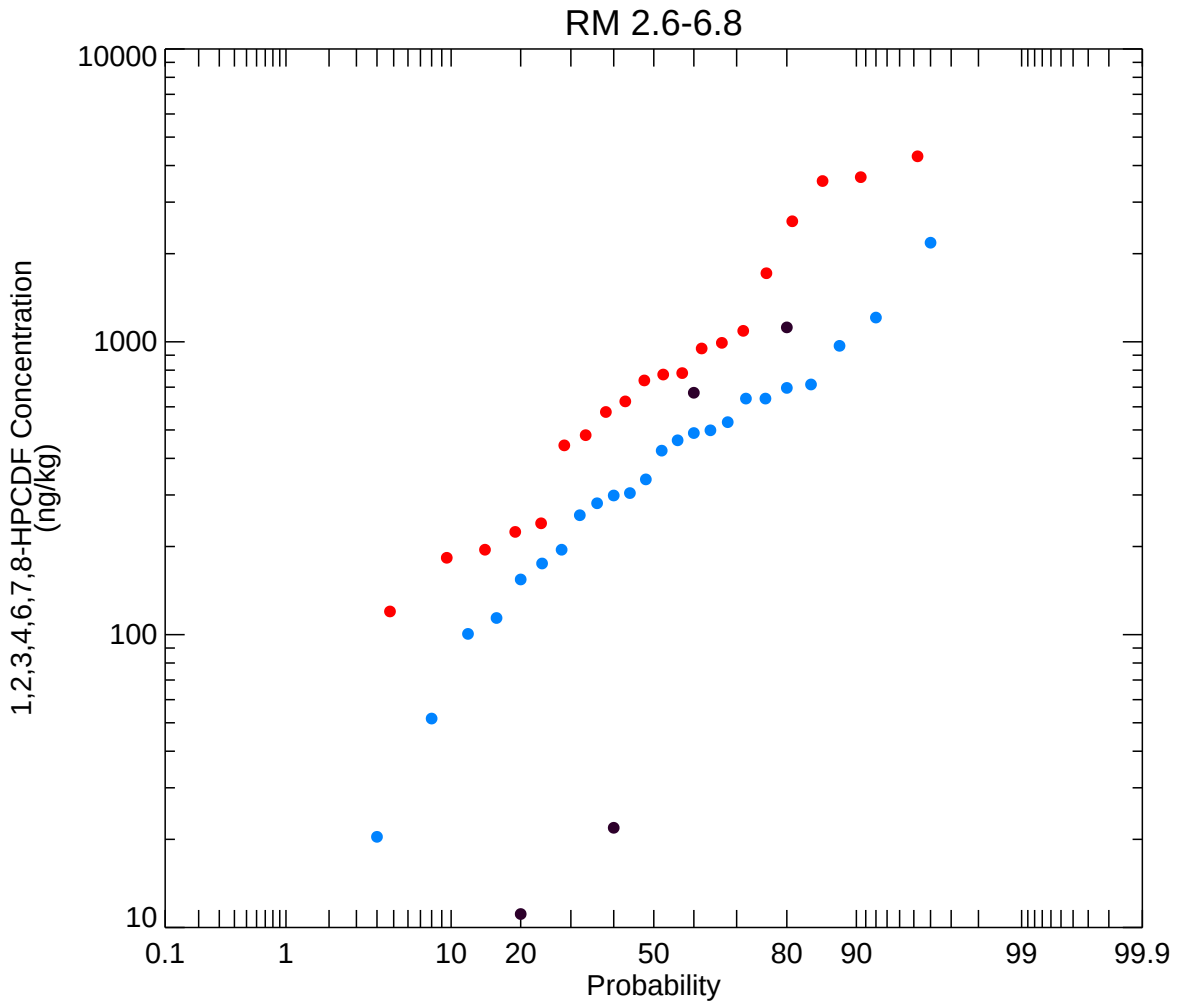
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 5

1,2,3,4,6,7,8-HPCDF Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



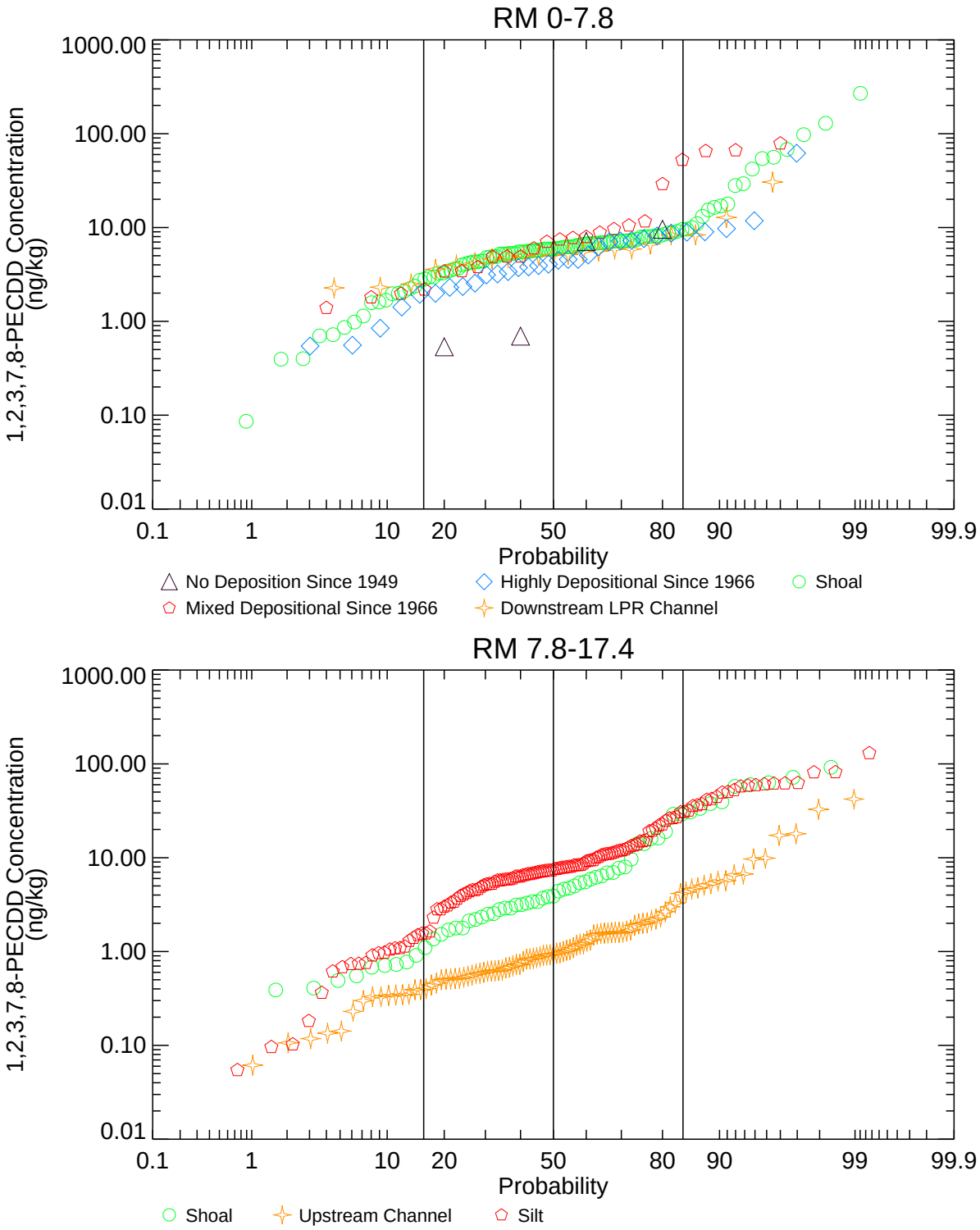
Note: Includes data from 2005-2013. Excludes data in the shoals

- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 6

Distribution of Surface 1,2,3,4,6,7,8-HPCDF Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8



Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

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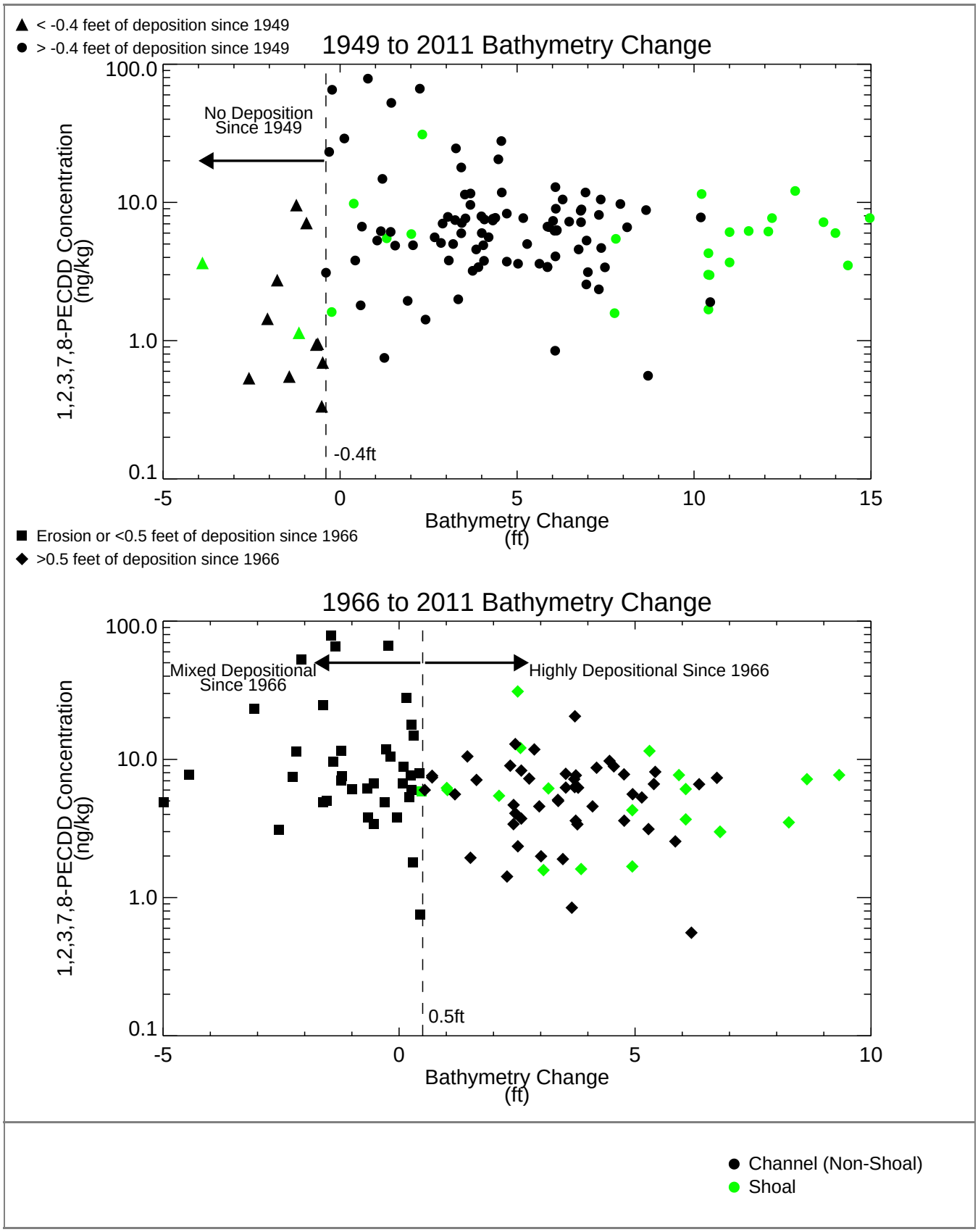
Figure 7

Distribution of Surface Sediment 1,2,3,7,8-PECDD Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



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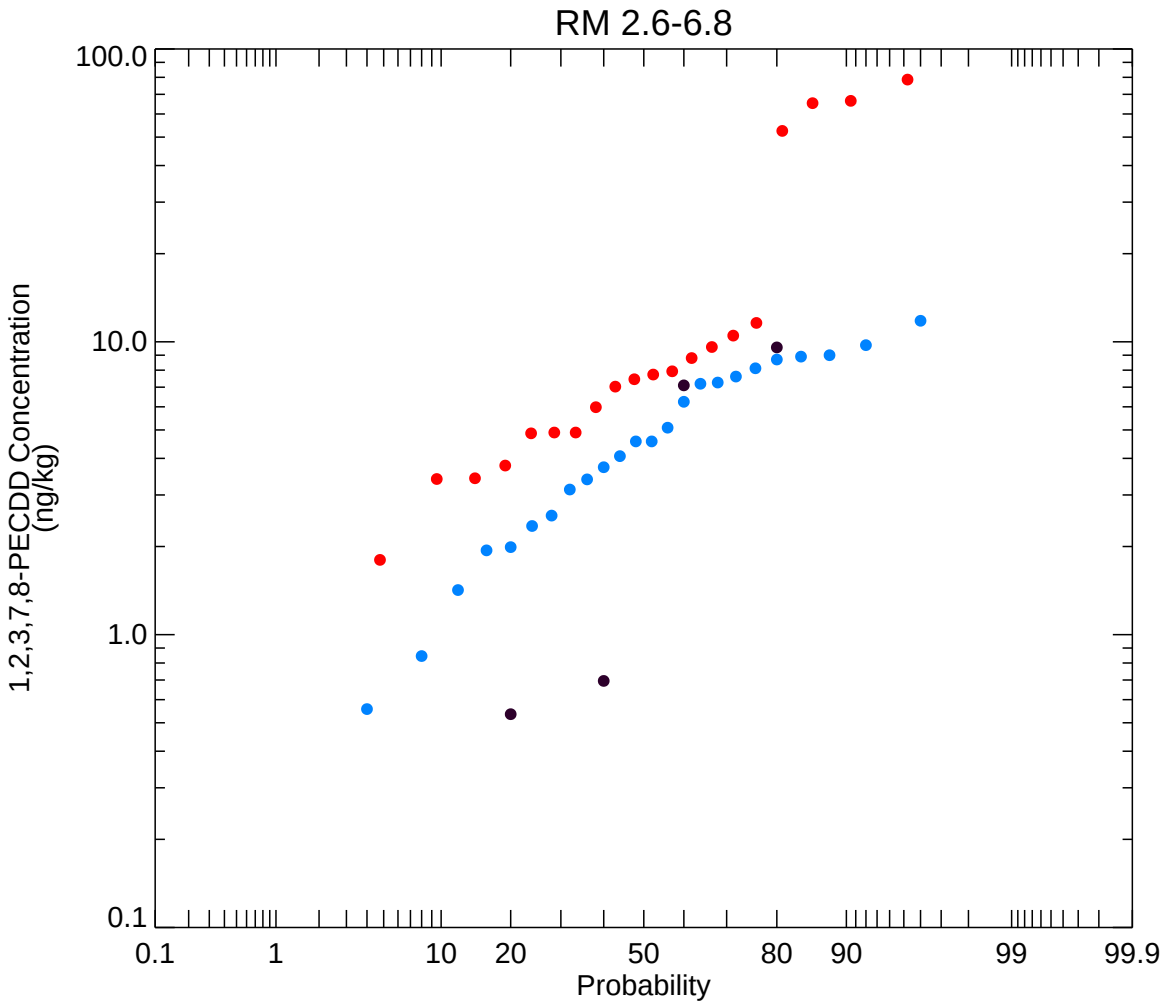
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 8

1,2,3,7,8-PECDD Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



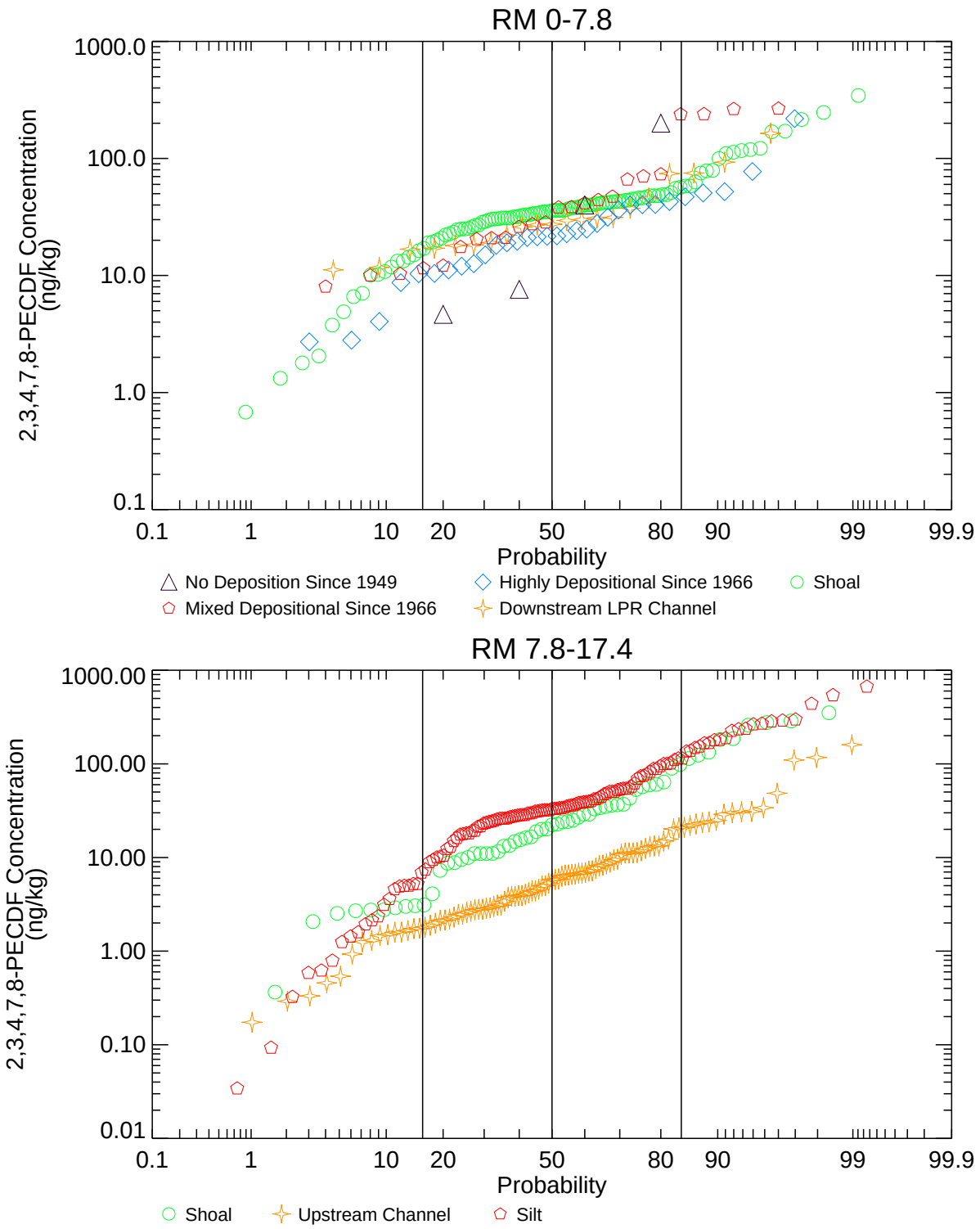
Note: Includes data from 2005-2013. Excludes data in the shoals

- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 9

Distribution of Surface 1,2,3,7,8-PECDD Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8



Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

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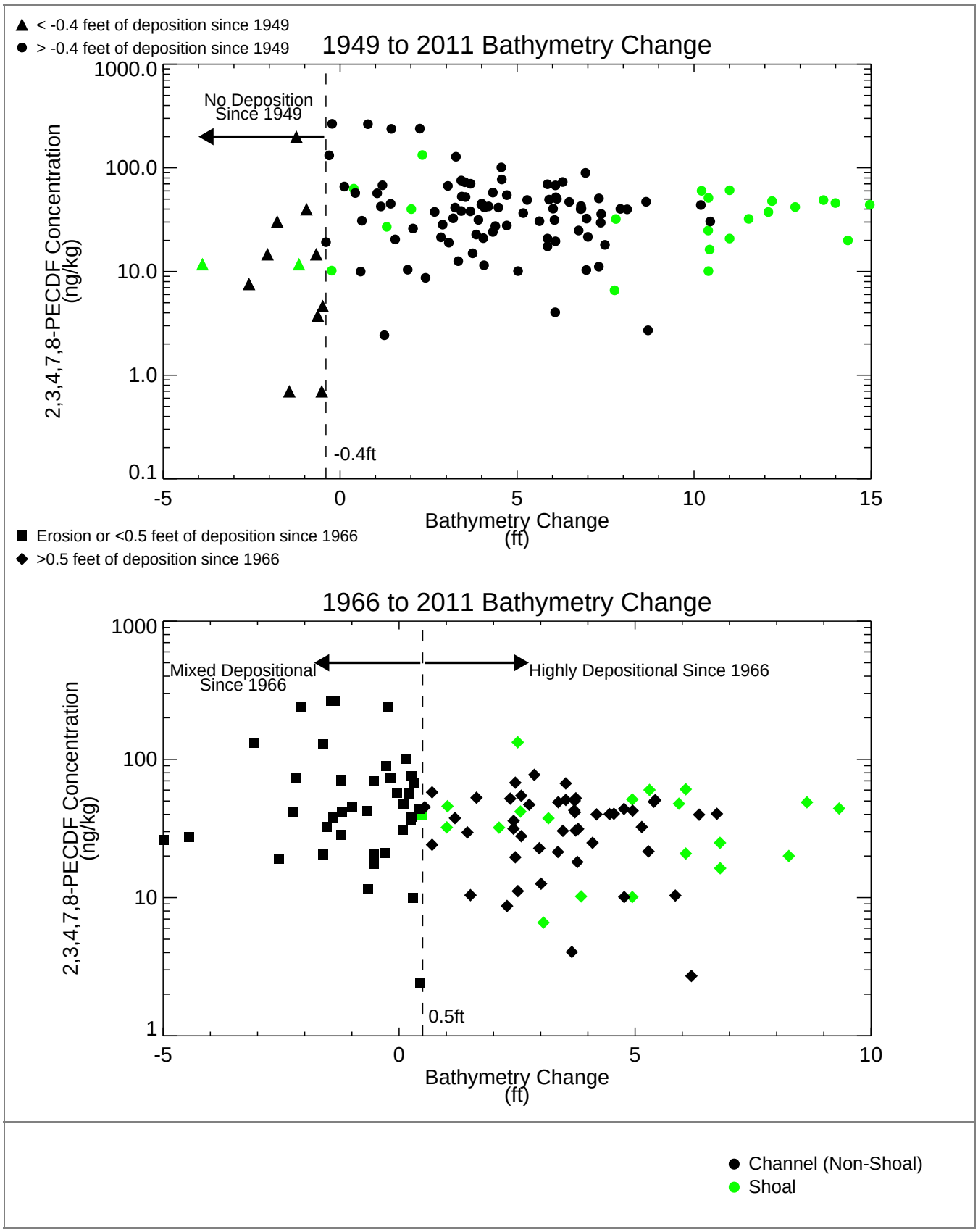
Figure 10

Distribution of Surface Sediment 2,3,4,7,8-PECDF Concentration Between RM 0 and 17.4 by Geomorphic Group



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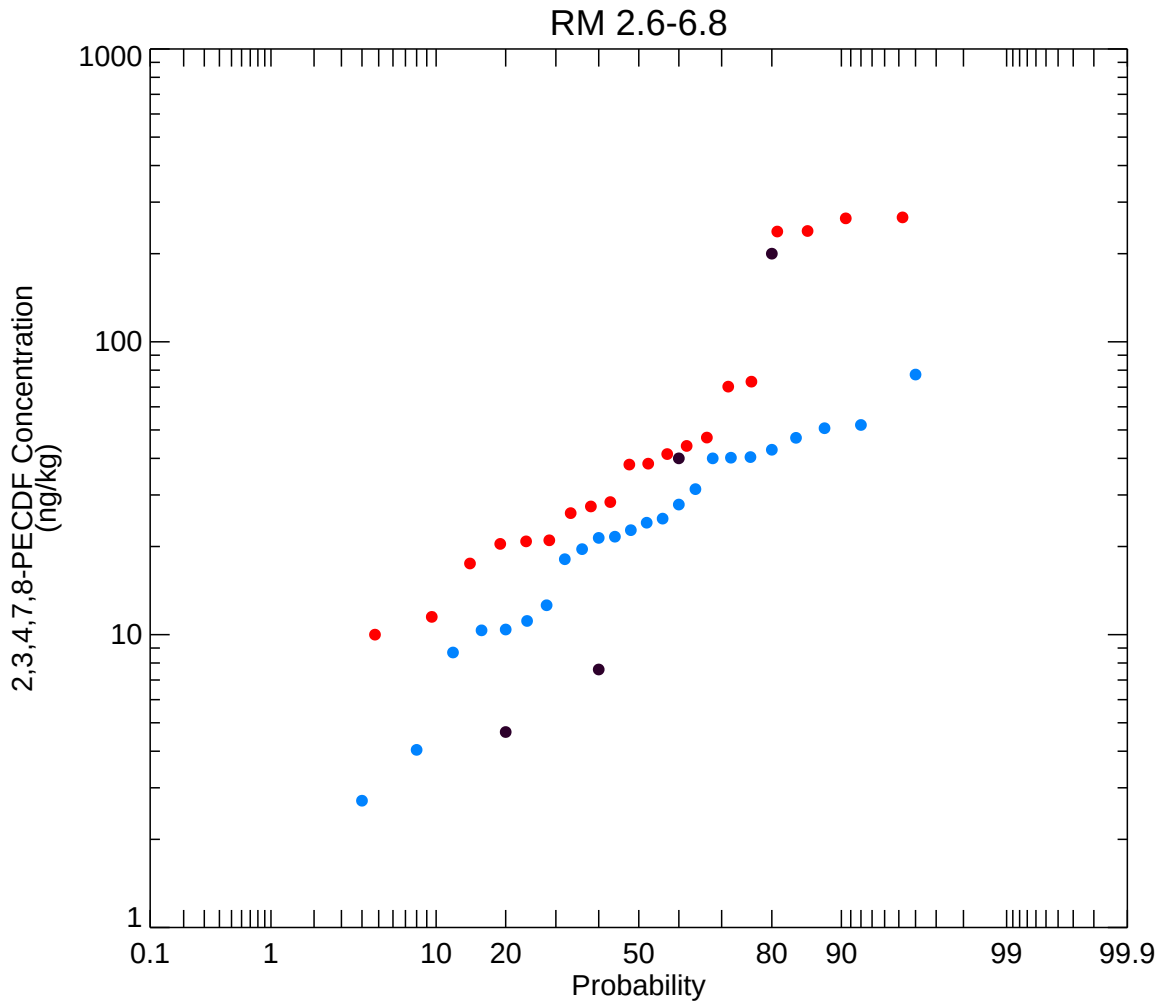
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 11

2,3,4,7,8-PECDF Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Excludes data in the shoals

- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

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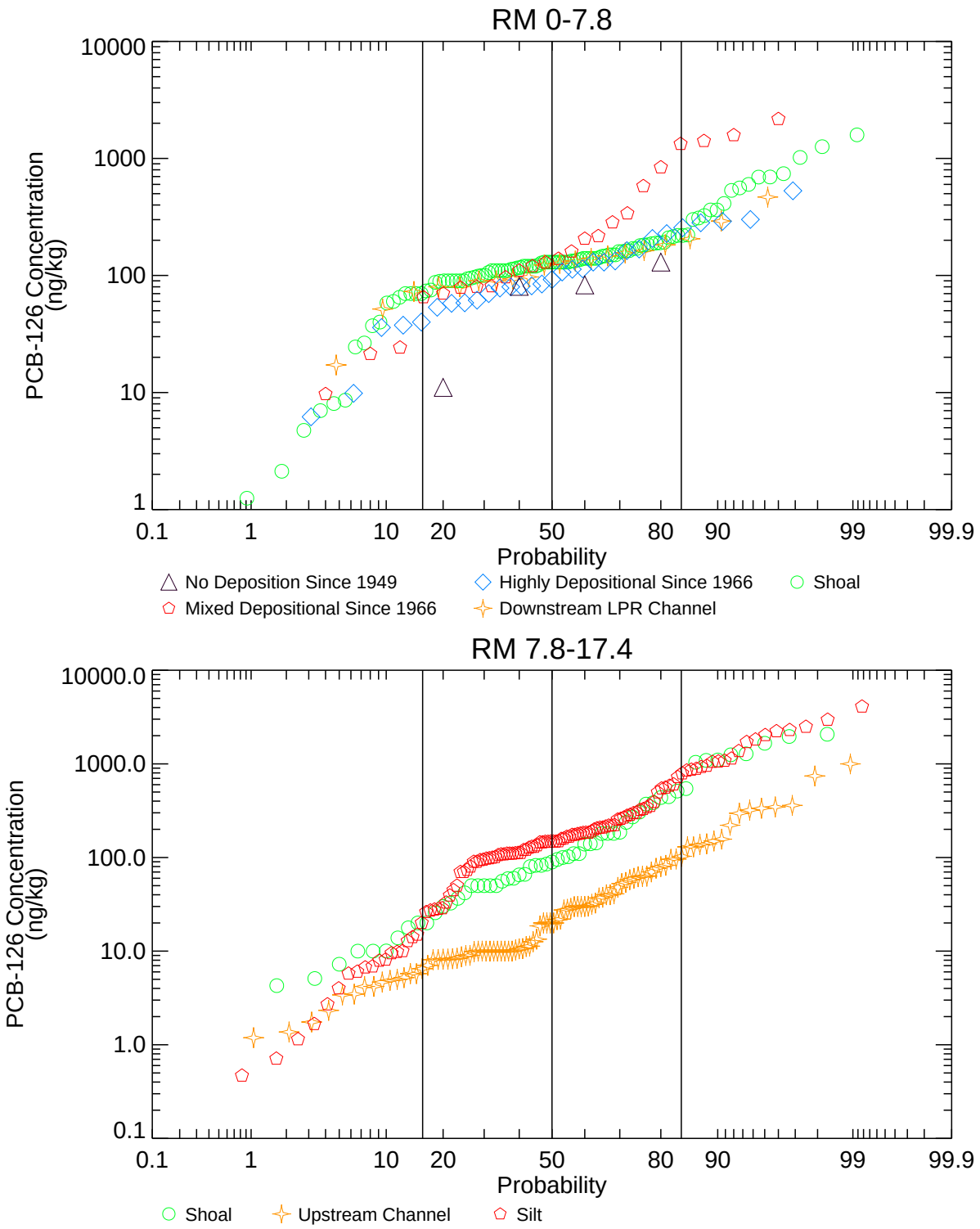
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 12

Distribution of Surface 2,3,4,7,8-PECDF Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8



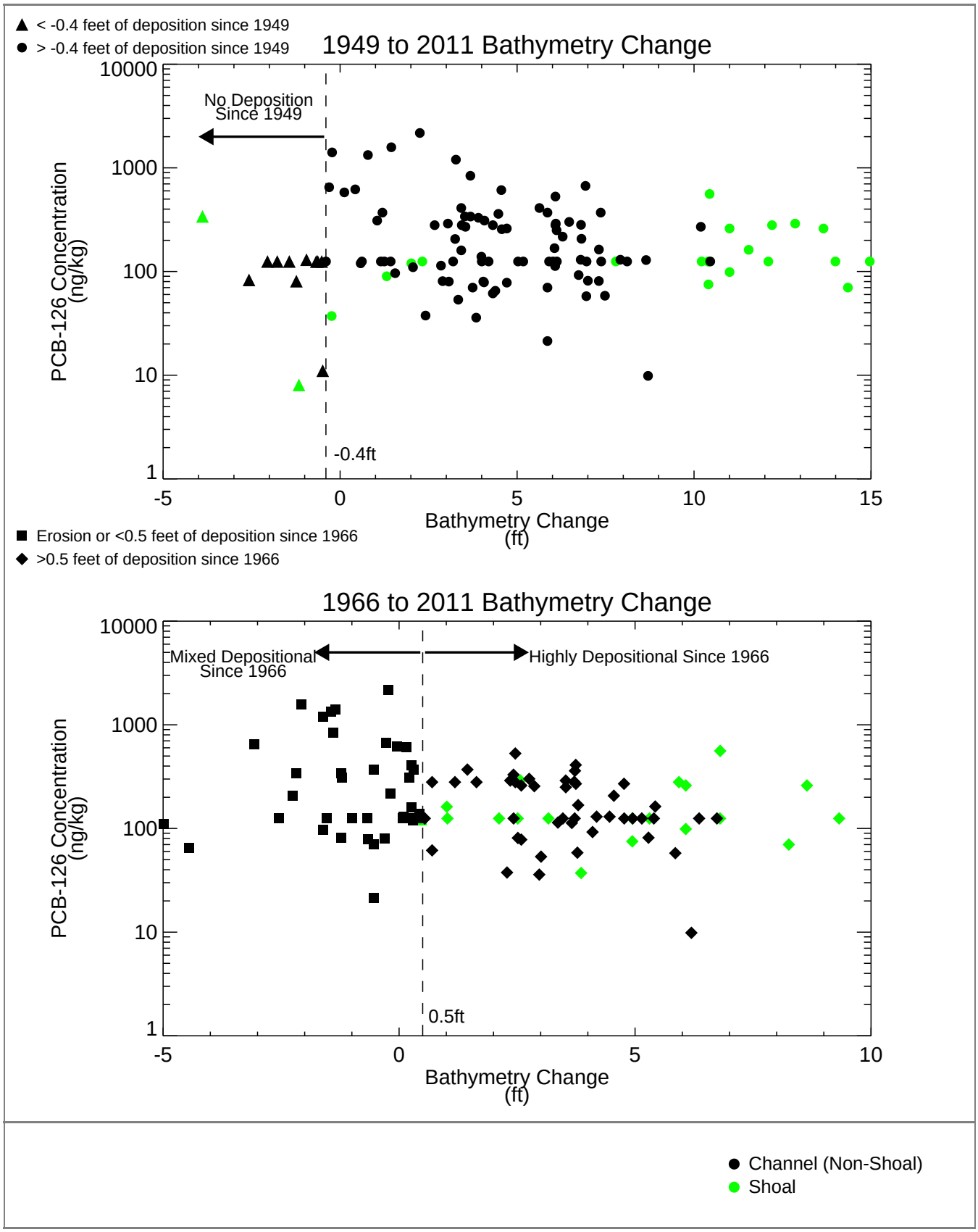
Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

Publish Date: 06/20/2019 11:44 | User: GD/EP/CH
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_2_probplot_Shoal_Channel_141110.pro

Figure 13

Distribution of Surface Sediment PCB-126 Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



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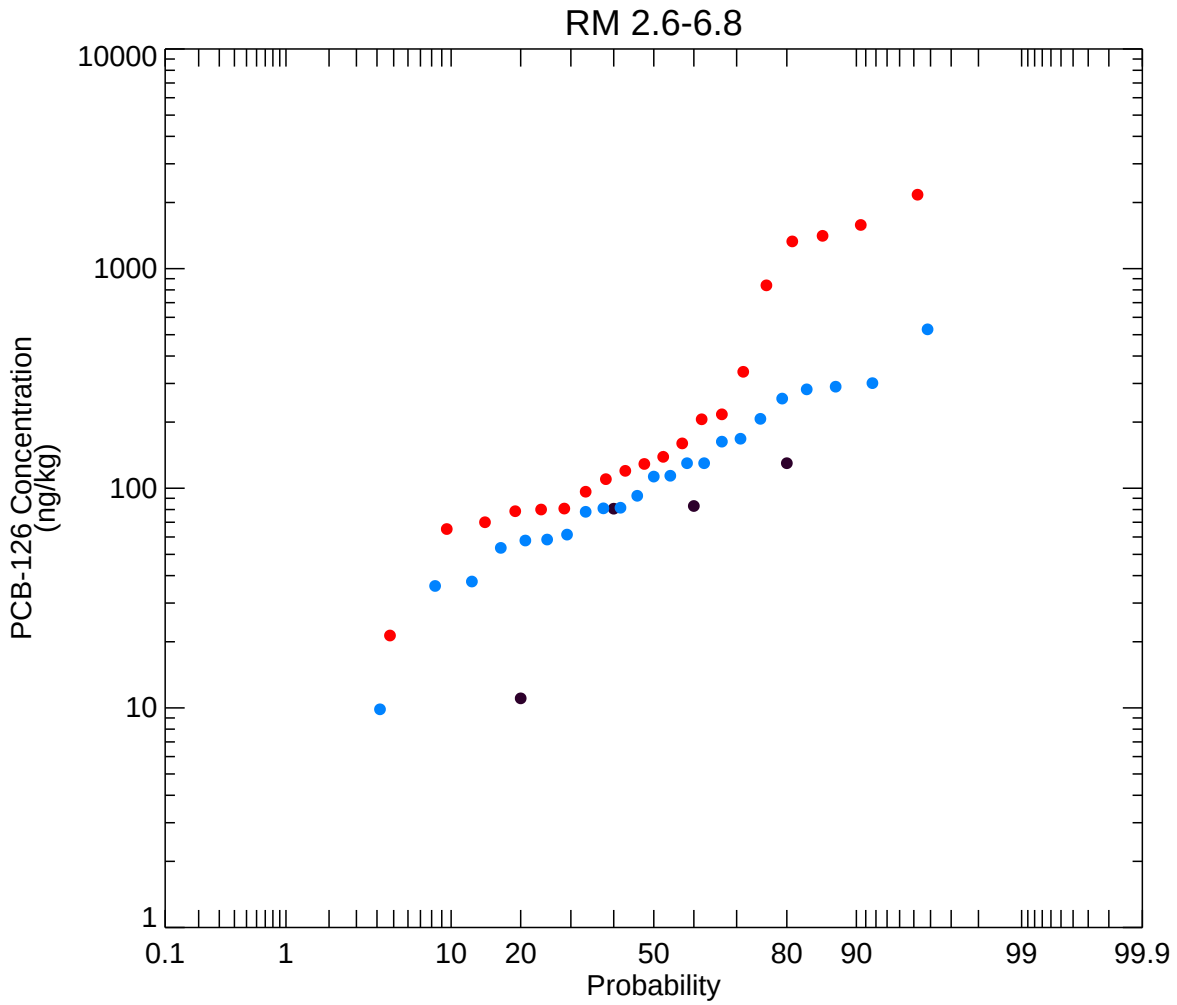
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 14

PCB-126 Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Excludes data in the shoals

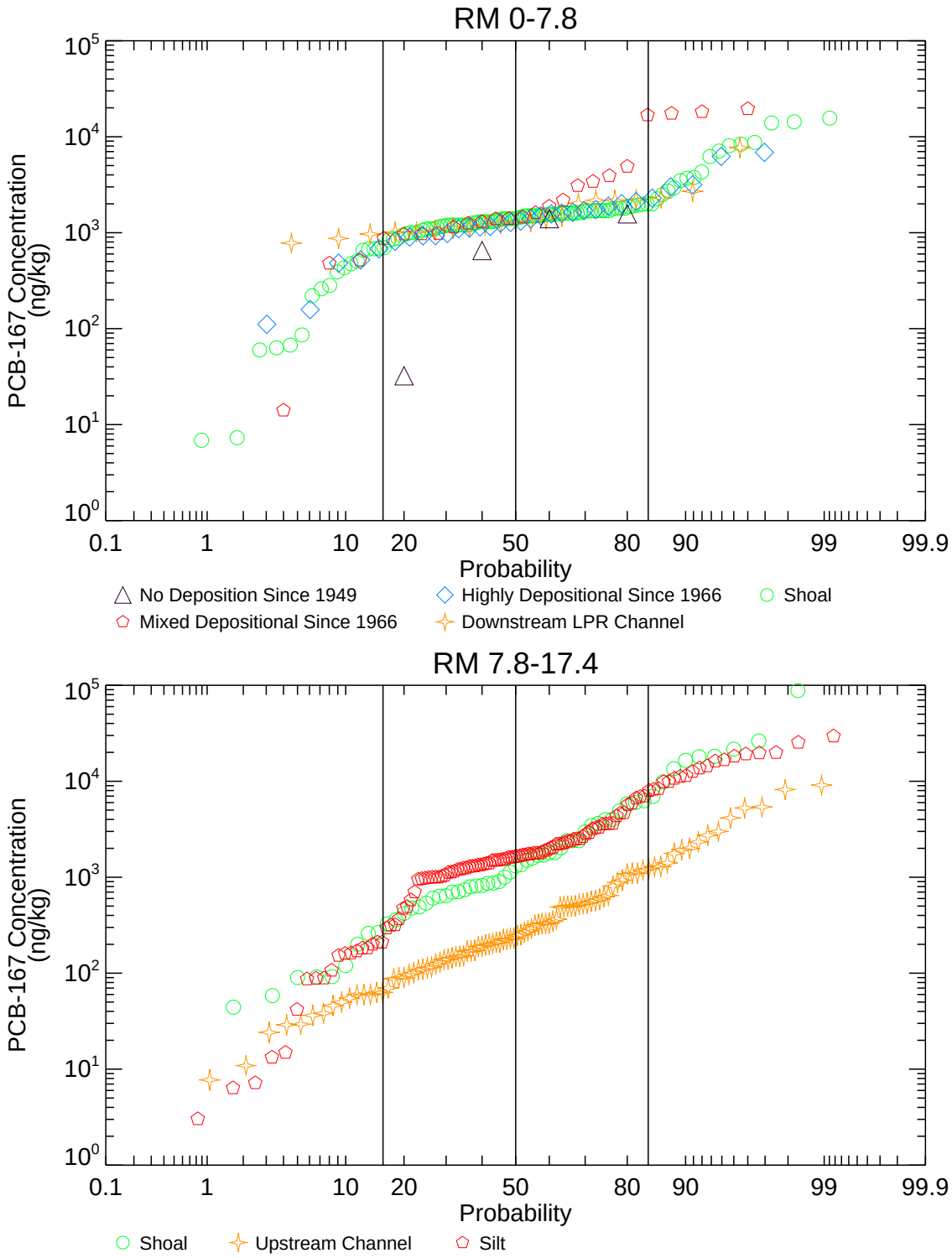
- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 15

Distribution of Surface PCB-126 Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



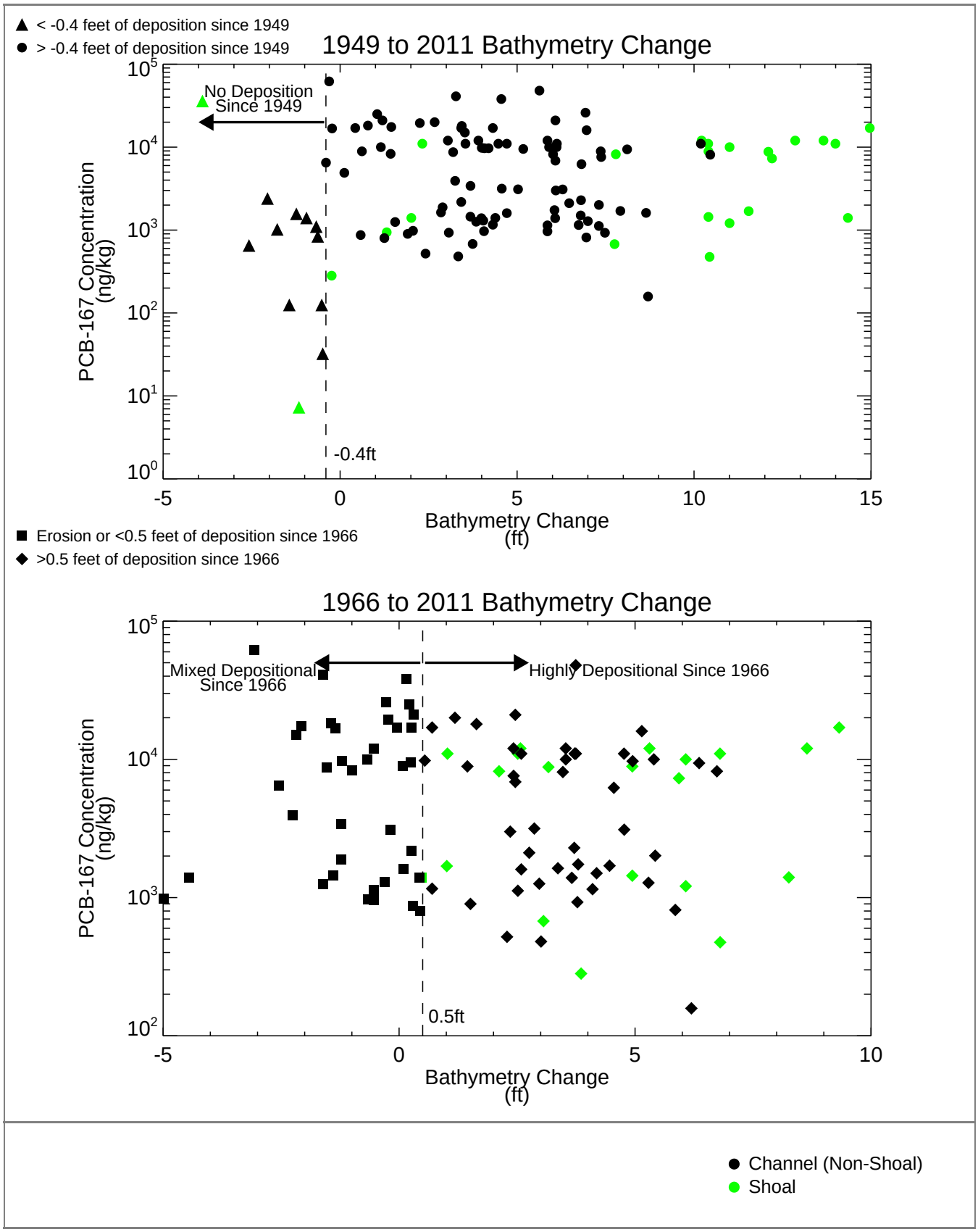
Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

Publish Date: 06/20/2019 11:44 | User: GD/EP/CH
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_2_probplot_Shoal_Channel_141110.pro

Figure 16

Distribution of Surface Sediment PCB-167 Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

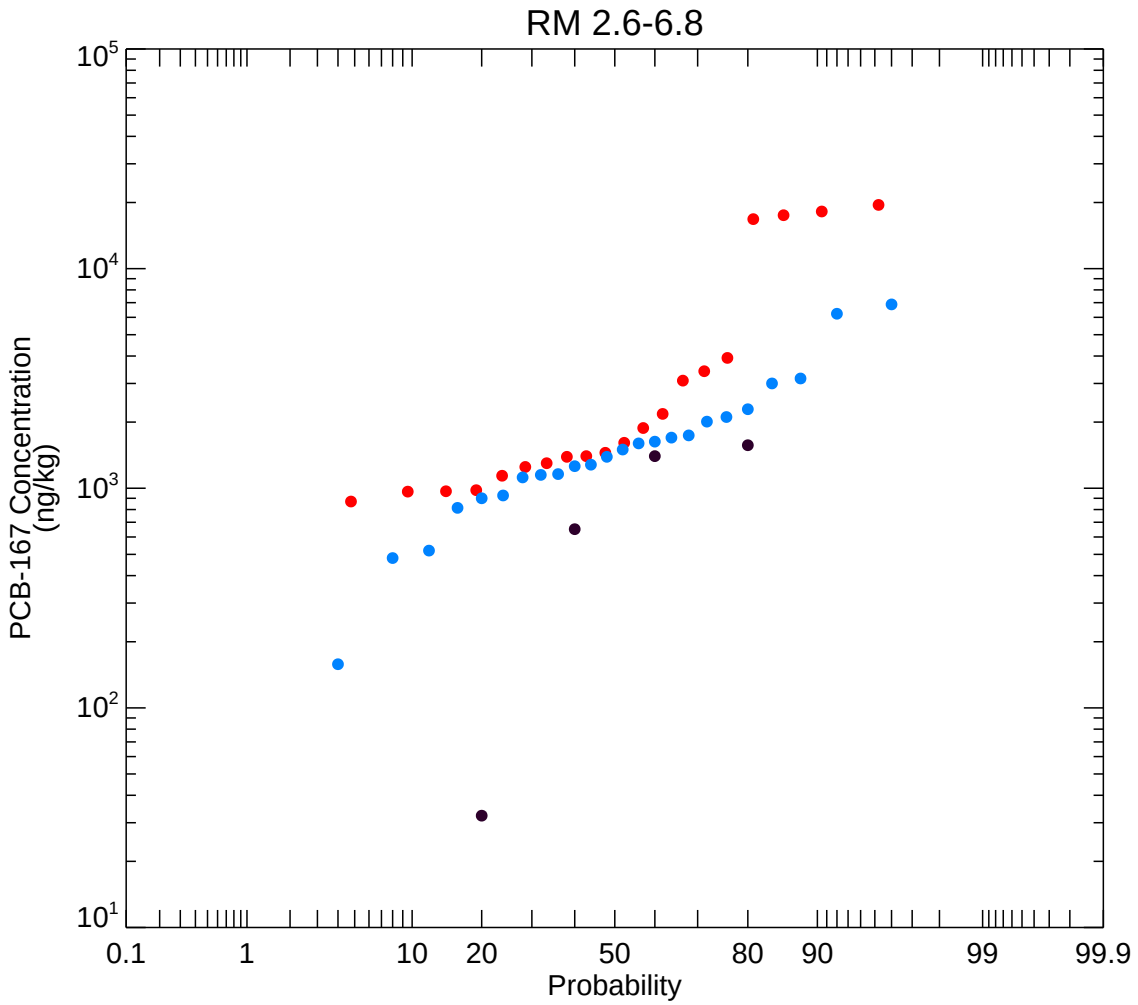


Publish Date: 06/19/2019 16:01 | User: sm/ep/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 17

PCB-167 Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Excludes data in the shoals

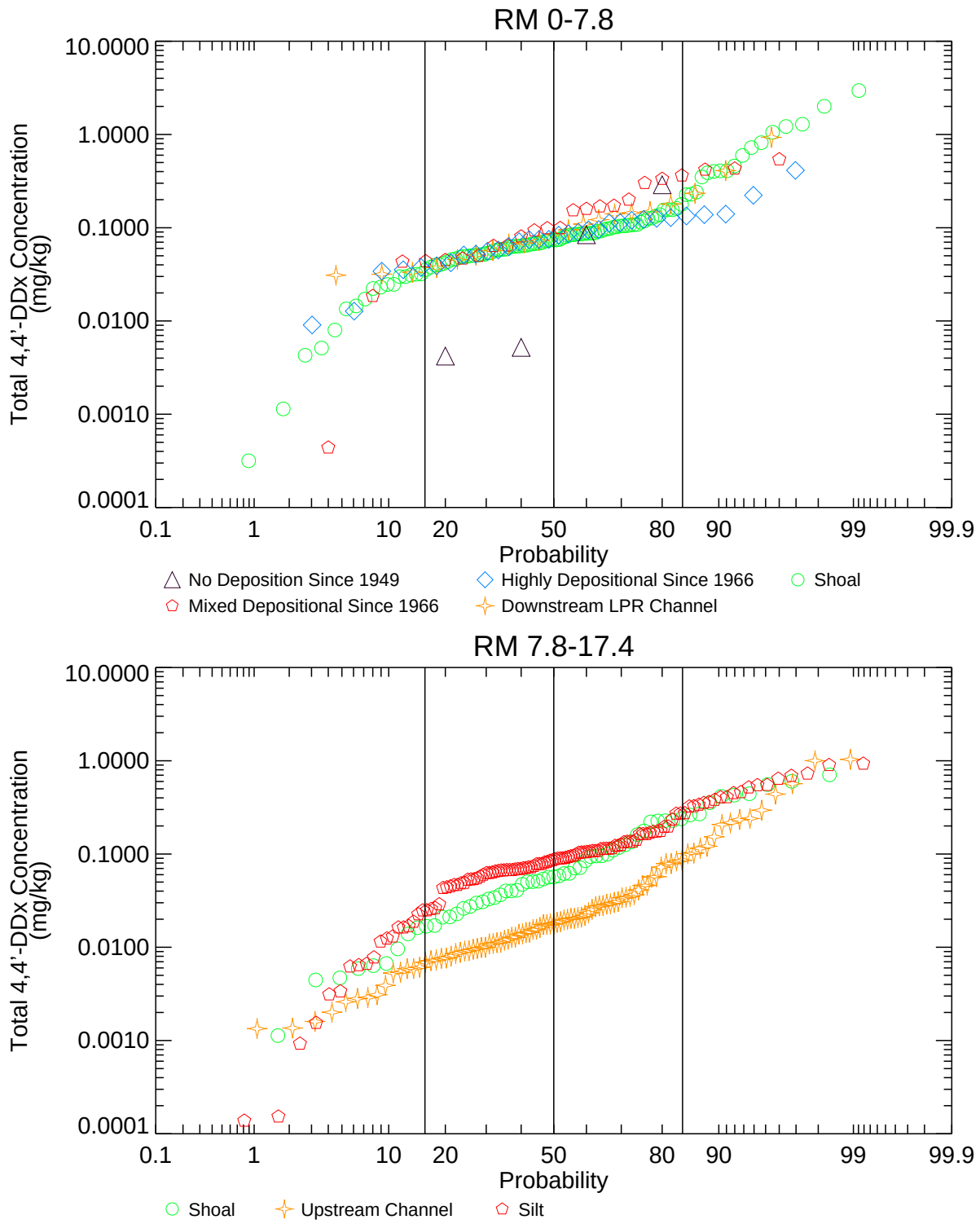
- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 18

Distribution of Surface PCB-167 Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



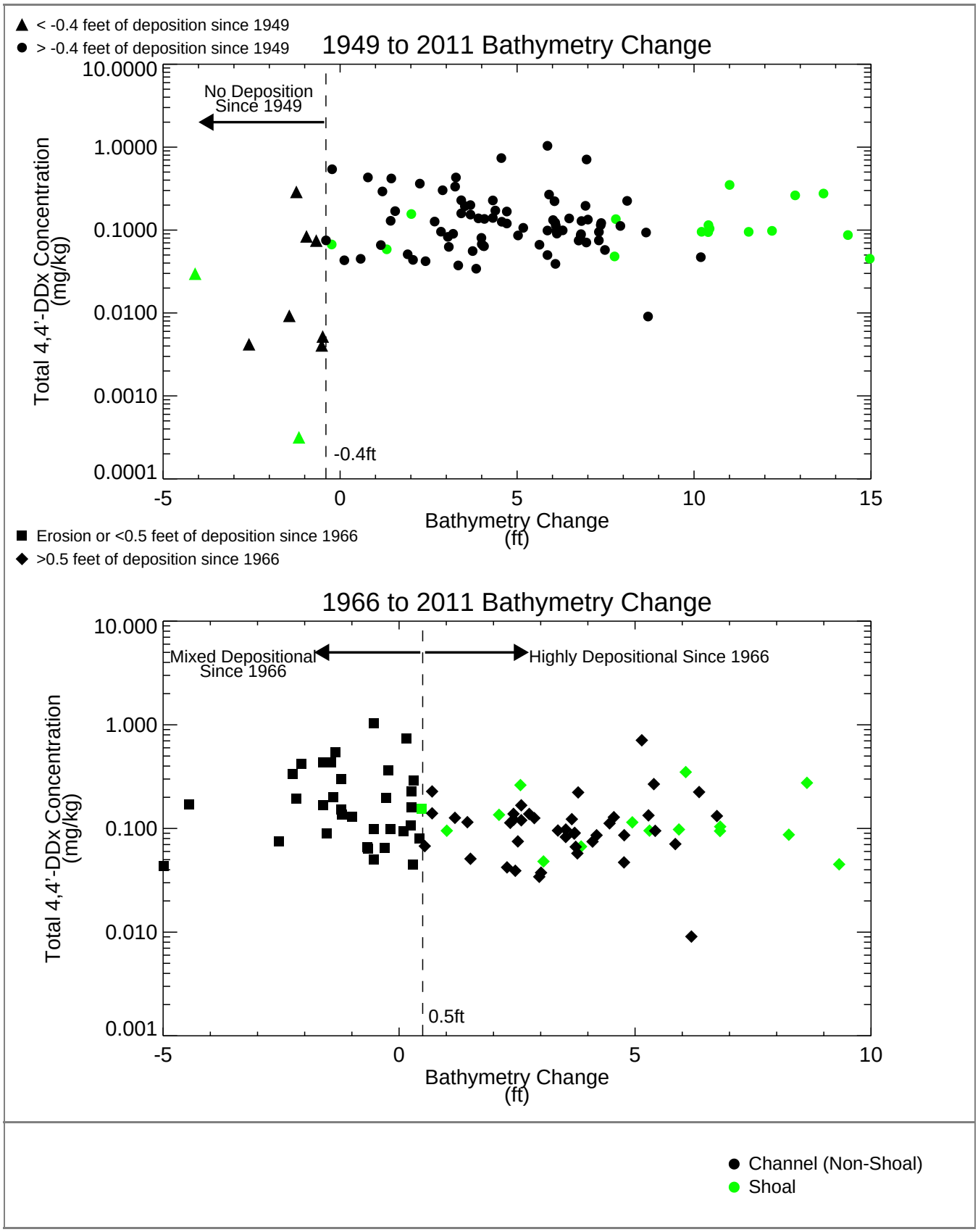
Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

Publish Date: 06/20/2019 11:44 | User: GD/EP/CH
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_2_probplot_Shoal_Channel_141110.pro

Figure 19

Distribution of Surface Sediment Total 4,4'-DDx Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



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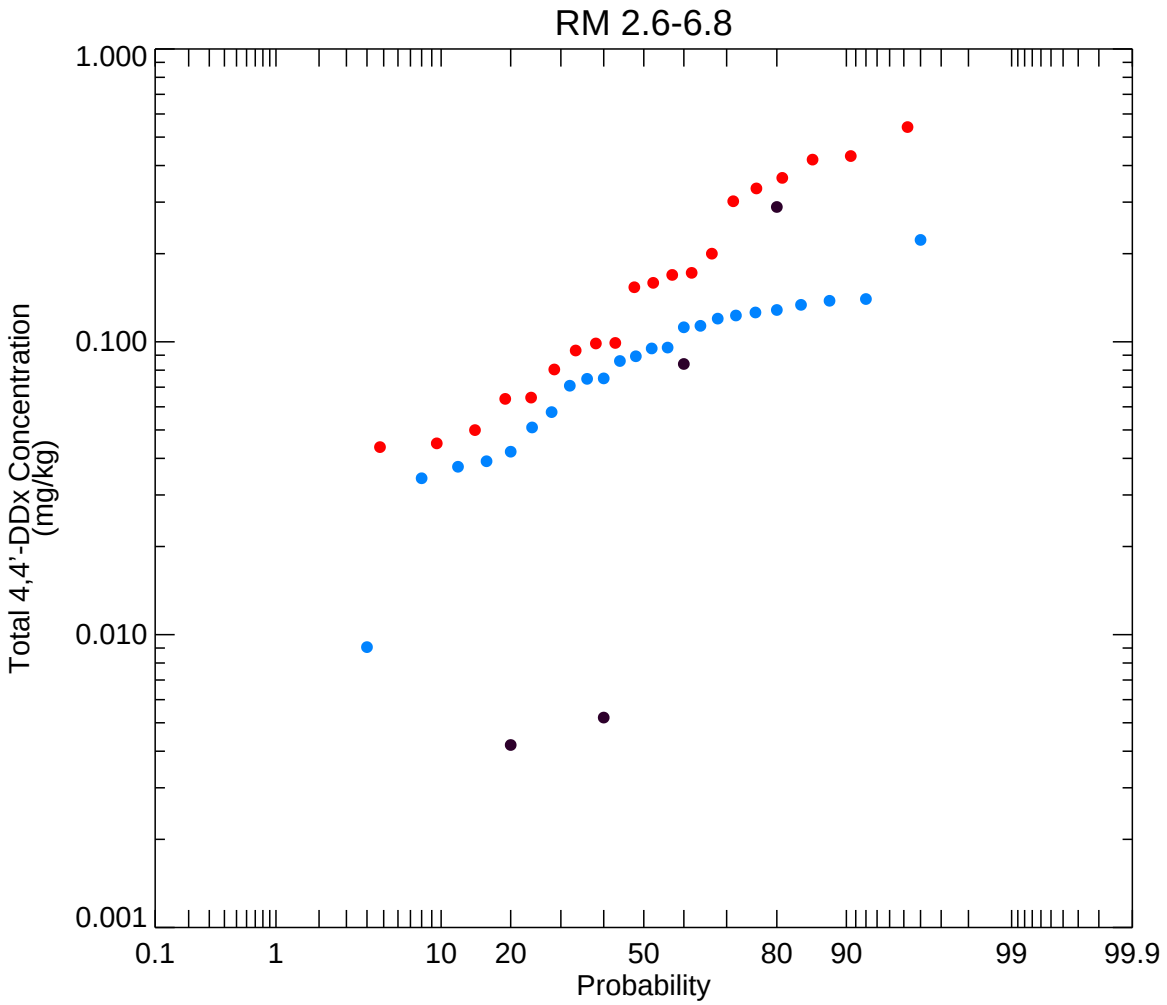
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 20

Total 4,4'-DDx Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



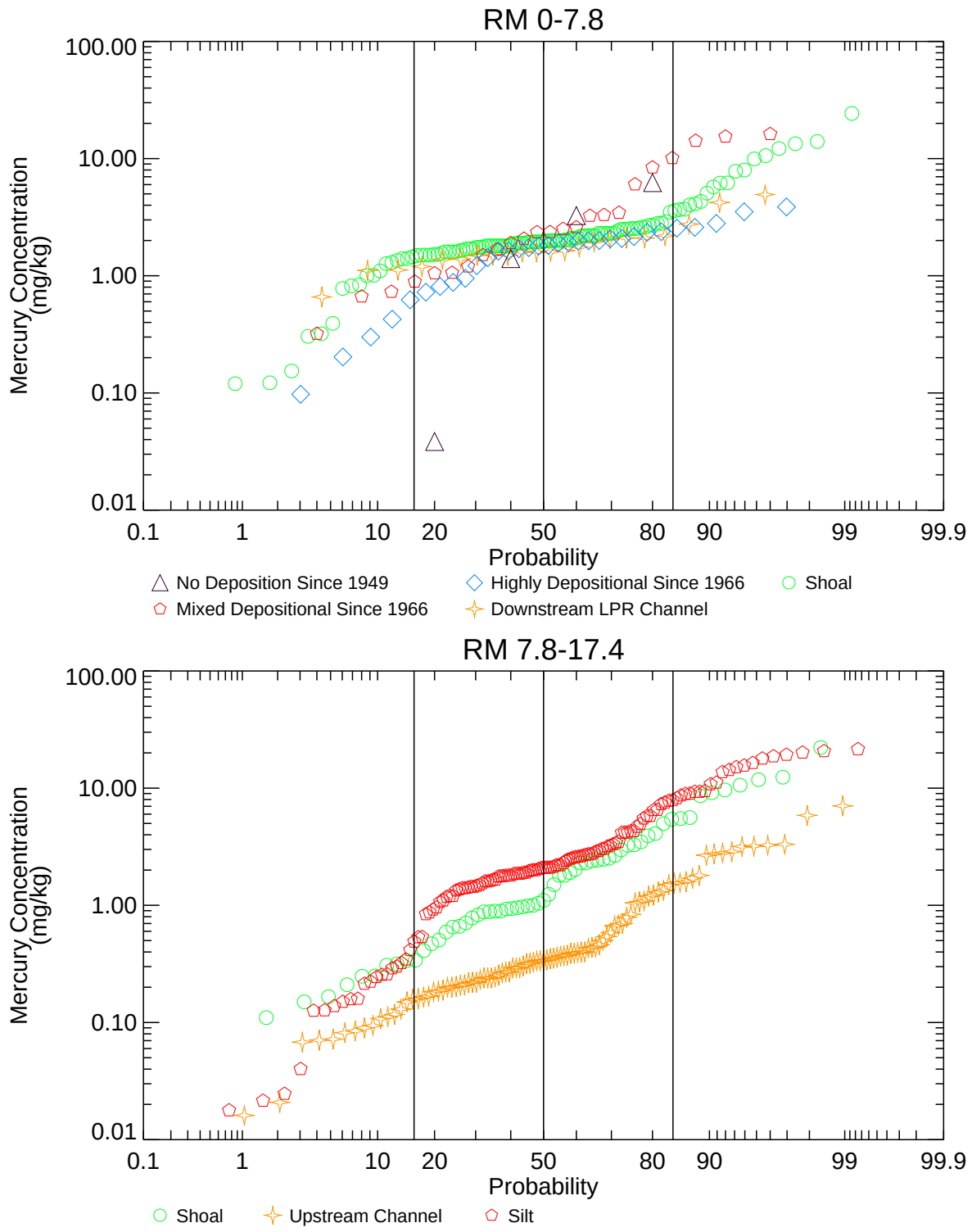
Note: Includes data from 2005-2013. Excludes data in the shoals

- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 21

Distribution of Surface Total 4,4'-DDx Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8



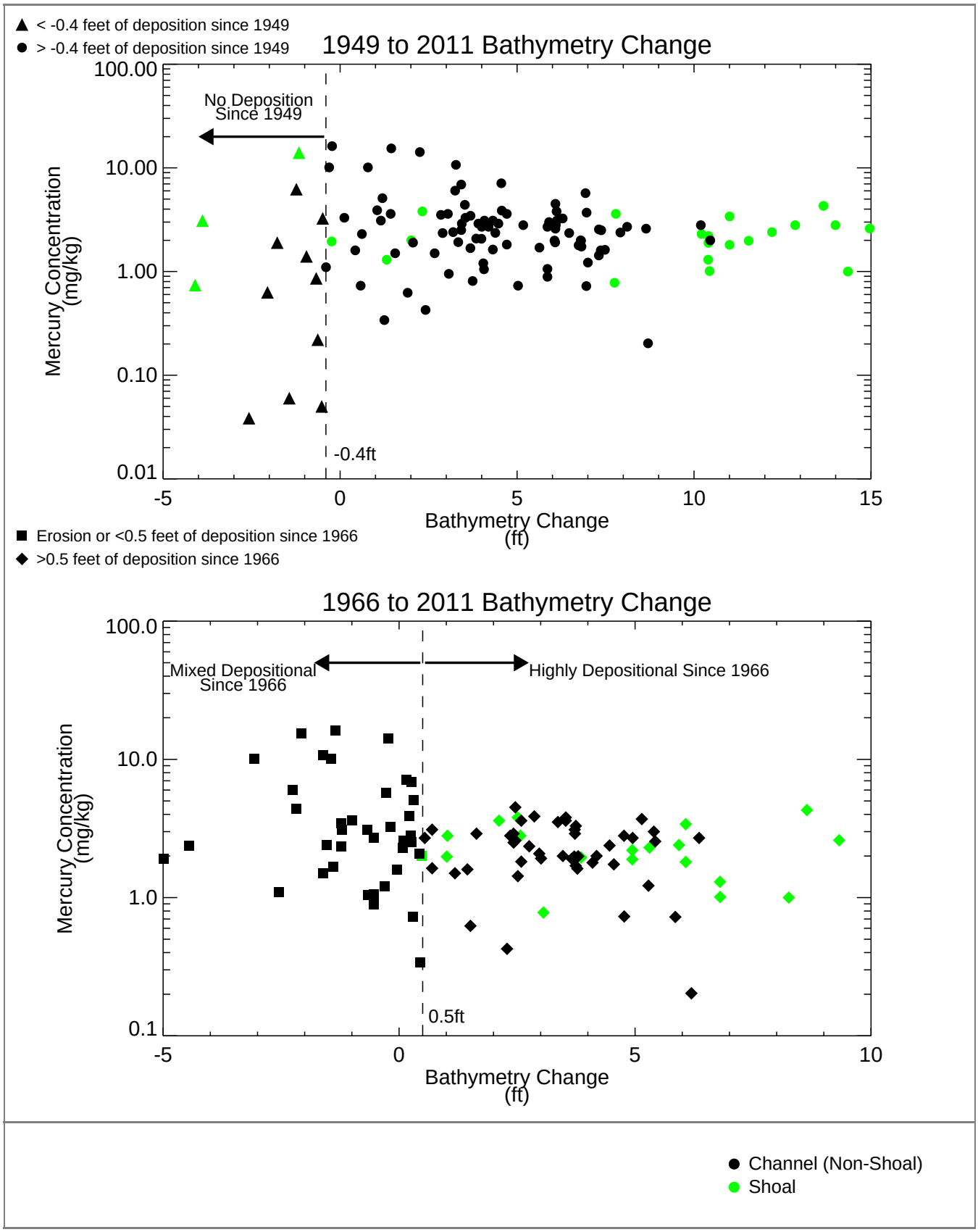
Note: Includes data from 2005-2013. Shoal category is composed of left and right shoal groupings.

Publish Date: 06/20/2019 11:44 | User: GD/EP/CH
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_2_probplot_Shoal_Channel_141110.pro

Figure 22

Distribution of Surface Sediment Mercury Concentration Between RM 0 and 17.4 by Geomorphic Group

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

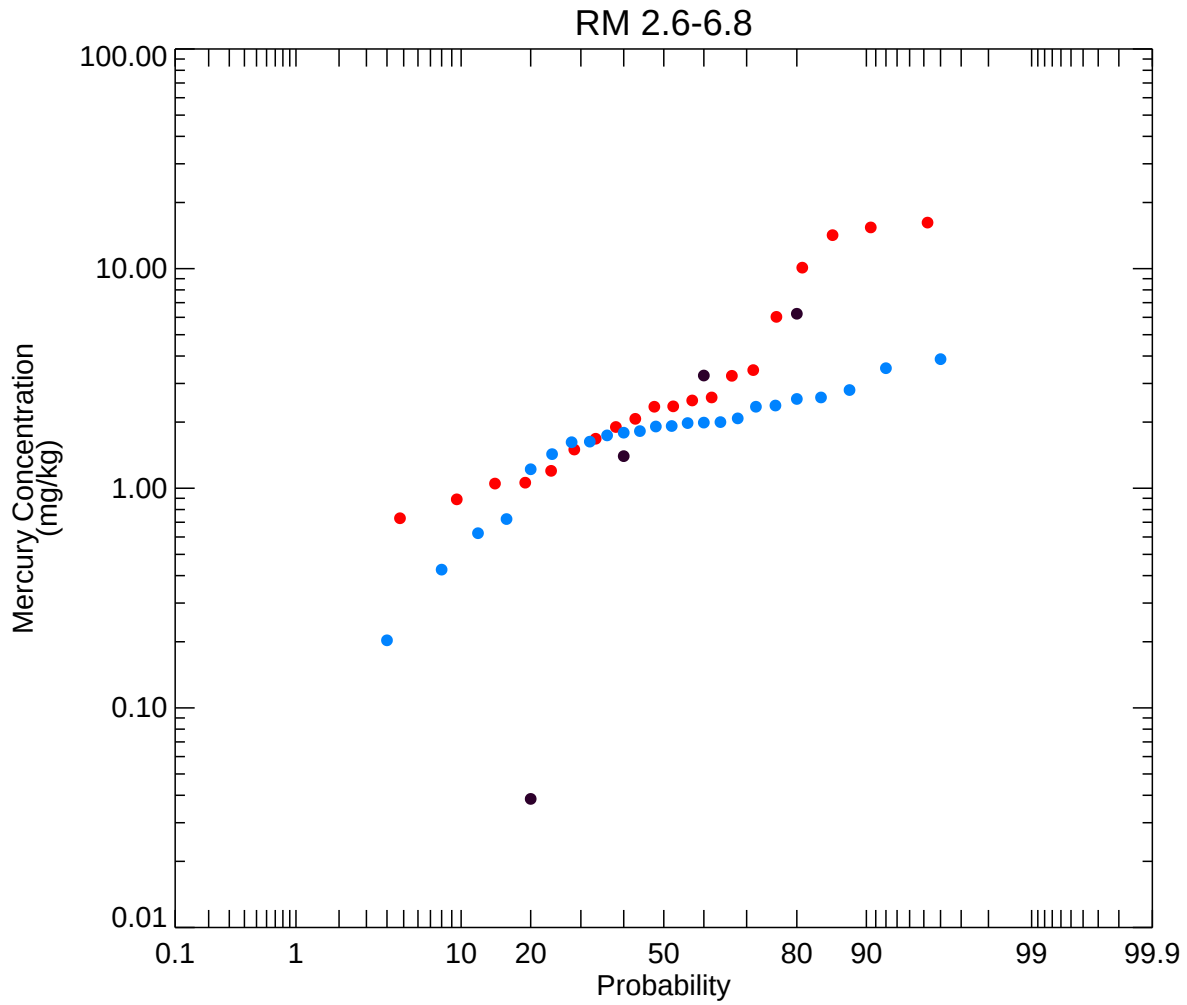


Publish Date: 06/19/2019 16:01 | User: sm/ep/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_3_copc_conc_vs_bathydiff_mapping_data_2panel.pro

Figure 23

Mercury Surface Concentration Versus Bathymetry Change

Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study



Note: Includes data from 2005-2013. Excludes data in the shoals

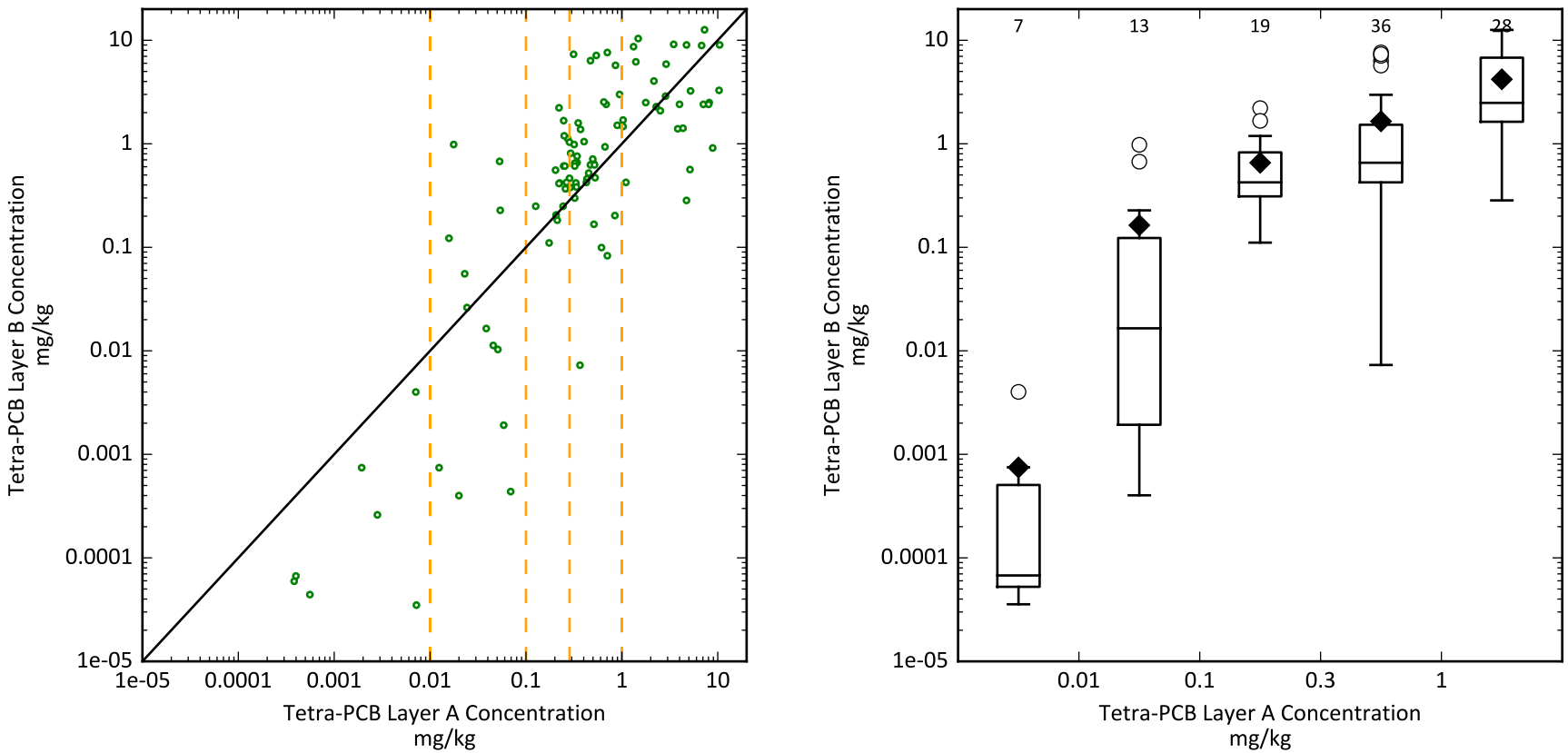
- No Deposition Since 1949
- Mixed Depositional Since 1966
- Highly Depositional Since 1966

Publish Date: 06/20/2019 11:50 | User: sm/ch
File Path: H:\Passaic_CPG\DOCUMENTS\2019\RI_Report\source\v5\Appendix_J\code\Fig_3_4_pascpg_probplot_mapgroups.pro

Figure 24

Distribution of Surface Mercury Concentration of Channel Geomorphic Groups Between RM 2.6 and 6.8

Attachment 2
Pooled Data for Resampling of Layer B for Additional COPCs



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1 Layer B concentration with a value of zero is not shown.

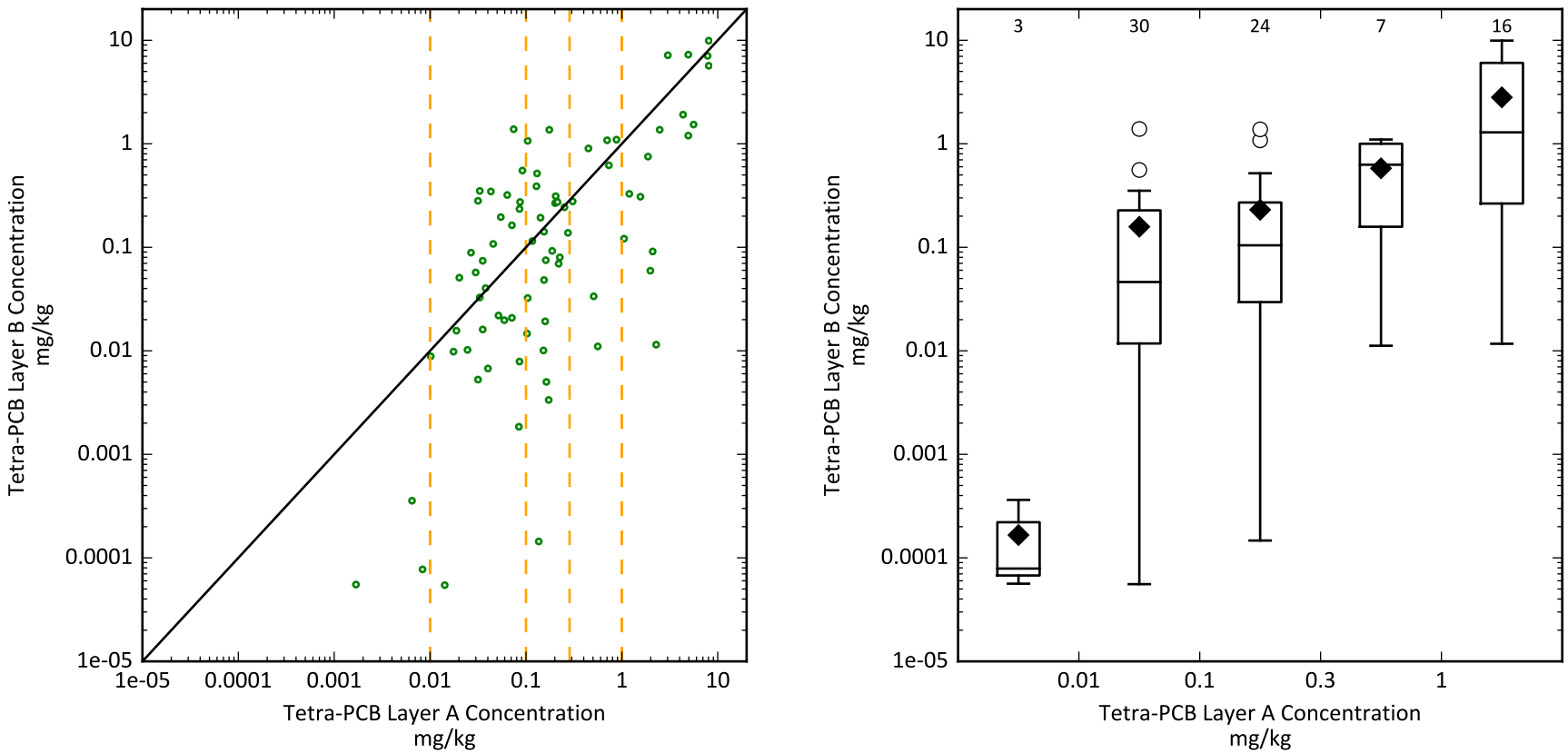
Publish Date: 06/19/2019 15:32 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 1a

Tetra-PCB: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

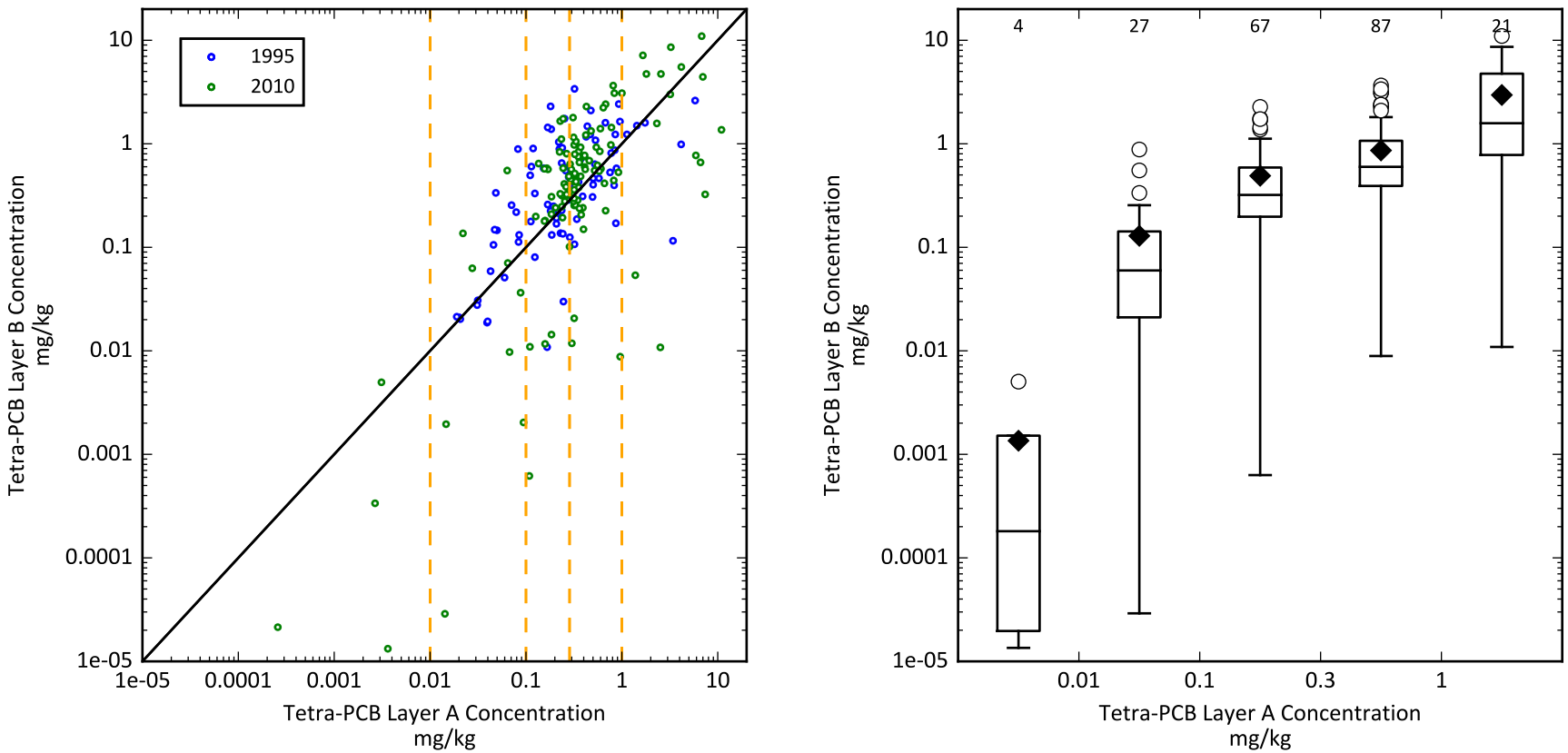
Publish Date: 06/19/2019 15:32 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 1b

Tetra-PCB: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

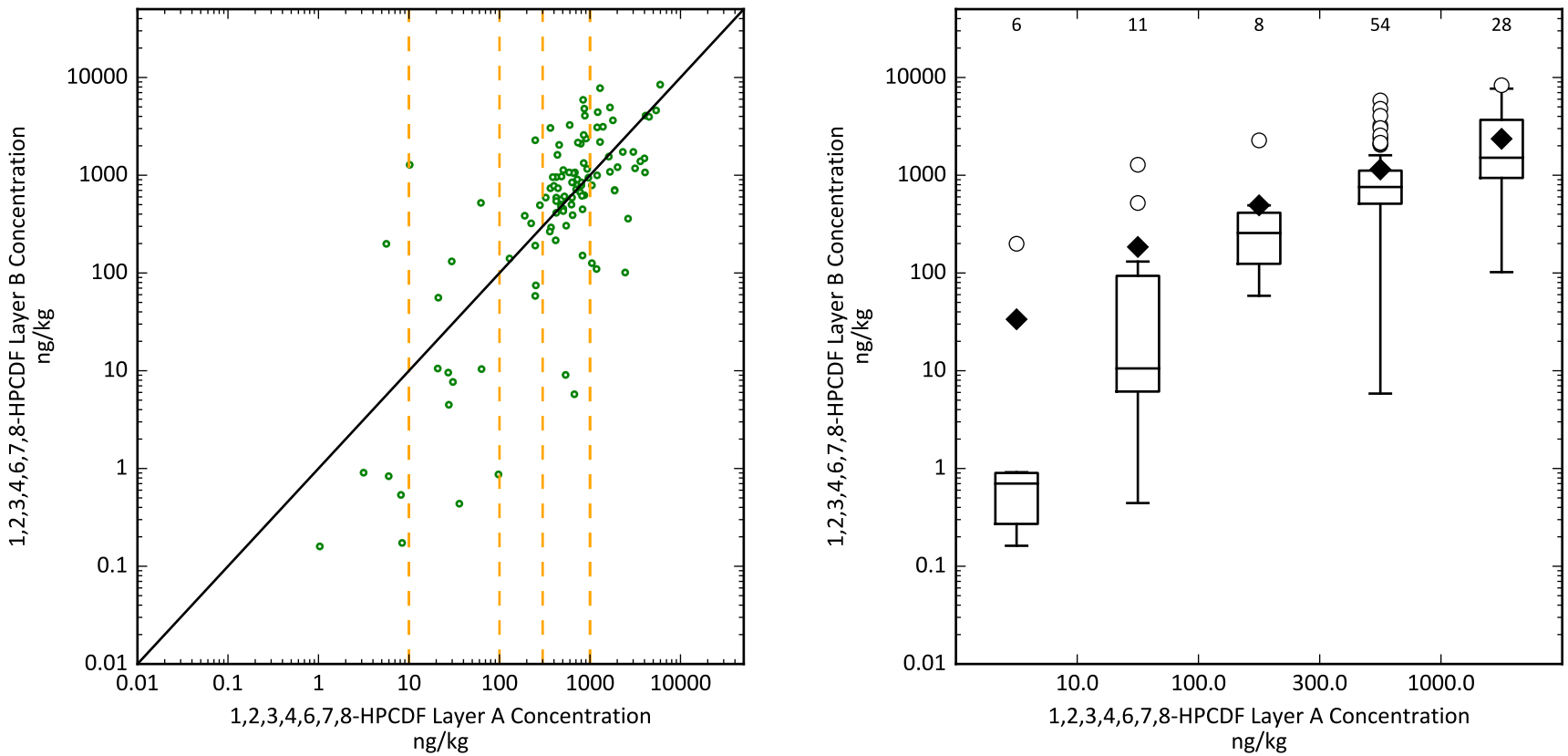
Publish Date: 06/19/2019 15:32 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 1c

Tetra-PCB: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

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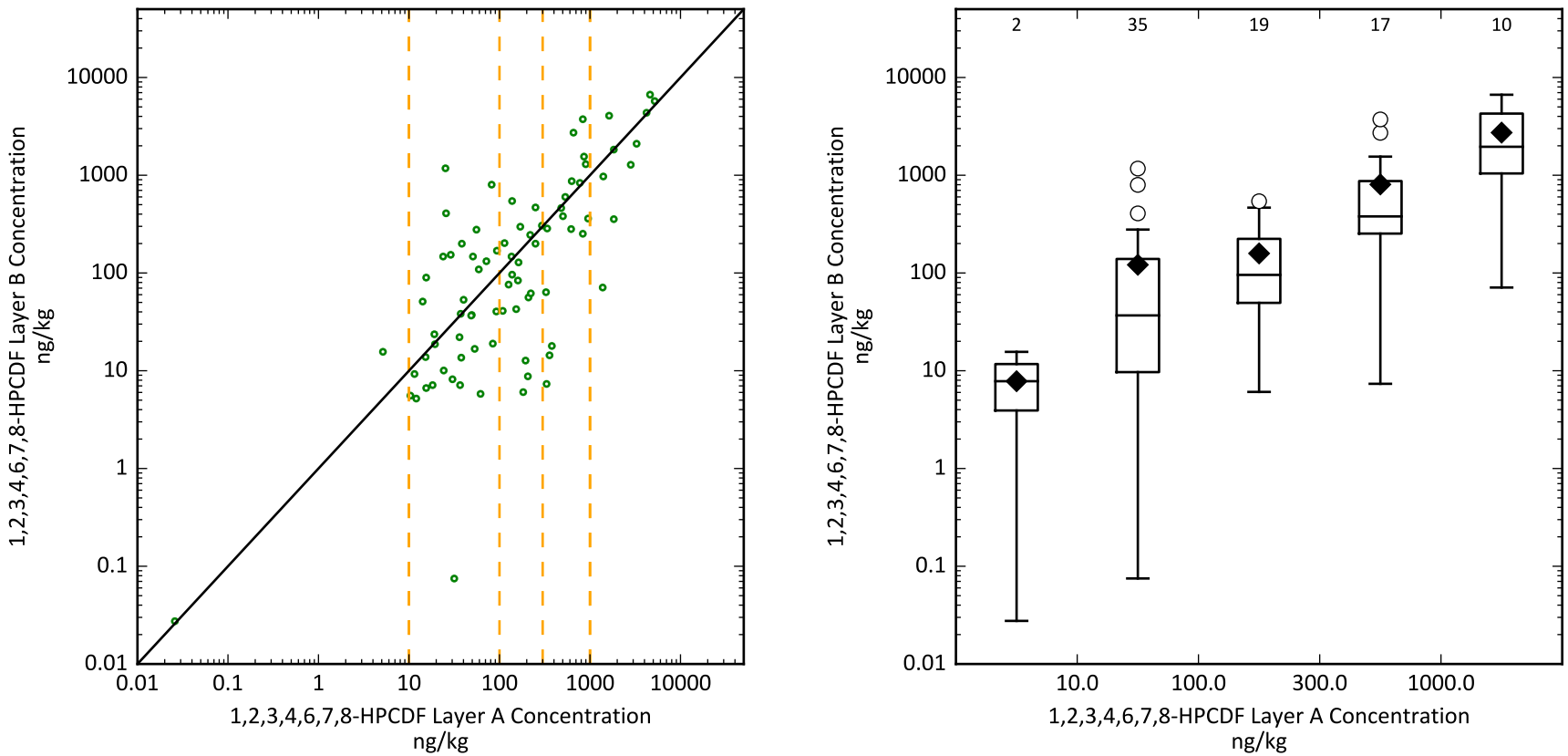
Figure 2a

1,2,3,4,6,7,8-HPCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

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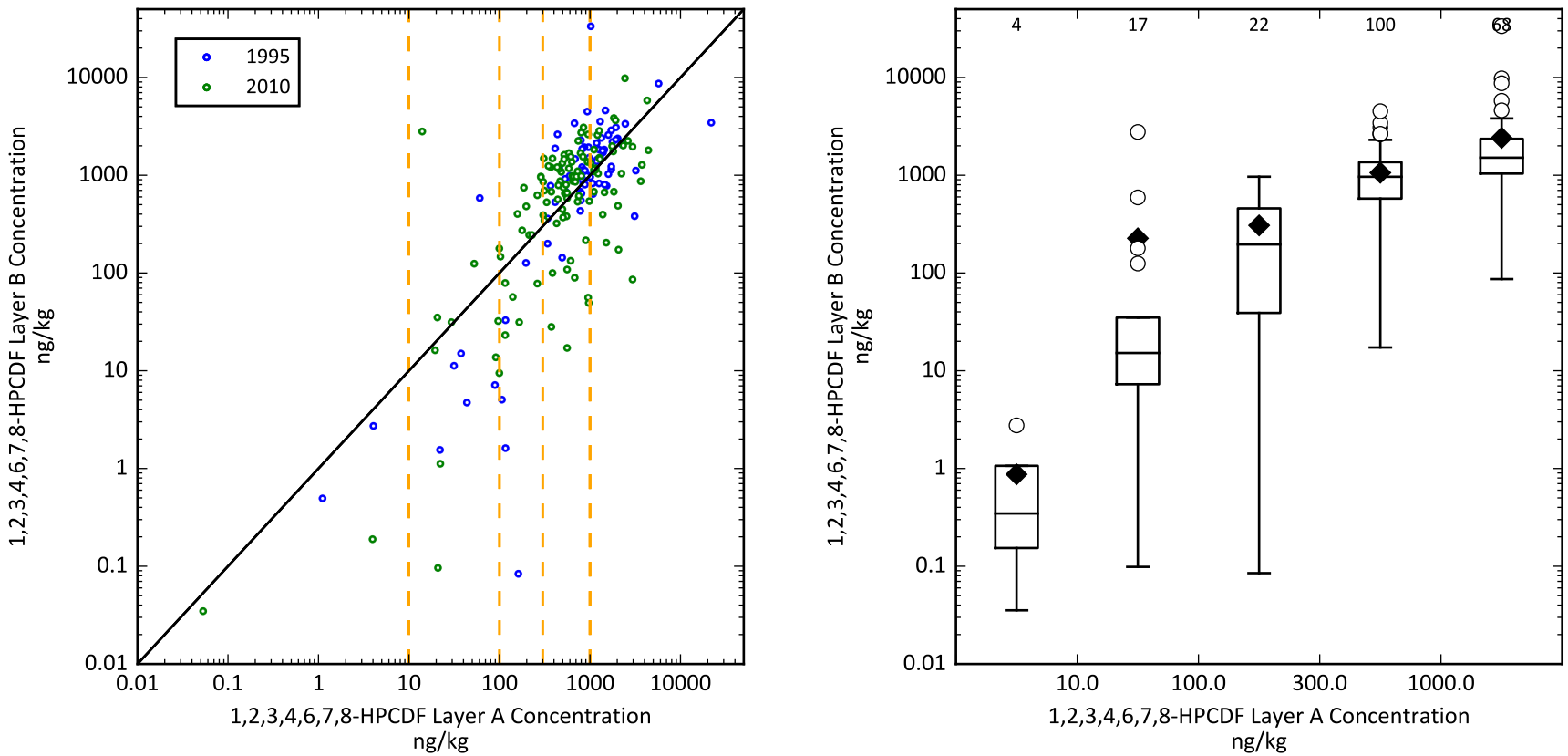
Figure 2b

1,2,3,4,6,7,8-HPCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

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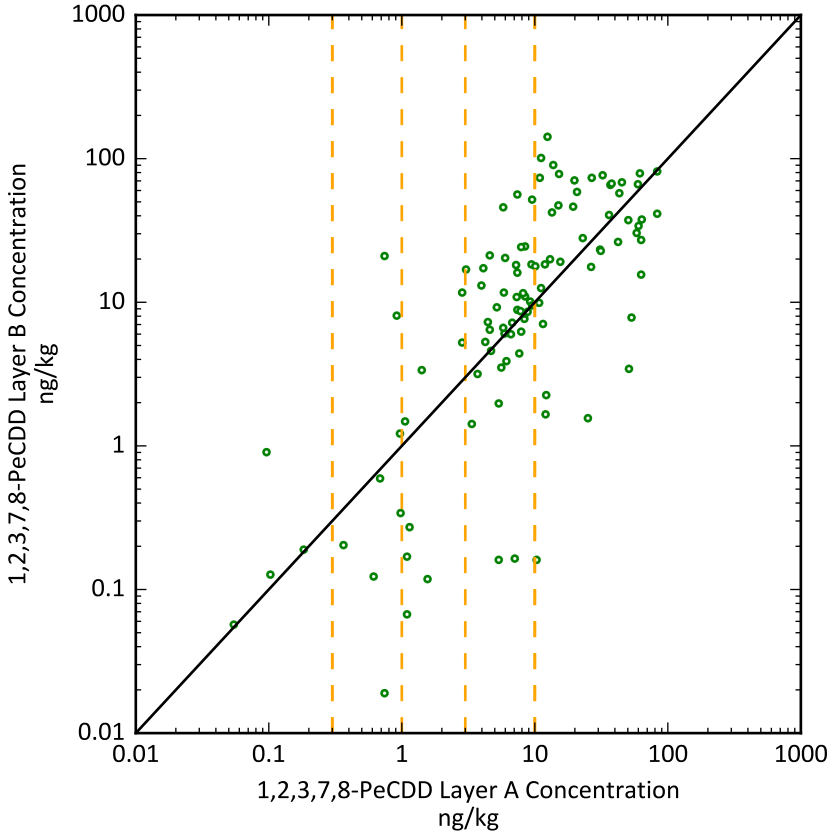
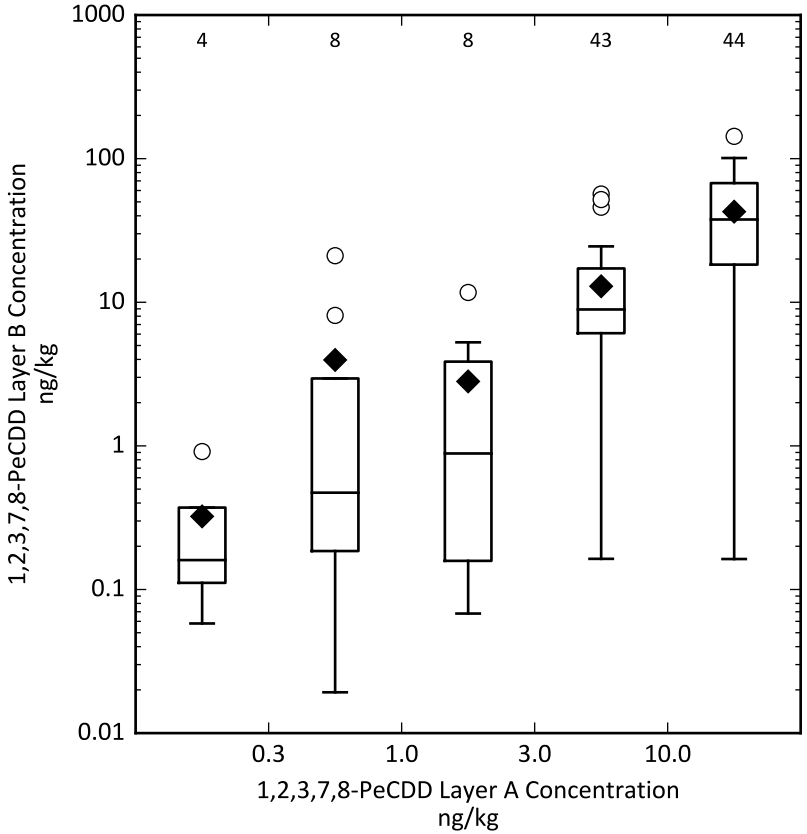
Figure 2c

1,2,3,4,6,7,8-HPCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

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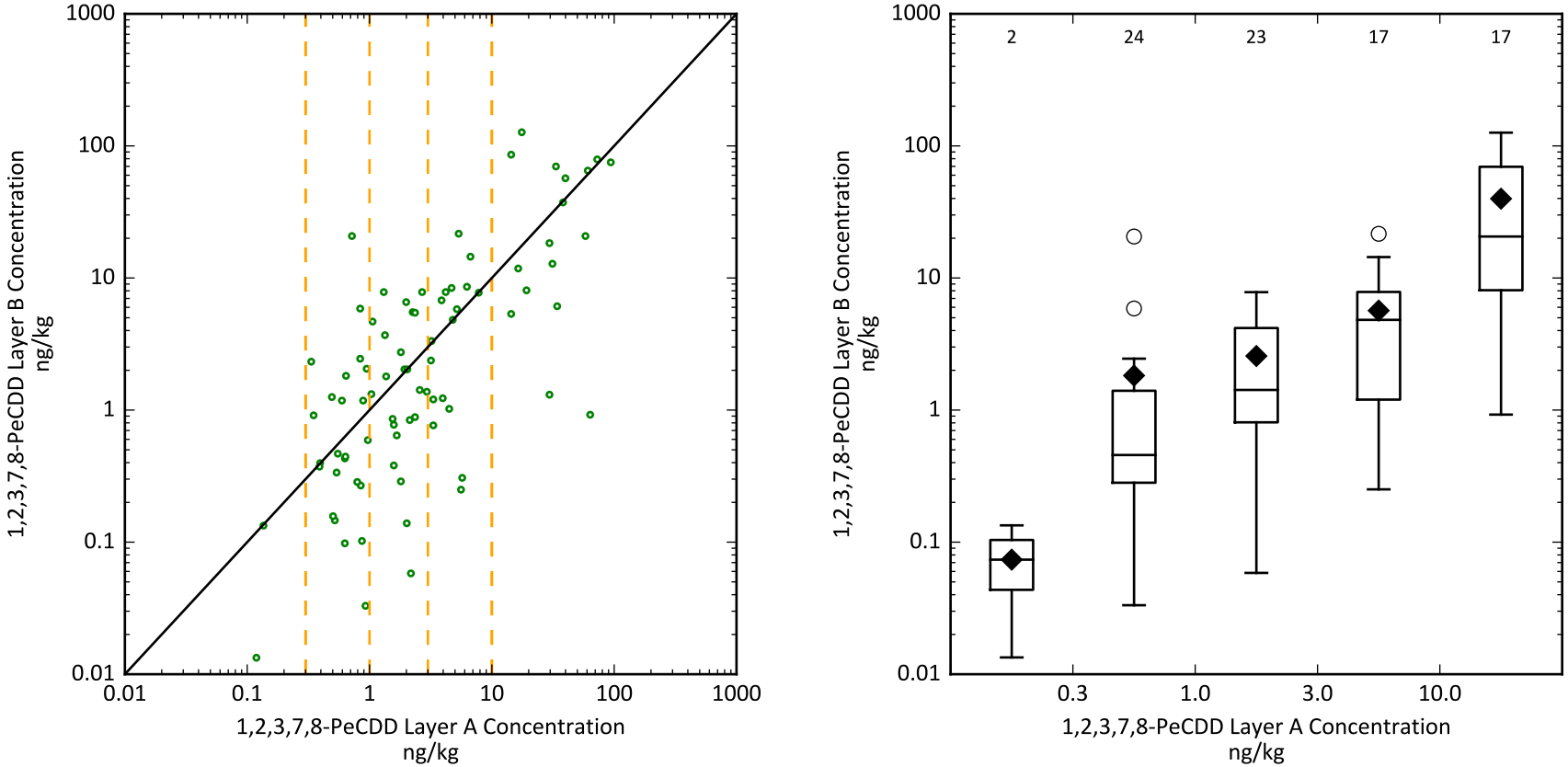
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 3a

1,2,3,7,8-PeCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

Publish Date: 06/19/2019 15:32 PM | User: DB
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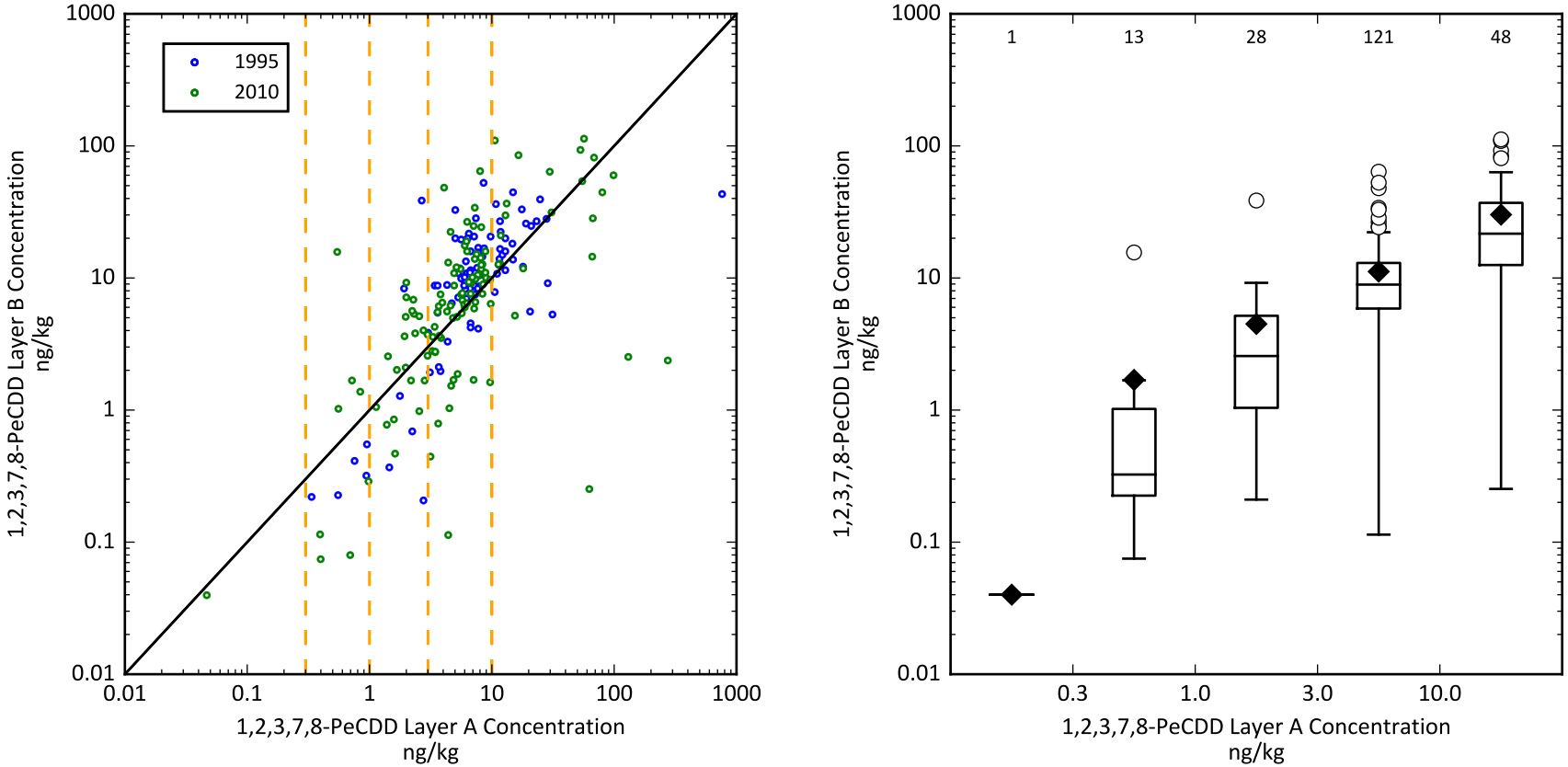
Figure 3b

1,2,3,7,8-PeCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

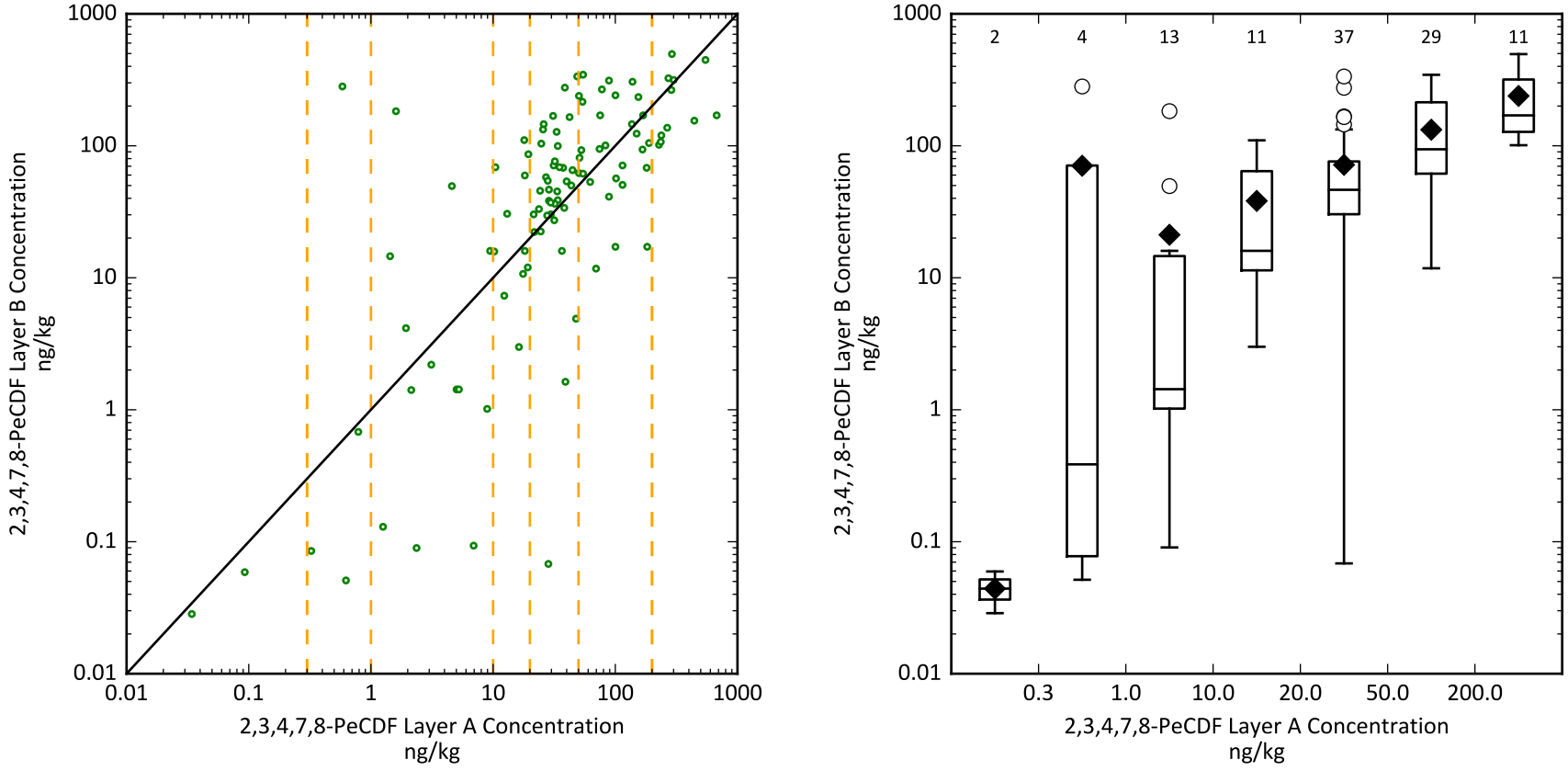
Publish Date: 06/19/2019 15:32 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 3c

1,2,3,7,8-PeCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

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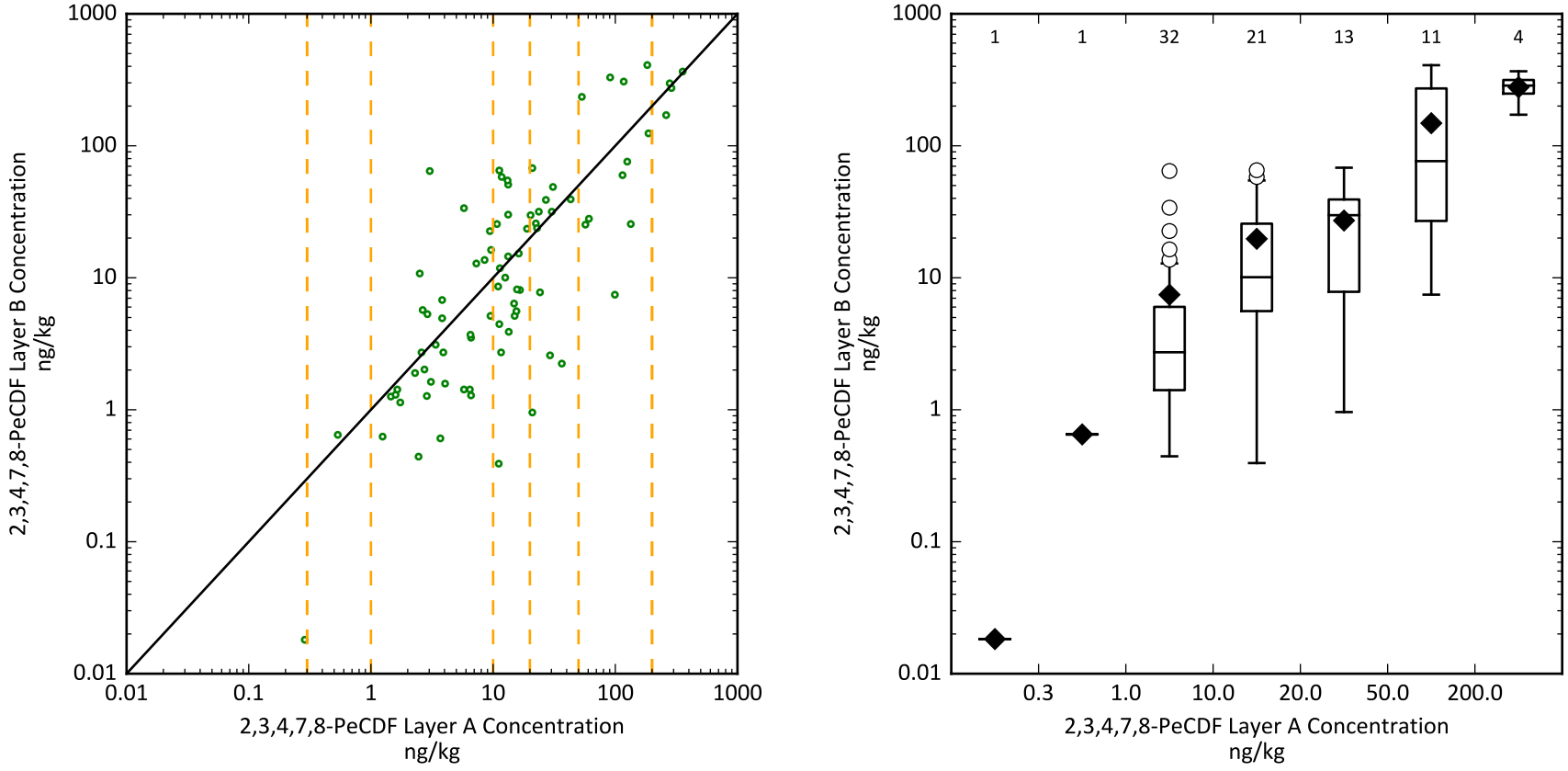
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 4a

2,3,4,7,8-PeCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

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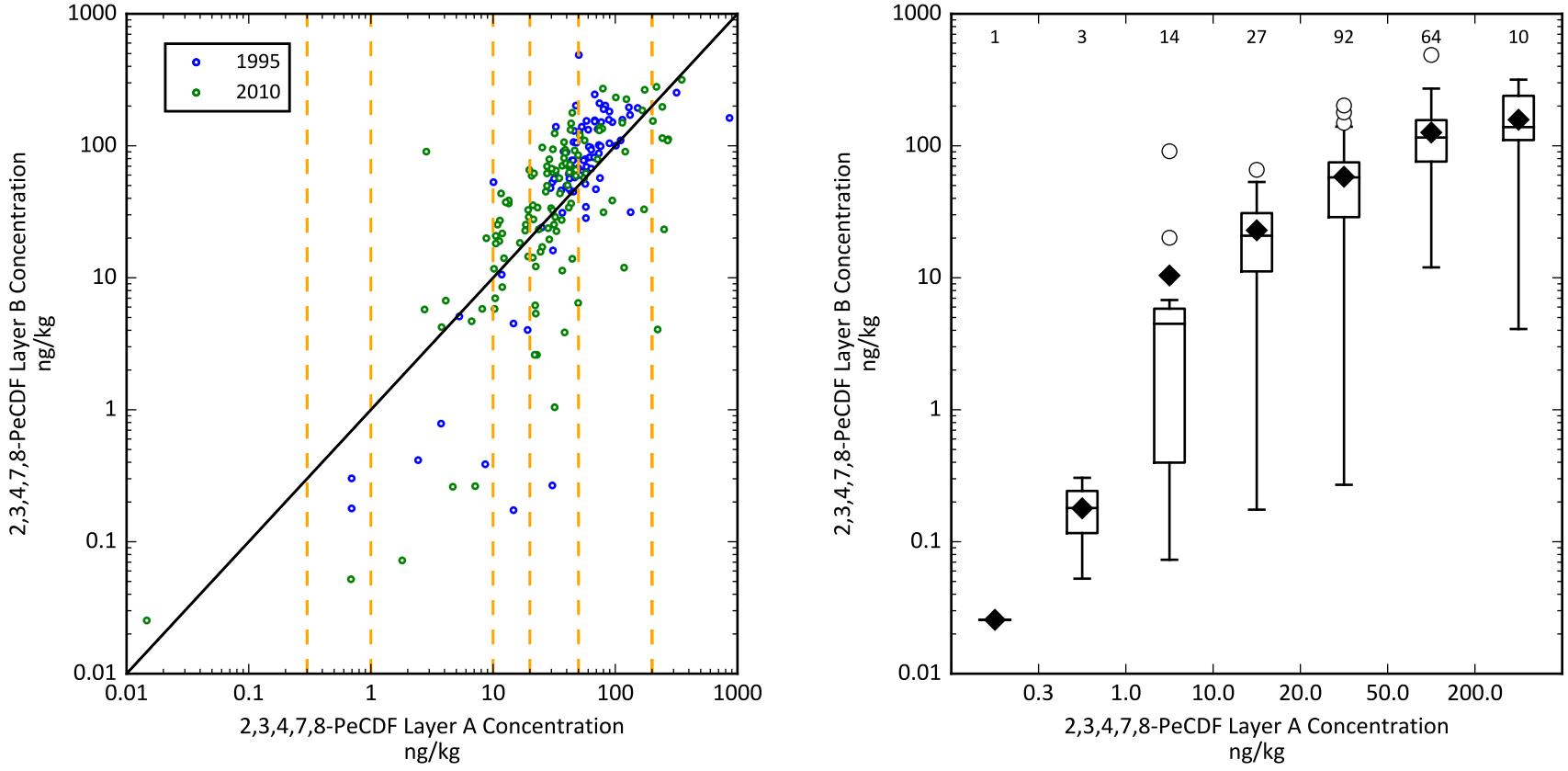
Figure 4b

2,3,4,7,8-PeCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

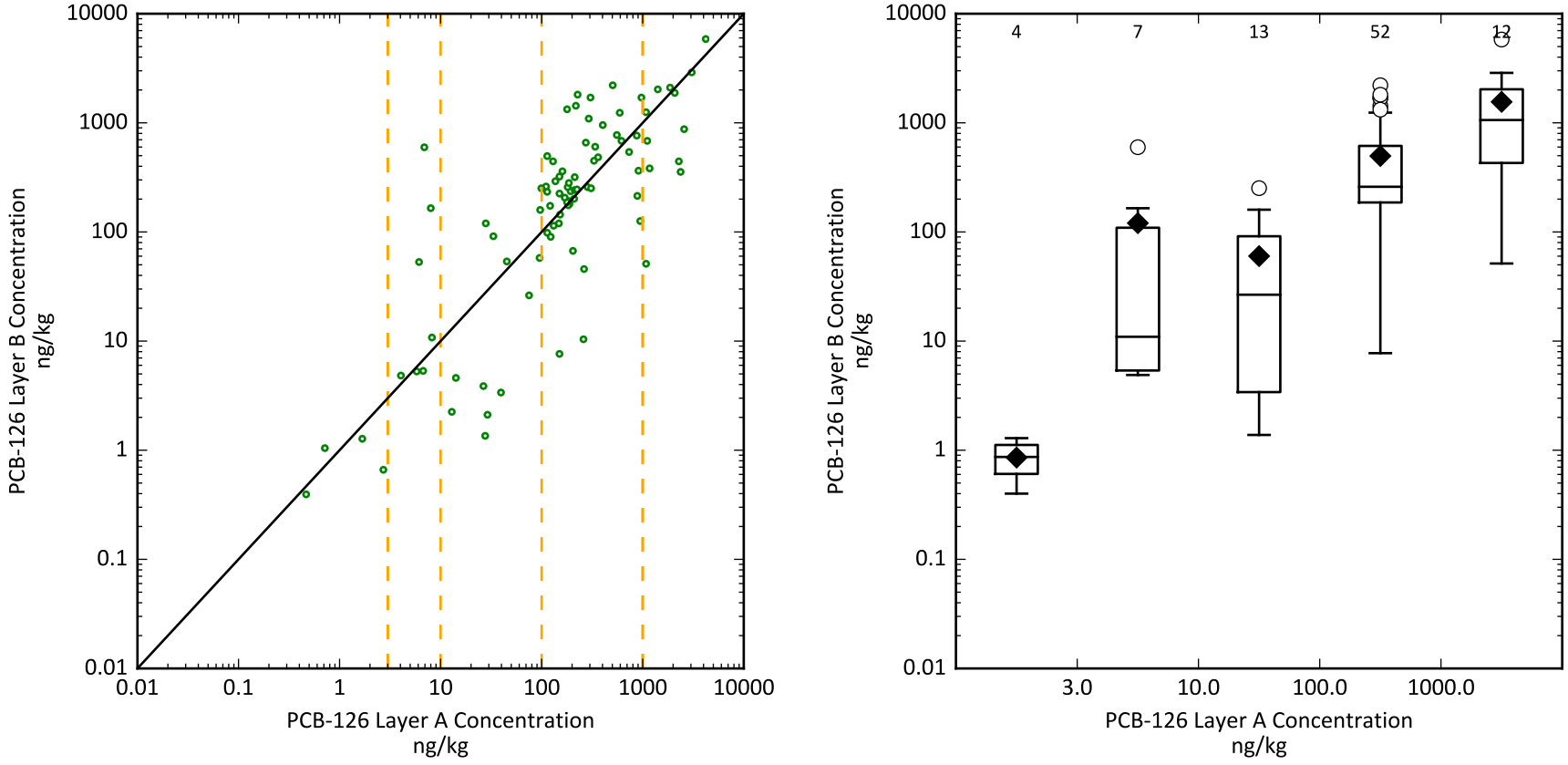
Publish Date: 06/19/2019 15:32 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 4c

2,3,4,7,8-PeCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1 Layer B concentration with a value of zero is not shown.

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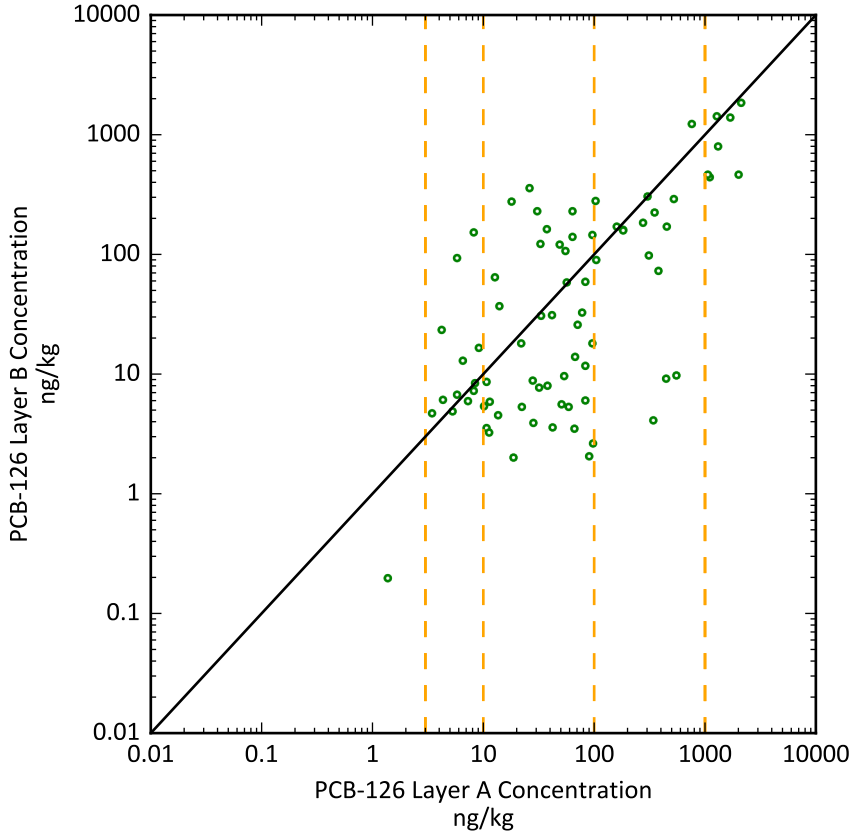
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

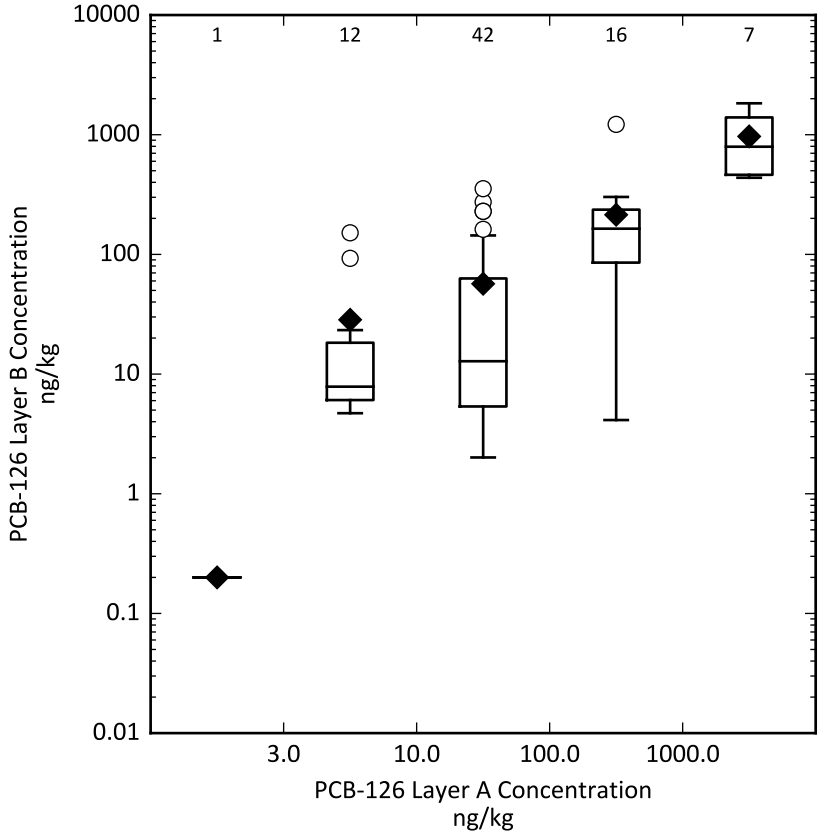
Figure 5a

PCB-126: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

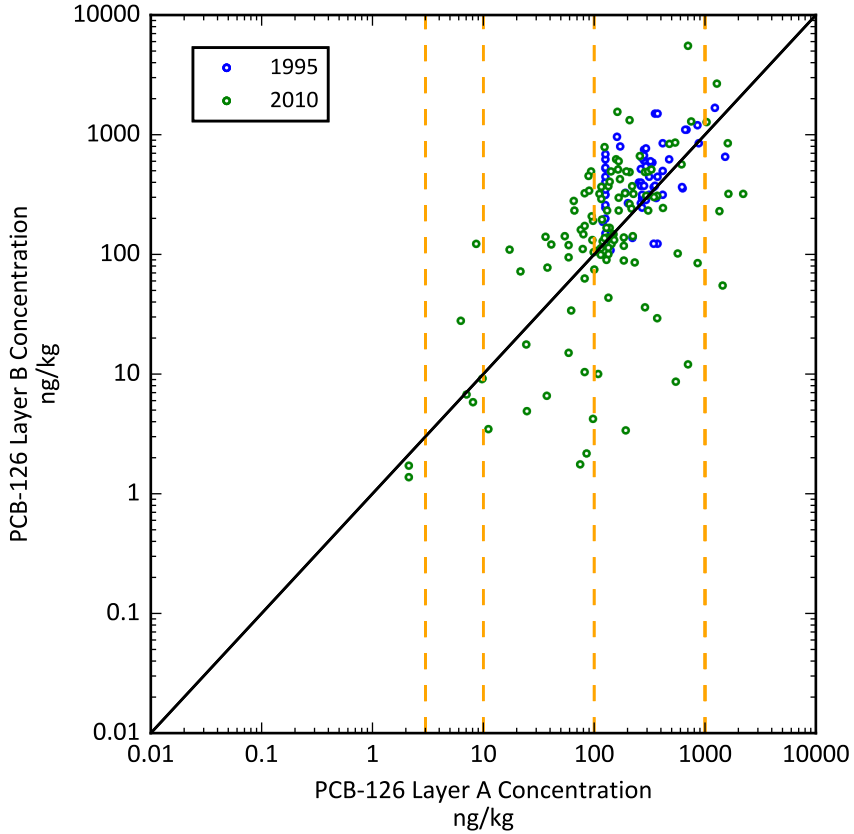
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

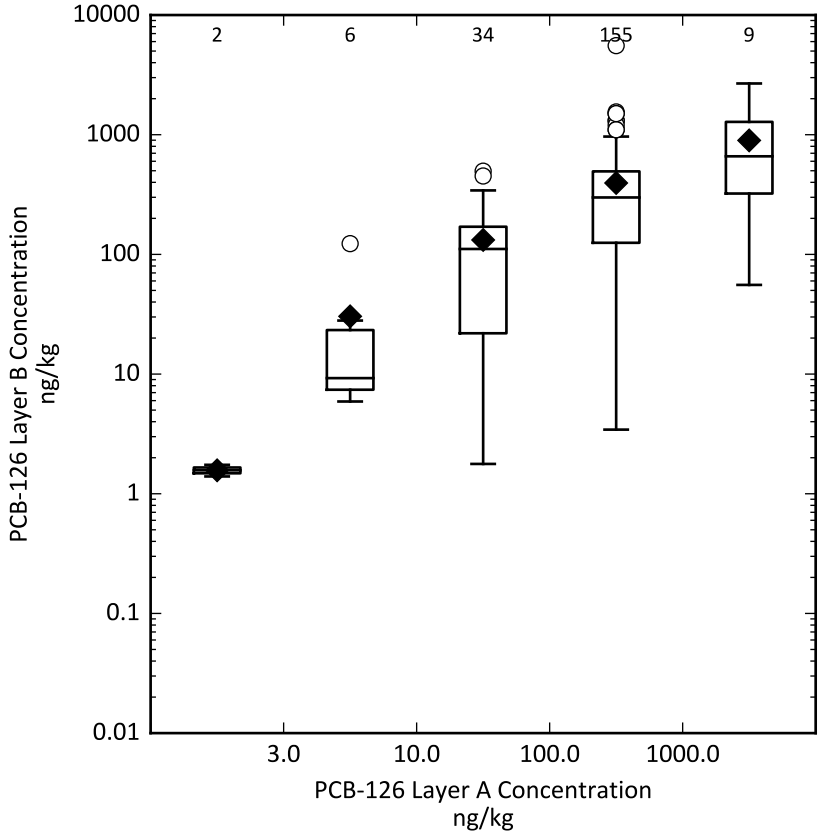
Figure 5b

PCB-126: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

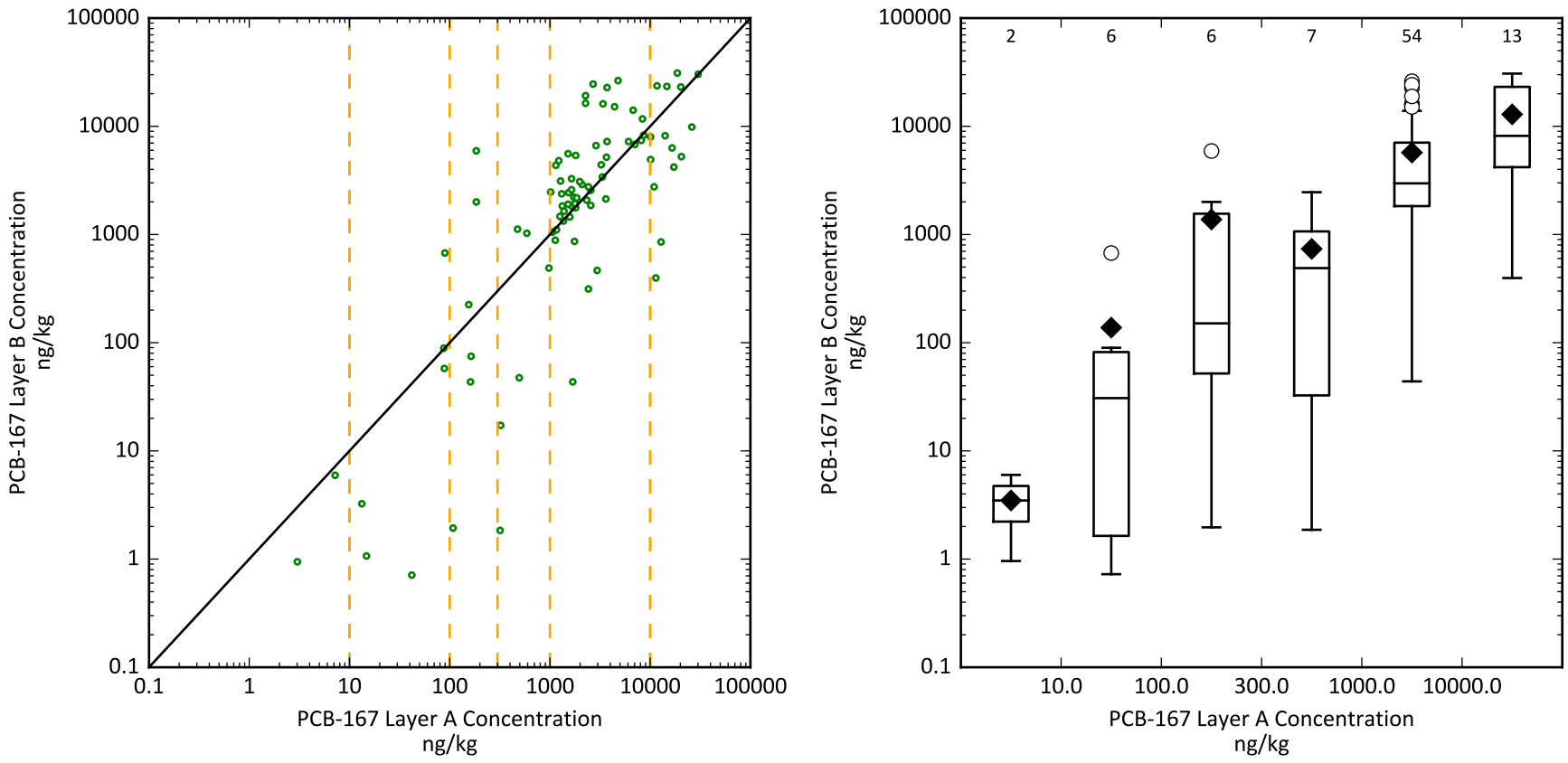
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 5c

PCB-126: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1 Layer B concentration with a value of zero is not shown.

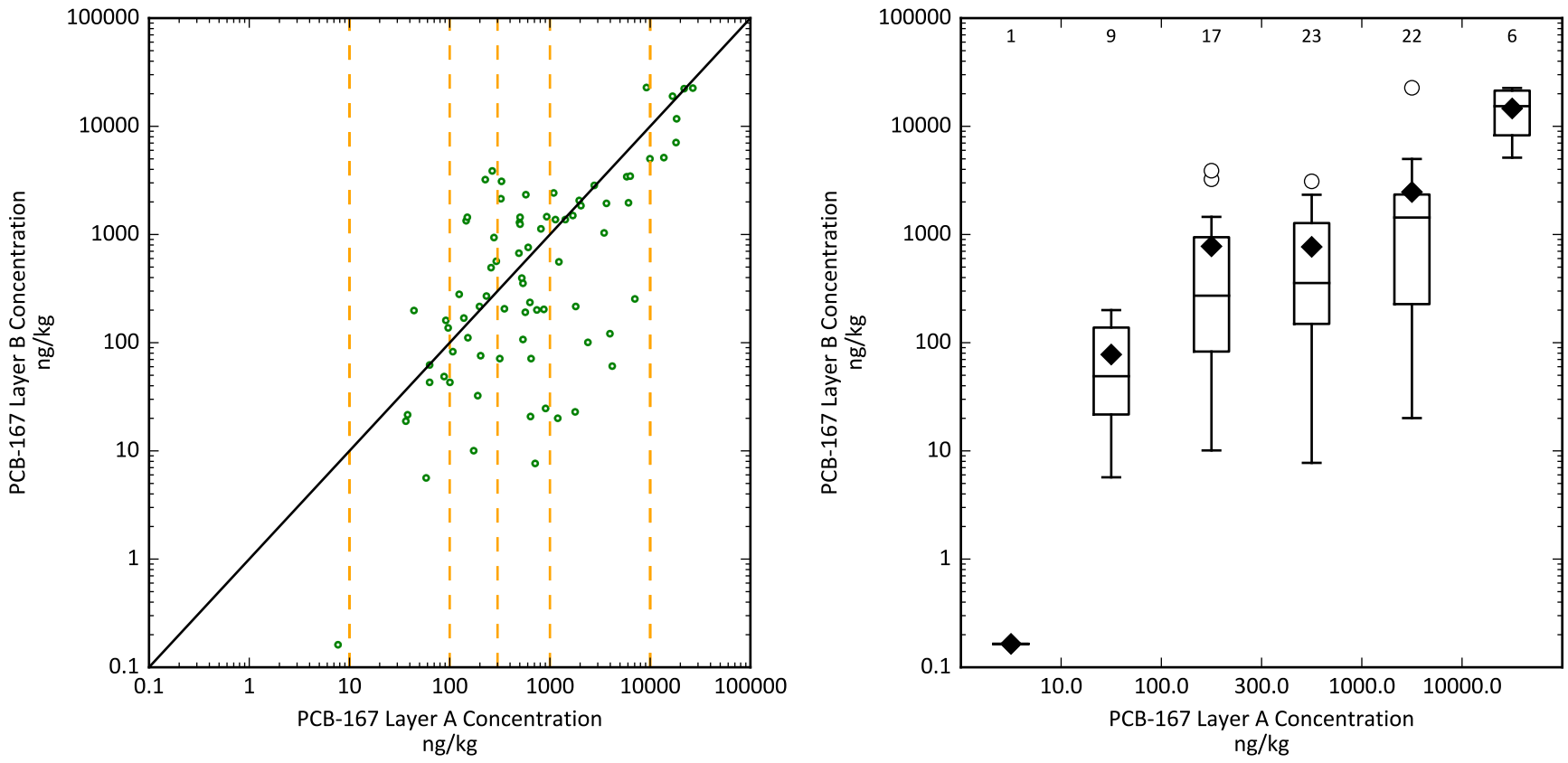
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 6a

PCB-167: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

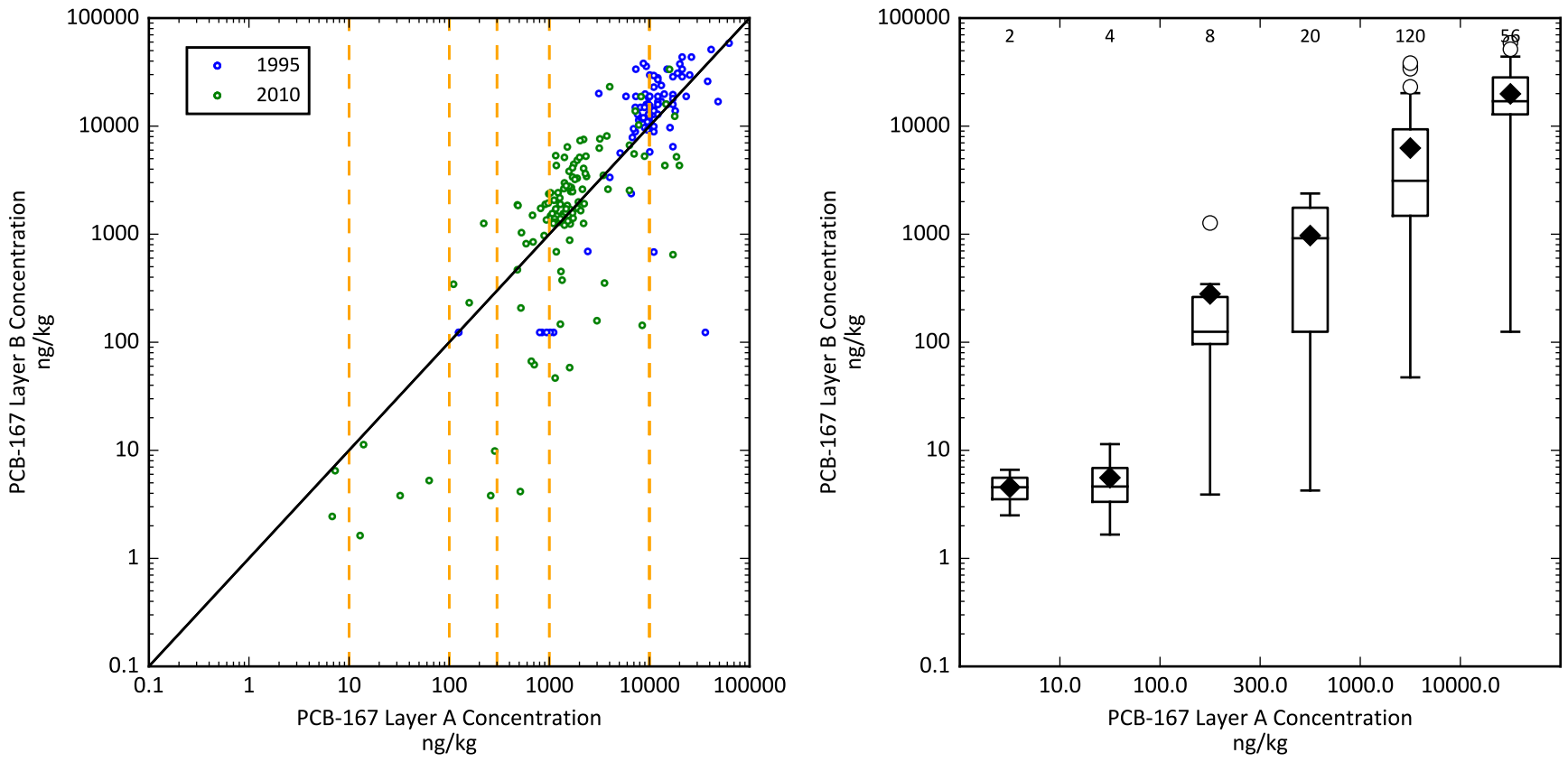
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 6b

PCB-167: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

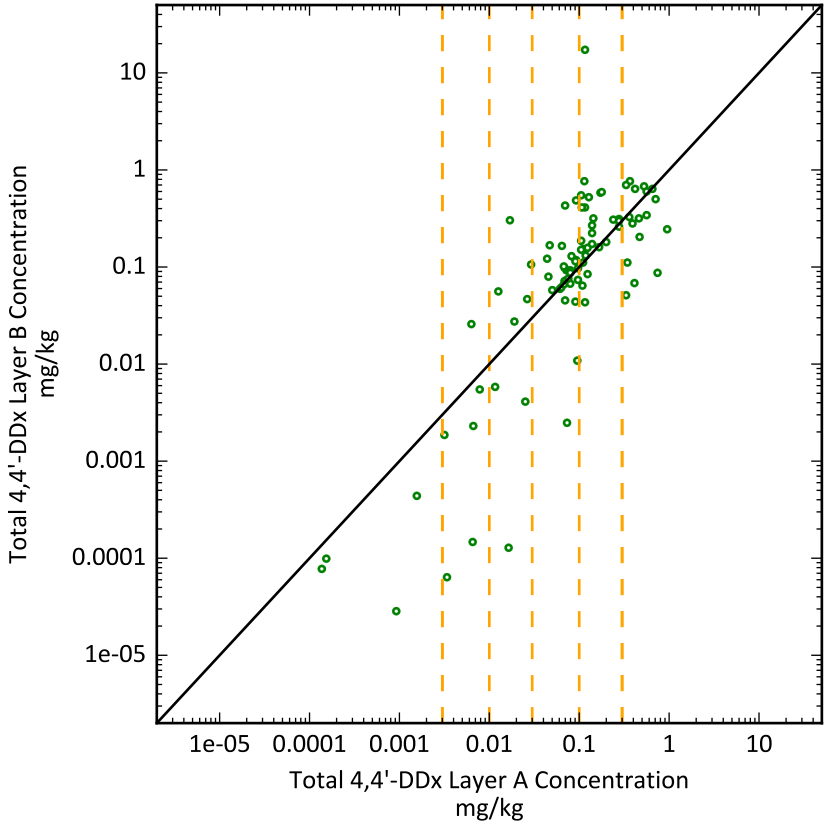
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

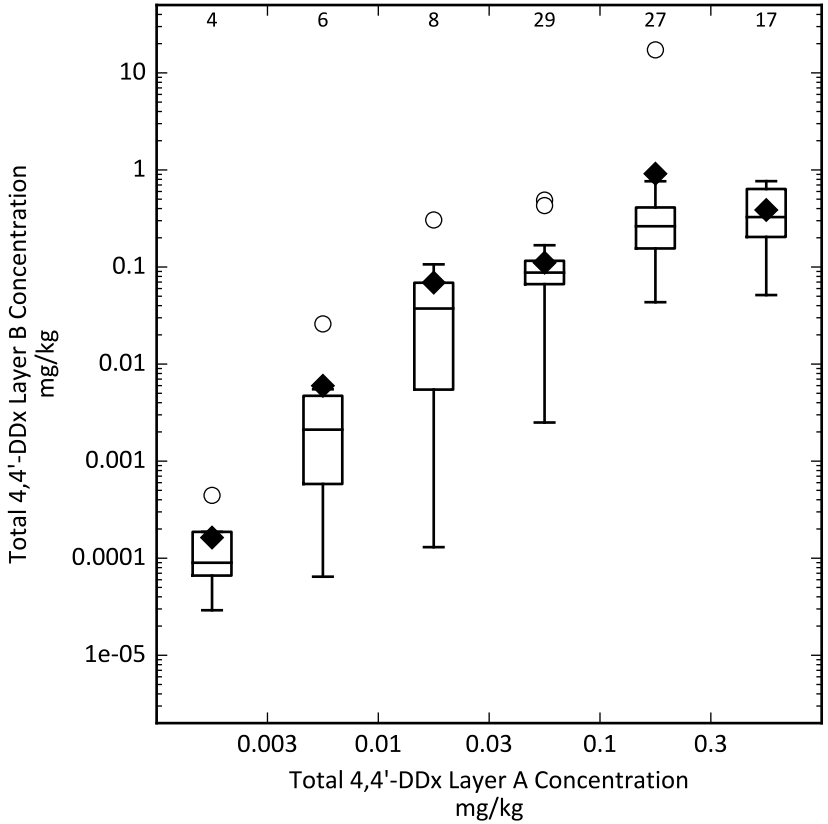
Figure 6c

PCB-167: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

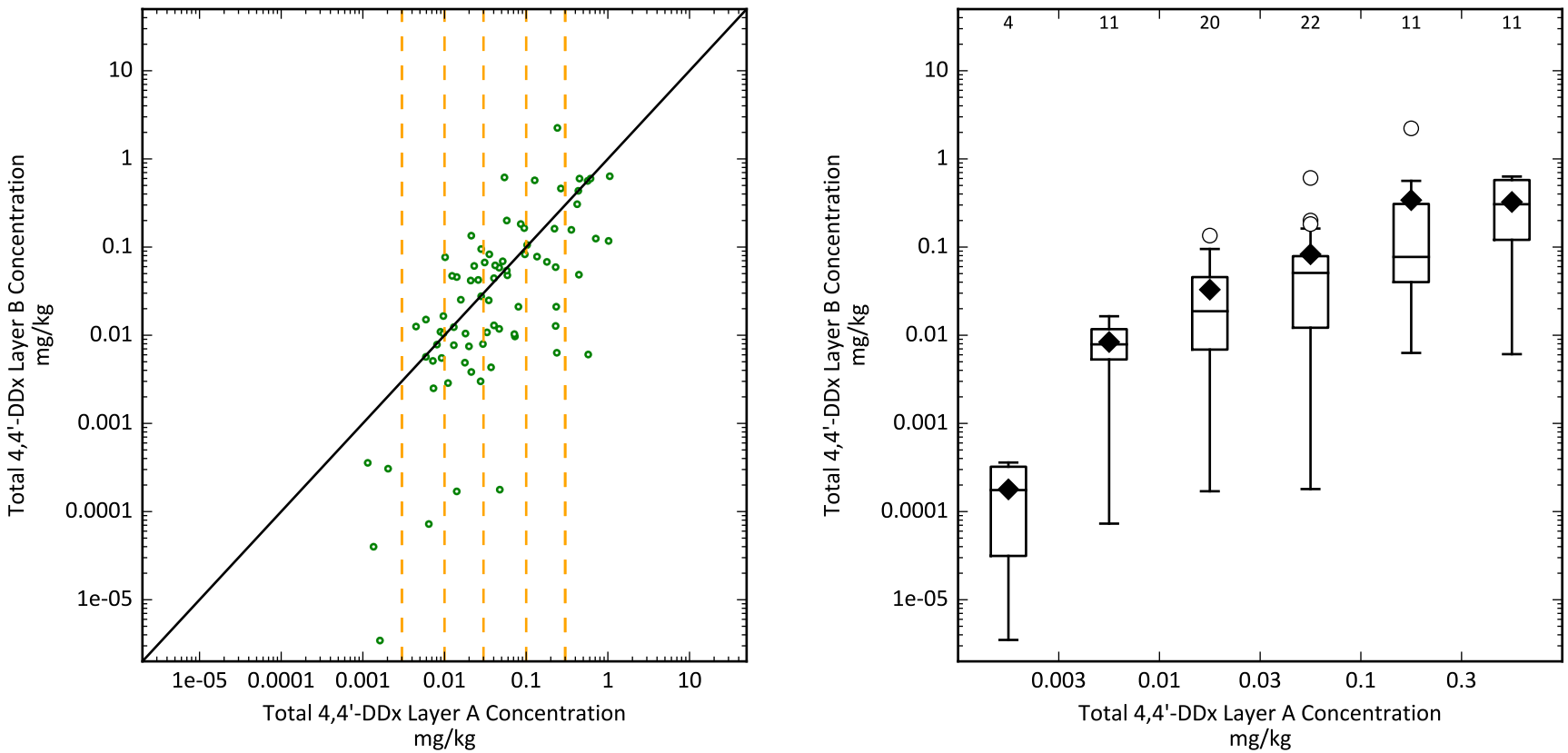
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 7a

Total 4,4'-DDx: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
7 Layer B concentrations with a value of zero are not shown.

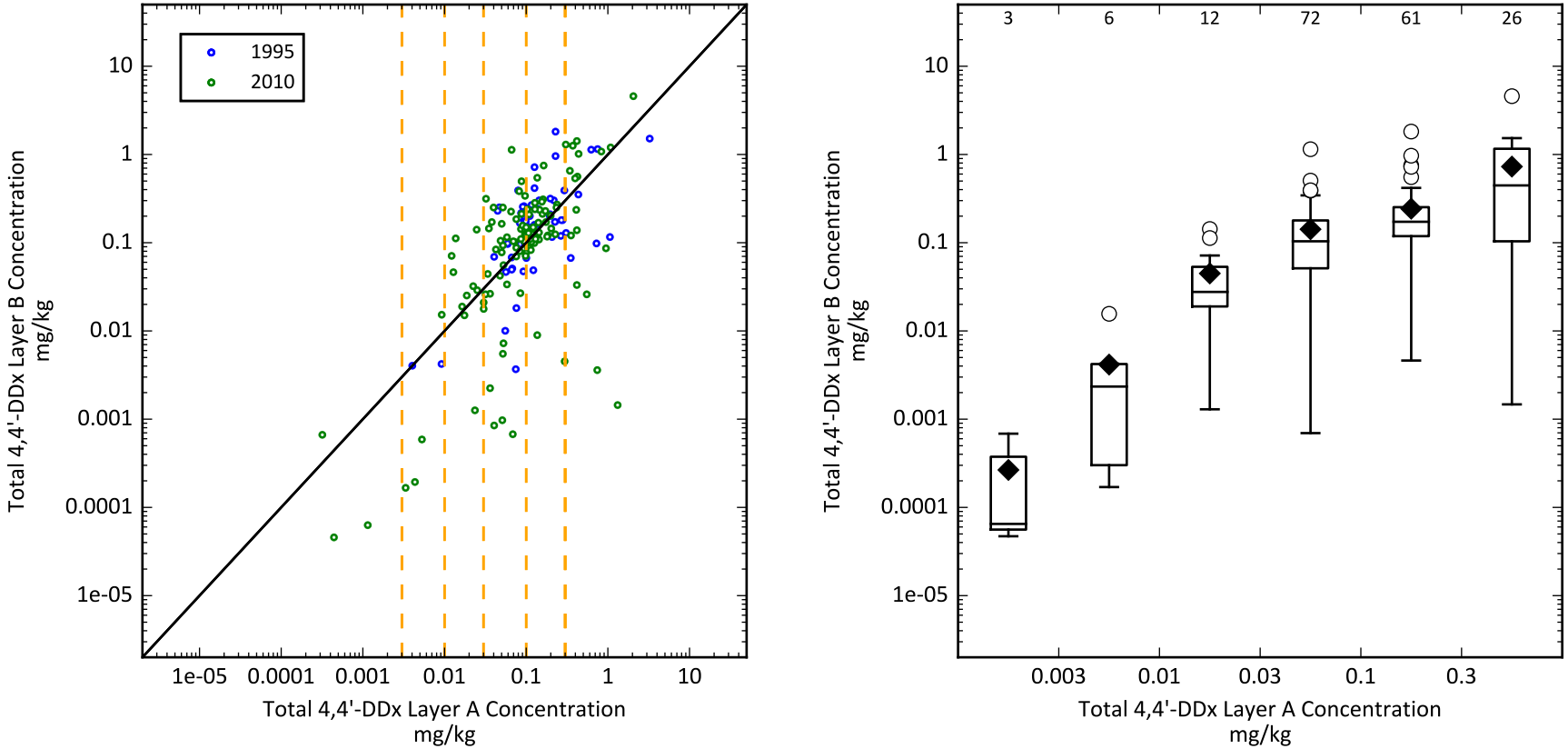
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 7b

Total 4,4'-DDx: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

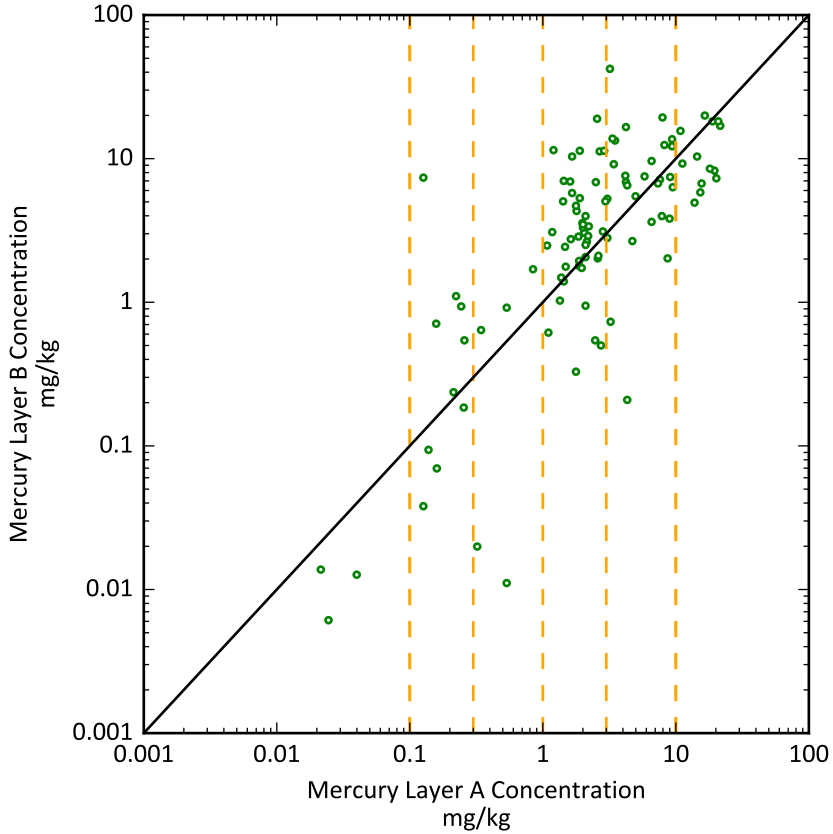
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

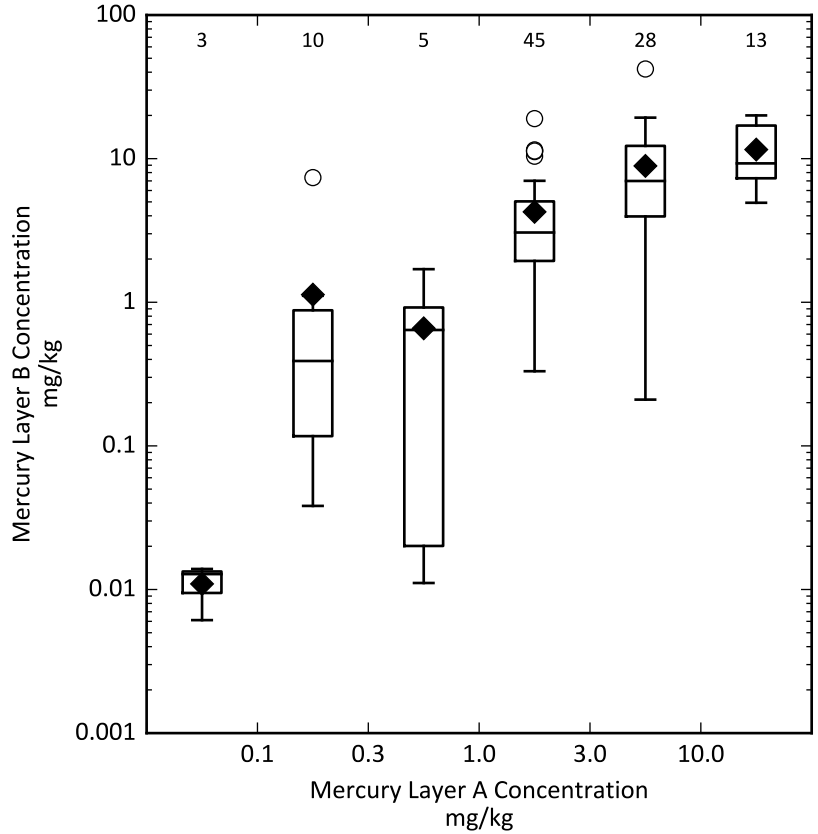
Figure 7c

Total 4,4'-DDx: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

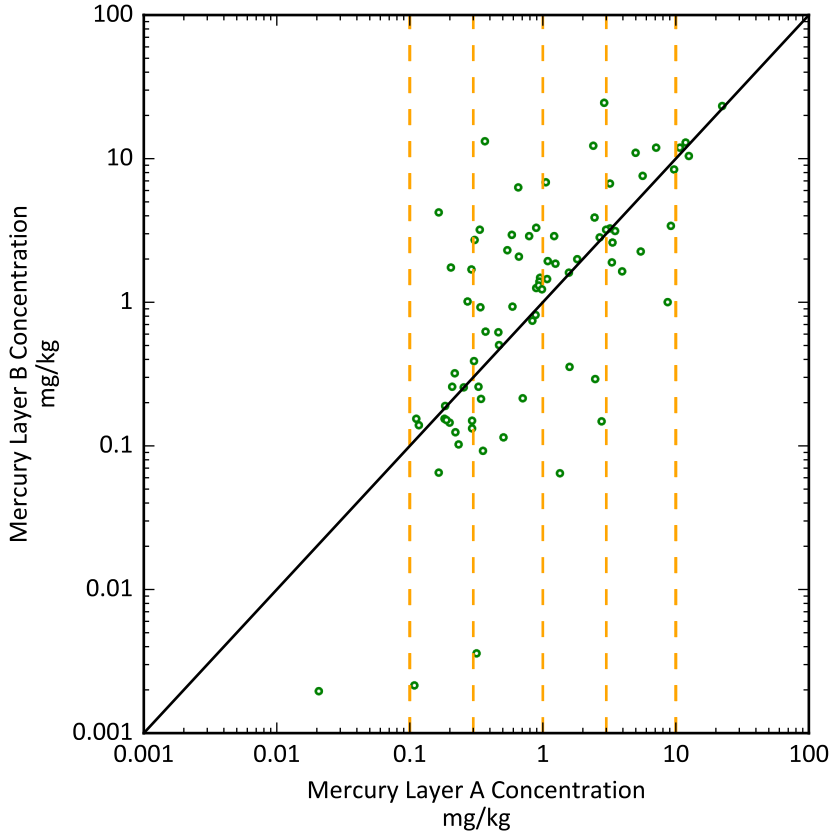
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

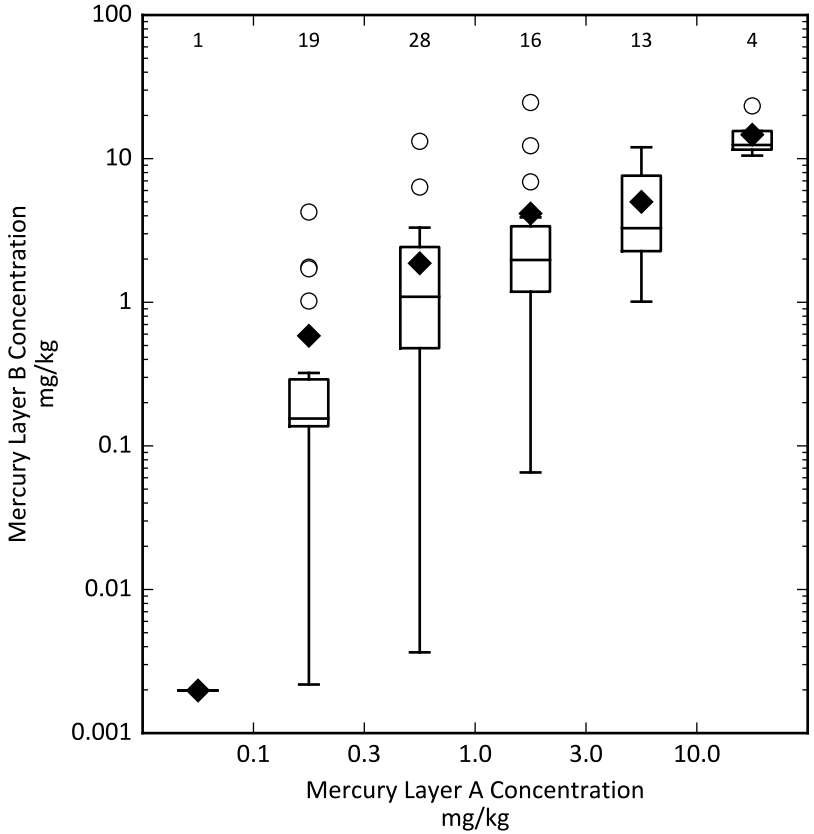
Figure 8a

Mercury: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
6 Layer B concentrations with a value of zero are not shown.

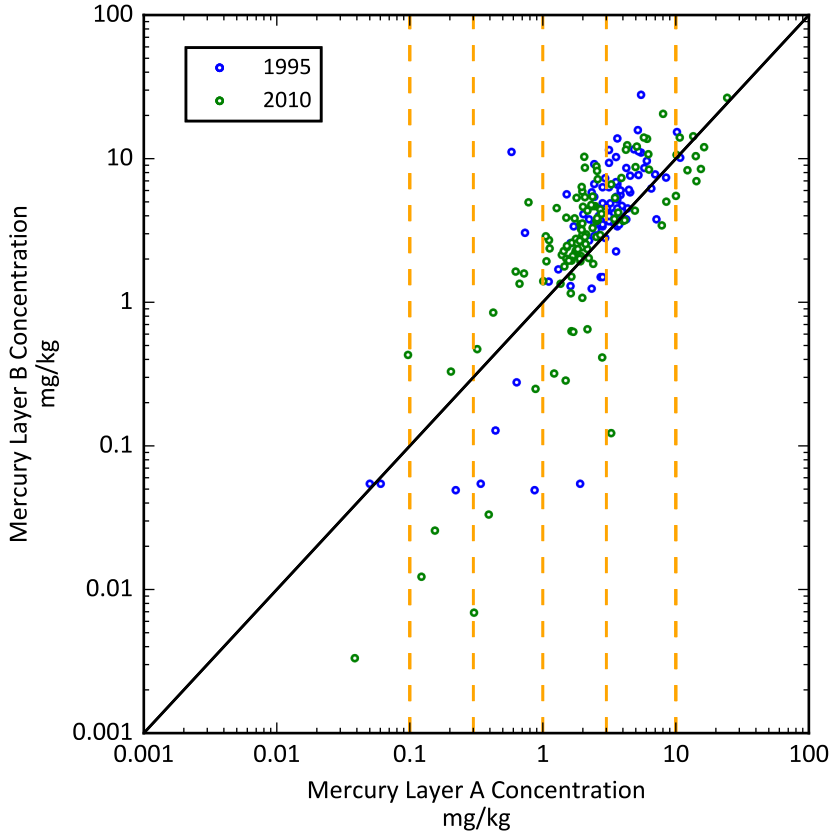
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

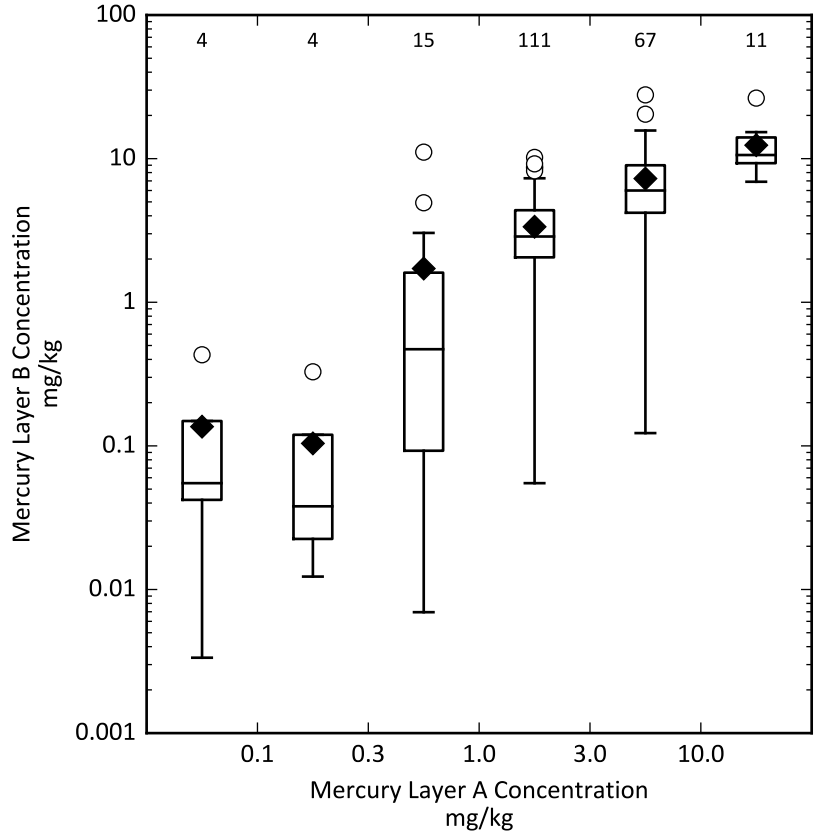
Figure 8b

Mercury: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
1995 data is available only from RM 1-7. There are no Layer B concentrations with a value of zero.

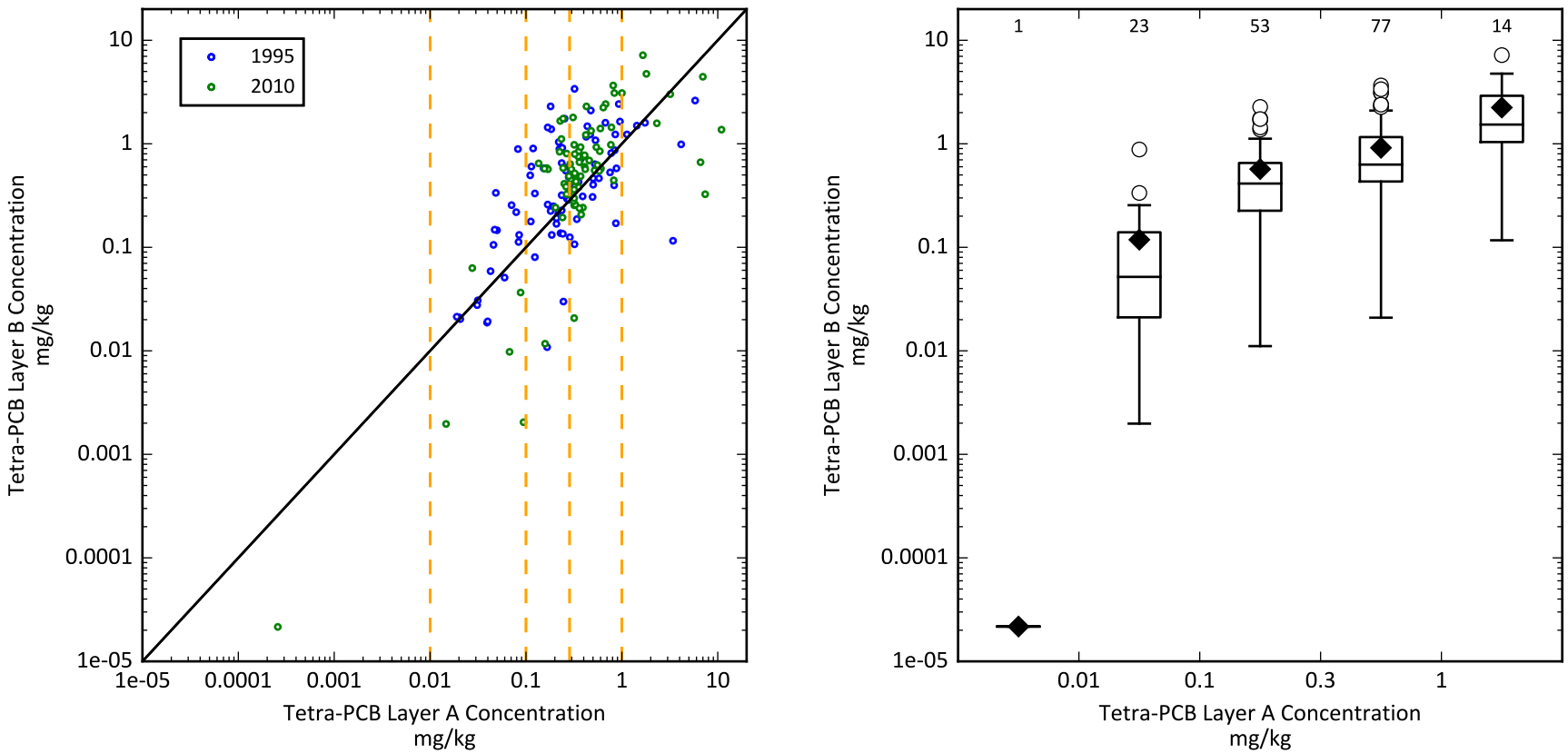
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 8c

Mercury: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 2010 Layer B for RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

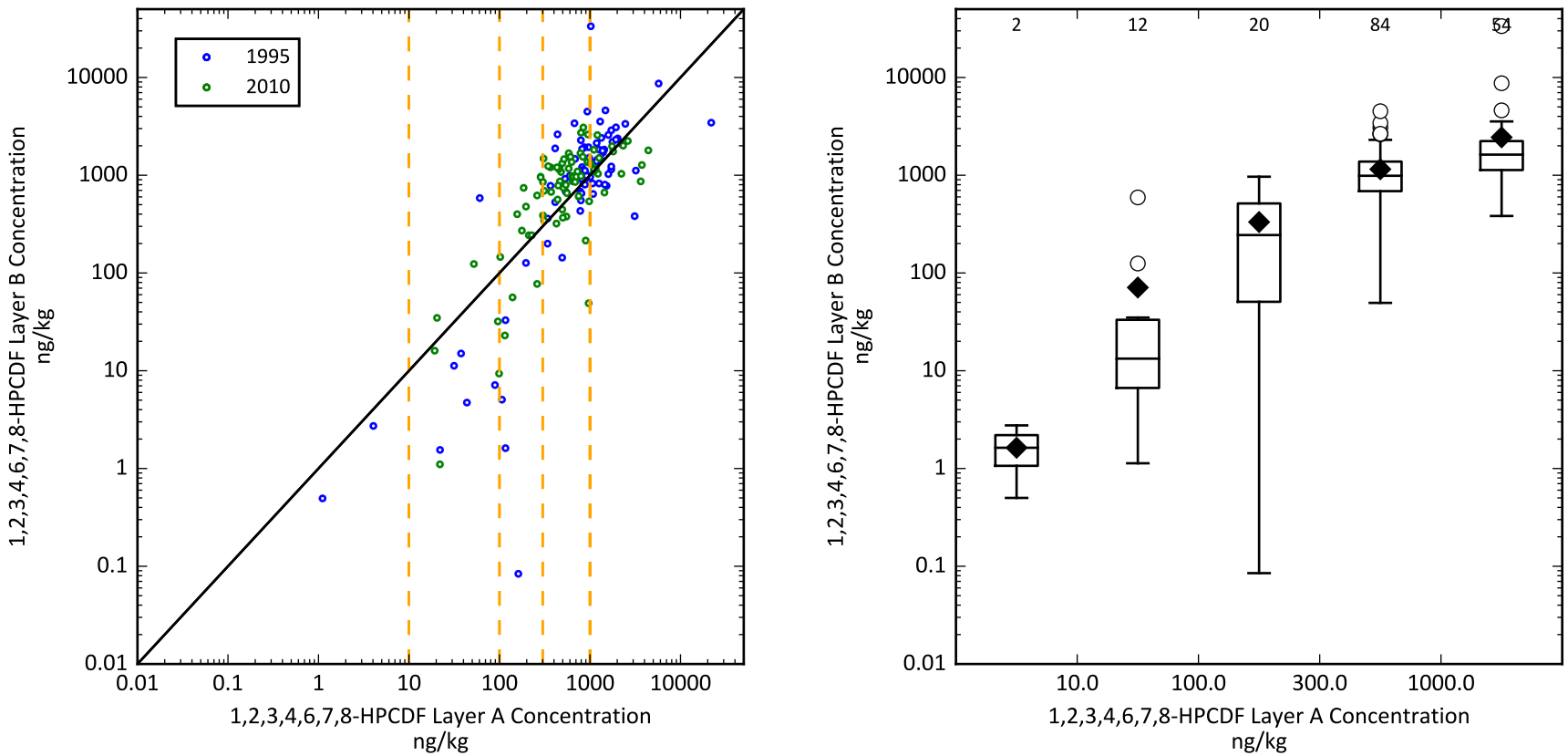
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 9

Tetra-PCB: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

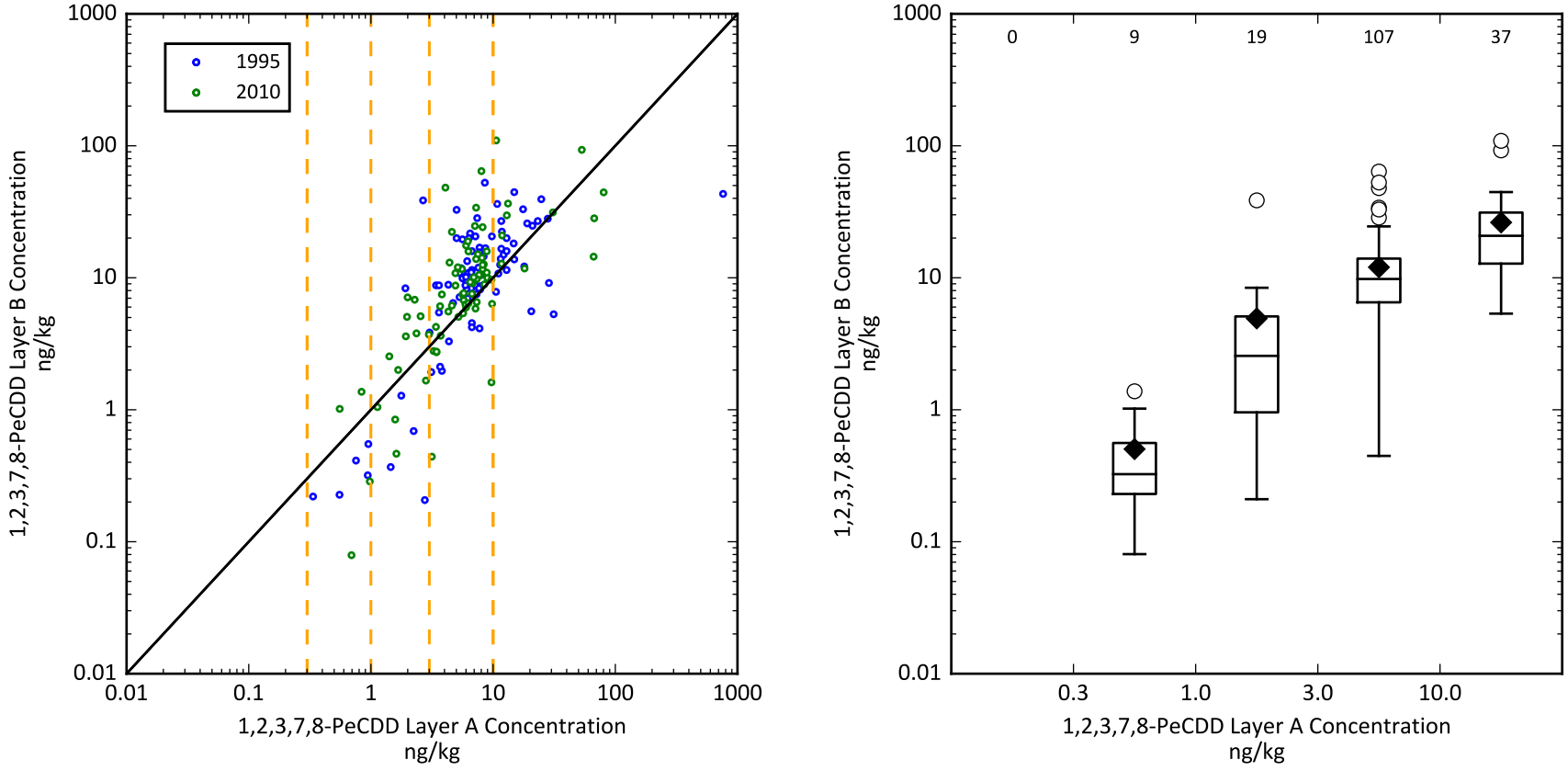
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 10

1,2,3,4,6,7,8-HPCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

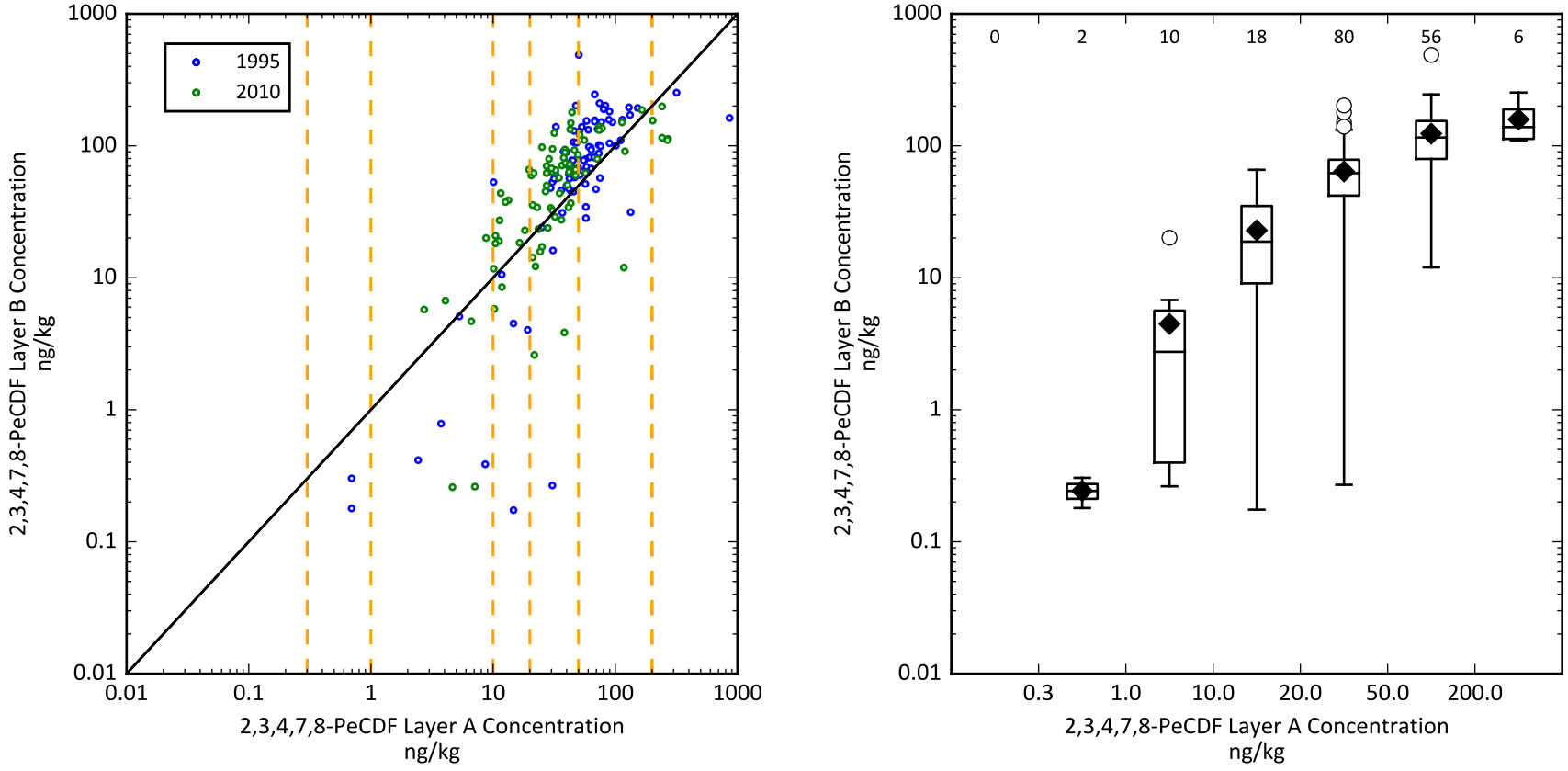
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 11

1,2,3,7,8-PeCDD: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

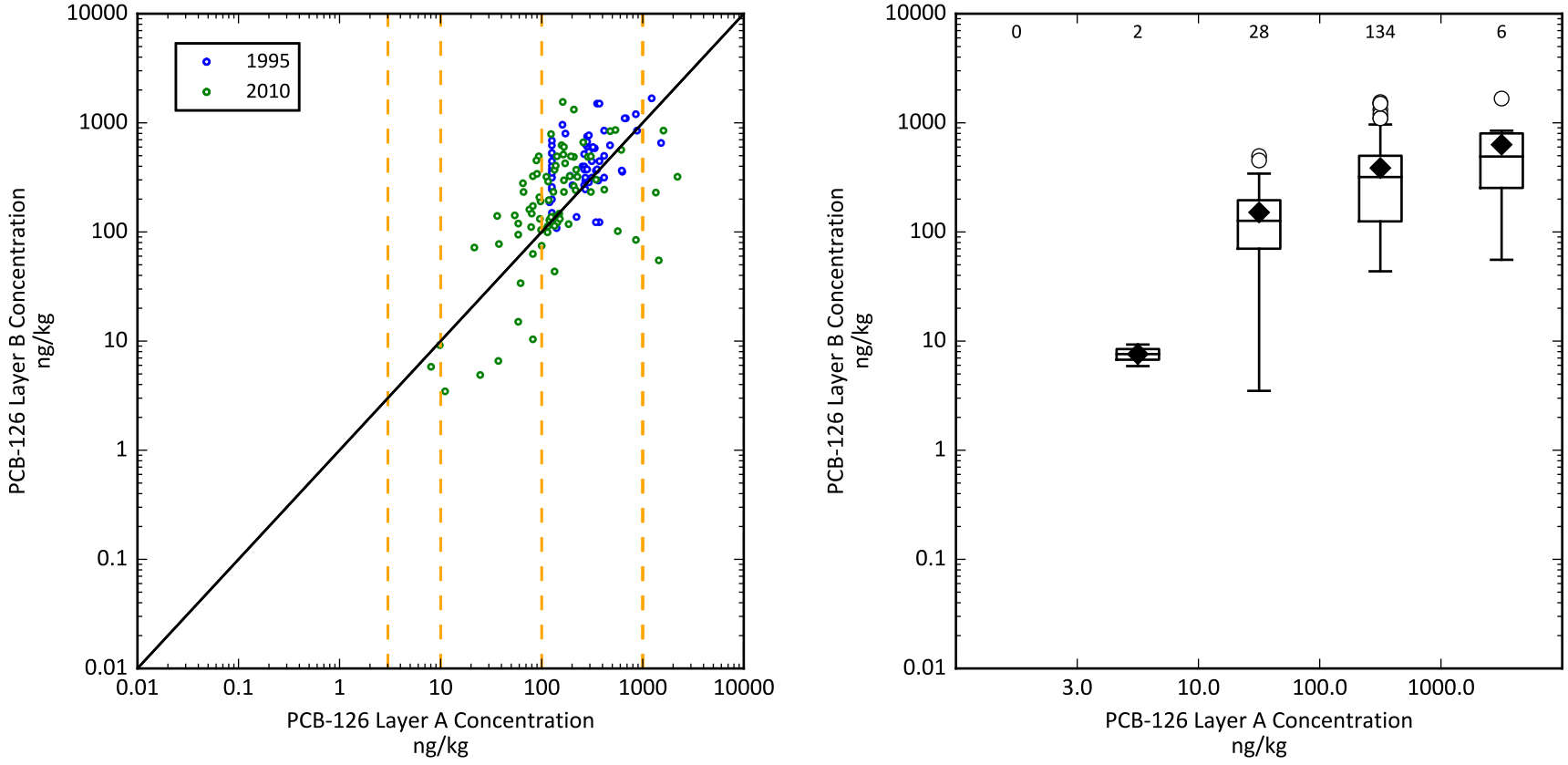
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 12

2,3,4,7,8-PeCDF: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

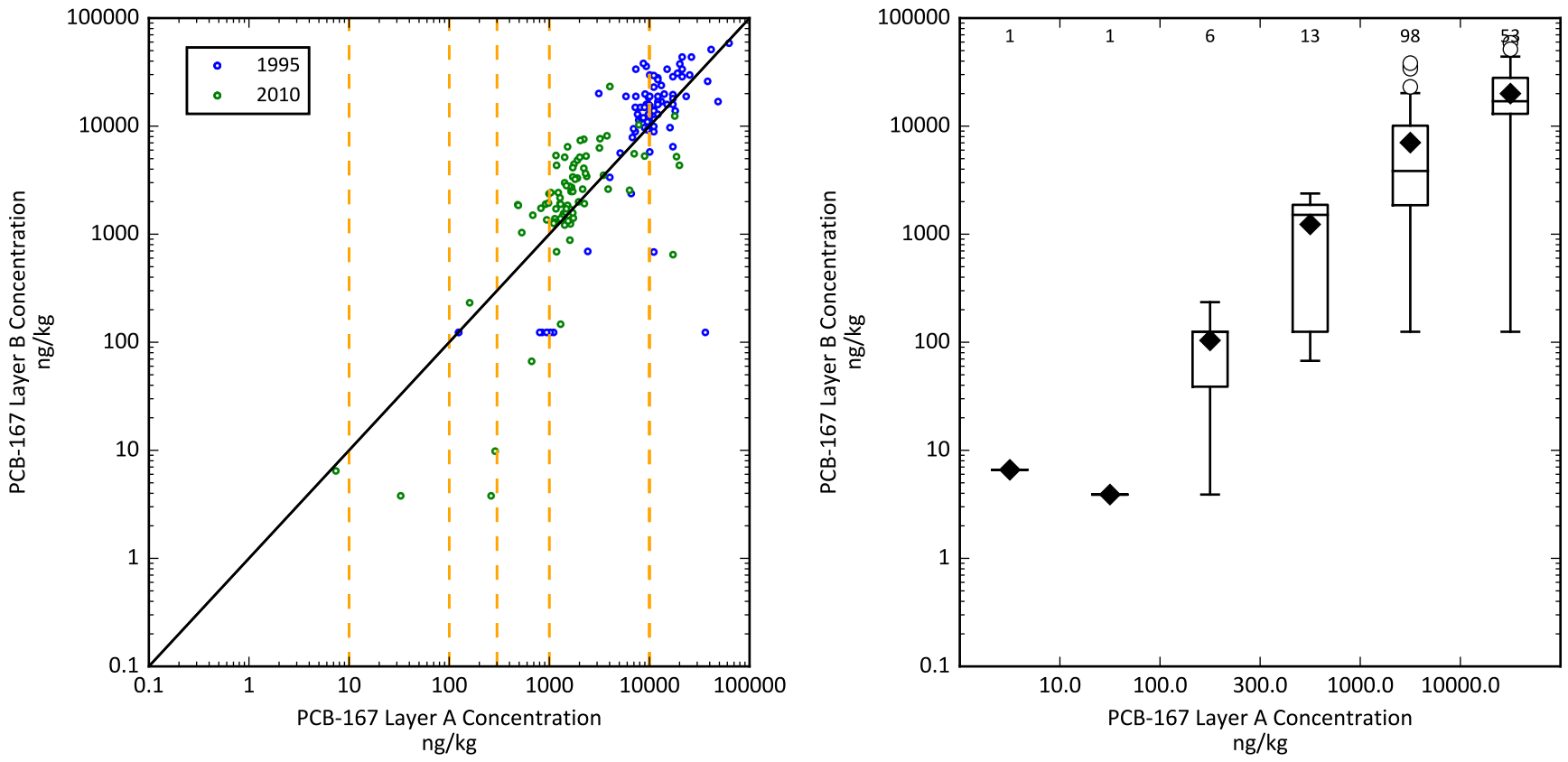
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 13

PCB-126: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

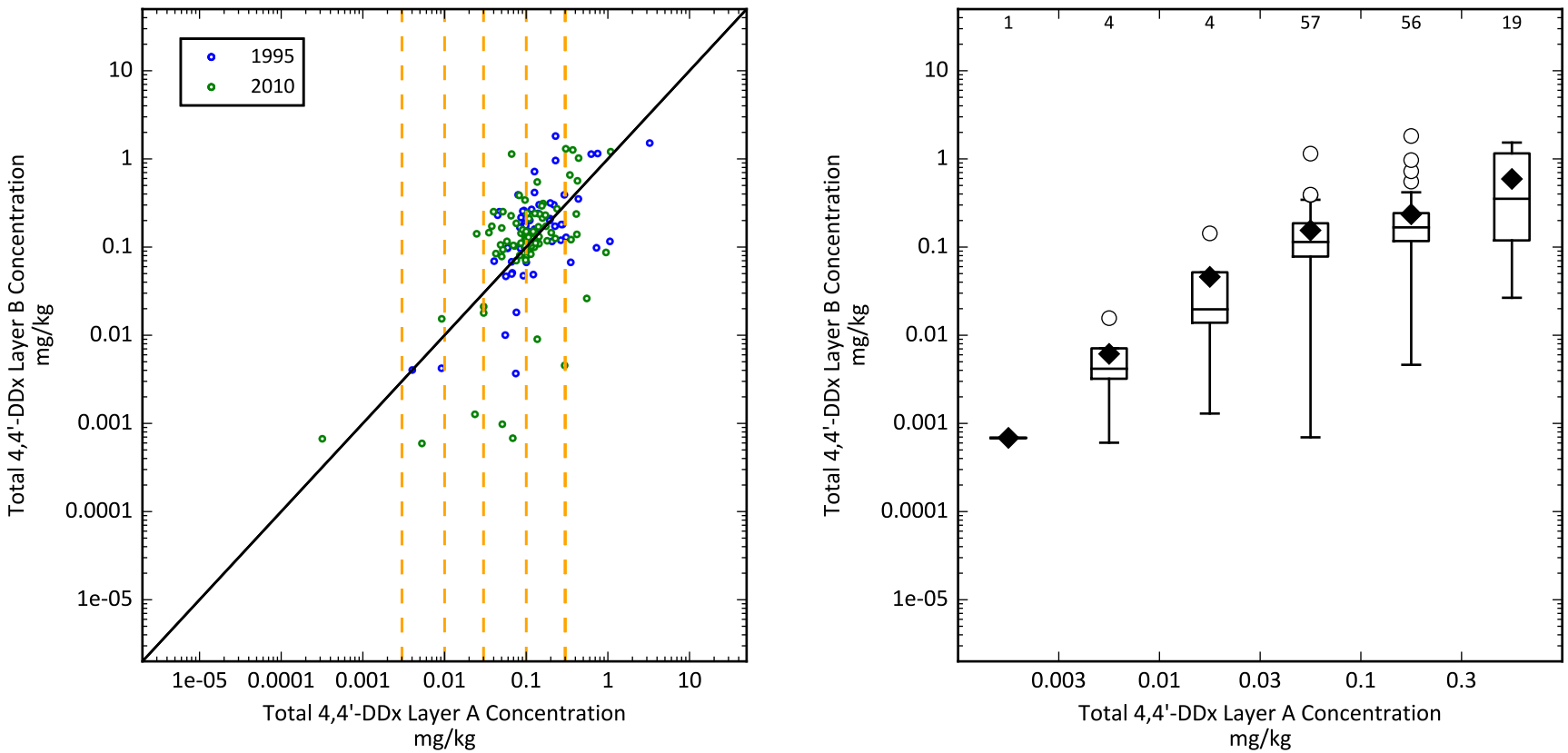
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

Figure 14

PCB-167: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

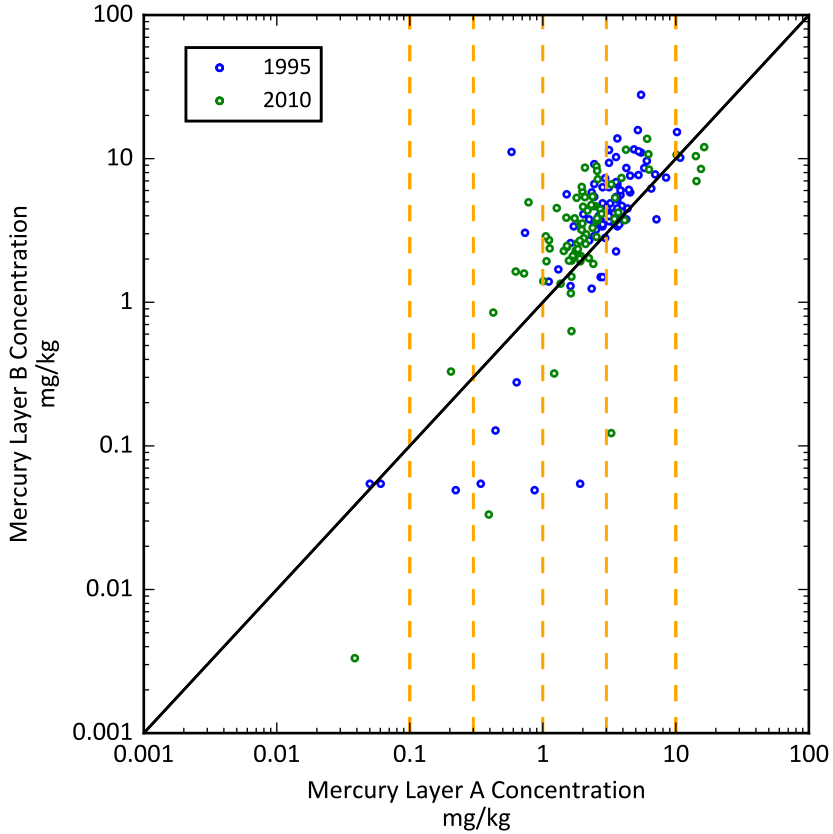
Publish Date: 06/19/2019 15:33 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

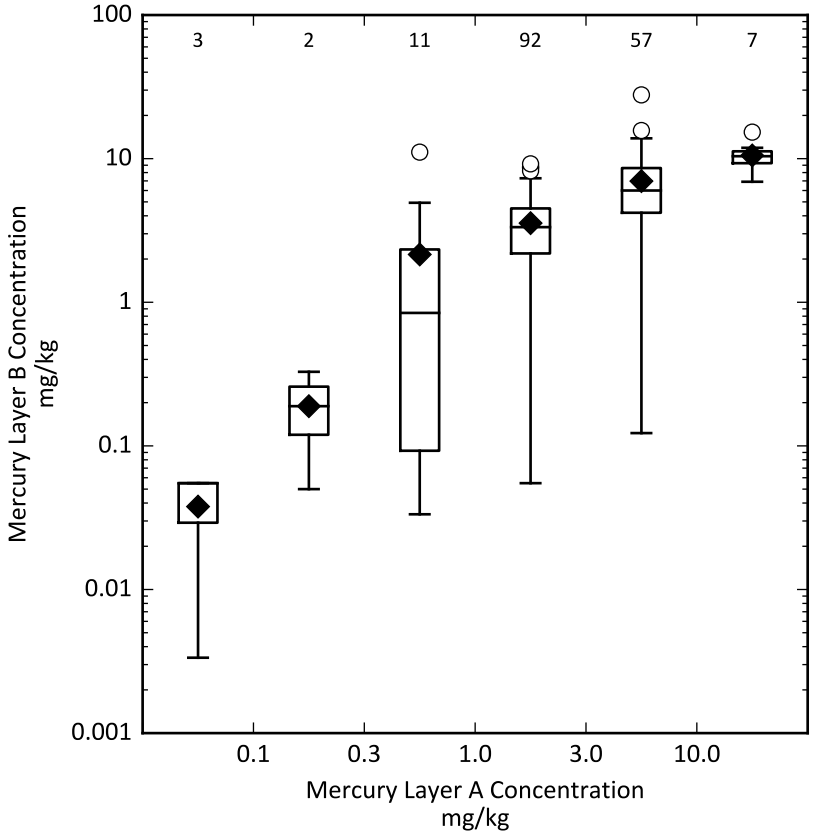
Figure 15

Total 4,4'-DDx: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
There are no Layer B concentrations with a value of zero.

Publish Date: 06/19/2019 15:34 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_6_3_and_4_crossplot_Data_19952010.py

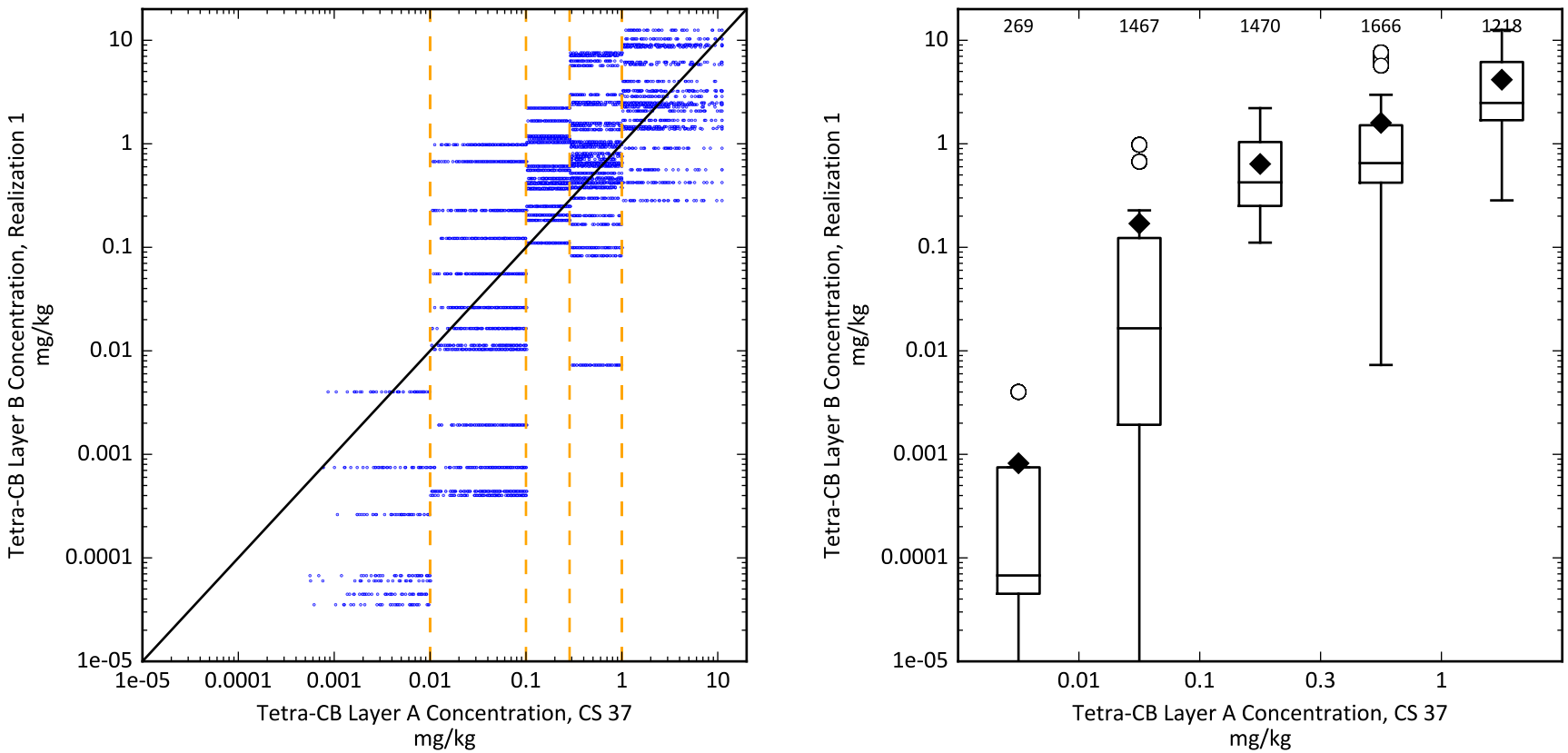
Figure 16

Mercury: Relationship Between Layer A and Layer B Data Used as a Pool to Resample 1995 Layer B for RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study

Attachment 3
Comparison of Mapped Surfaces for Layer A and Resampled Layer B for Additional COPCs



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions. Data is from the 2010 dataset.
The Conditional Simulation was sampled on a 20 x 20 ft grid.

Publish Date: 06/19/2019 15:18 PM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_12_crossplot_CS_LayerB_Resample.py

Figure 1a

Tetra-CB 2010 Mapped Conditional Simulation Layer A and Layer Resampled B Comparison: Silt RM 7.8-14.7

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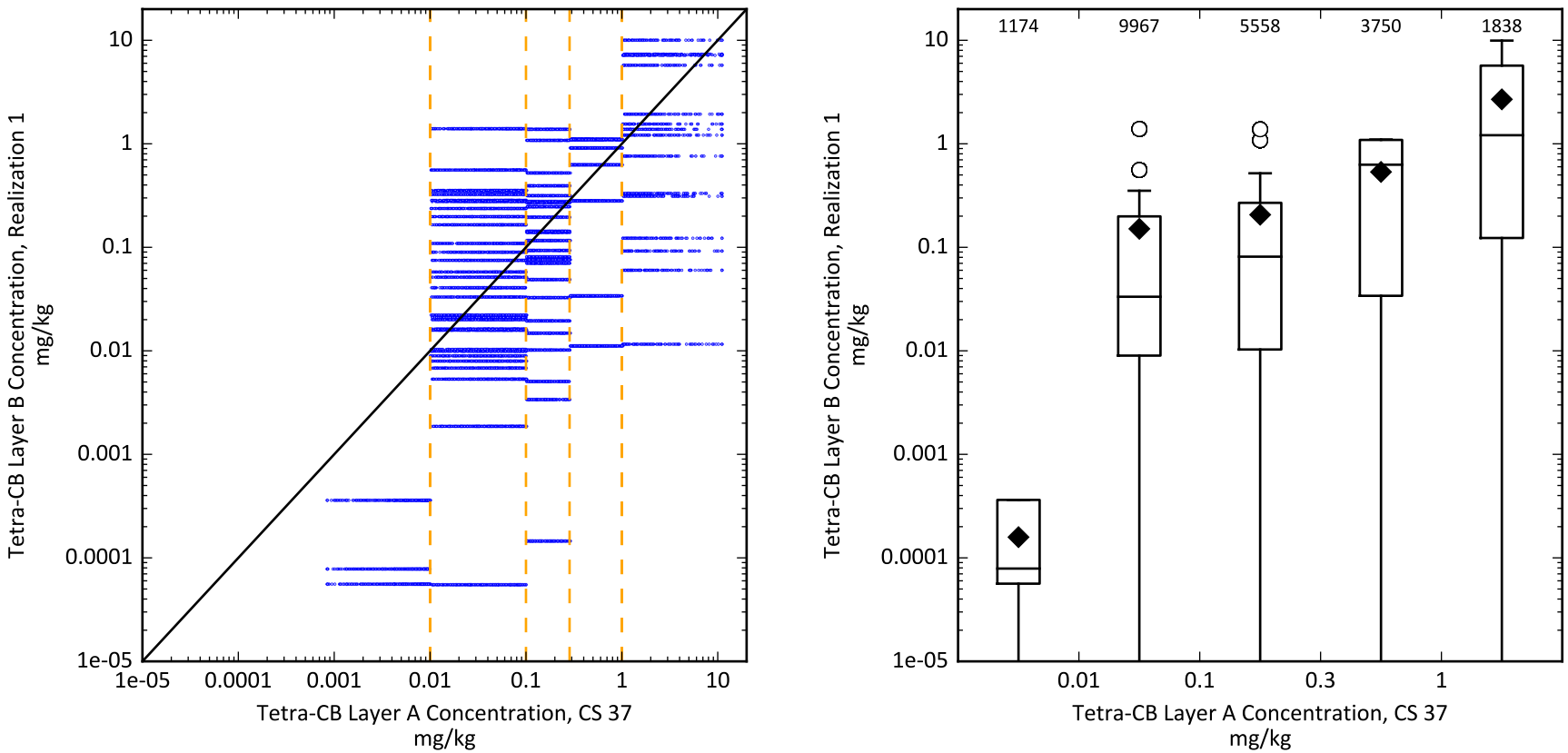
Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions. Data is from the 2010 dataset.
The Conditional Simulation was sampled on a 20 x 20 ft grid.

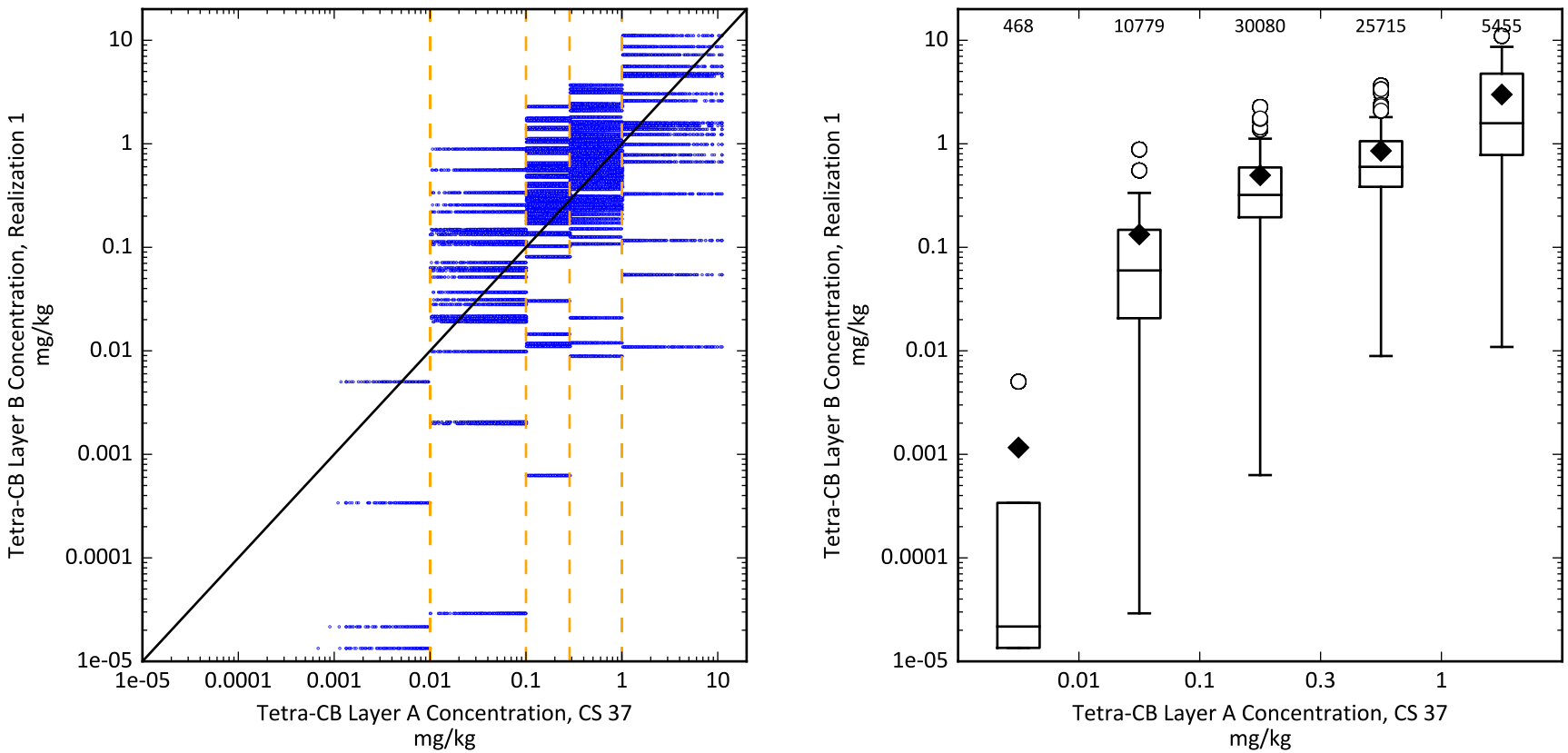
Publish Date: 06/19/2019 15:18 PM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_12_crossplot_CS_LayerB_Resample.py

Figure 1b

Tetra-CB 2010 Mapped Conditional Simulation Layer A and Layer Resampled B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions. Data is from the pooled 1995 and 2010 dataset.
The Conditional Simulation was sampled on a 20 x 20 ft grid.

Publish Date: 06/19/2019 15:18 PM | User: GD
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_12_crossplot_CS_LayerB_Resample.py

Figure 1c

Tetra-CB 2010 Mapped Conditional Simulation Layer A and Layer Resampled B Comparison: RM 0-7.8

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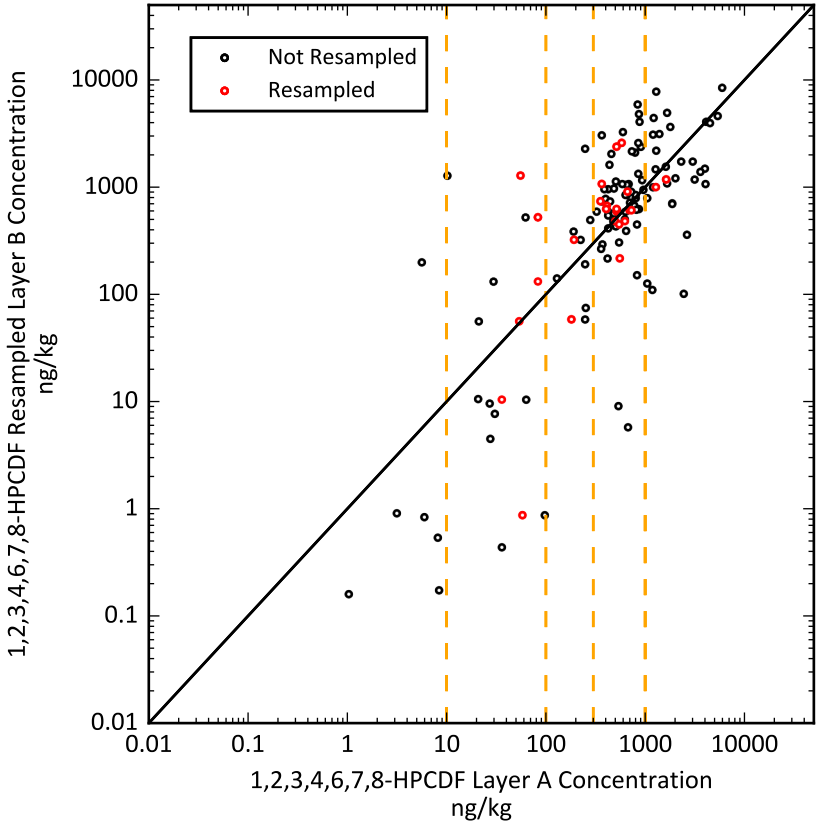
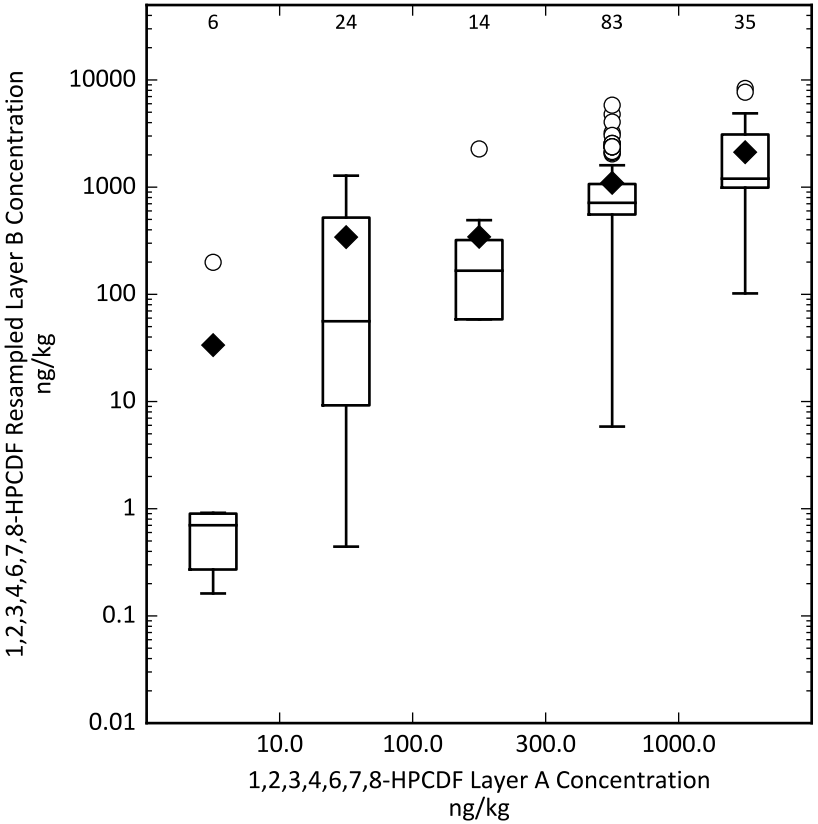
Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
2 Layer B concentrations with a value of zero are not shown.

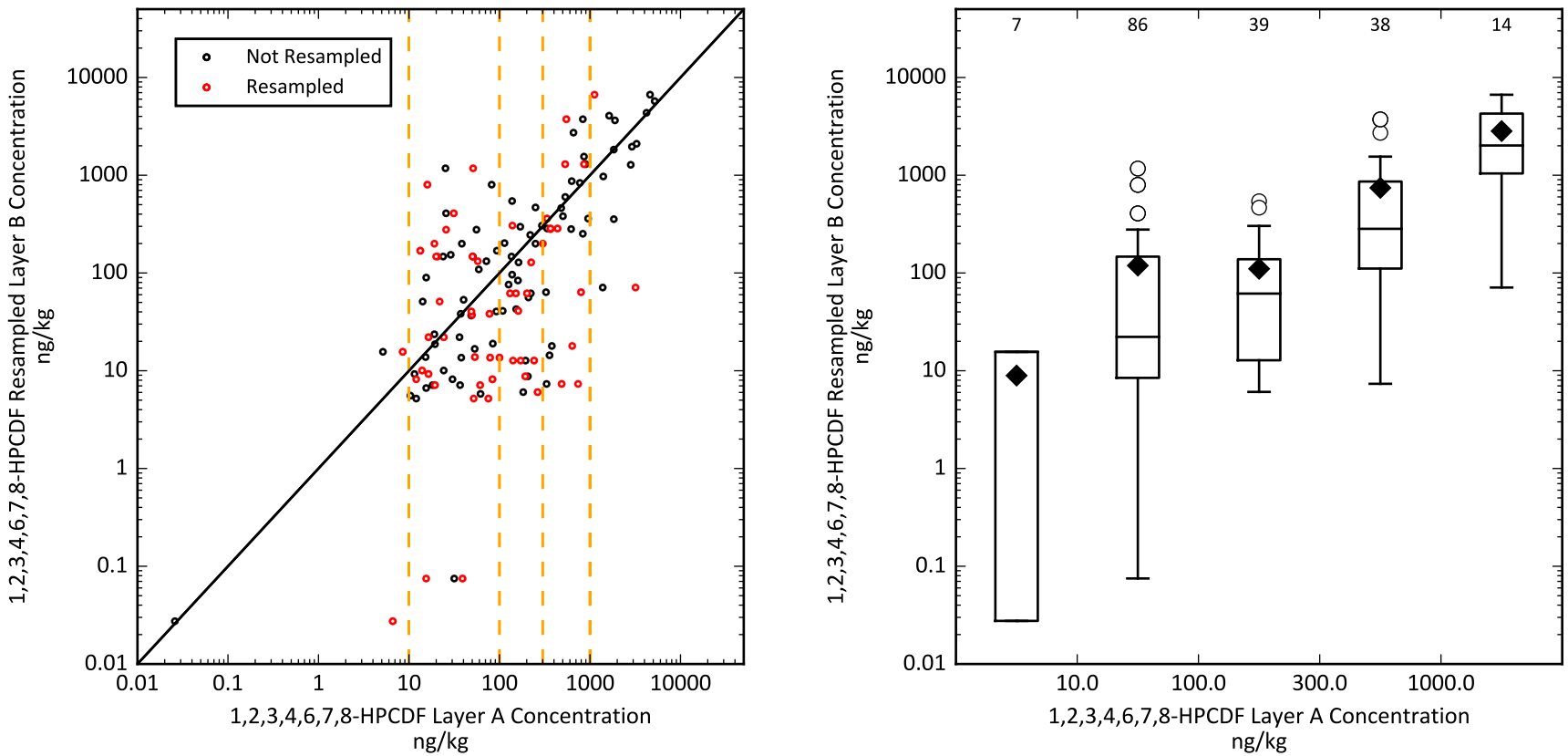
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 2a

1,2,3,4,6,7,8-HPCDF 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

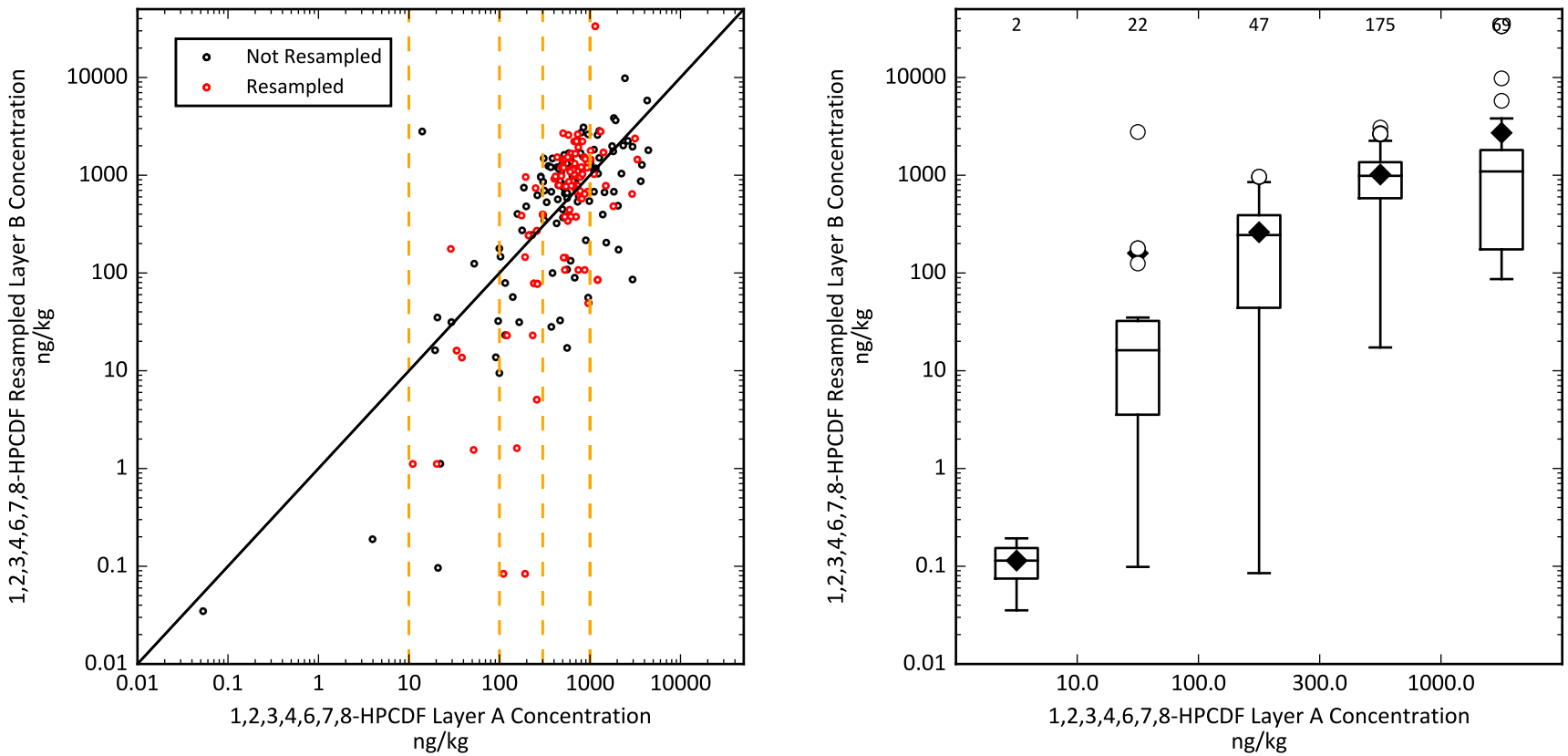
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 2b

1,2,3,4,6,7,8-HPCDF 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

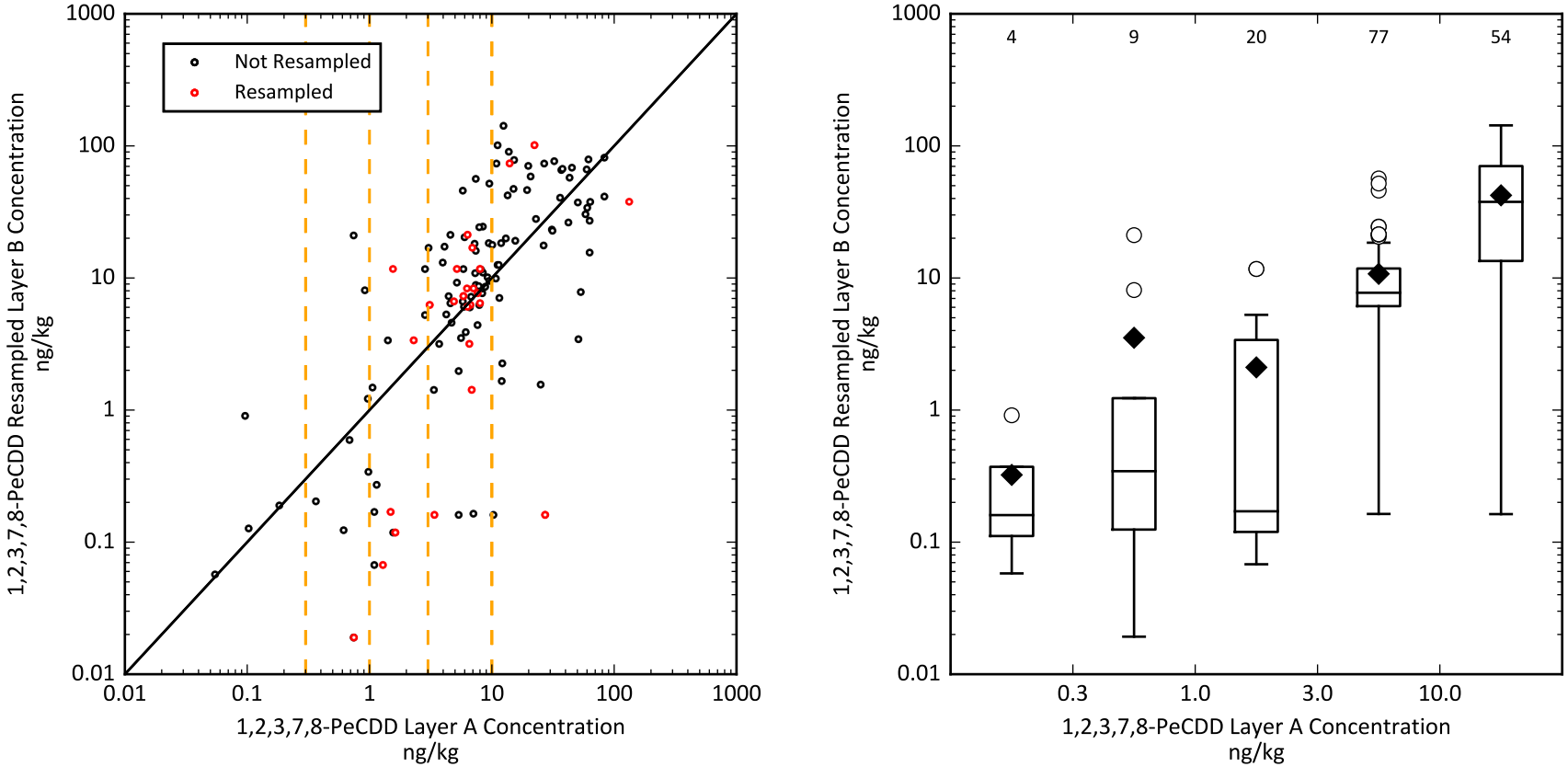
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 2c

1,2,3,4,6,7,8-HPCDF 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
2 Layer B concentrations with a value of zero are not shown.

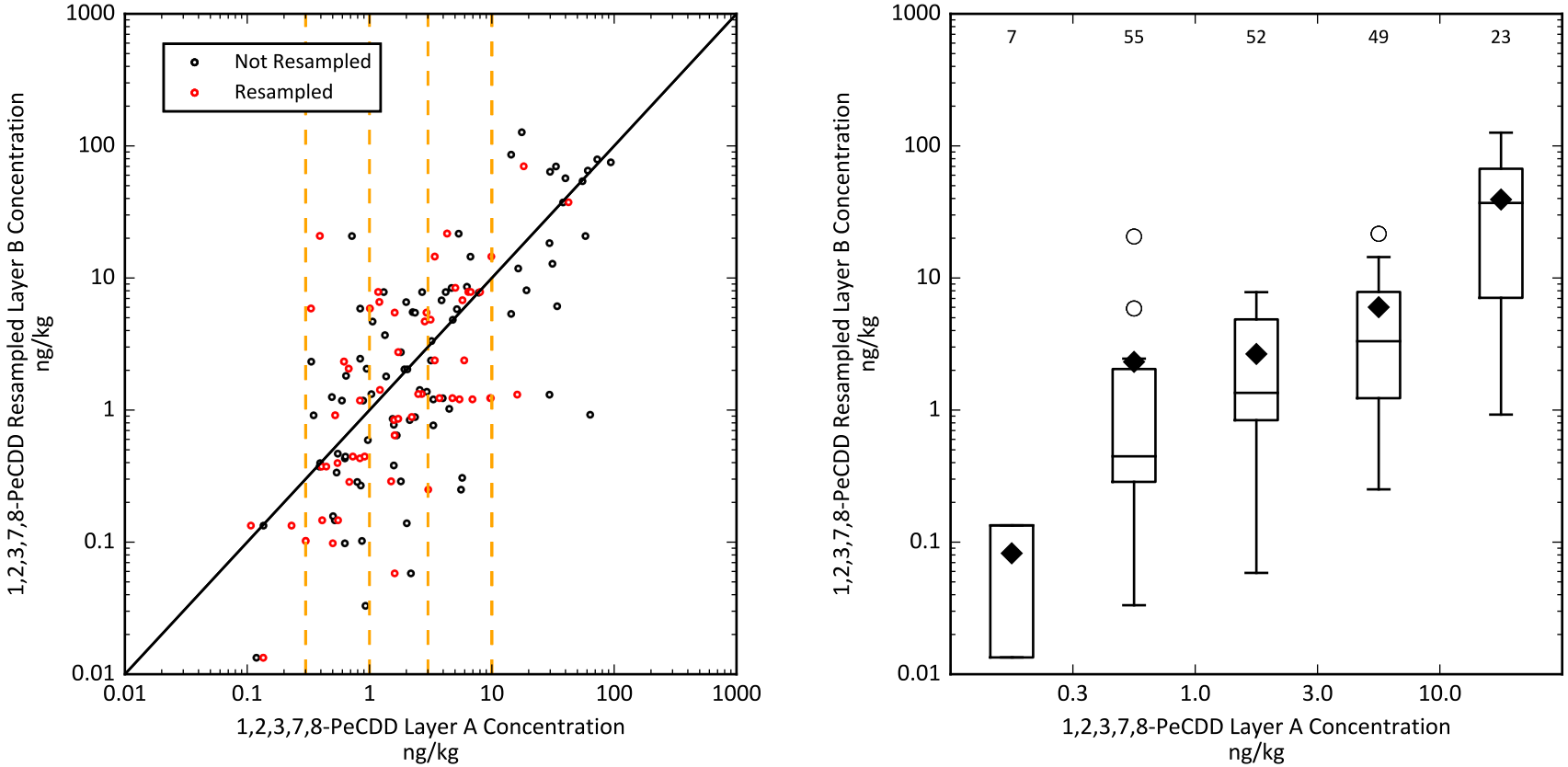
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 3a

1,2,3,7,8-PeCDD 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 3b

1,2,3,7,8-PeCDD 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

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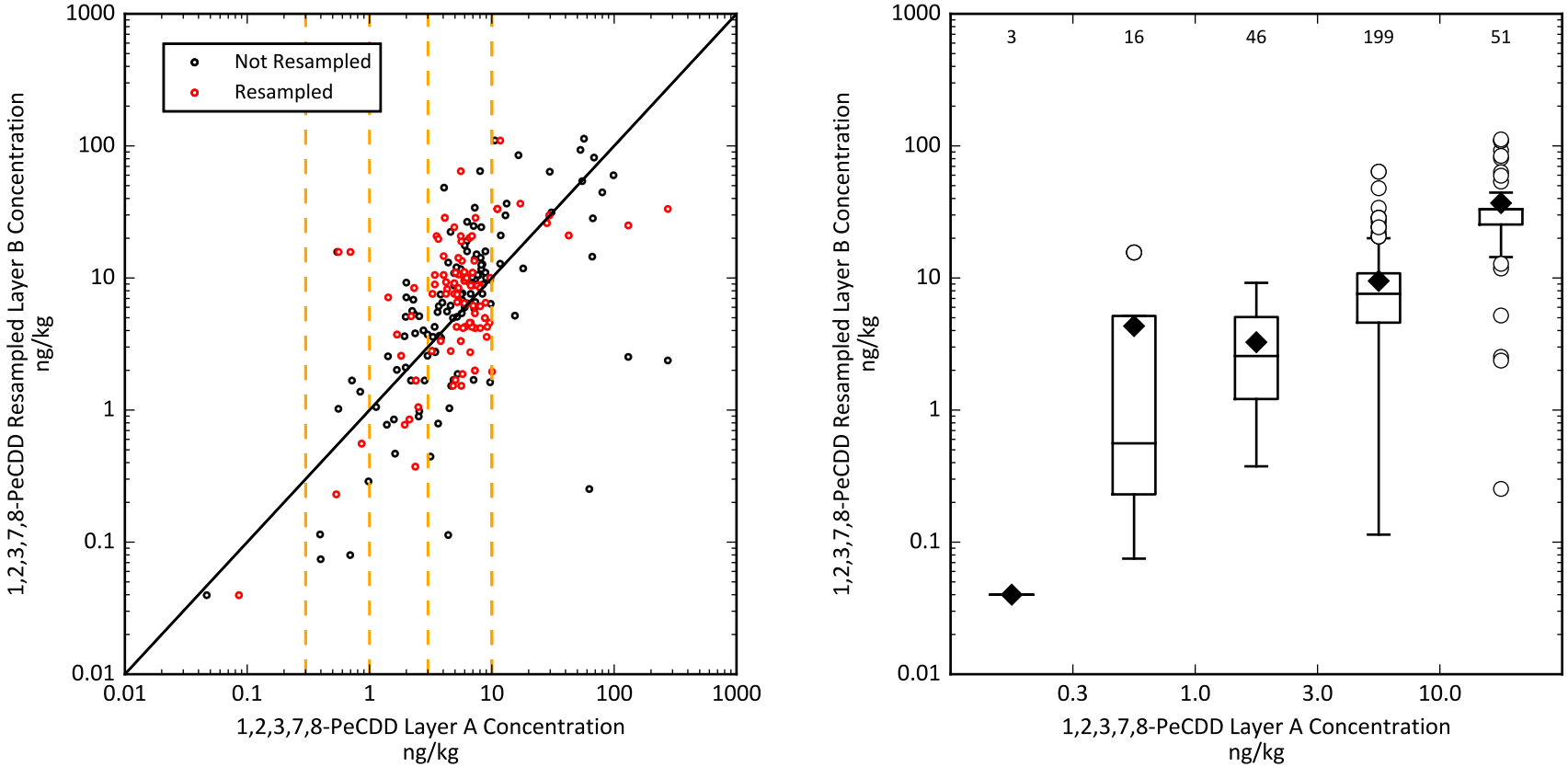
Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

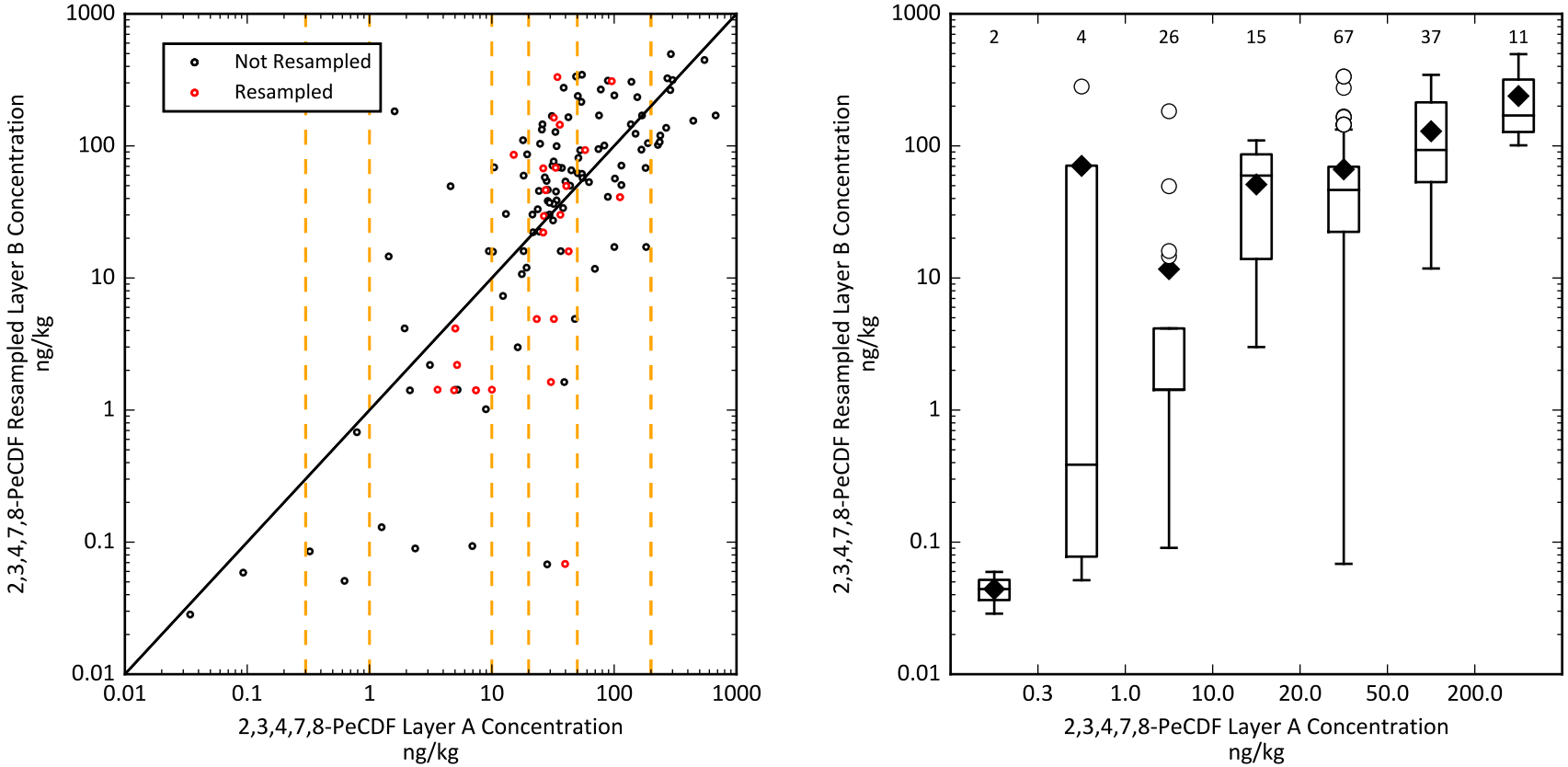
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 3c

1,2,3,7,8-PeCDD 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
2 Layer B concentrations with a value of zero are not shown.

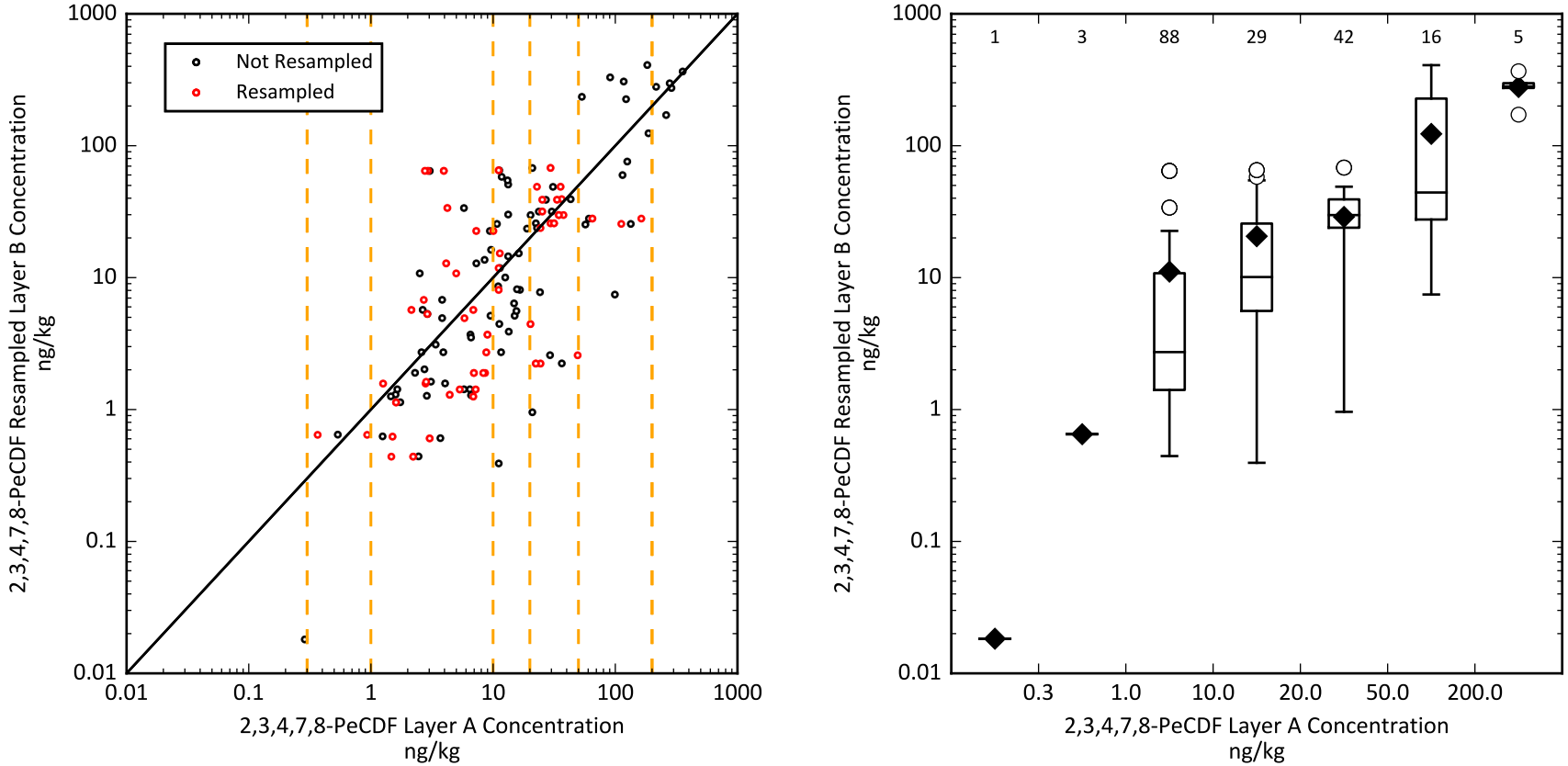
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 4a

2,3,4,7,8-PeCDF 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

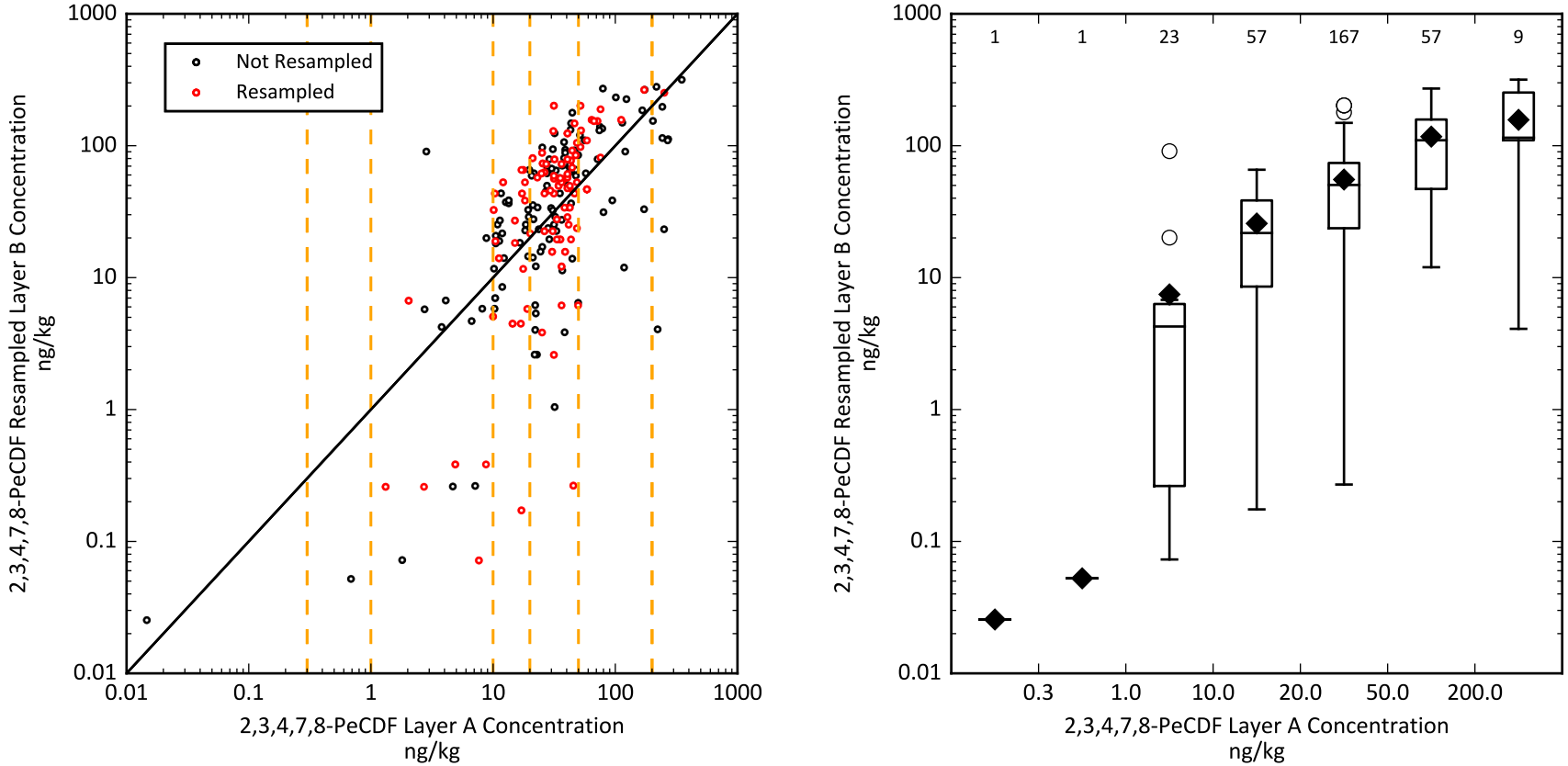
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 4b

2,3,4,7,8-PeCDF 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

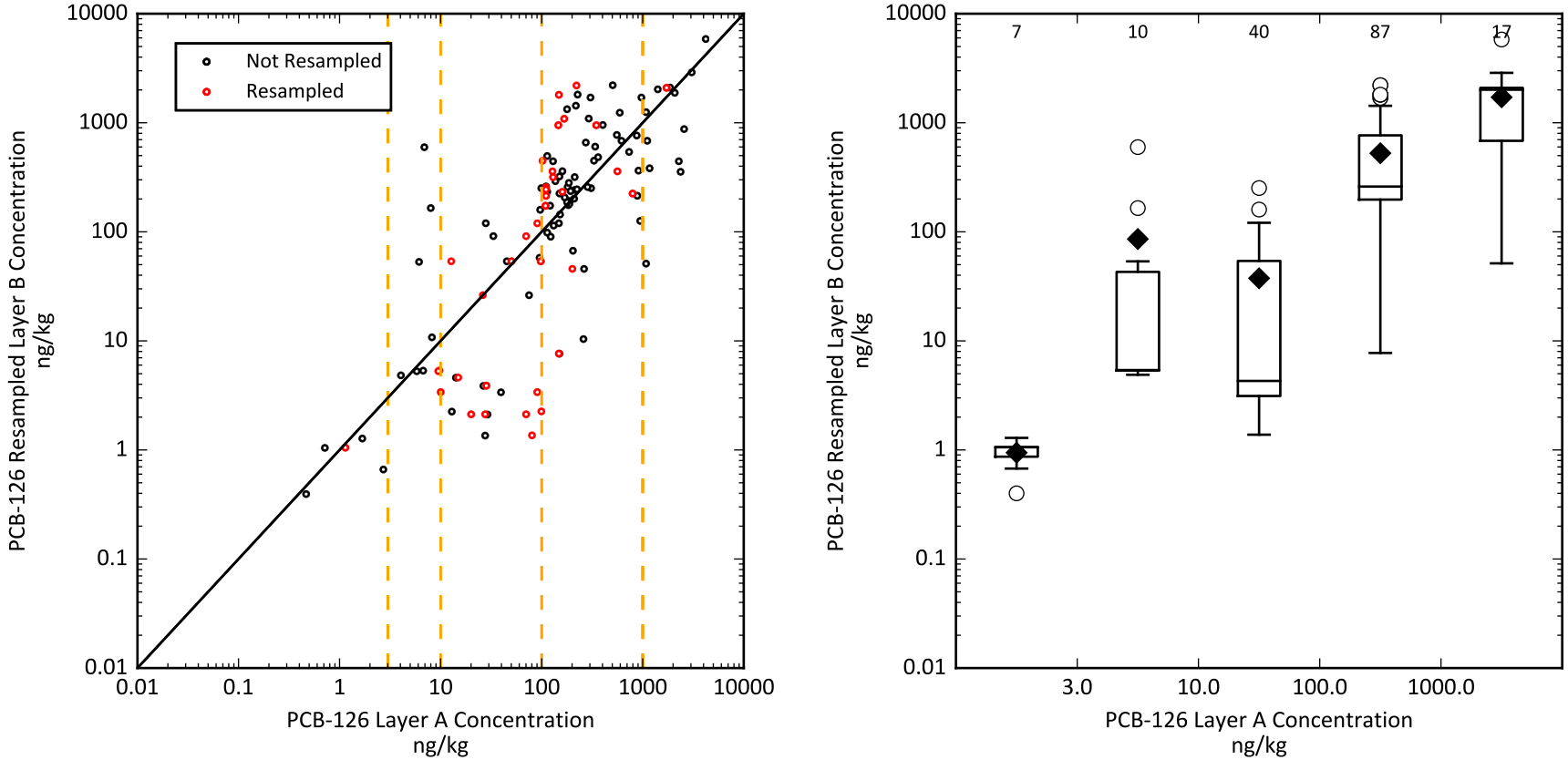
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 4c

2,3,4,7,8-PeCDF 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
3 Layer B concentrations with a value of zero are not shown.

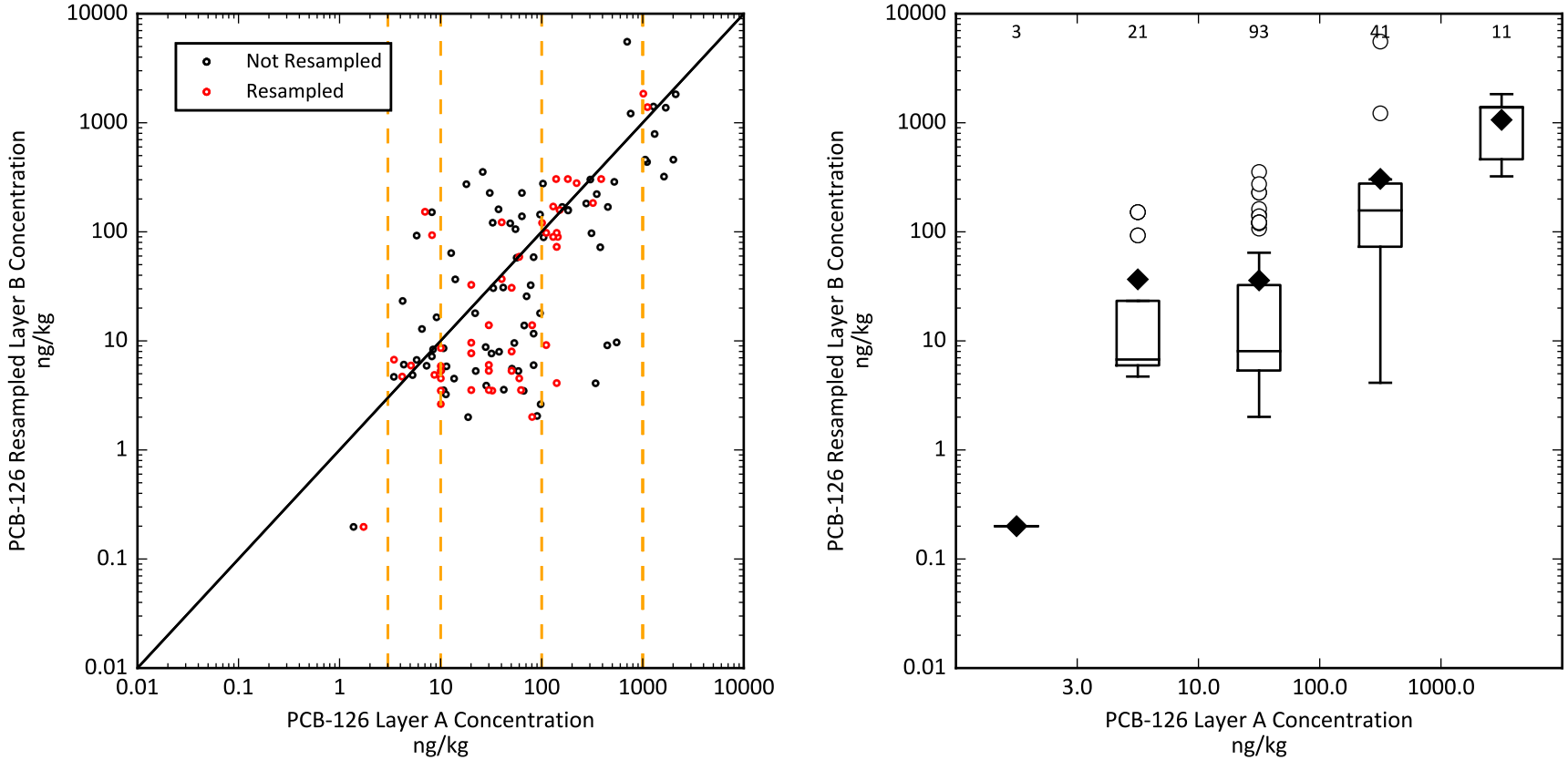
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 5a

PCB-126 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

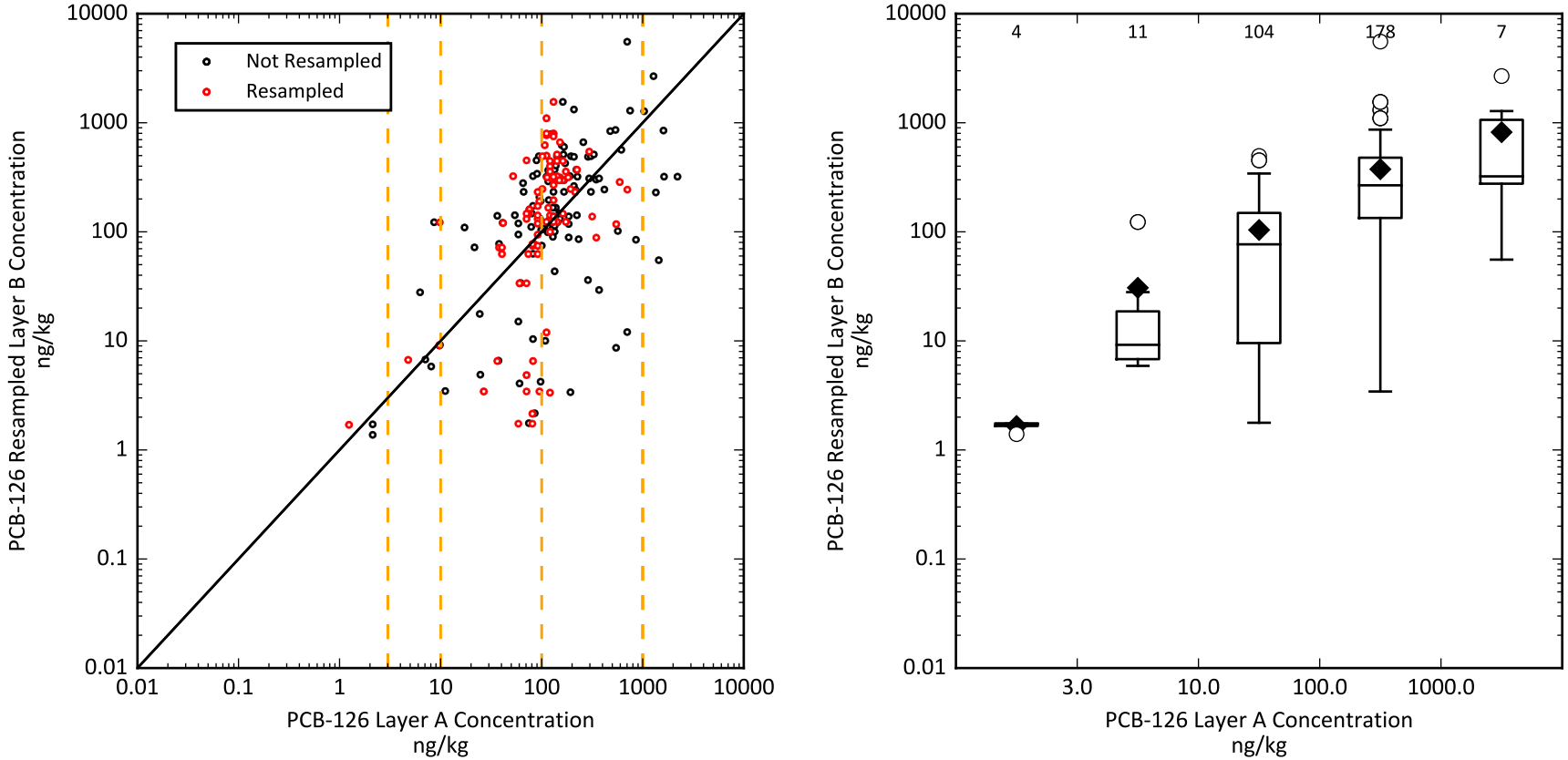
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 5b

PCB-126 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

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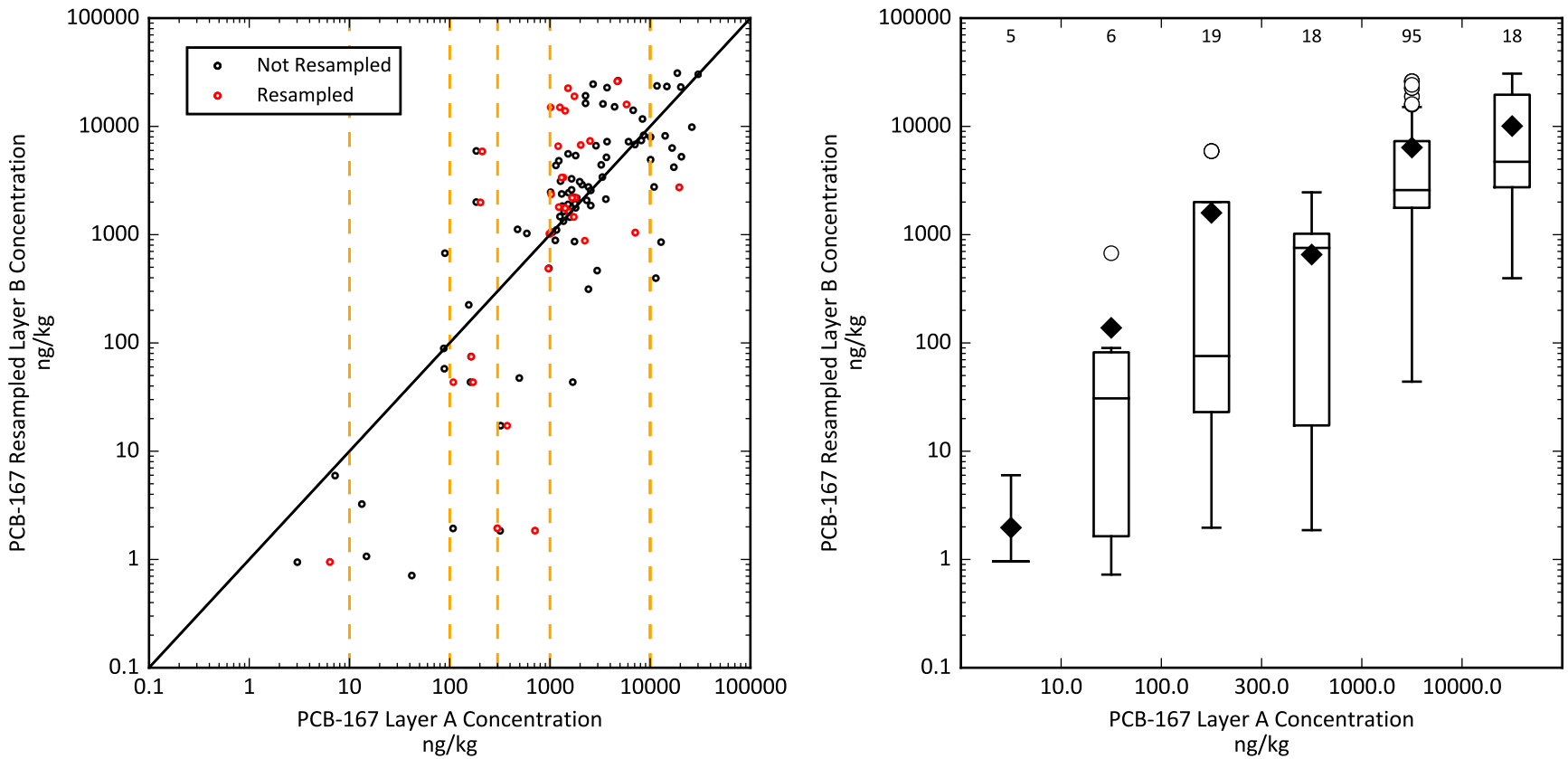
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 5c

PCB-126 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
3 Layer B concentrations with a value of zero are not shown.

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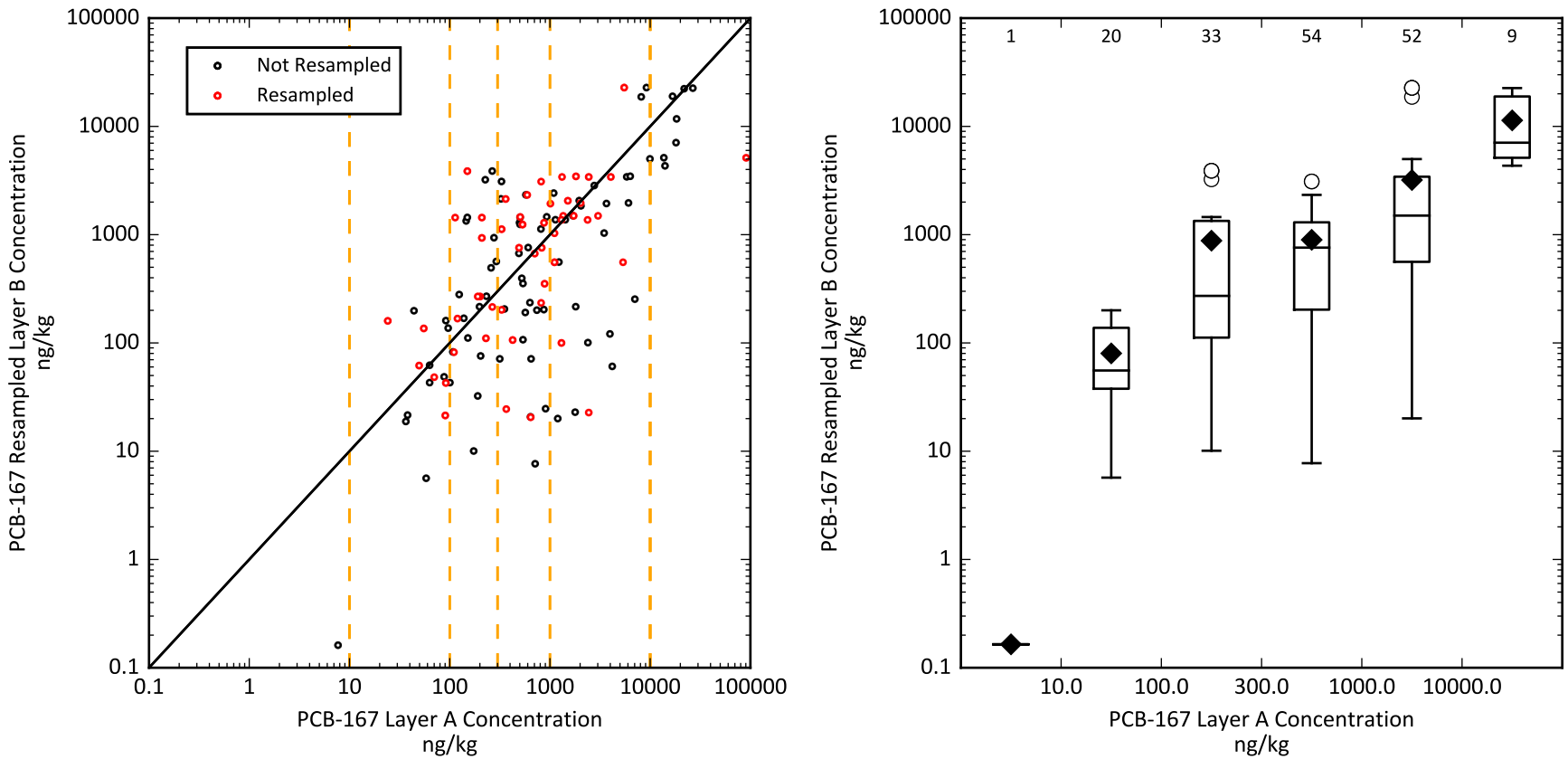
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 6a

PCB-167 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

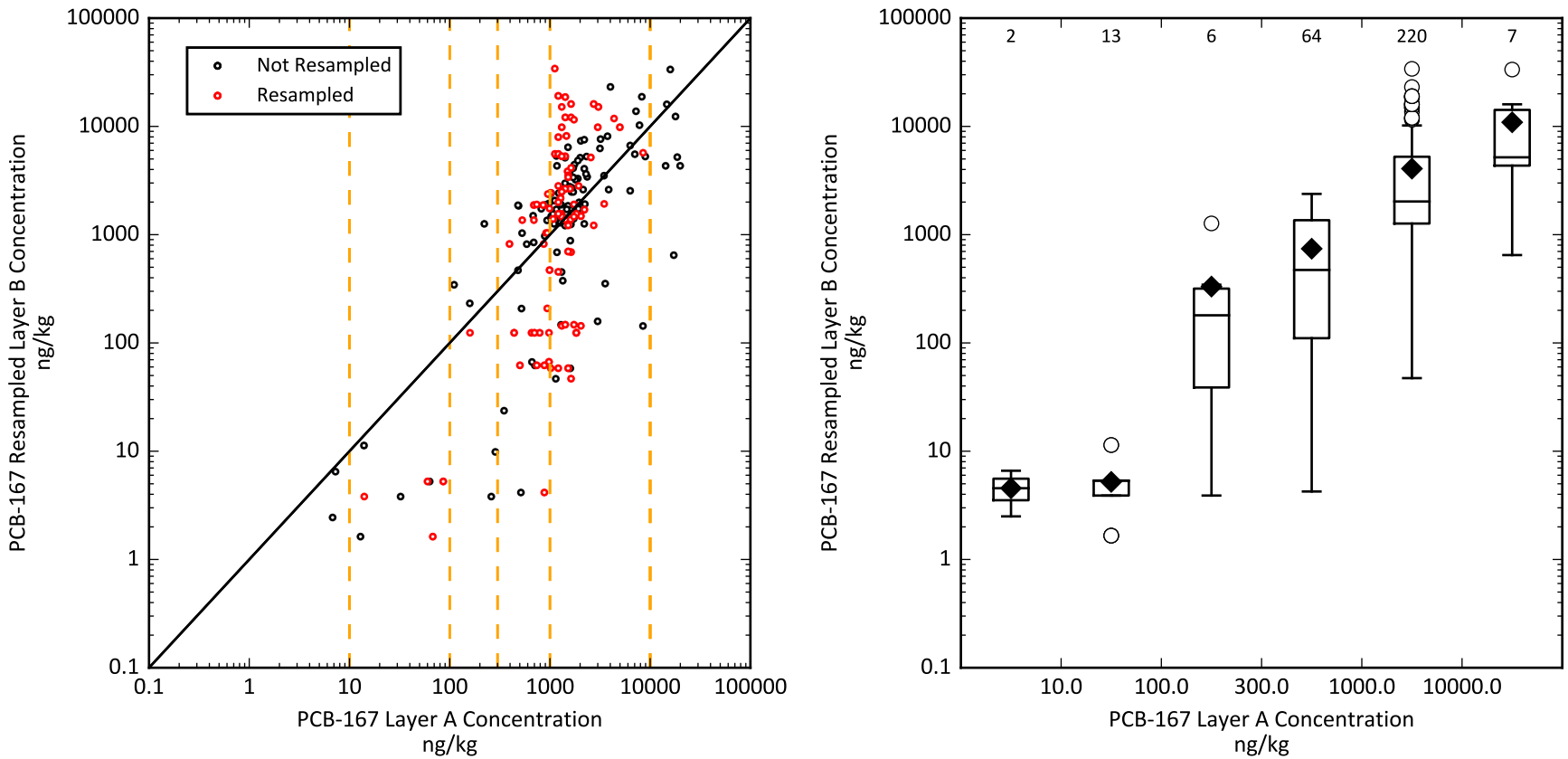
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 6b

PCB-167 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

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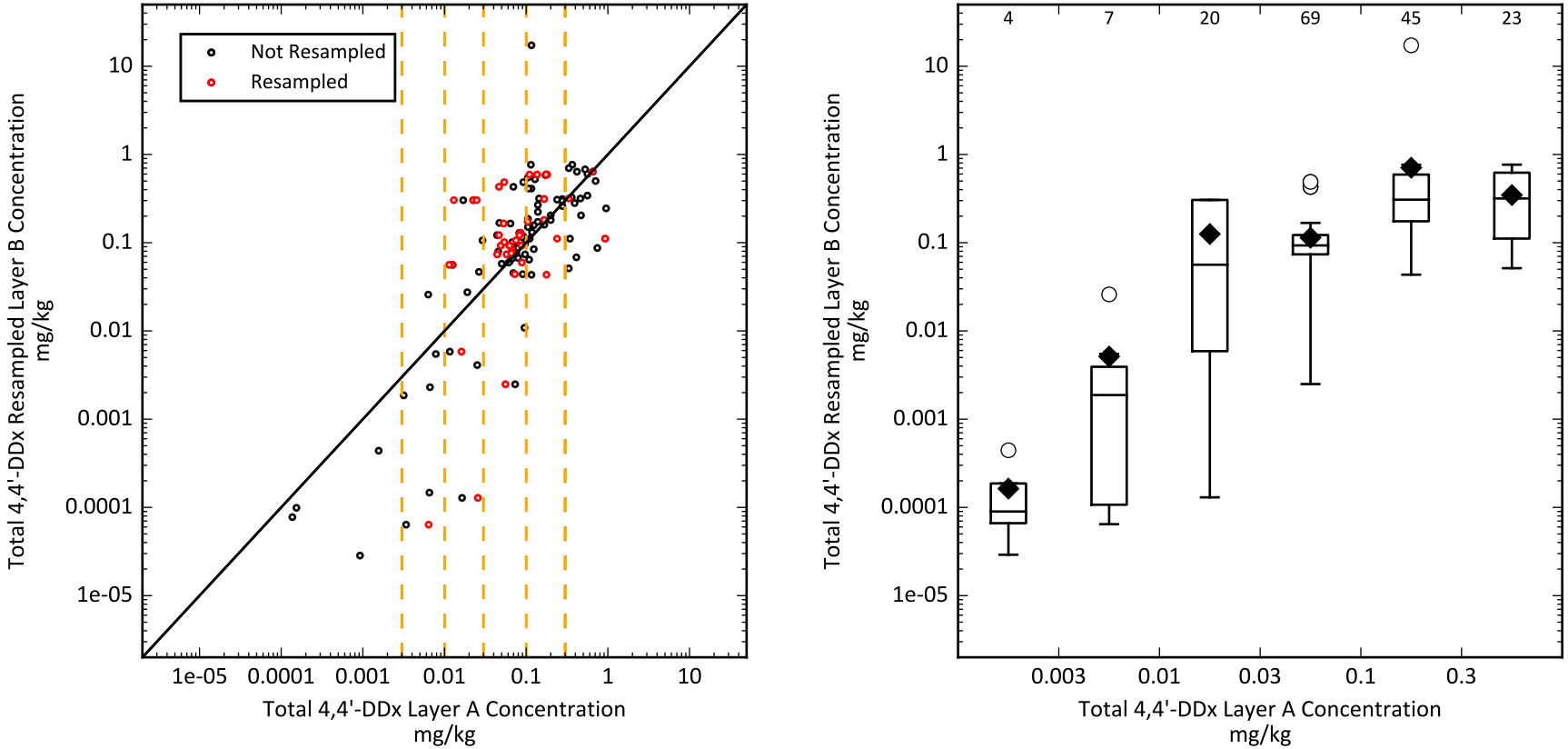
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 6c

PCB-167 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
2 Layer B concentrations with a value of zero are not shown.

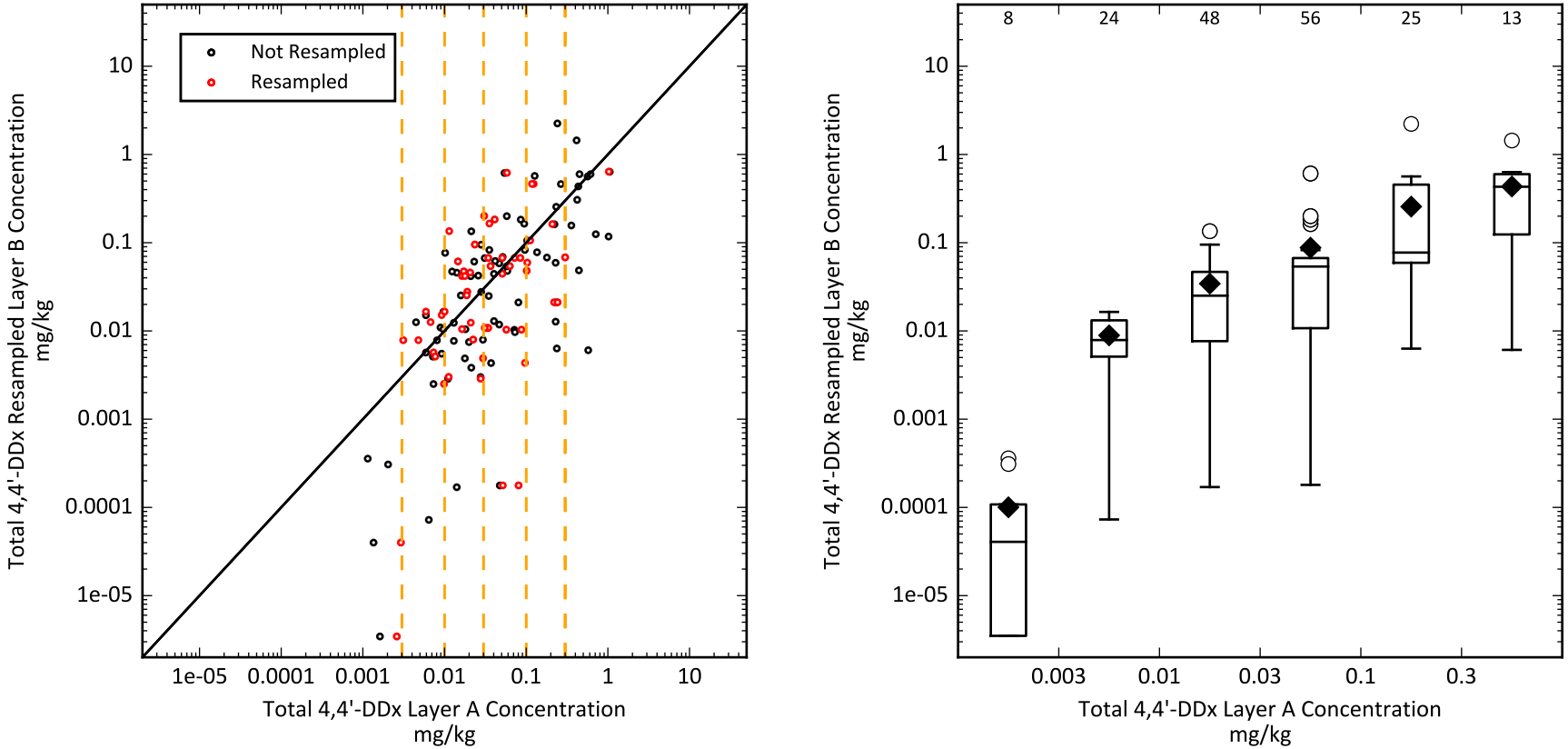
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 7a

Total 4,4'-DDx 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
48 Layer B concentrations with a value of zero are not shown.

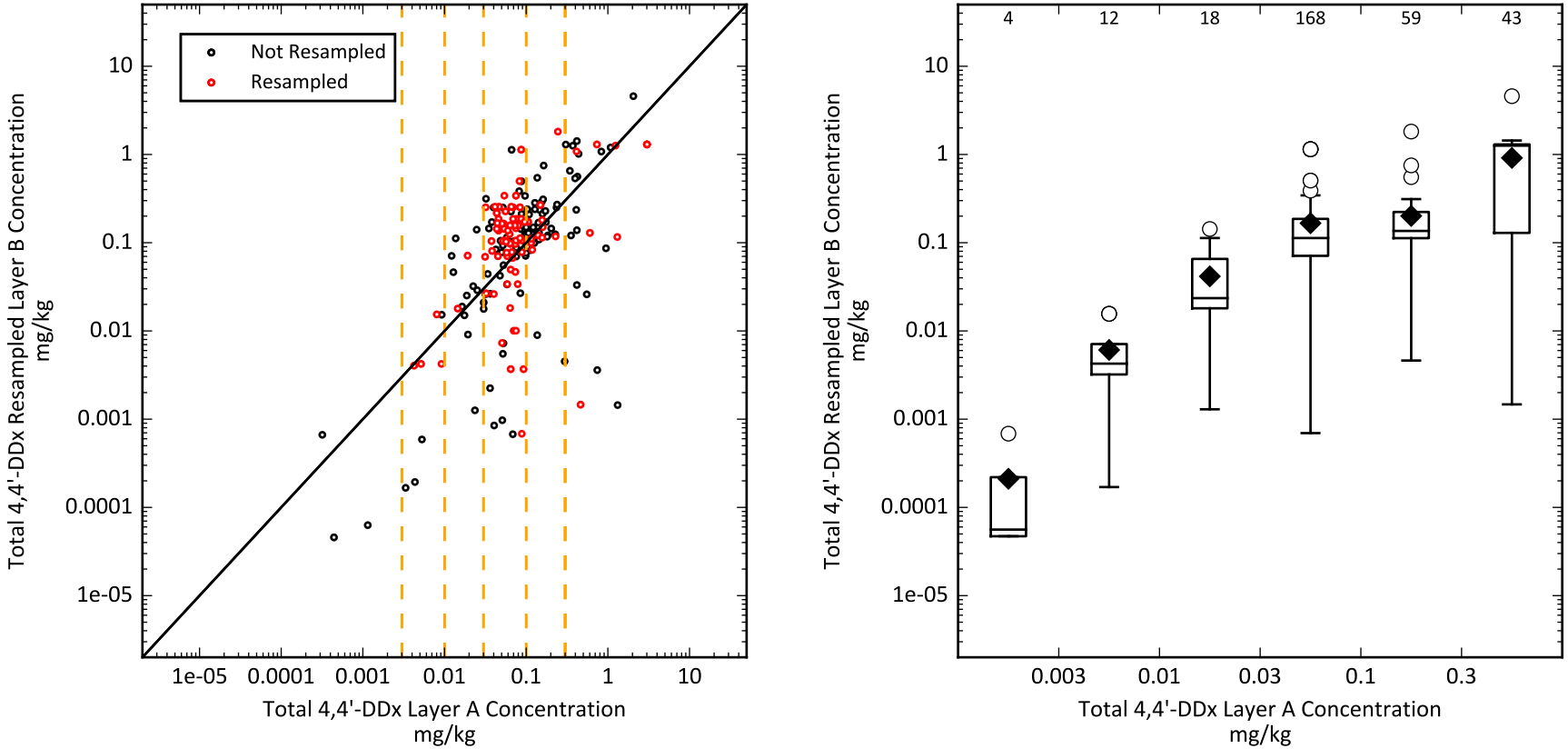
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 7b

Total 4,4'-DDx 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

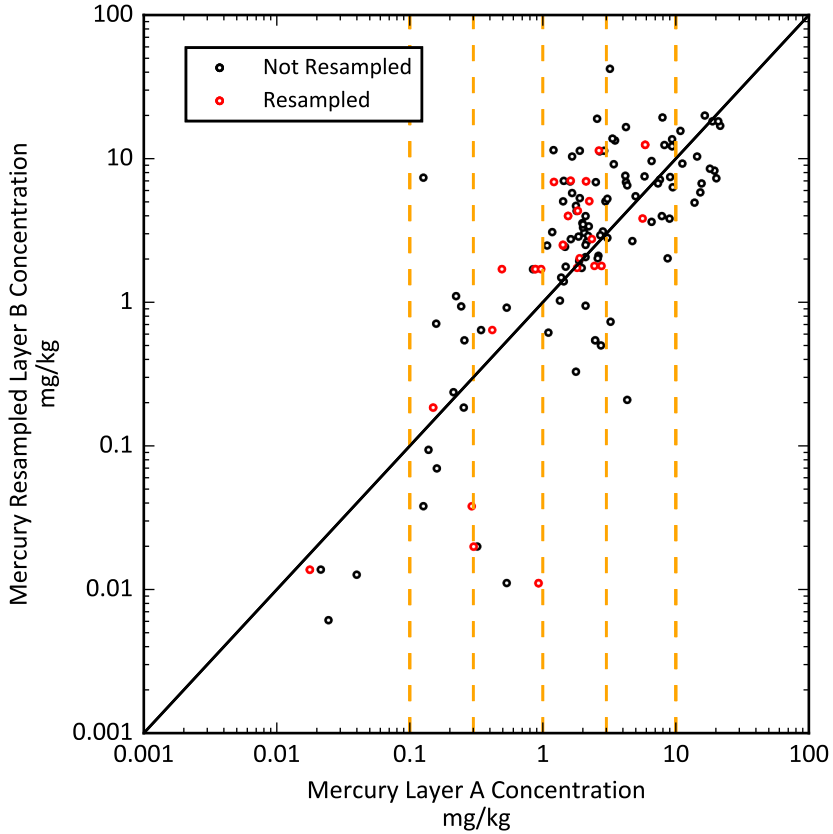
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

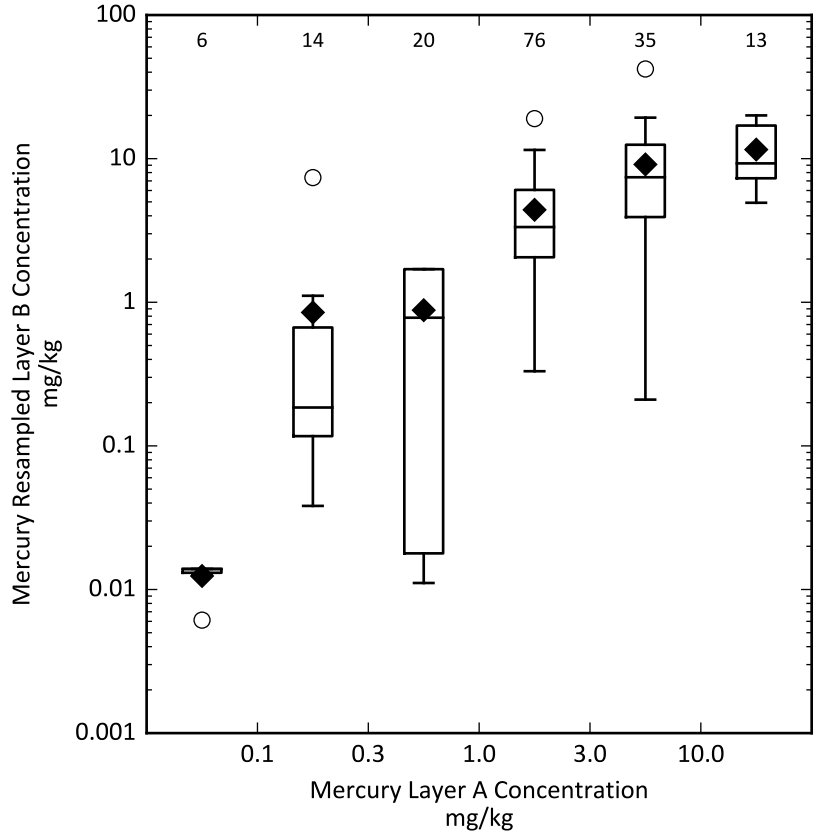
Figure 7c

Total 4,4'-DDx 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
2 Layer B concentrations with a value of zero are not shown.

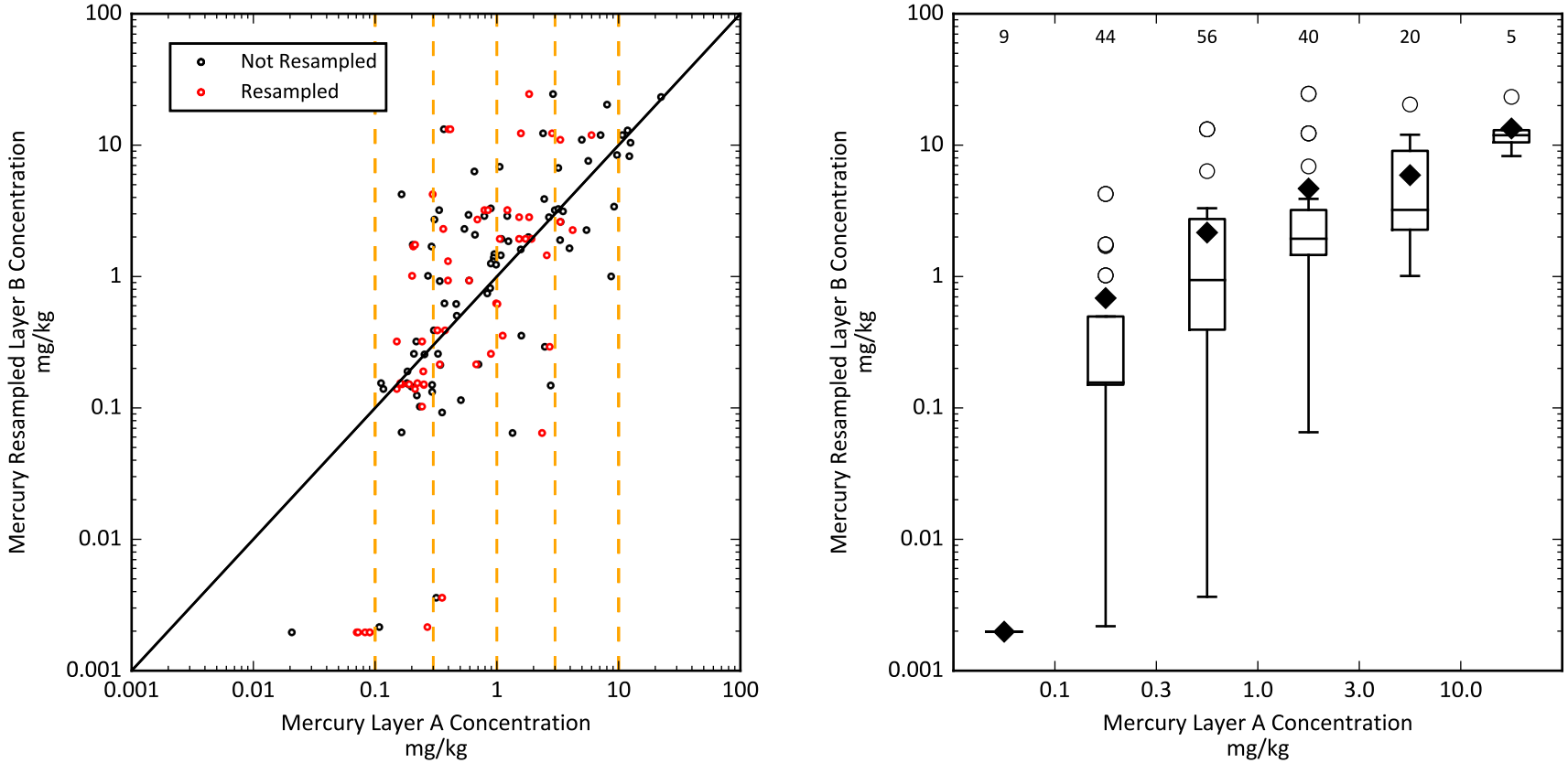
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 8a

Mercury 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 2010 dataset.
48 Layer B concentrations with a value of zero are not shown.

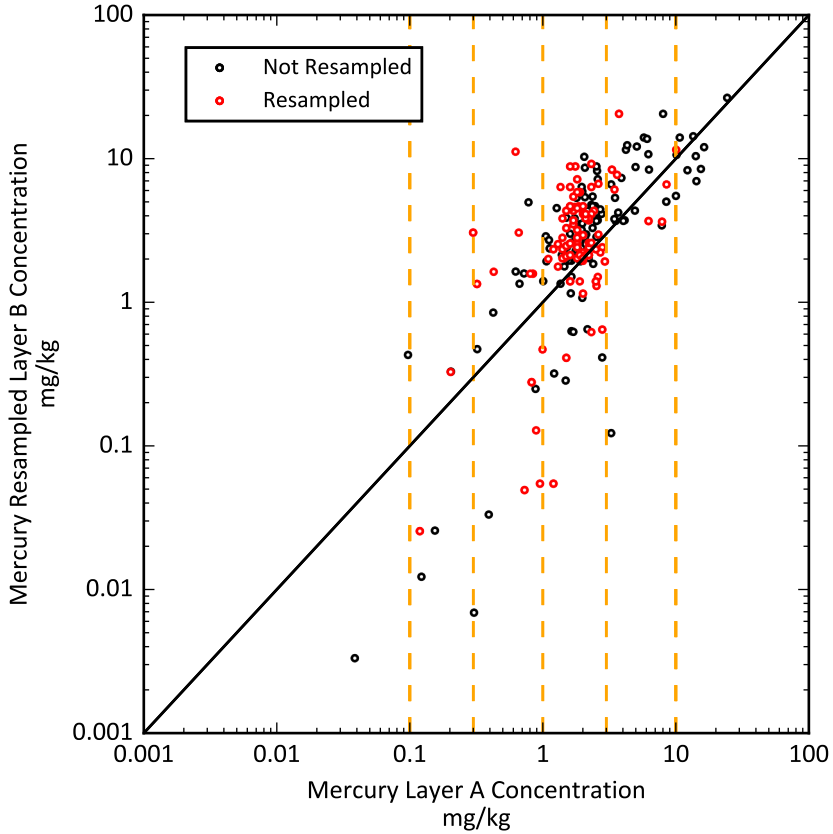
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

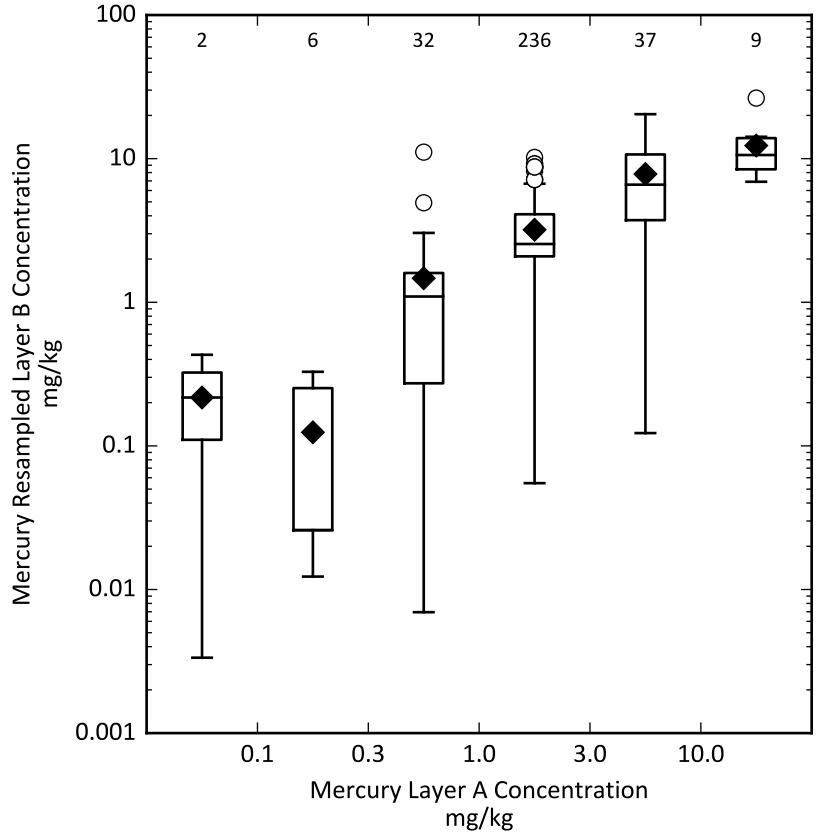
Figure 8b

Mercury 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

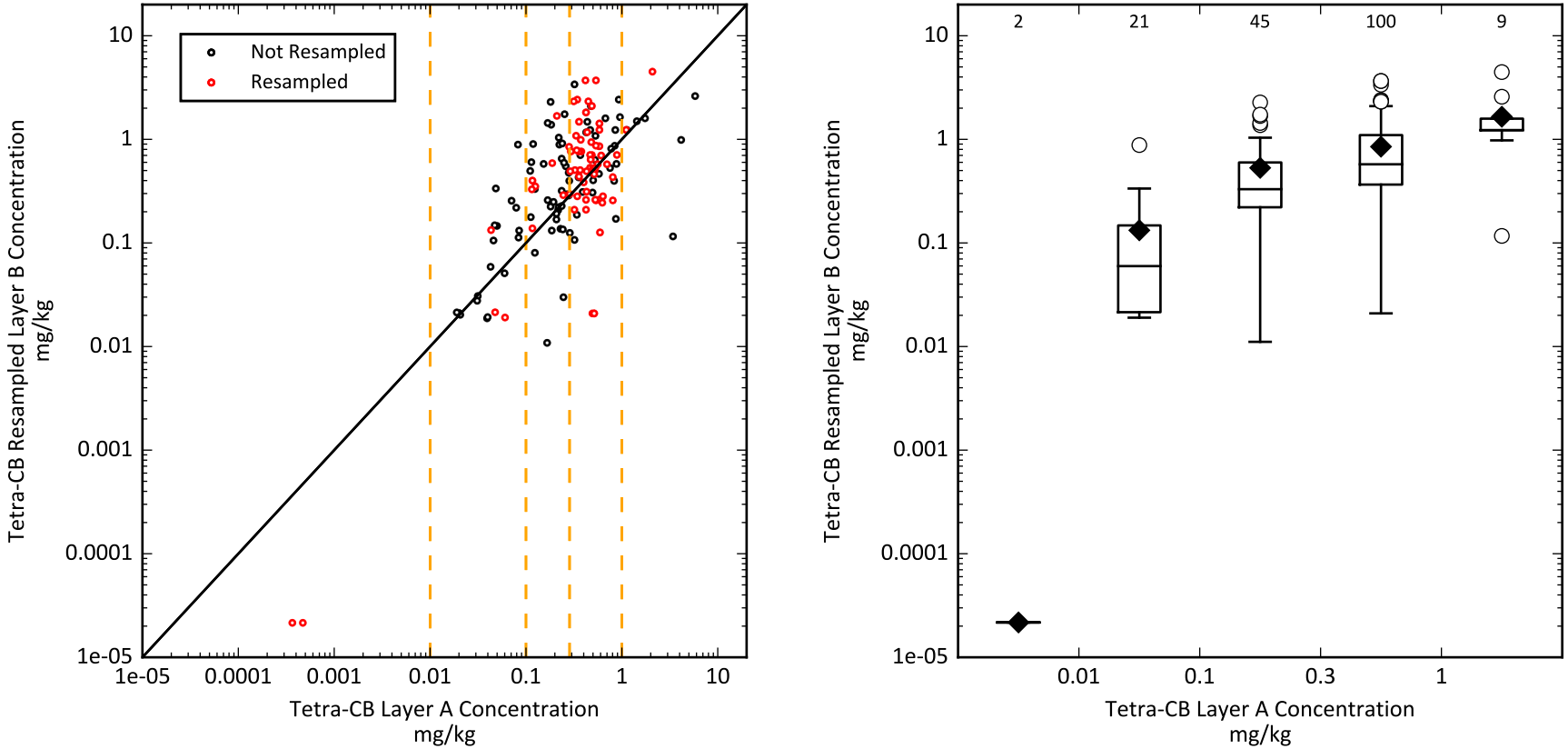
Publish Date: 06/19/2019 15:29 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 8c

Mercury 2010 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

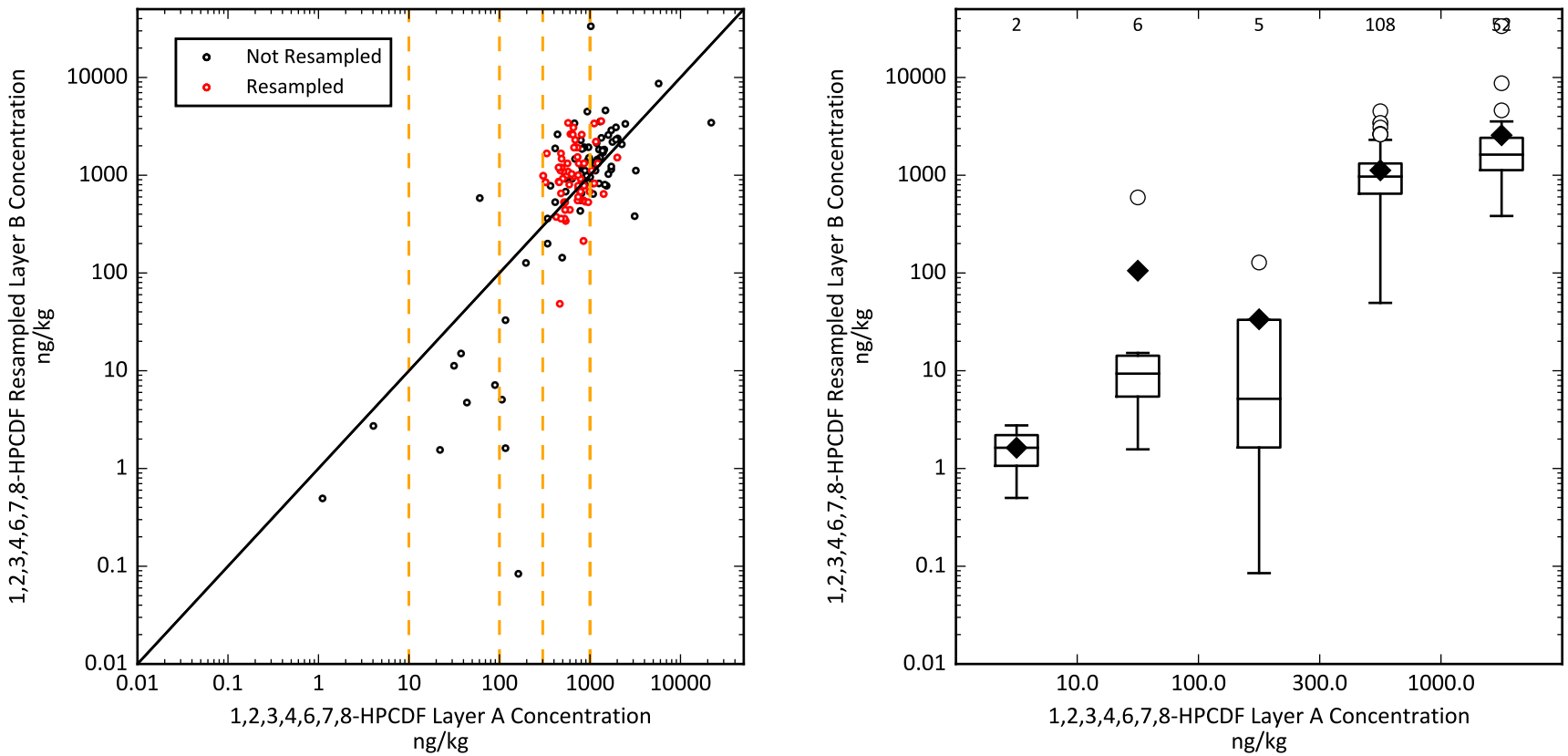
Publish Date: 06/19/2019 15:21 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 9

Tetra-CB 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

Publish Date: 06/19/2019 15:21 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 10

1,2,3,4,6,7,8-HPCDF 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

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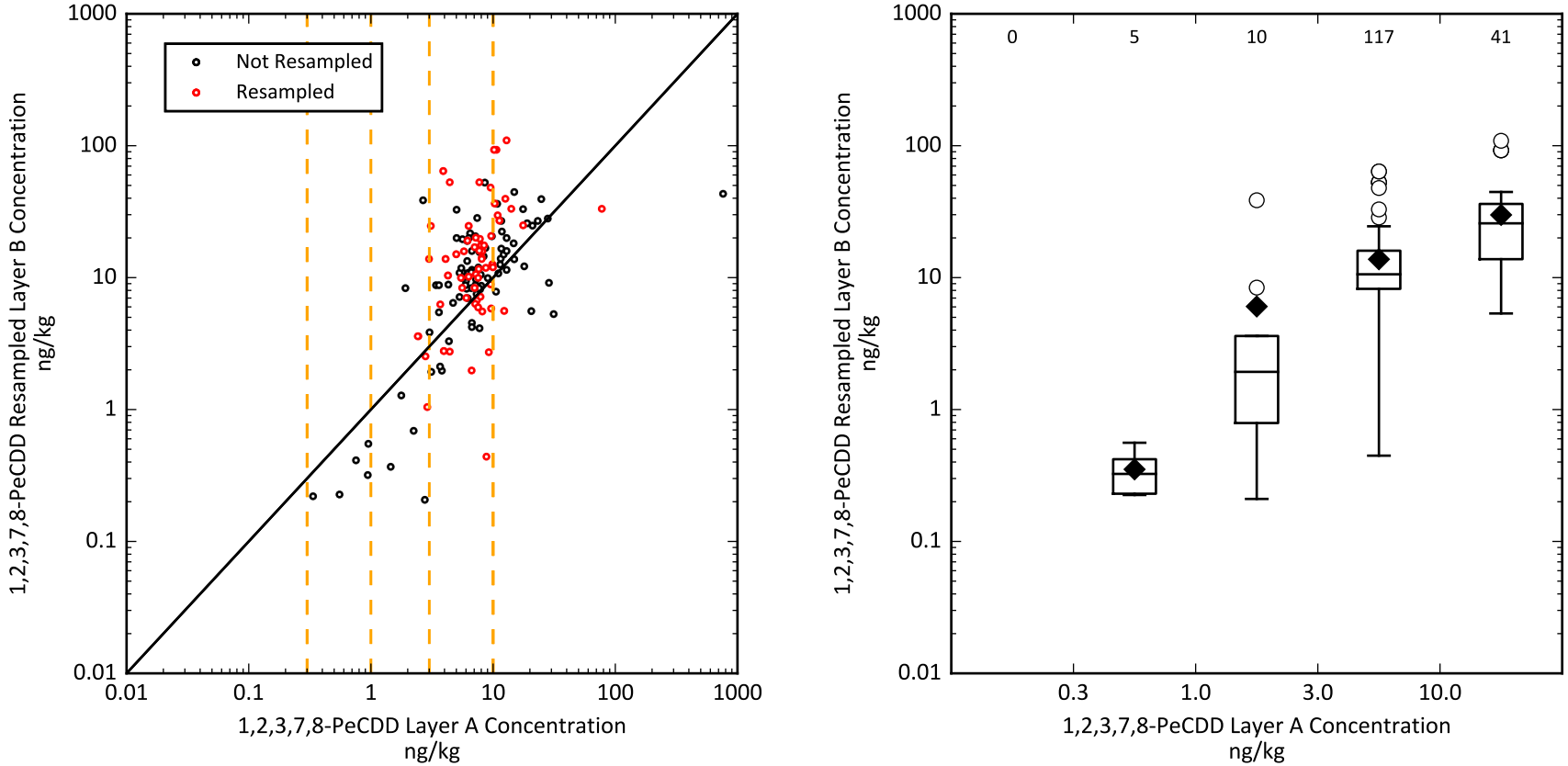
Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

Publish Date: 06/19/2019 15:21 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 11

1,2,3,7,8-PeCDD 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

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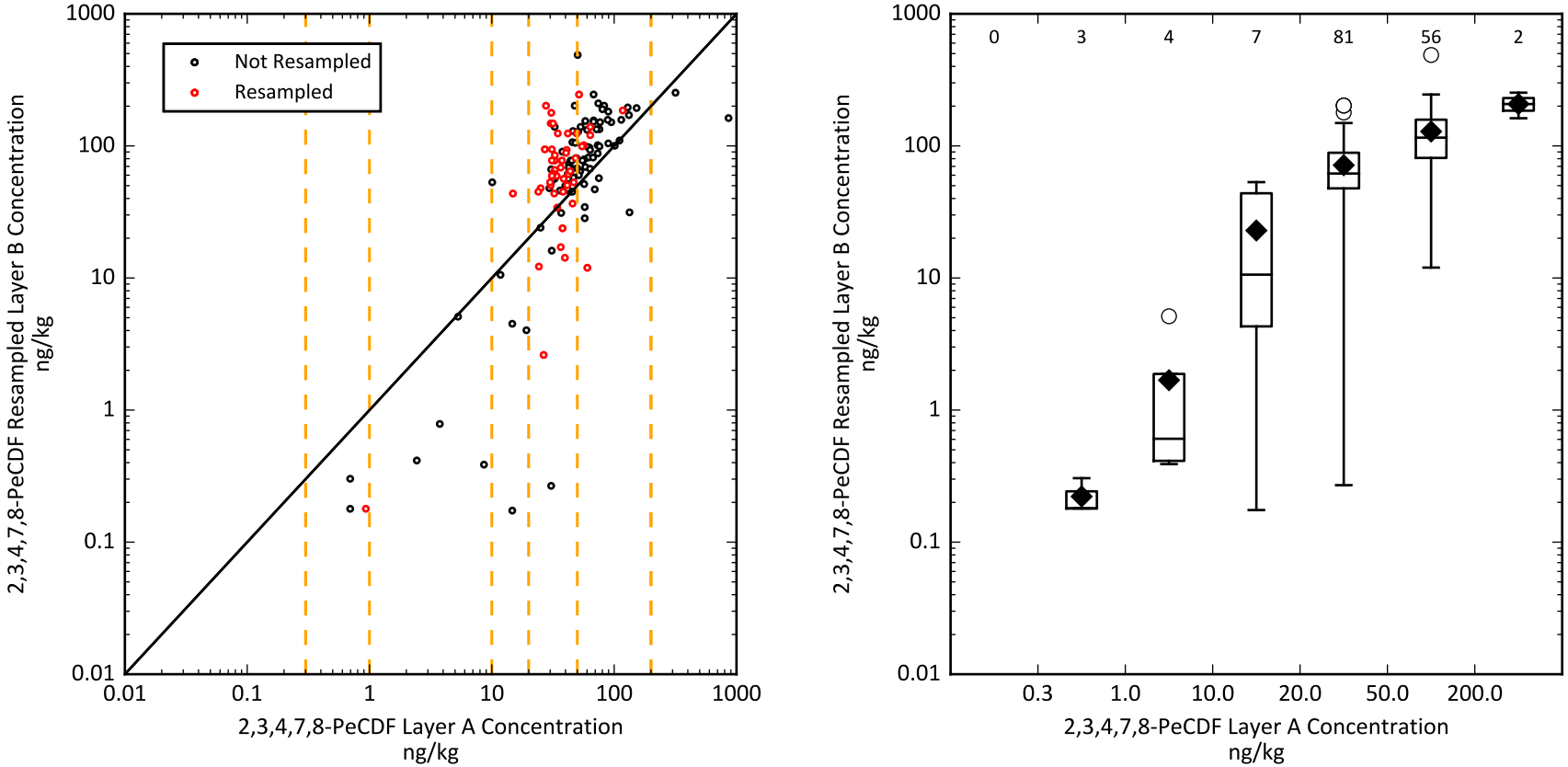
Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

Publish Date: 06/19/2019 15:21 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 12

2,3,4,7,8-PeCDF 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

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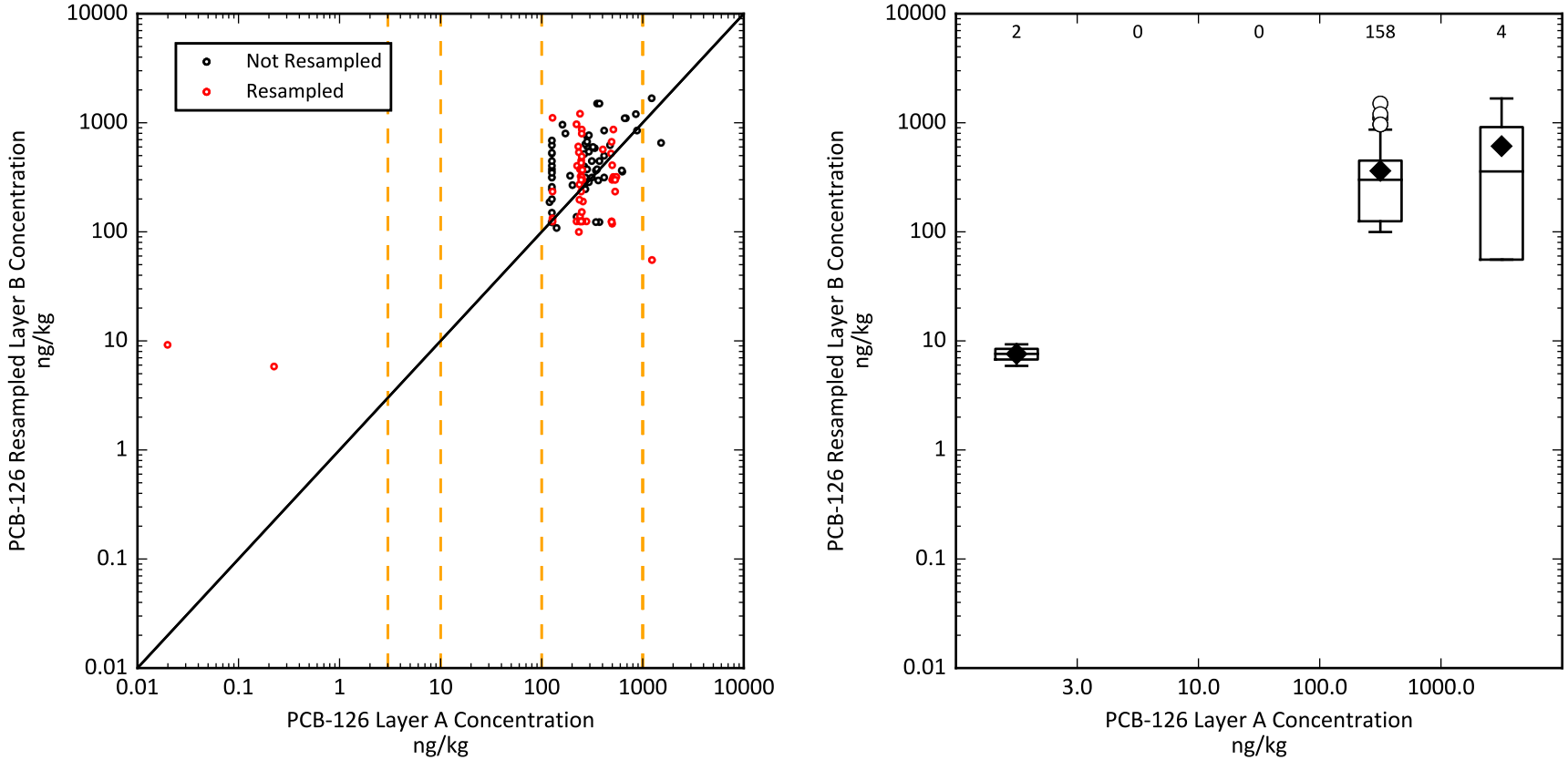

Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

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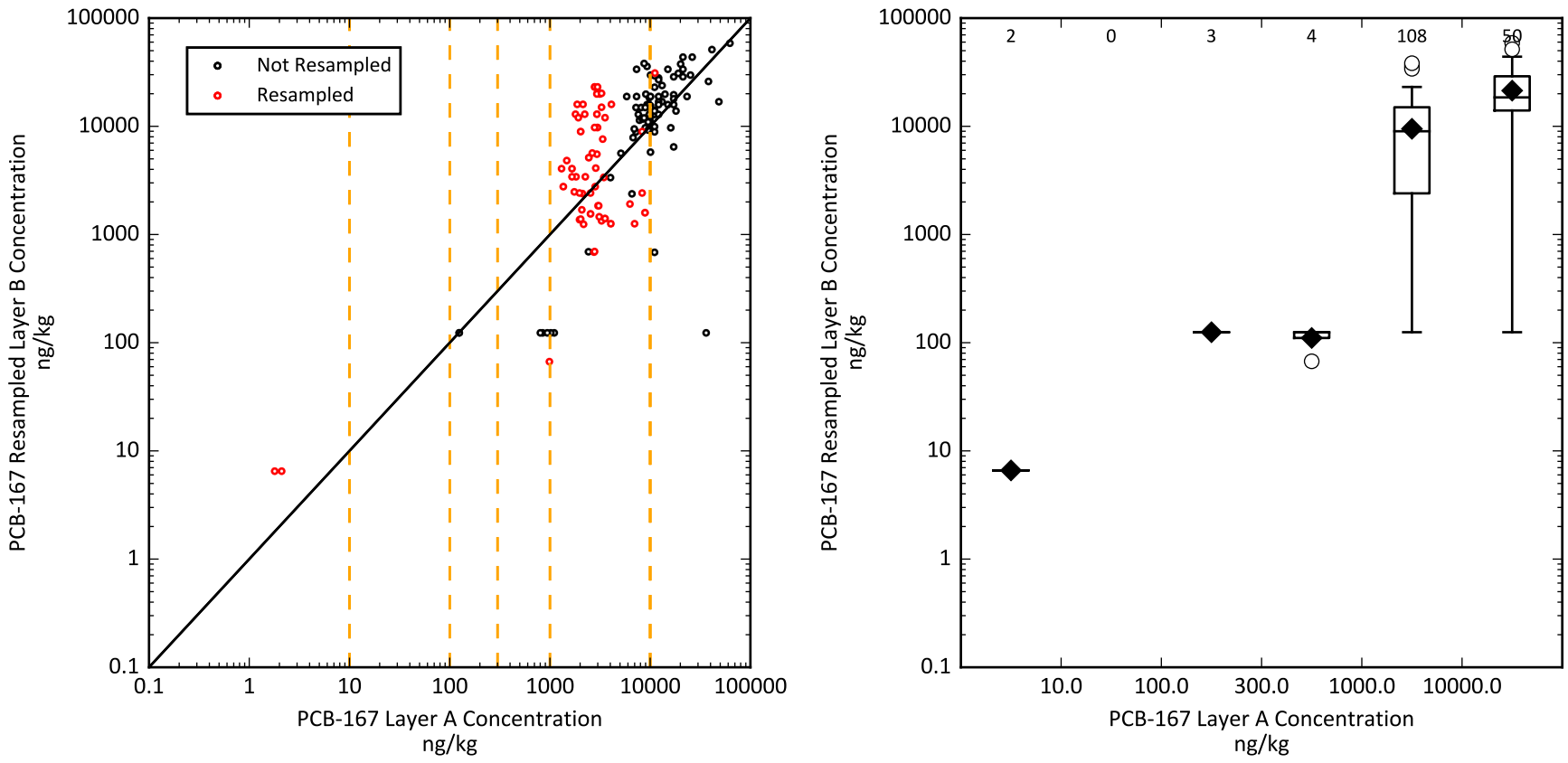
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 13

PCB-126 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

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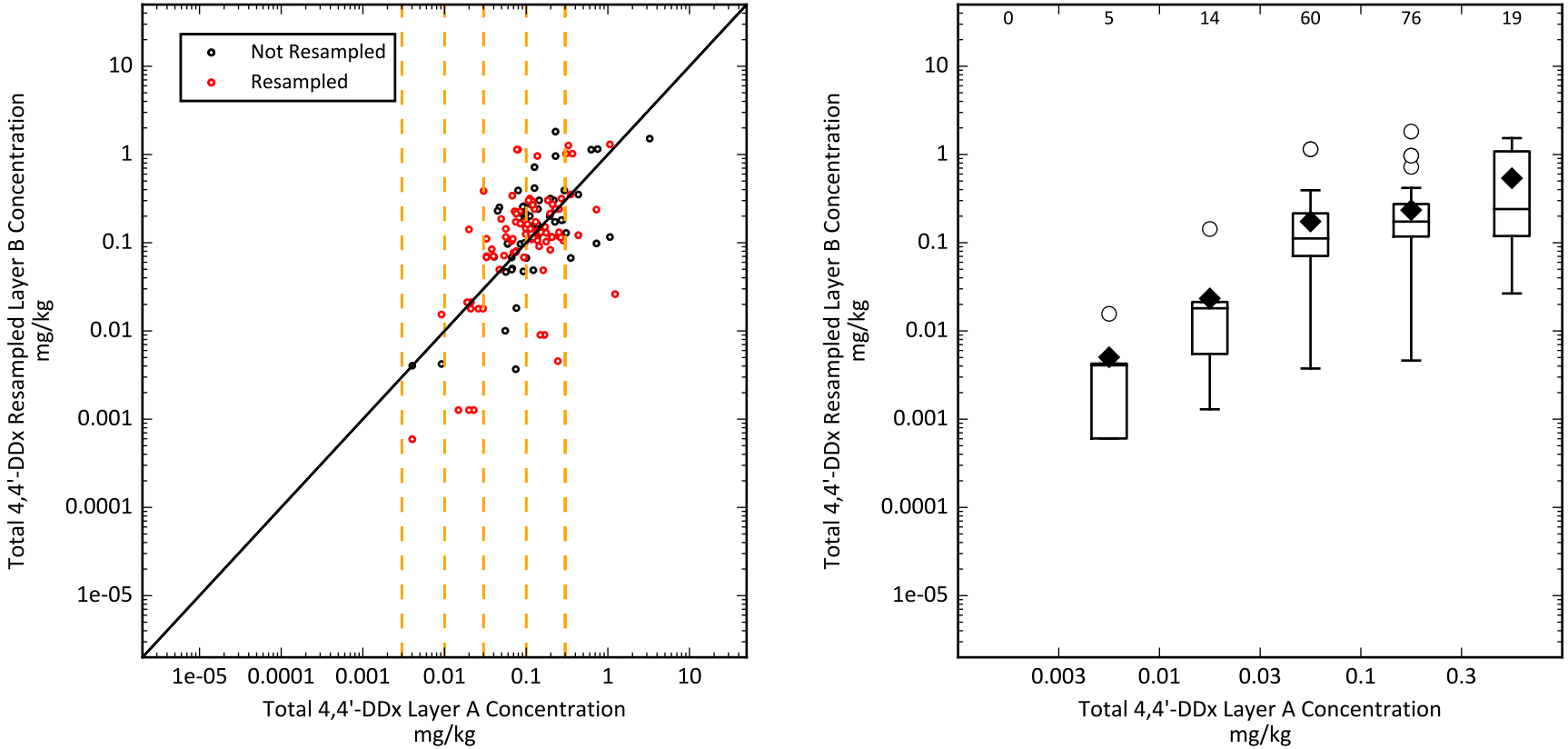
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 14

PCB-167 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

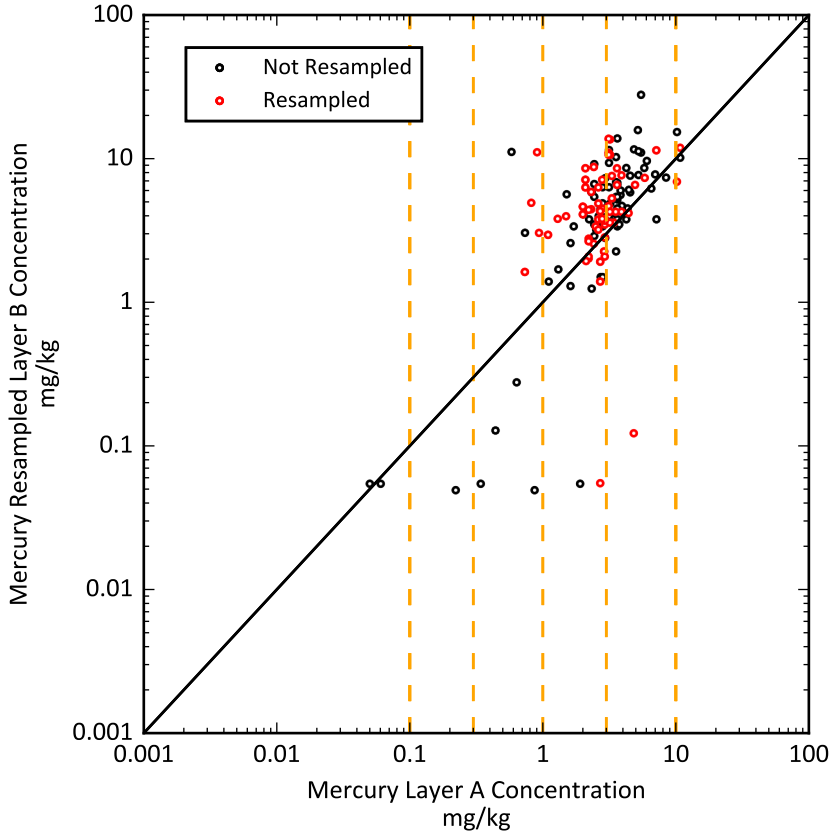
Publish Date: 06/19/2019 15:22 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

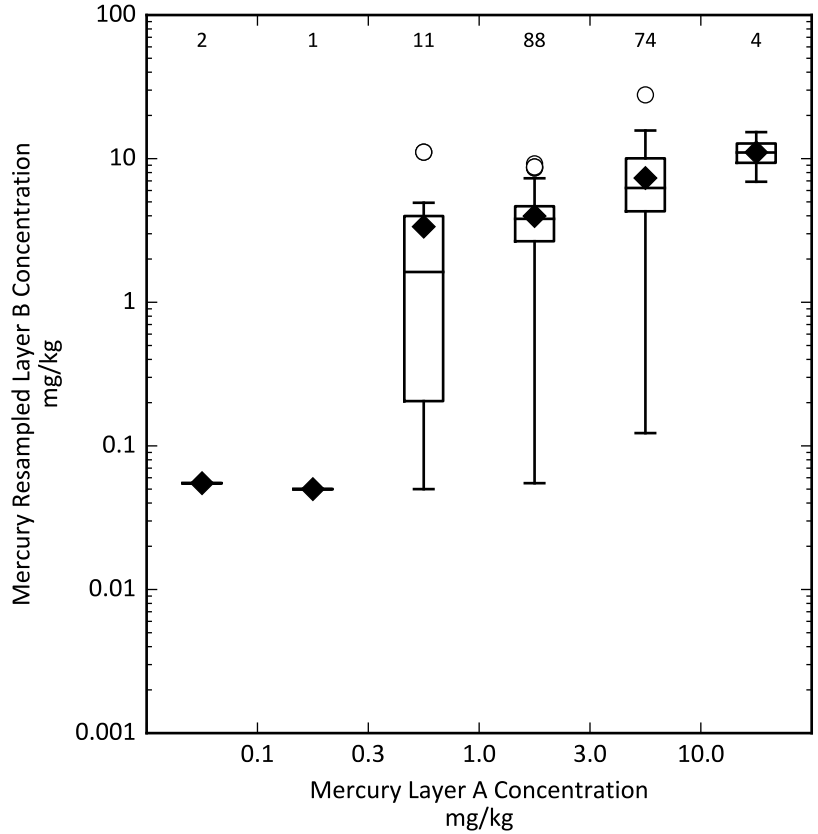
Figure 15

Total 4,4'-DDx 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

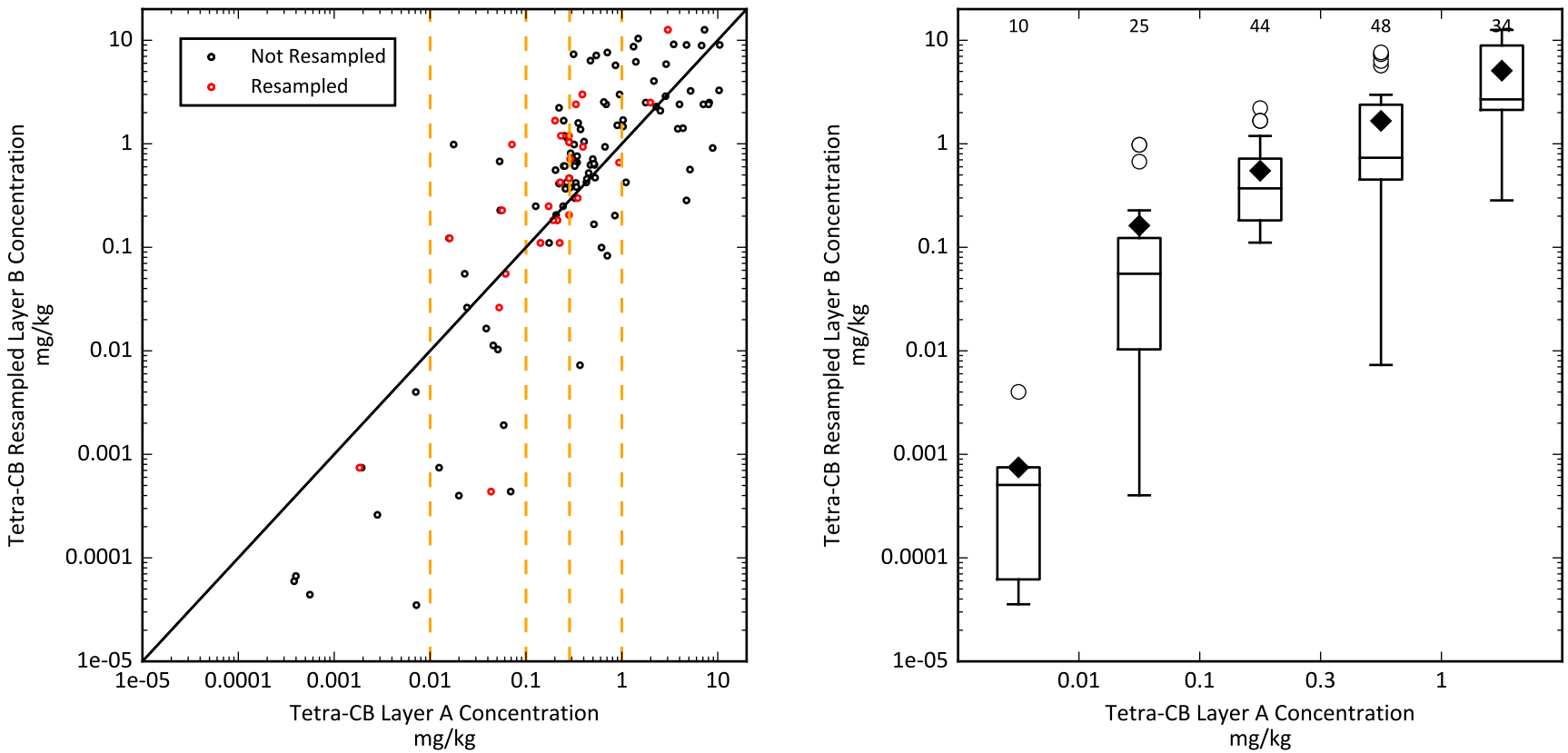
Publish Date: 06/19/2019 15:22 PM | User: DB
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

Figure 16

Mercury 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 1-7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study



Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 2010 dataset.
3 Layer B concentrations with a value of zero are not shown.

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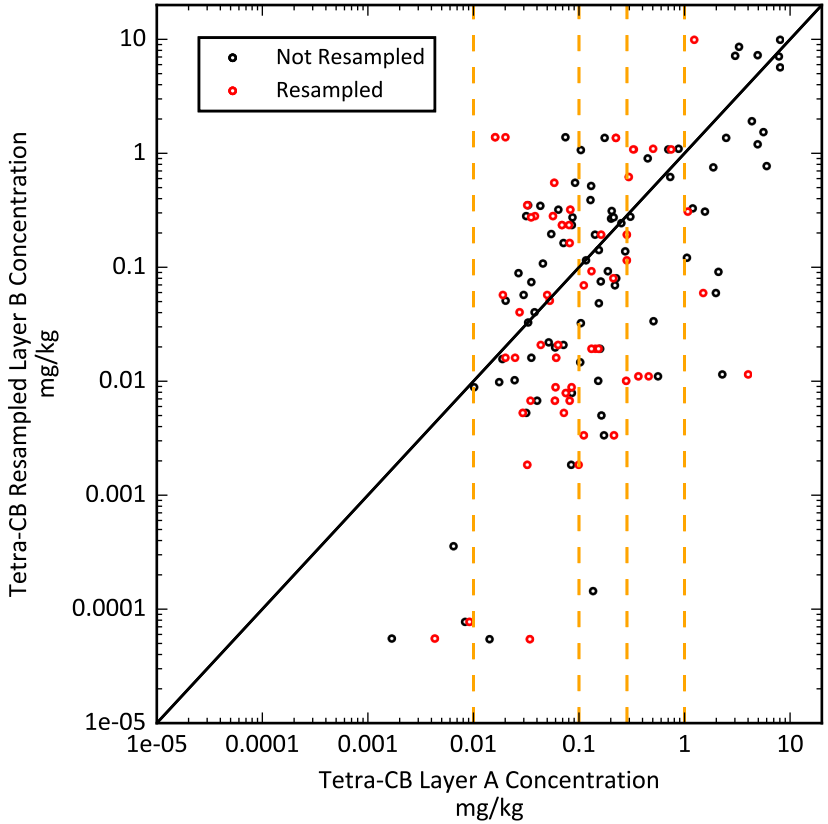
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

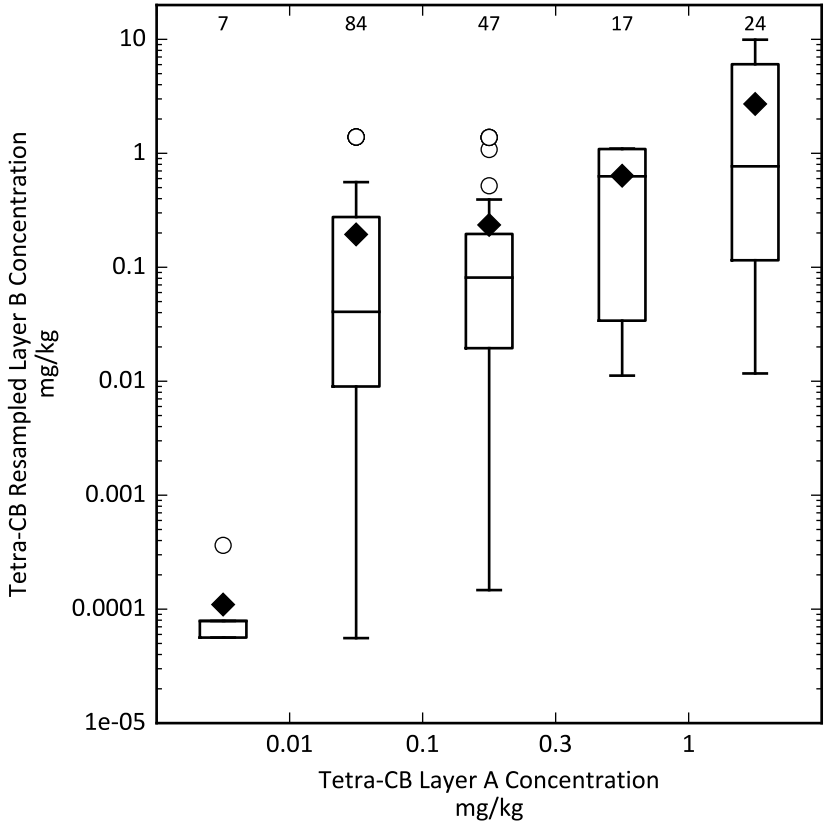
Figure 17a

Tetra-CB 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 1995 Thiessen mapping and pooled 2010 dataset.
49 Layer B concentrations with a value of zero are not shown.

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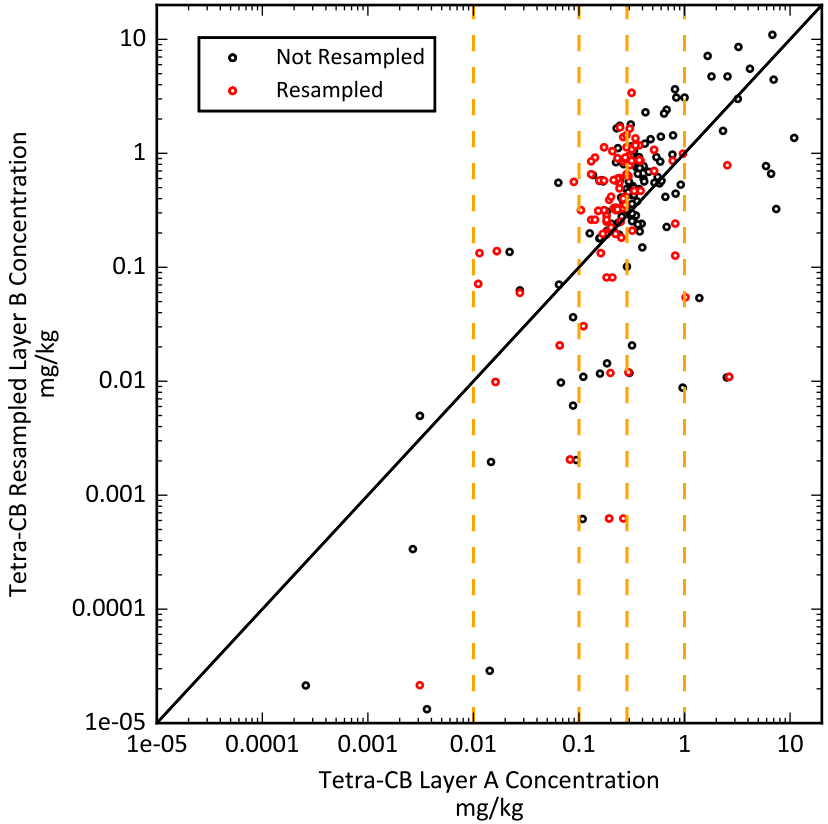
File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

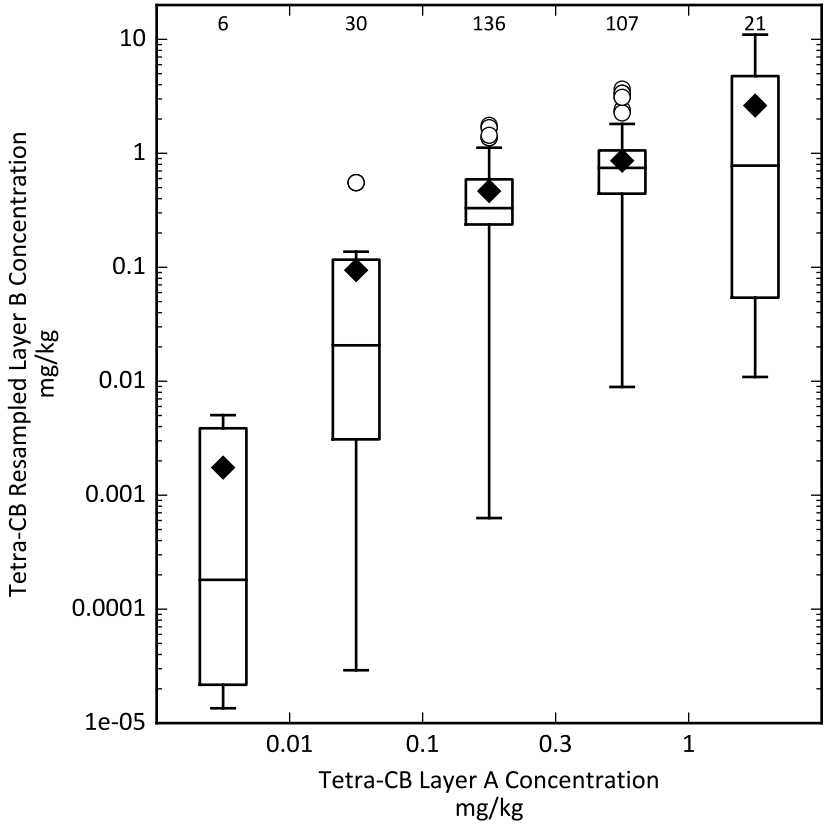
Figure 17b

Tetra-CB 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: Non-Silt RM 7.8-14.7

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study





Layer A is 0 - 15 cm. Layer B is 15 - 45 cm. Vertical orange lines are bin divisions.
The layer B resampling is based on the 2010 Thiessen mapping and pooled 1995 and 2010 dataset.
There are no Layer B concentrations with a value of zero.

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File Path: H:/Passaic_CPG/DOCUMENTS/2019/RI_Report/source/v5/Appendix_J/code/Fig_7_13_14_crossplot_ThiesvThies_newlayerB.py

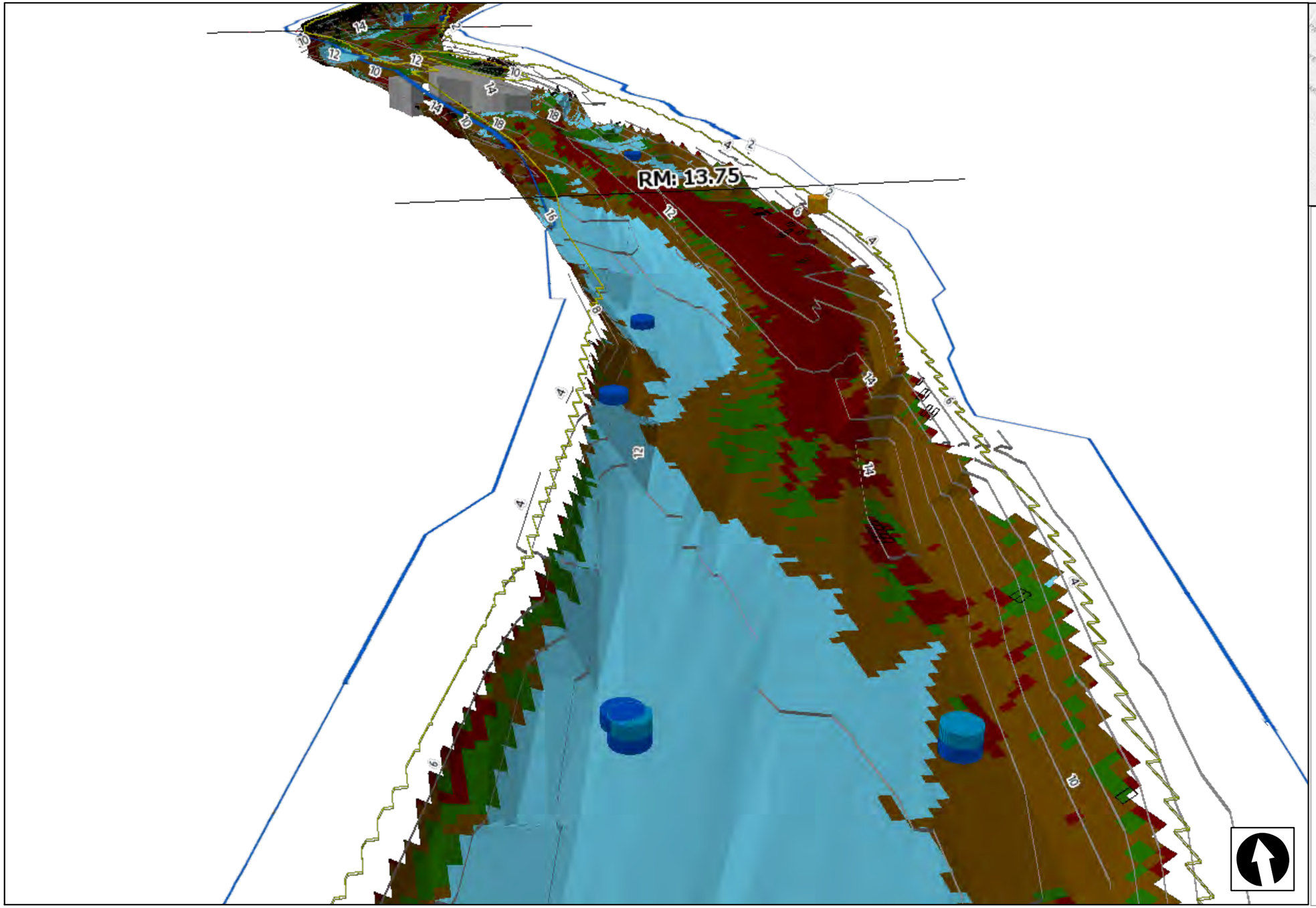
Figure 17c

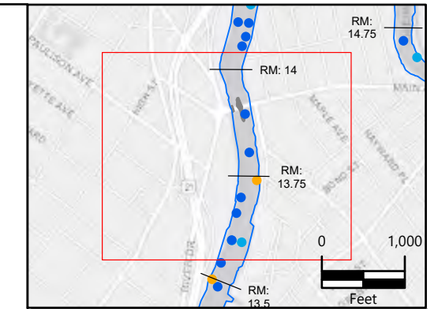
Tetra-CB 1995 Mapped Thiessen Layer A and Resampled Layer B Comparison: RM 0-7.8

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation\Feasibility Study

Appendix K
Section 4 Supporting Figures





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period.
Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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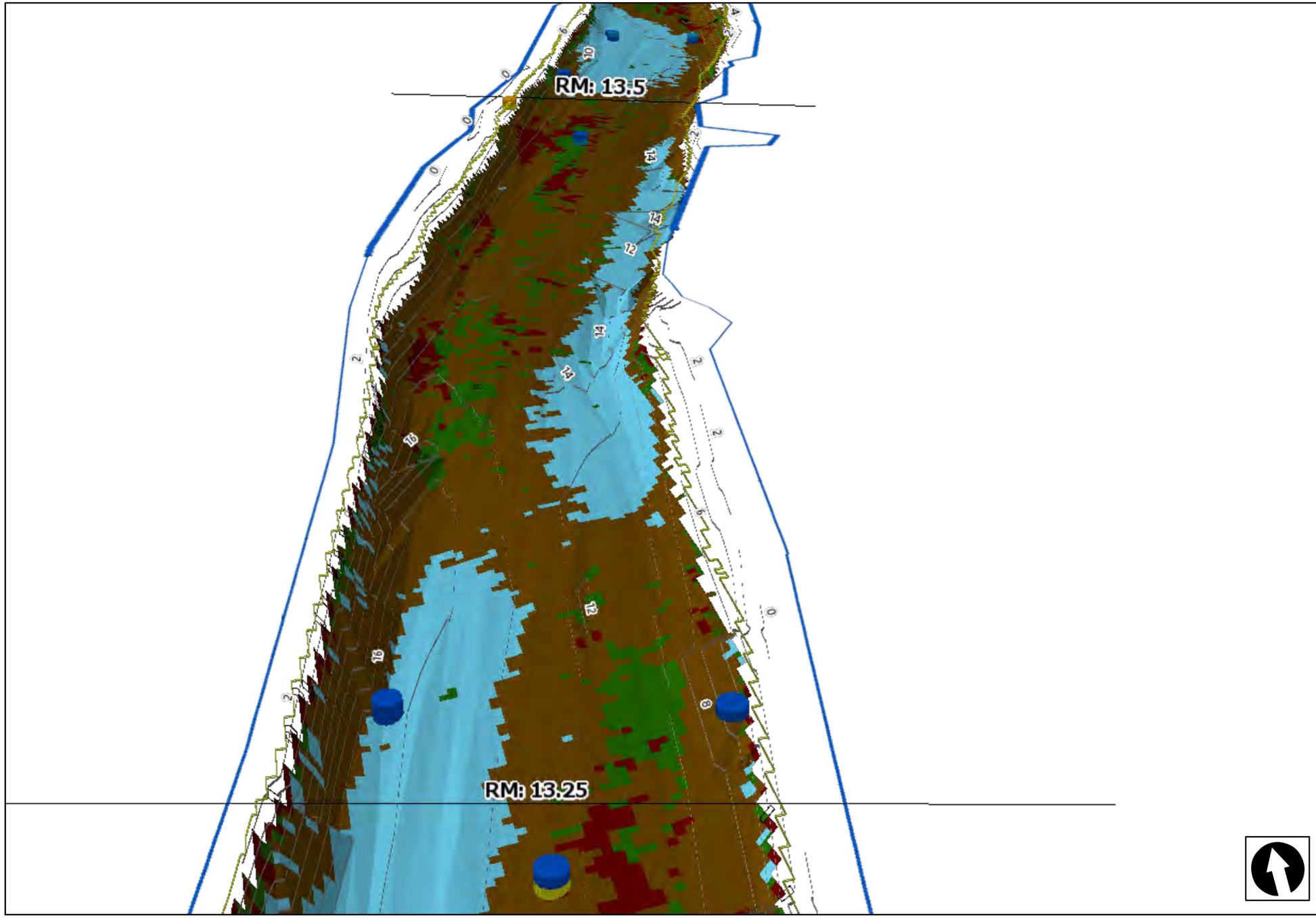
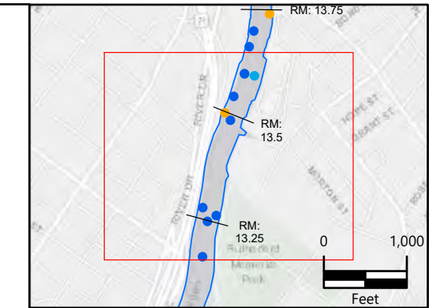
Figure 1-1a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period.
Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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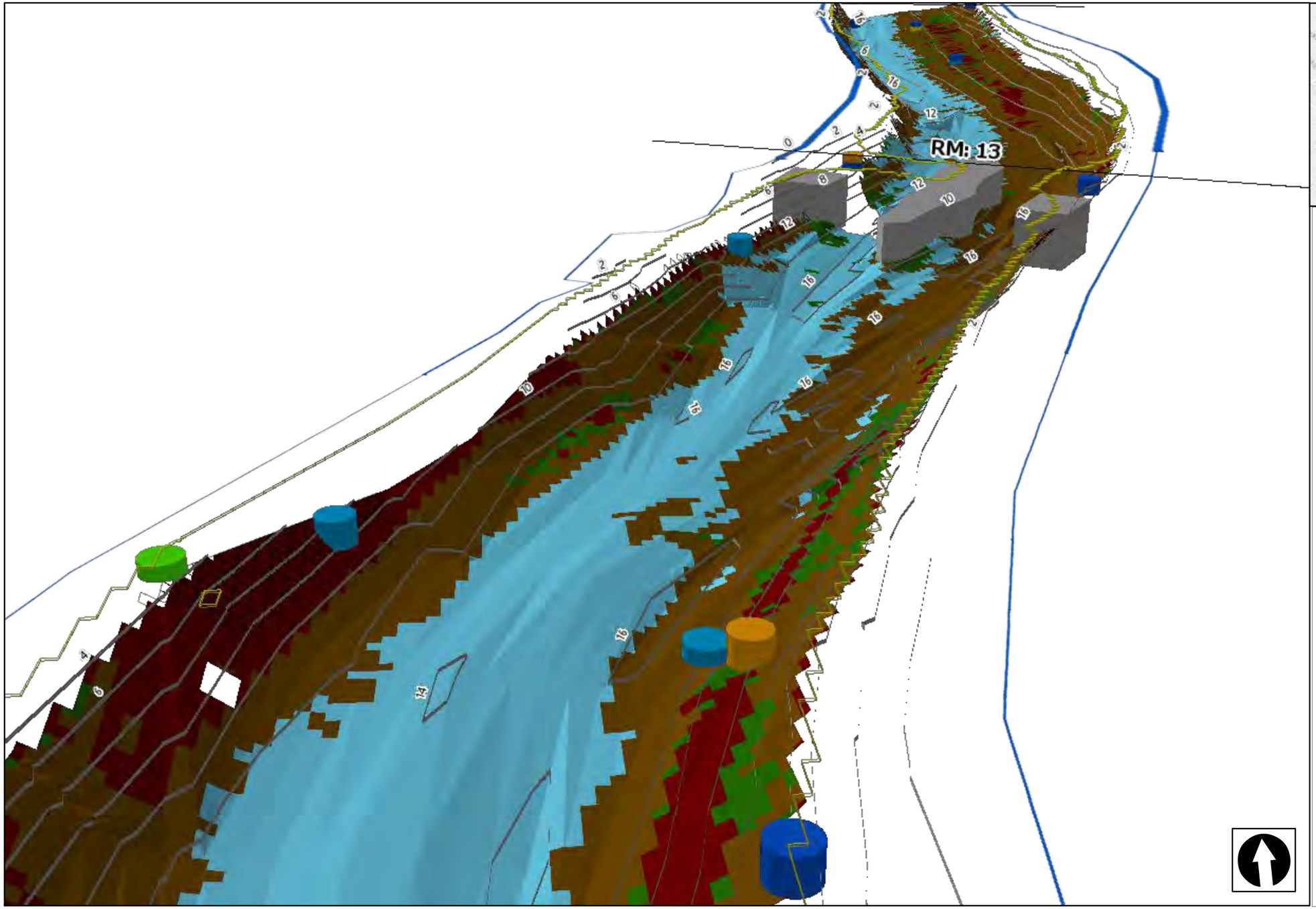
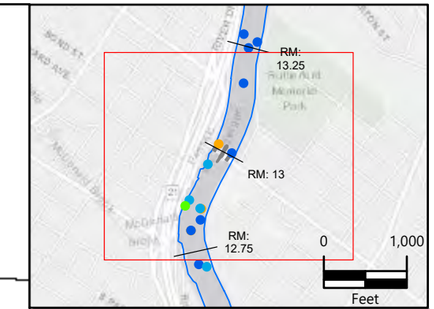
Figure 1-1b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period.
Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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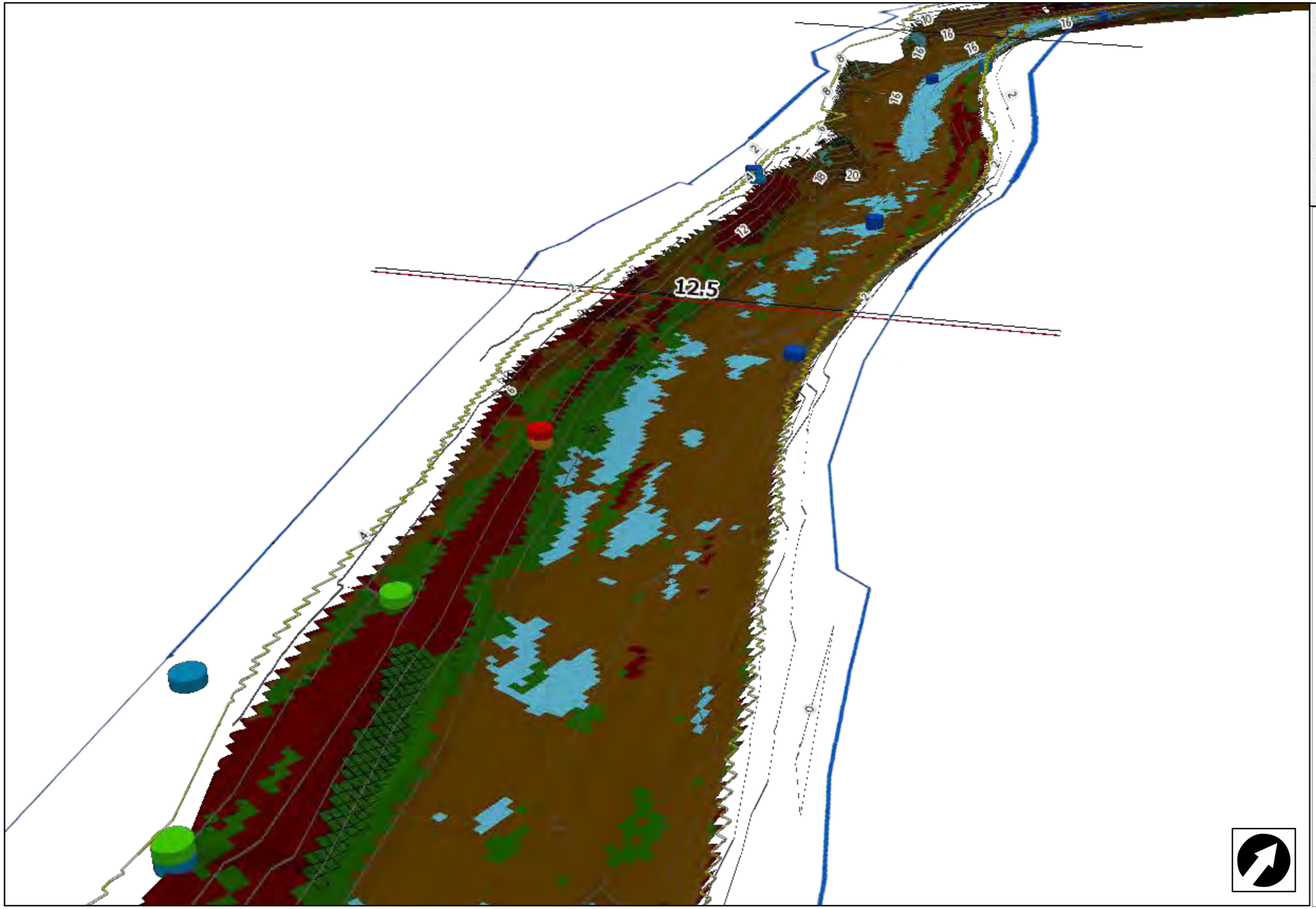
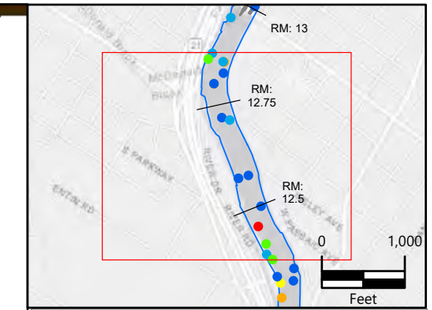
Figure 1-1c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period.
Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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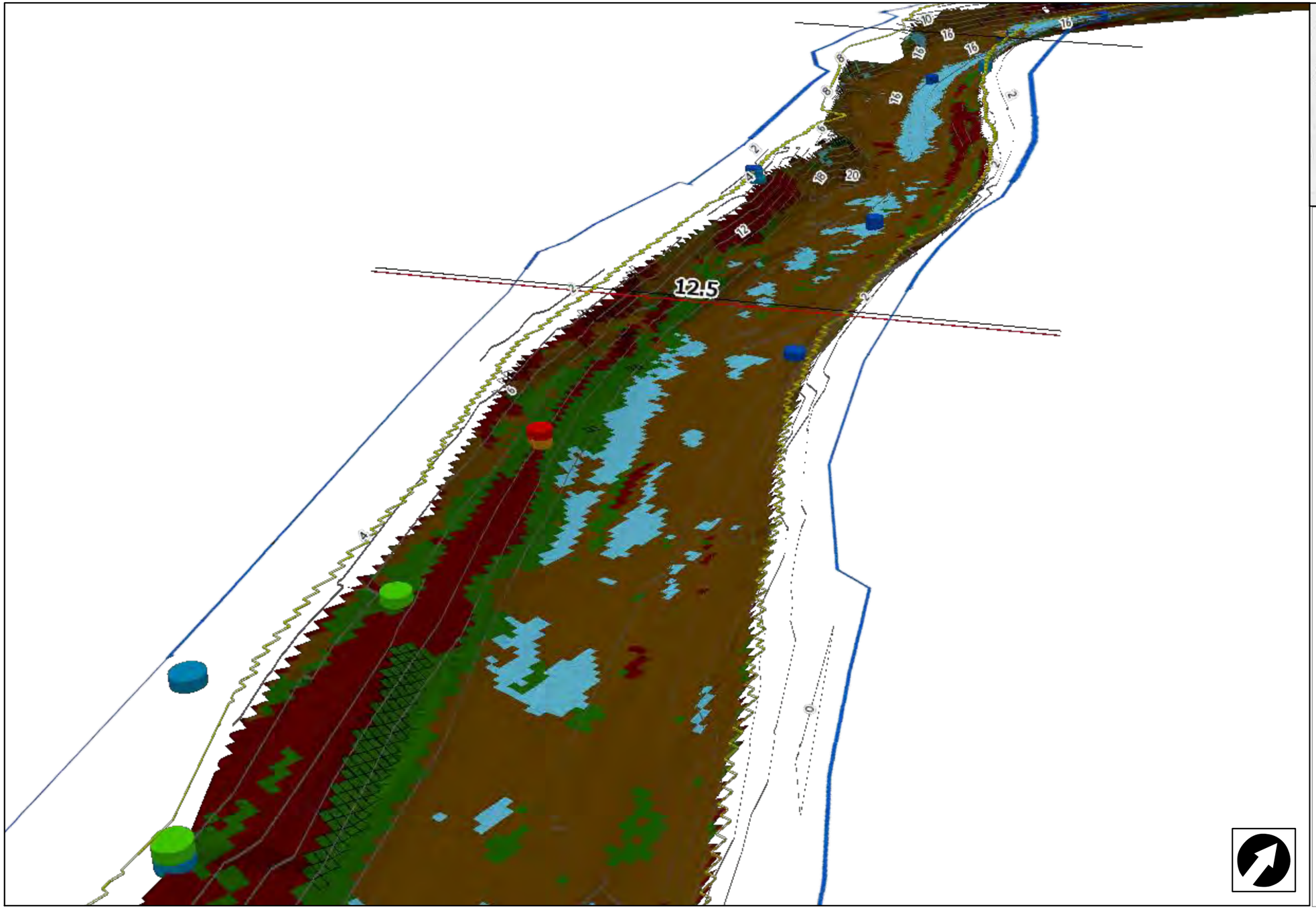
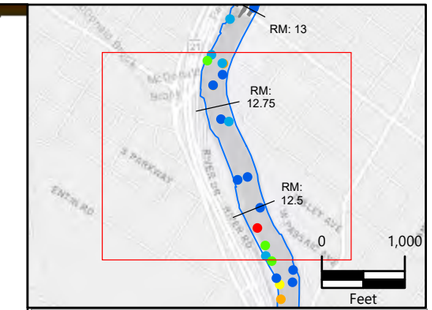
Figure 1-1d

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period.
Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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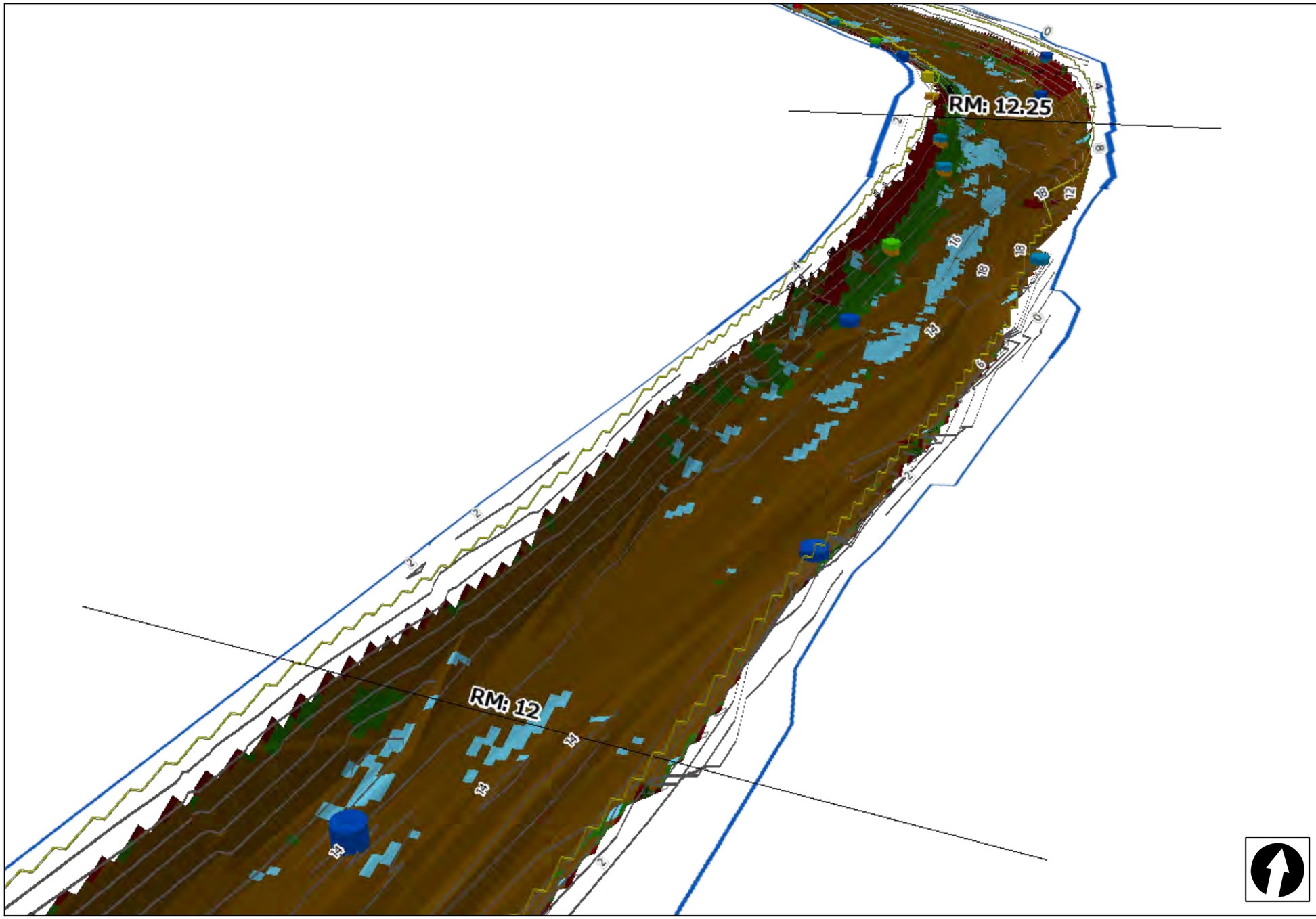
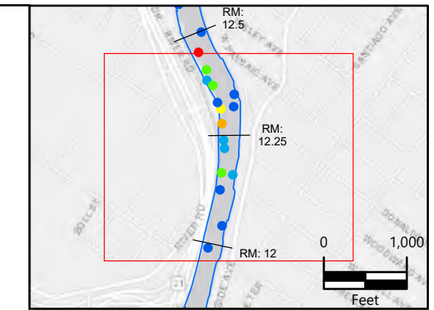
Figure 1-2a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period.
Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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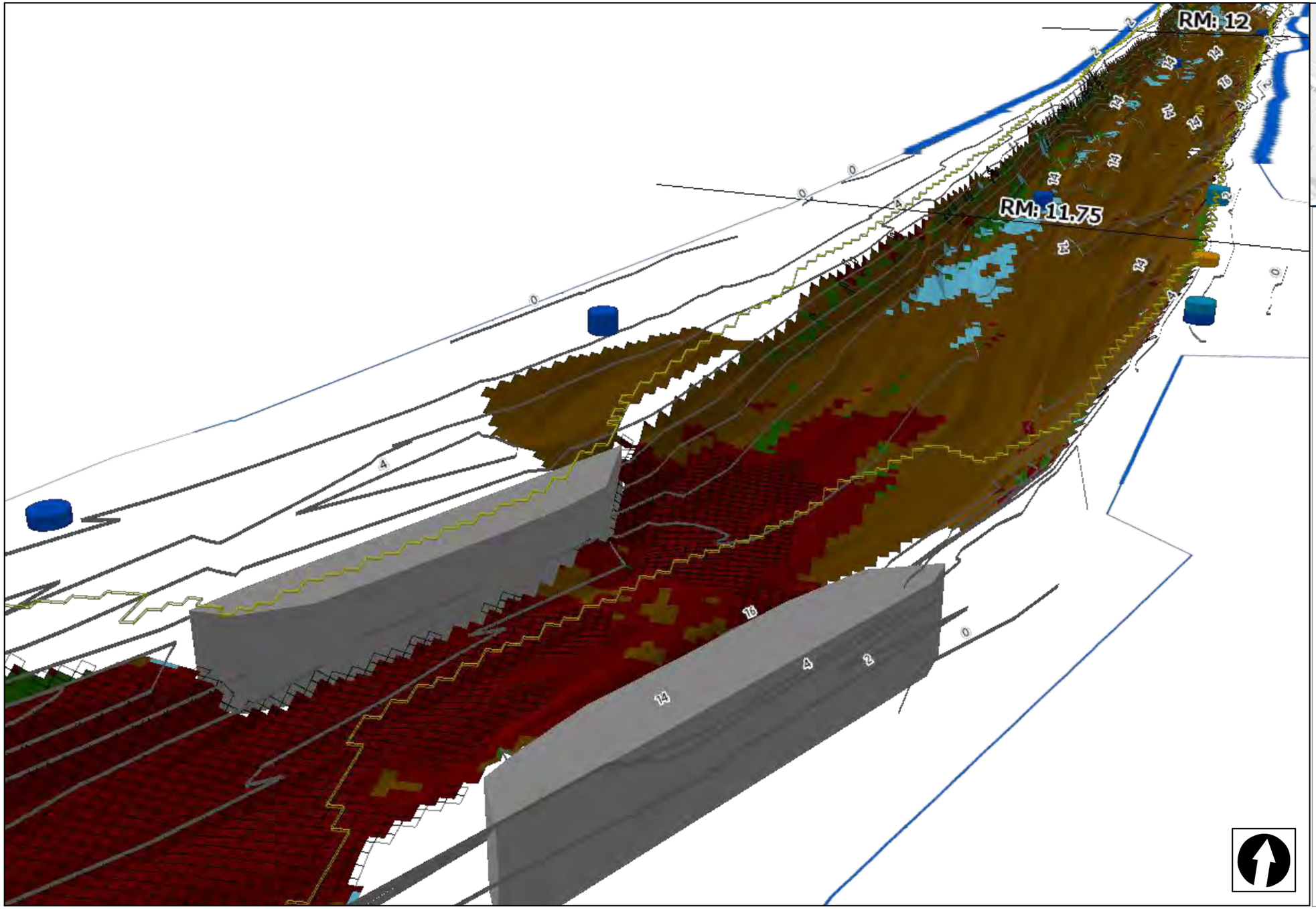
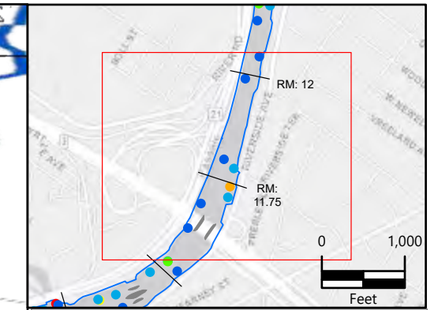
Figure 1-2b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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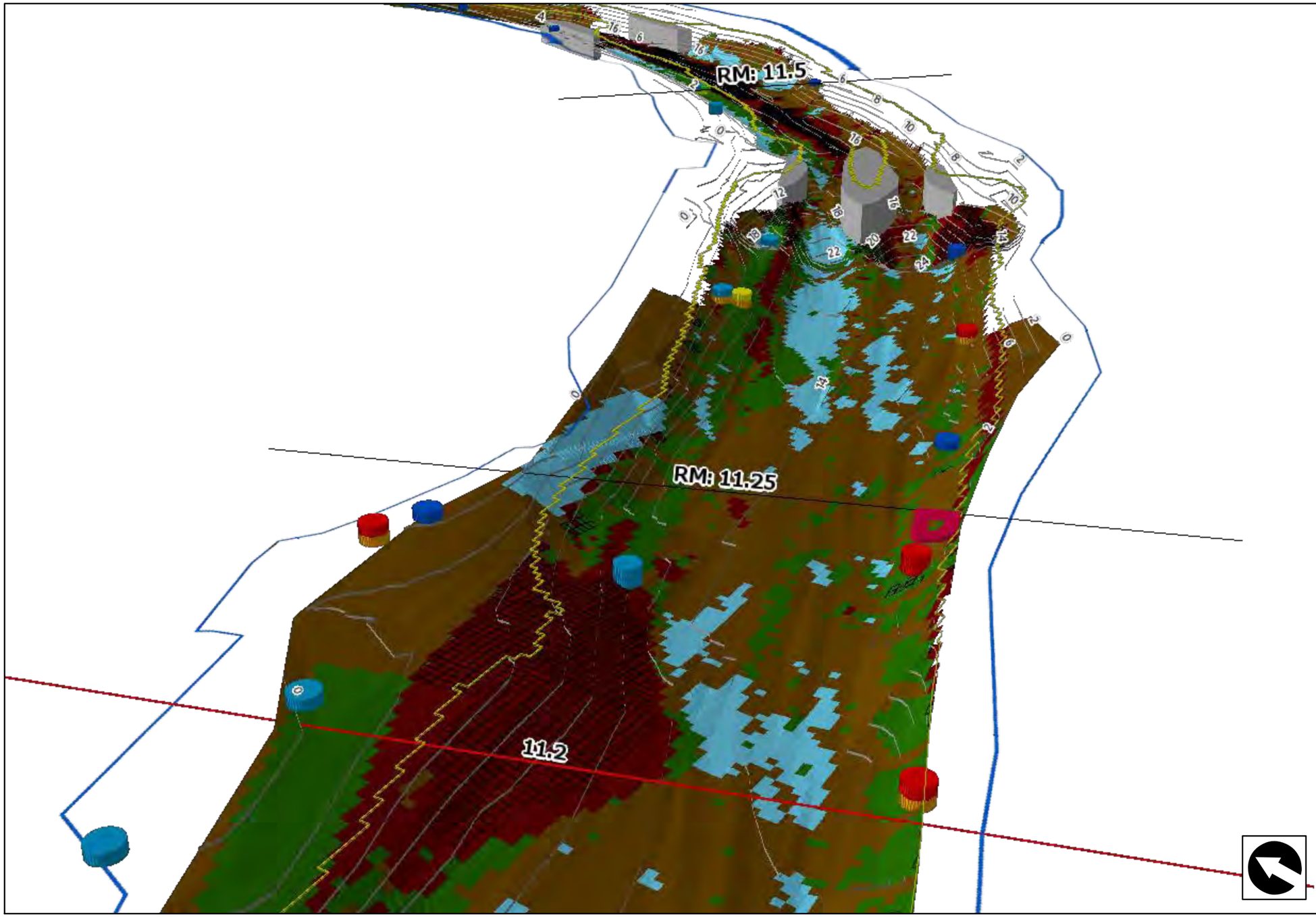
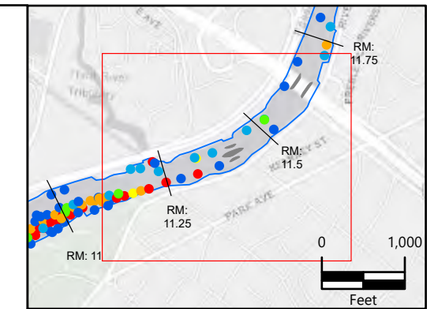
Figure 1-2c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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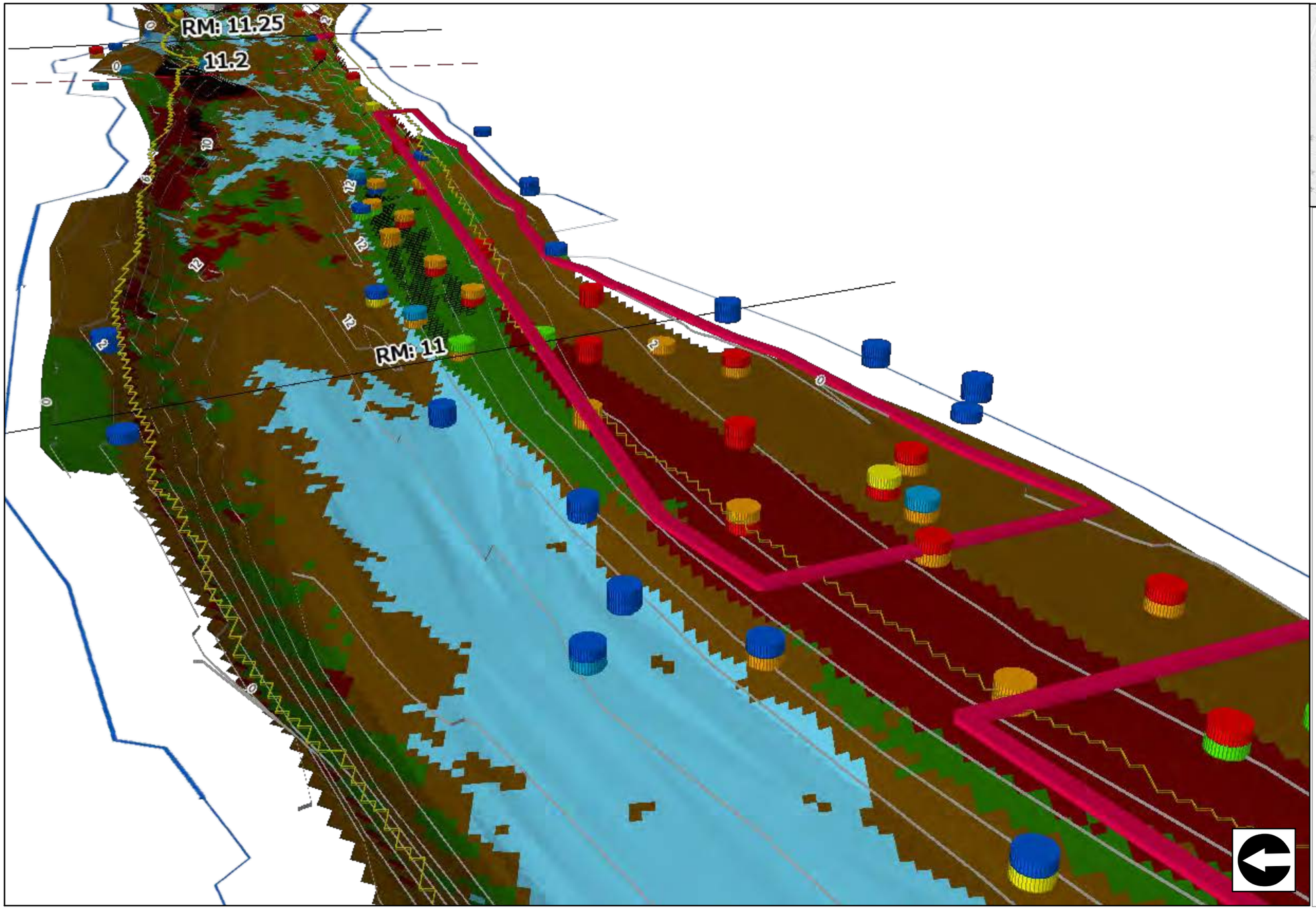
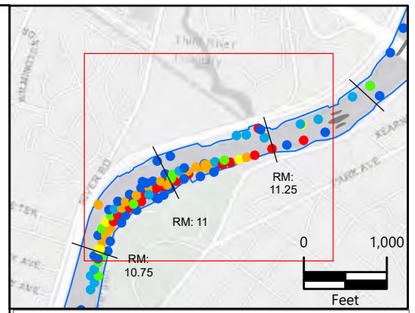
Figure 1-2d

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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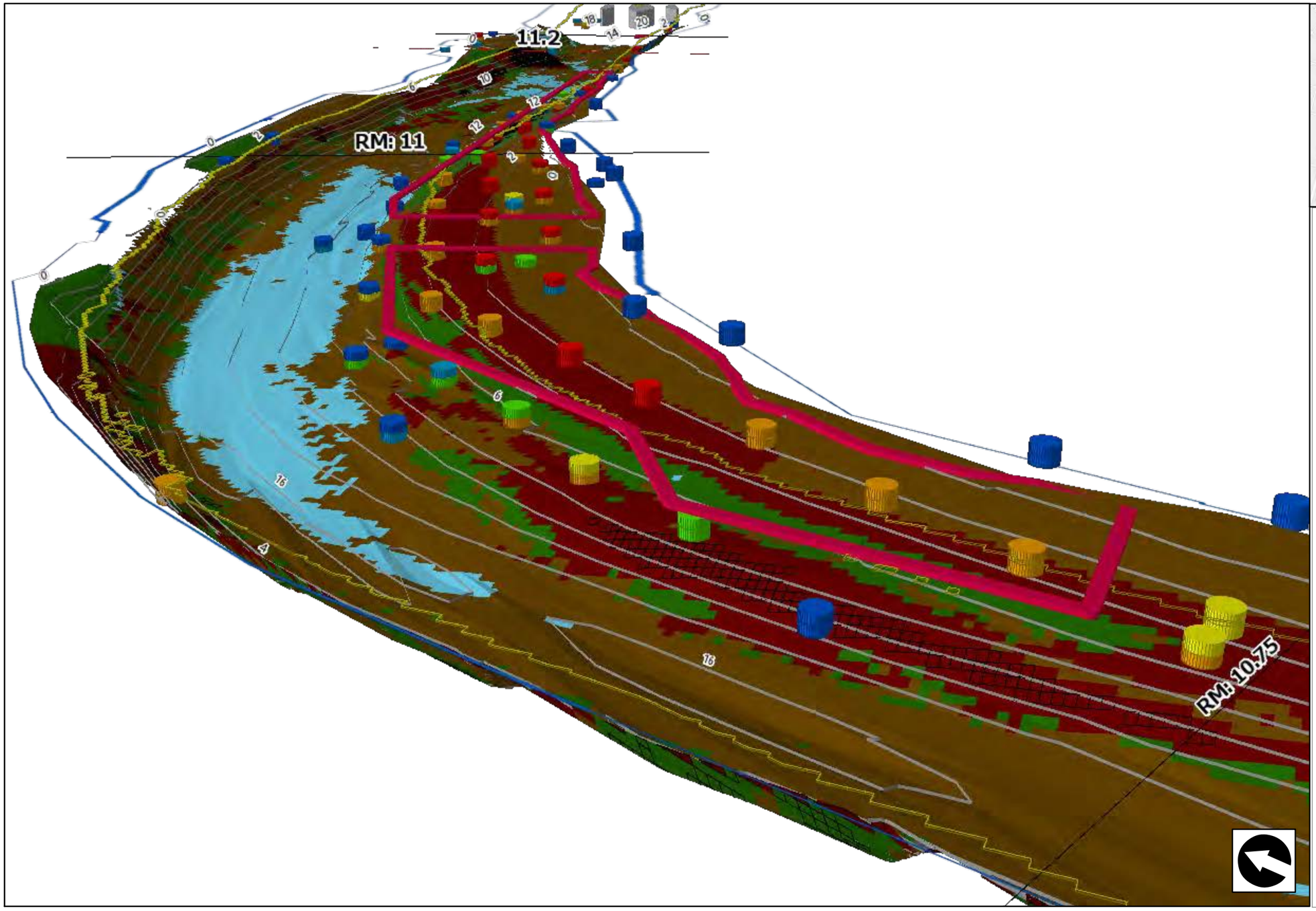
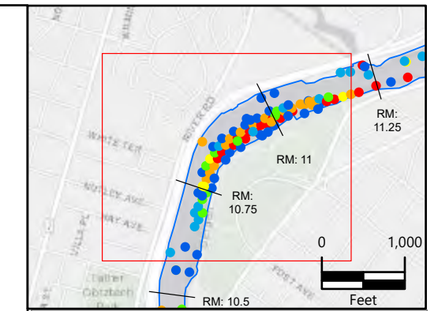
Figure 1-3a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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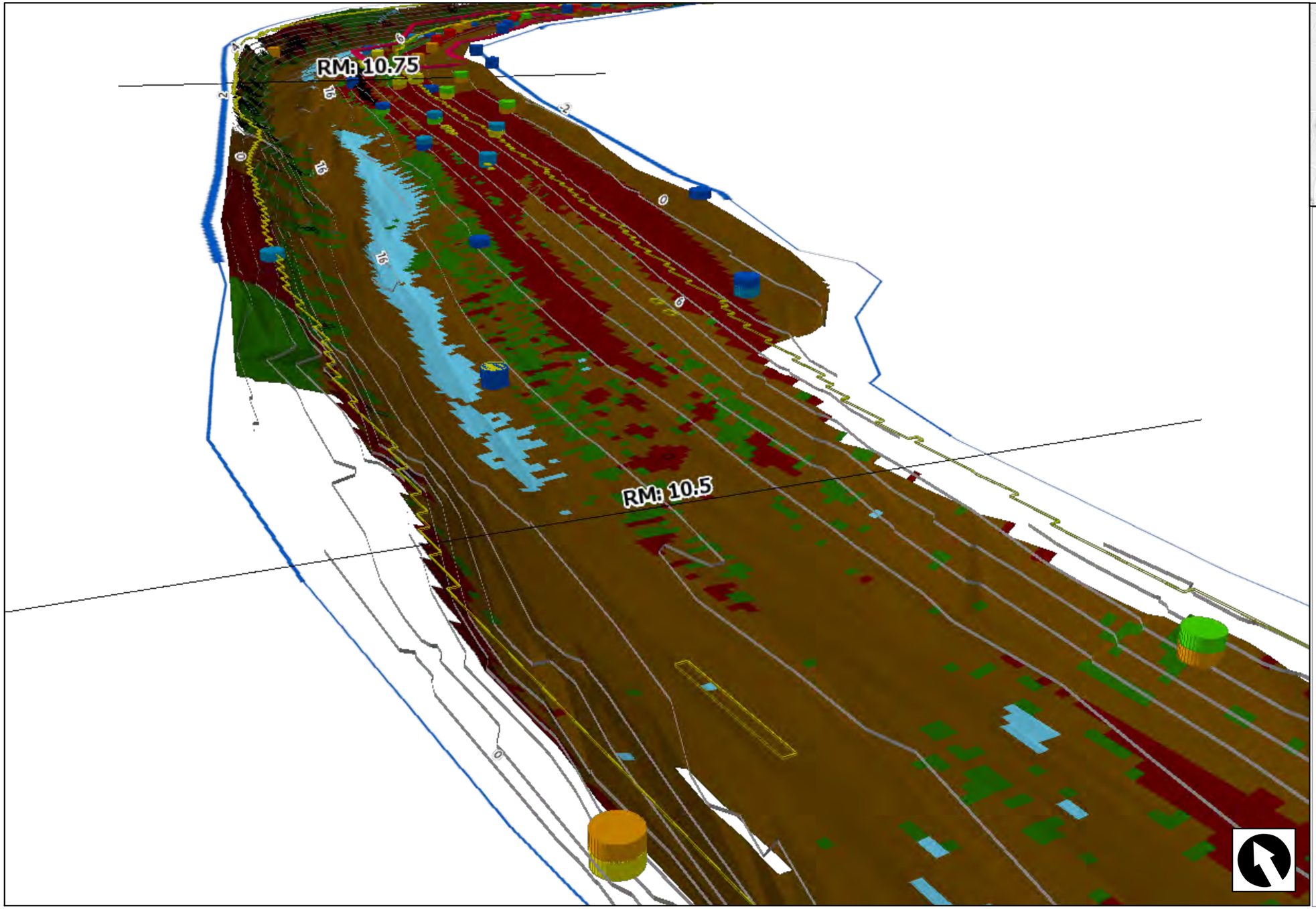
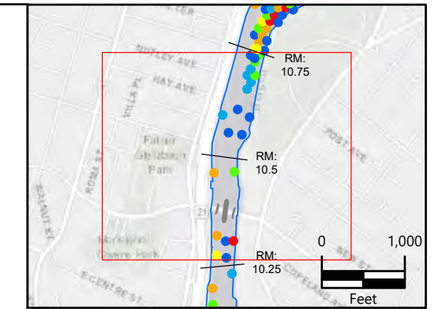
Figure 1-3b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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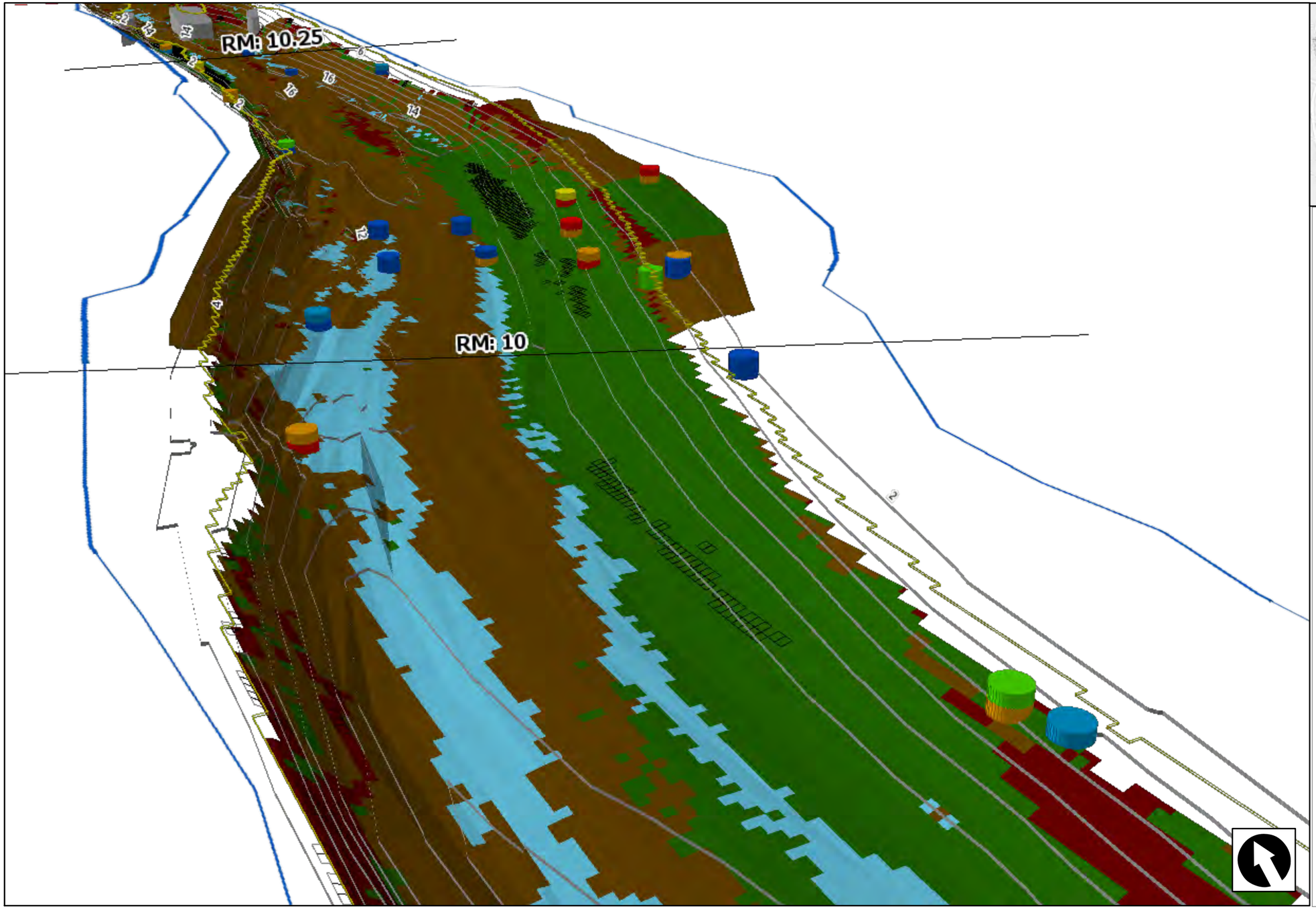
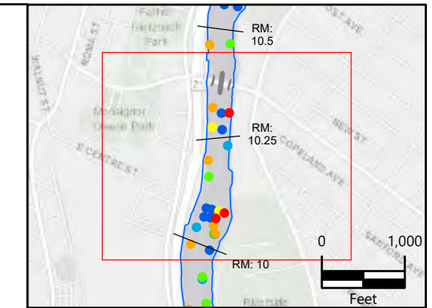
Figure 1-3c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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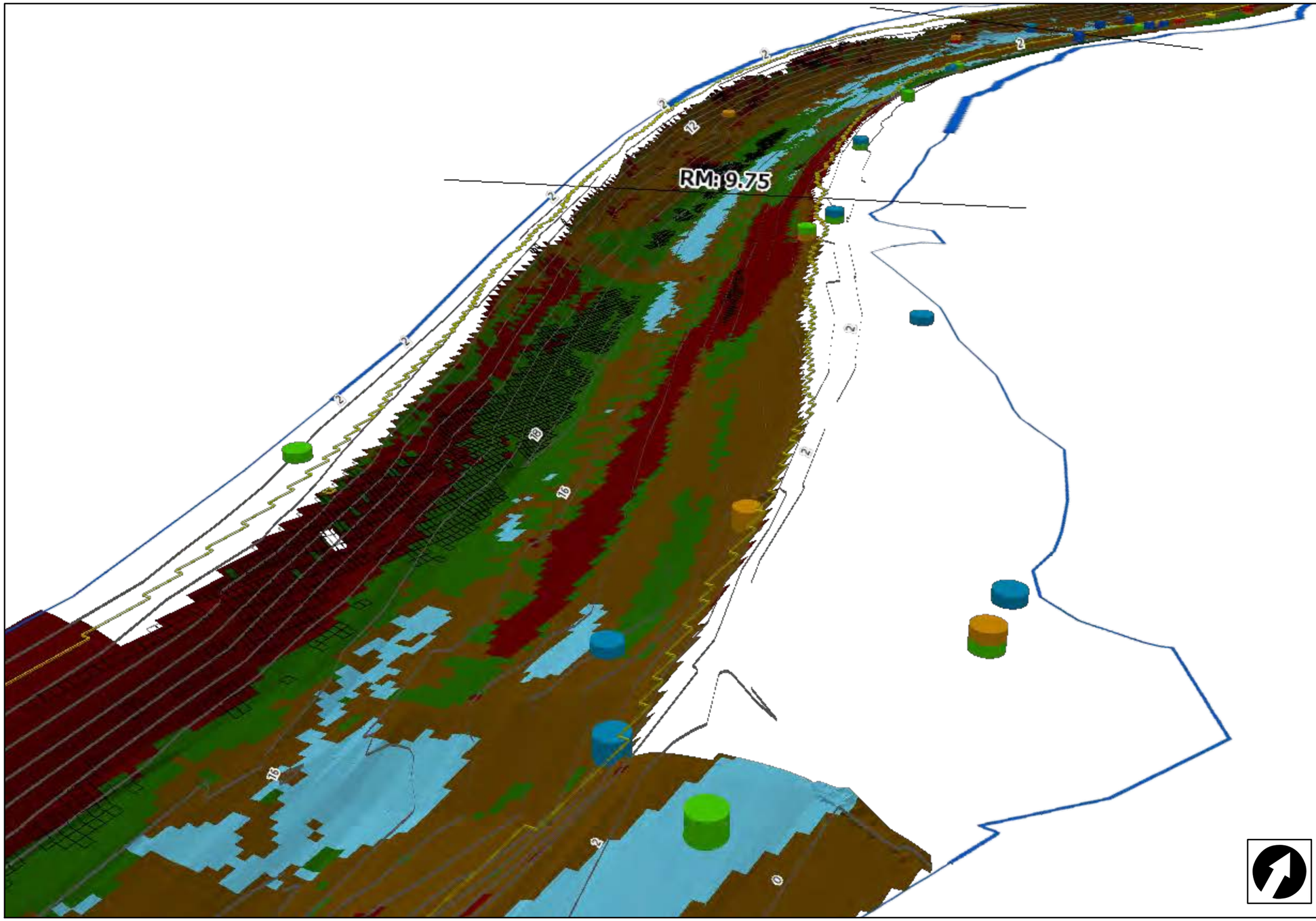
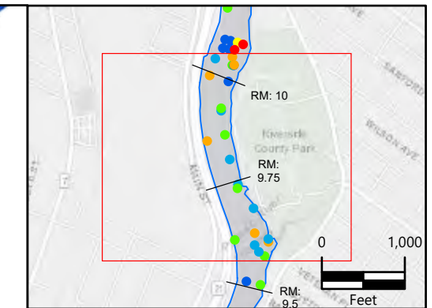
Figure 1-4a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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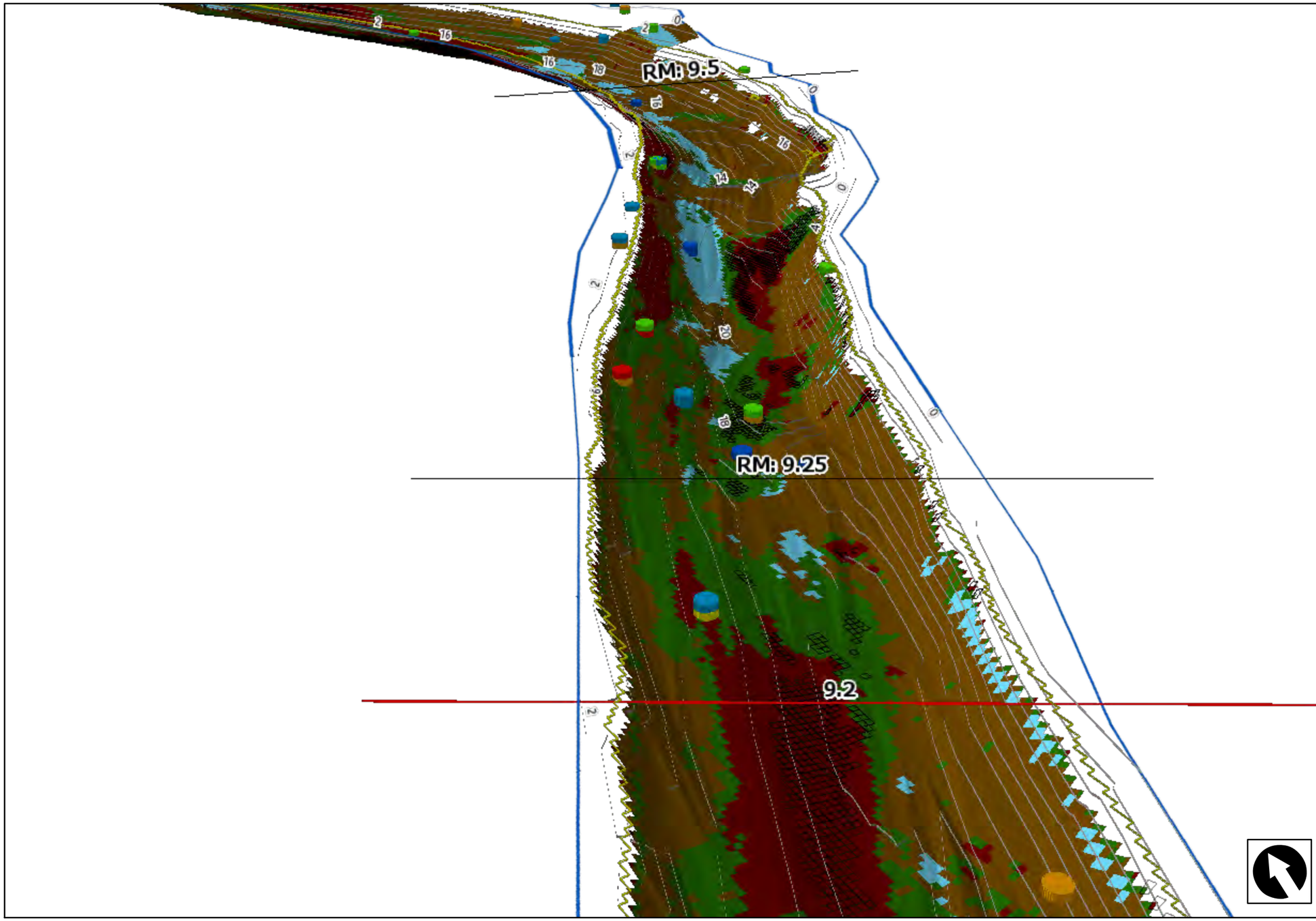
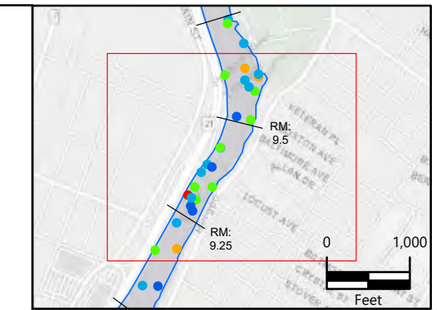
Figure 1-4b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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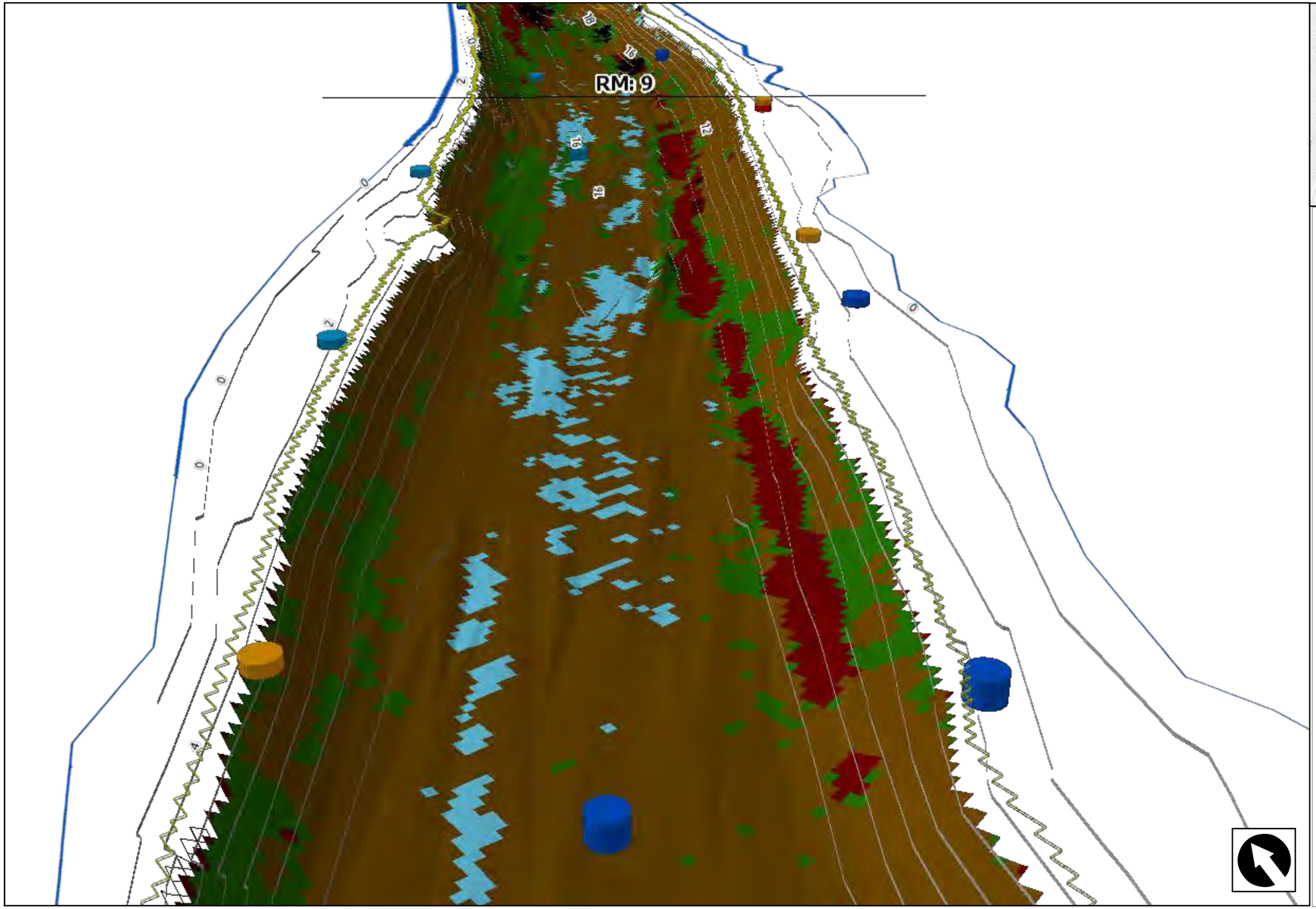
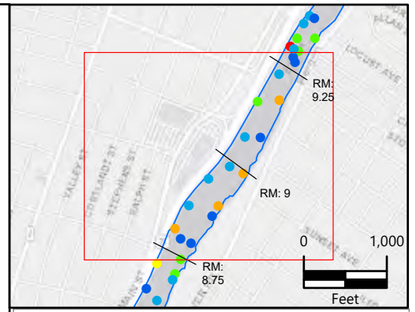
Figure 1-4c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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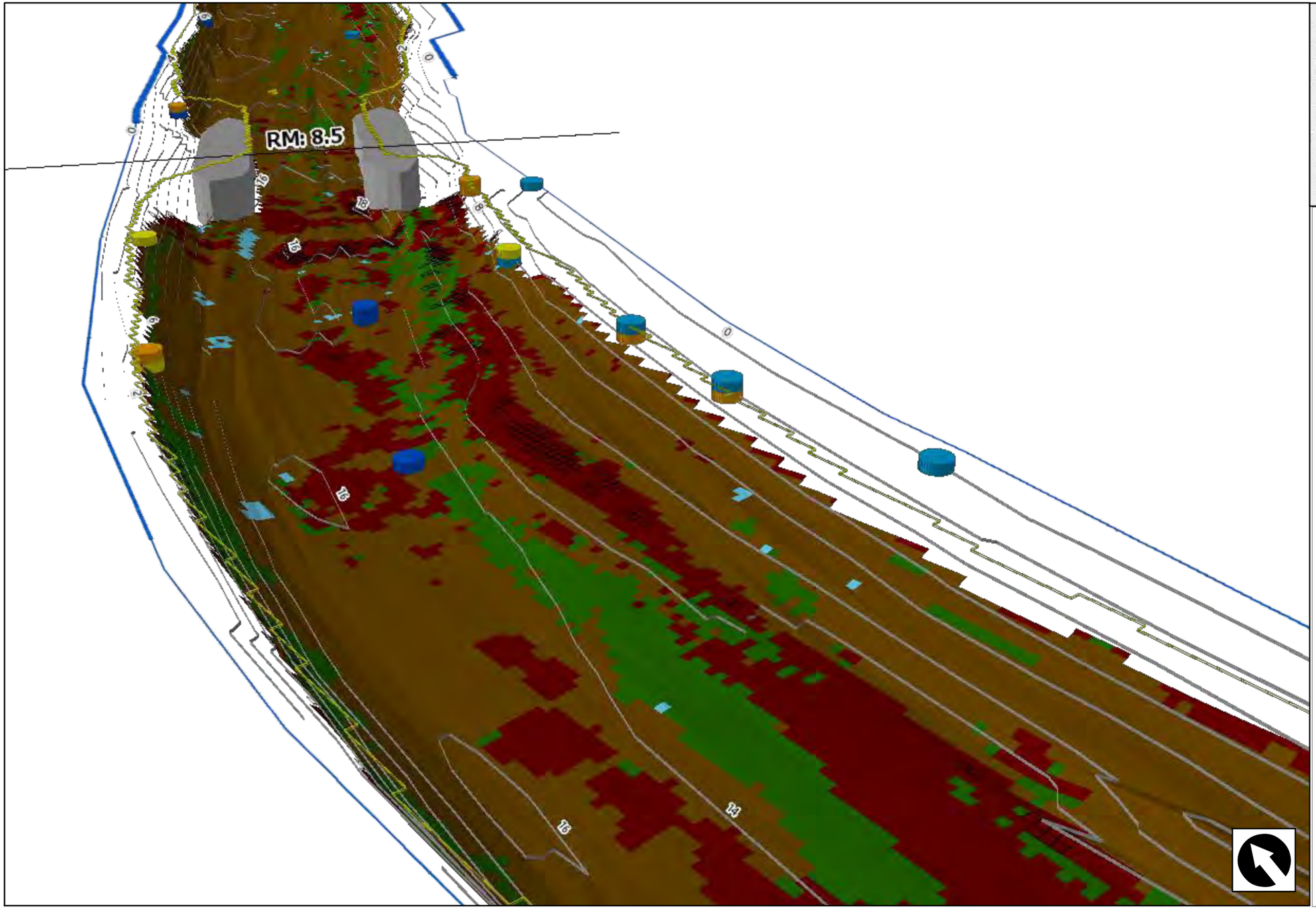
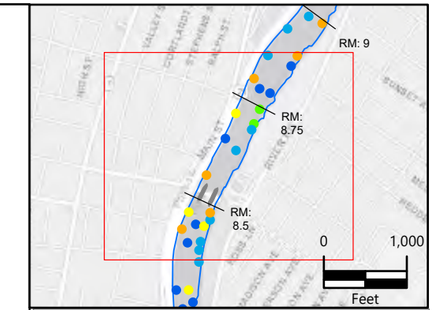
Figure 1-5a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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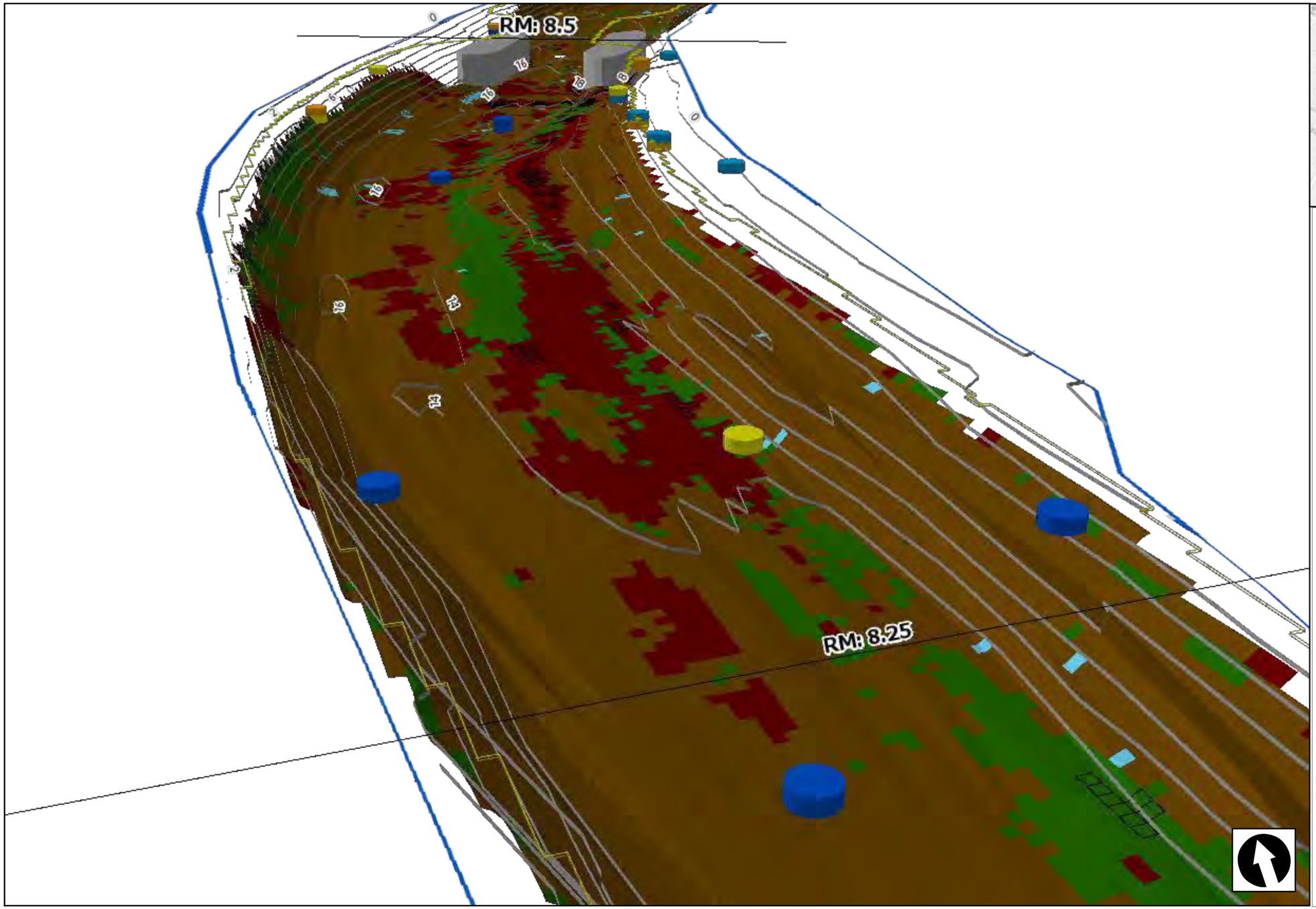
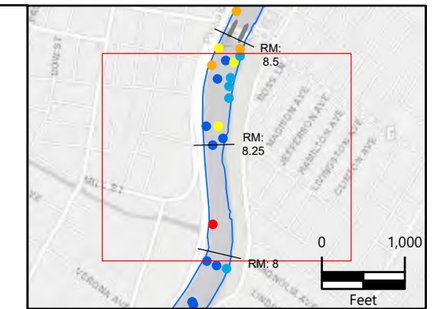
Figure 1-5b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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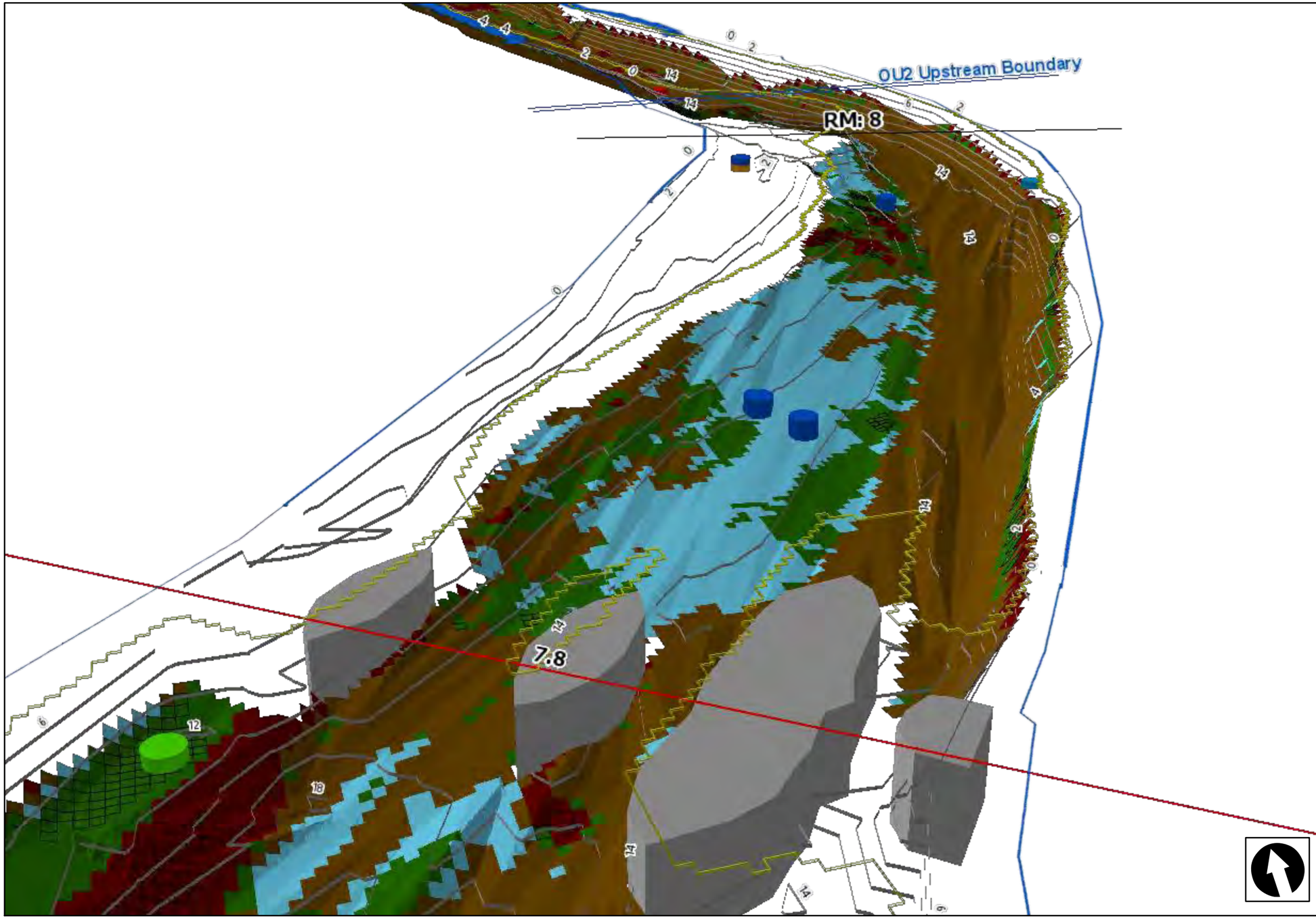
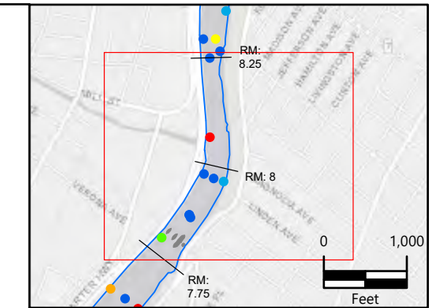
Figure 1-5c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

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- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

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NOTES:
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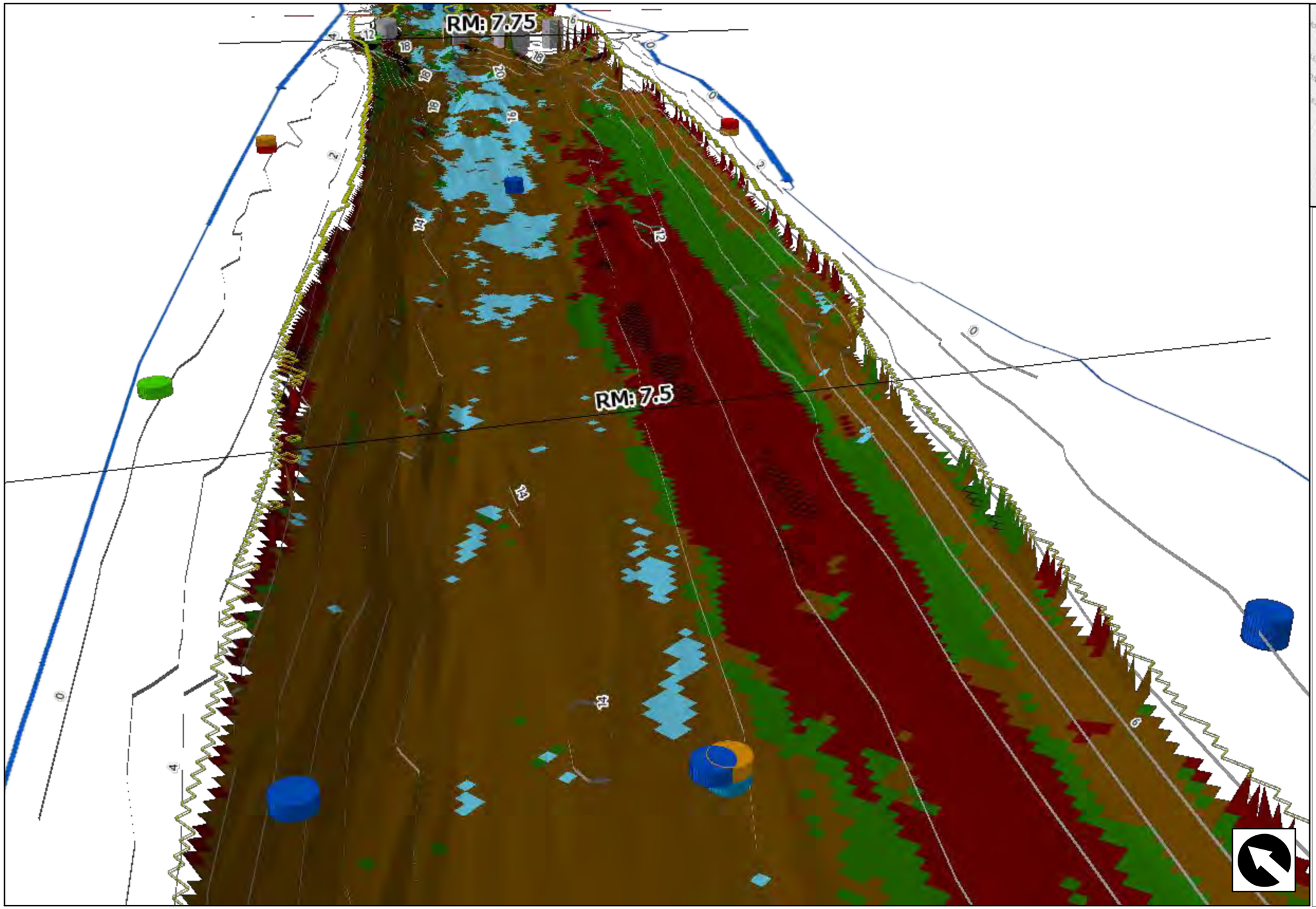
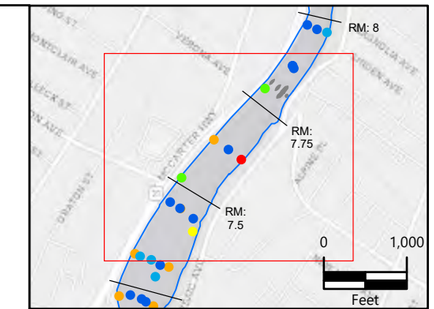
Figure 1-5d

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

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- 1.5 - 2.0
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Bathymetric Change Category *

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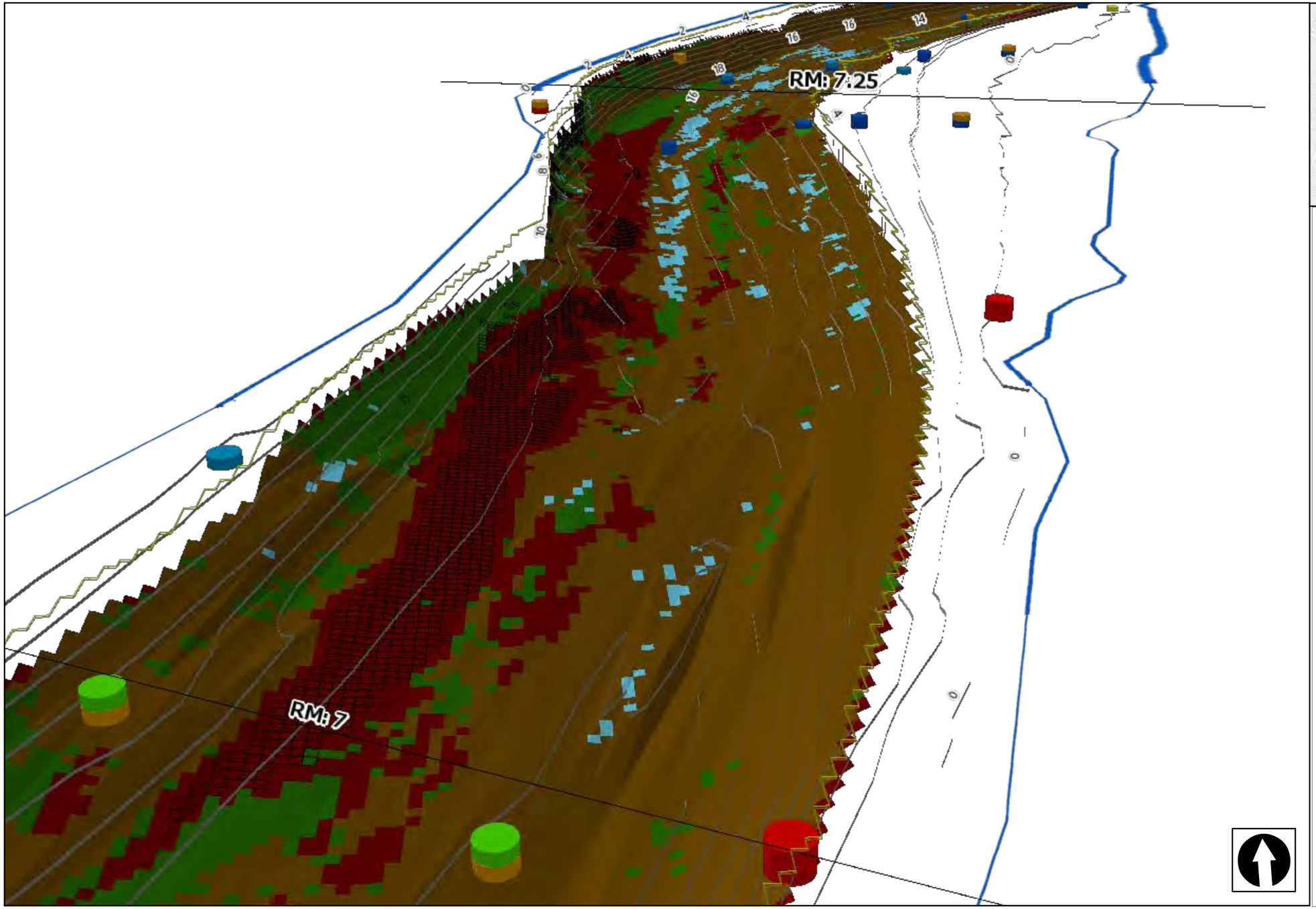
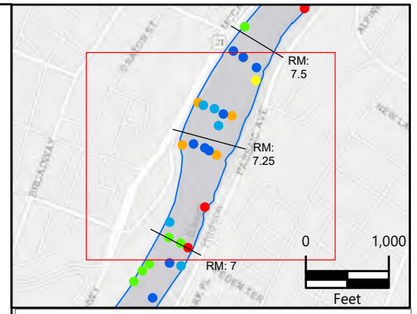
Figure 1-6a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
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- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

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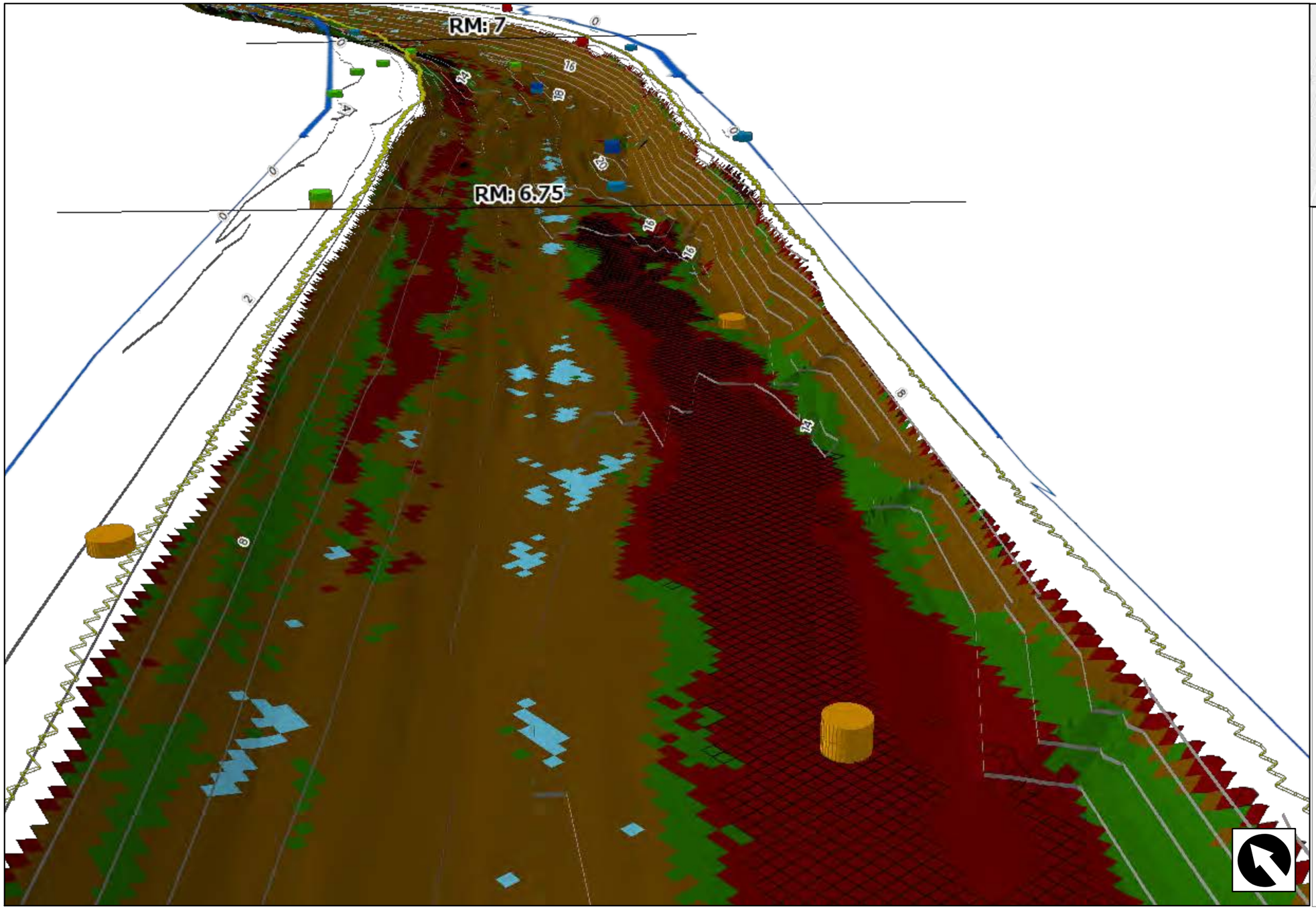
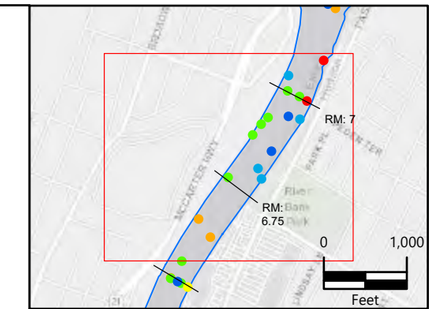
Figure 1-6b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

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- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
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Bathymetric Change Category *

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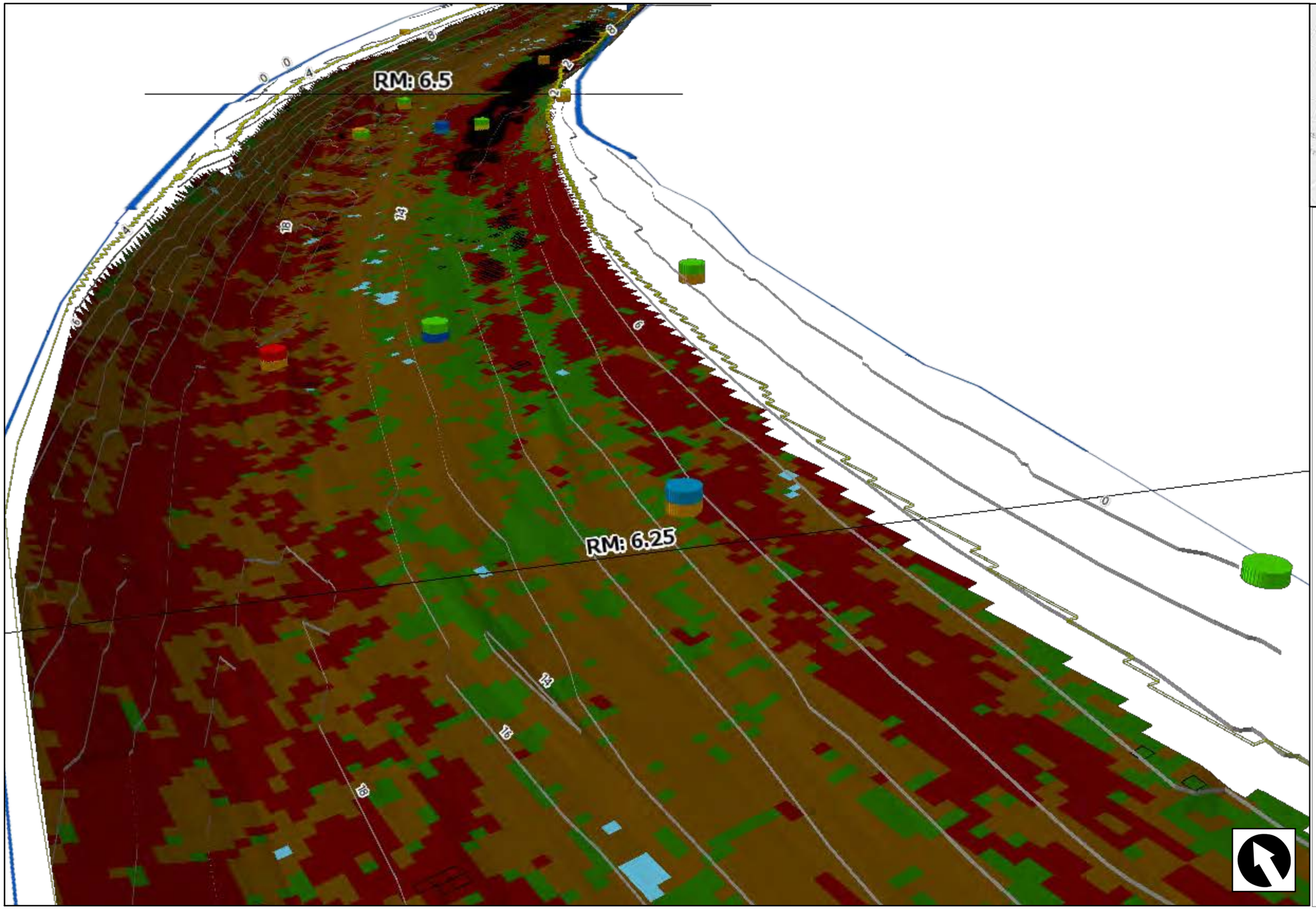
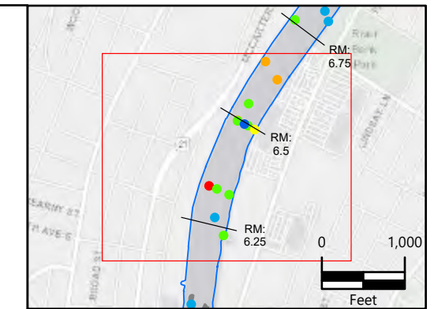
Figure 1-6c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

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- Depositional from 2007 to 2012
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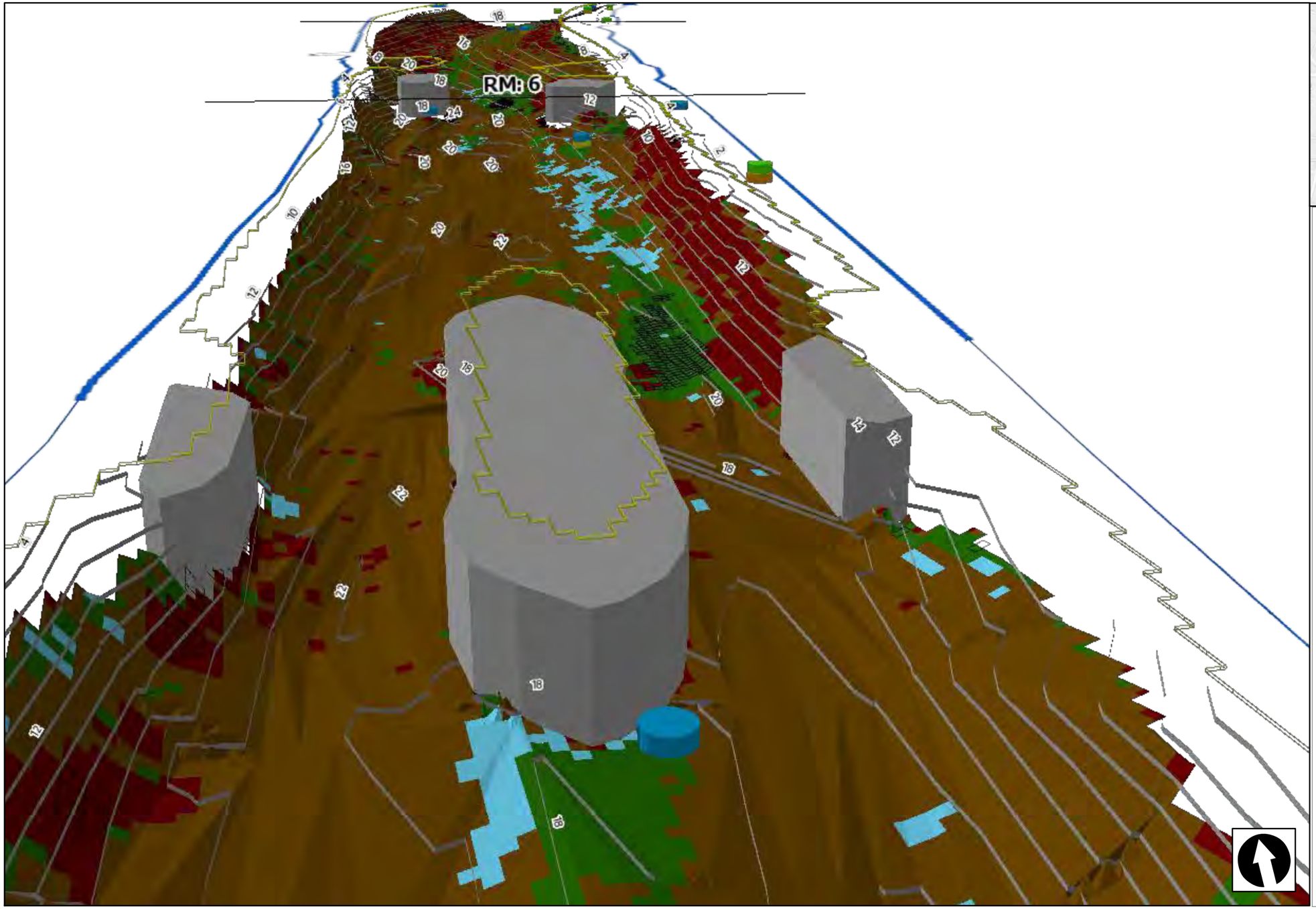
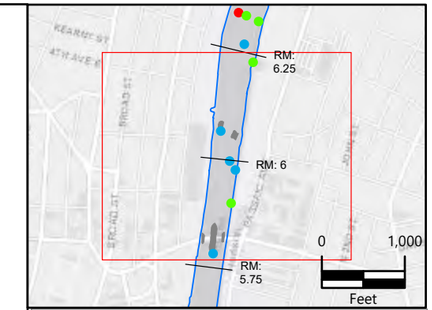
Figure 1-6d

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

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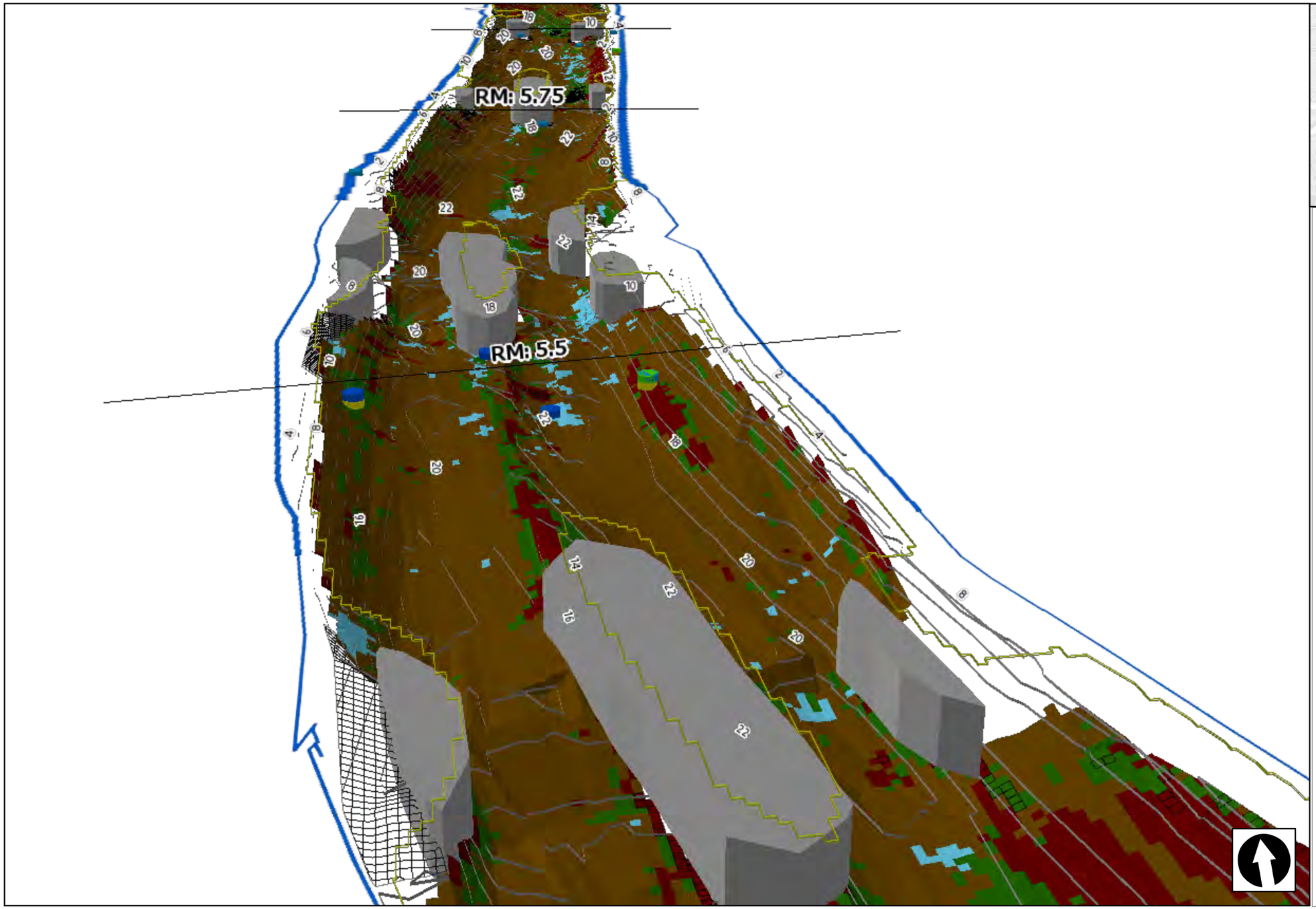
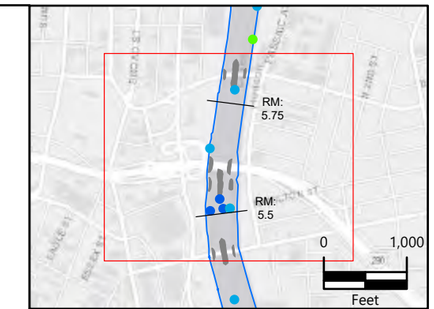
Figure 1-6e

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

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- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
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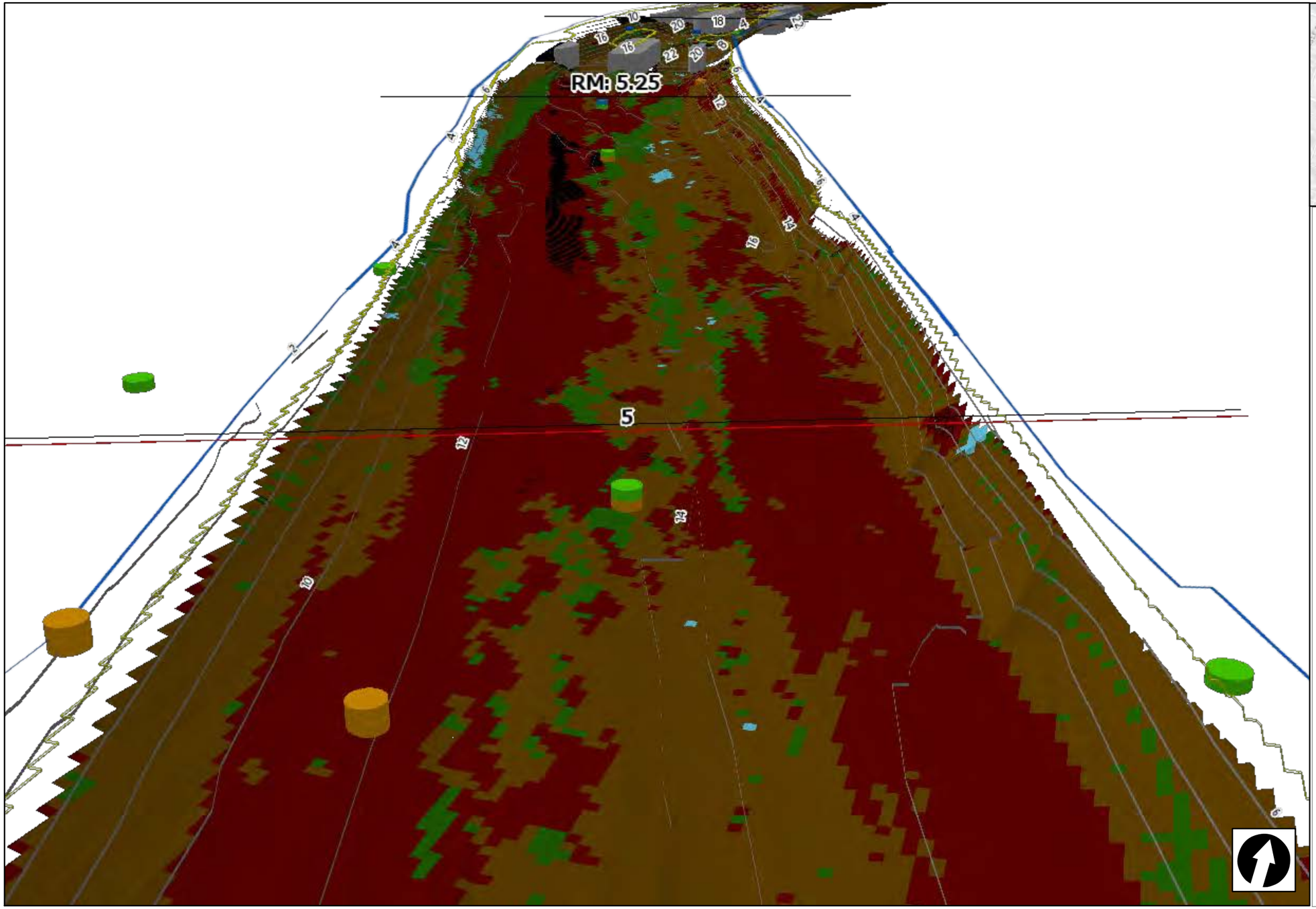
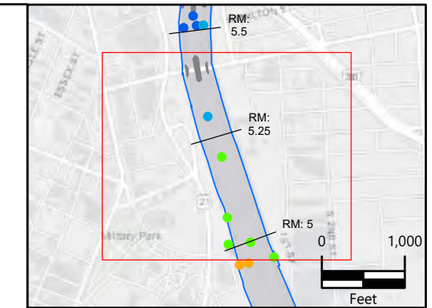
Figure 1-6f

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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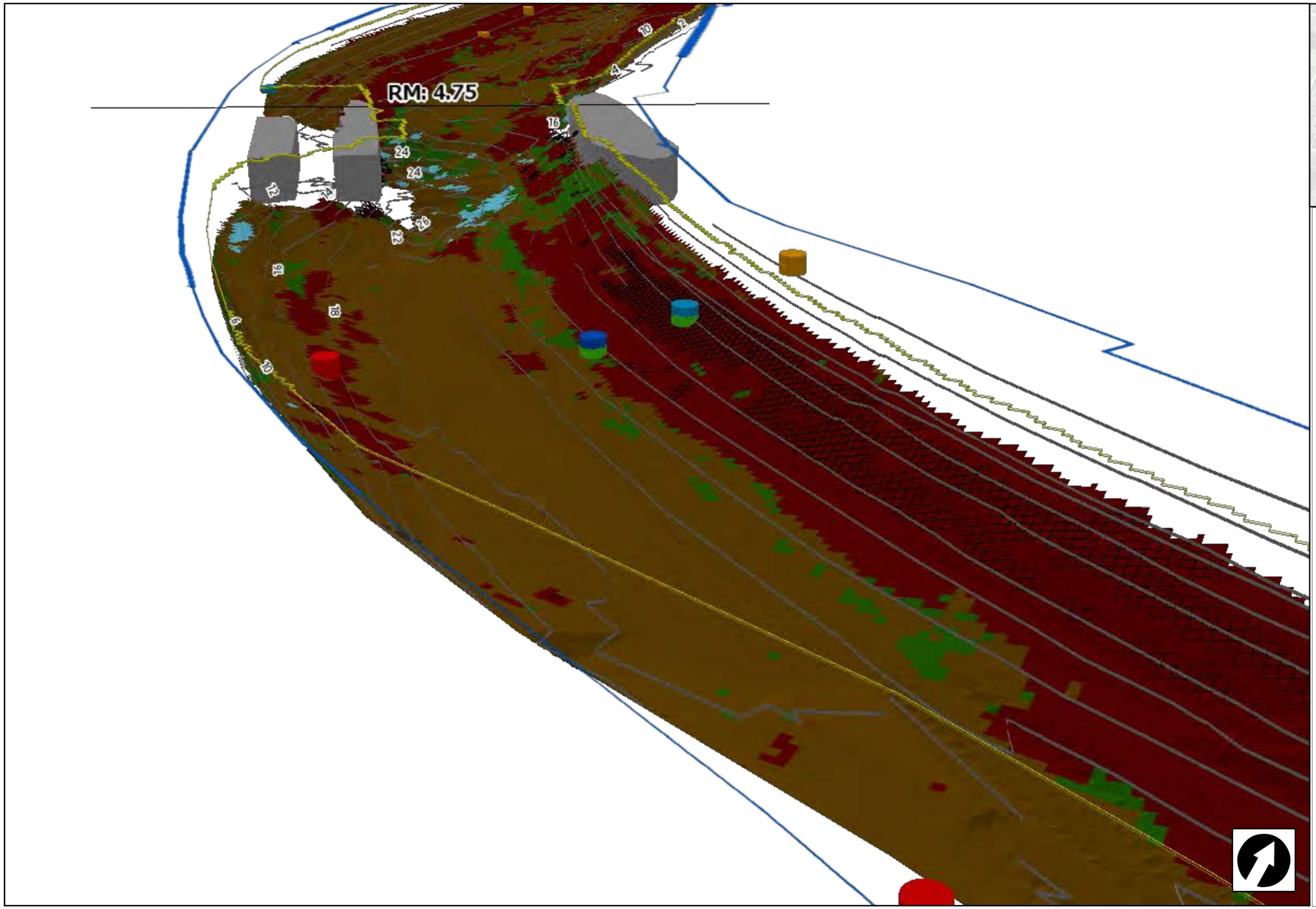
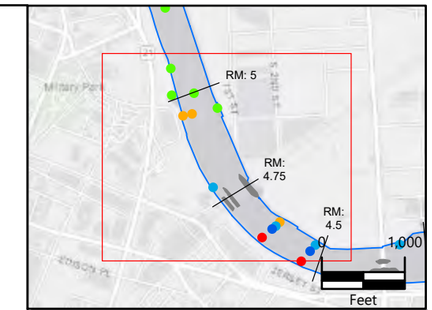
Figure 1-6g

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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- Subreach Boundary
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- Multi-Beam Extent
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- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

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- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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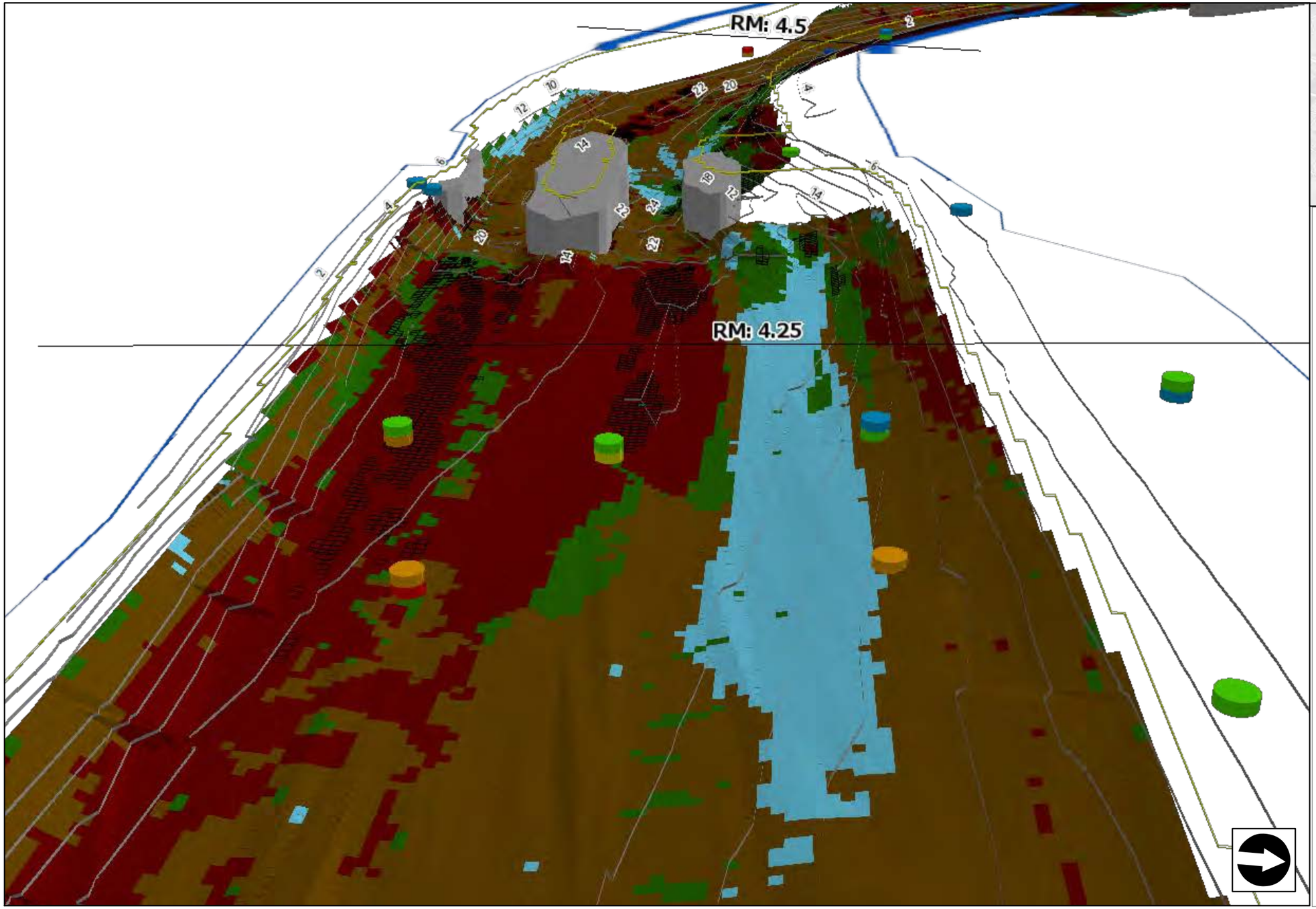
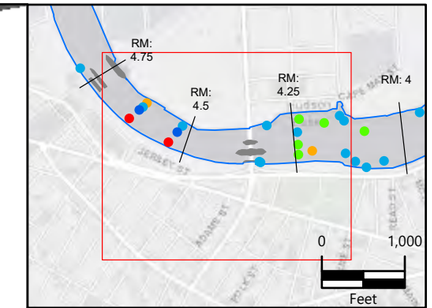
Figure 1-7a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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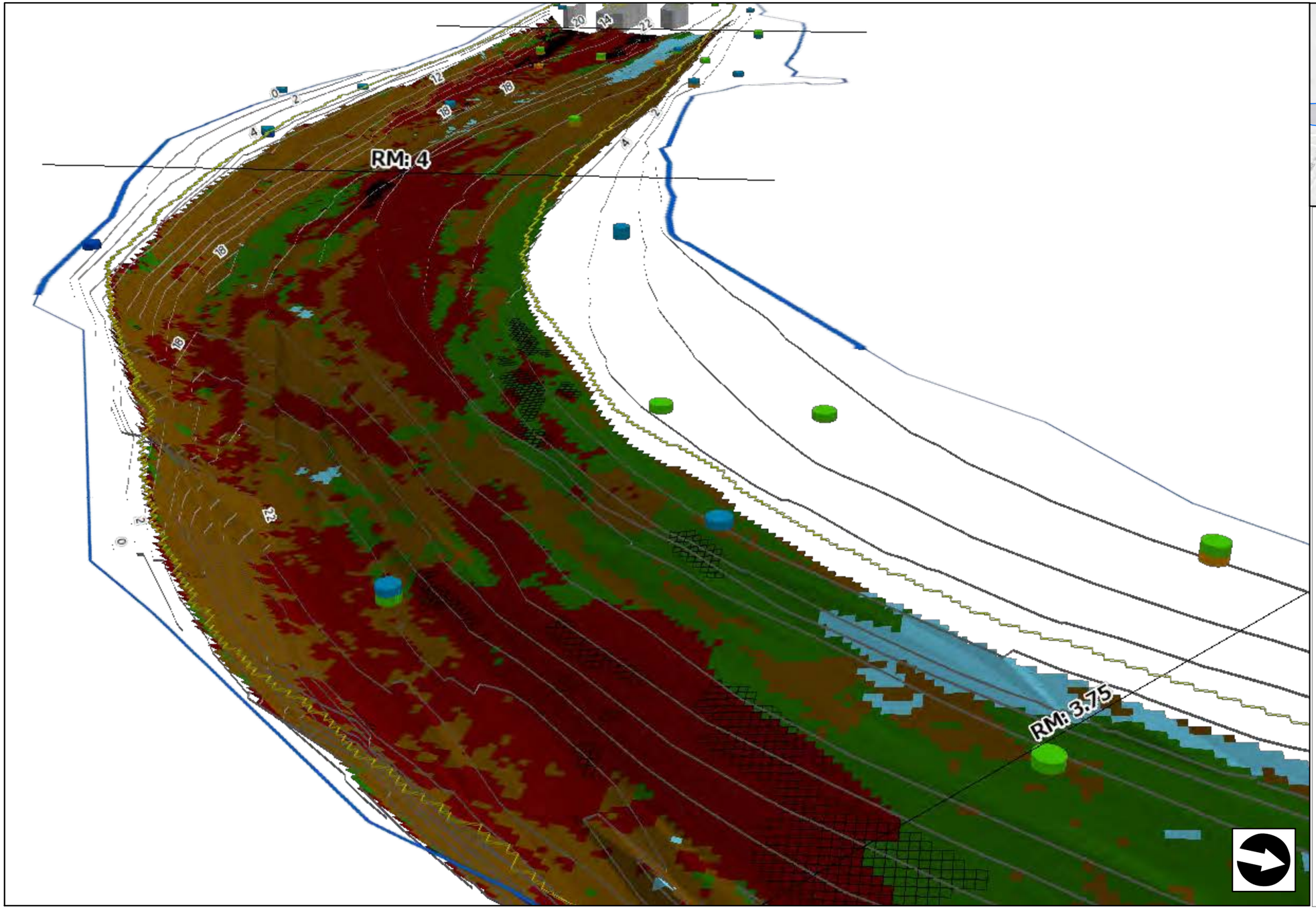
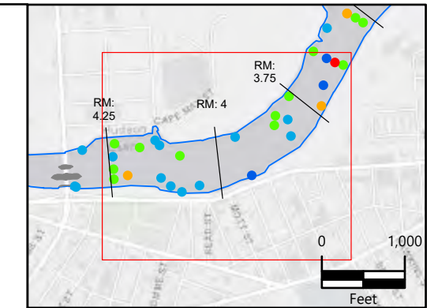
Figure 1-7b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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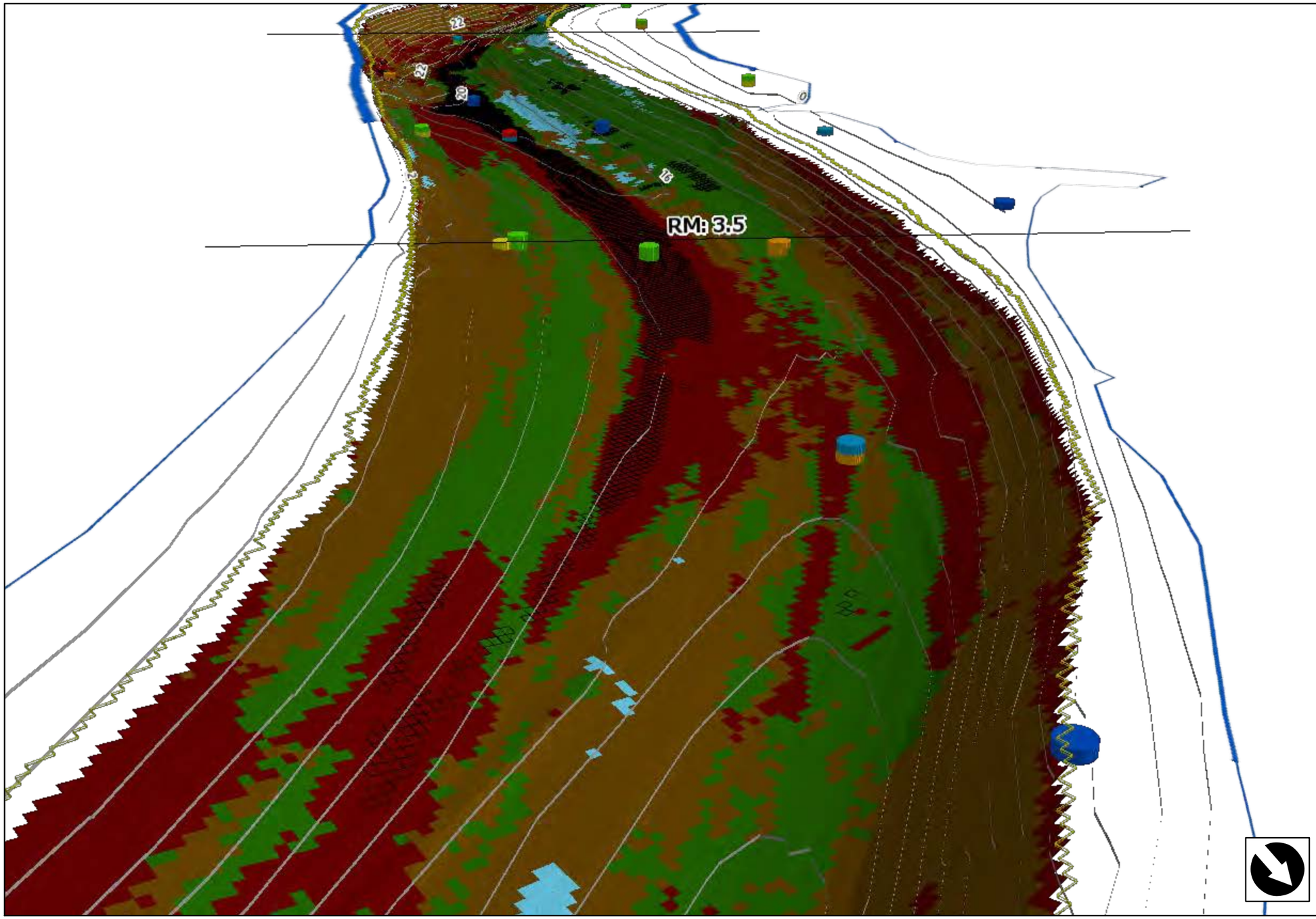
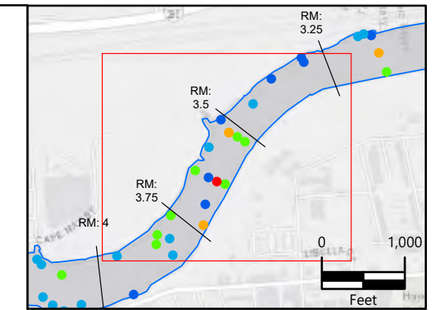
Figure 1-7c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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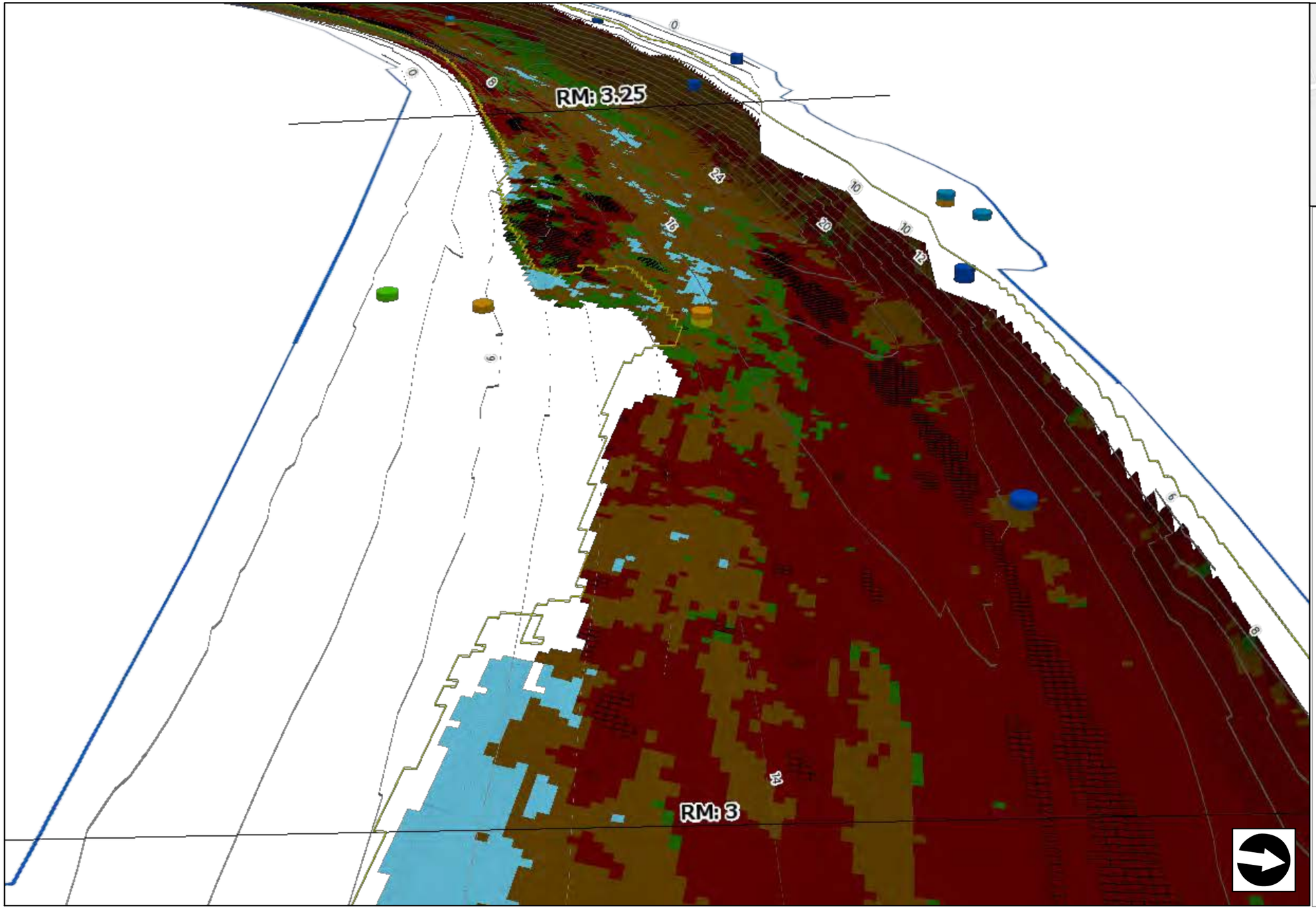
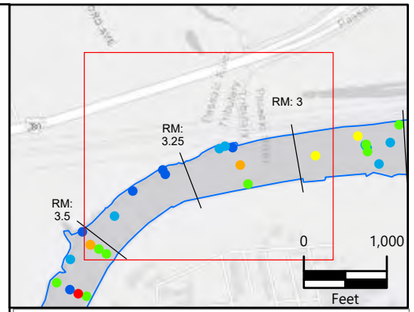
Figure 1-7d

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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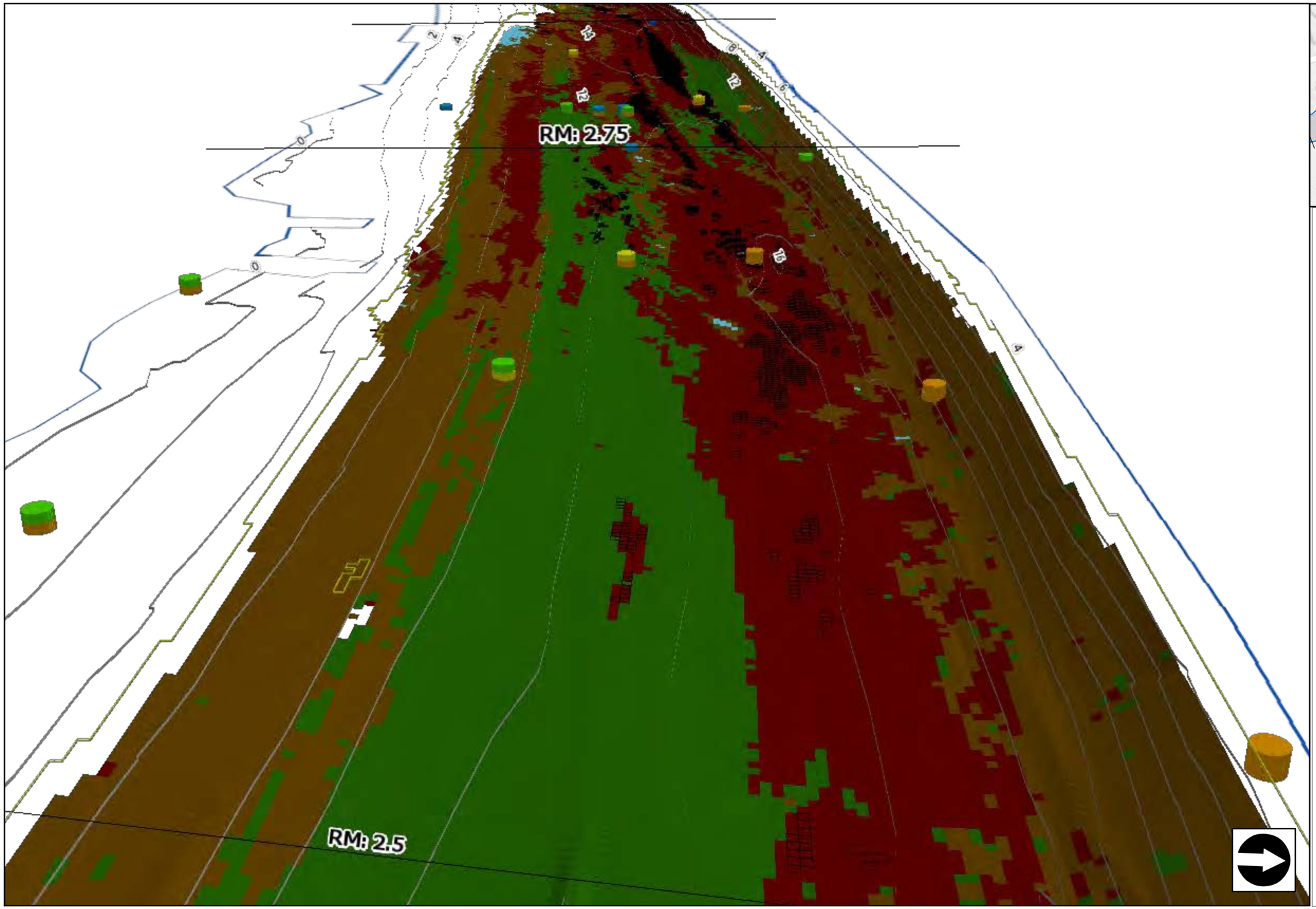
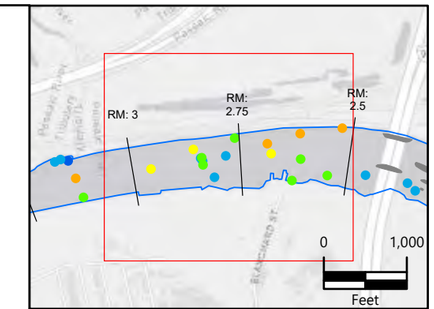
Figure 1-7e

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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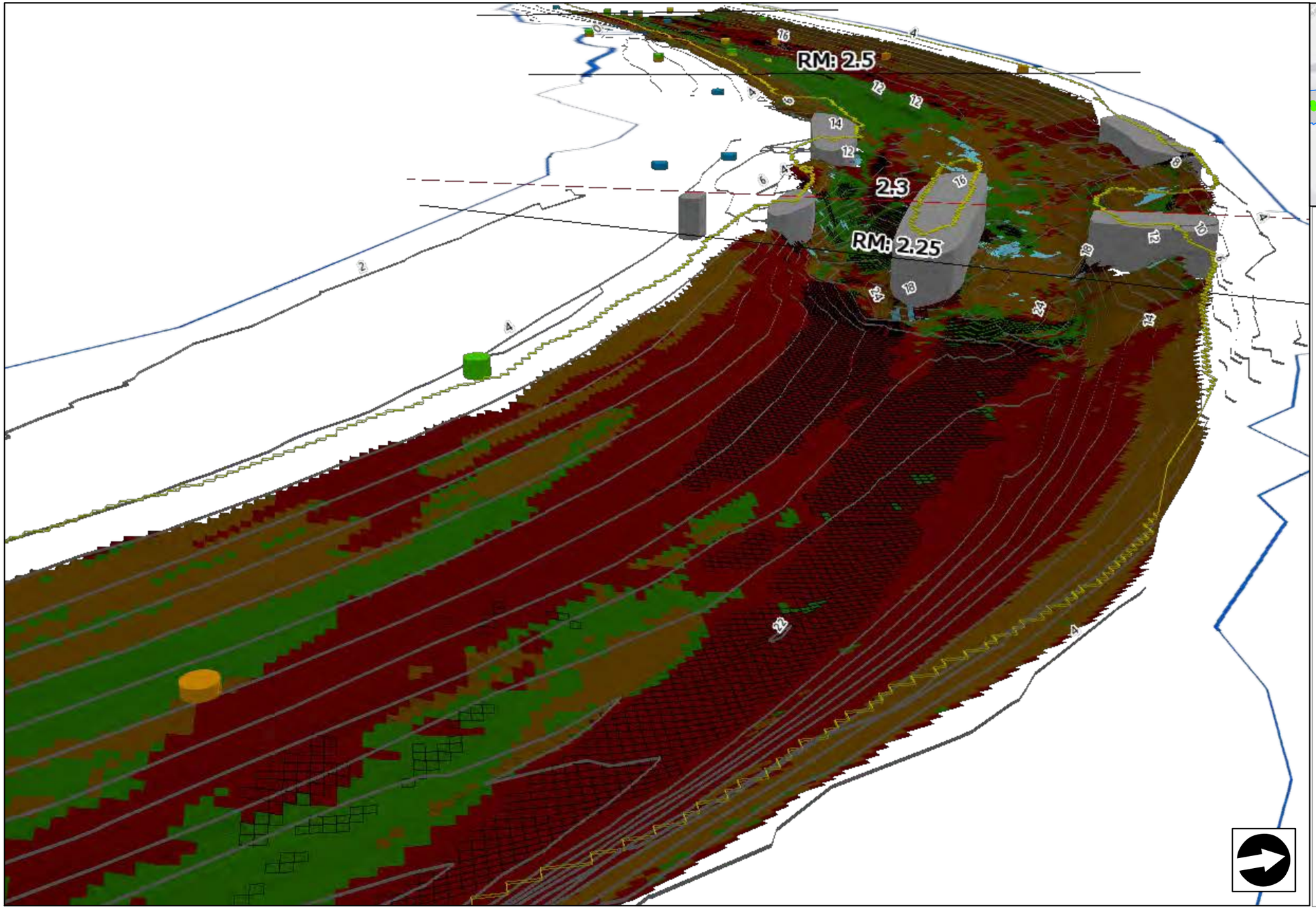
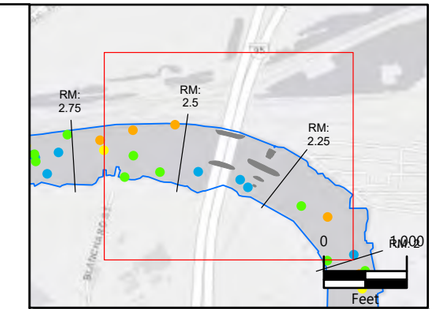
Figure 1-7f

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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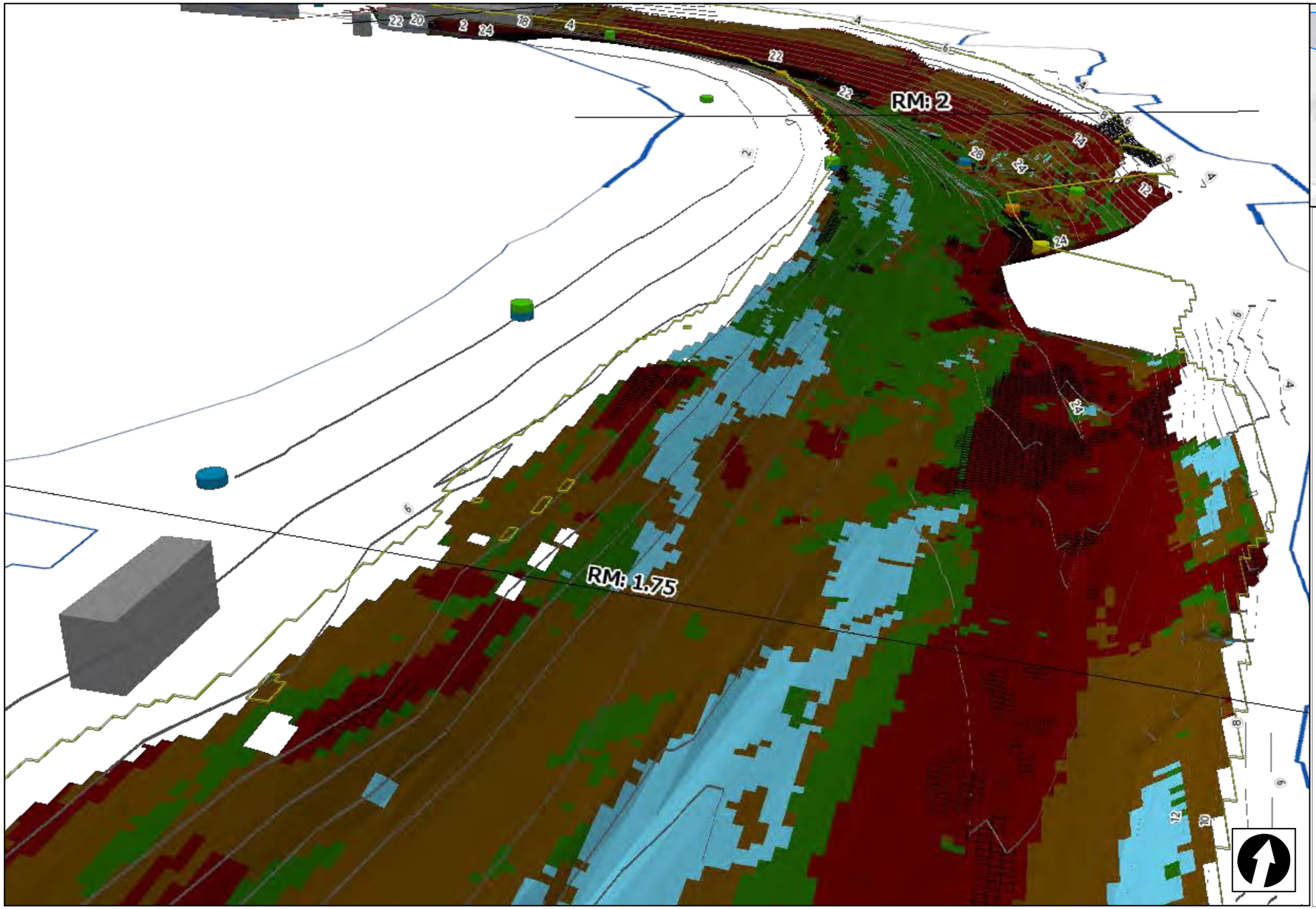
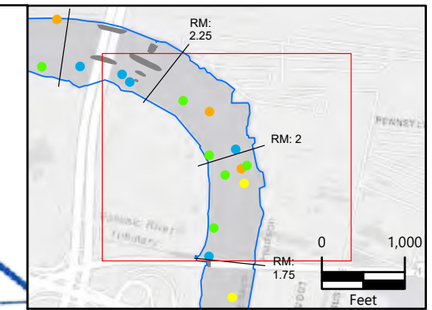
Figure 1-7g

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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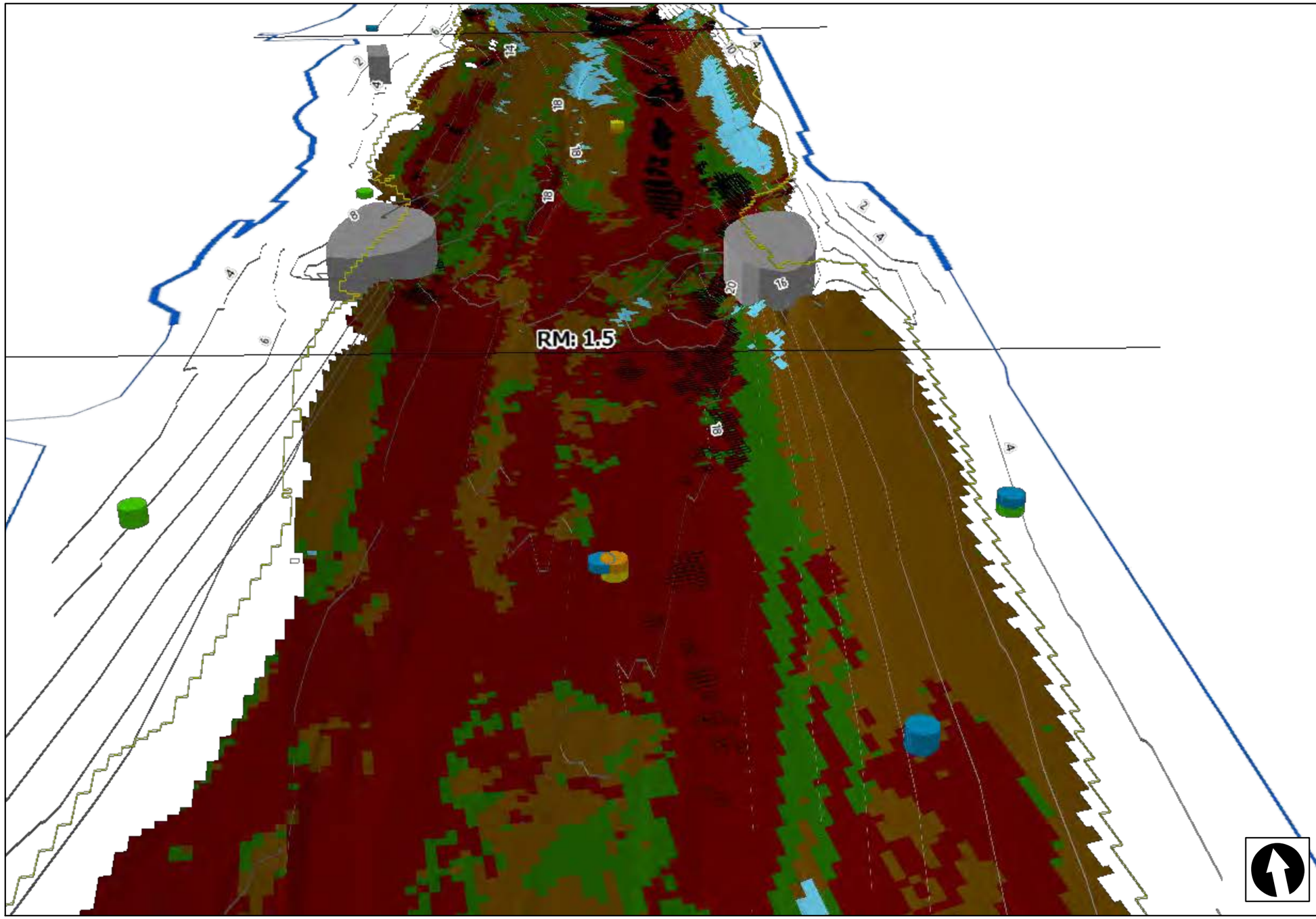
Figure 1-8a

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study



LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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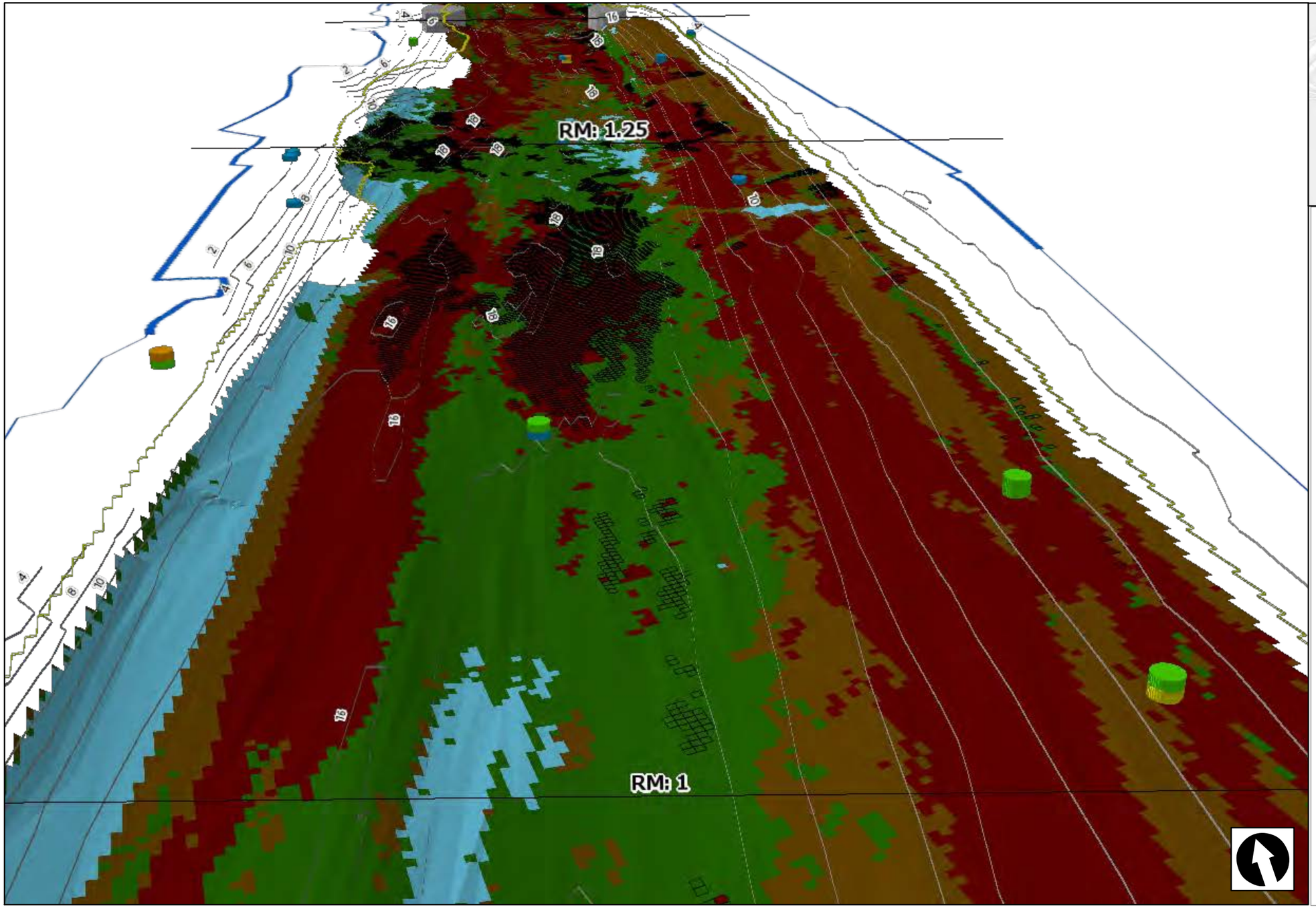
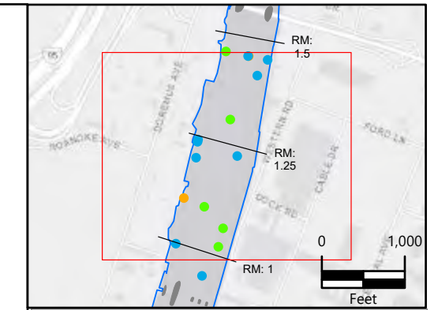
Figure 1-8b

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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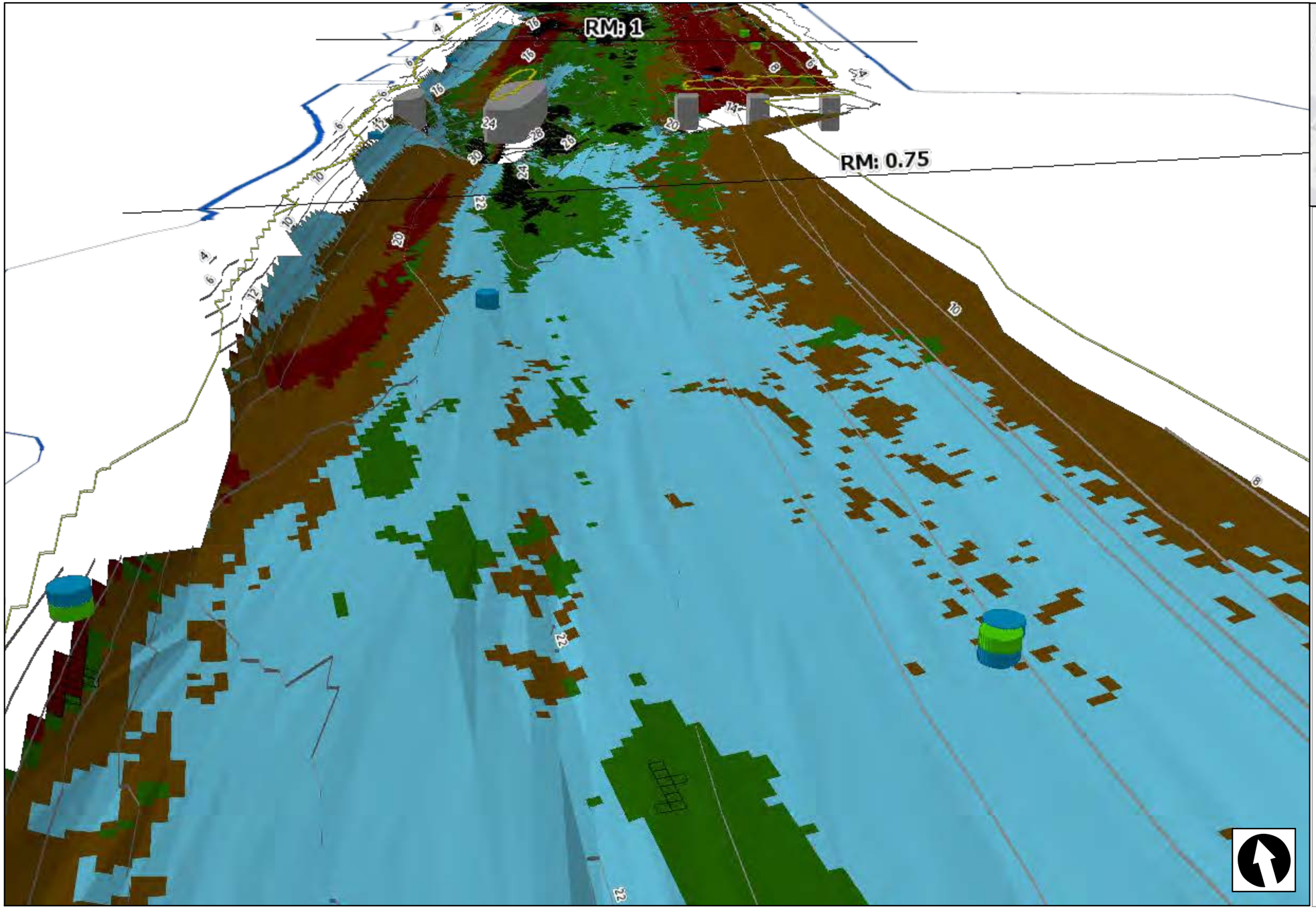
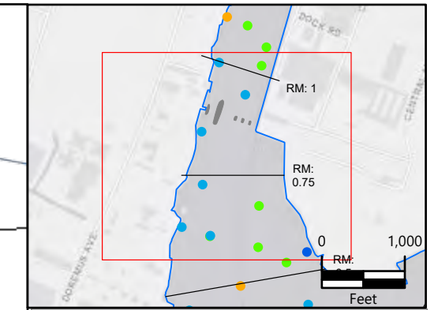
Figure 1-8c

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period. Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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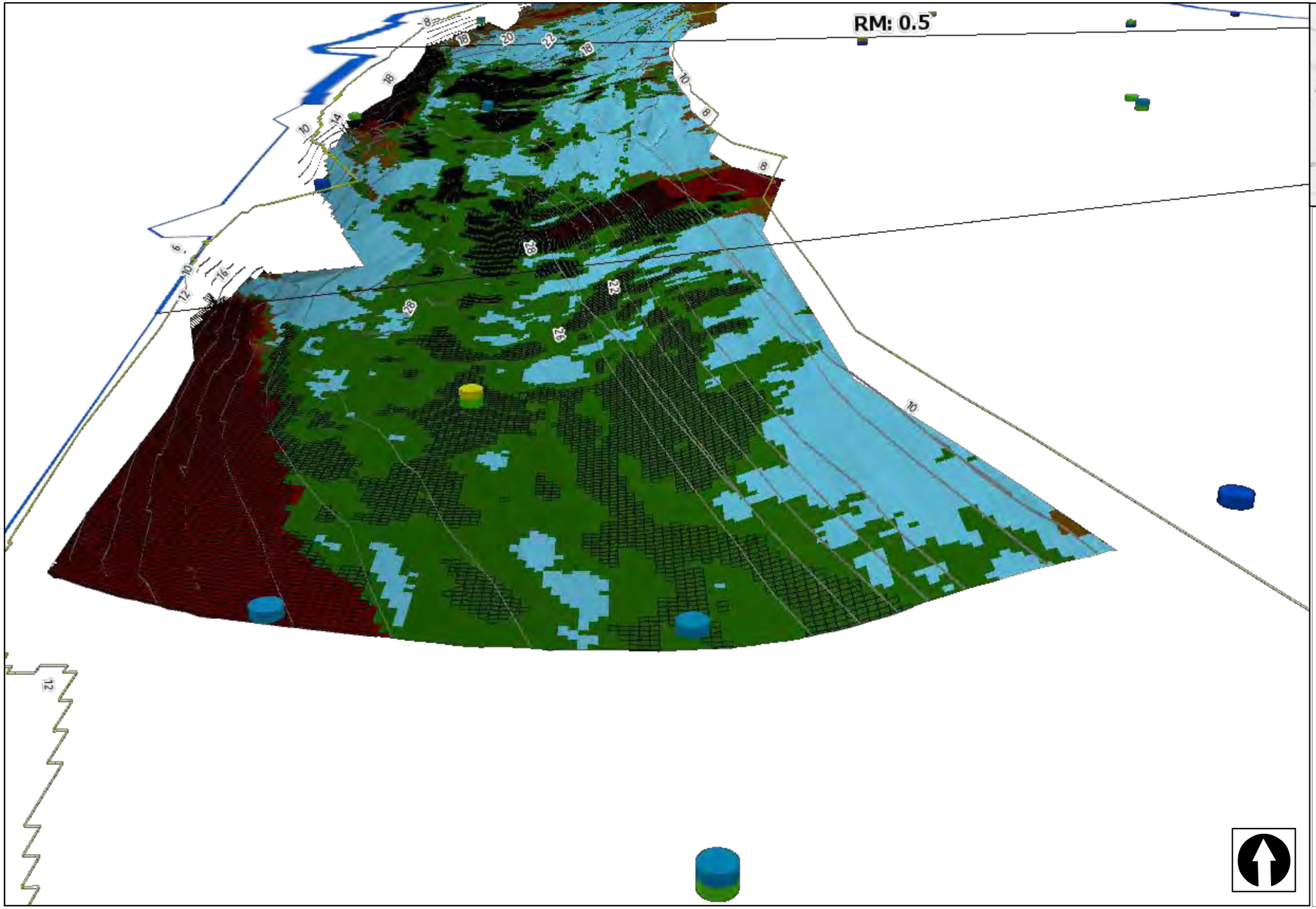
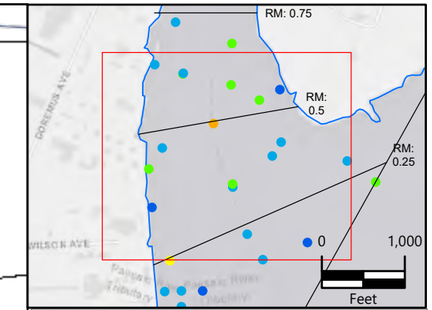
Figure 1-8d

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total PCB Concentration (mg/kg)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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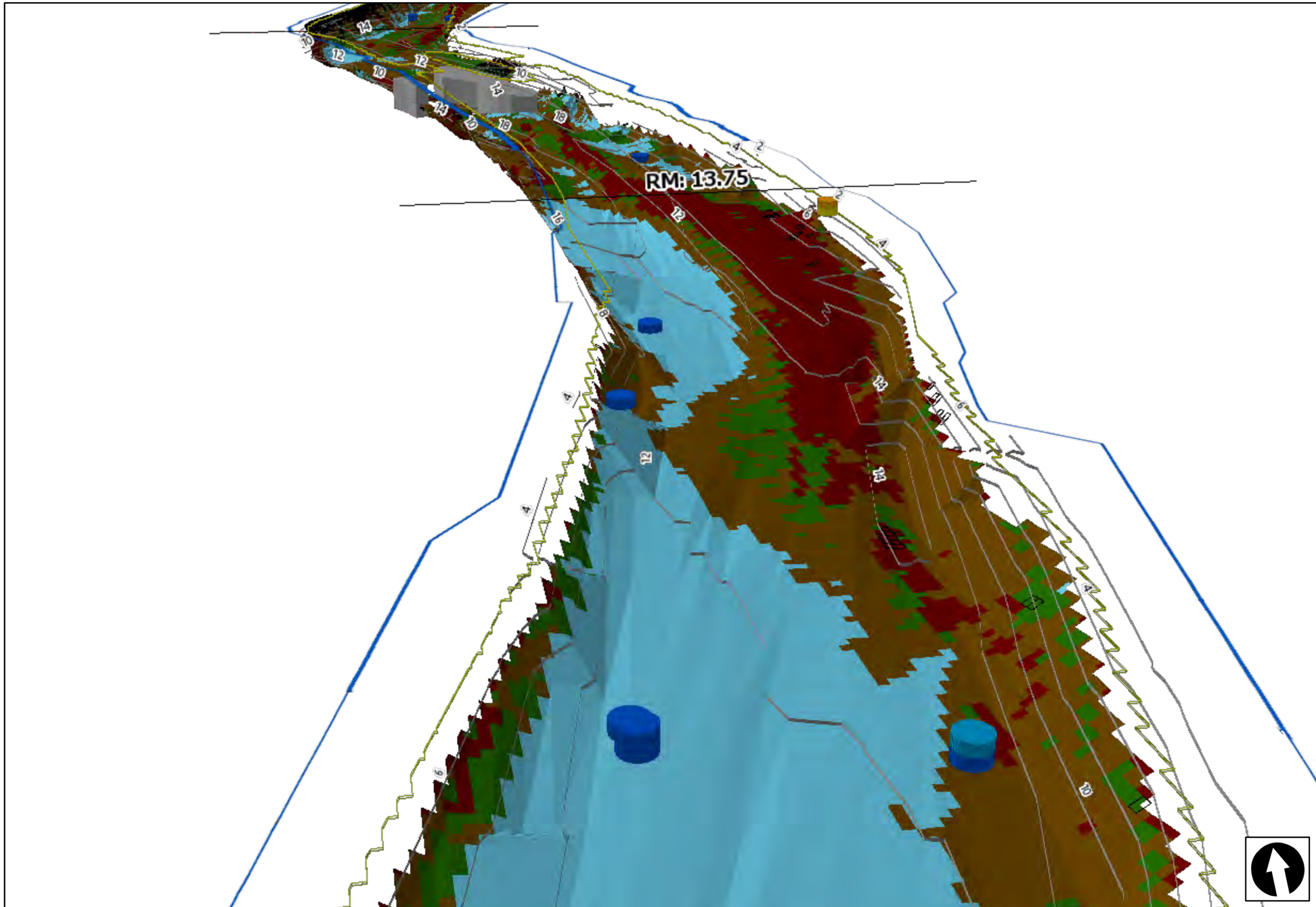
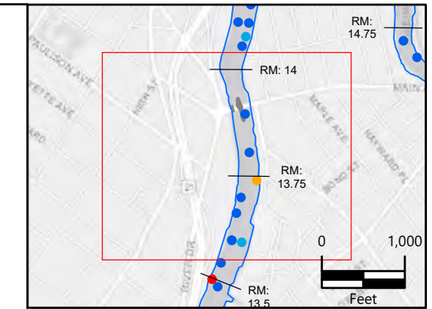
Figure 1-8e

Total PCB Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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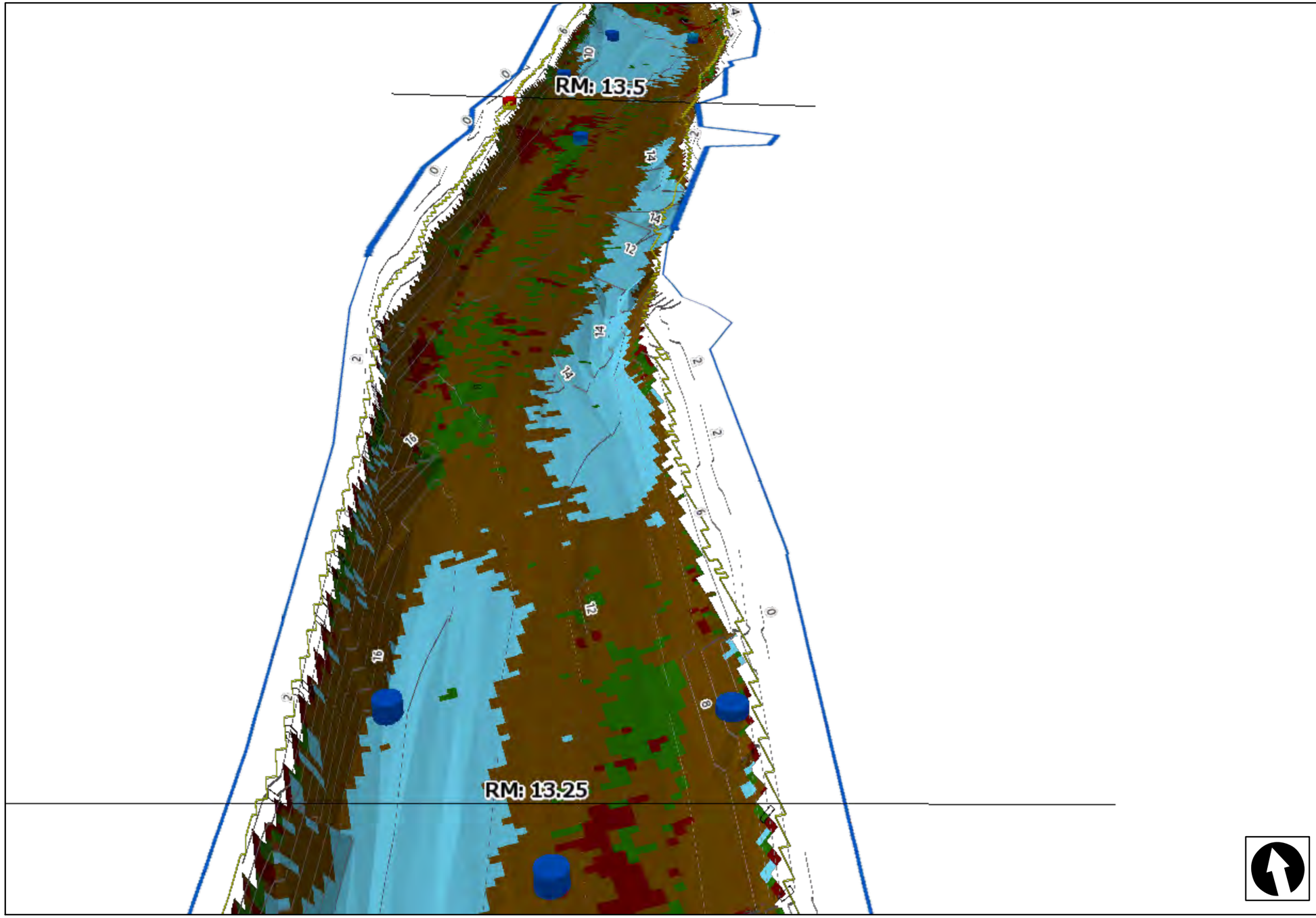
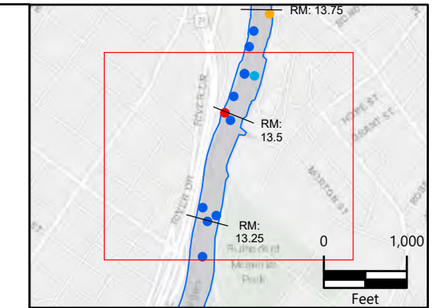
Figure 2-1a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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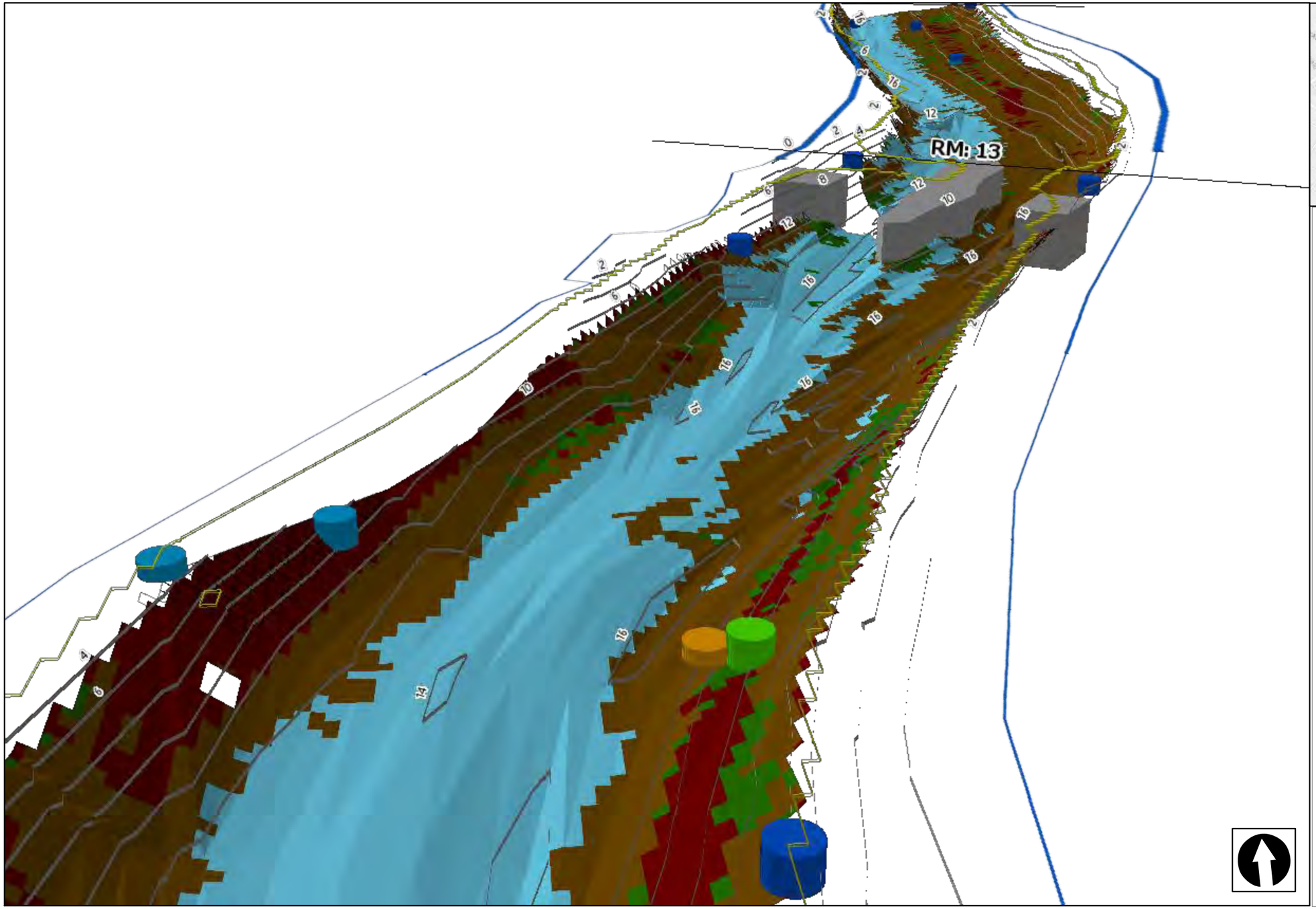
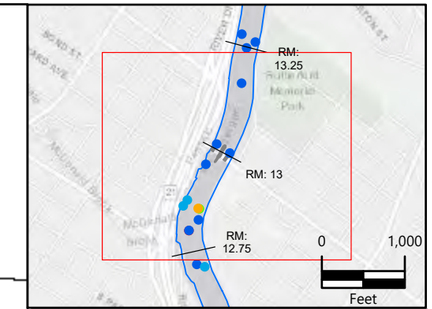
Figure 2-1b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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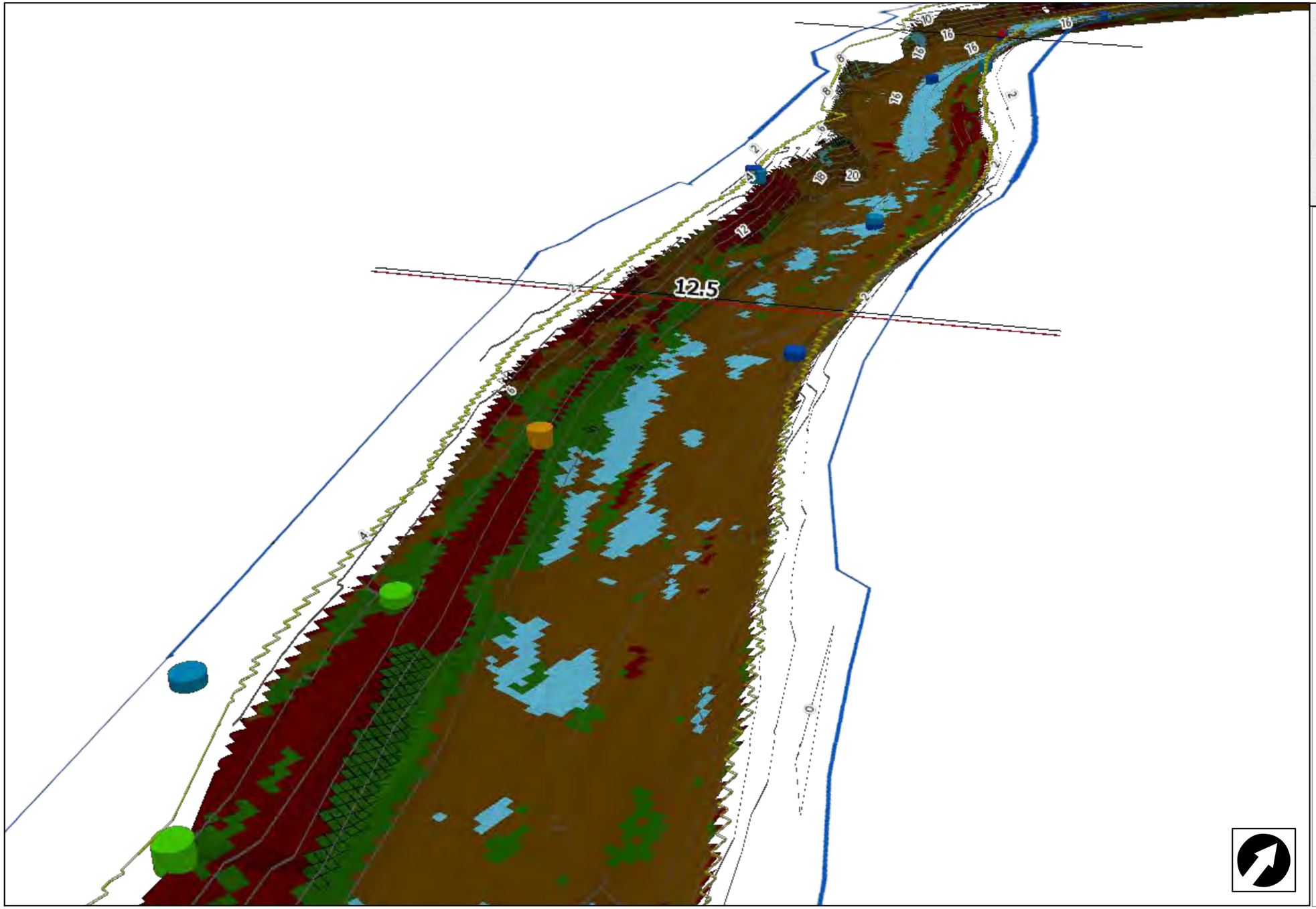
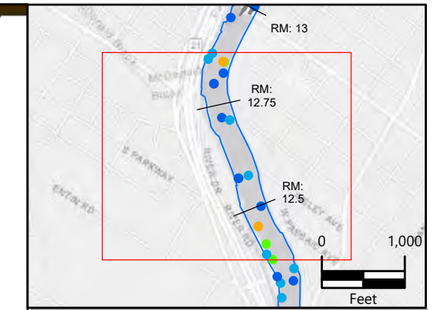
Figure 2-1c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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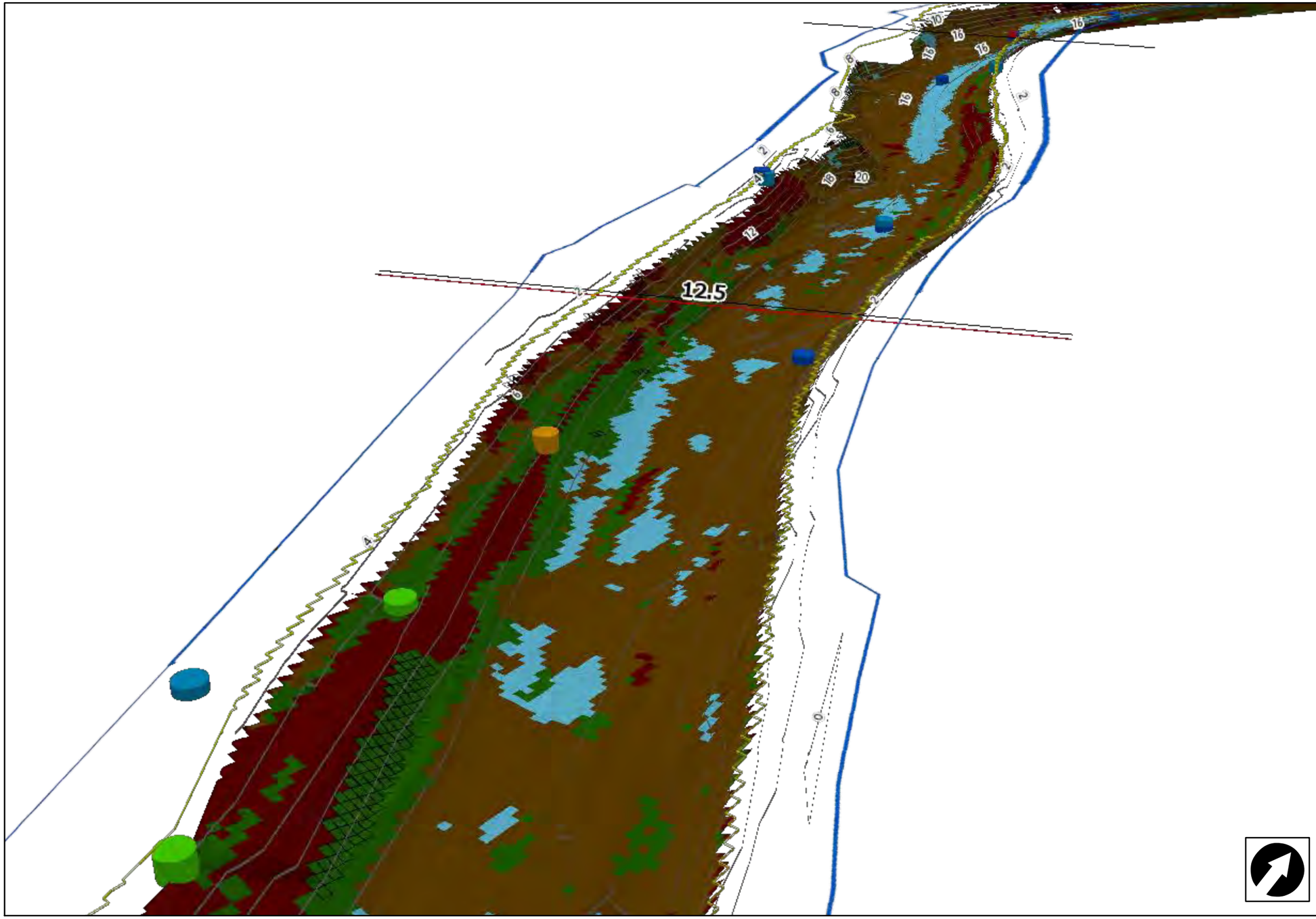
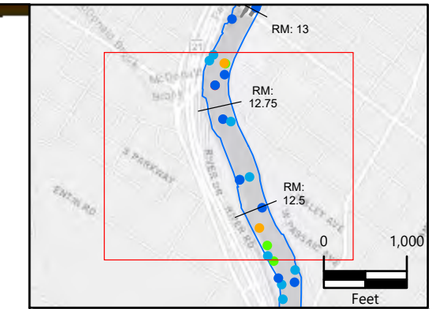
Figure 2-1d

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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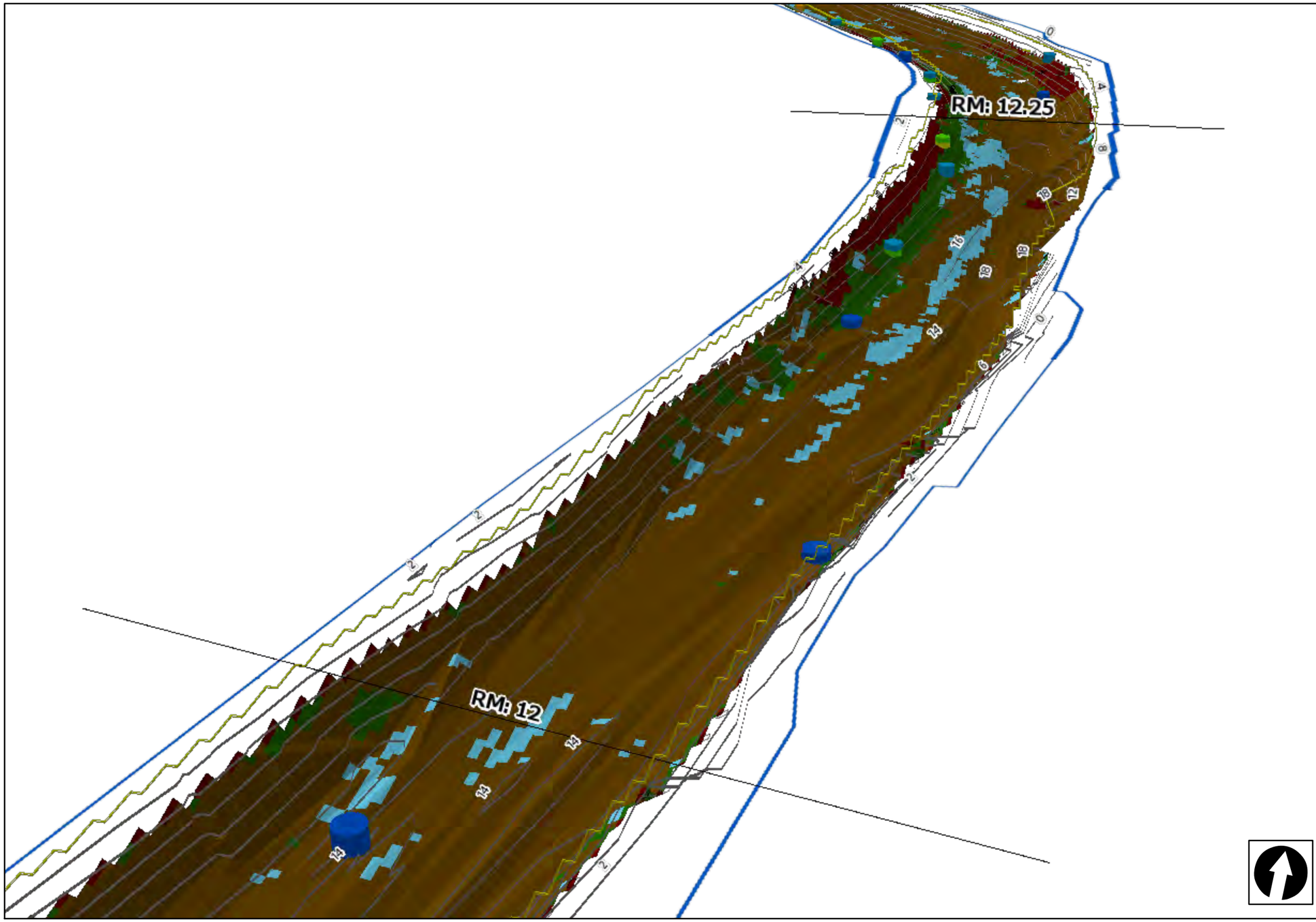
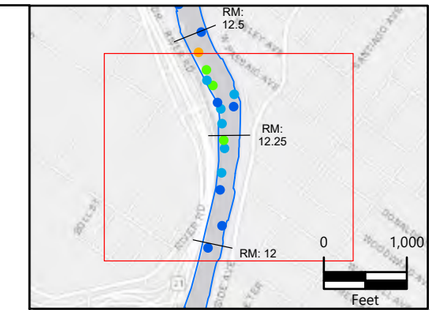
Figure 2-2a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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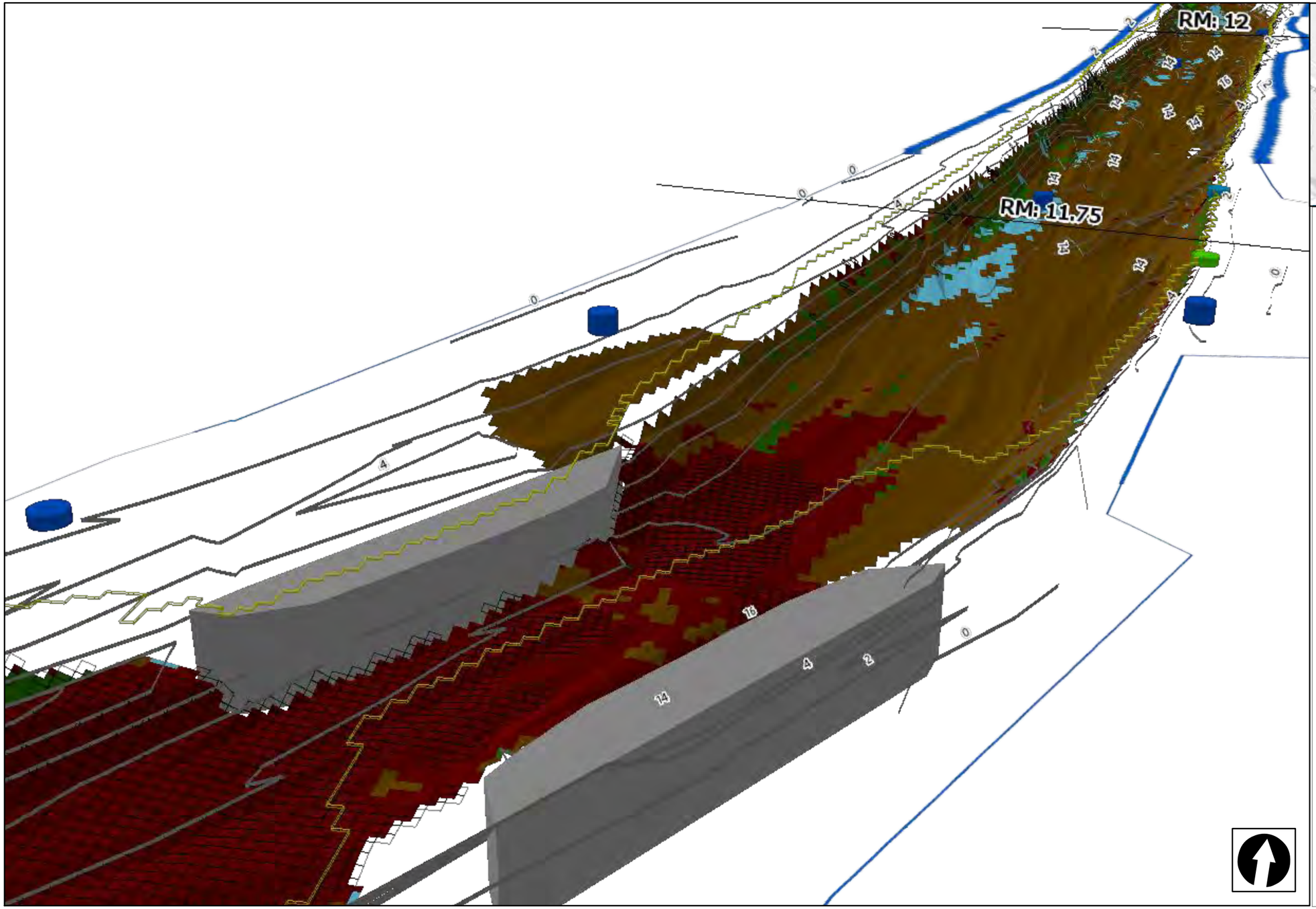
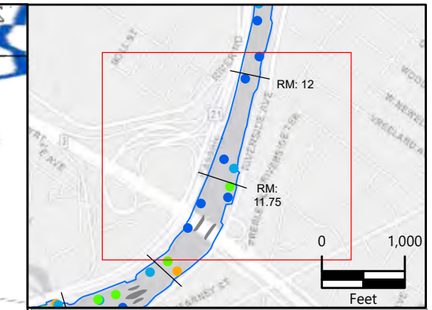
Figure 2-2b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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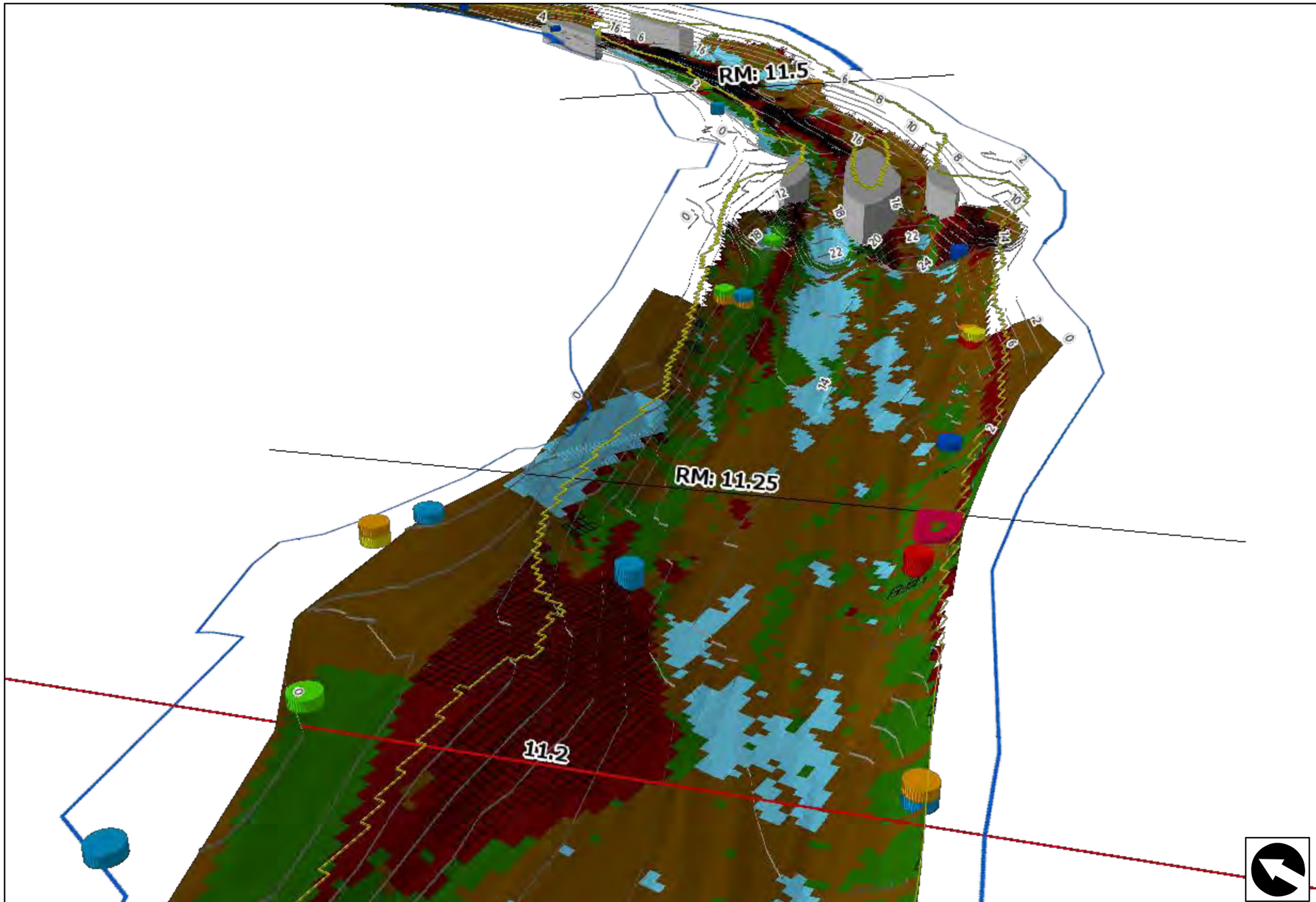
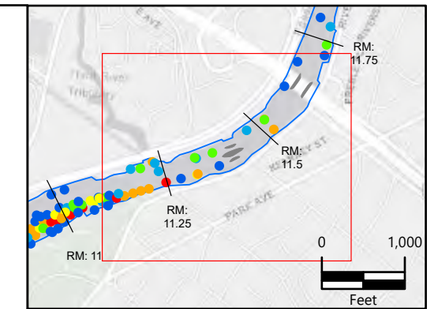
Figure 2-2c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
*A start year of 2007 and end year of 2012 was used for the multi-beam bathymetry. A start year of 2004 and end year of either 2013 or 2012 was used for single-beam bathymetry. Erosion > 1.5 feet is based on the difference between 2007 to 2012 or between the sequential bathymetry surveys in that period. Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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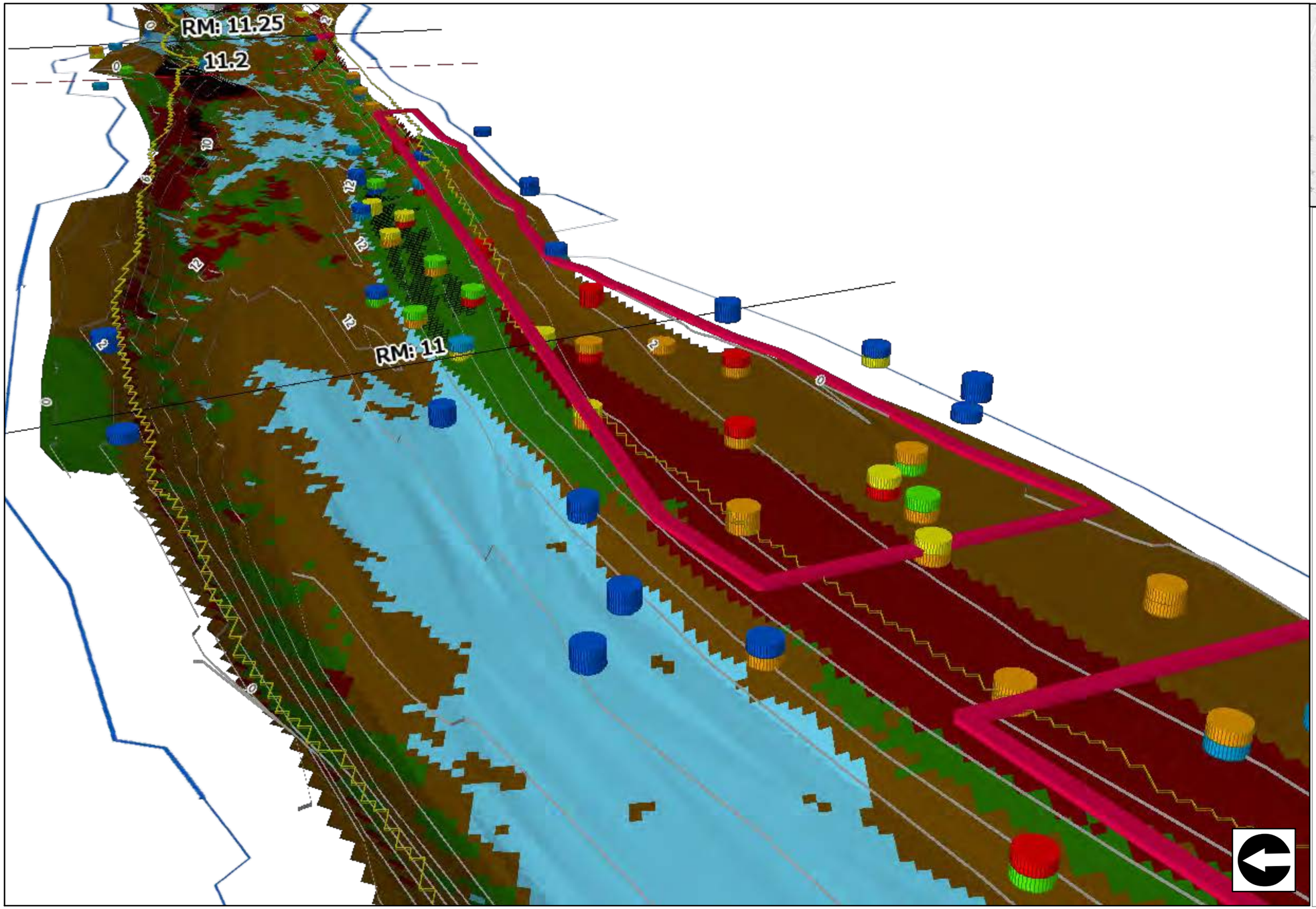
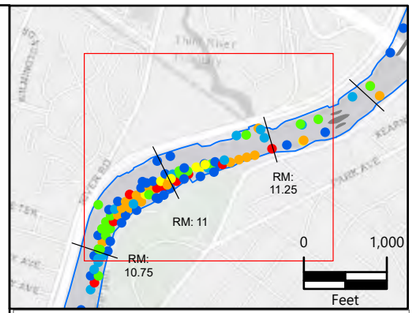
Figure 2-2d

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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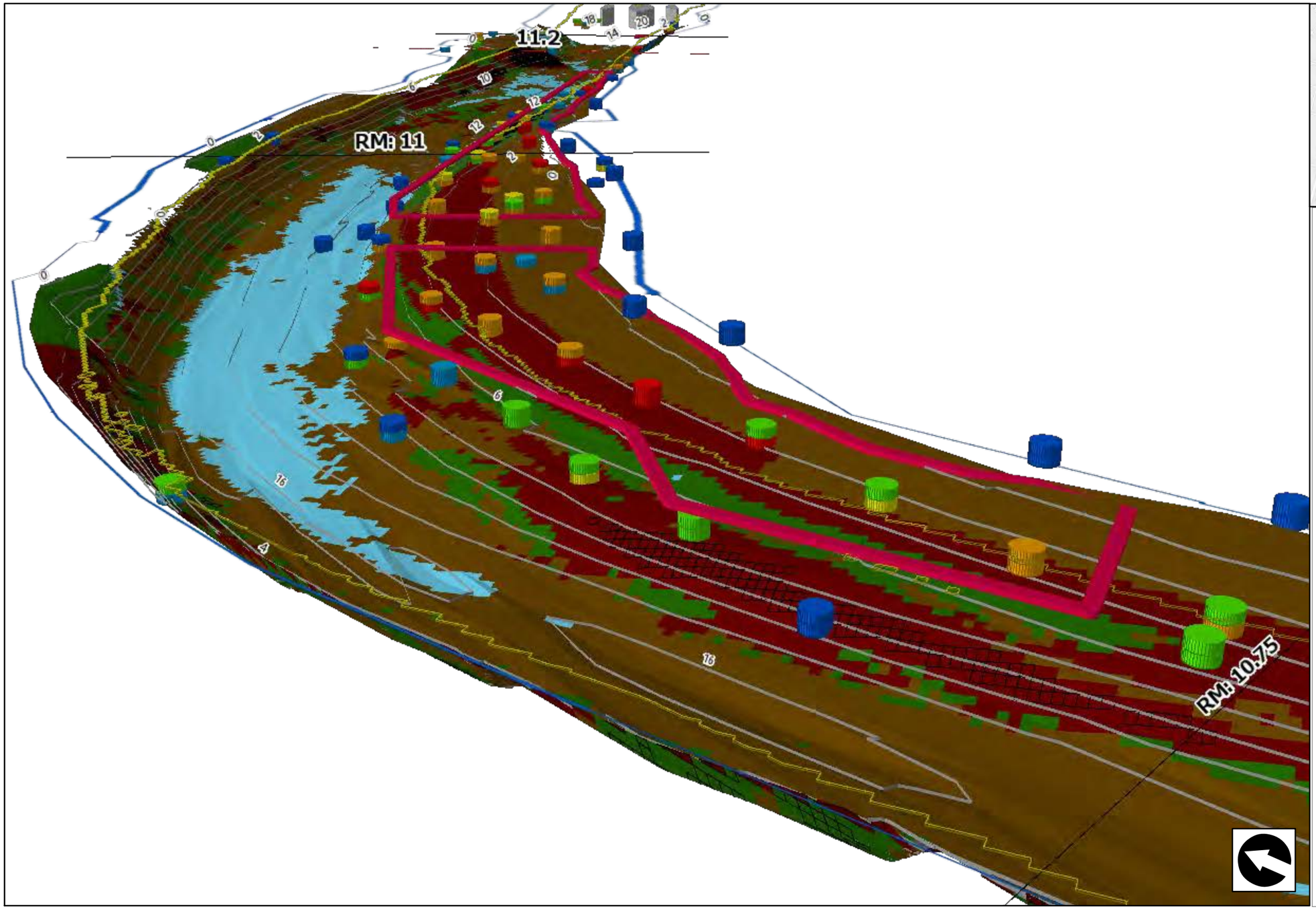
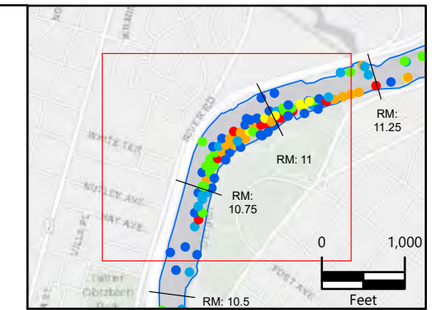
Figure 2-3a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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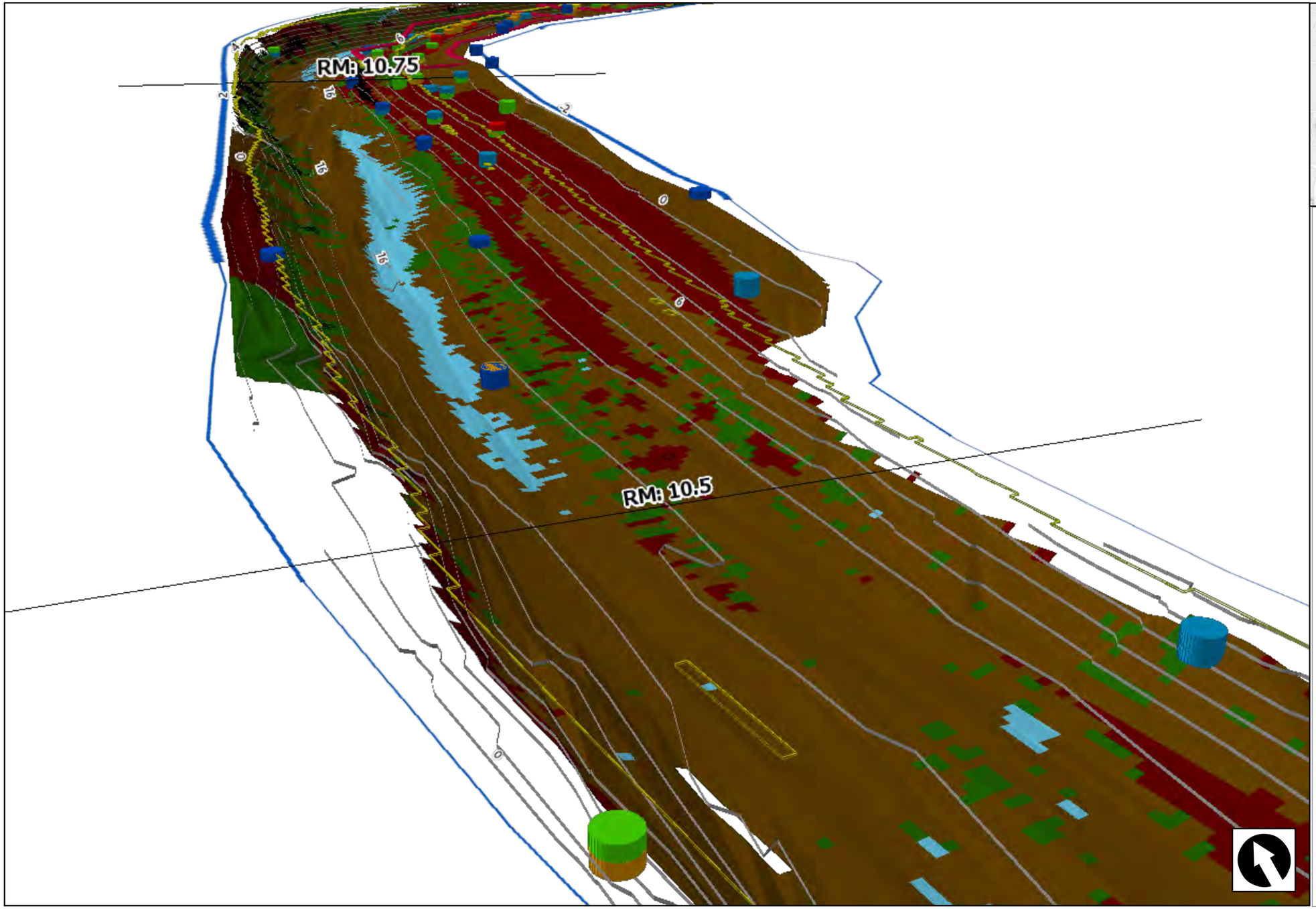
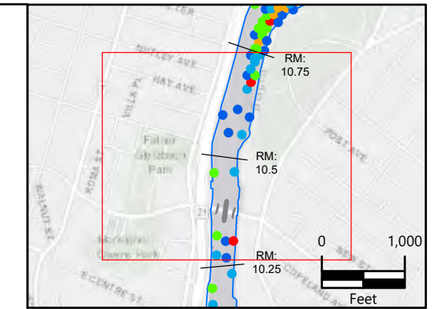
Figure 2-3b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty.
White areas have no bathymetric change category.
Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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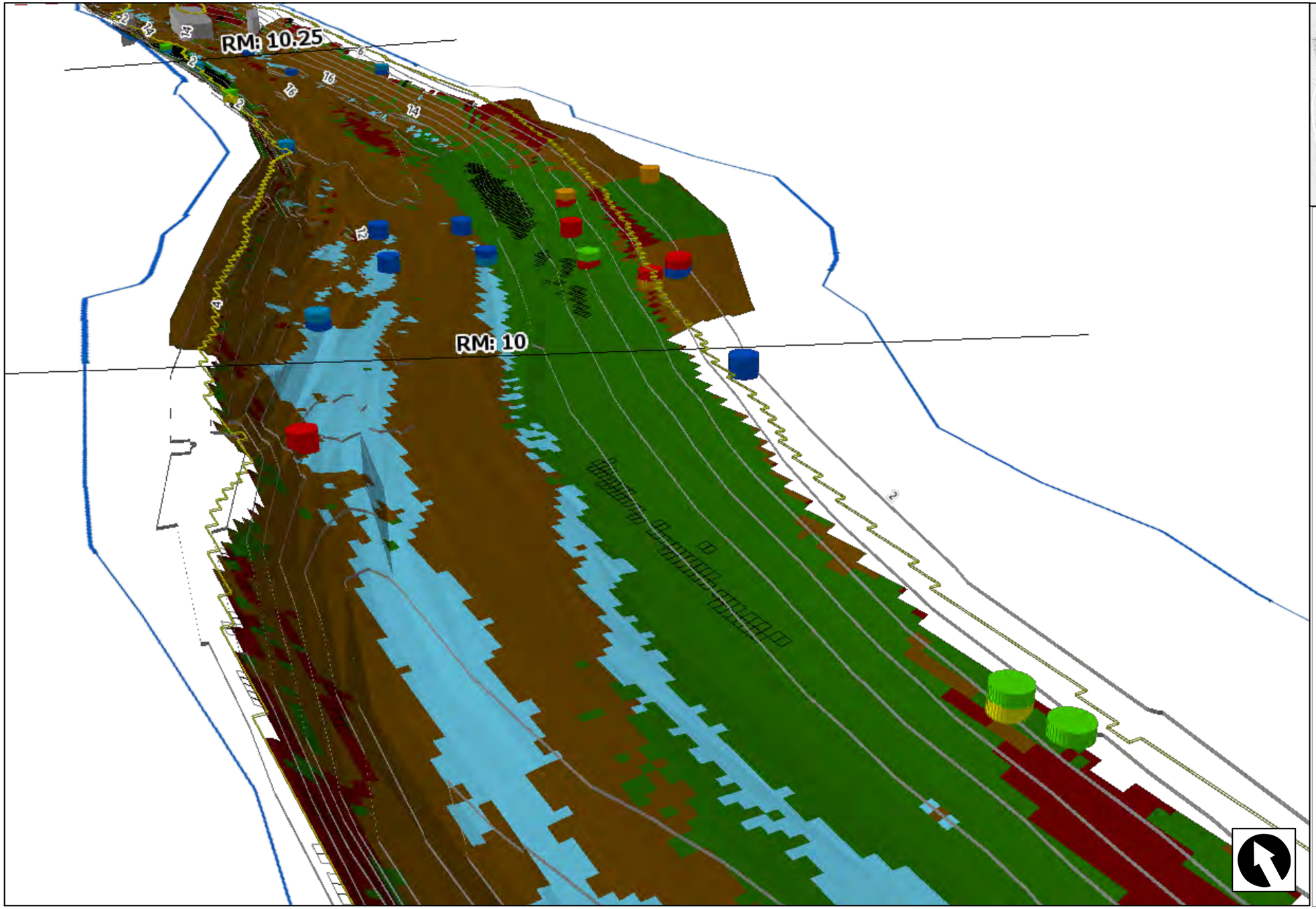
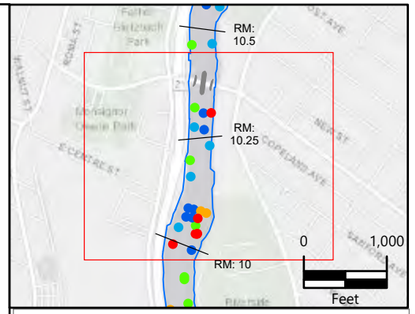
Figure 2-3c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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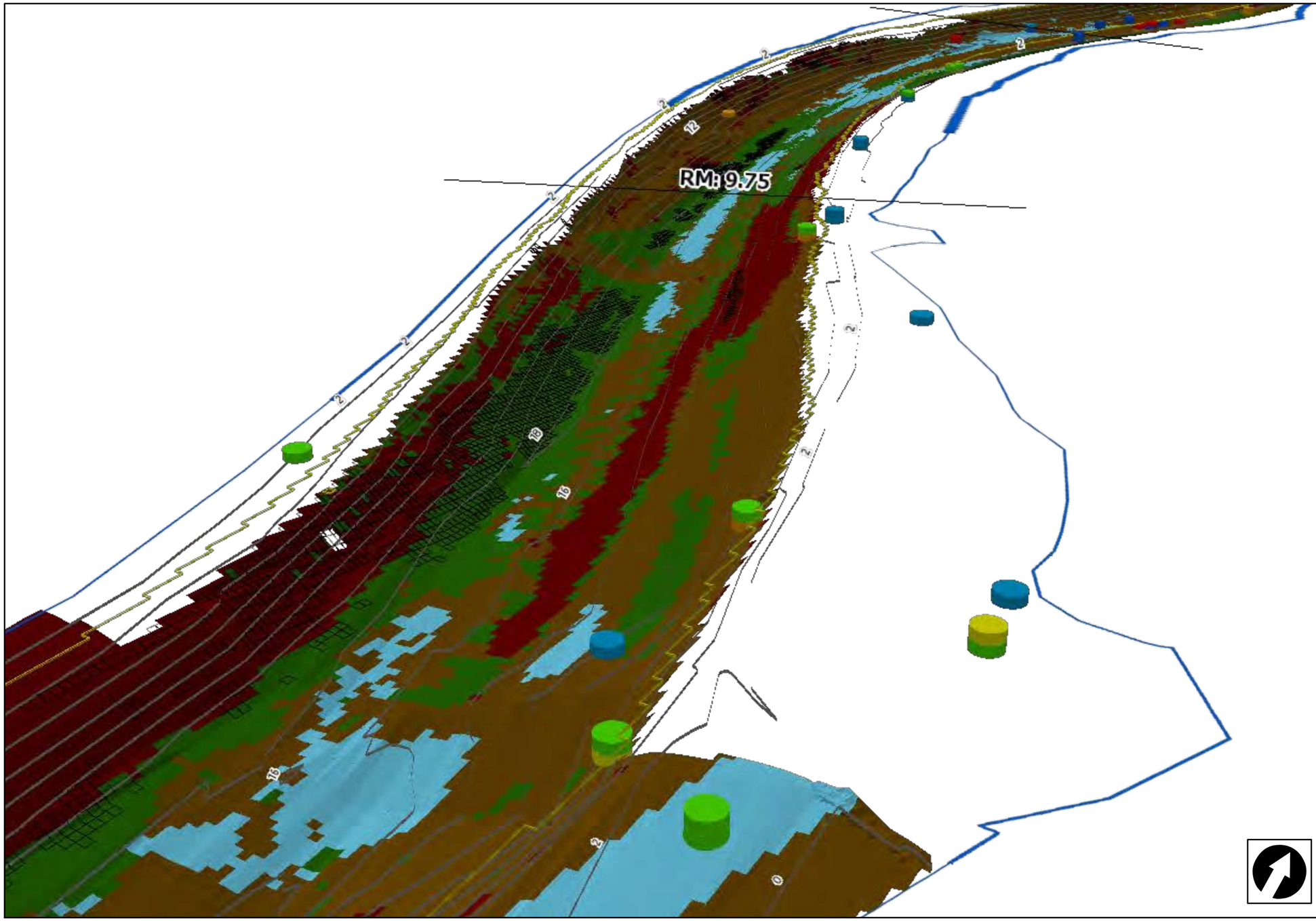
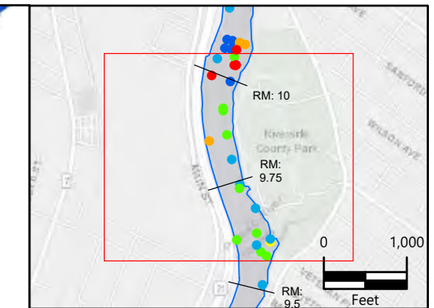
Figure 2-4a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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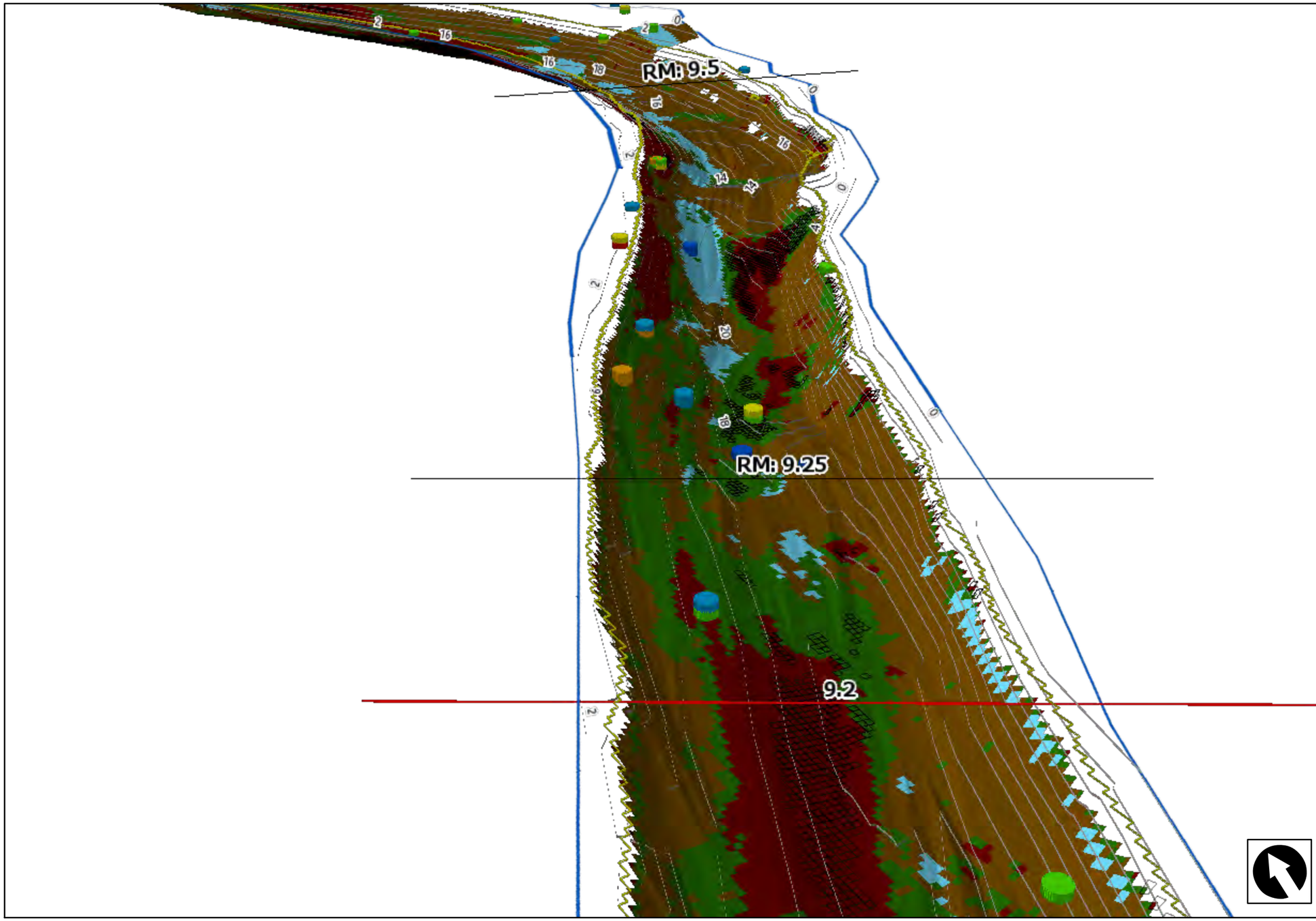
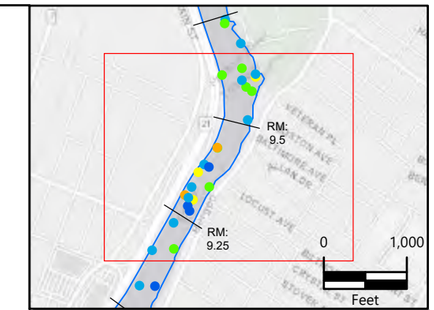
Figure 2-4b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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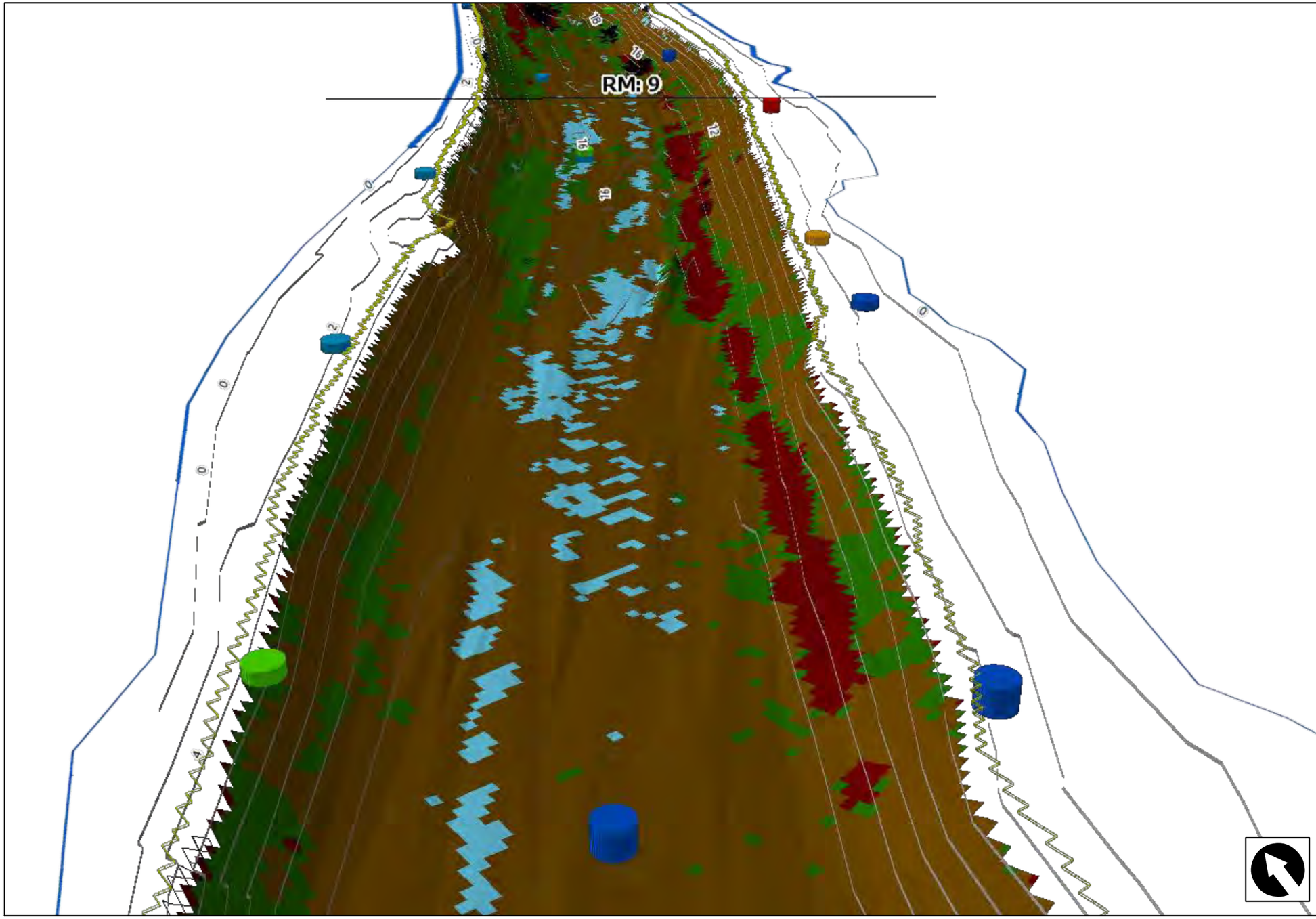
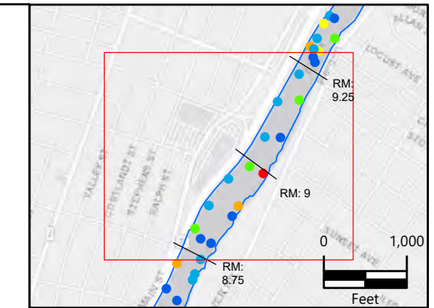
Figure 2-4c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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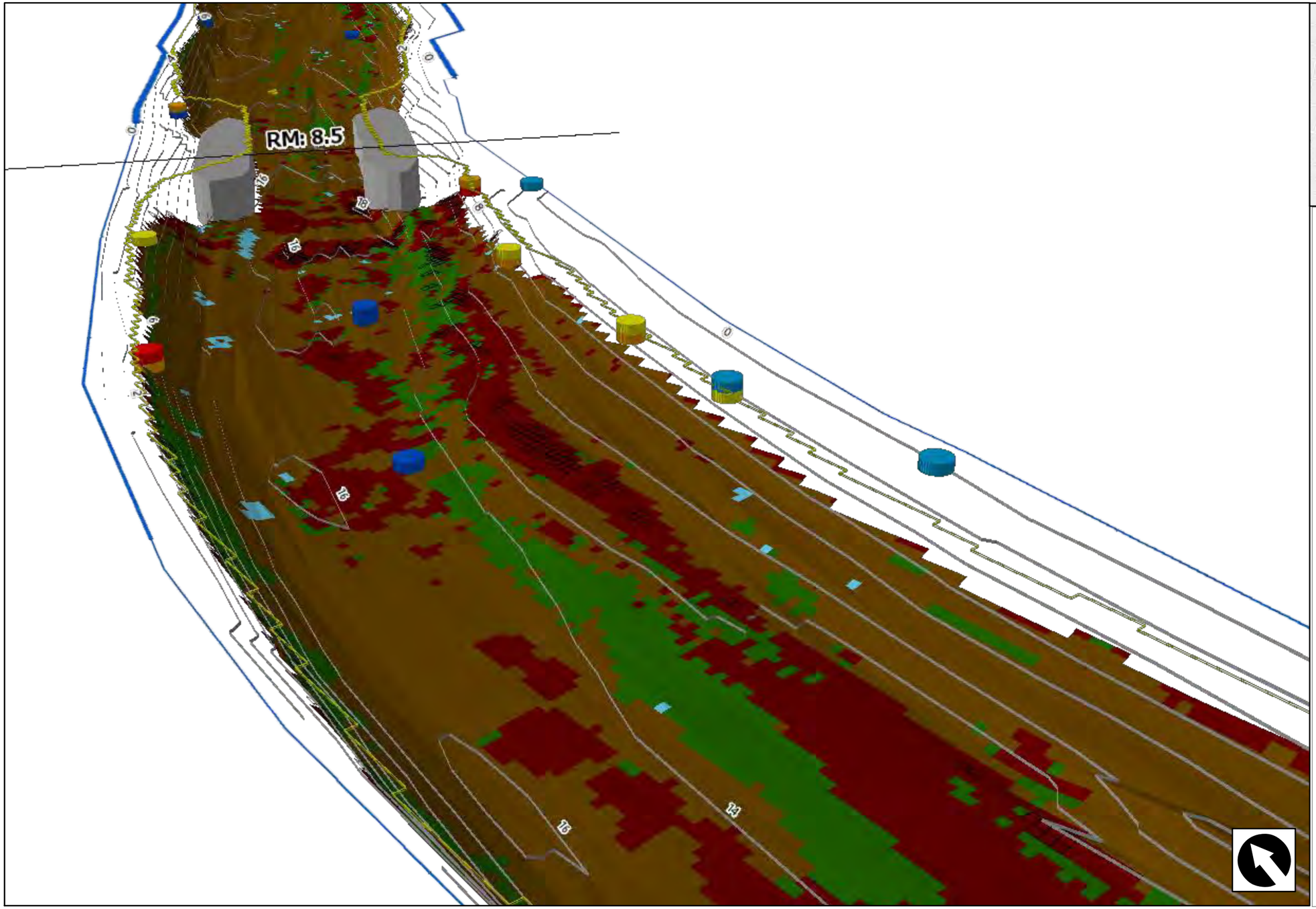
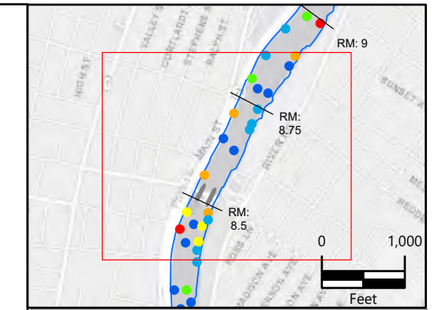
Figure 2-5a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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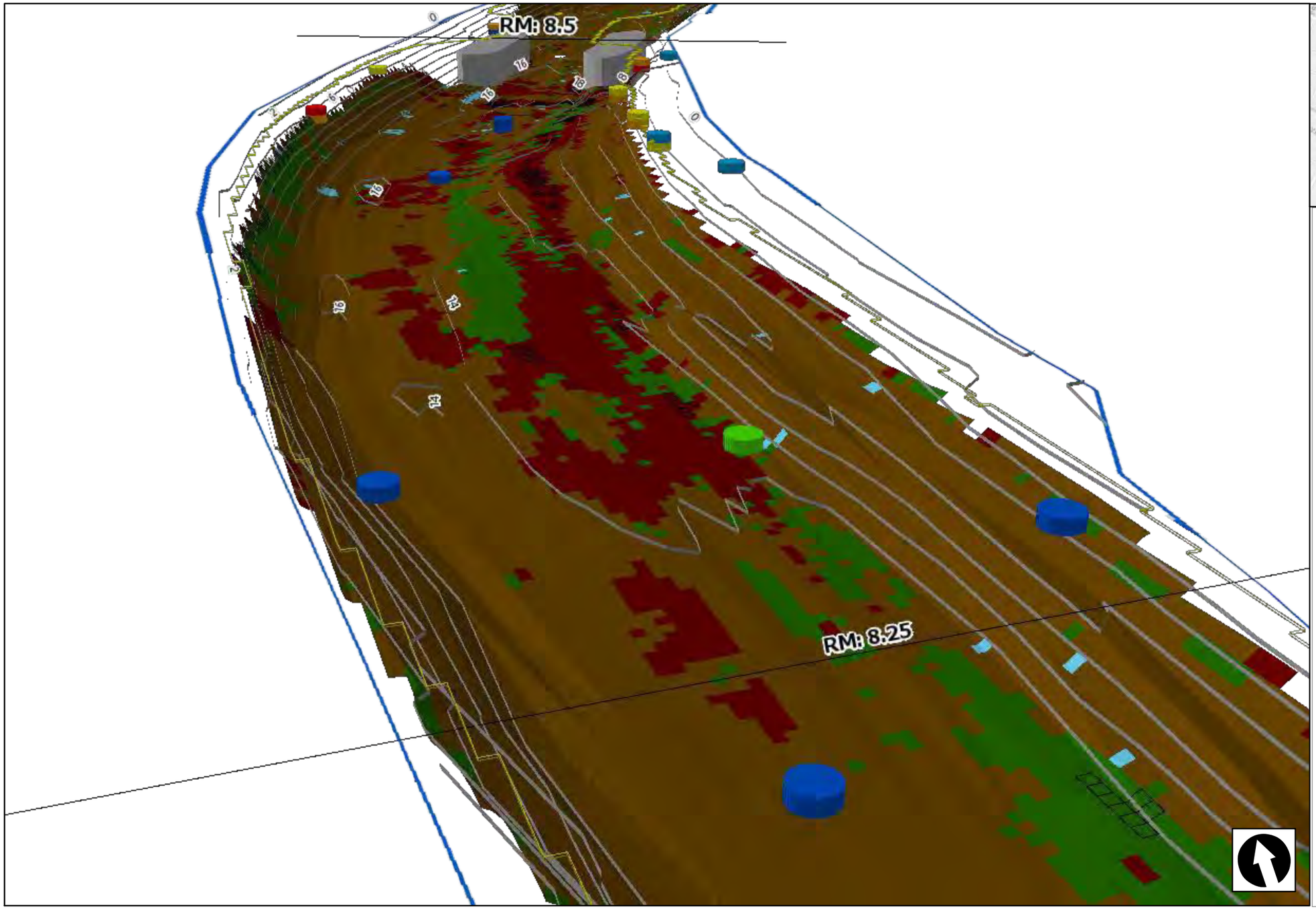
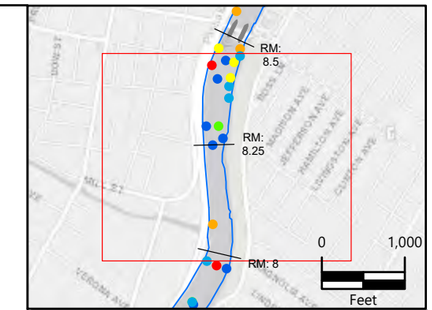
Figure 2-5b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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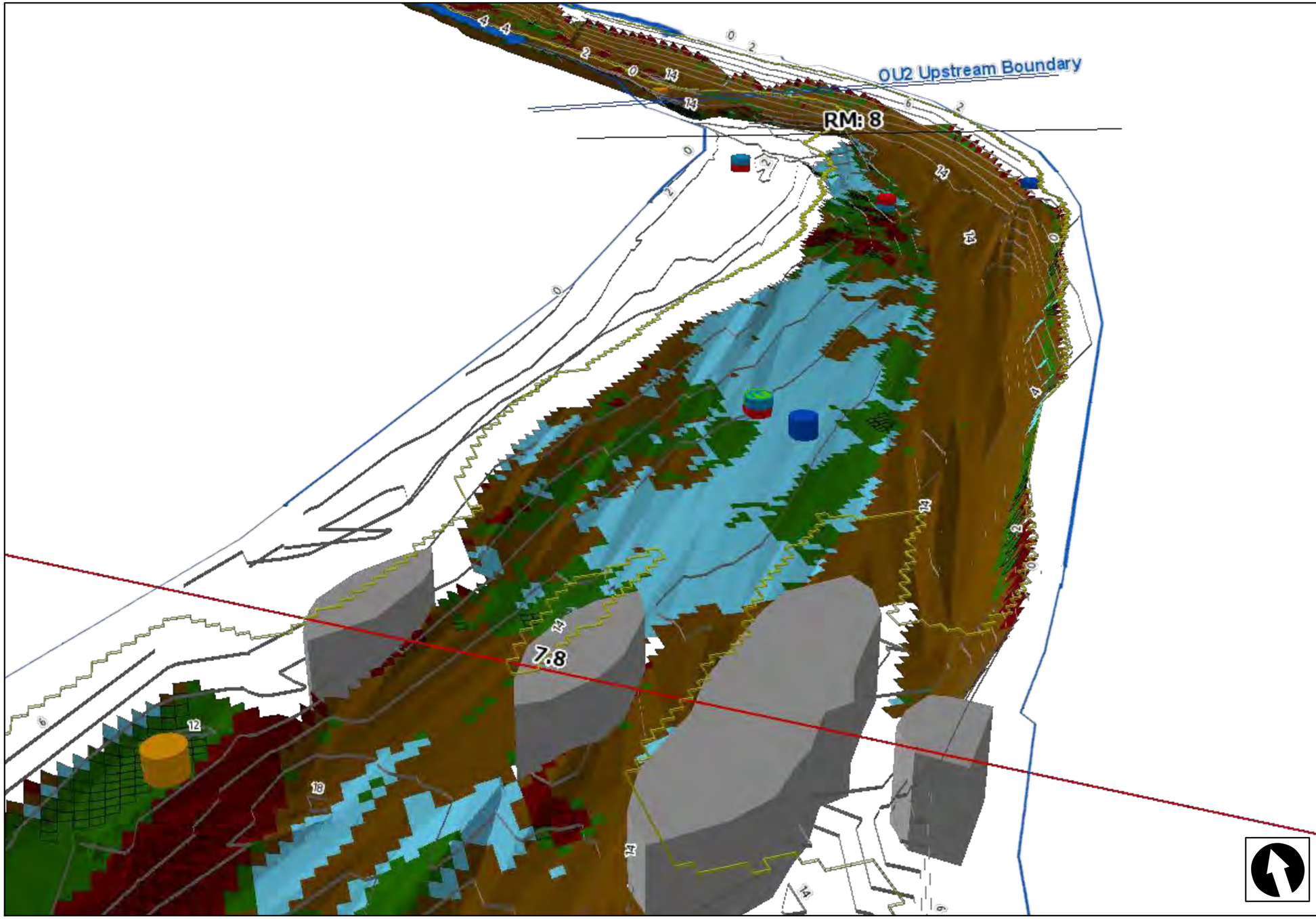
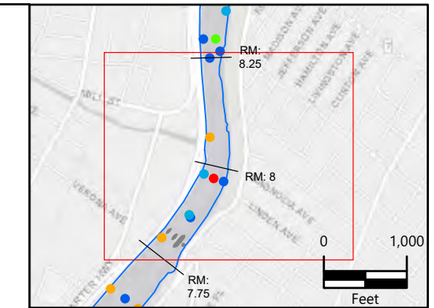
Figure 2-5c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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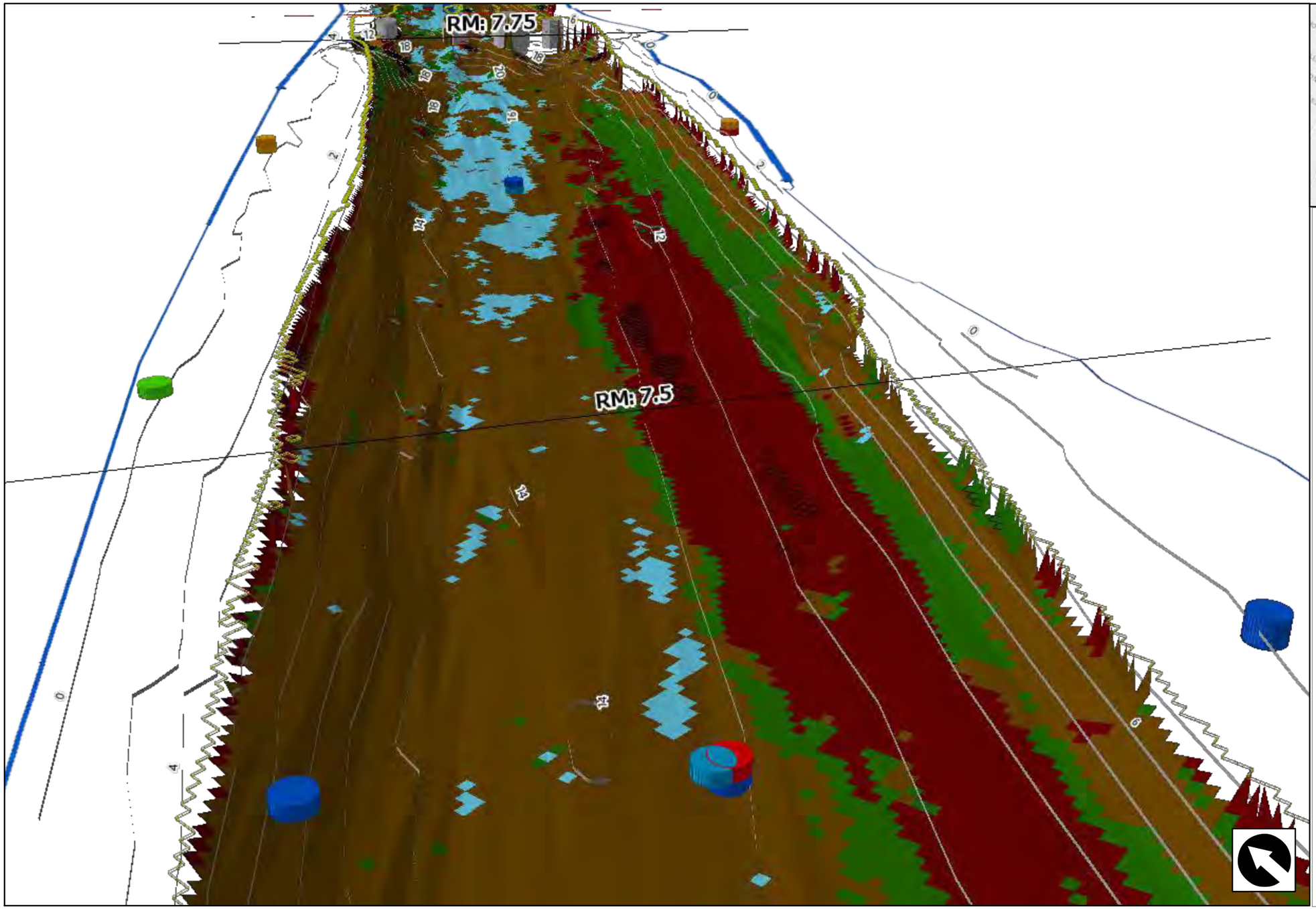
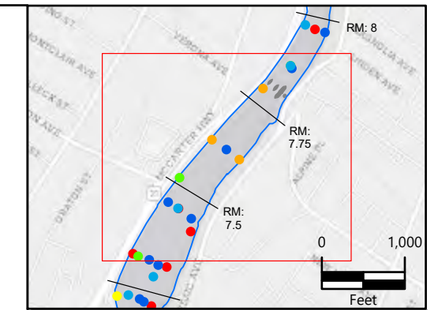
Figure 2-5d

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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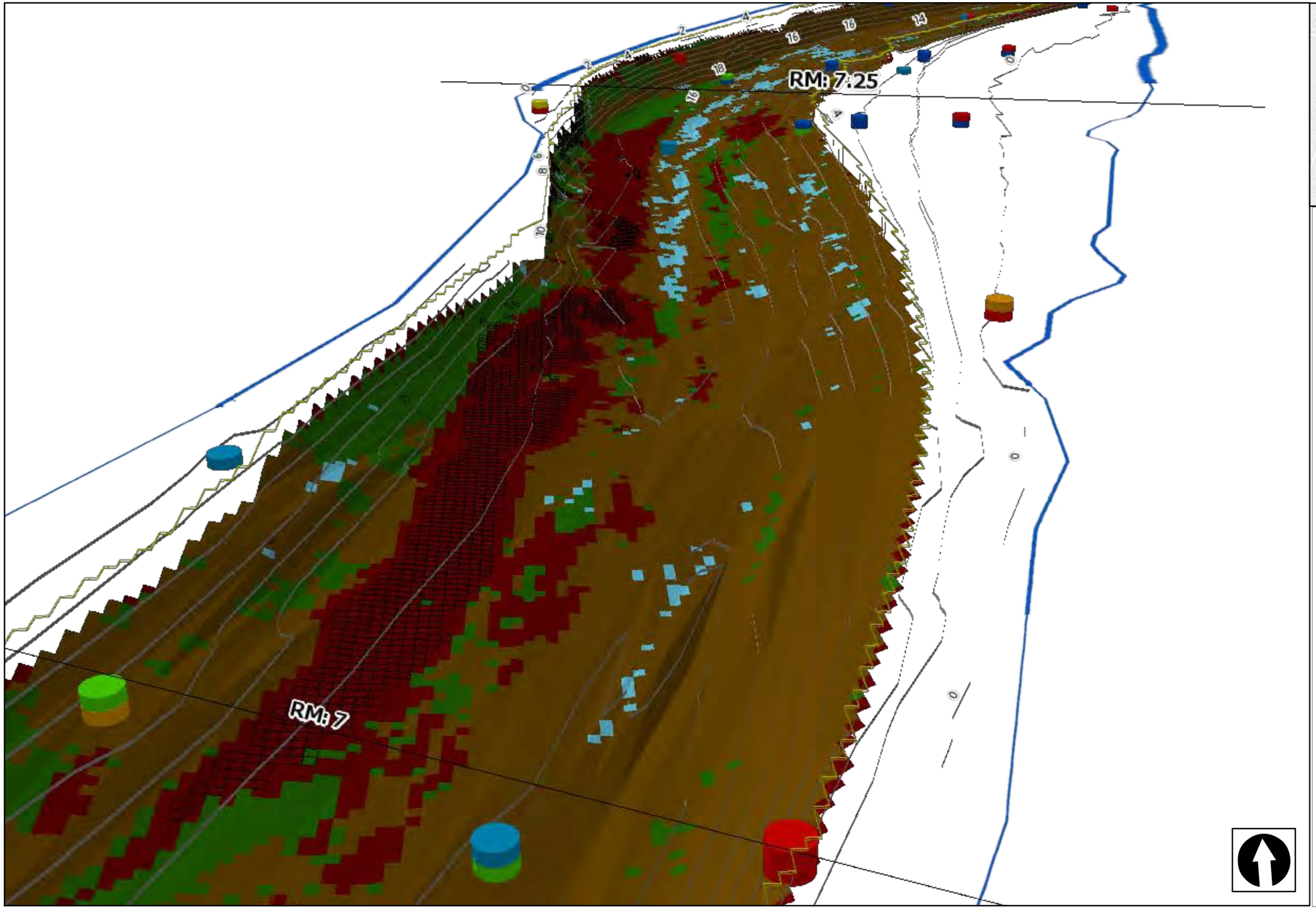
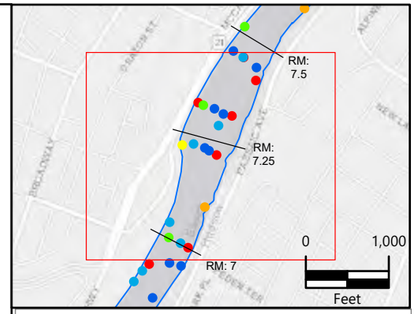
Figure 2-6a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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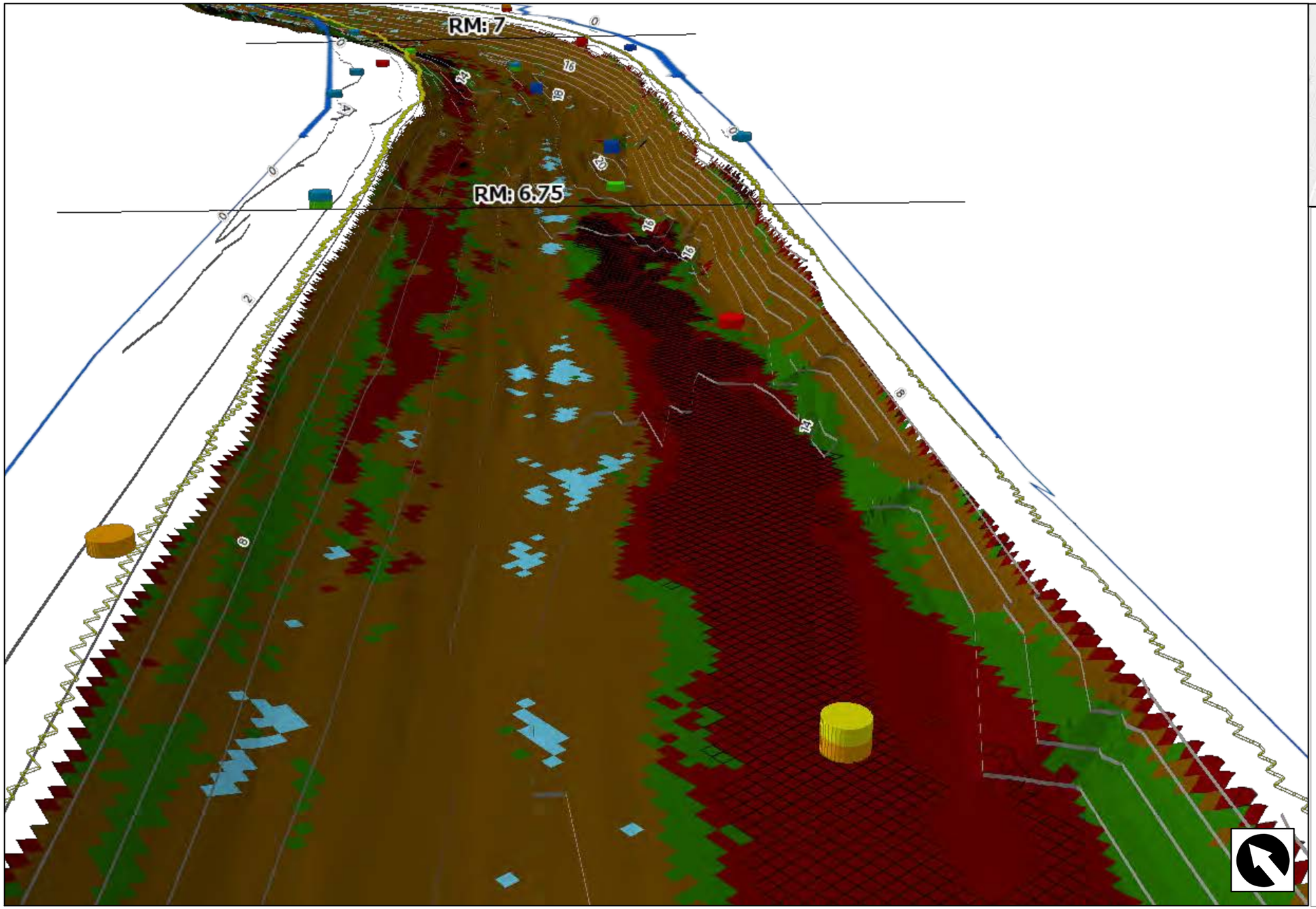
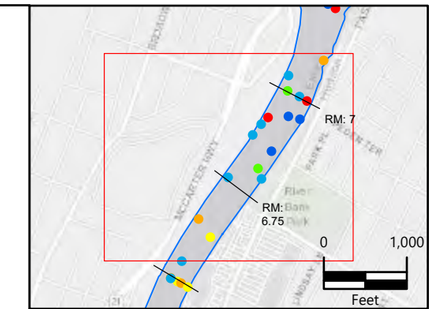
Figure 2-6b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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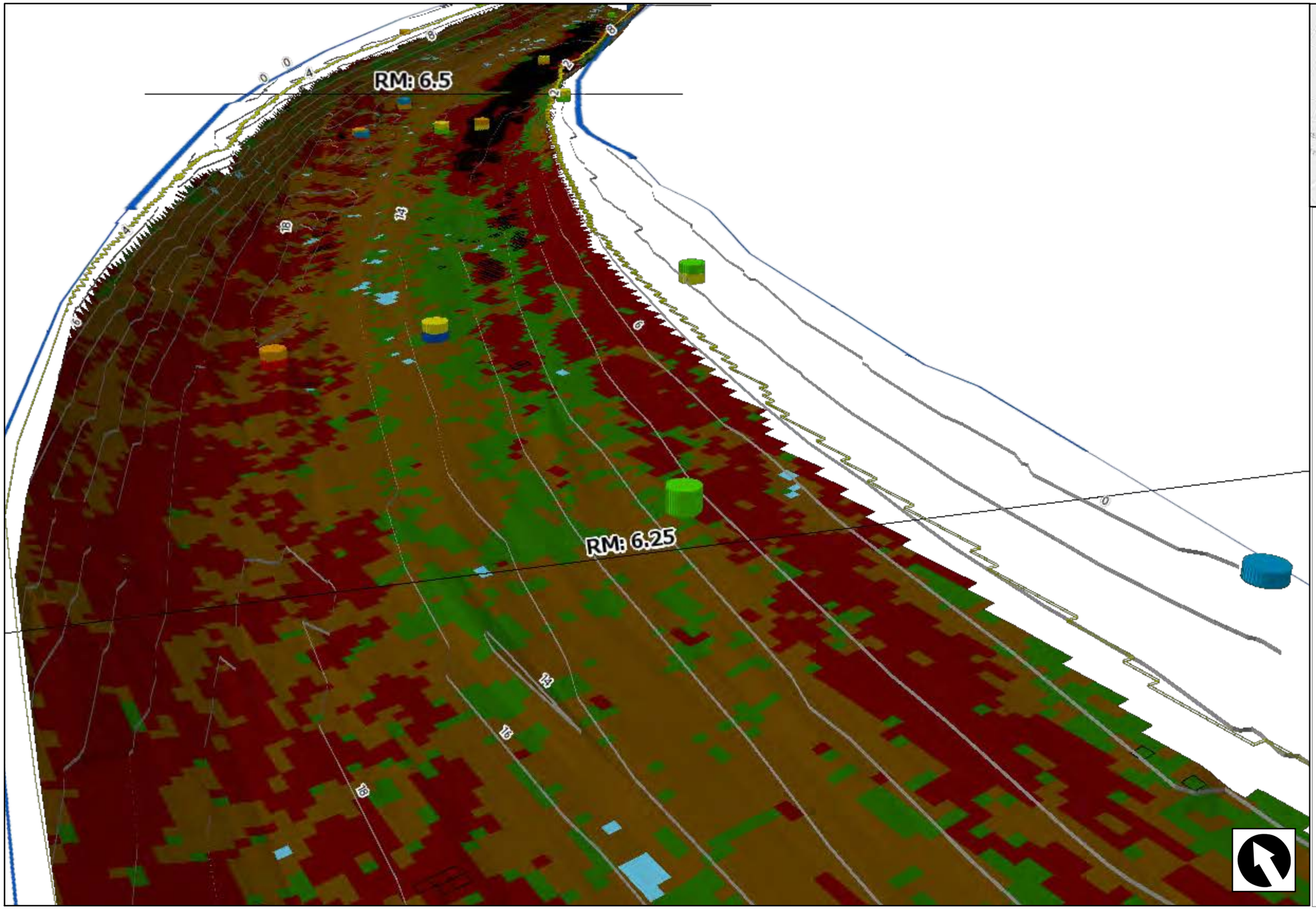
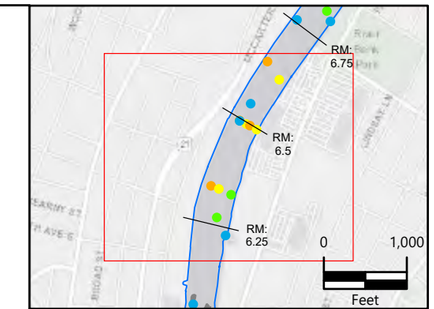
Figure 2-6c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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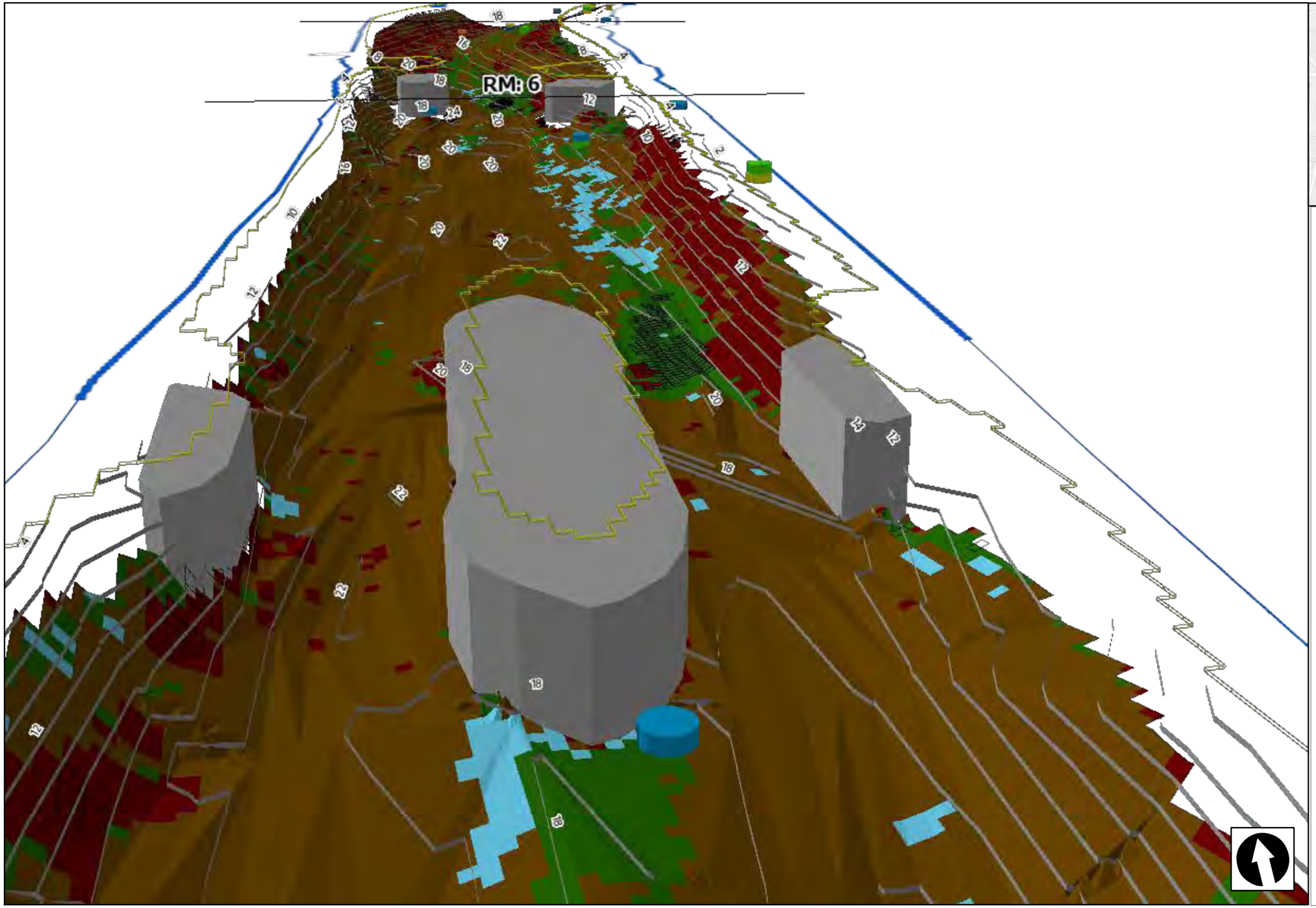
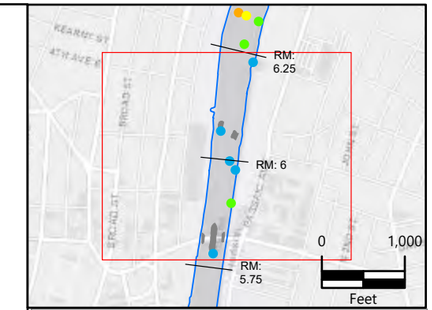
Figure 2-6d

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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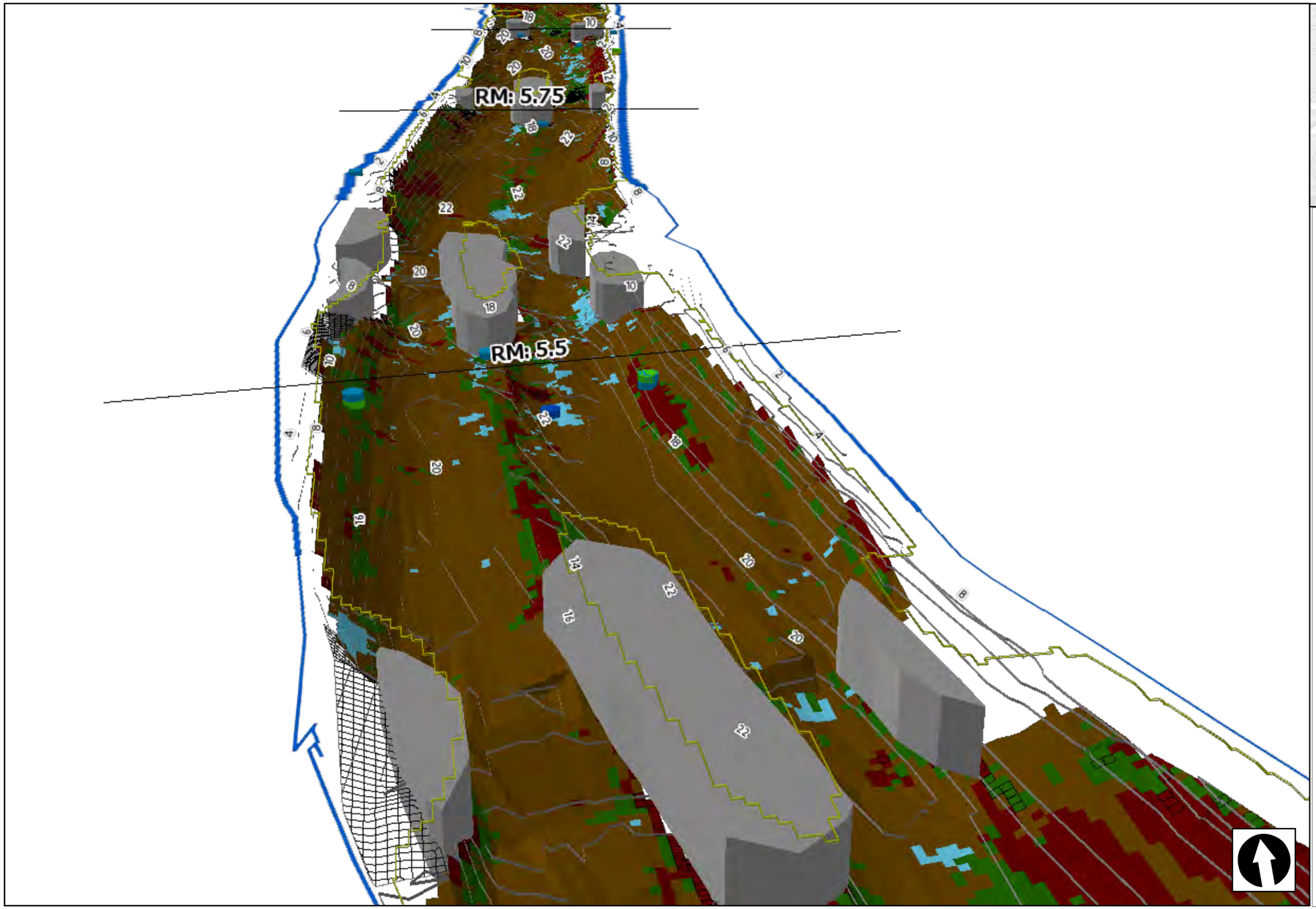
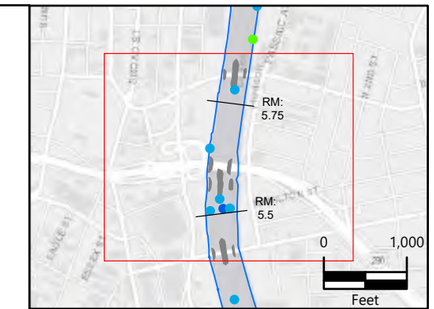
Figure 2-6e

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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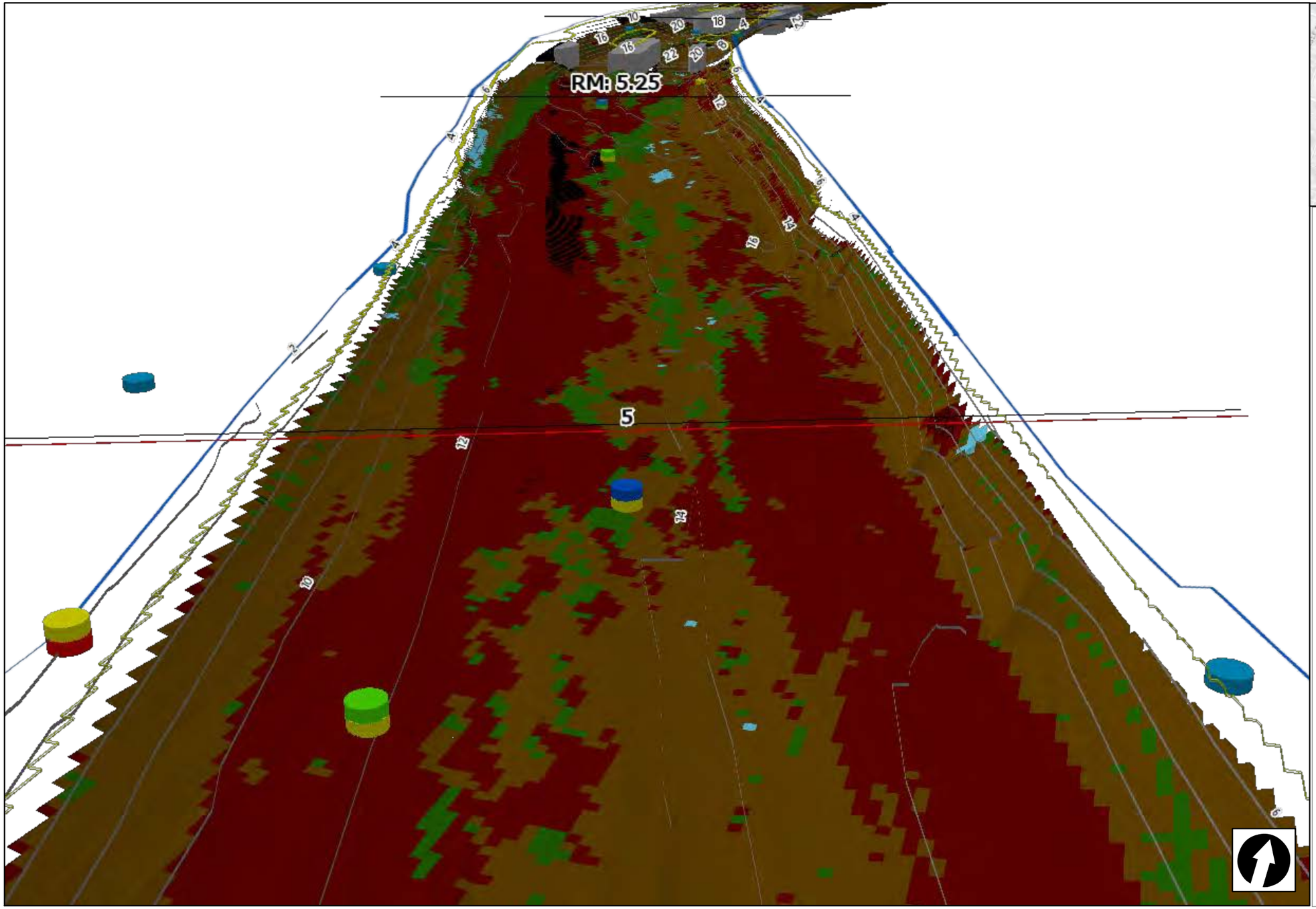
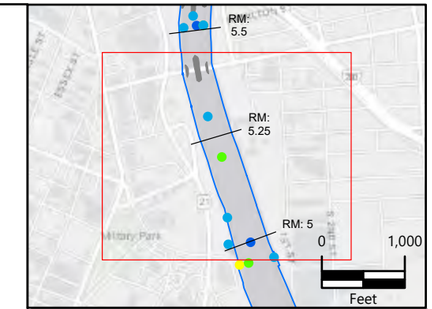
Figure 2-6f

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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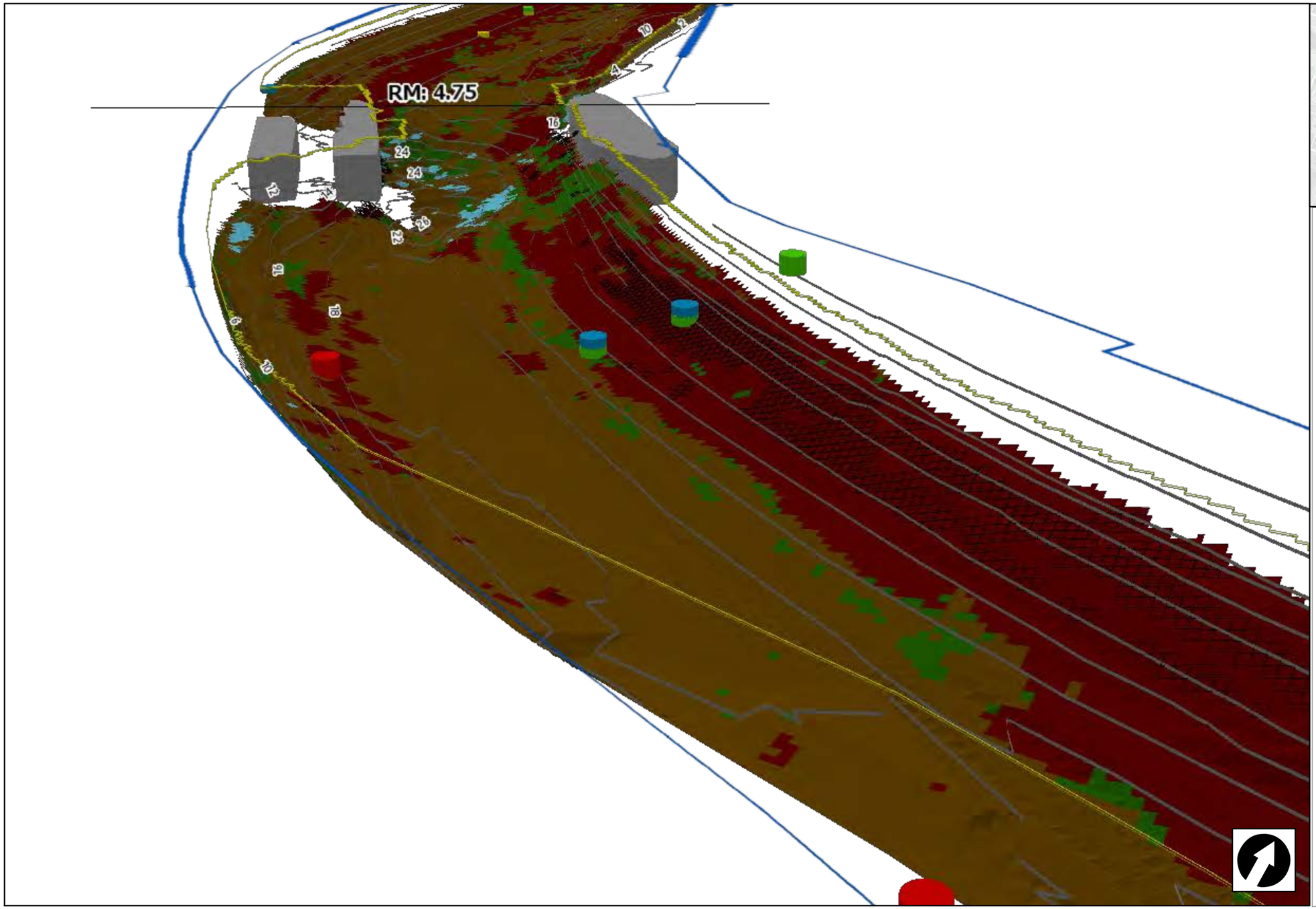
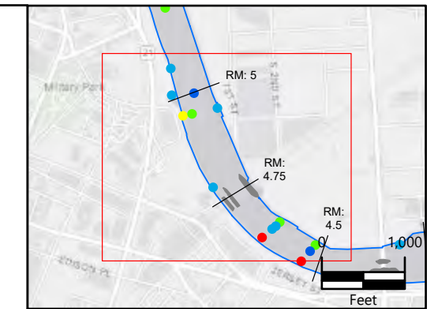
Figure 2-6g

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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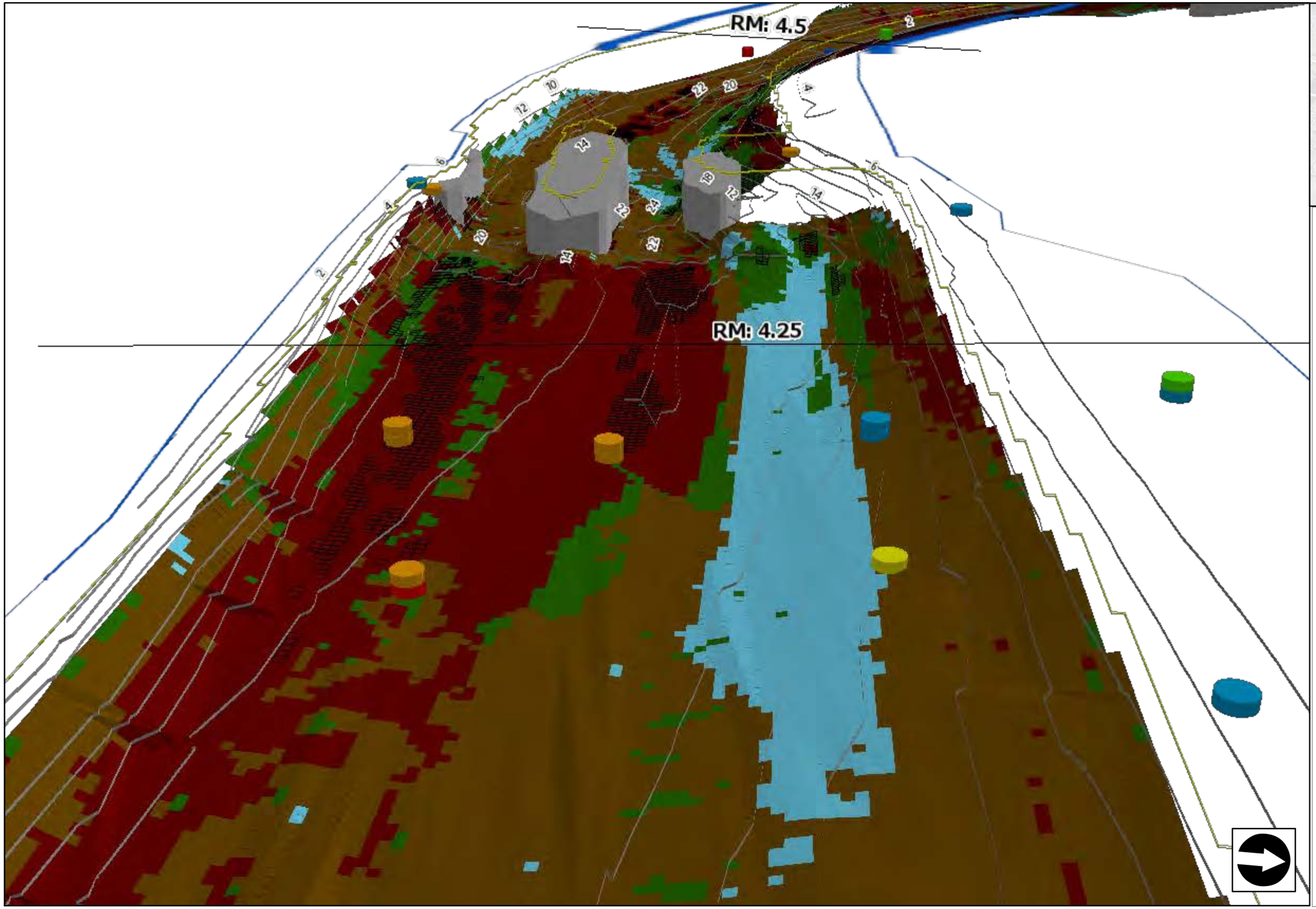
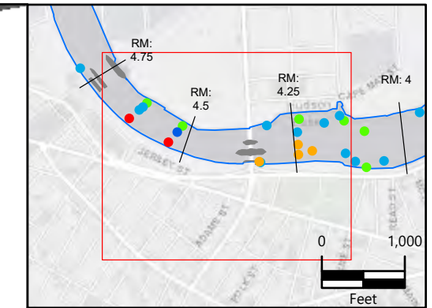
Figure 2-7a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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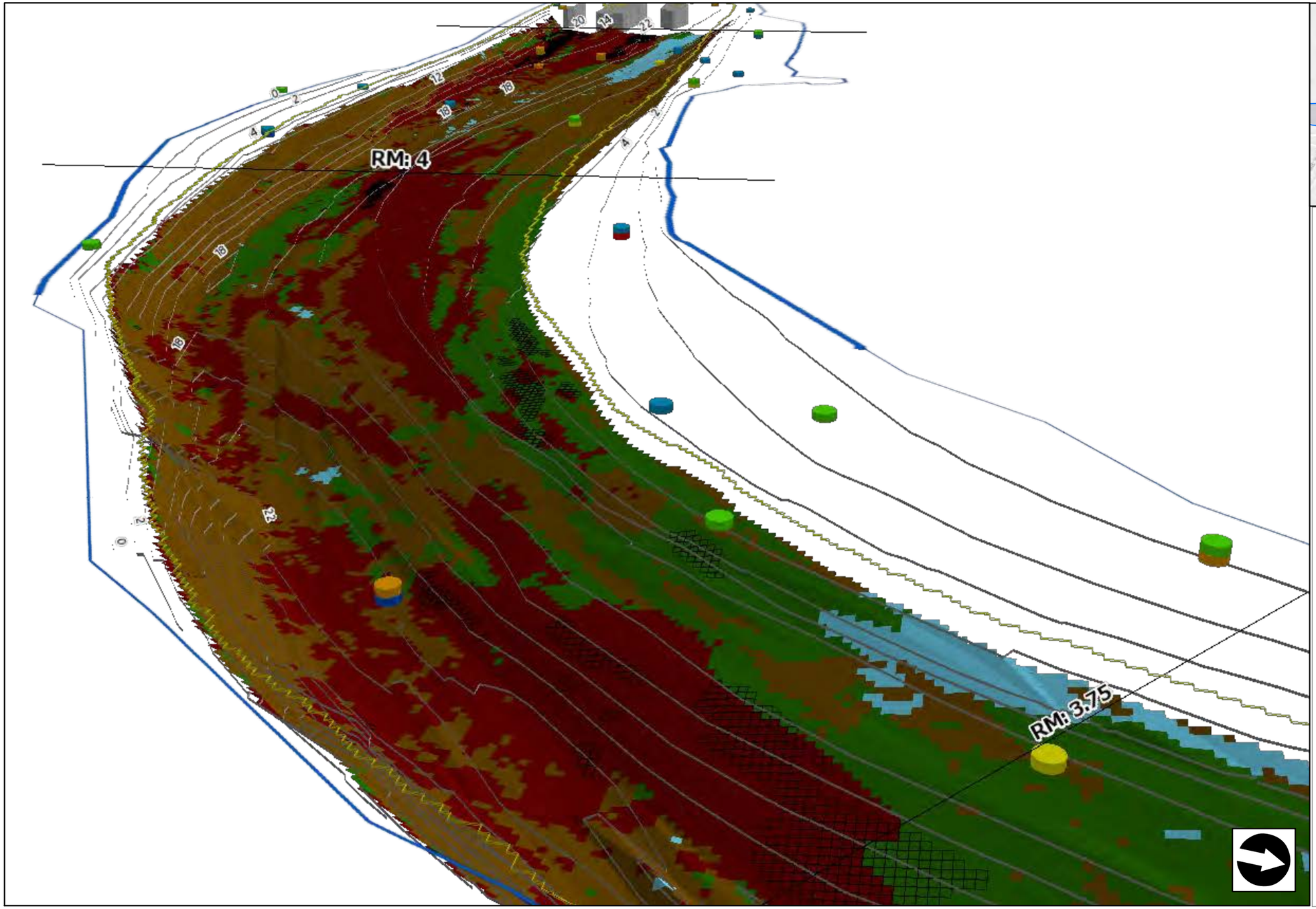
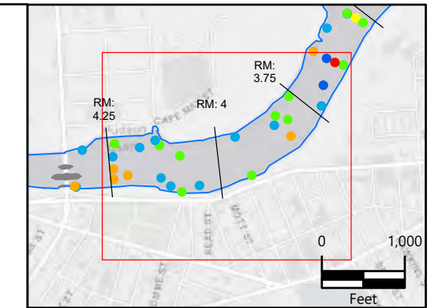
Figure 2-7b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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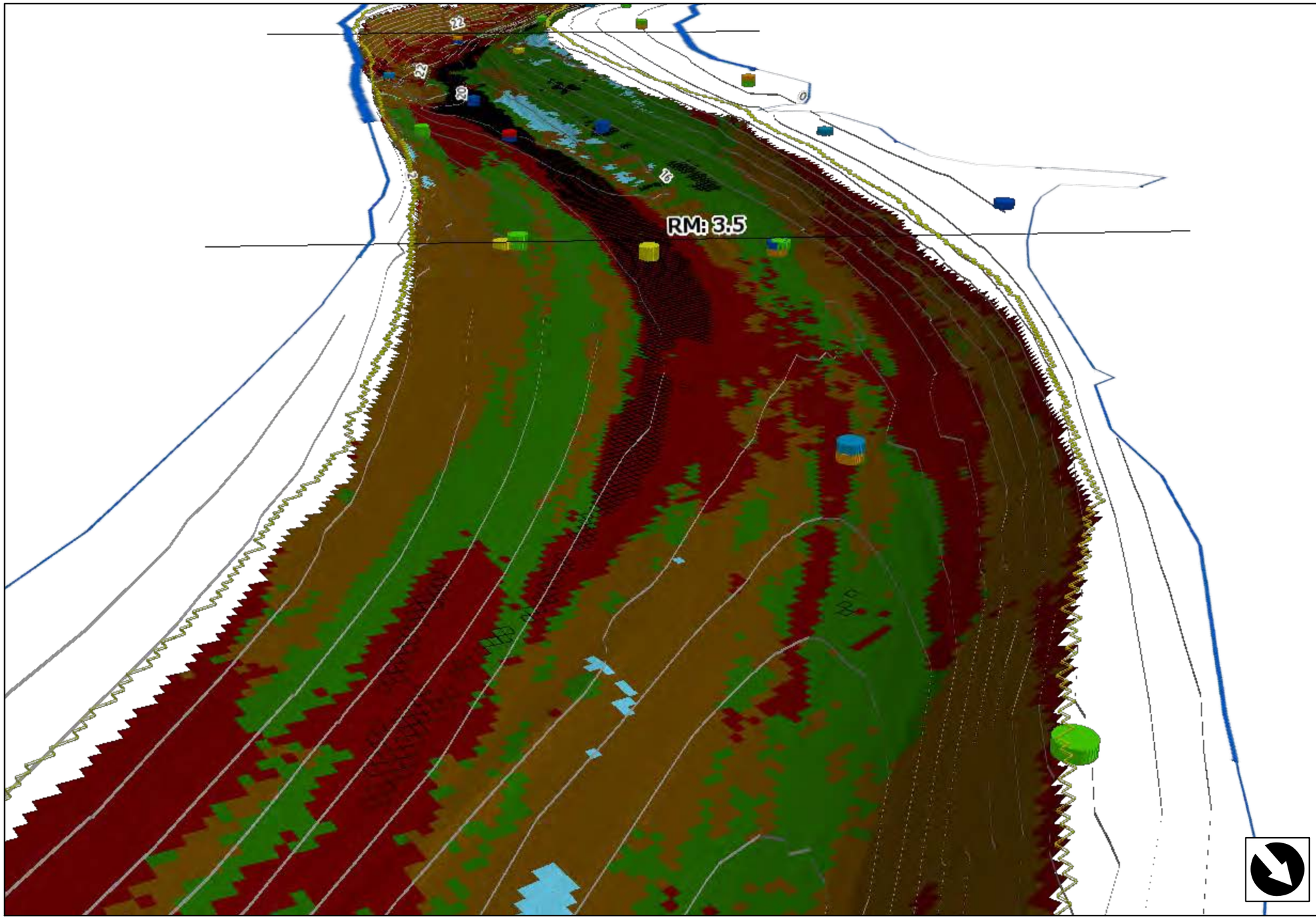
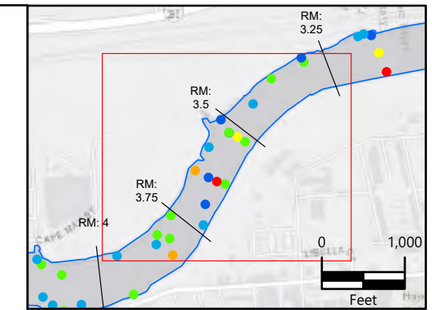
Figure 2-7c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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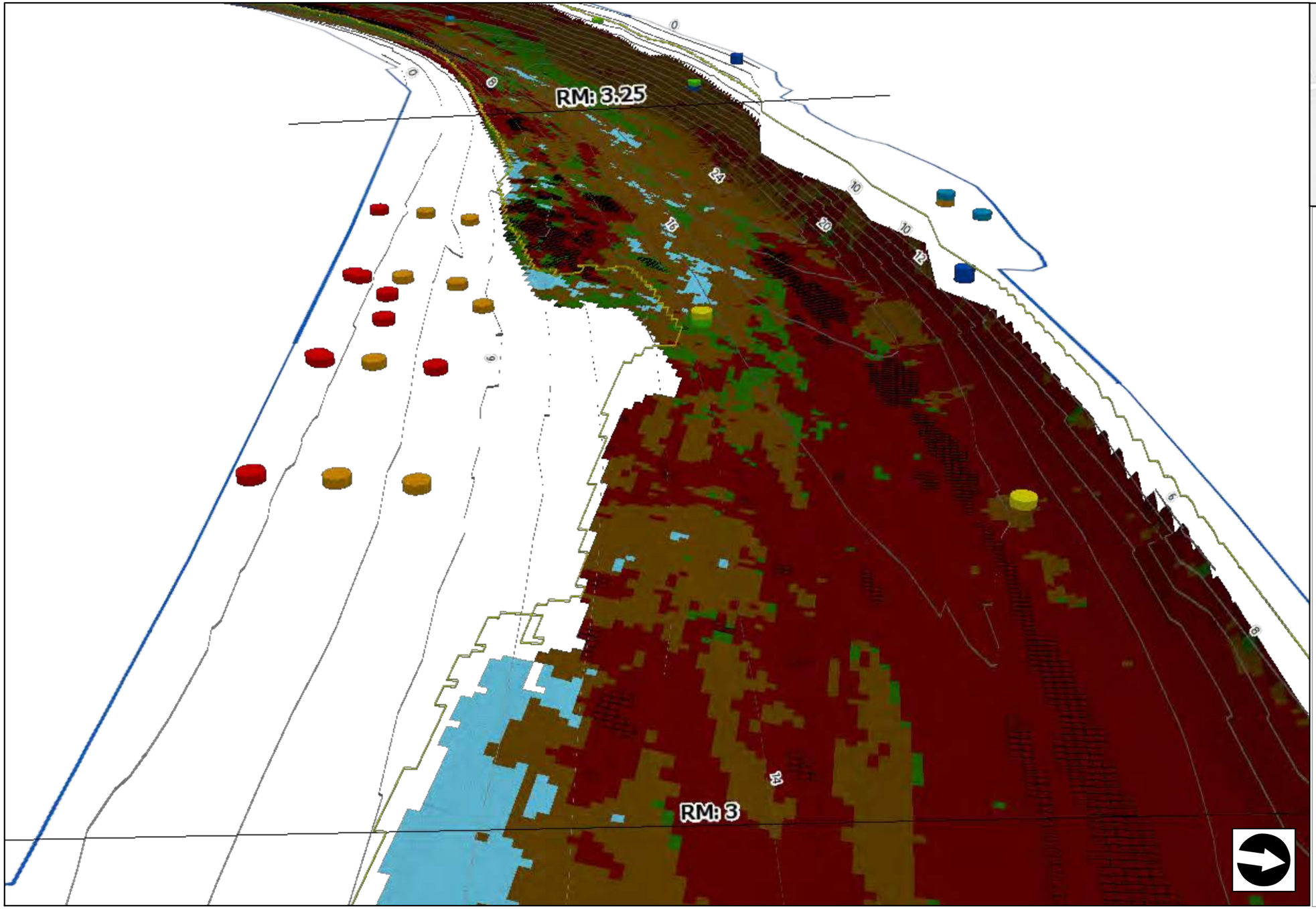
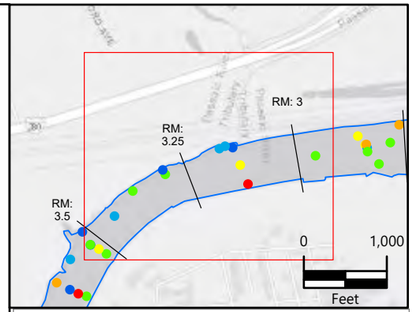
Figure 2-7d

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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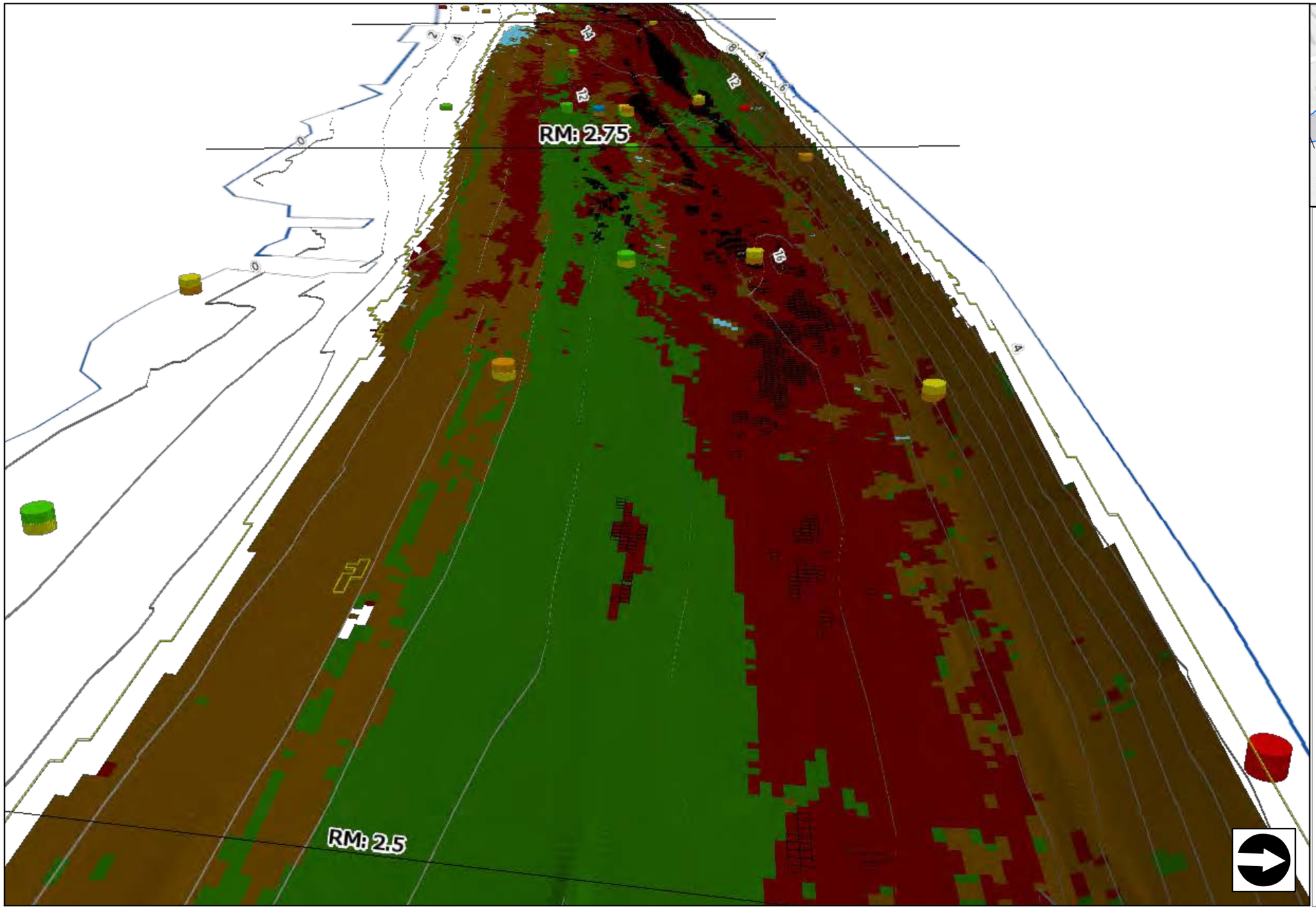
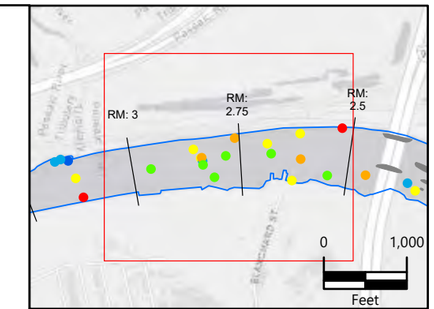
Figure 2-7e

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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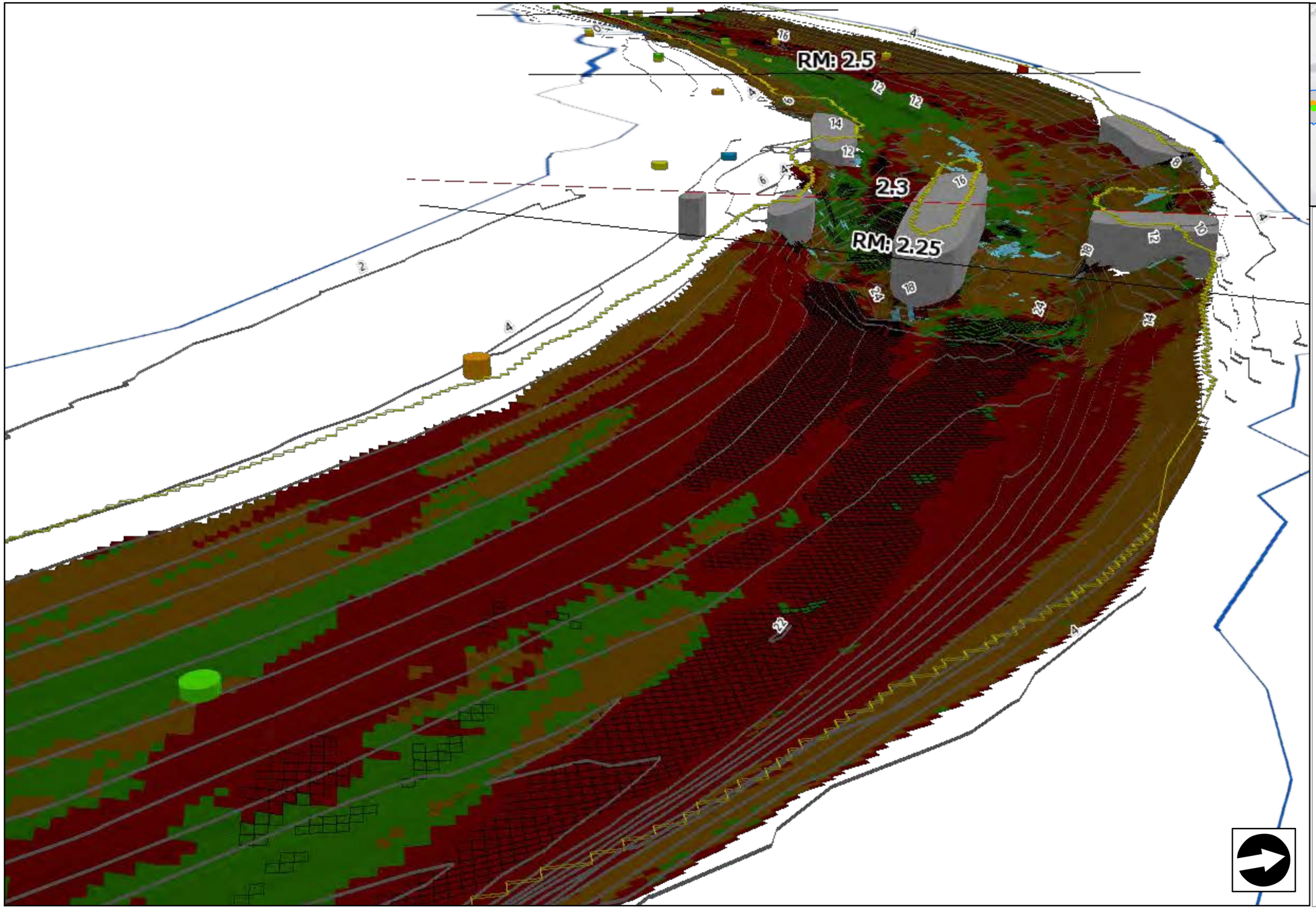
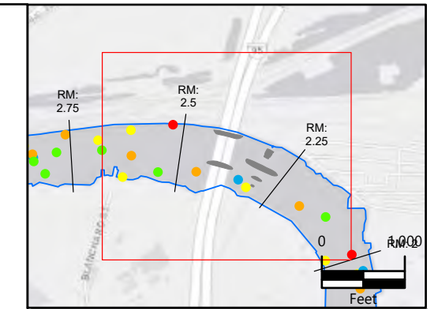
Figure 2-7f

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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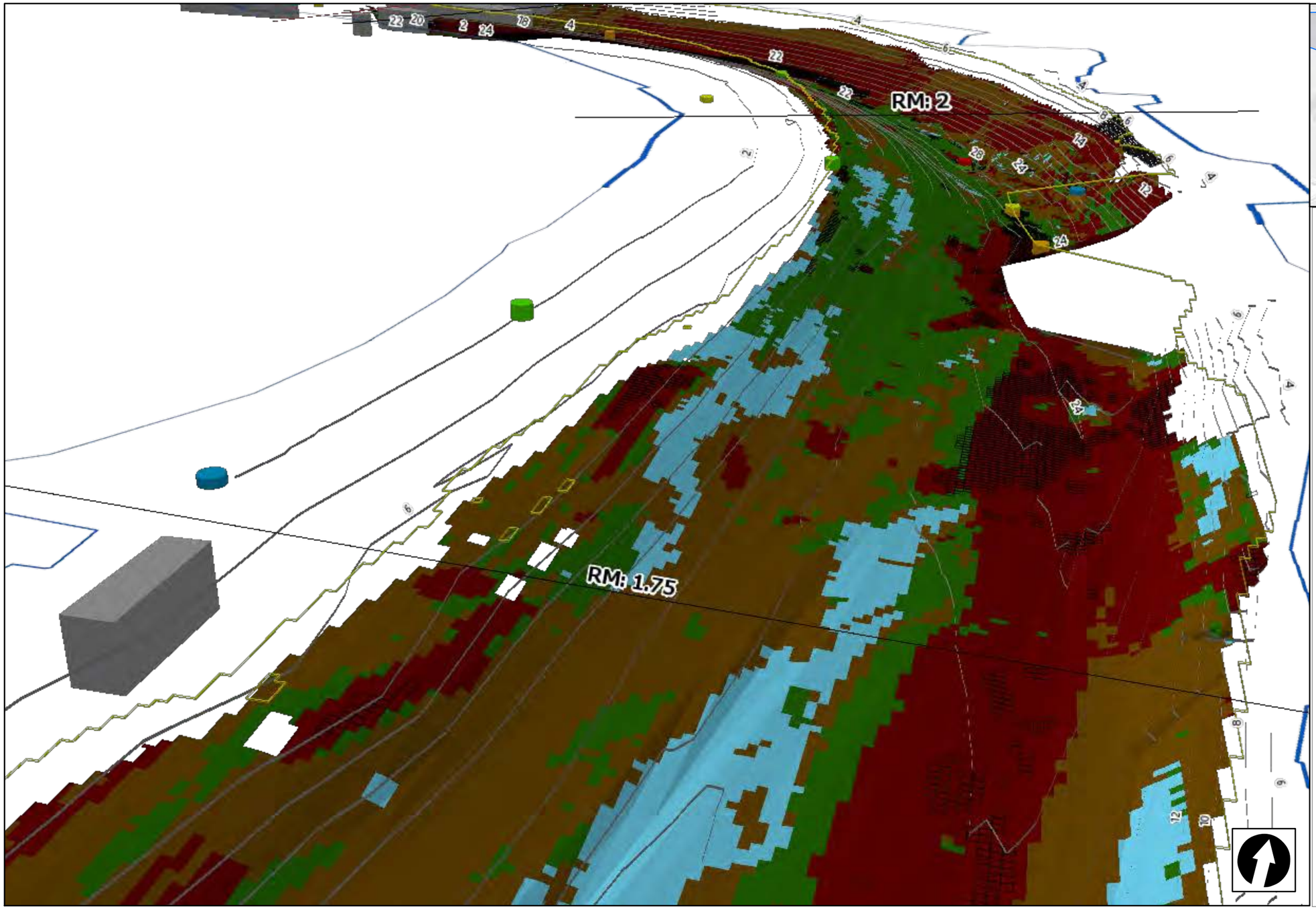
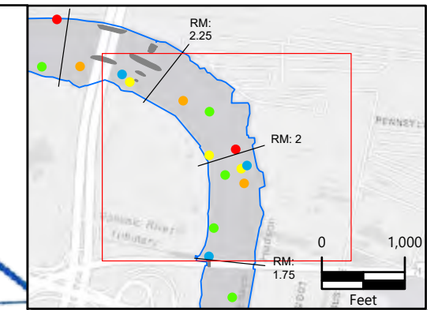
Figure 2-7g

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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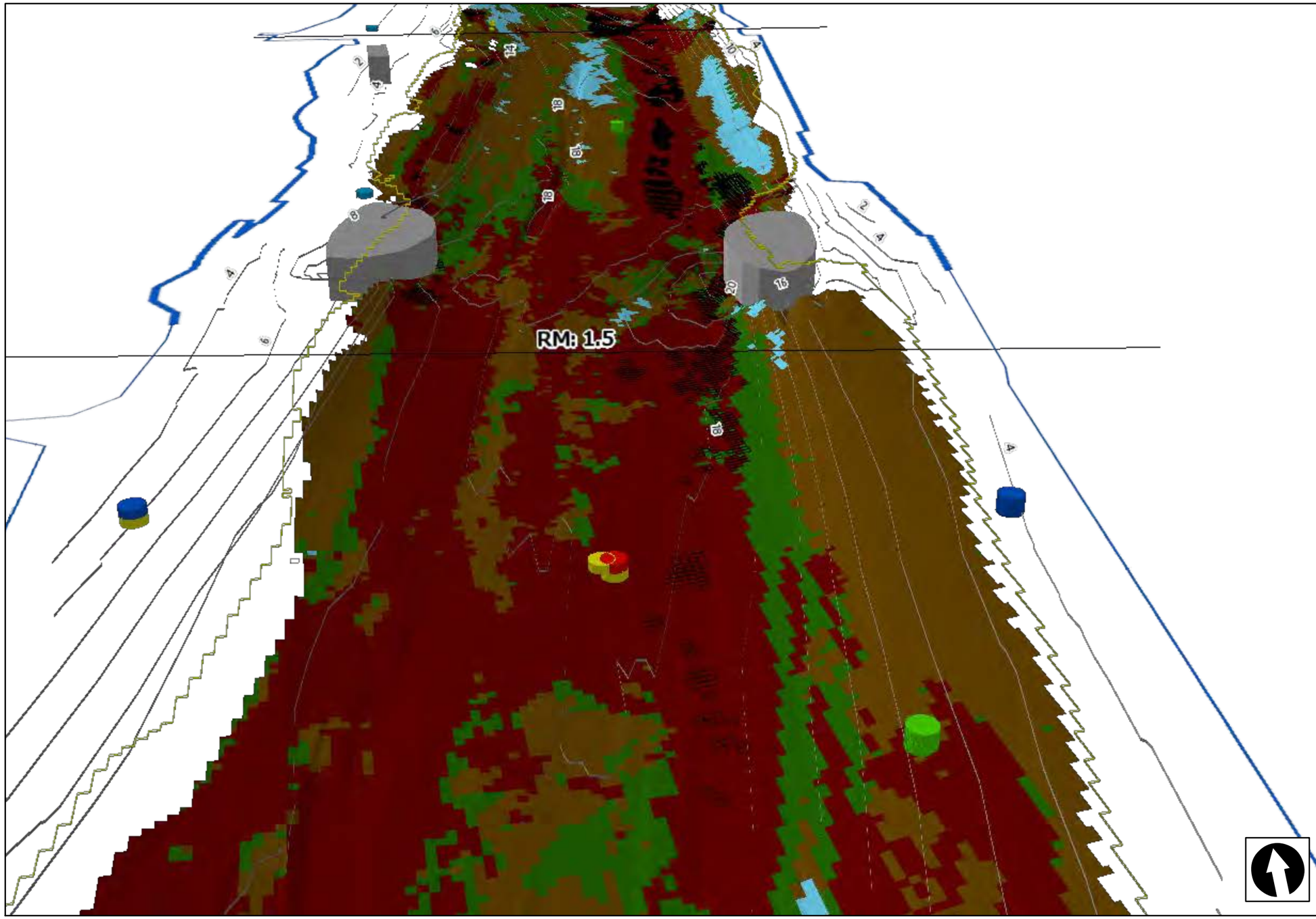
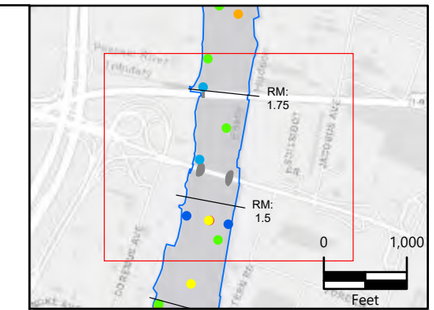
Figure 2-8a

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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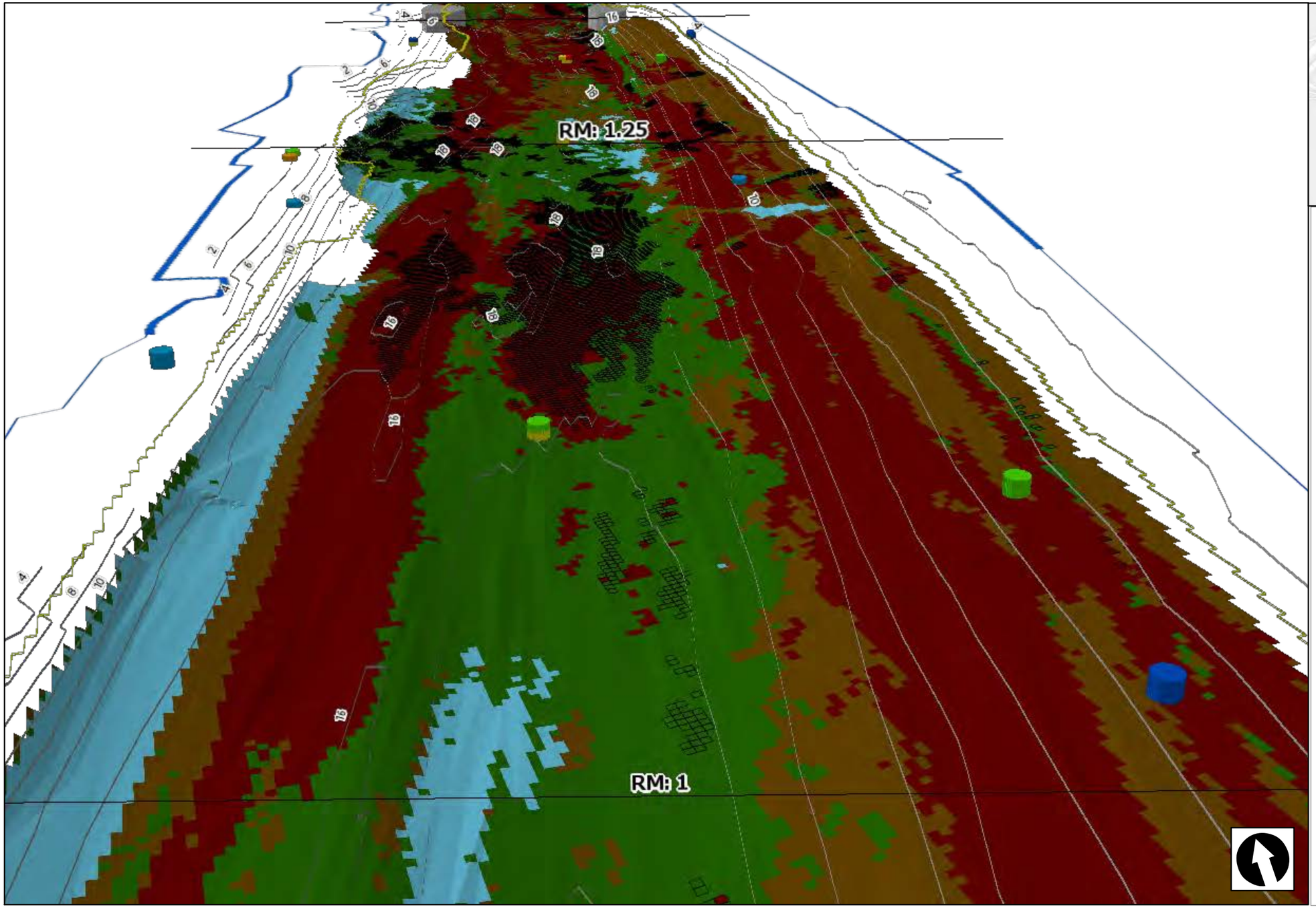
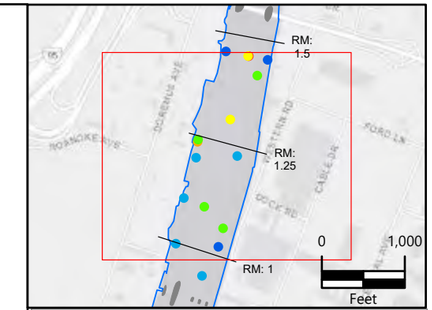
Figure 2-8b

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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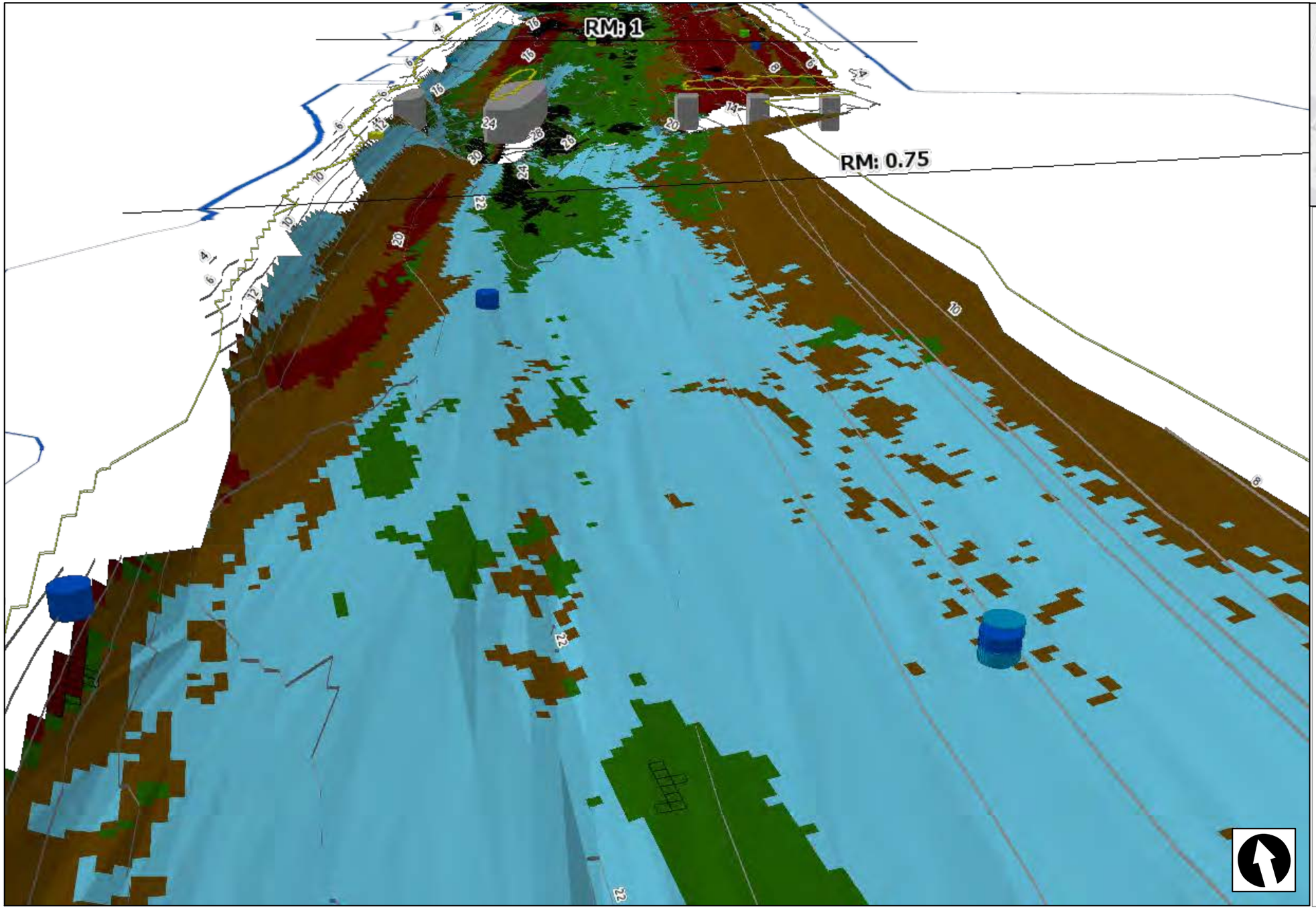
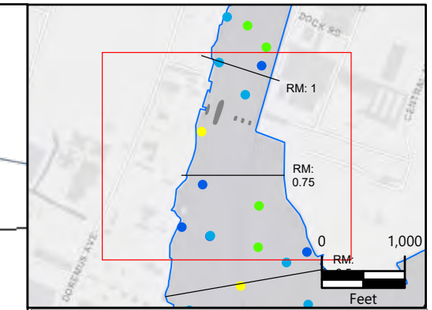
Figure 2-8c

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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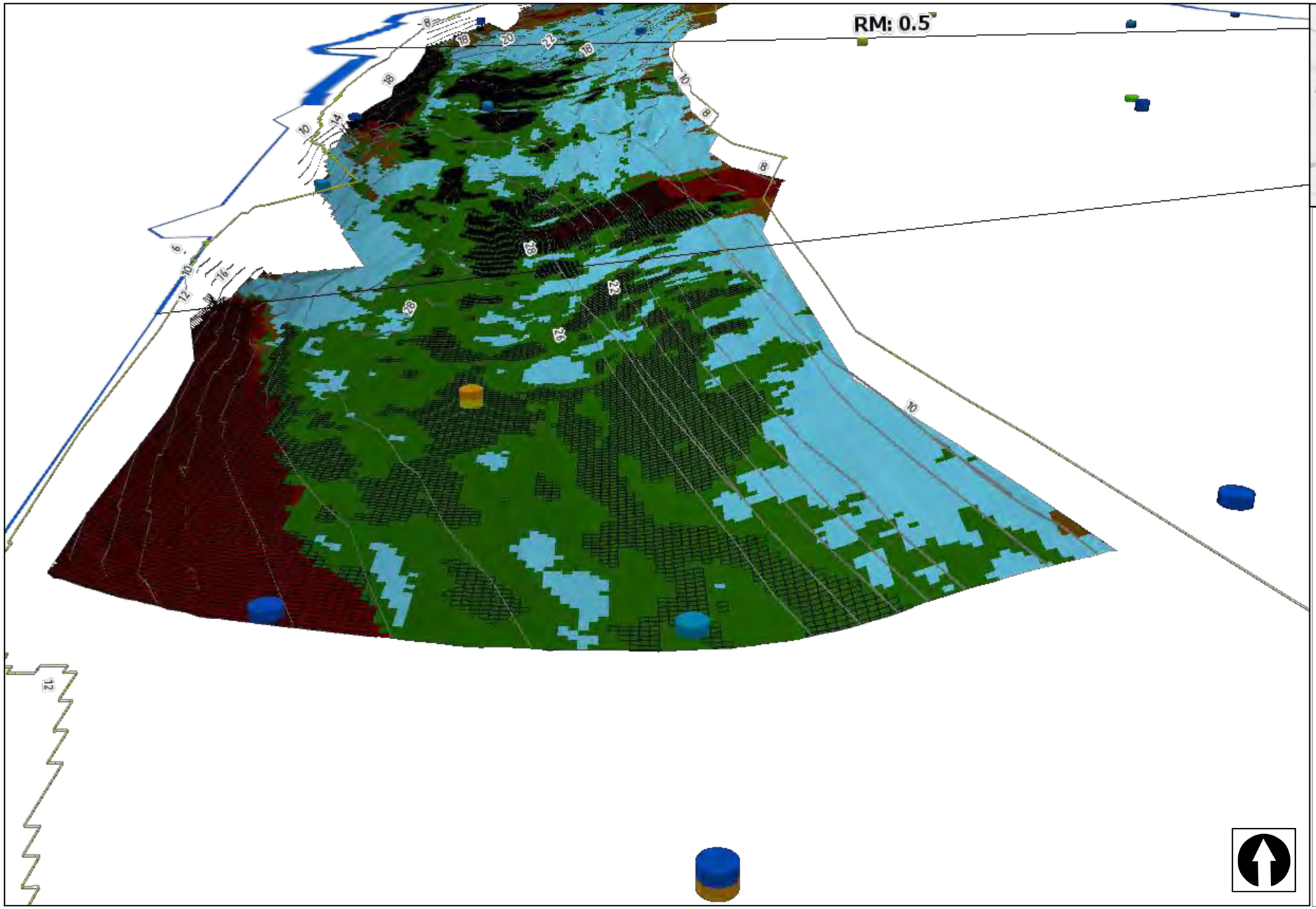
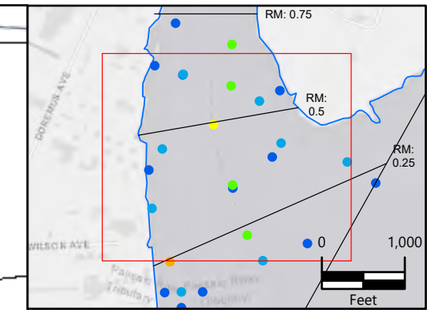
Figure 2-8d

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Total DDx Concentration (mg/kg)

- 0.0 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.5
- >0.5

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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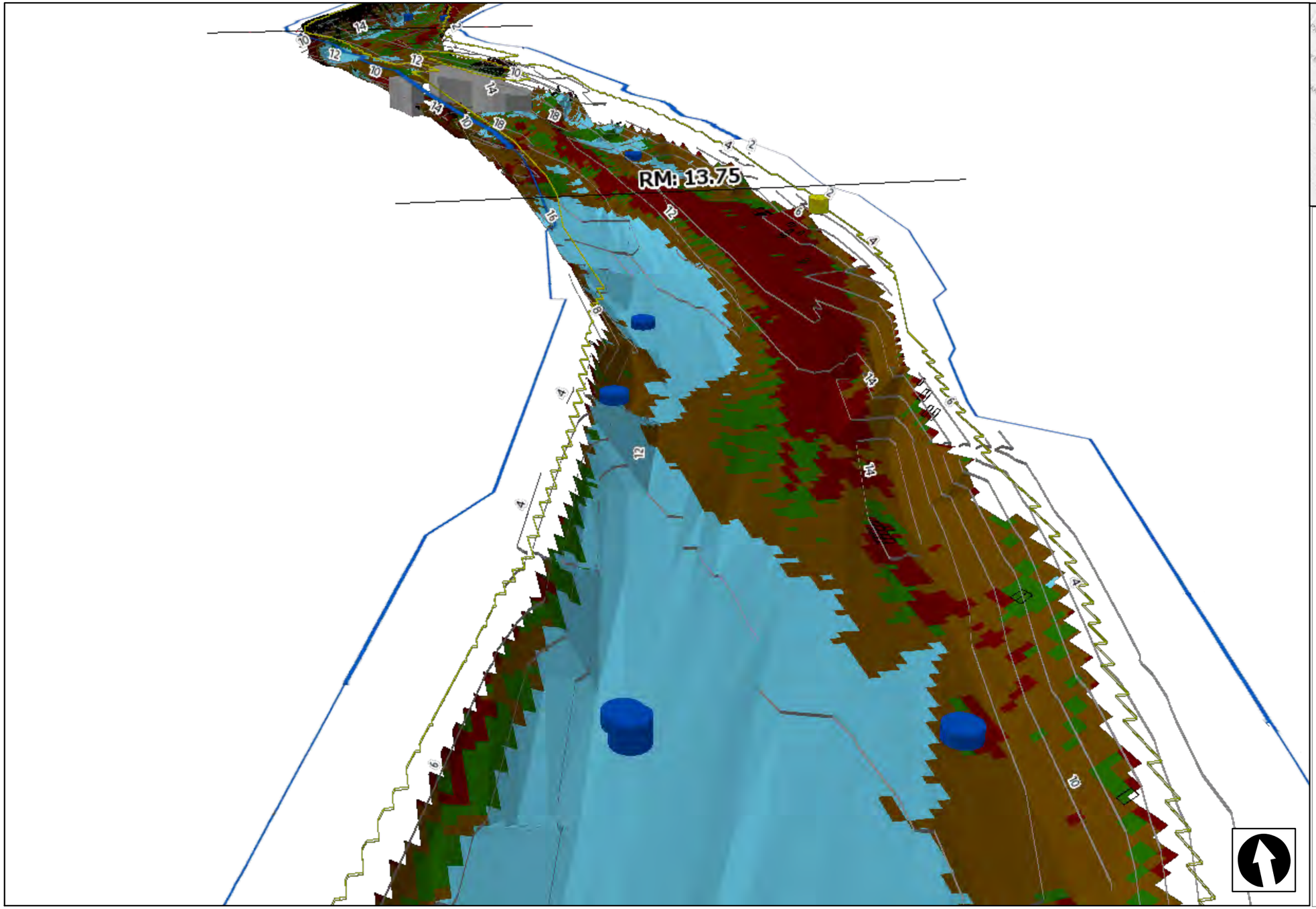
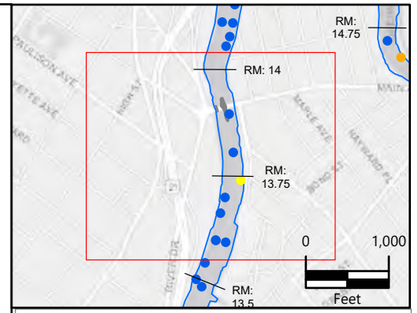
Figure 2-8e

Total DDx Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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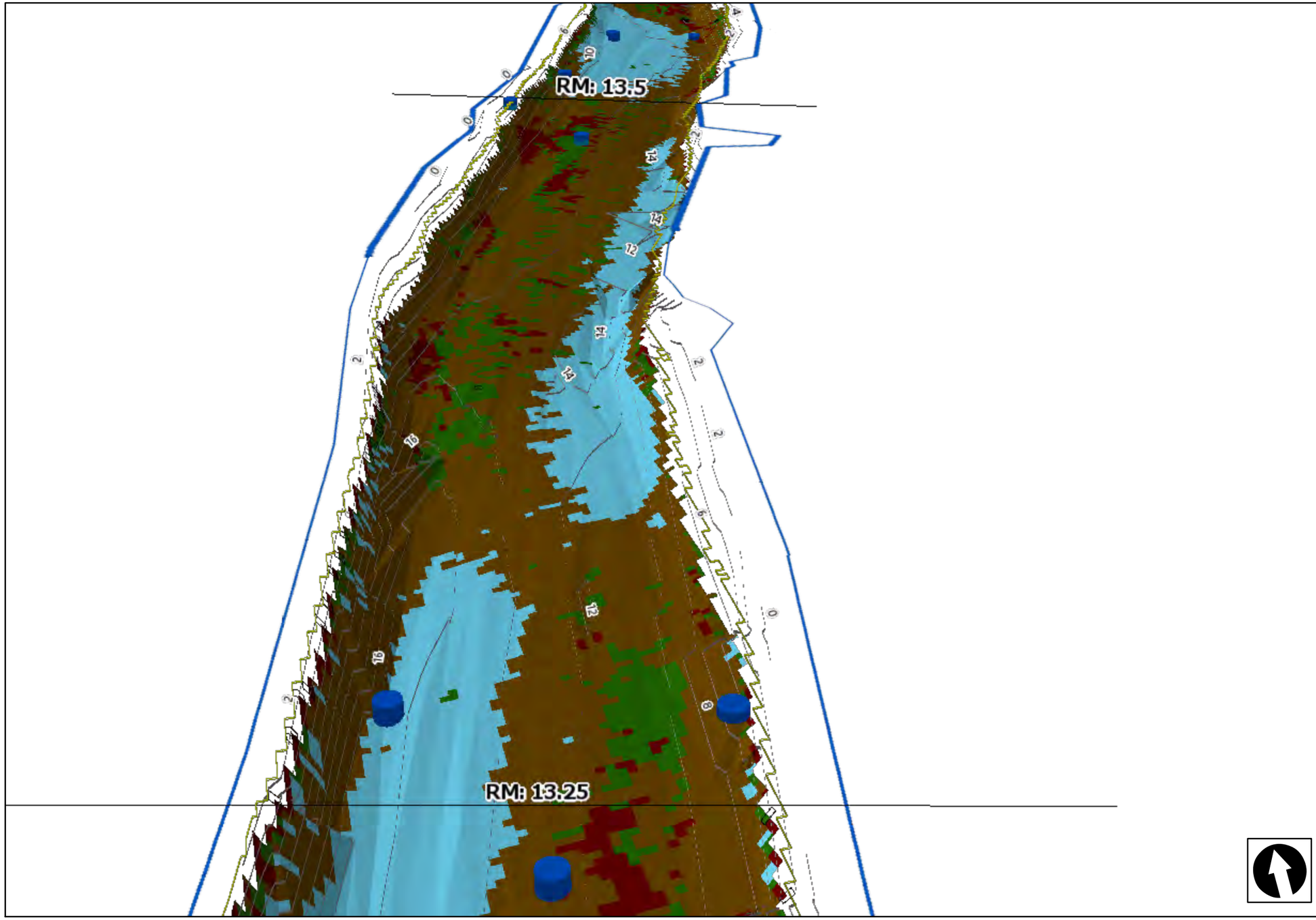
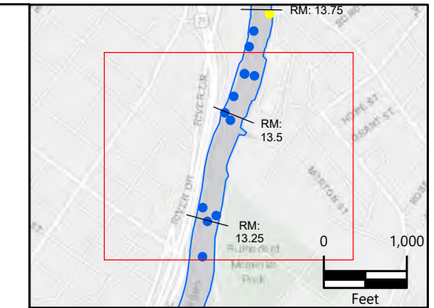
Figure 3-1a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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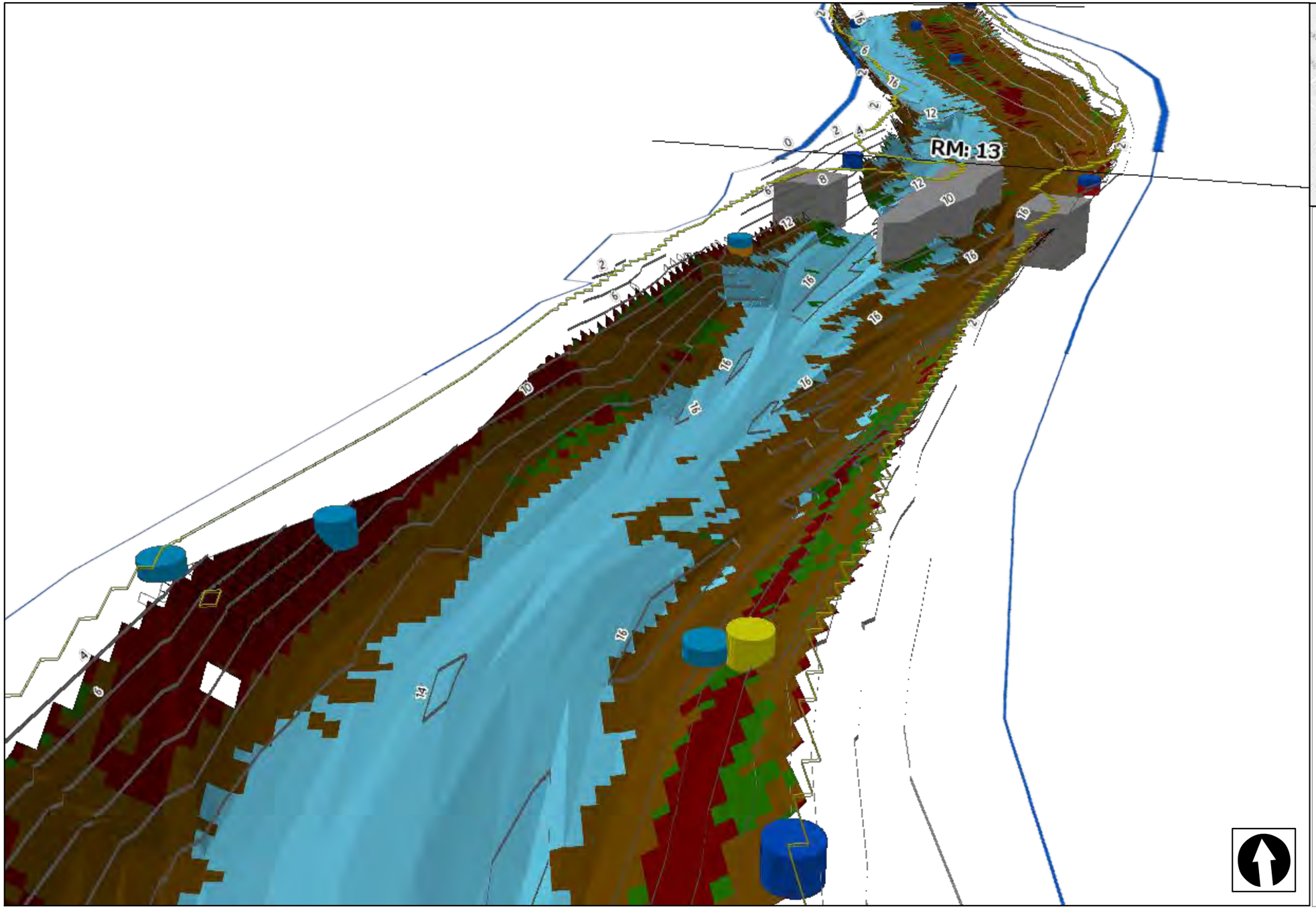
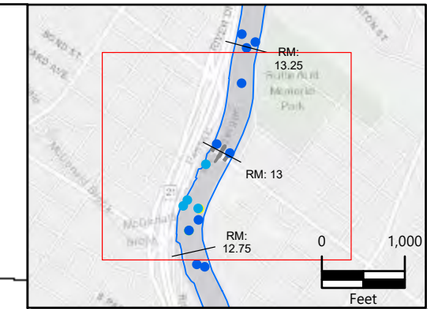
Figure 3-1b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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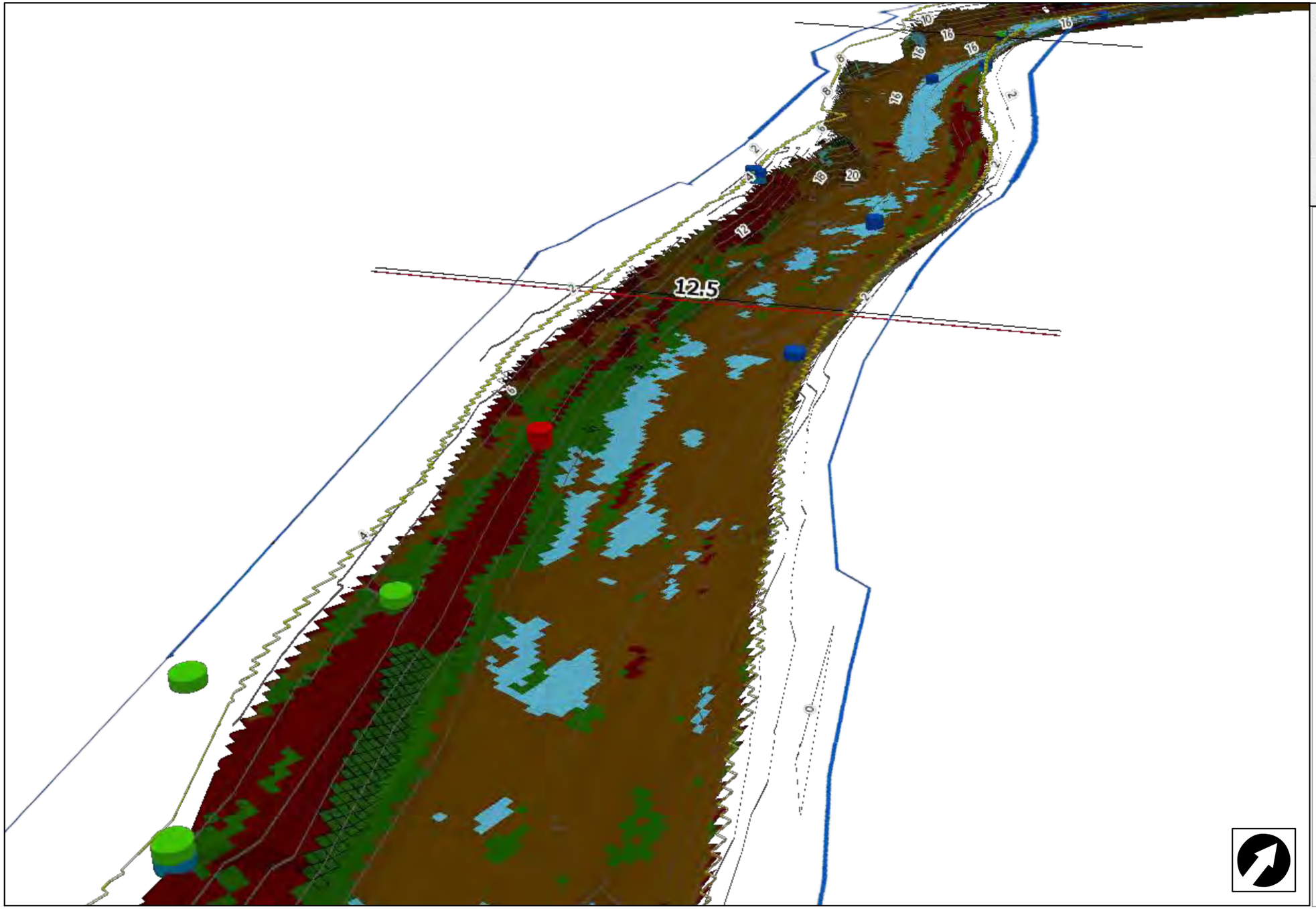
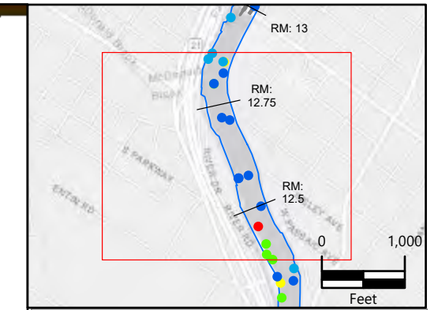
Figure 3-1c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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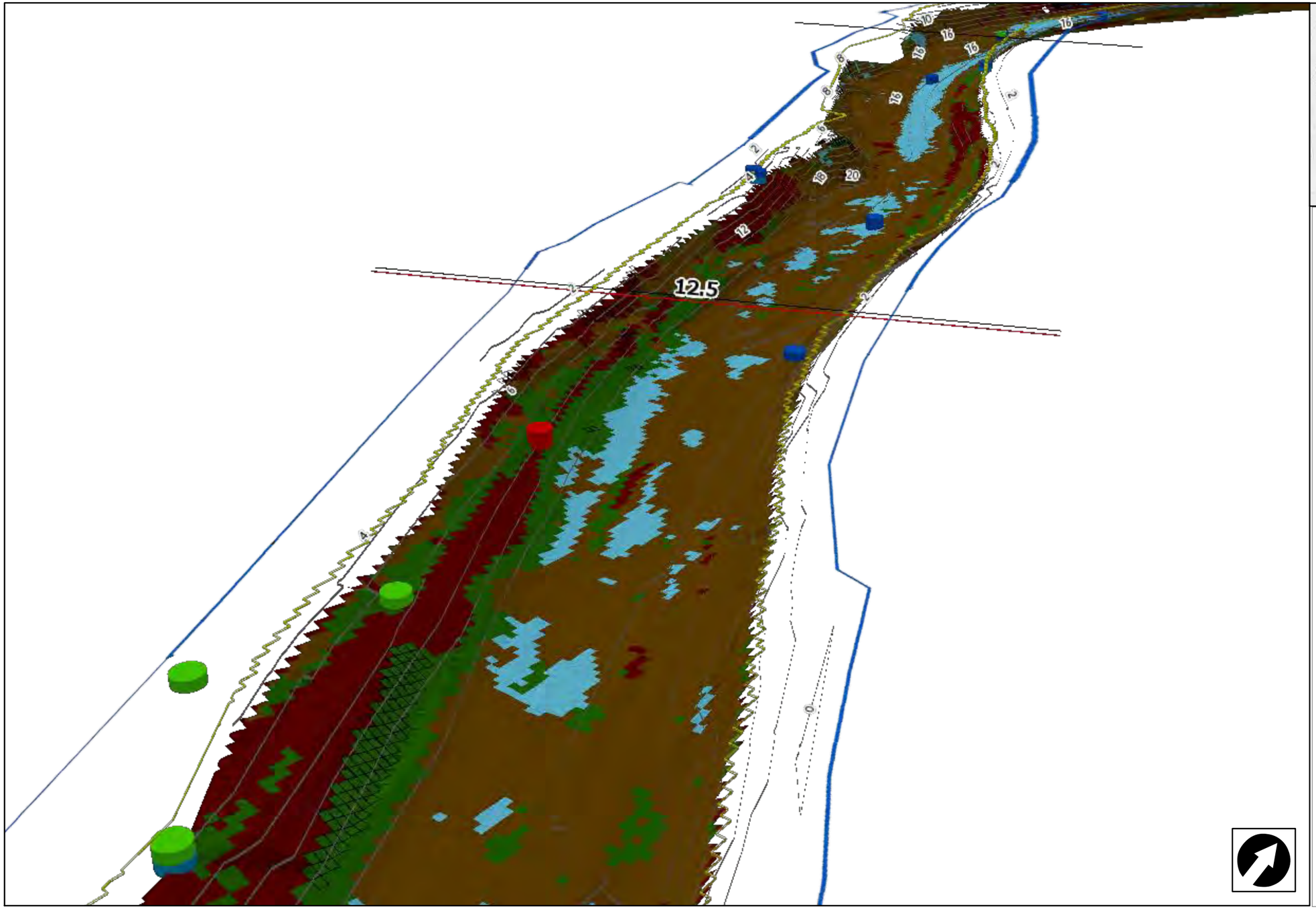
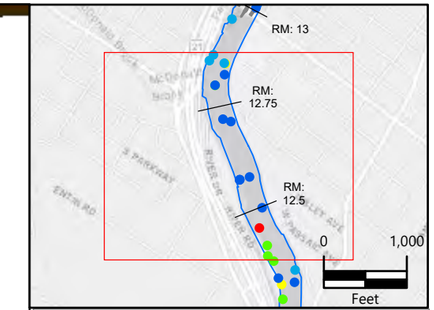
Figure 3-1d

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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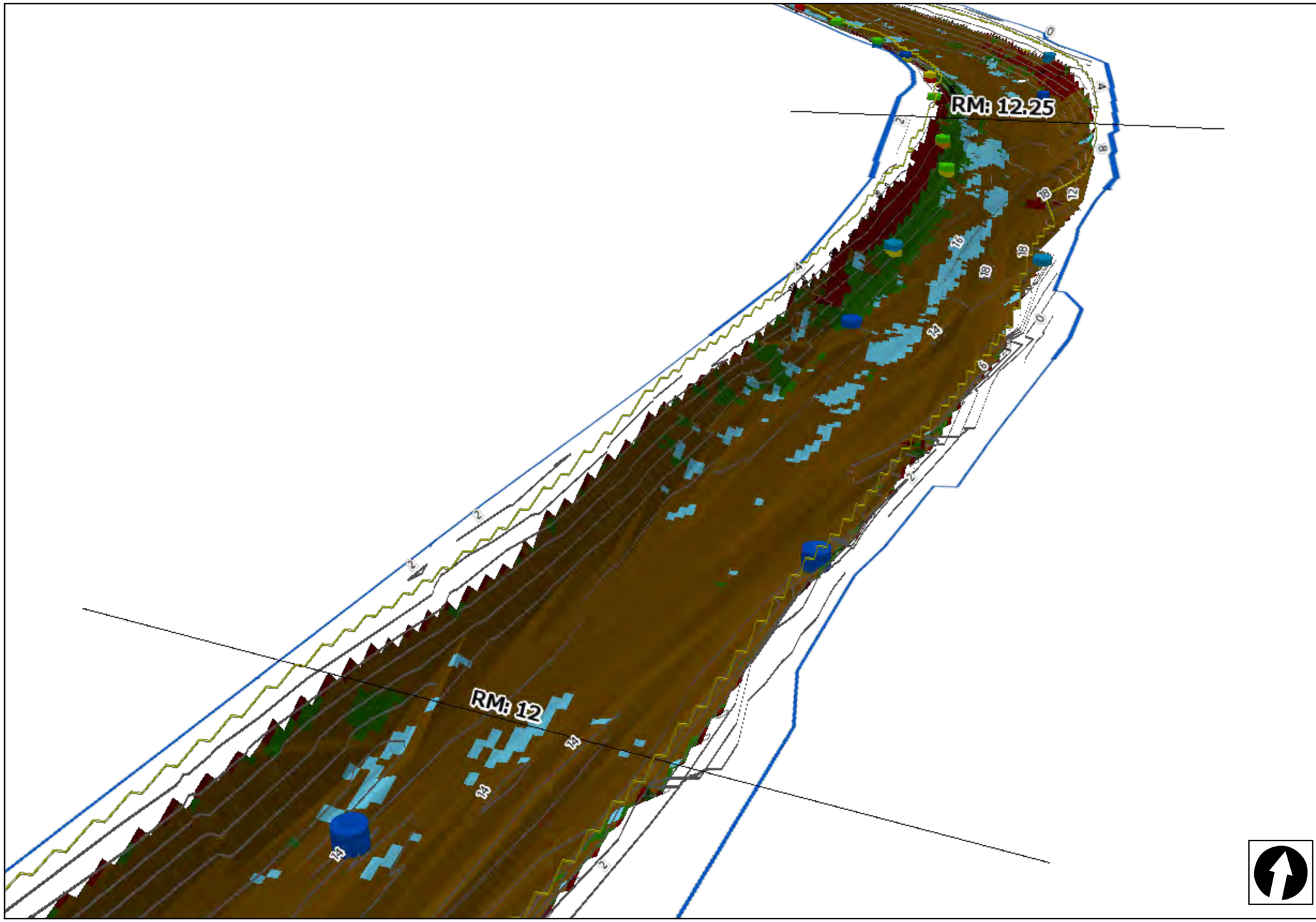
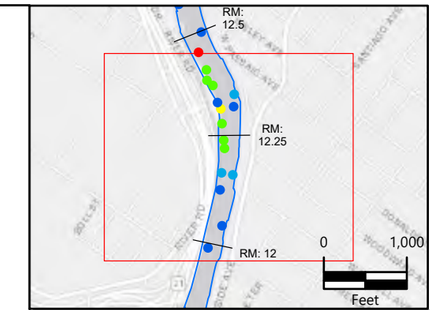
Figure 3-2a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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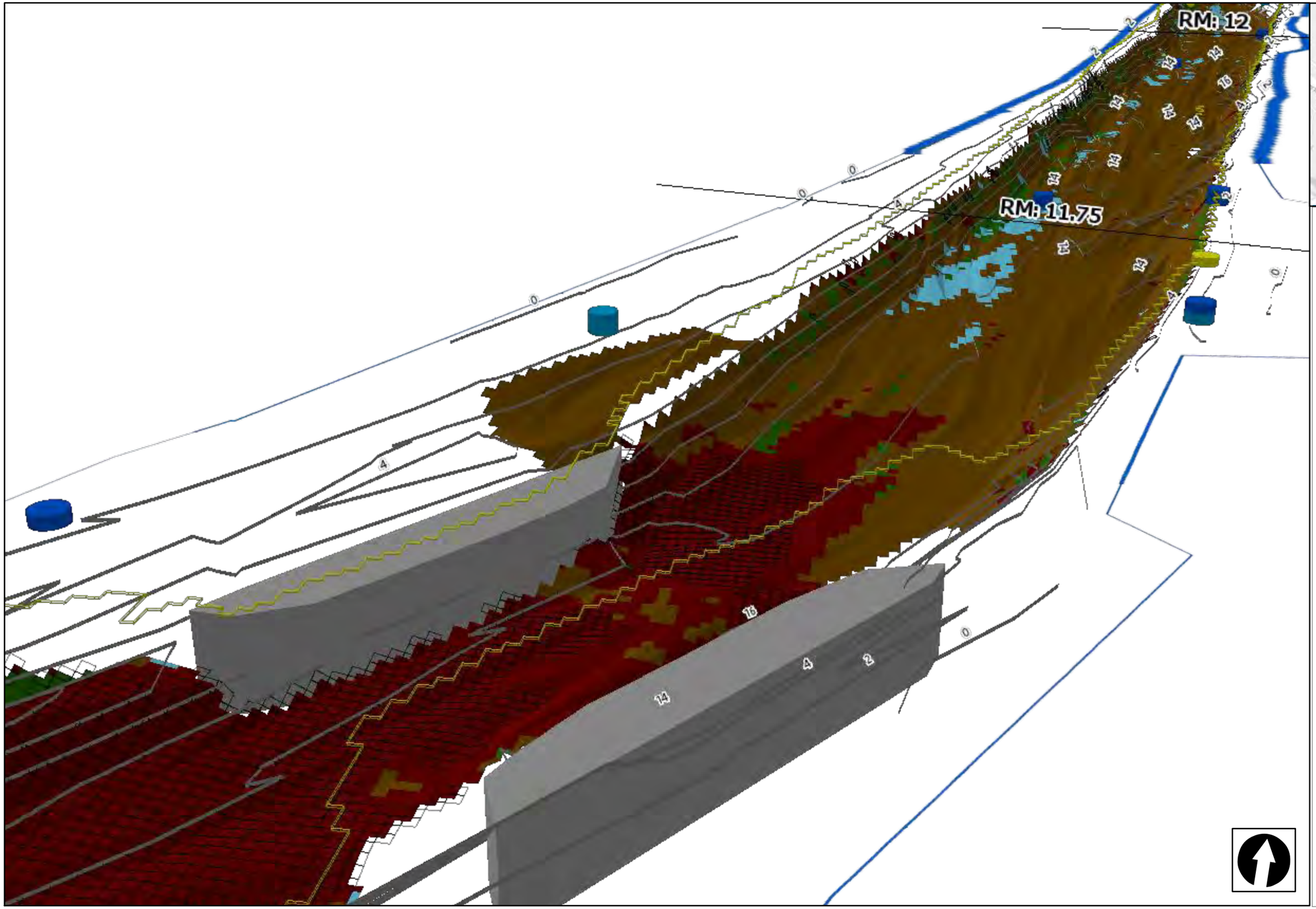
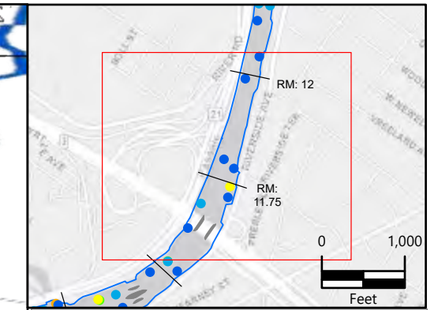
Figure 3-2b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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Figure 3-2c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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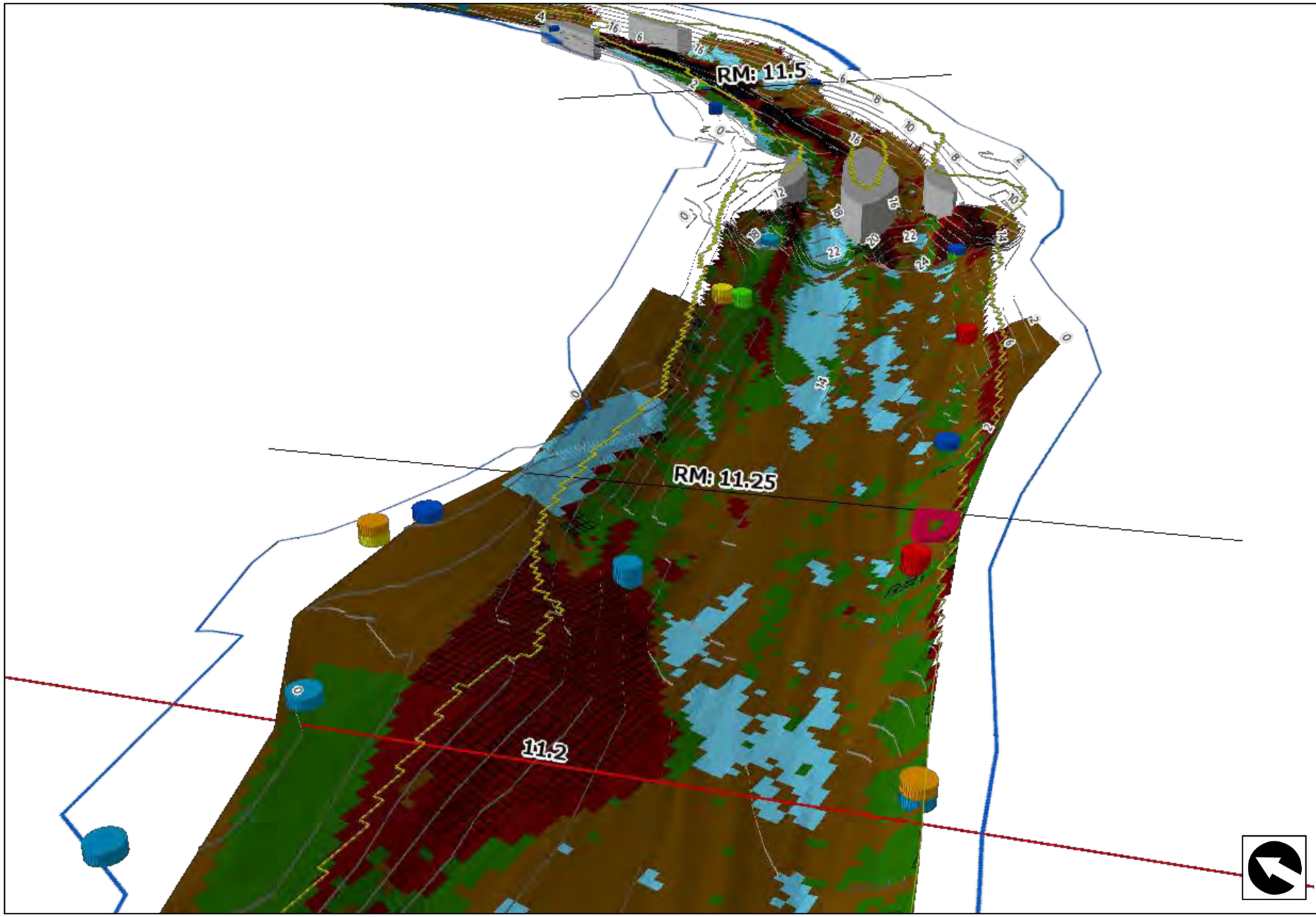
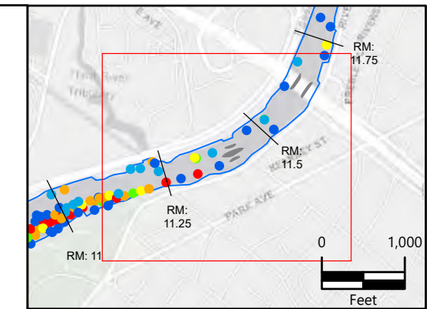
Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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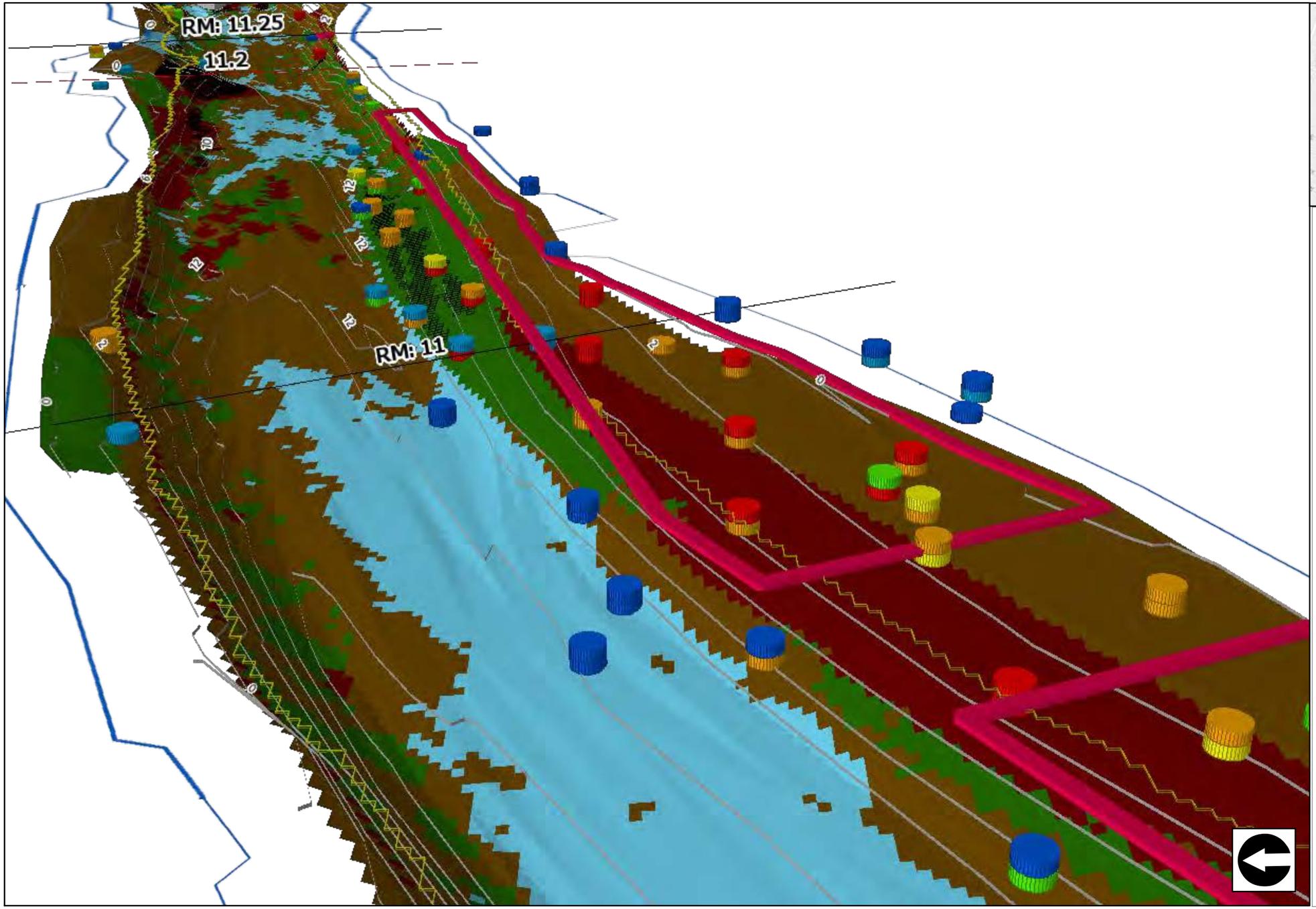
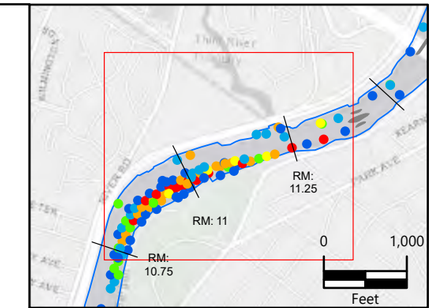
Figure 3-2d

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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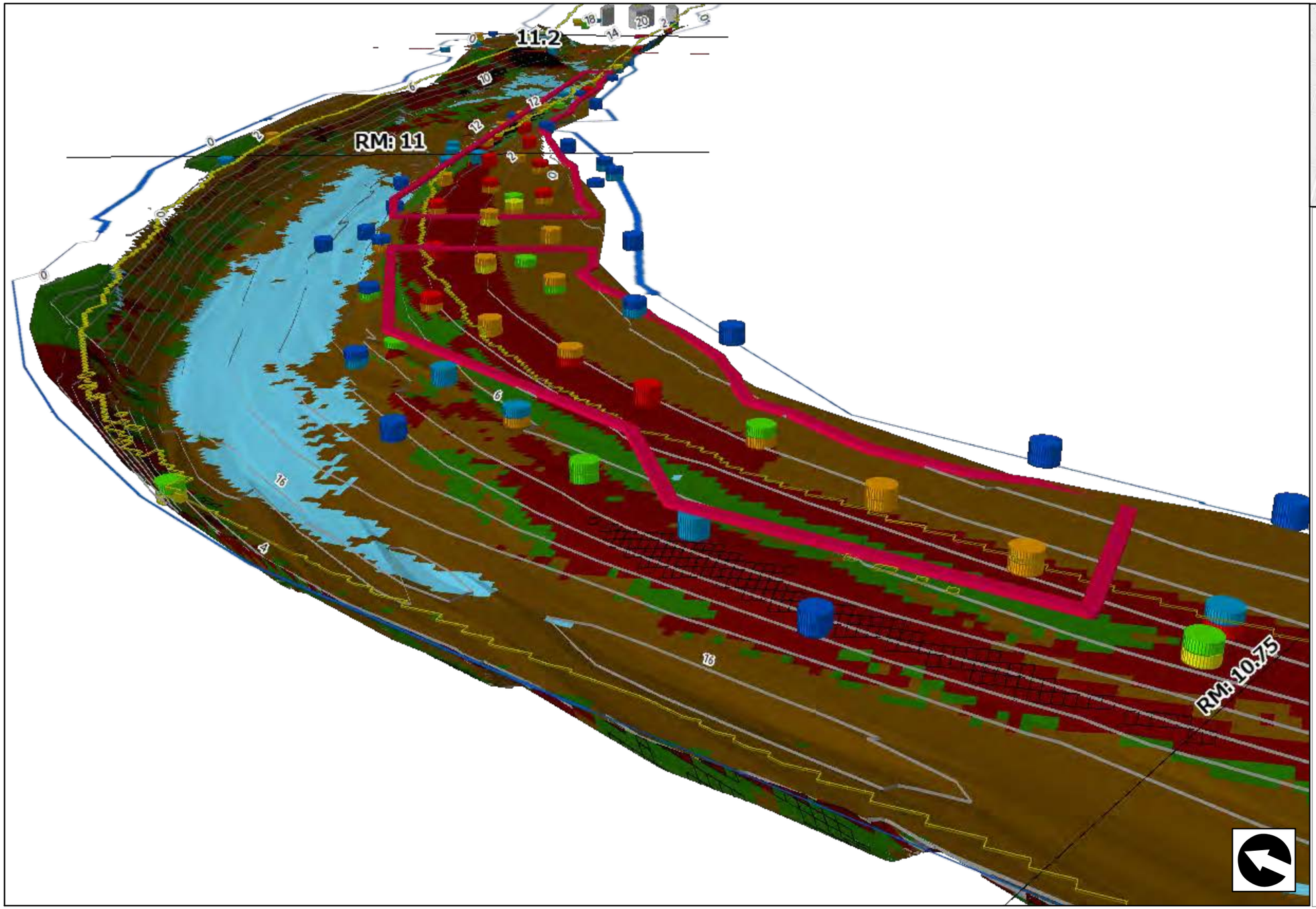
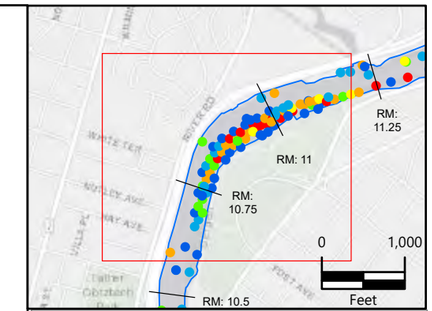
Figure 3-3a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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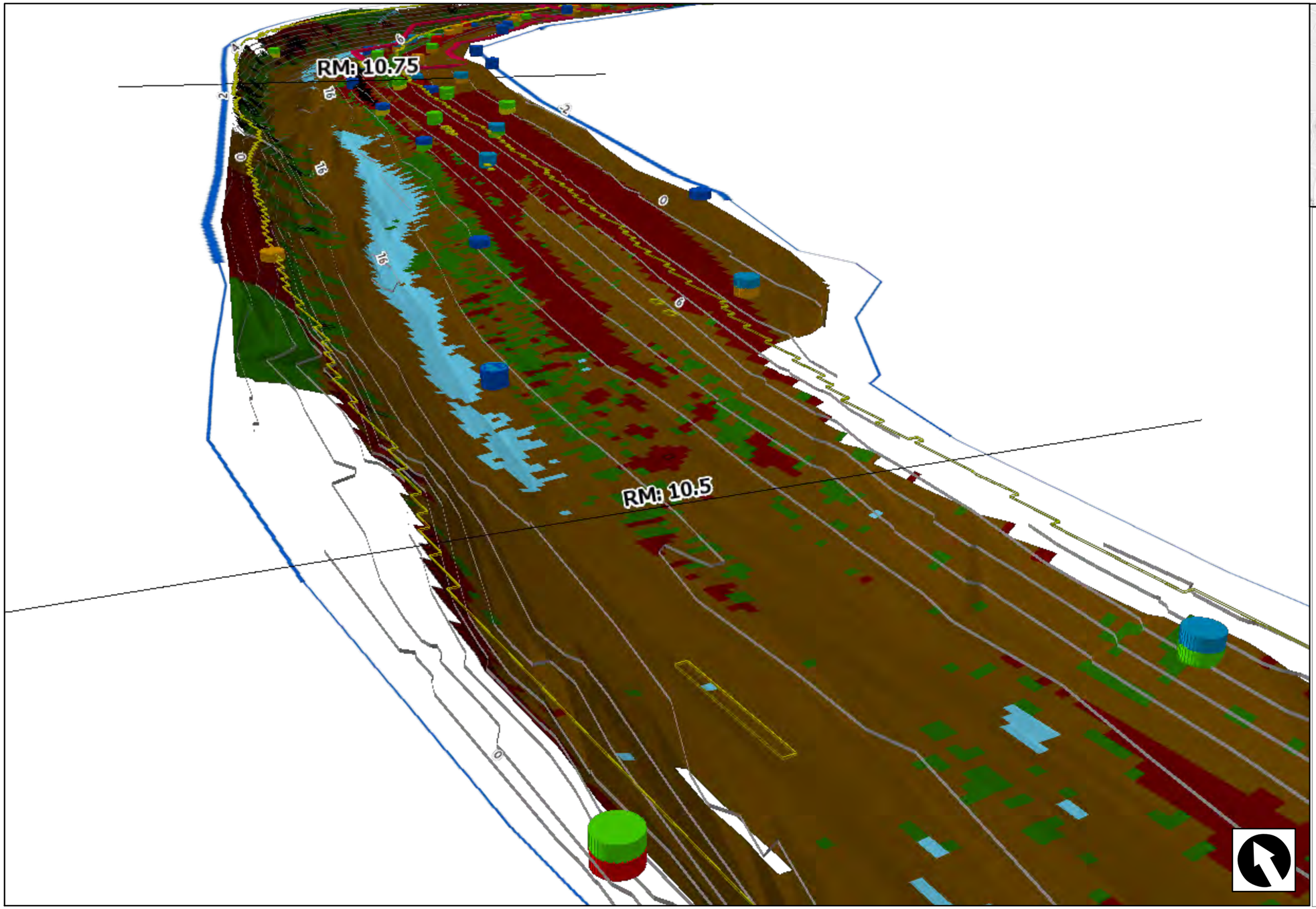
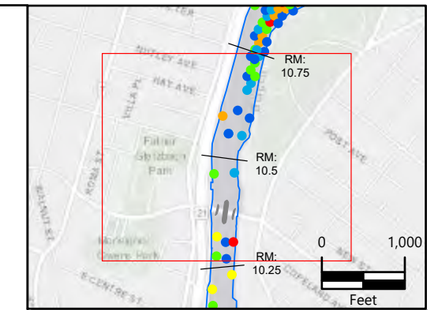
Figure 3-3b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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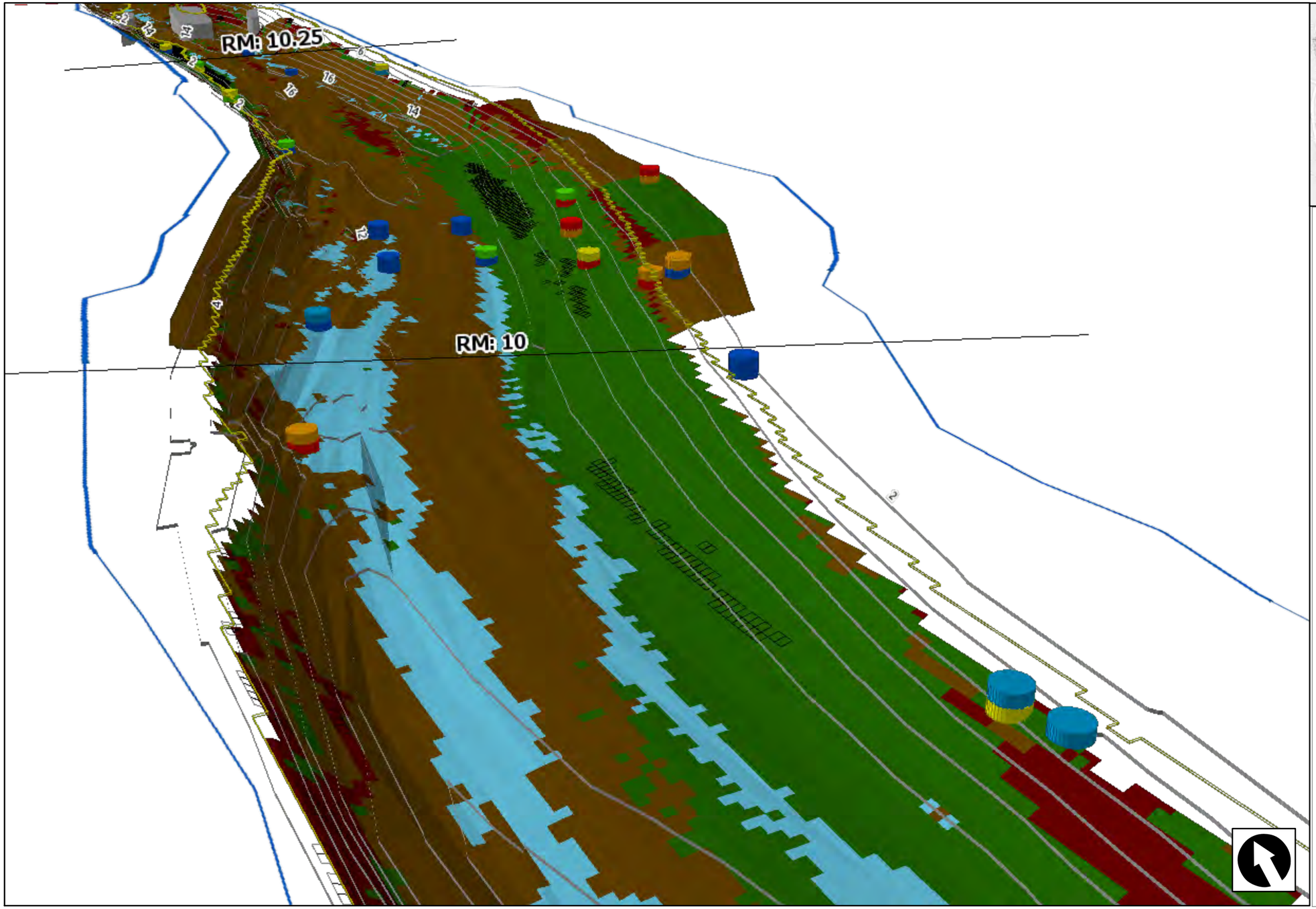
Figure 3-3c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study



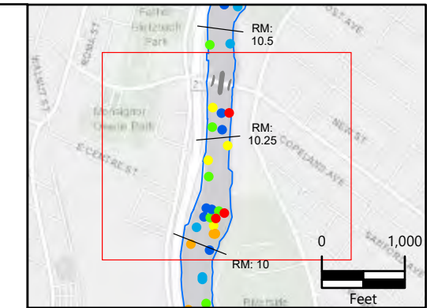


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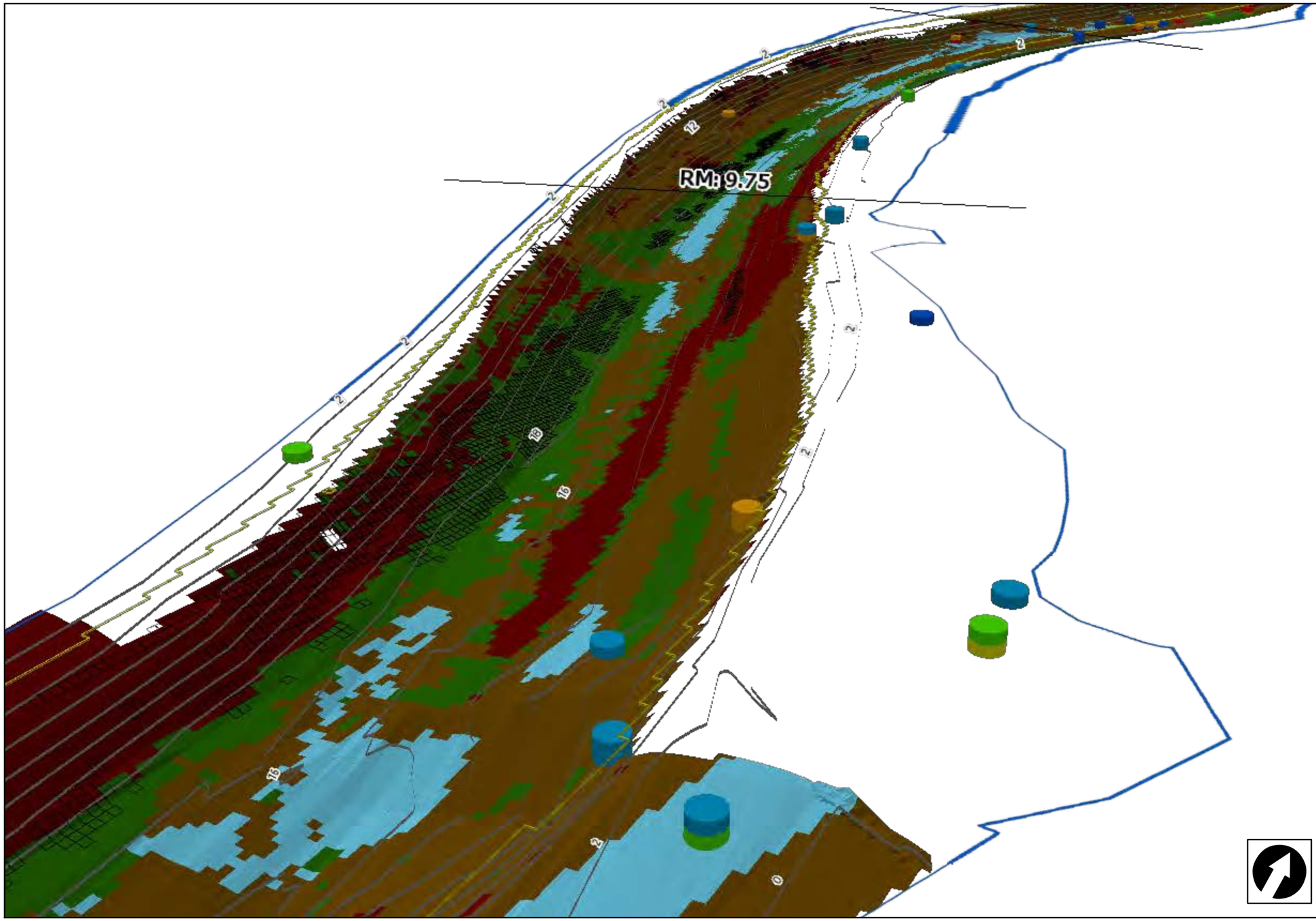
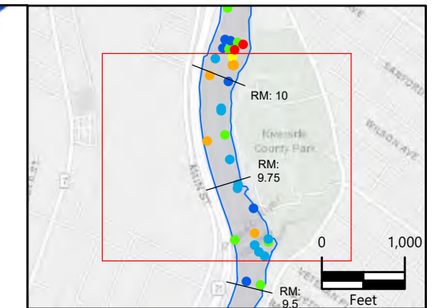
Figure 3-4a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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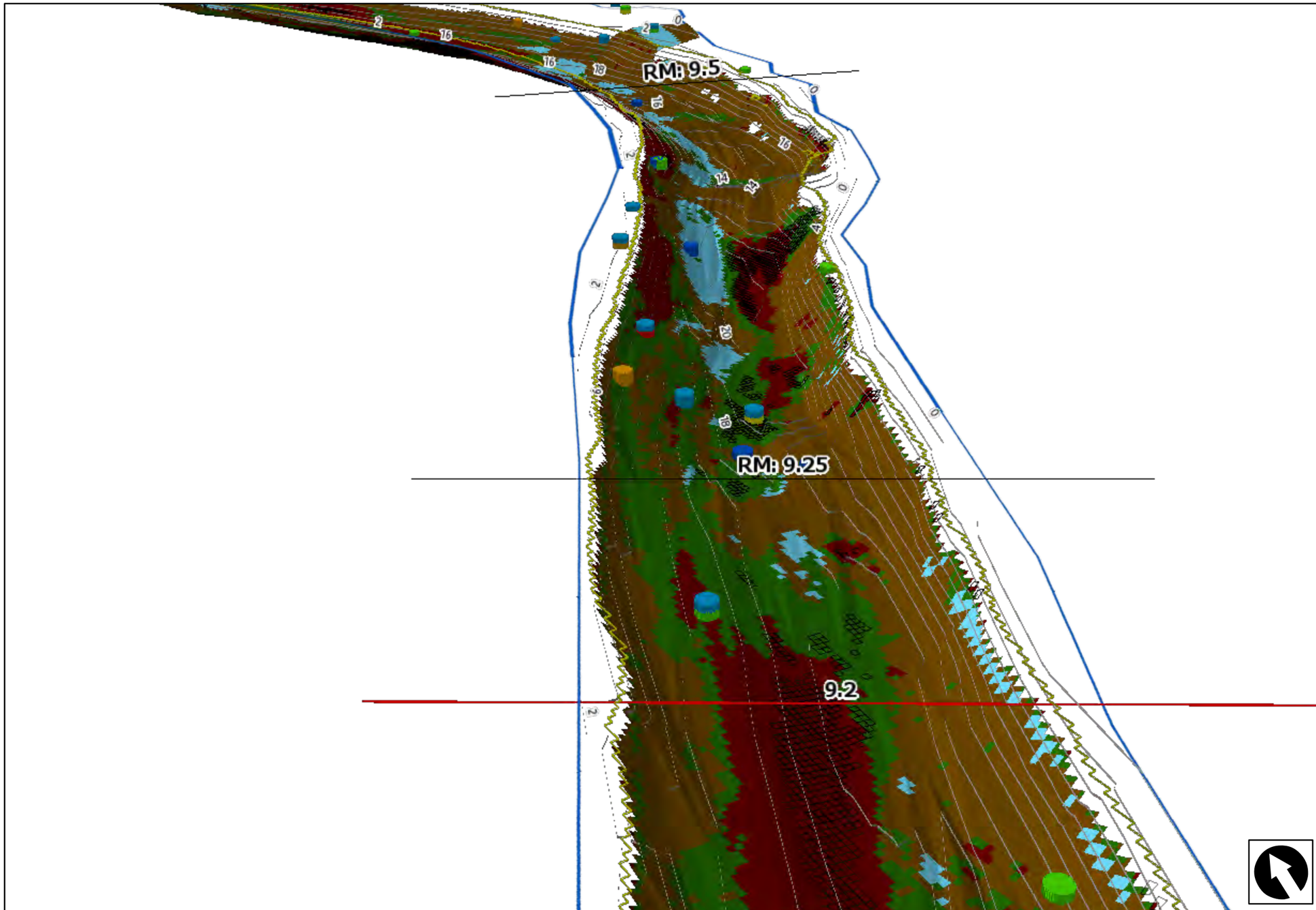
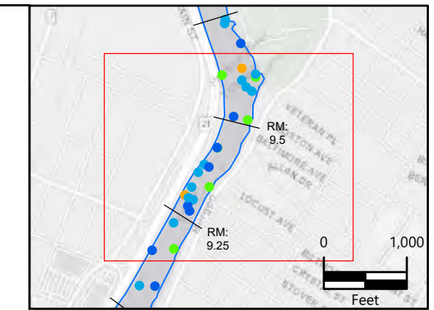
Figure 3-4b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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- Shoreline
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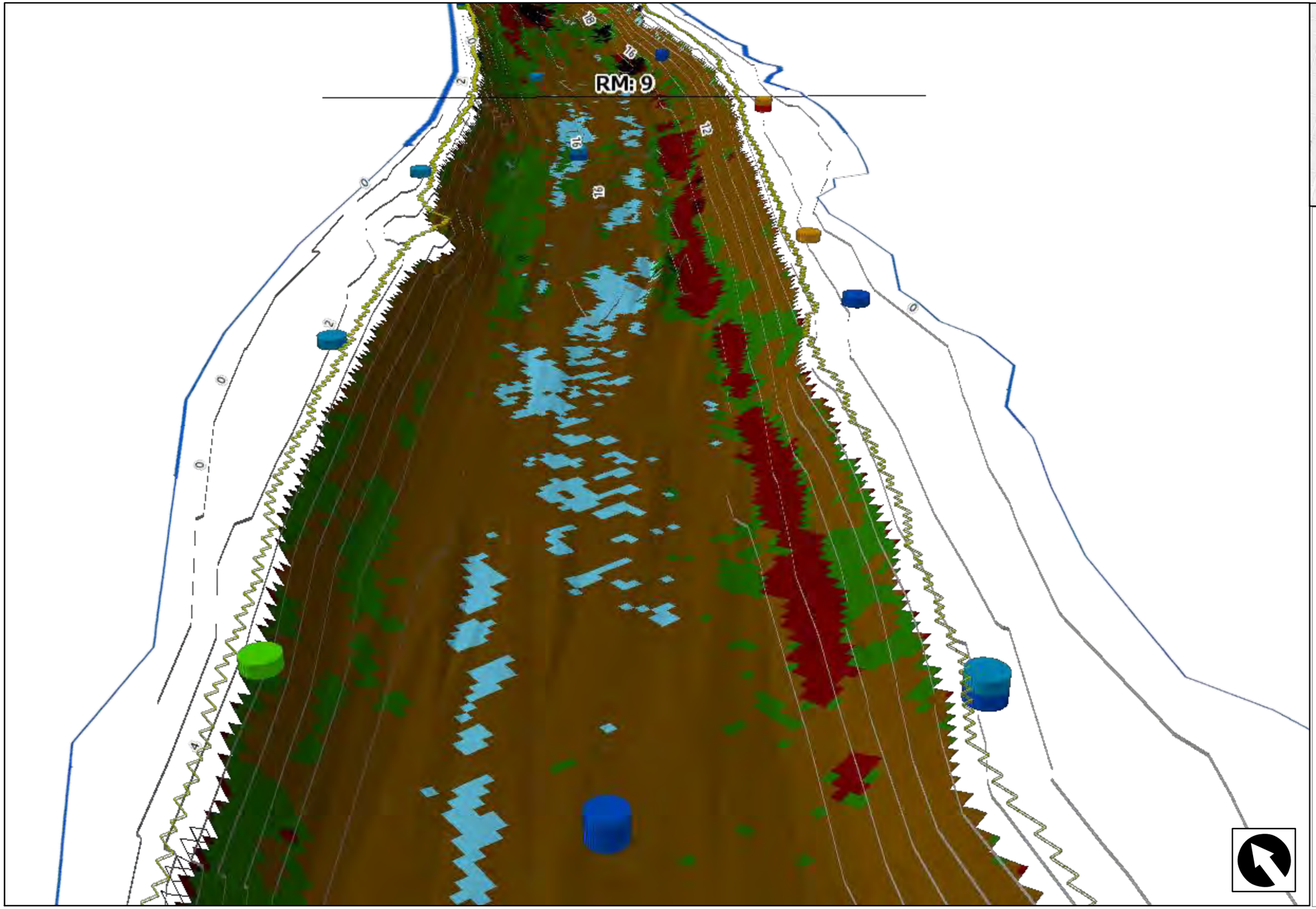
Figure 3-4c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study



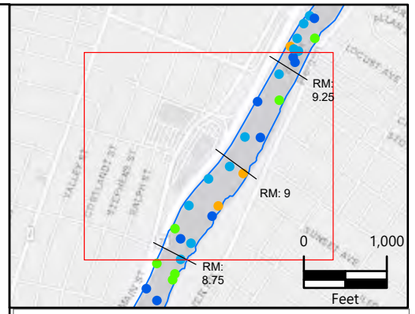


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Figure 3-5a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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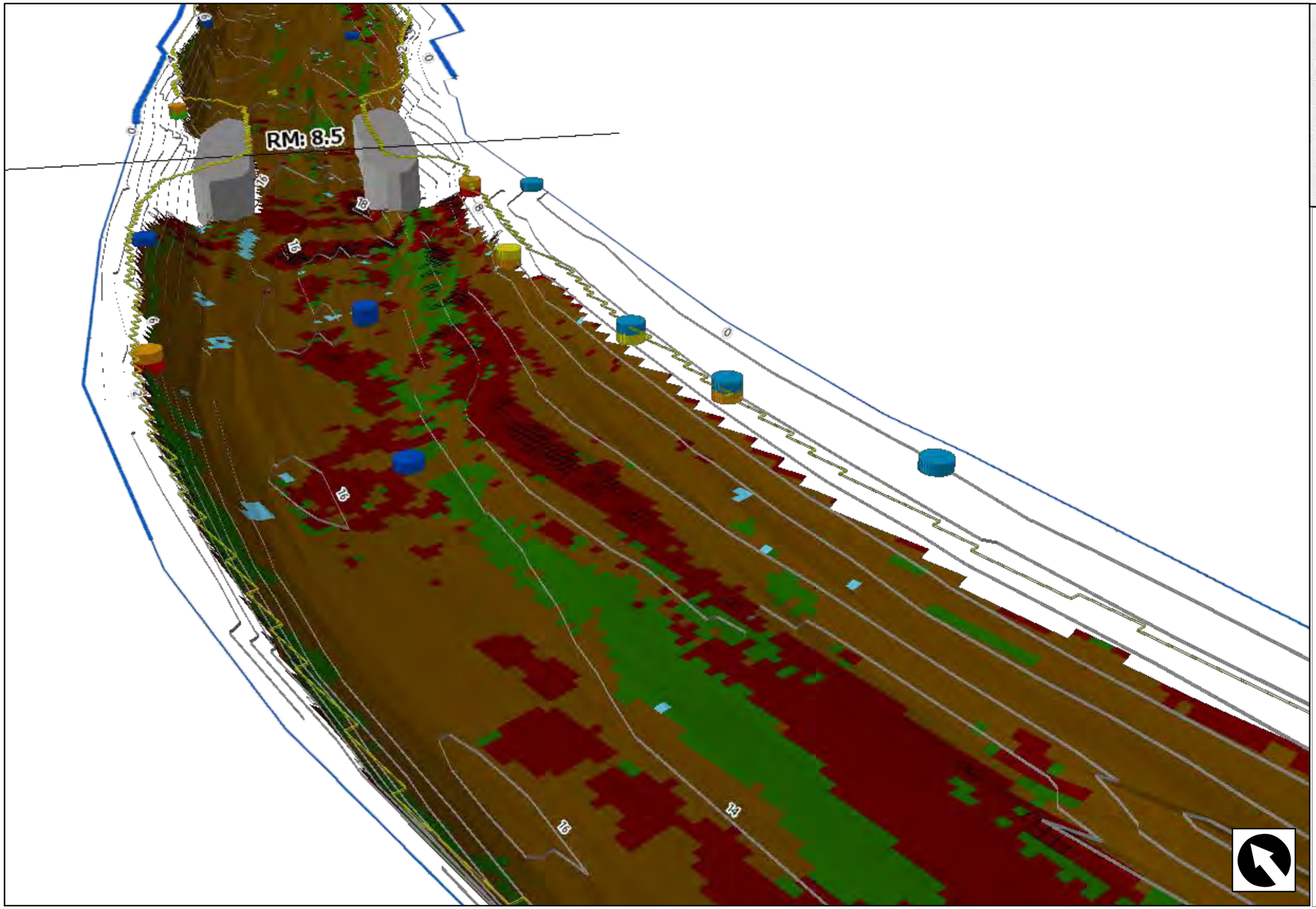

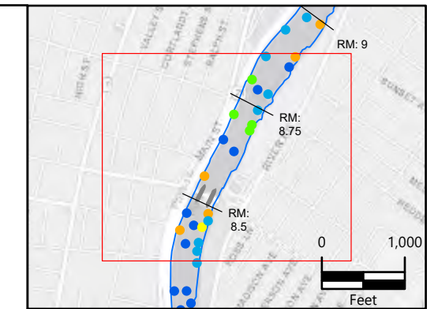

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Figure 3-5b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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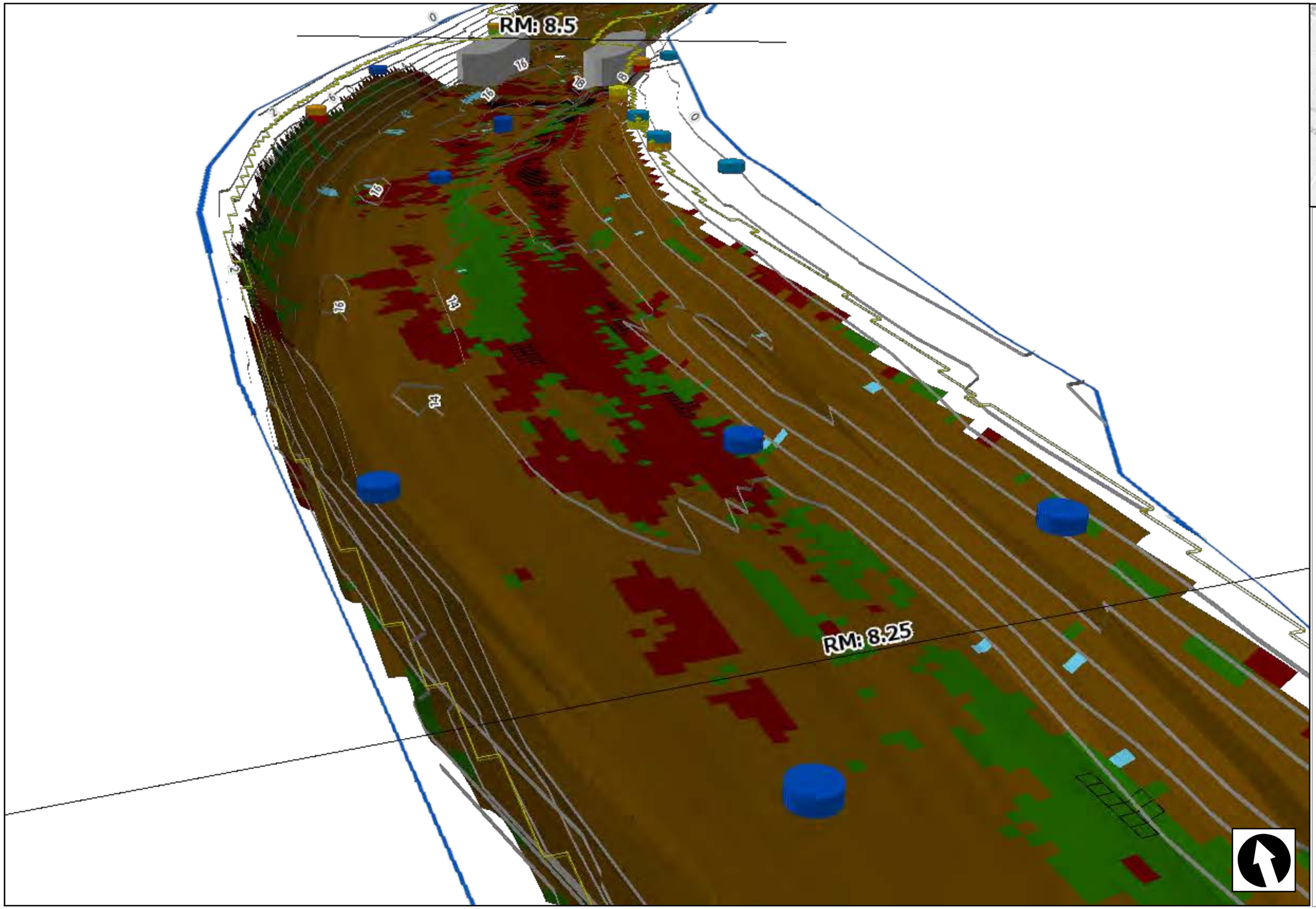

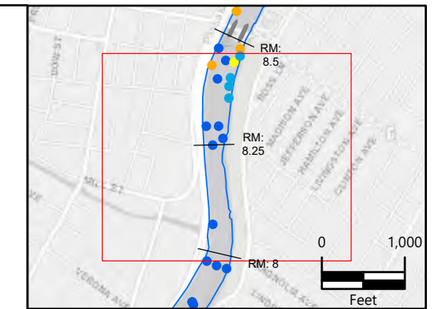

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Figure 3-5c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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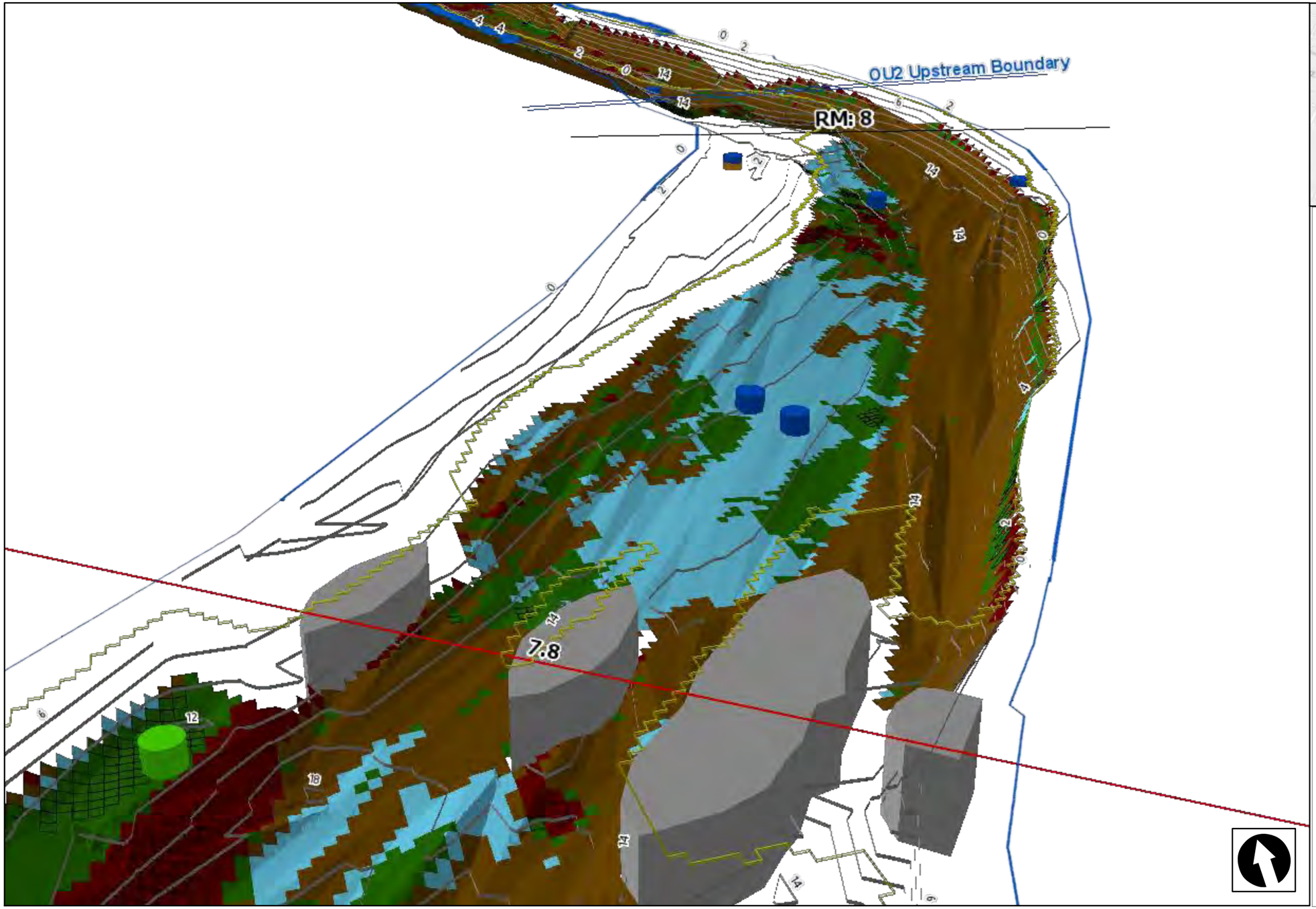

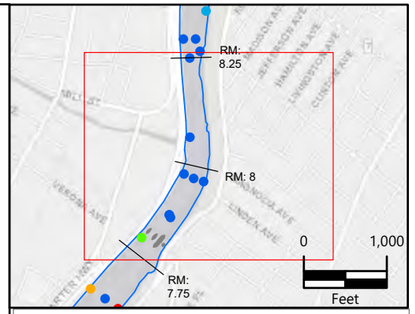

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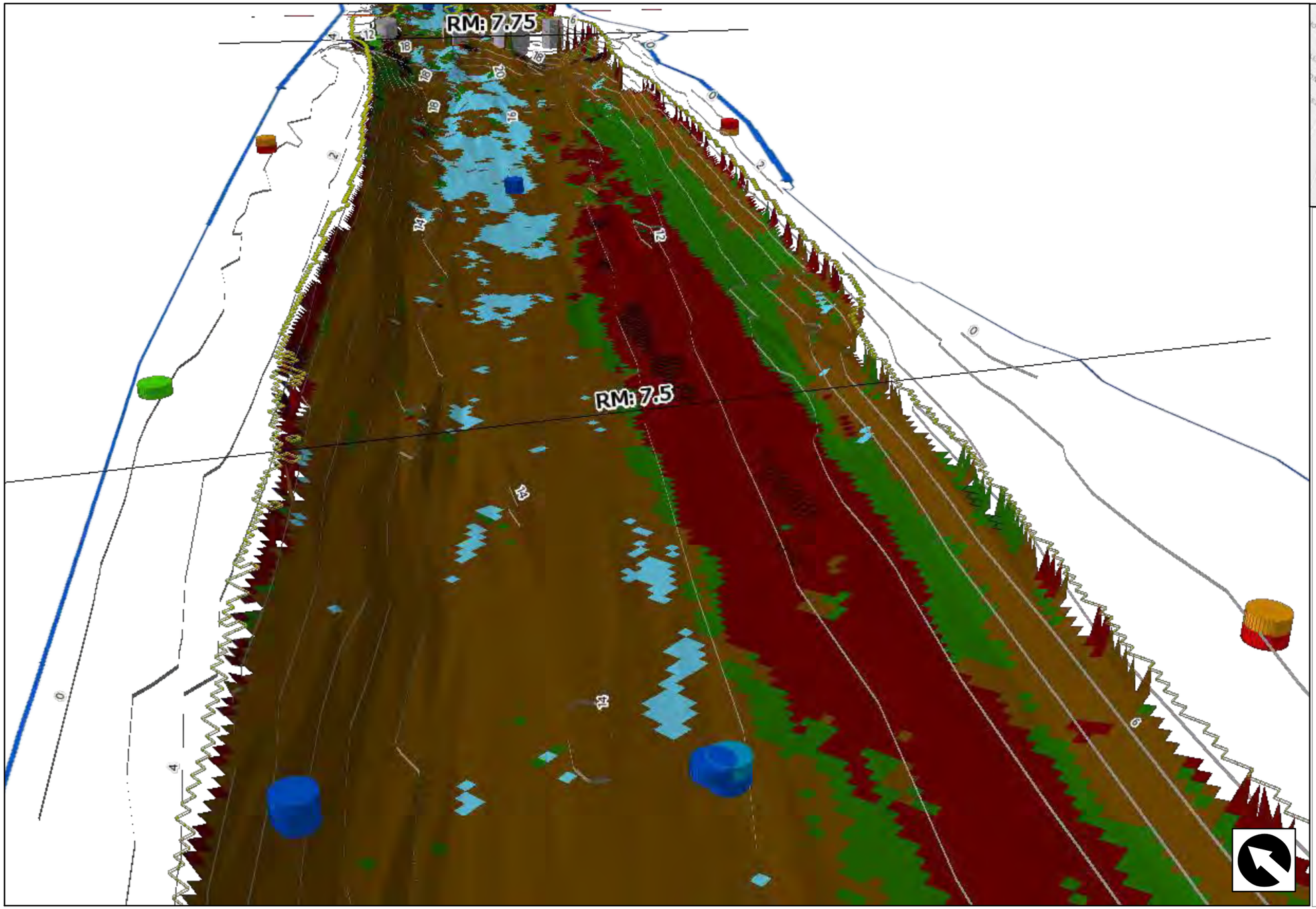
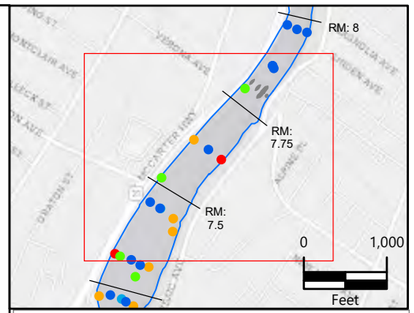
Figure 3-5d

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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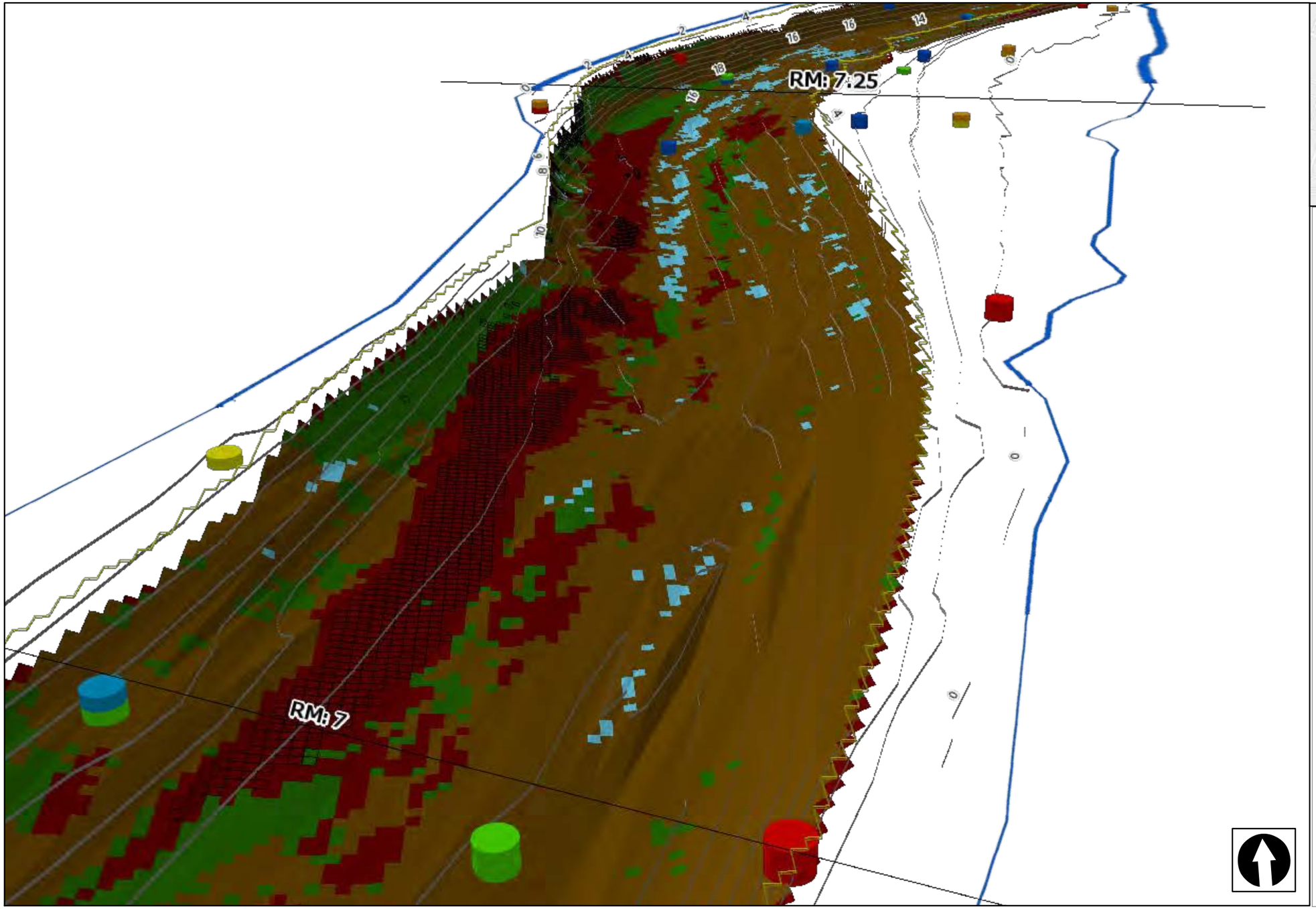
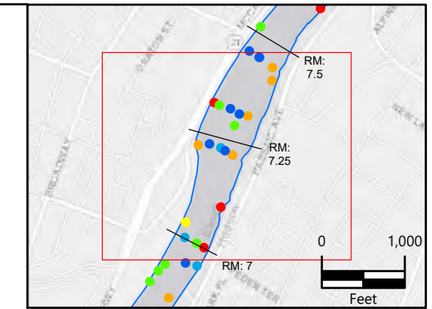
Figure 3-6a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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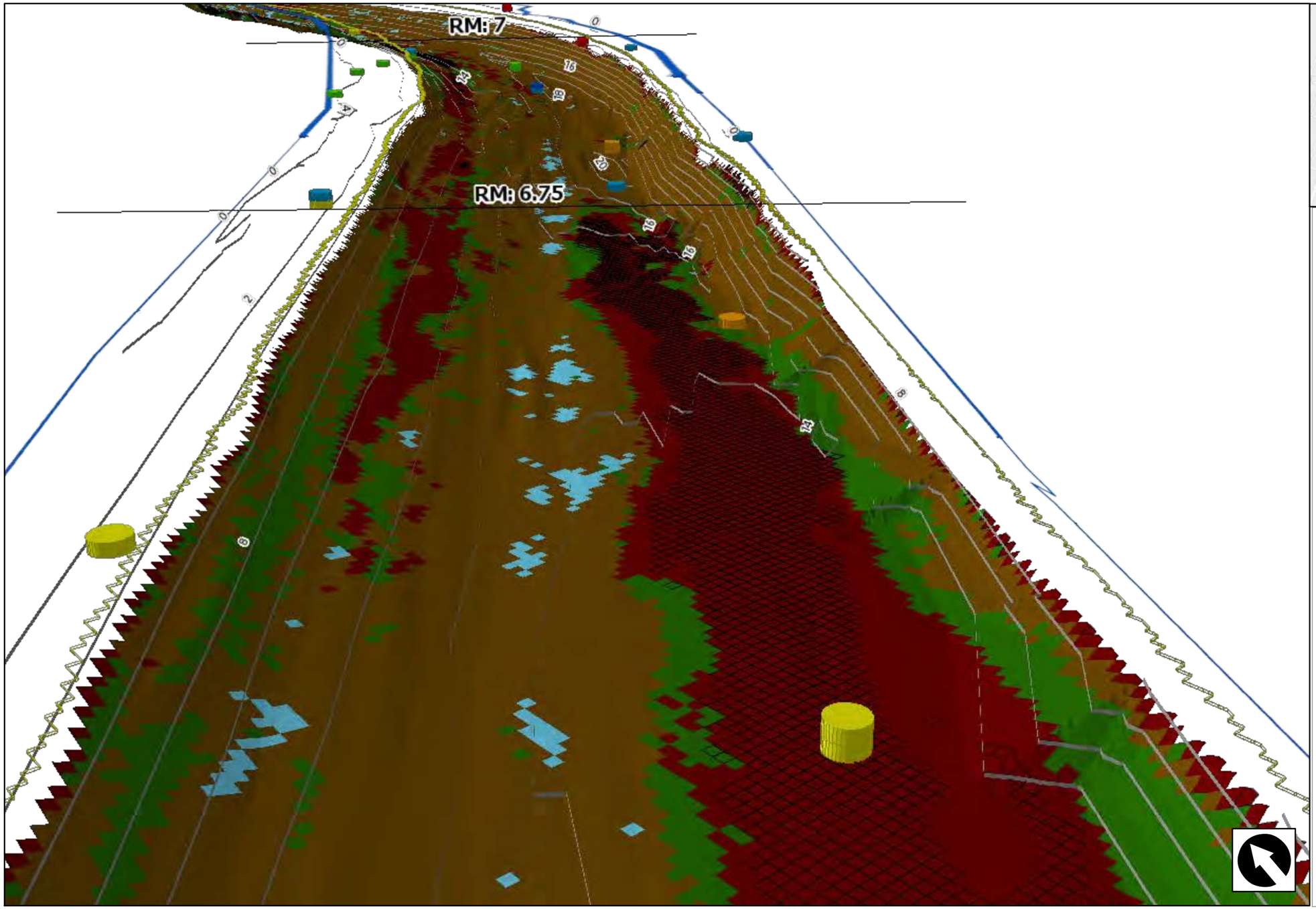
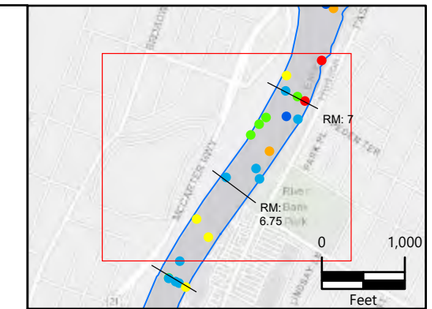
Figure 3-6b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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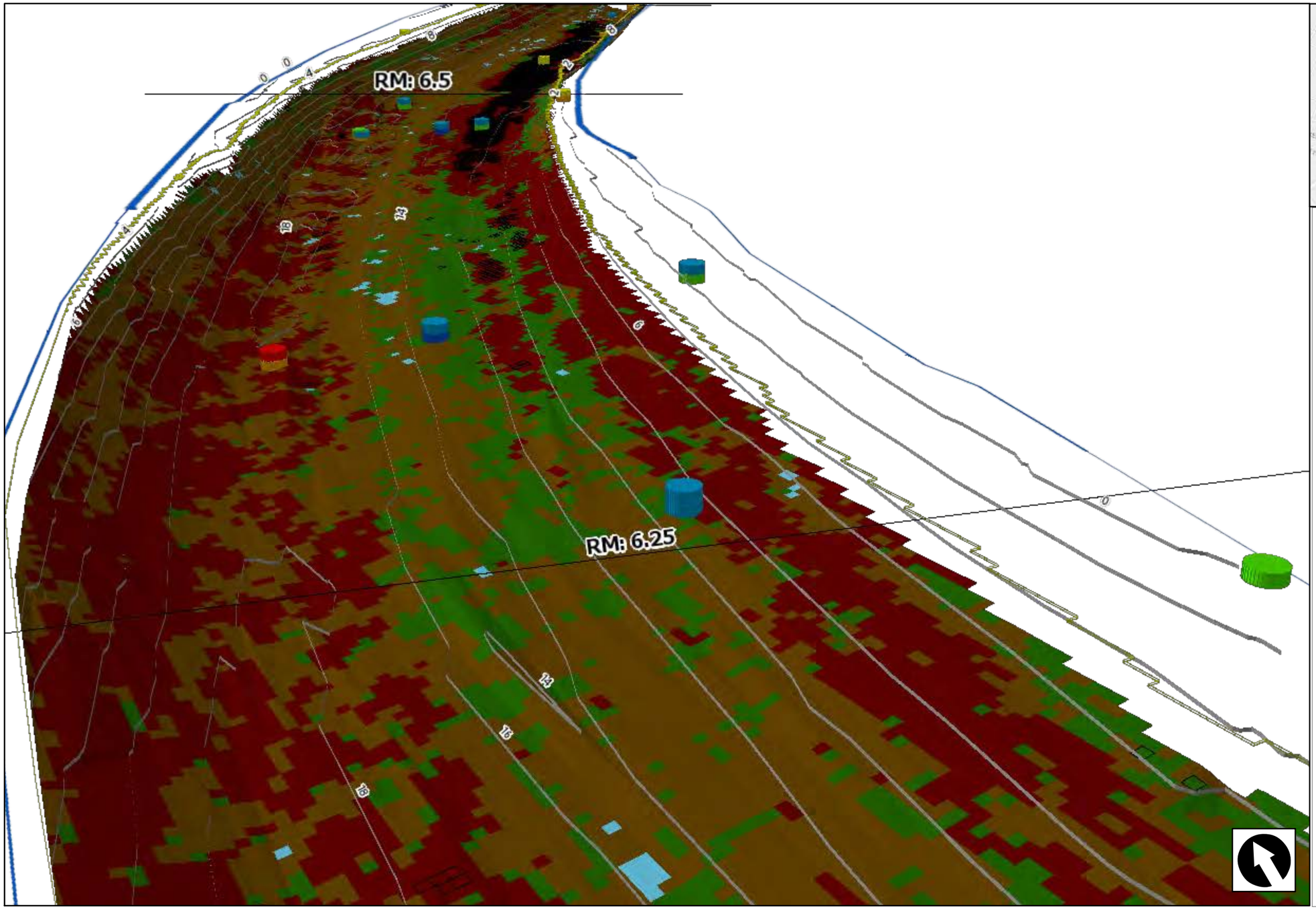
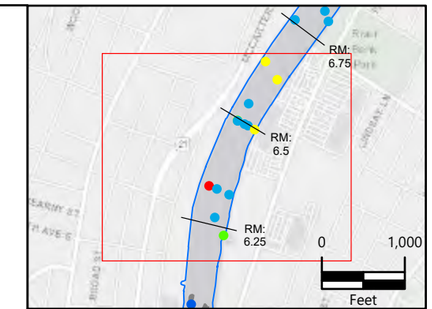
Figure 3-6c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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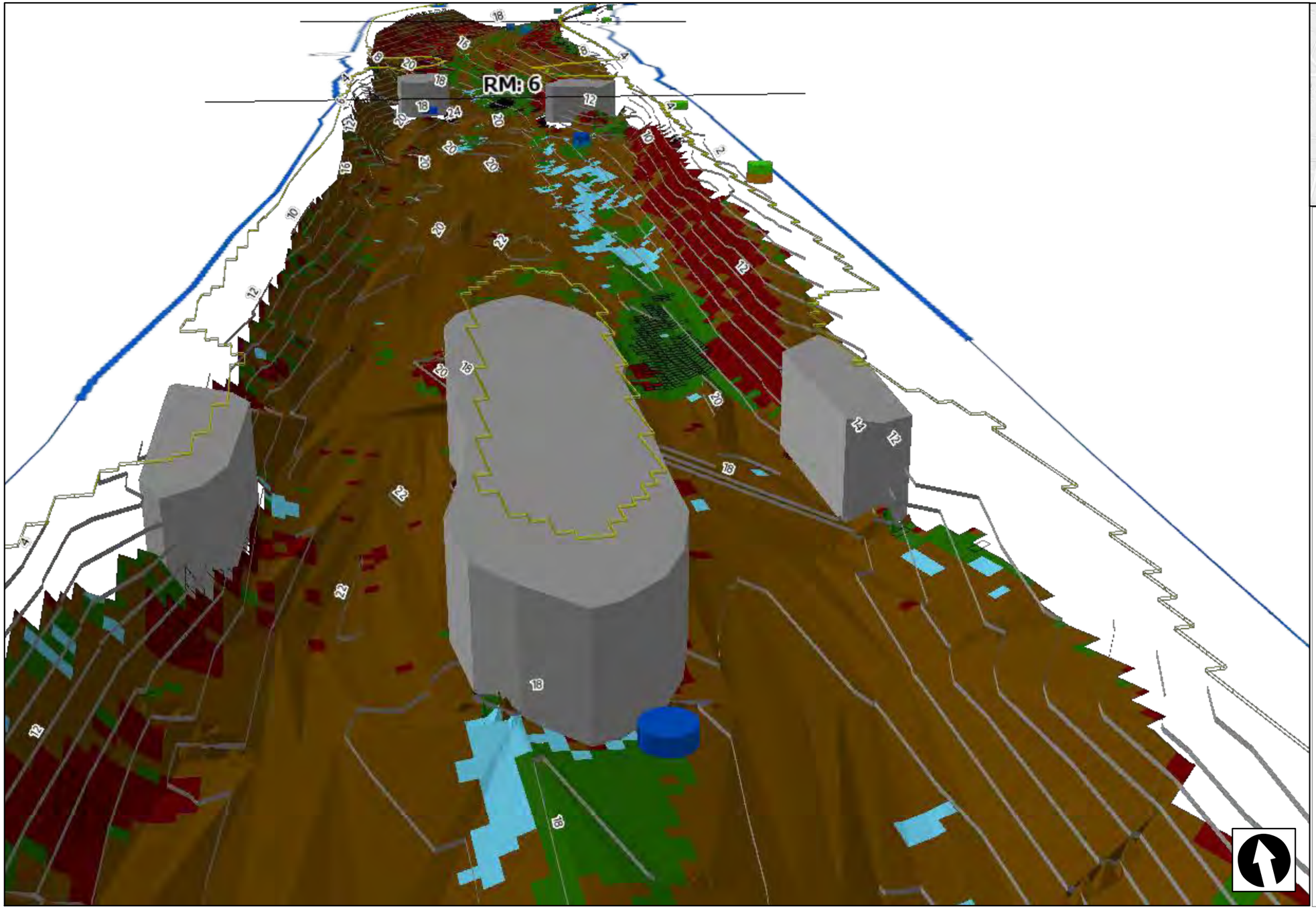
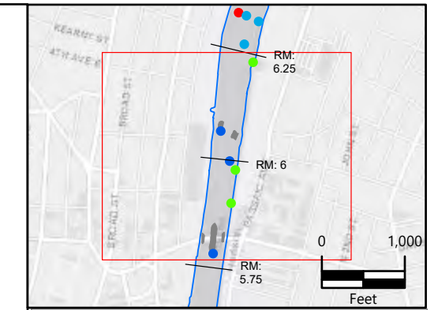
Figure 3-6d

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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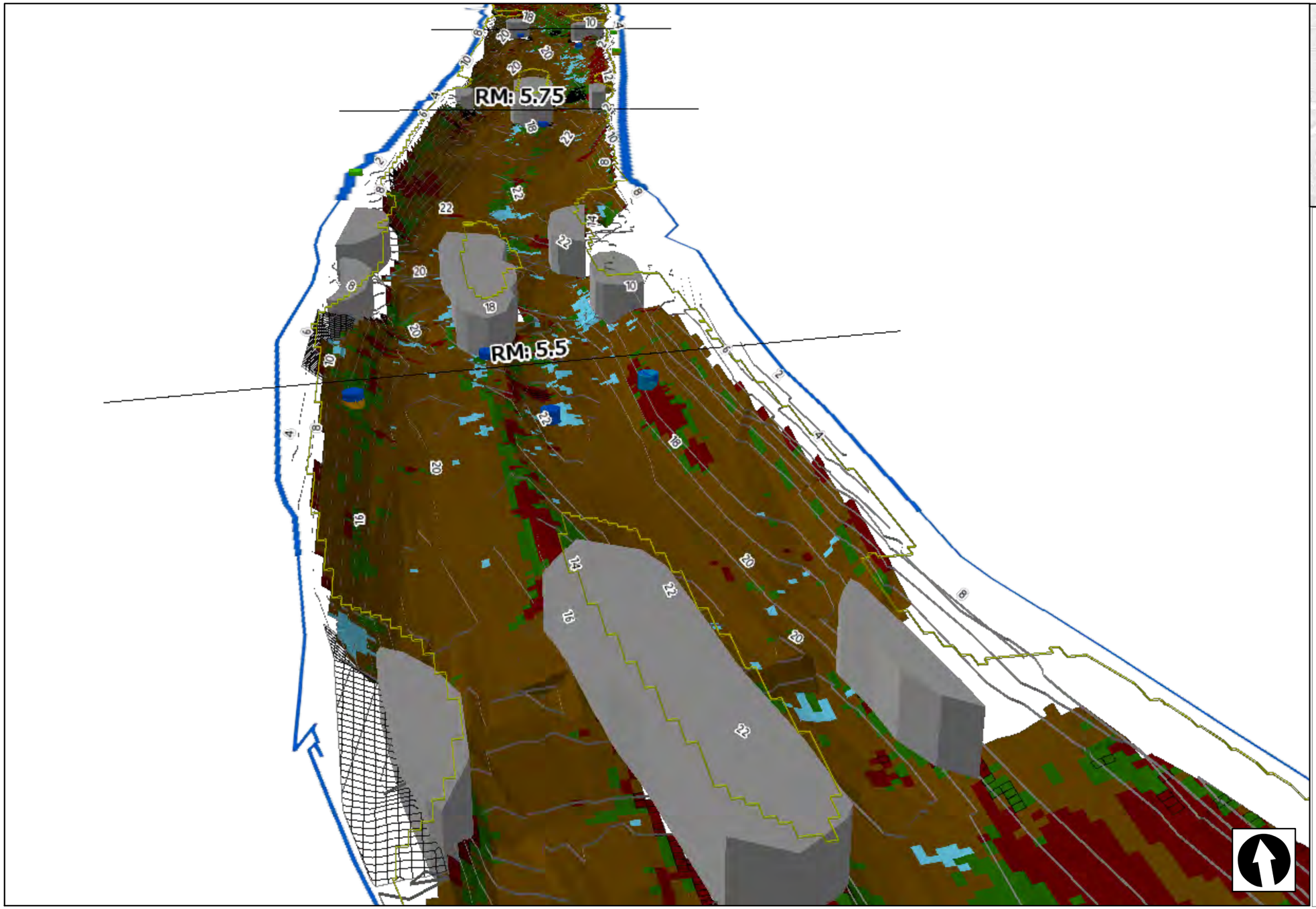
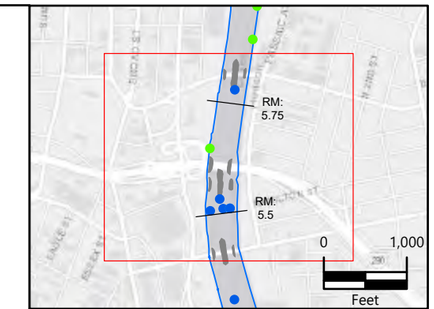
Figure 3-6e

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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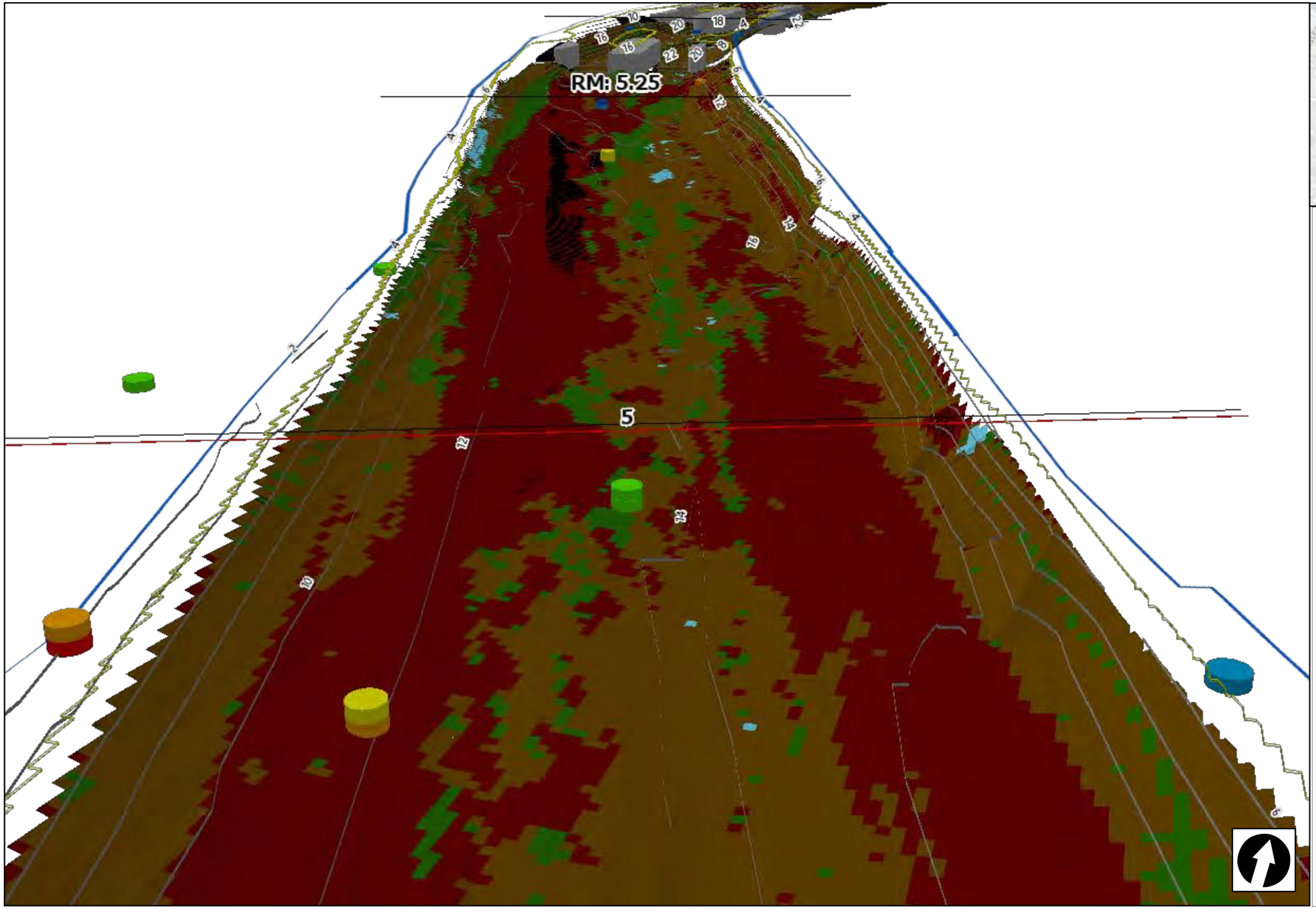
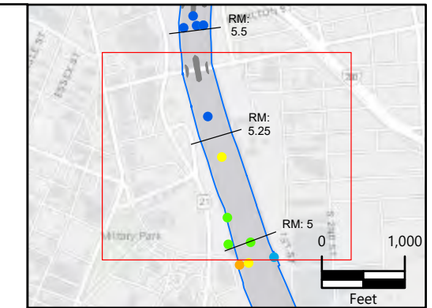
Figure 3-6f

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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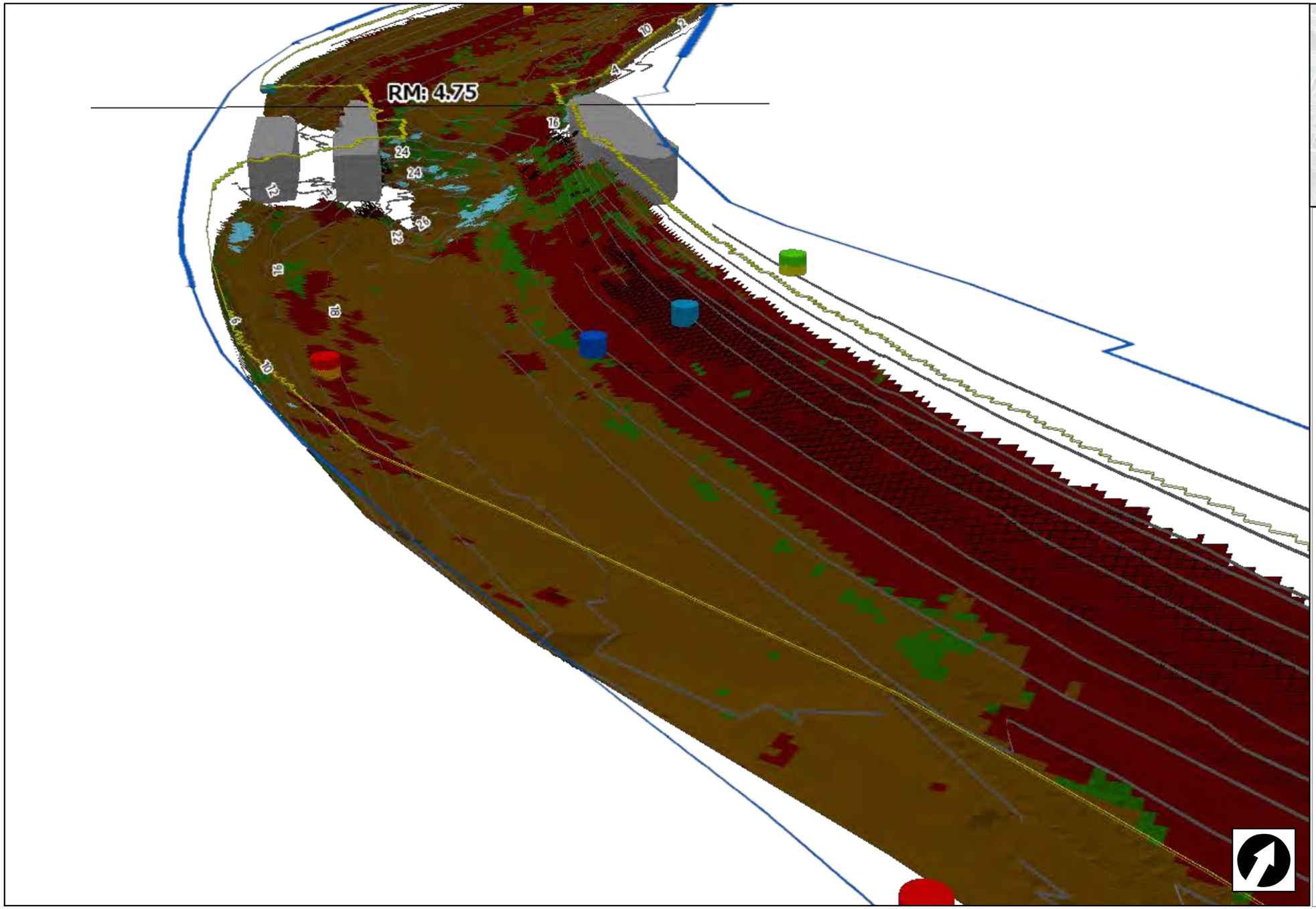
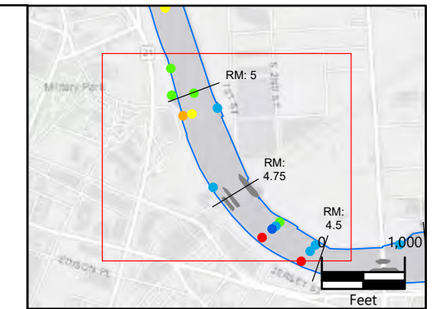
Figure 3-6g

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
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NOTES:
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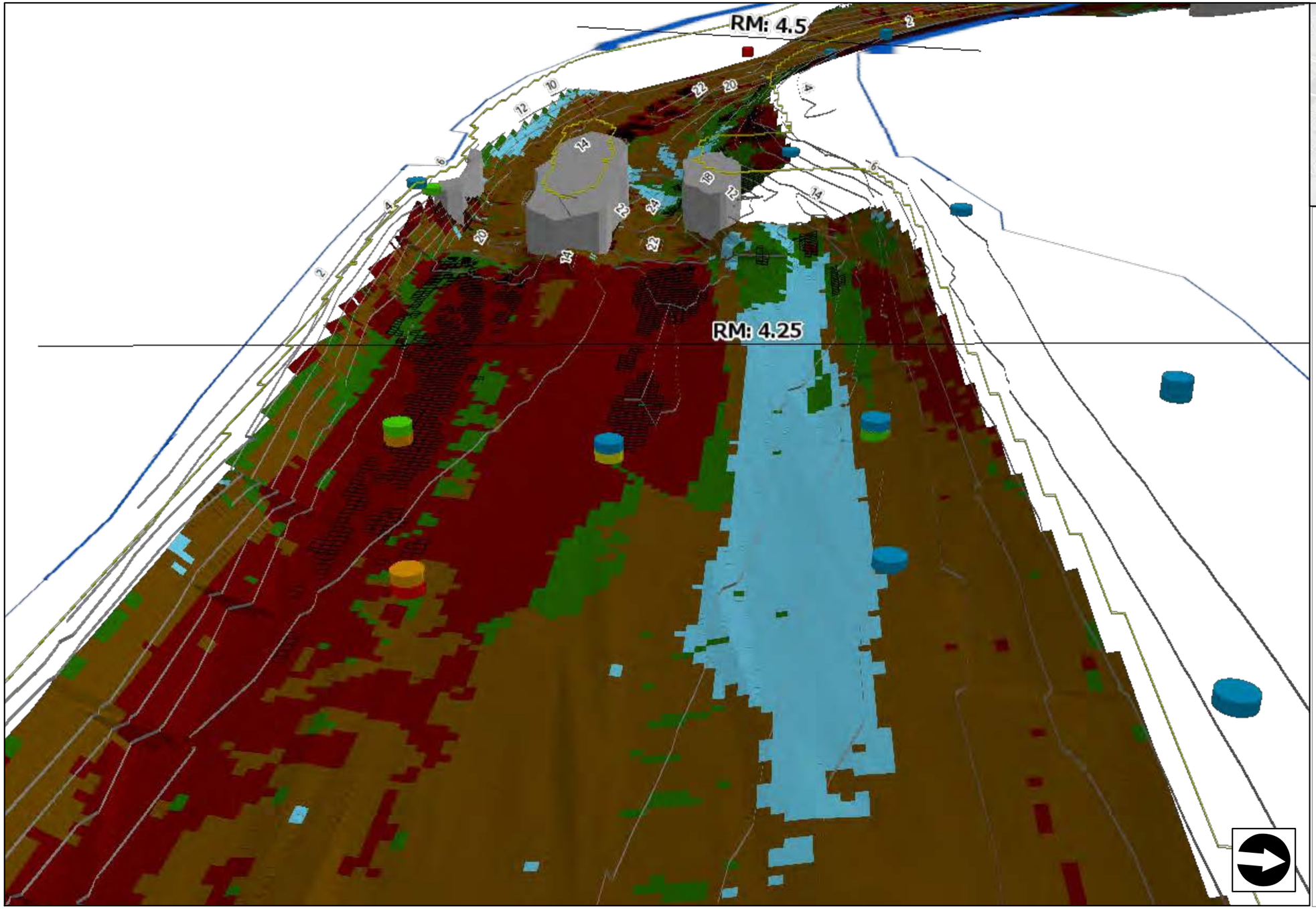
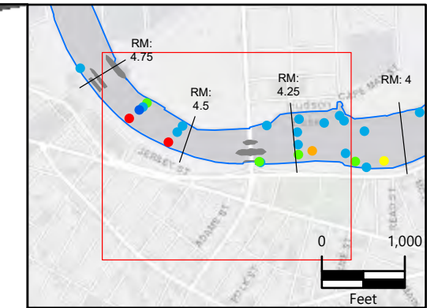
Figure 3-7a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
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- Depositional from 2007 to 2012
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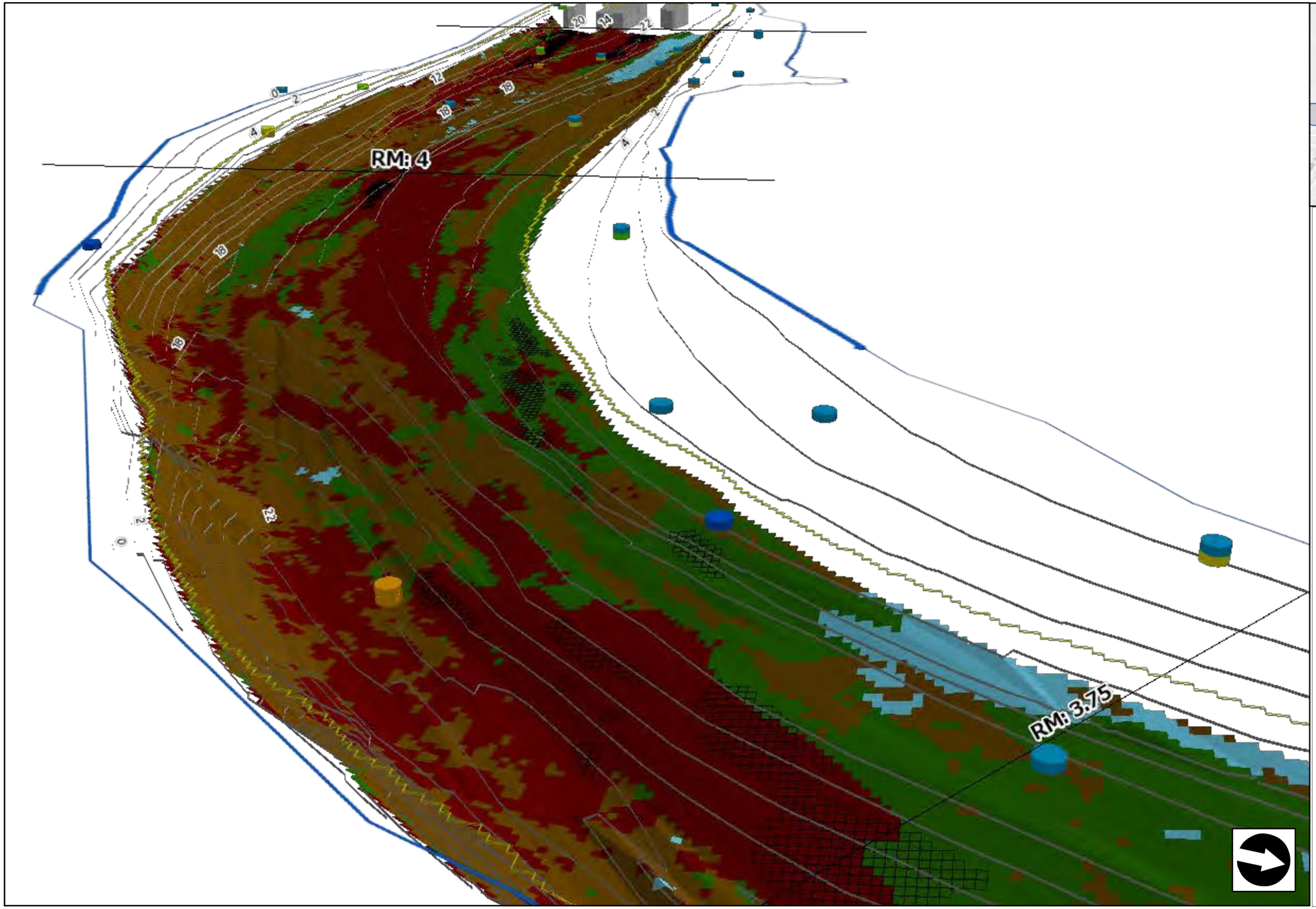
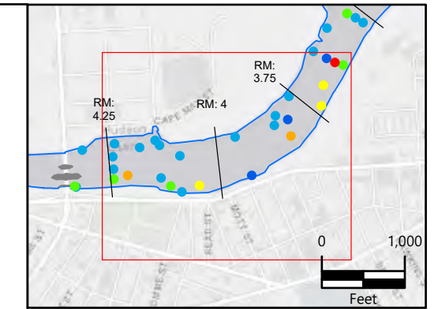
Figure 3-7b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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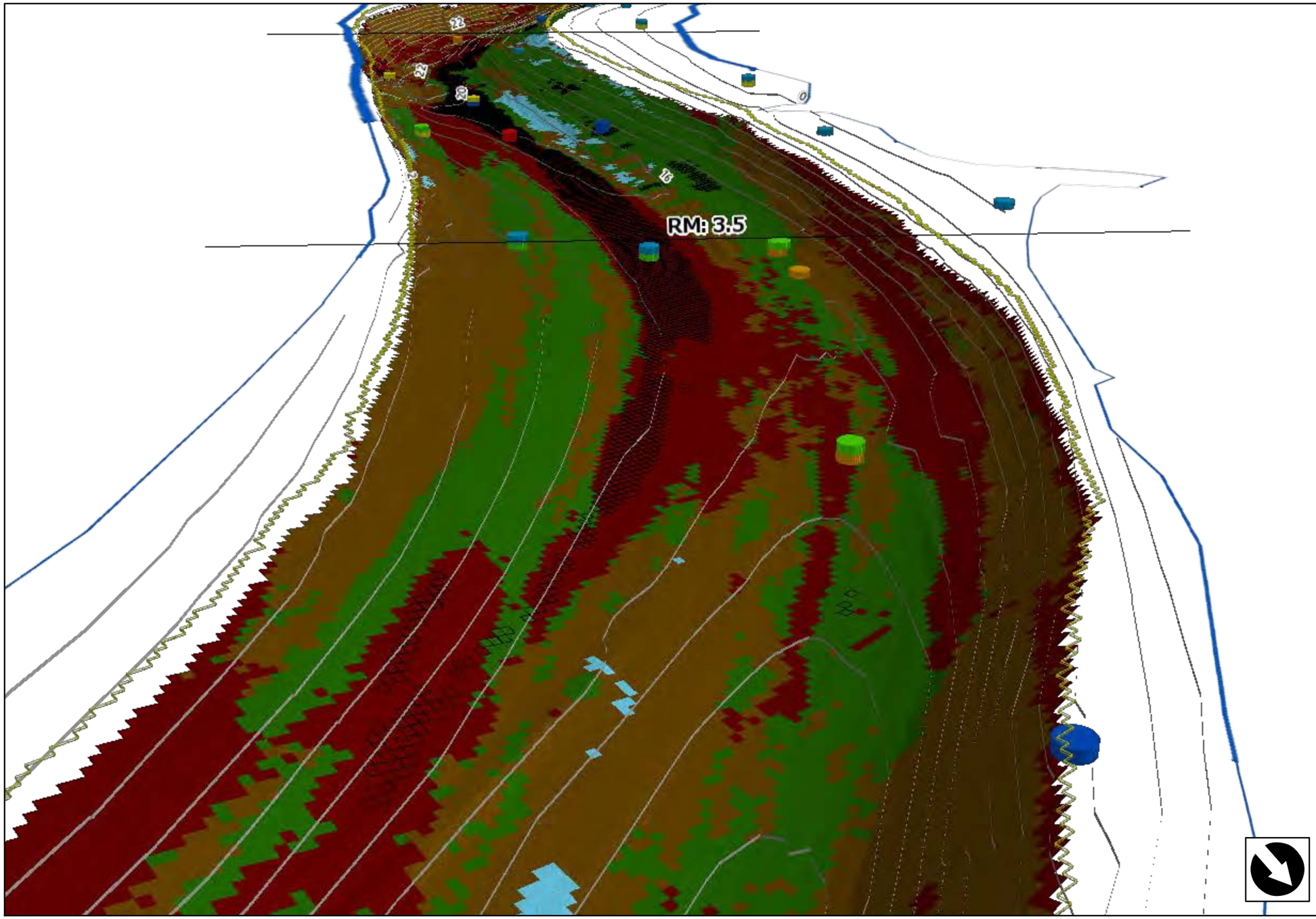
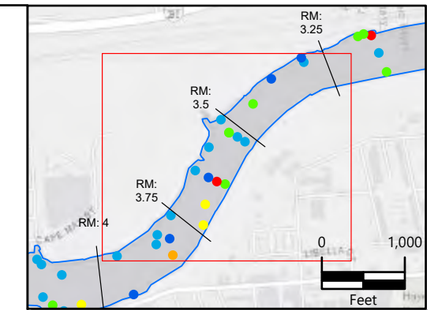
Figure 3-7c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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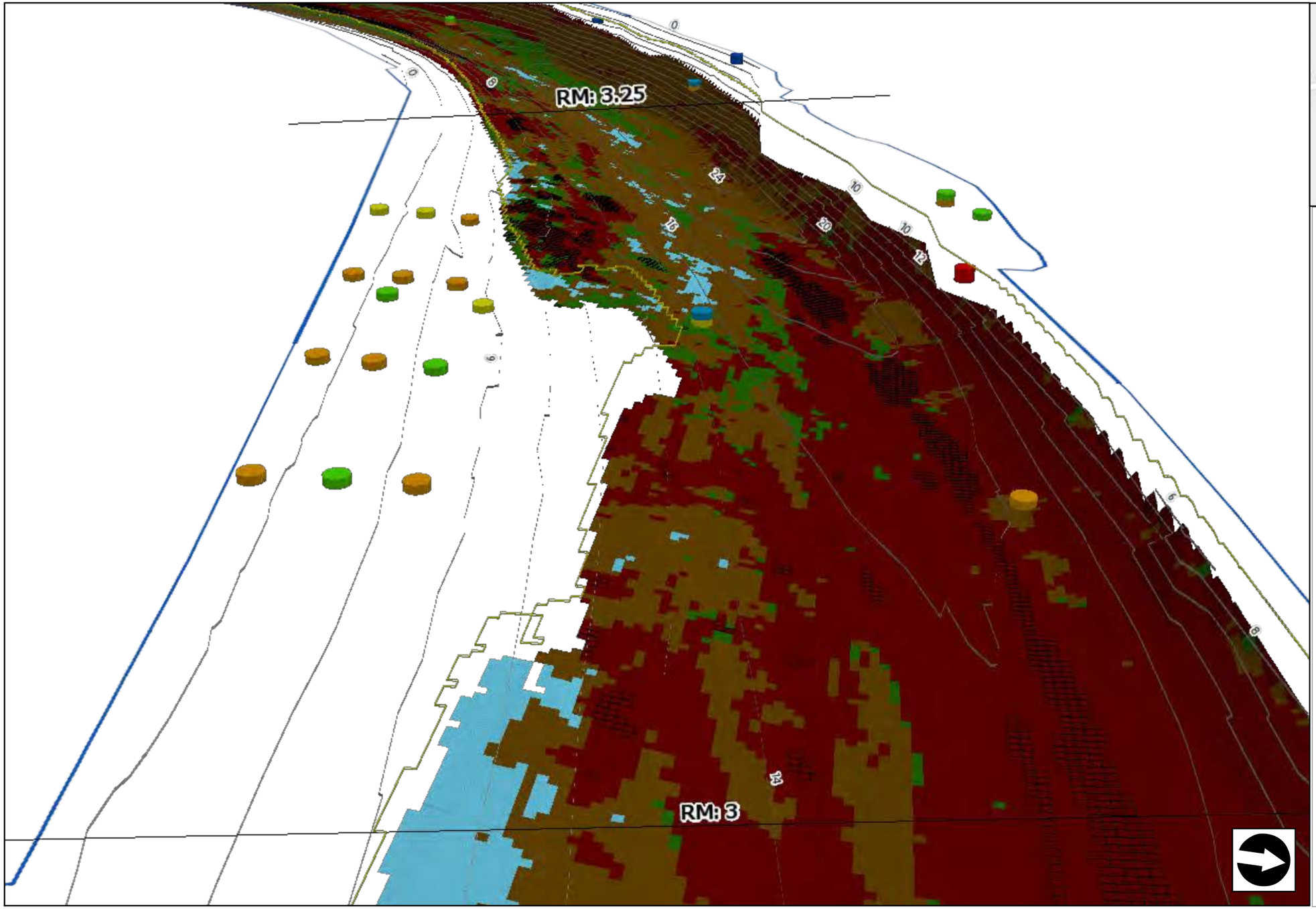
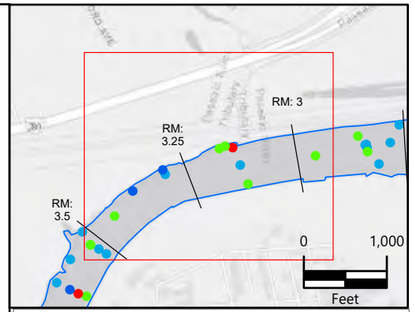
Figure 3-7d

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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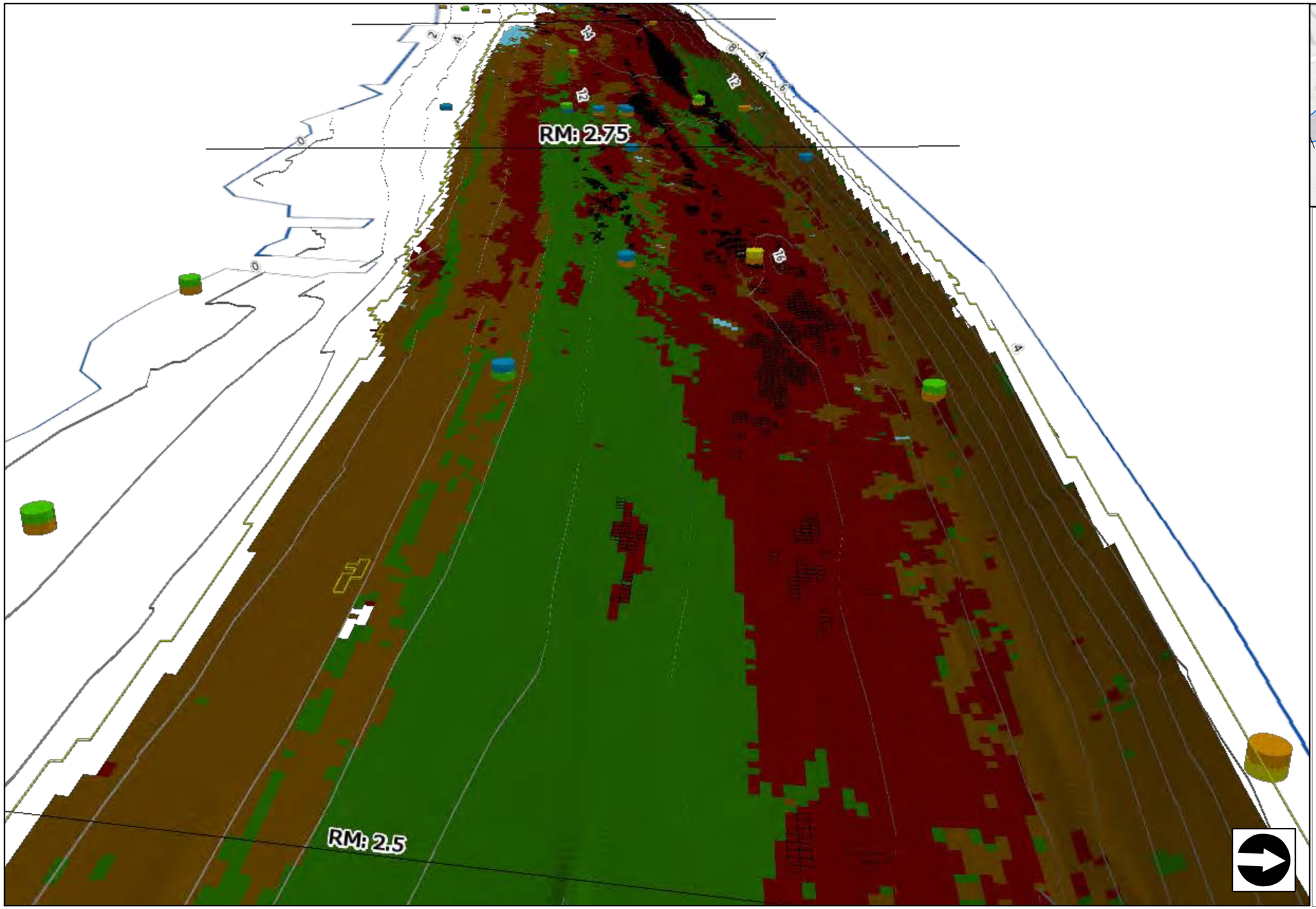
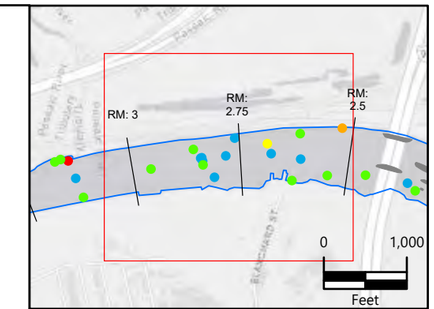
Figure 3-7e

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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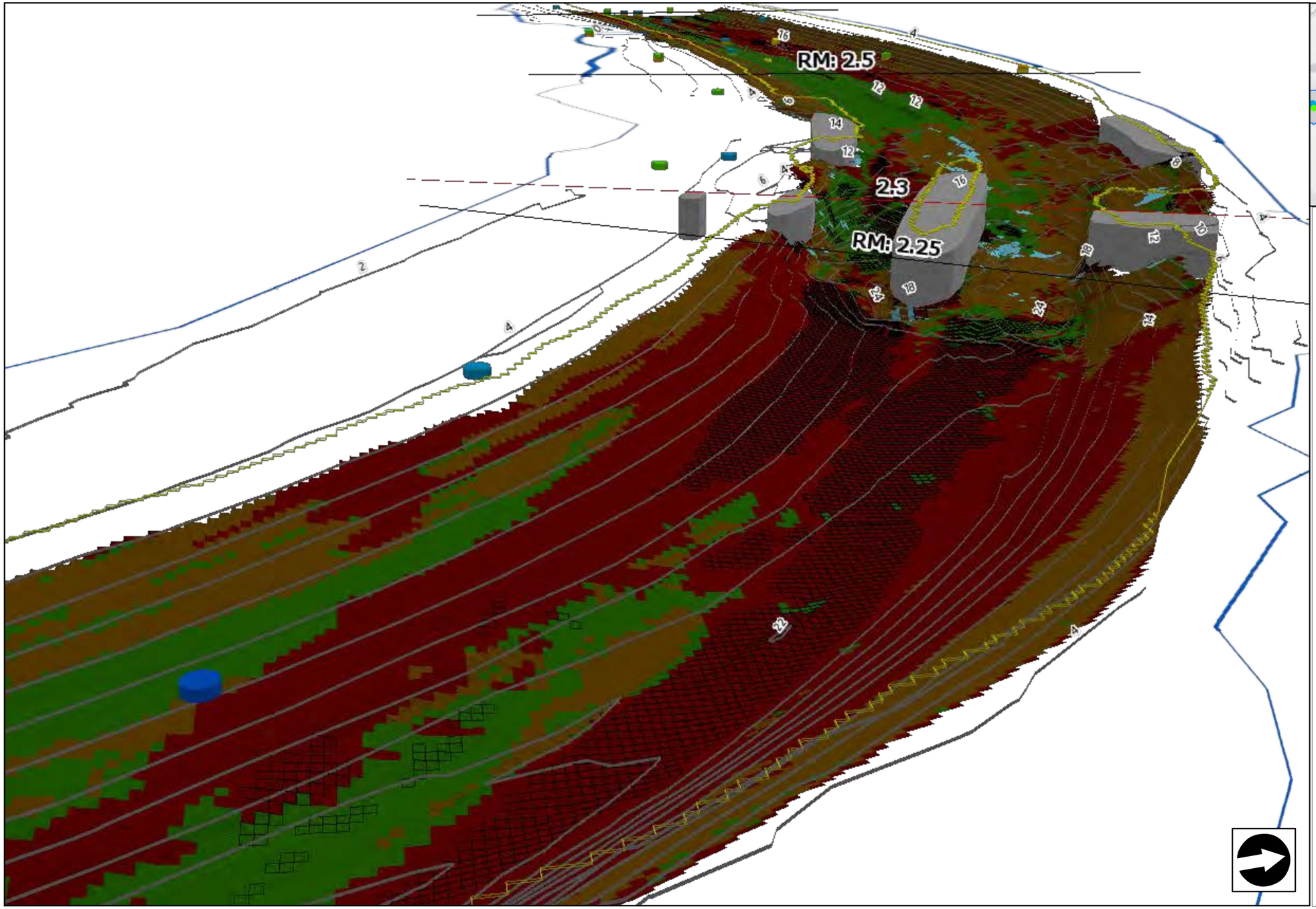
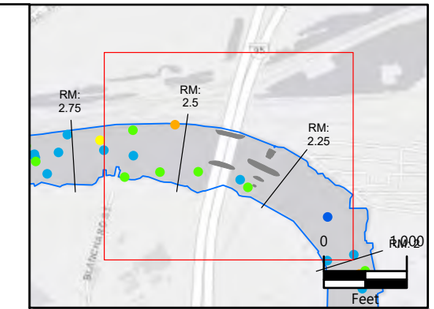
Figure 3-7f

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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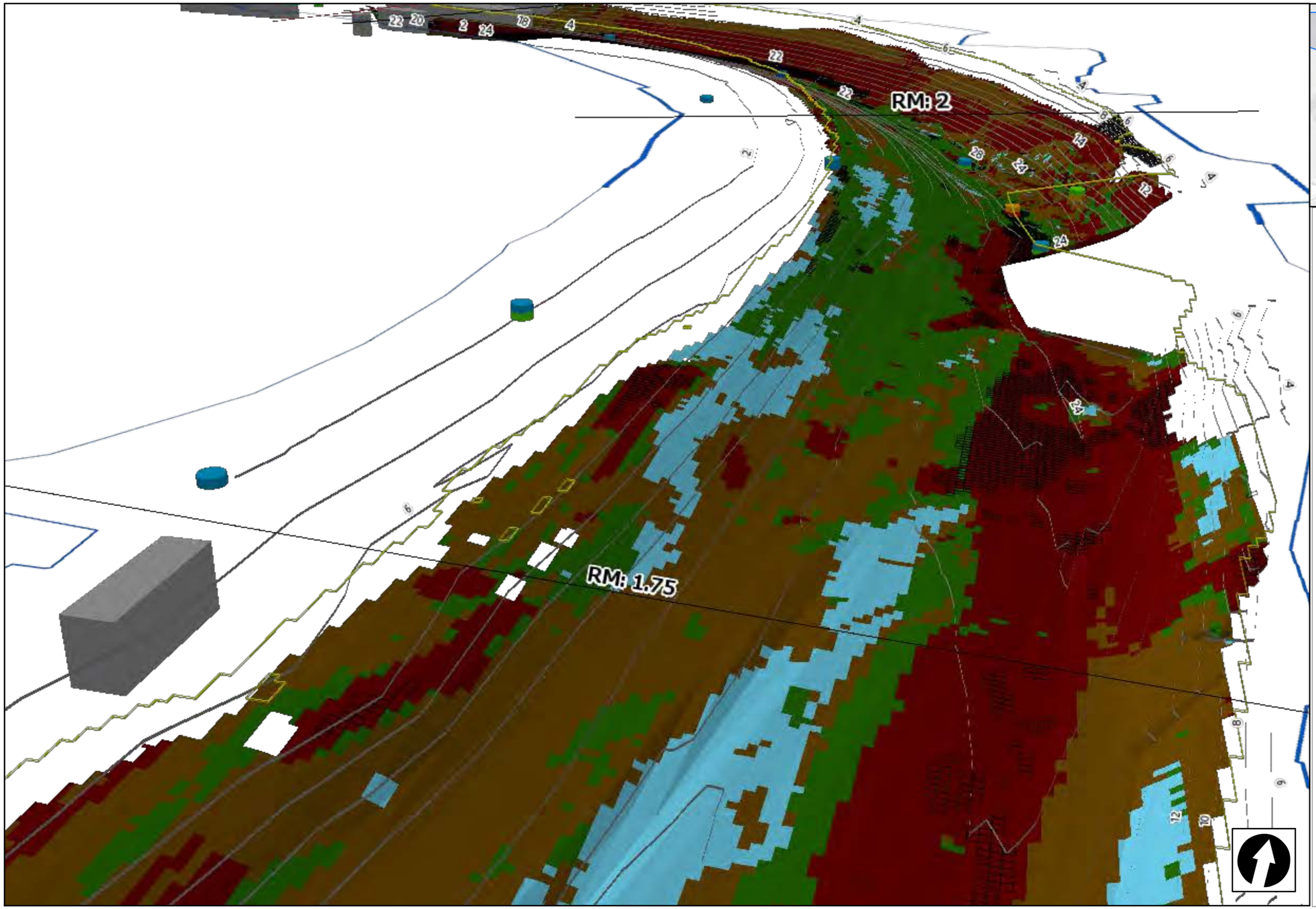
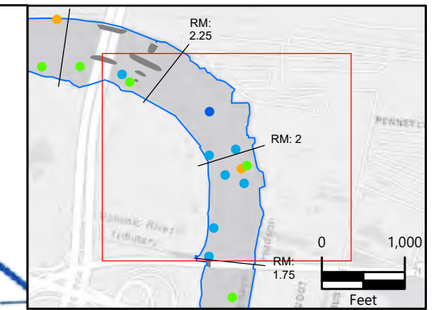
Figure 3-7g

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

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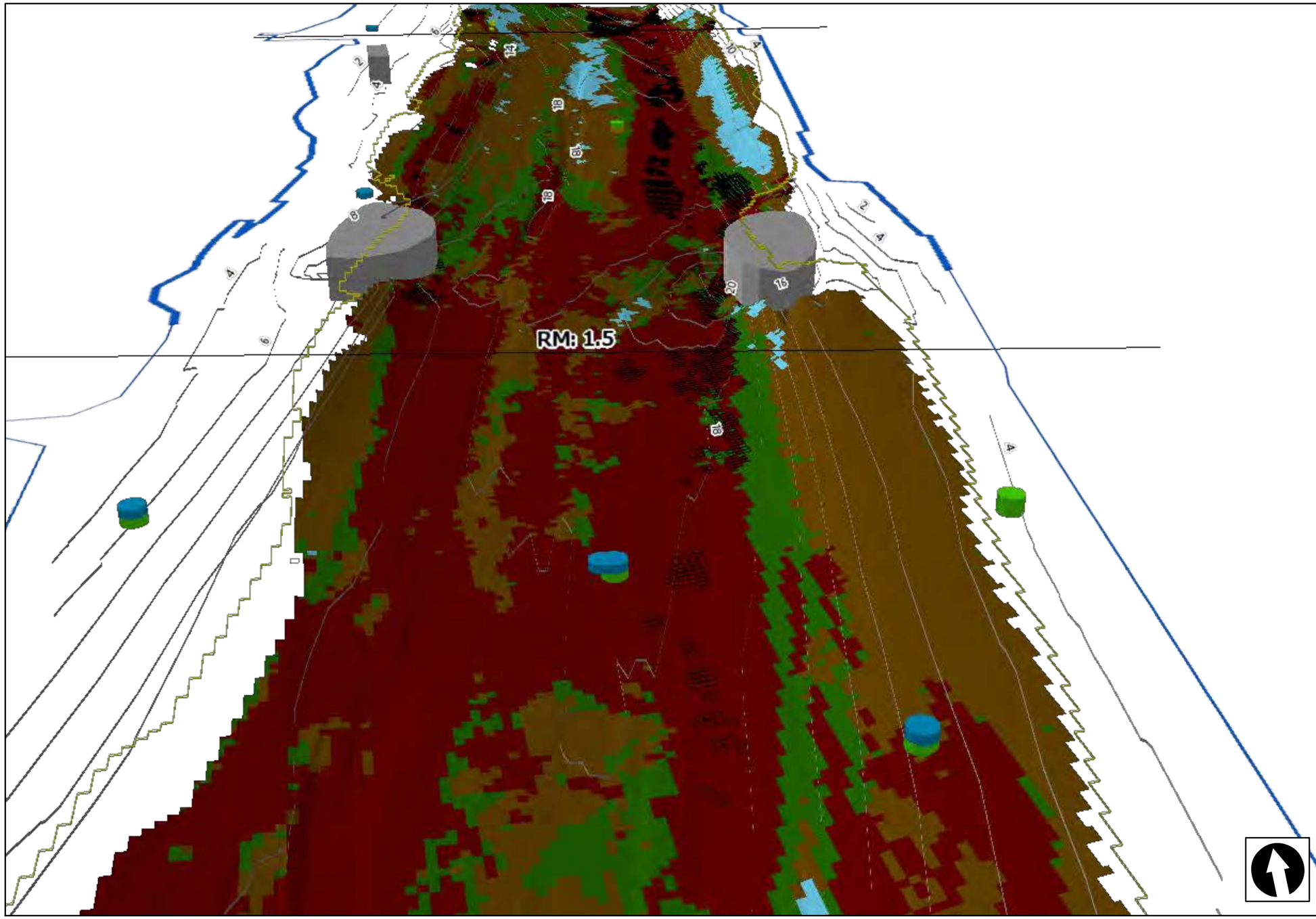
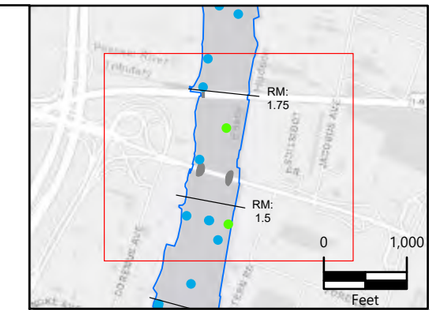
Figure 3-8a

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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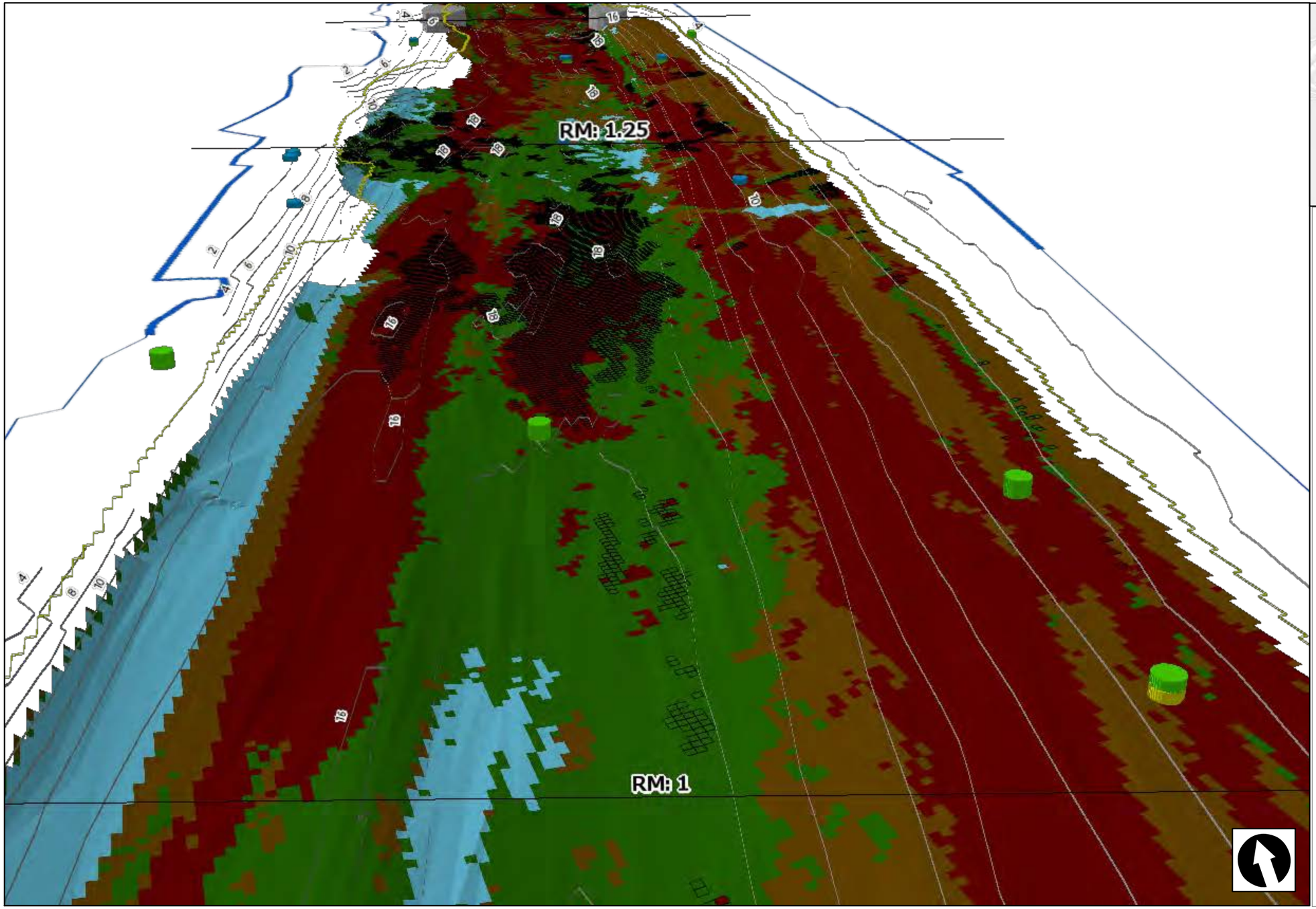
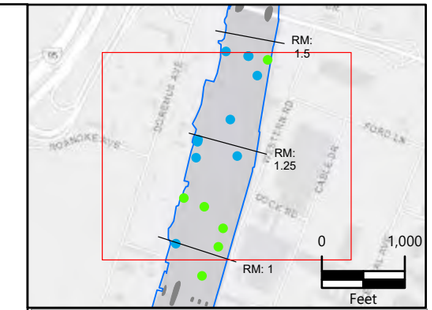
Figure 3-8b

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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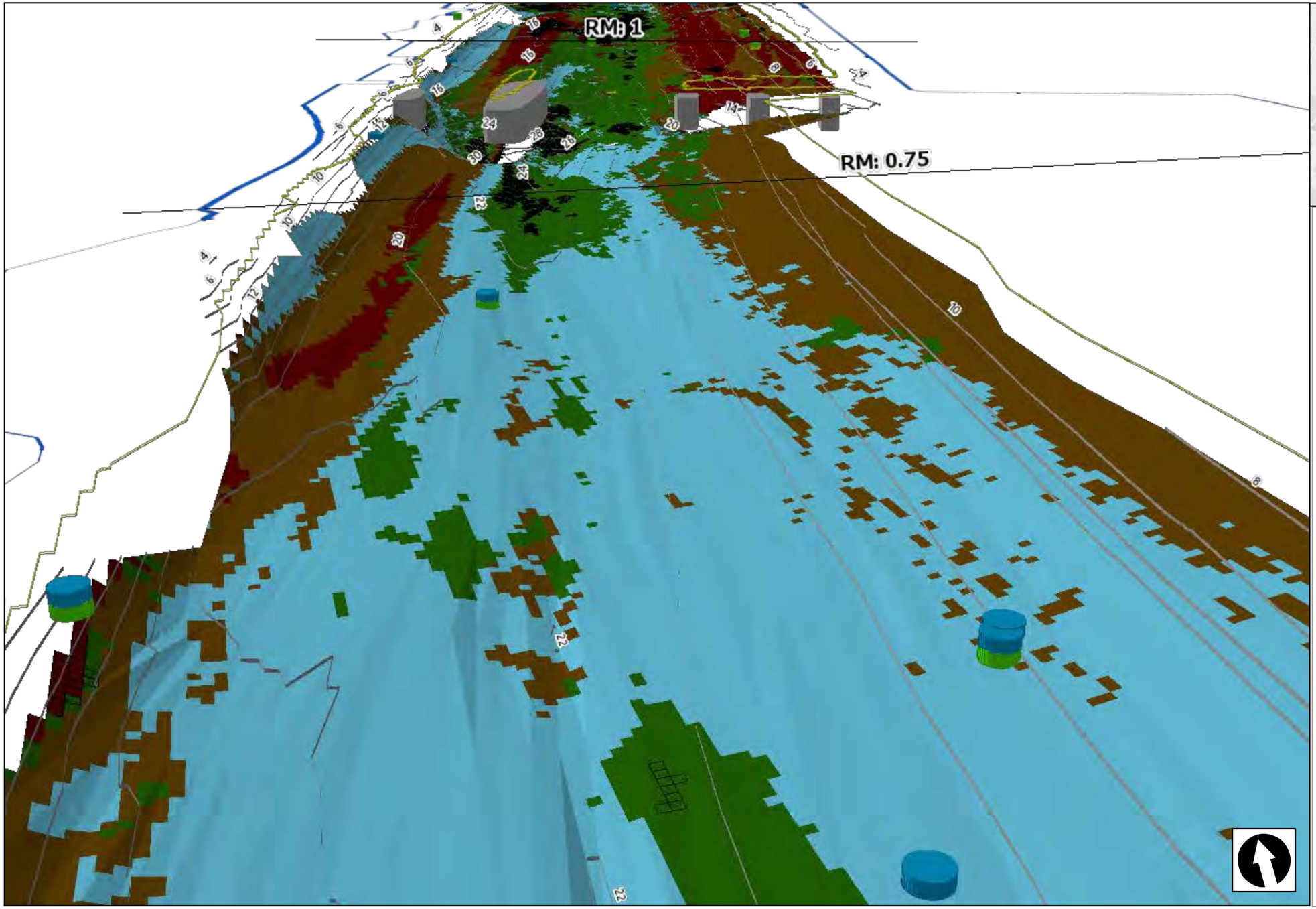
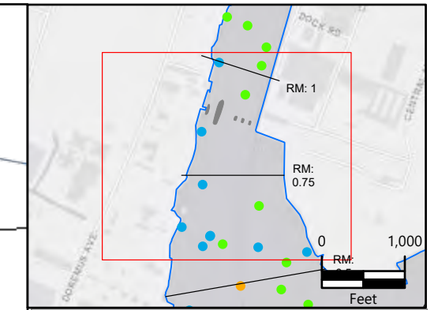
Figure 3-8c

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

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- >10

Bathymetric Change Category *

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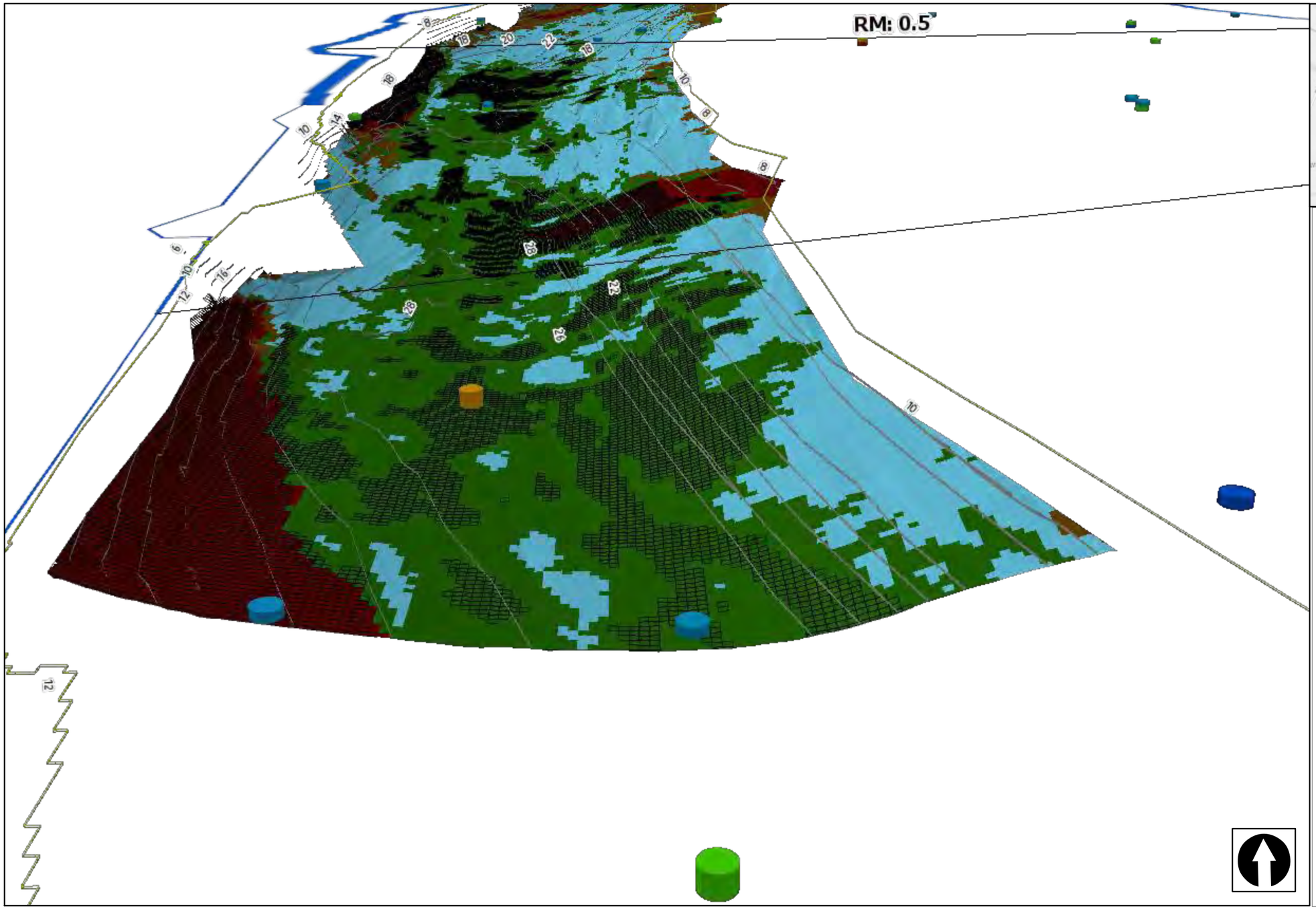
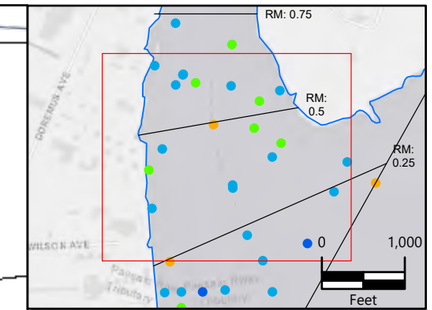
Figure 3-8d

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

Mercury Concentration (mg/kg)

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- 2 - 3
- 3 - 4
- 4 - 10
- >10

Bathymetric Change Category *

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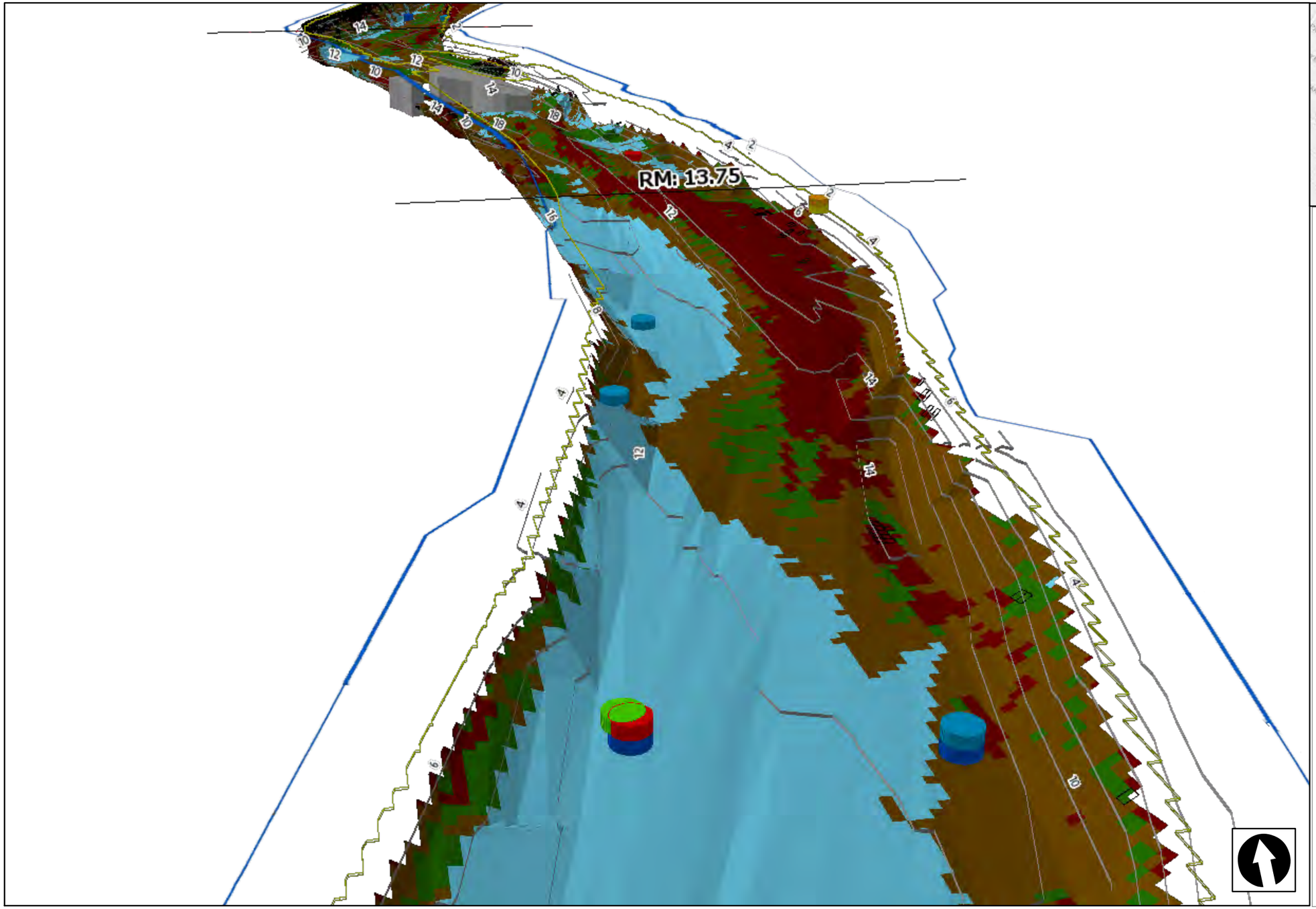
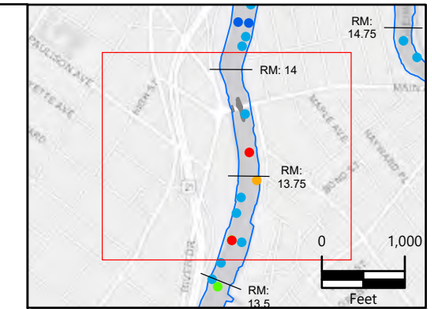
Figure 3-8e

Mercury Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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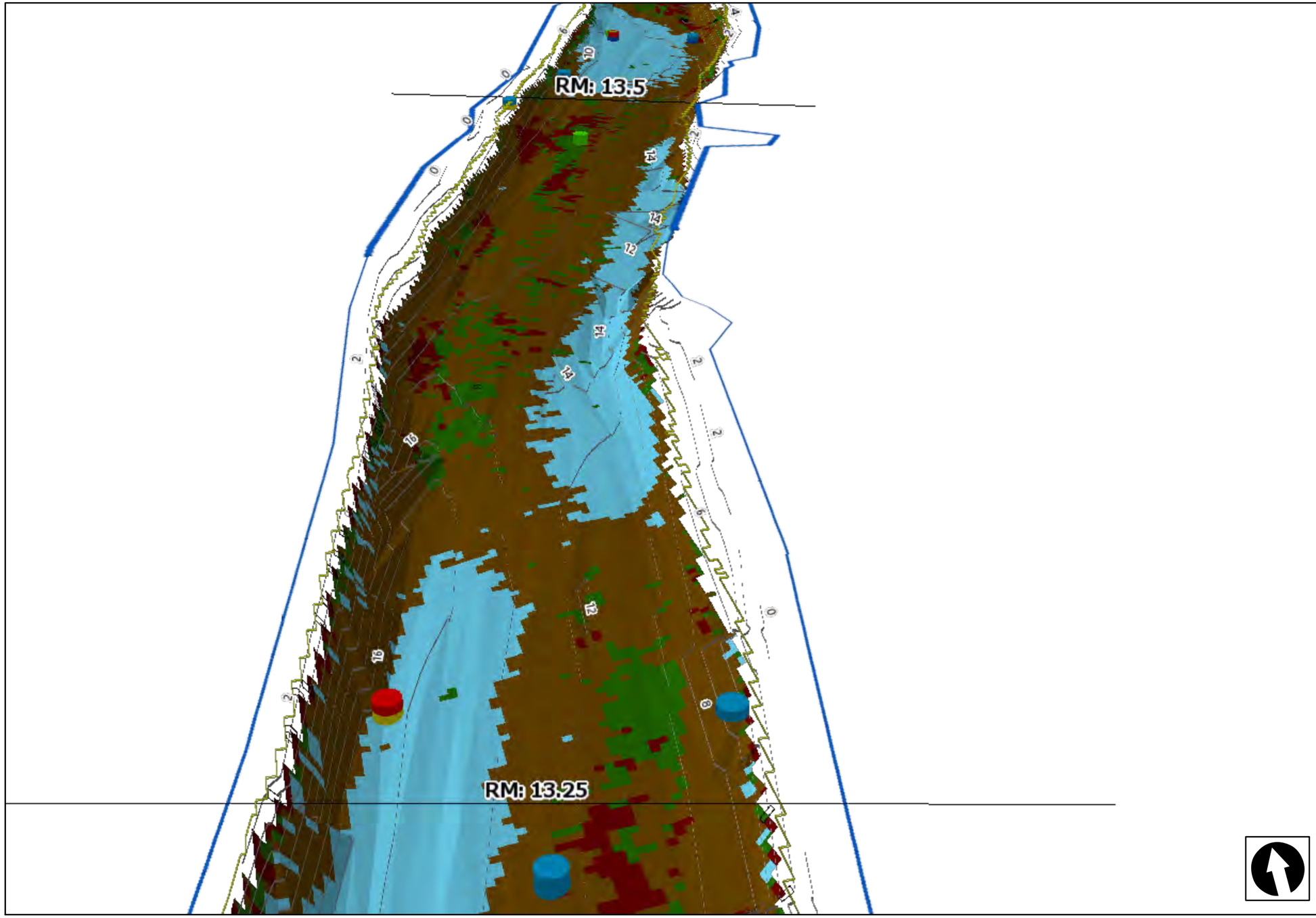
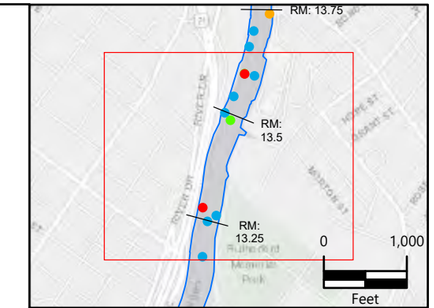
Figure 4-1a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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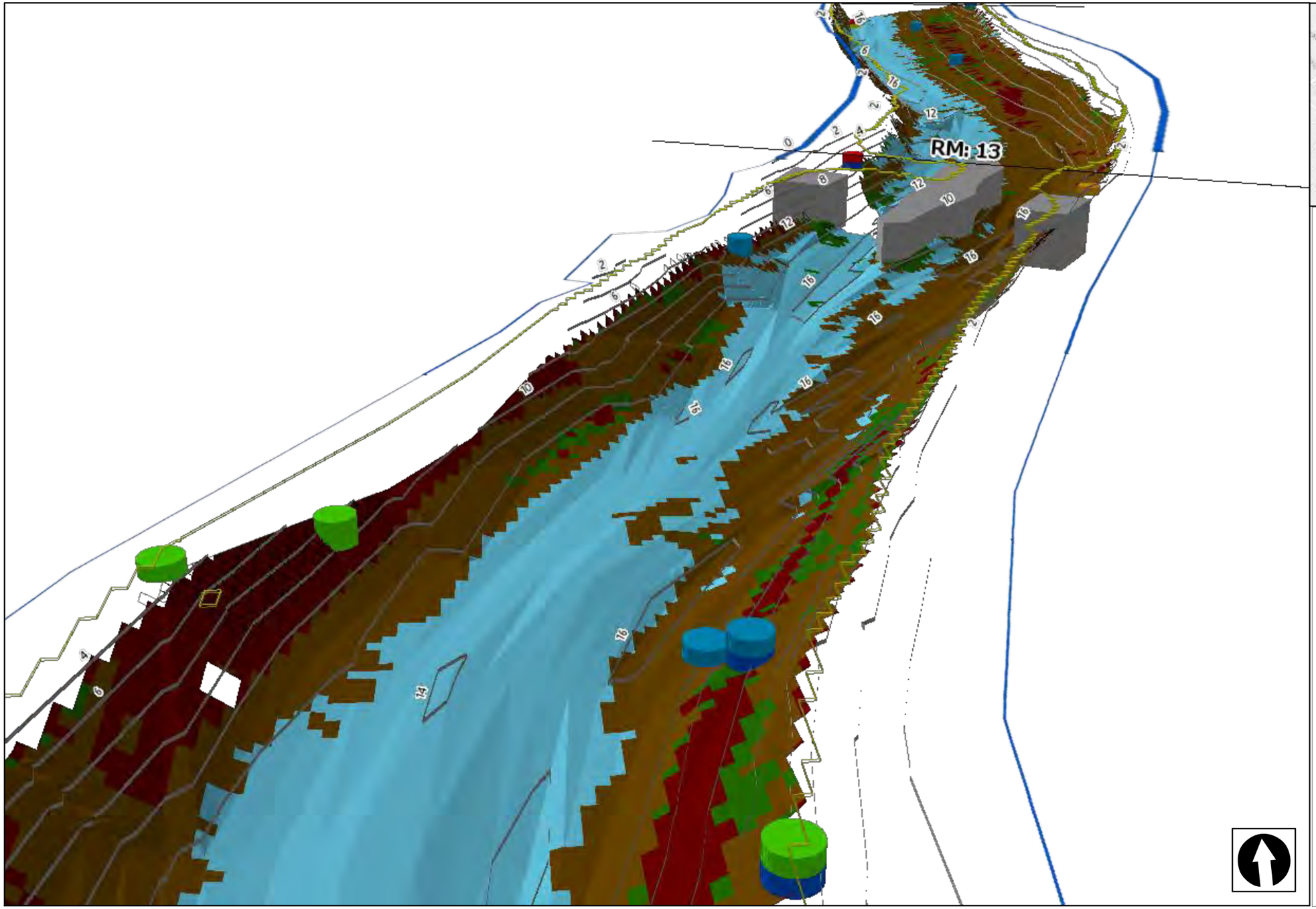
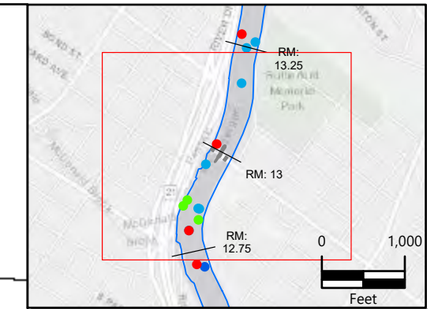
Figure 4-1b

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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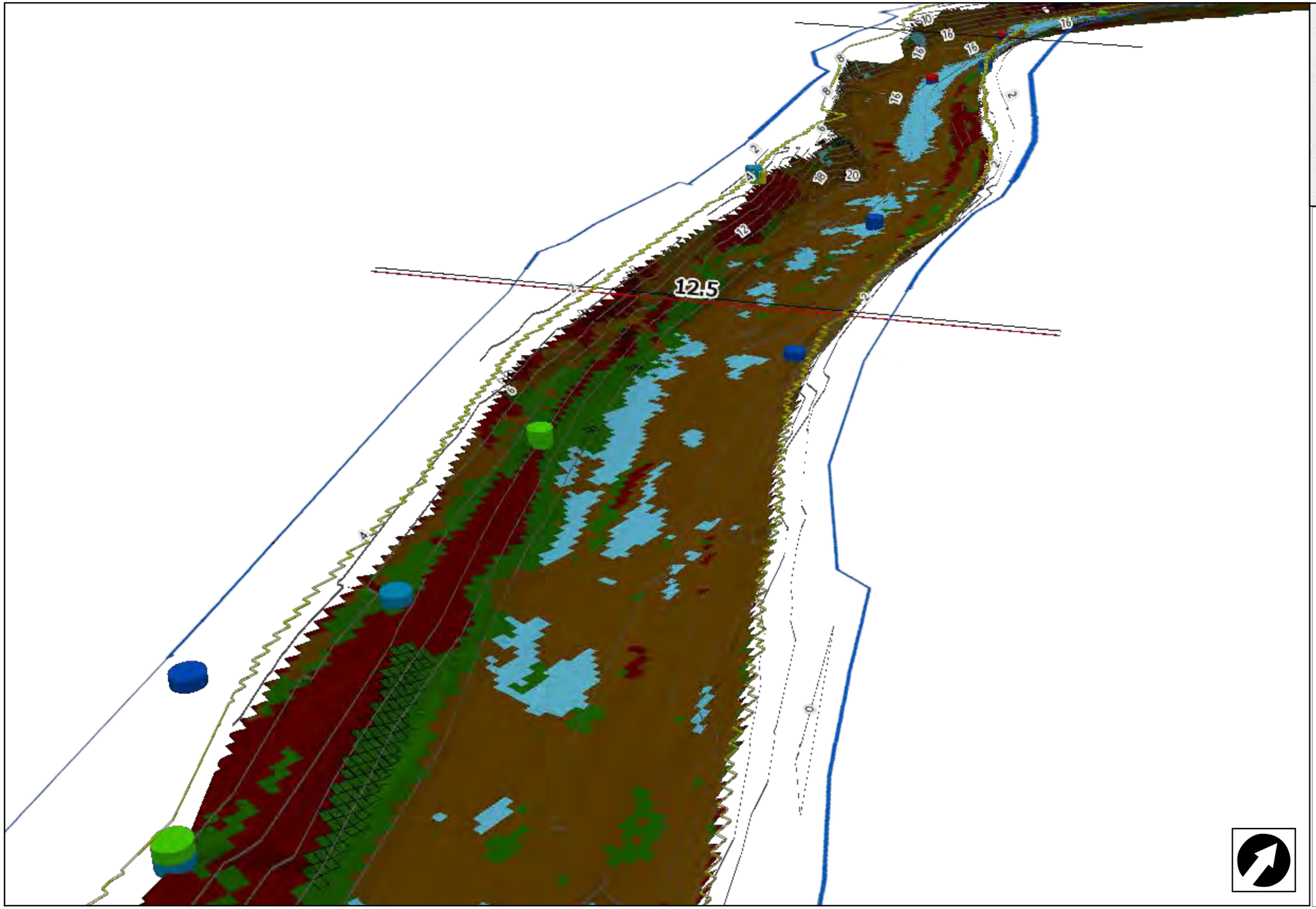
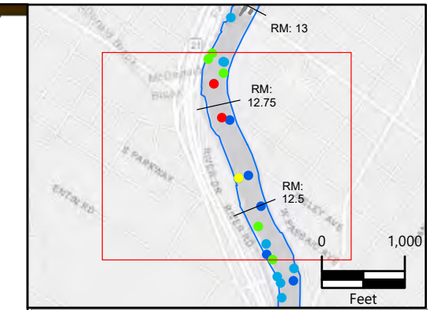
Figure 4-1c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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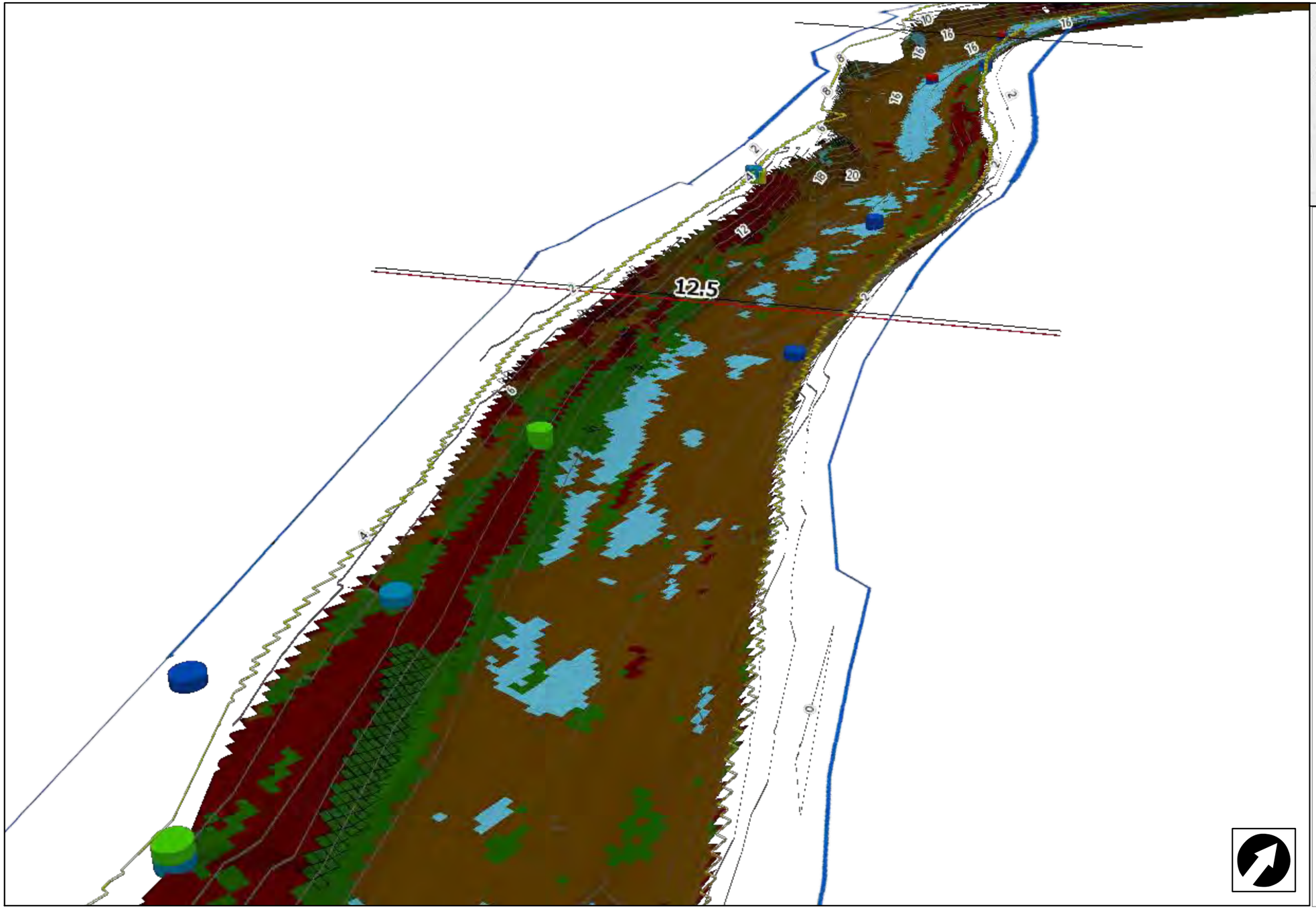
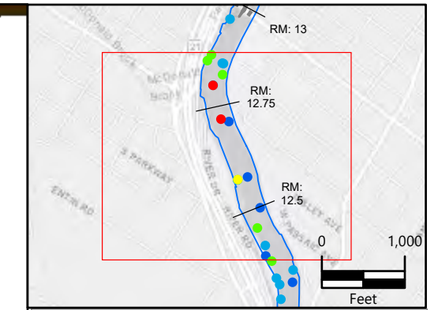
Figure 4-1d

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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Figure 4-2a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

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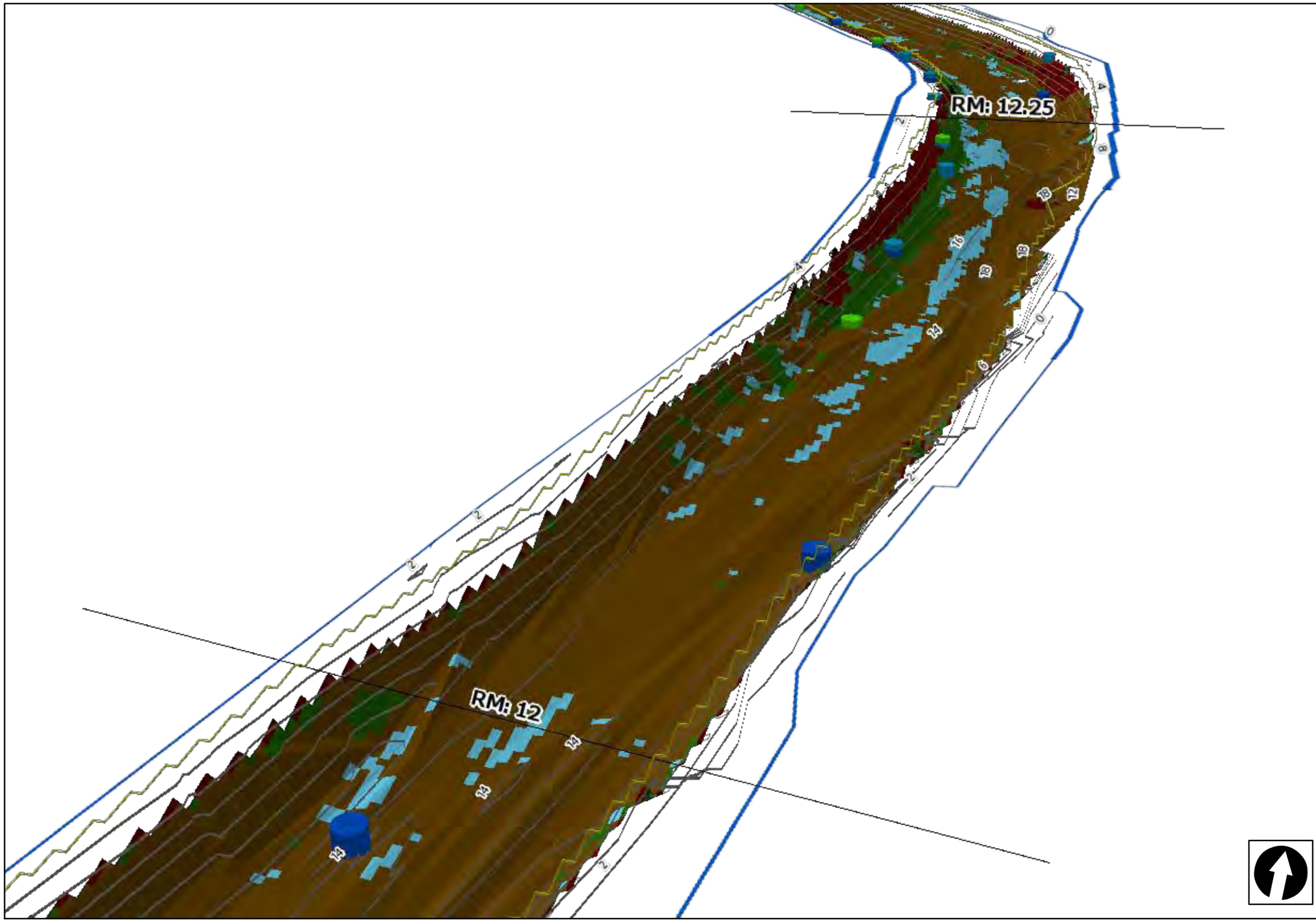

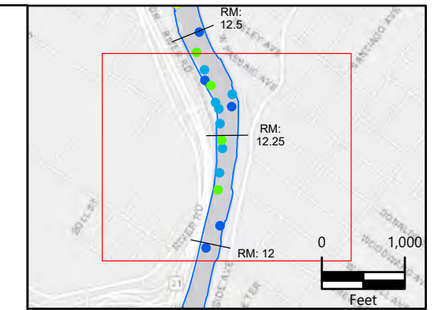

LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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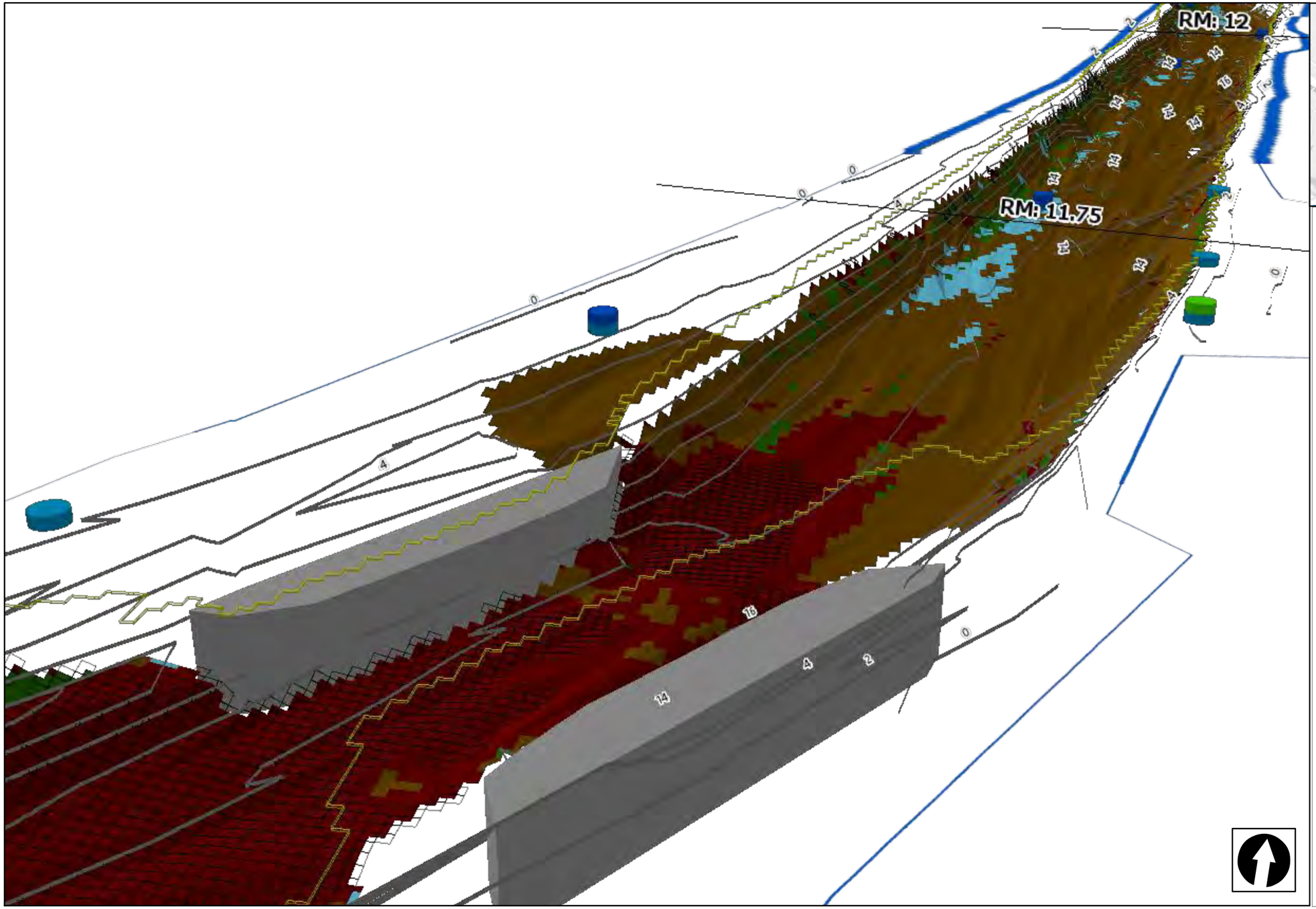
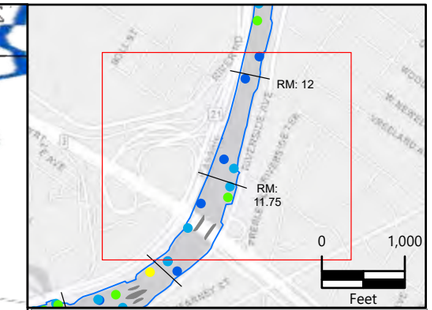
Figure 4-2b

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
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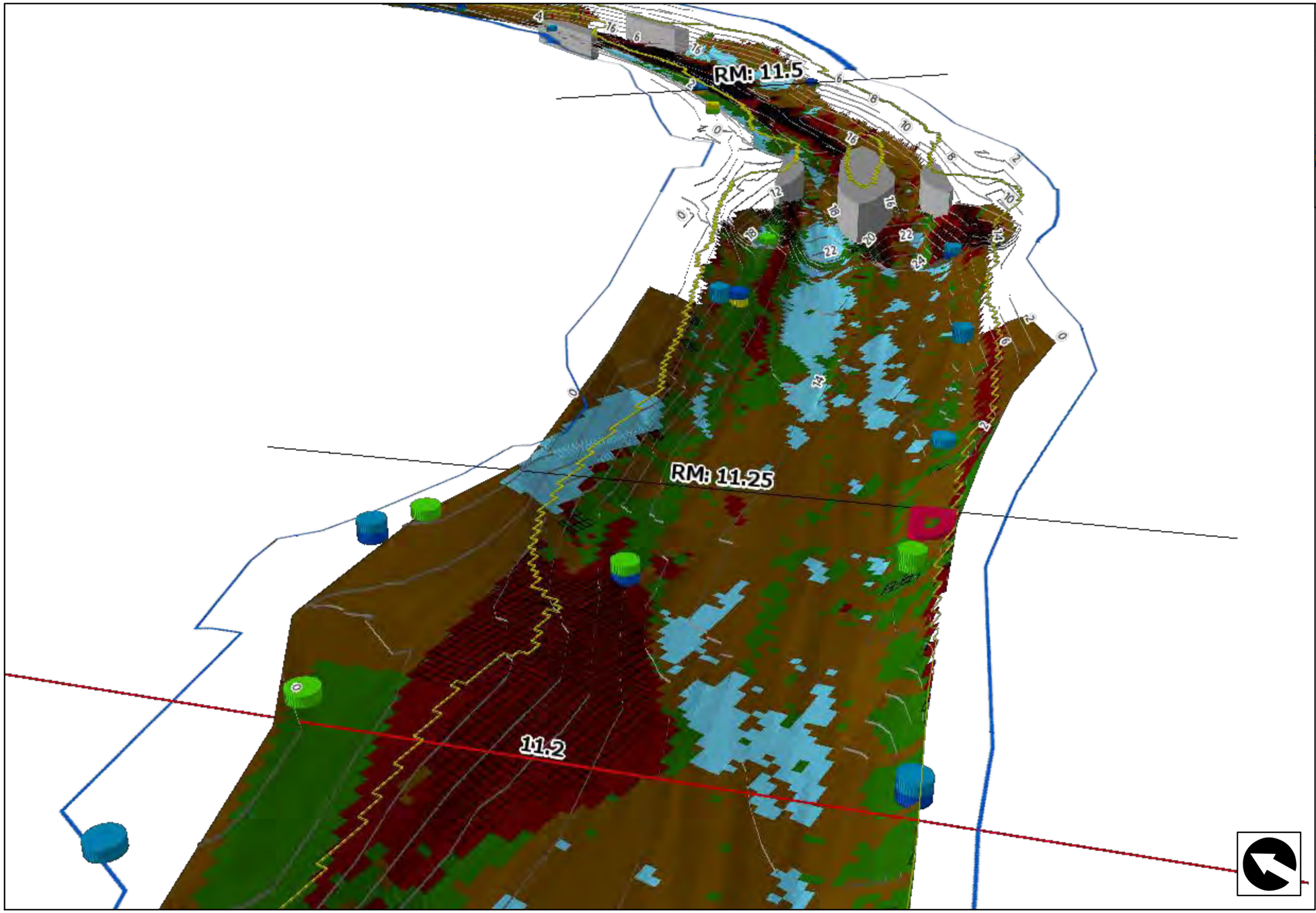
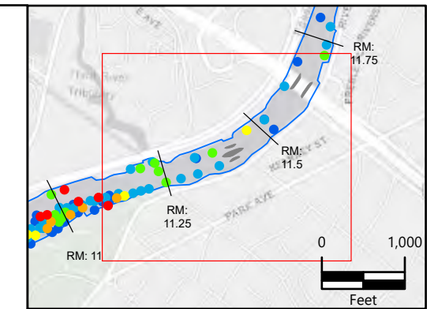
Figure 4-2c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

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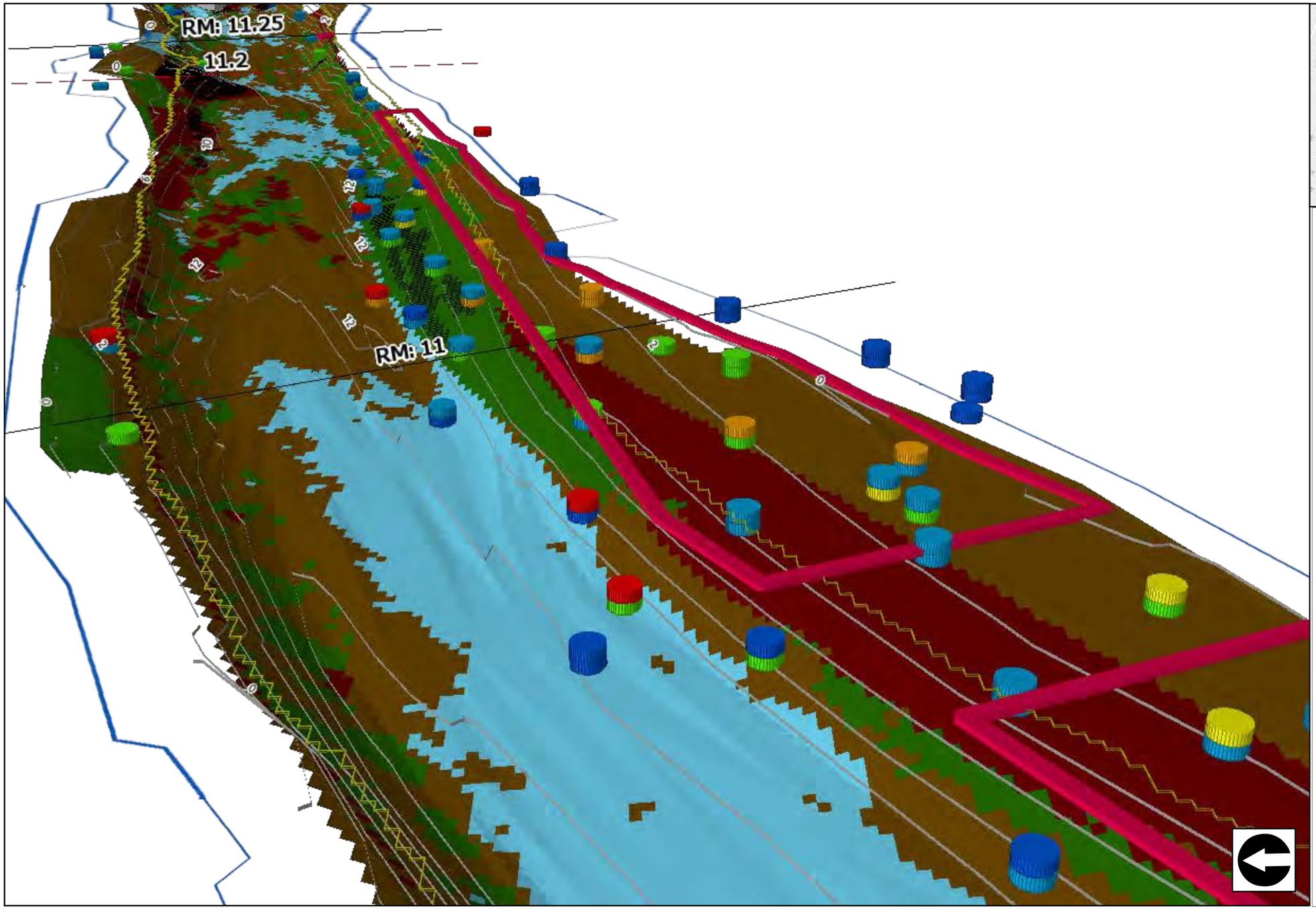
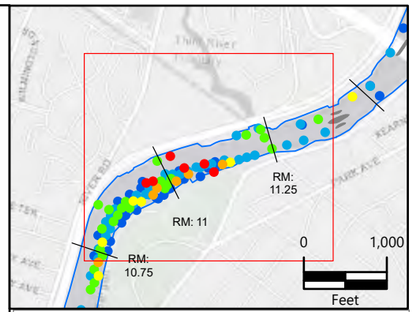
Figure 4-2d

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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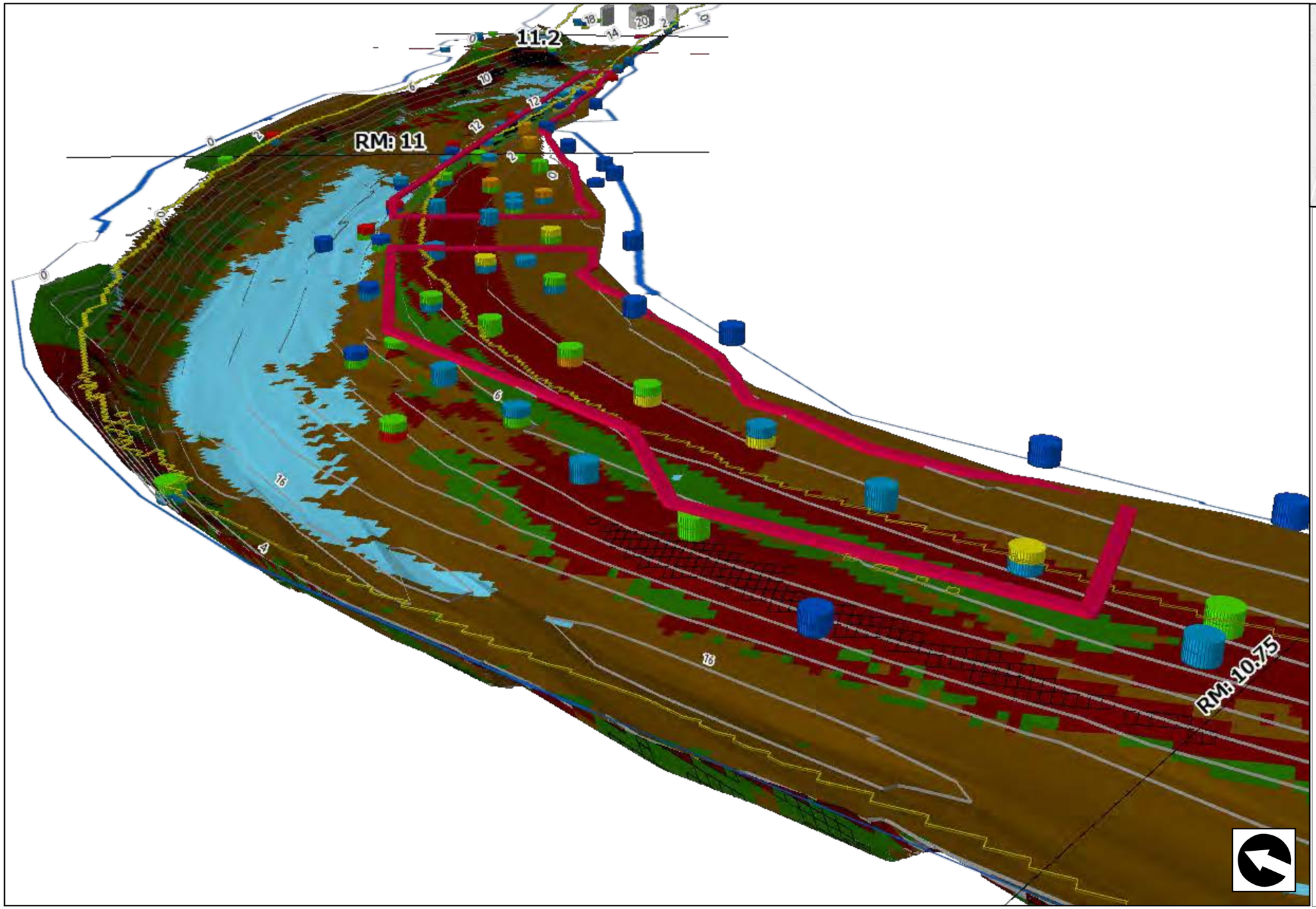
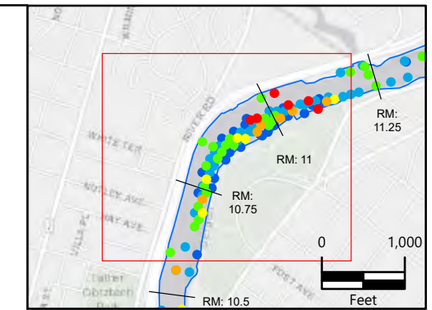
Figure 4-3a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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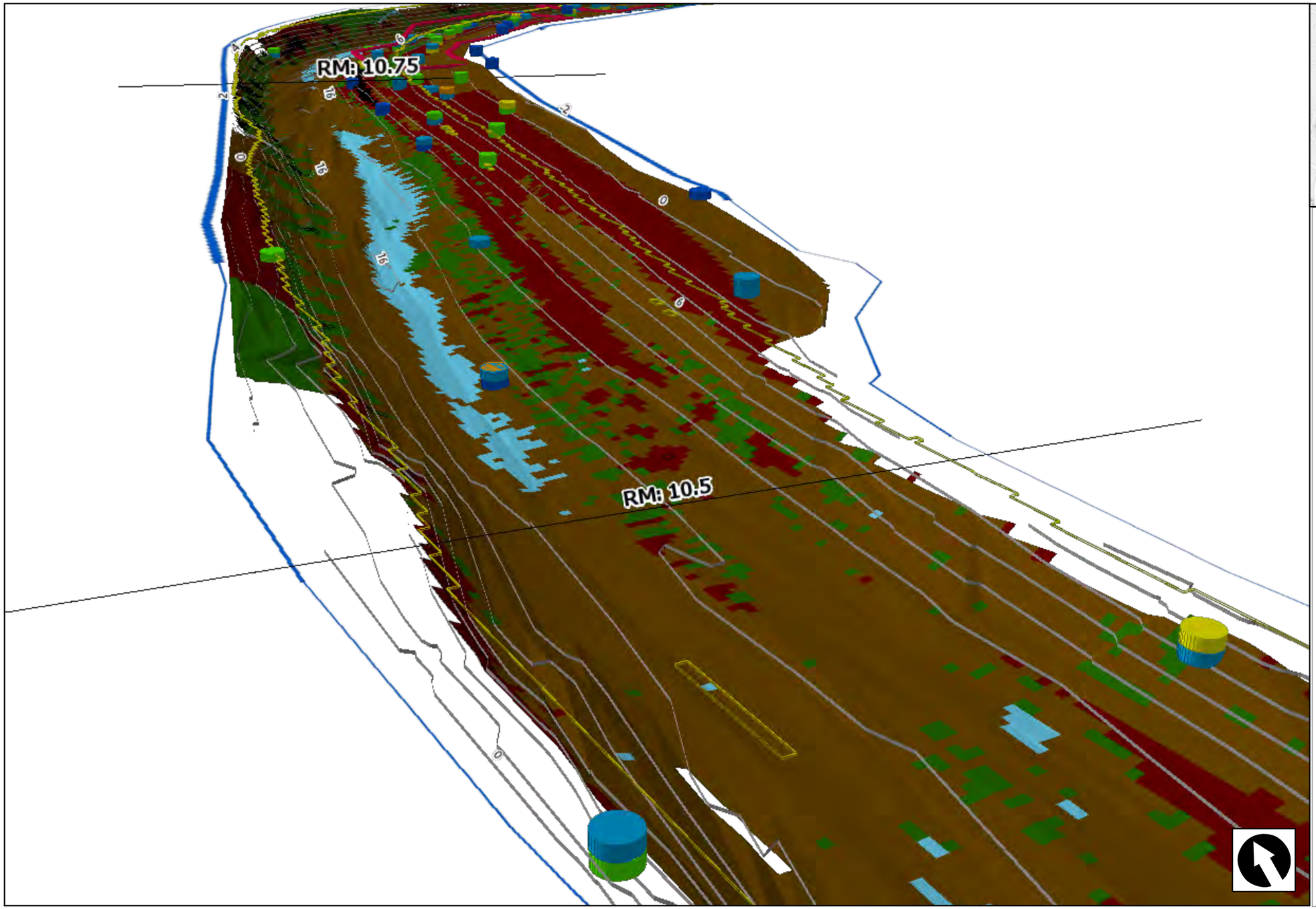
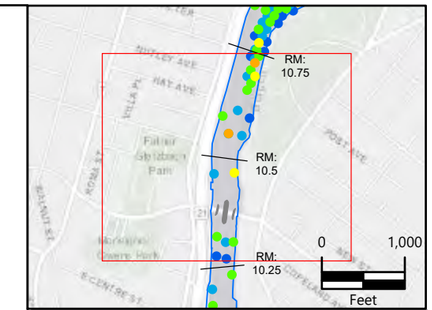
Figure 4-3b

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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- 50 - 80
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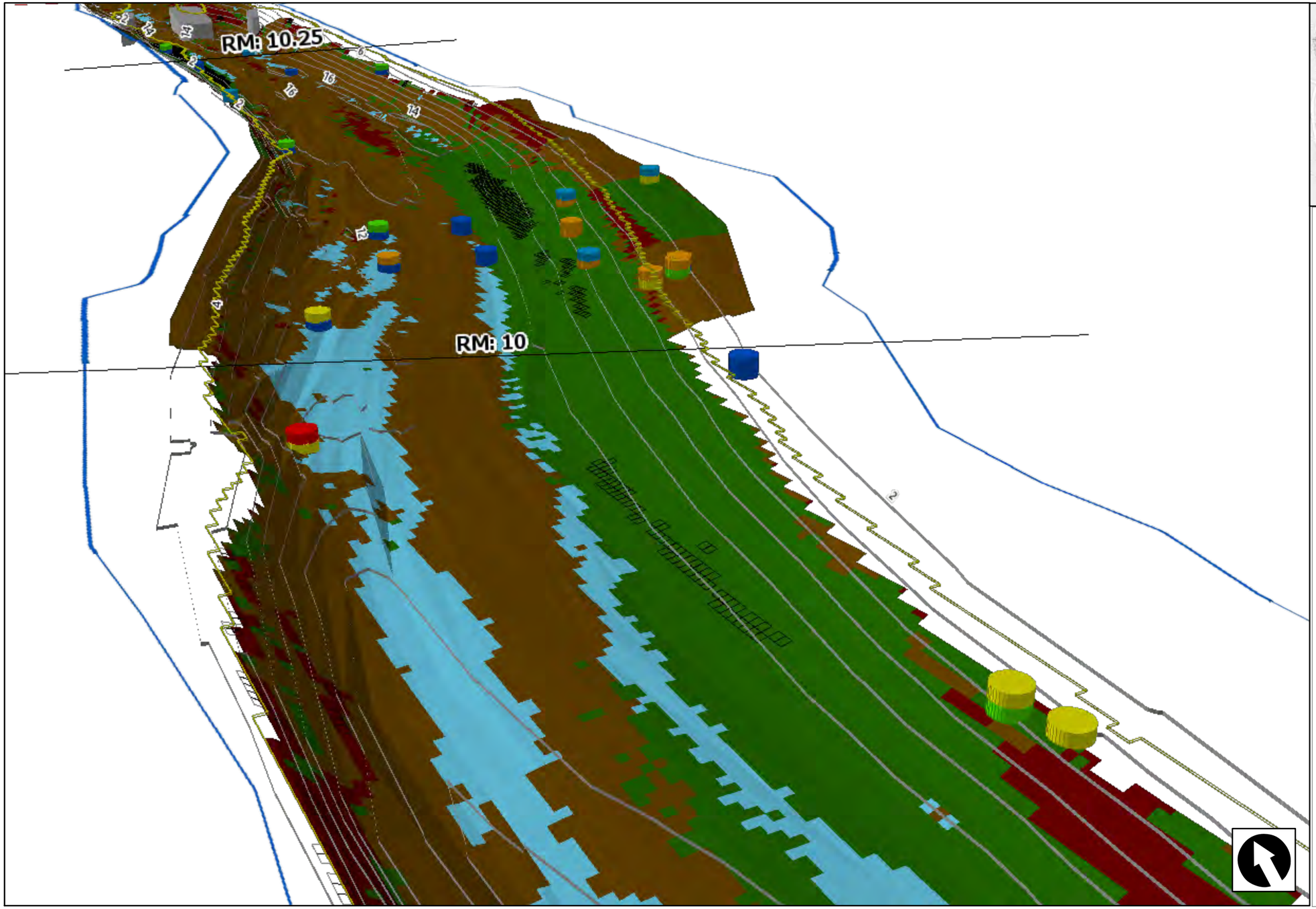
Figure 4-3c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study



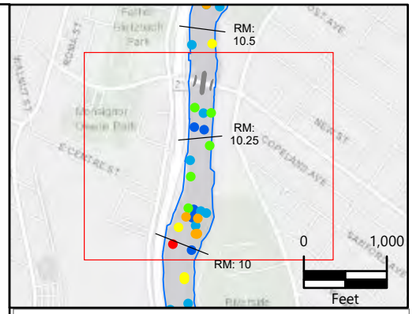


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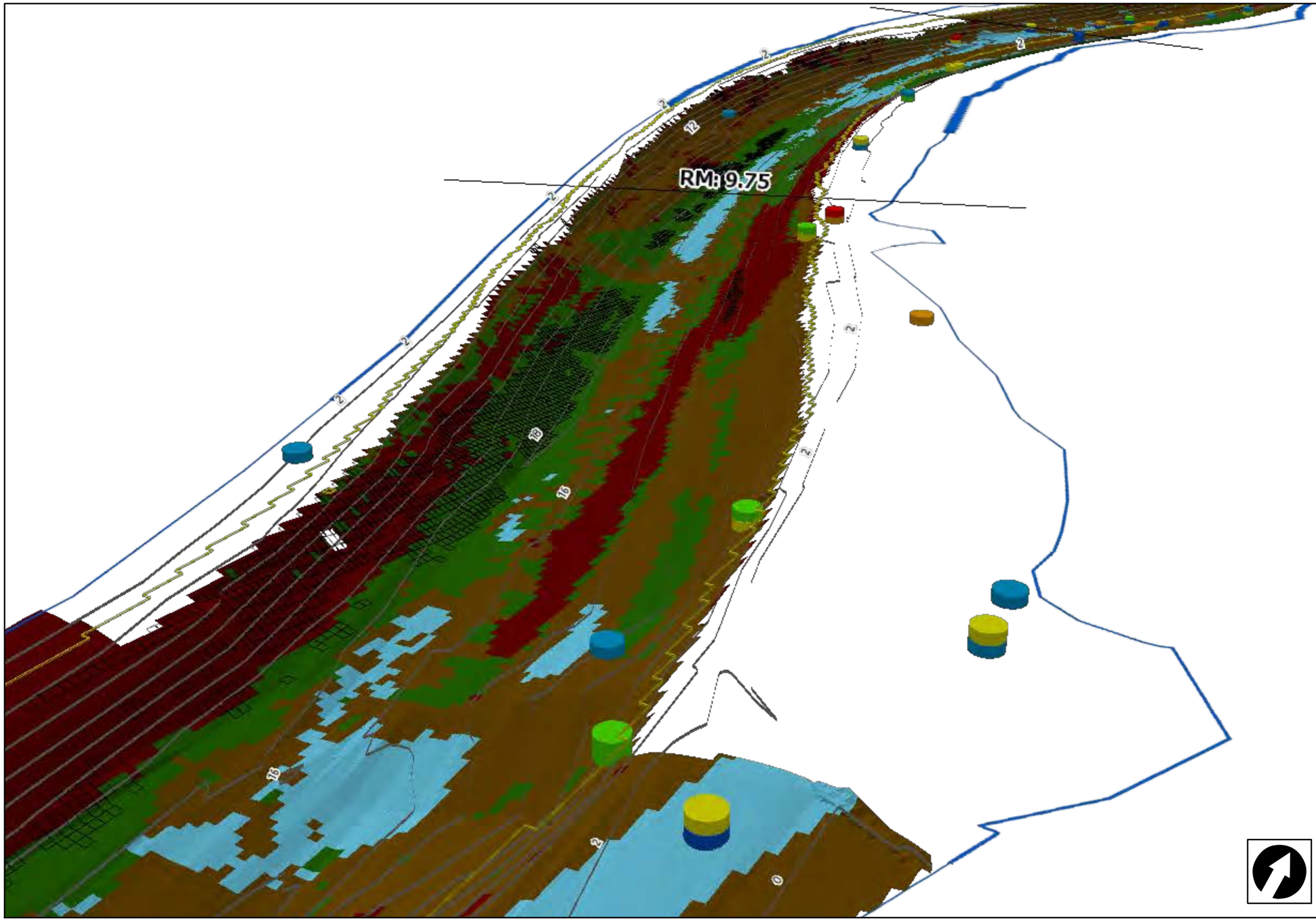
Figure 4-4a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study



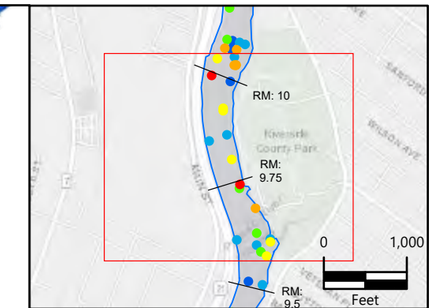


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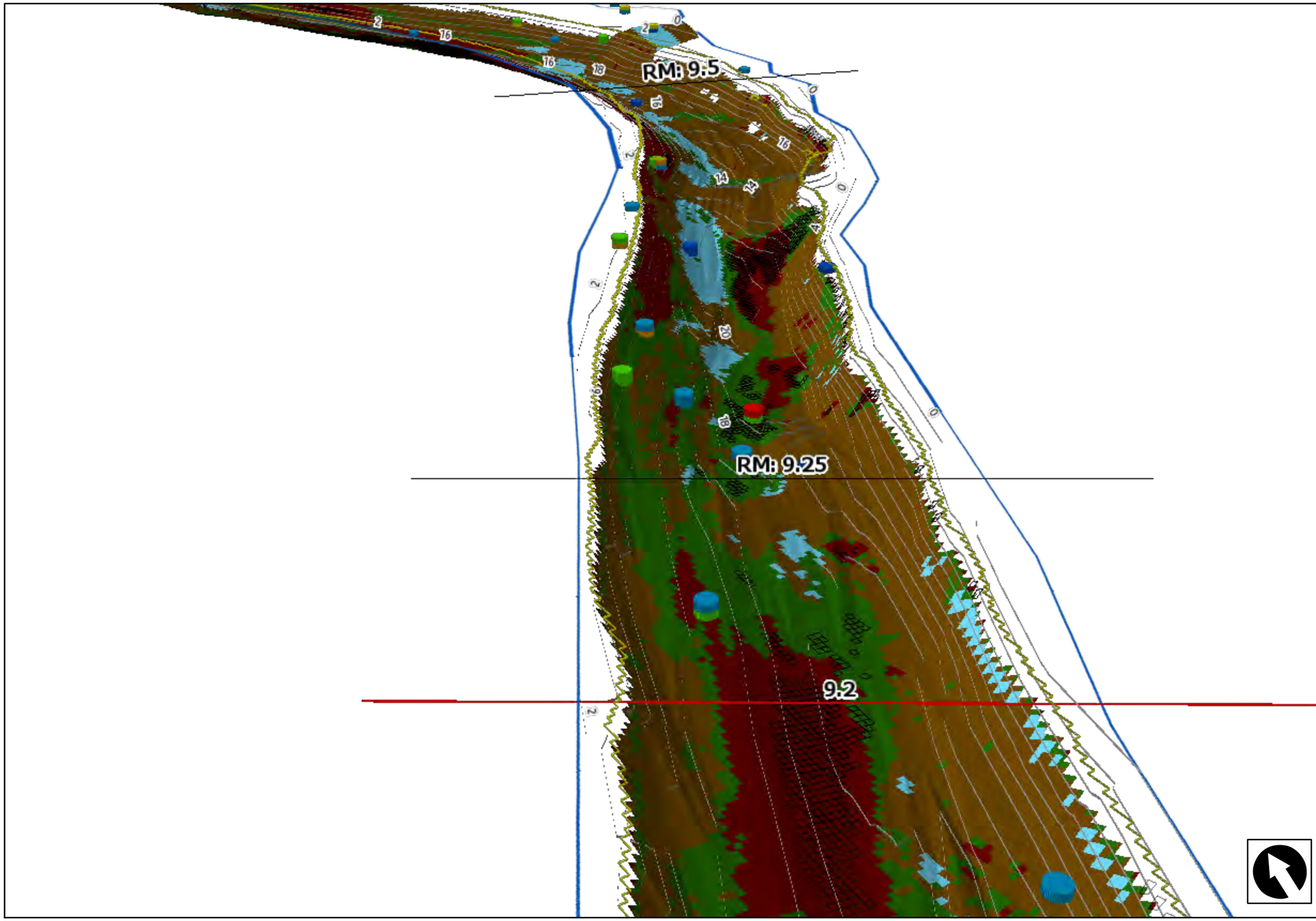
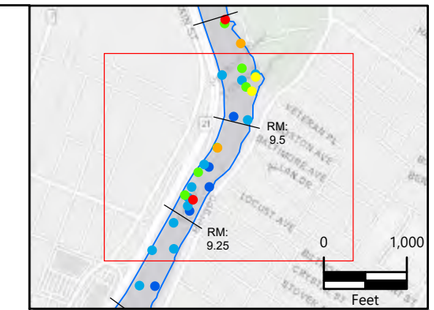
Figure 4-4b

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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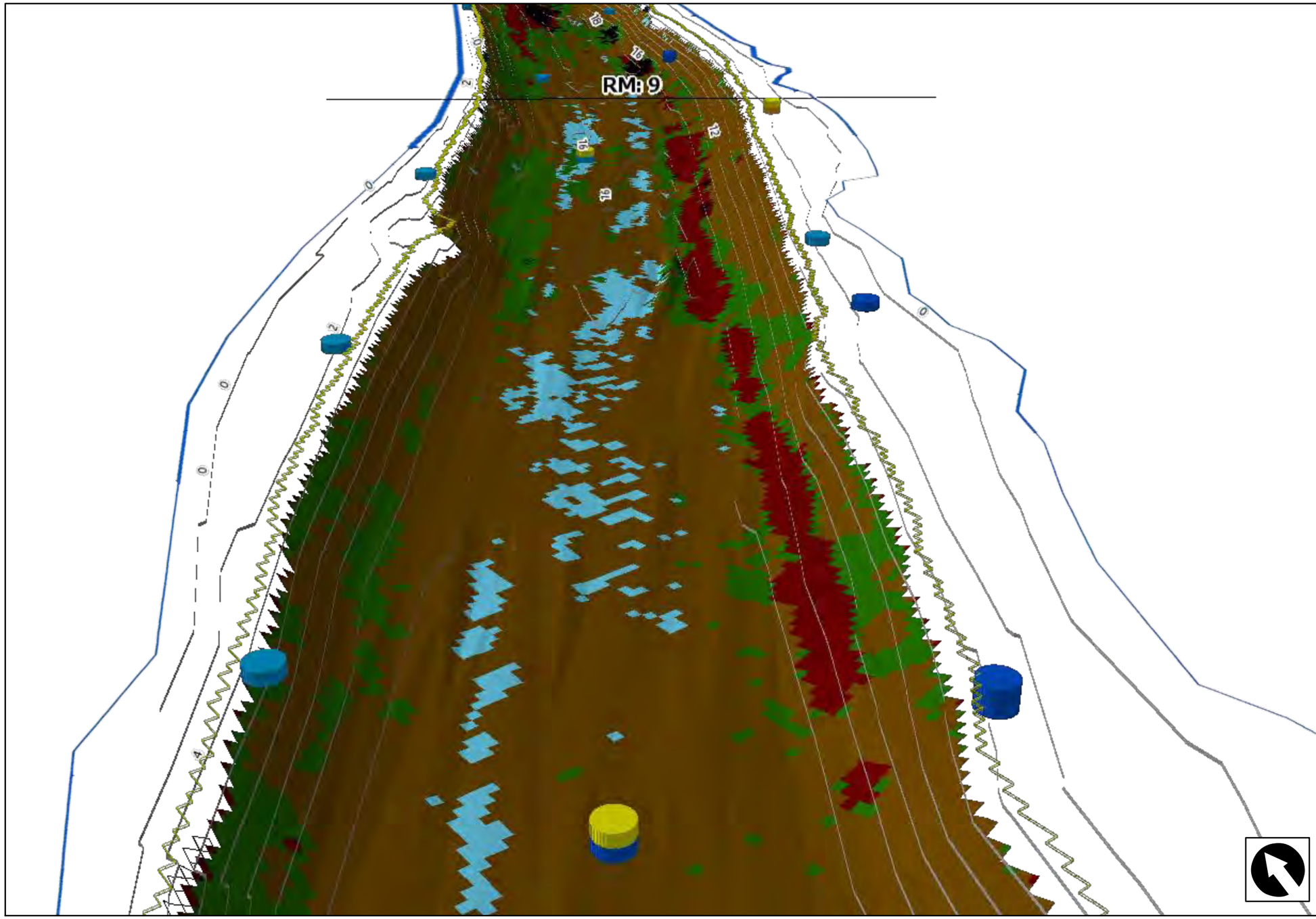
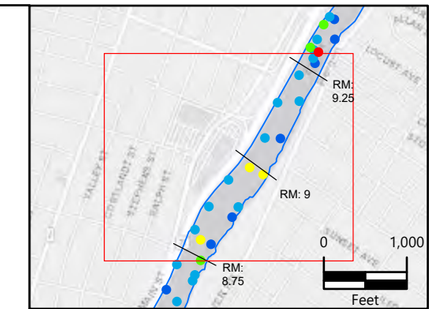
Figure 4-4c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

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- Shoreline
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- Abutment
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Figure 4-5a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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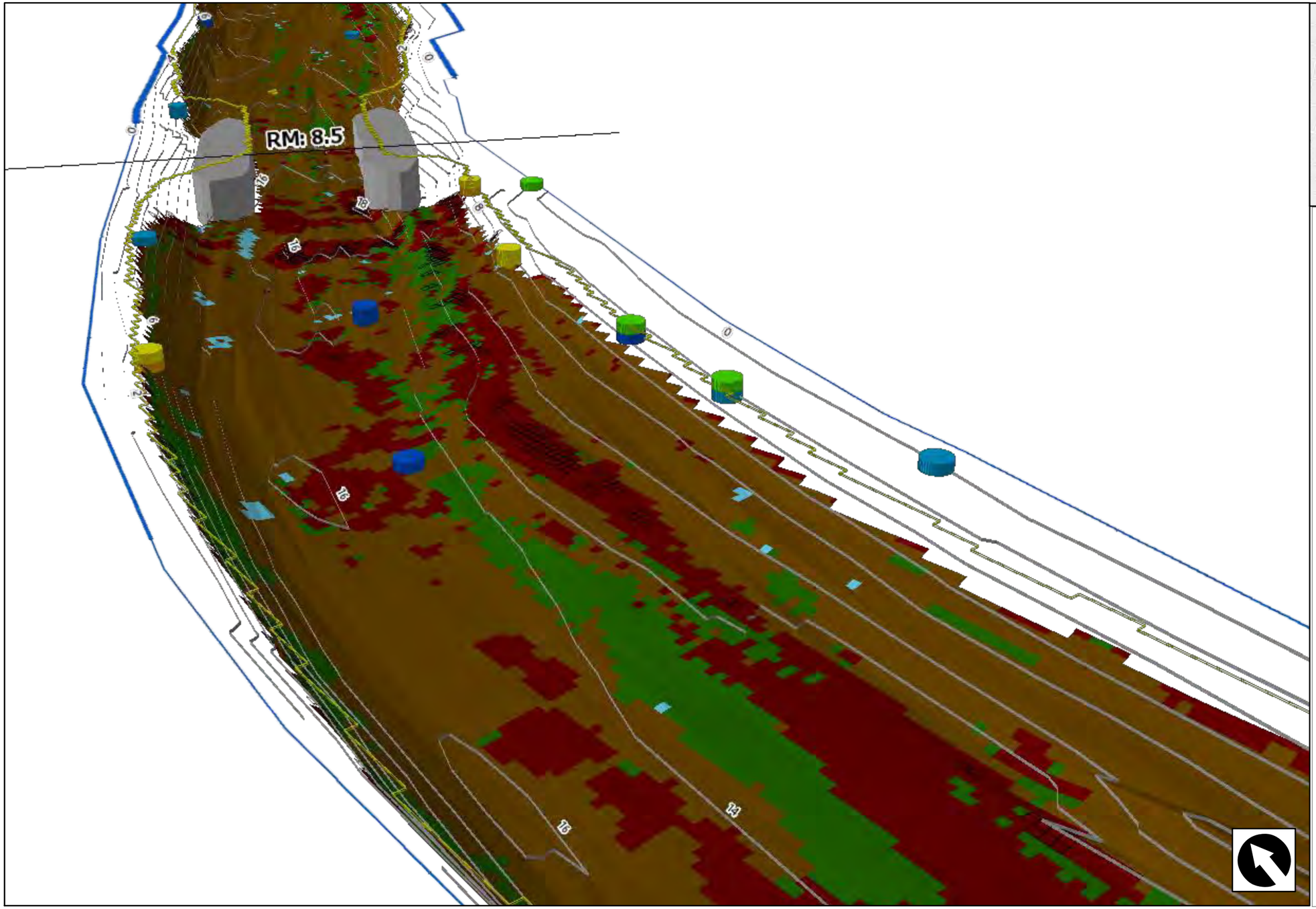

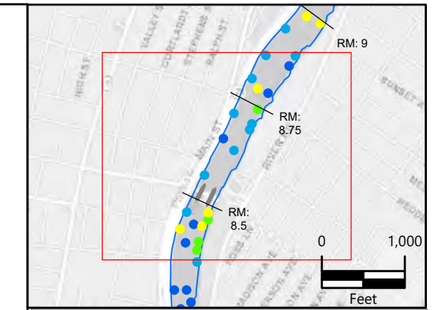

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Figure 4-5b

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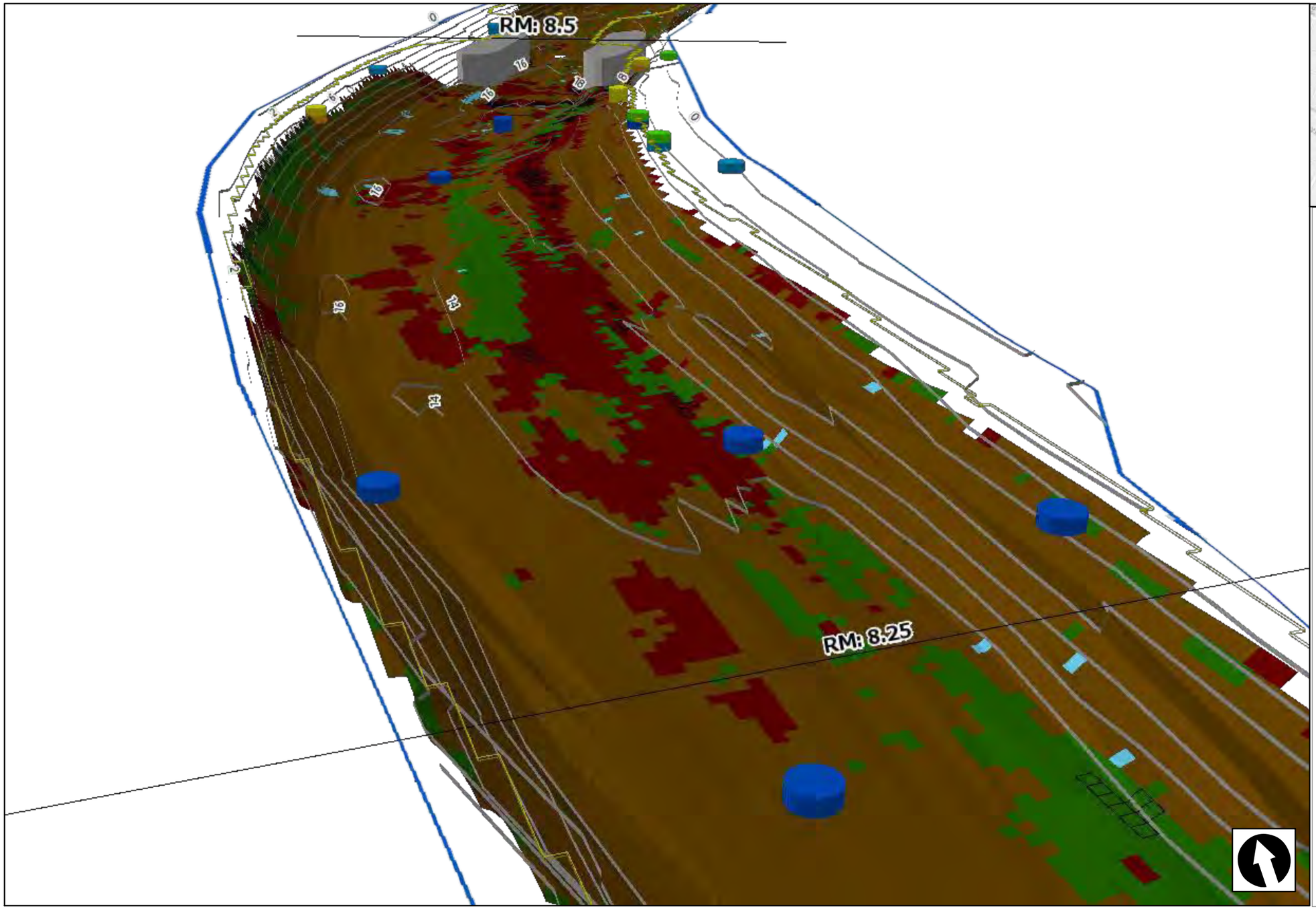

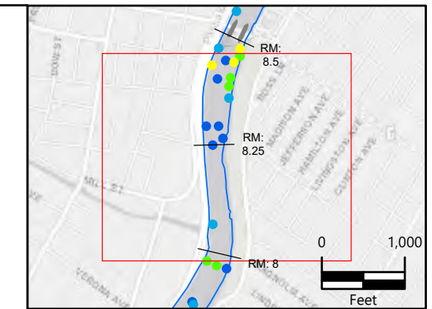

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Figure 4-5c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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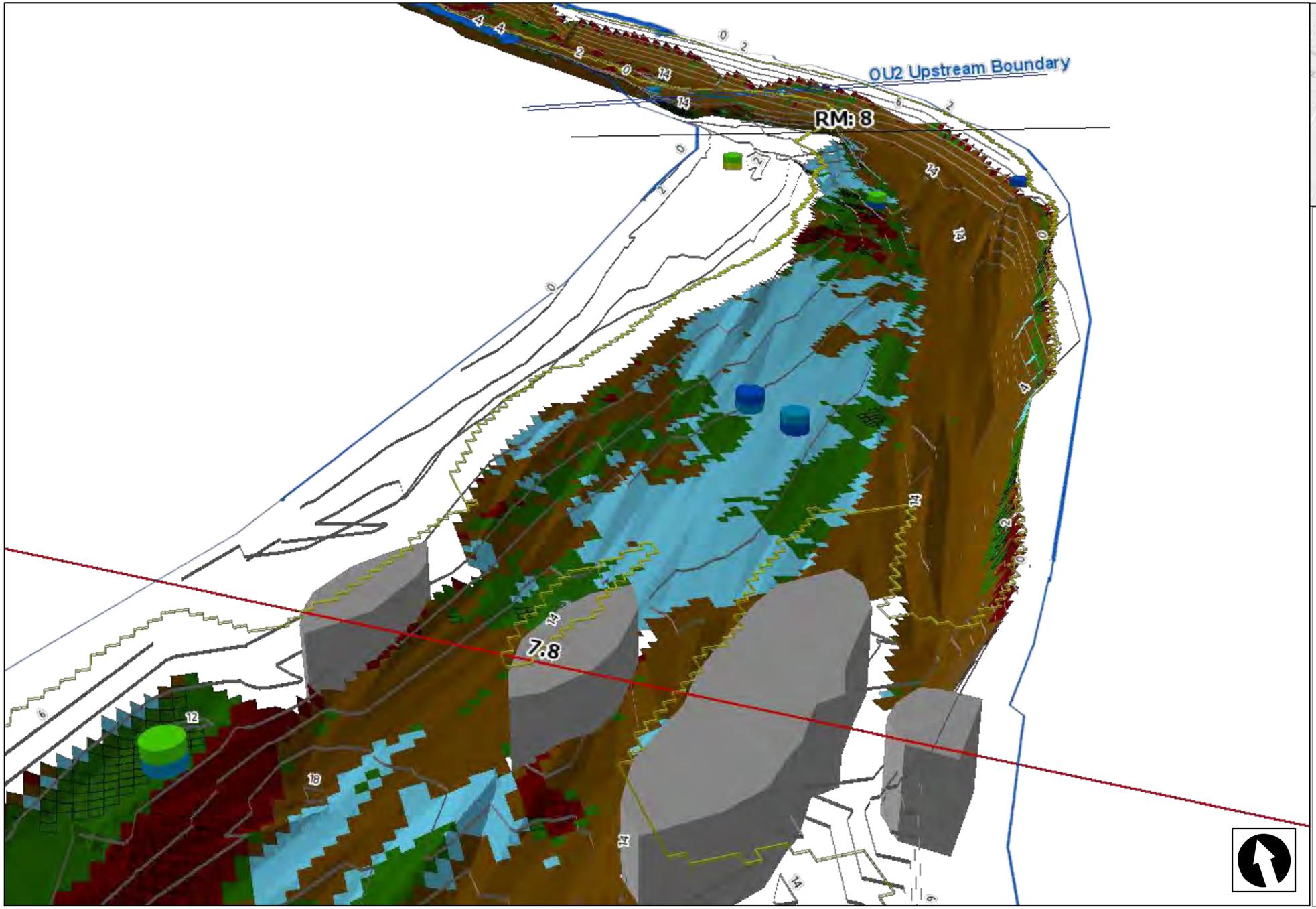

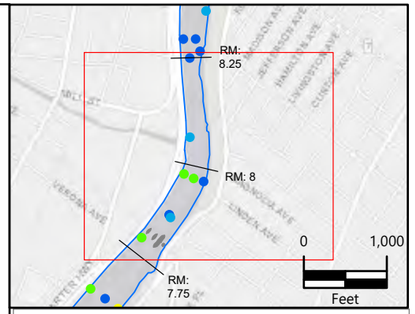

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Figure 4-5d

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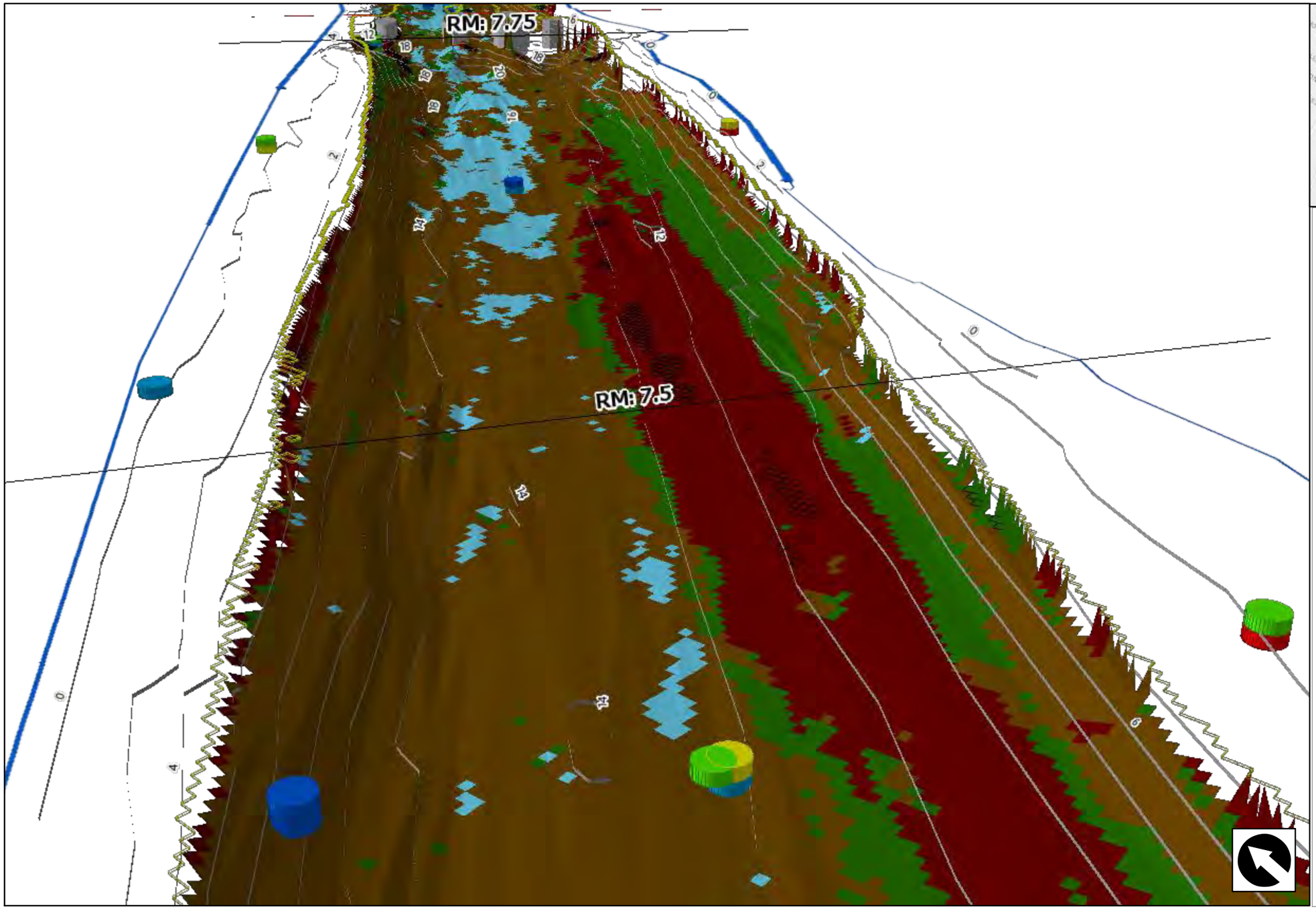

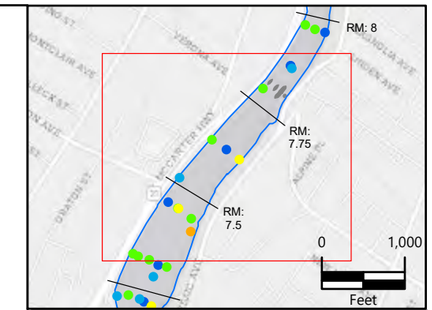

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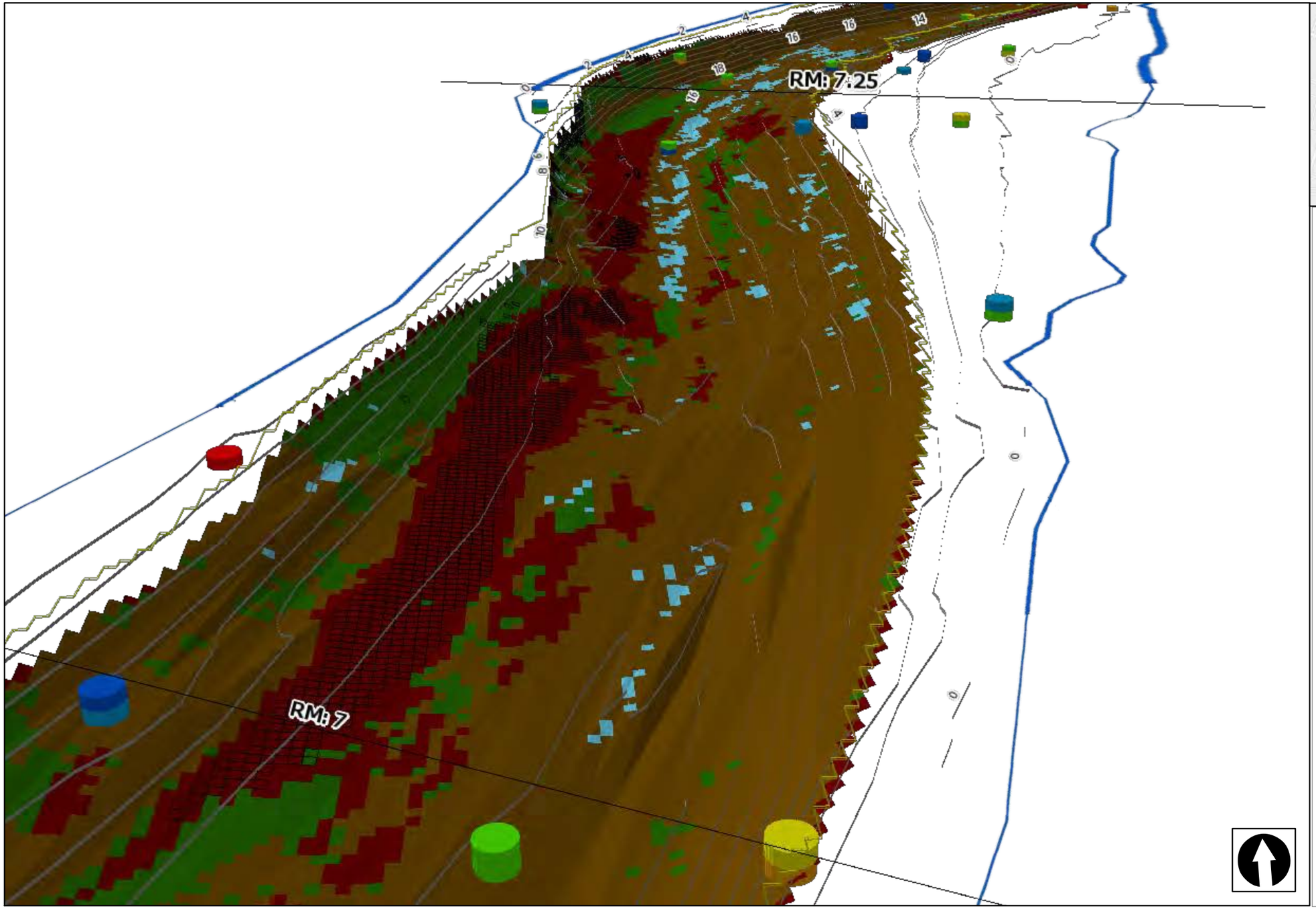
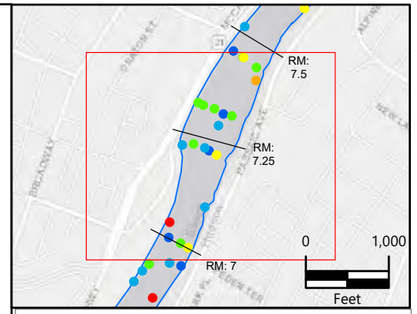
Figure 4-6a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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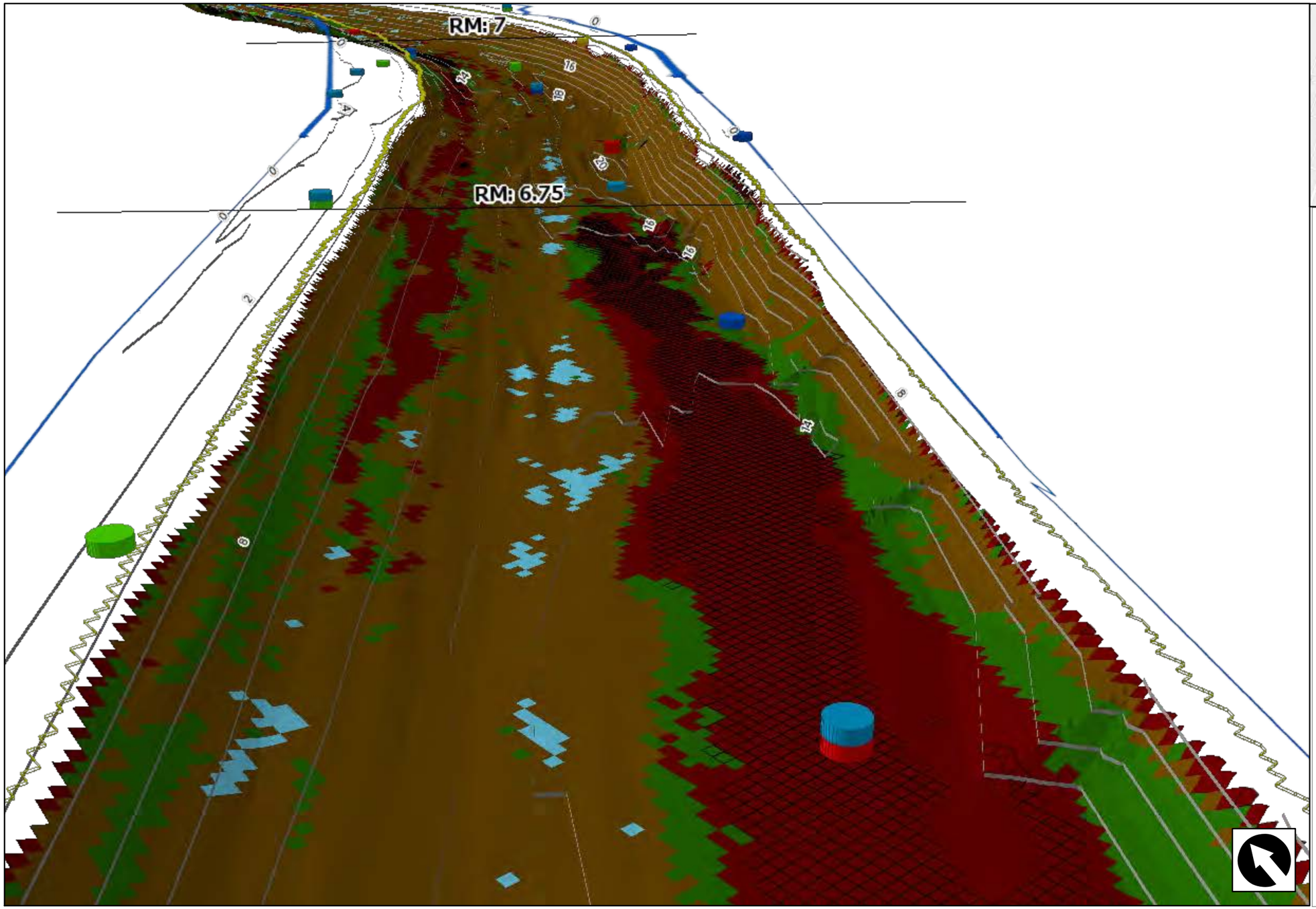
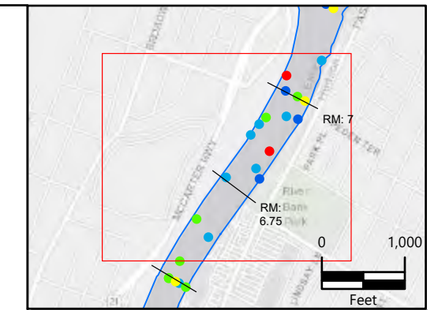
Figure 4-6b
HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns
Remedial Investigation Report
Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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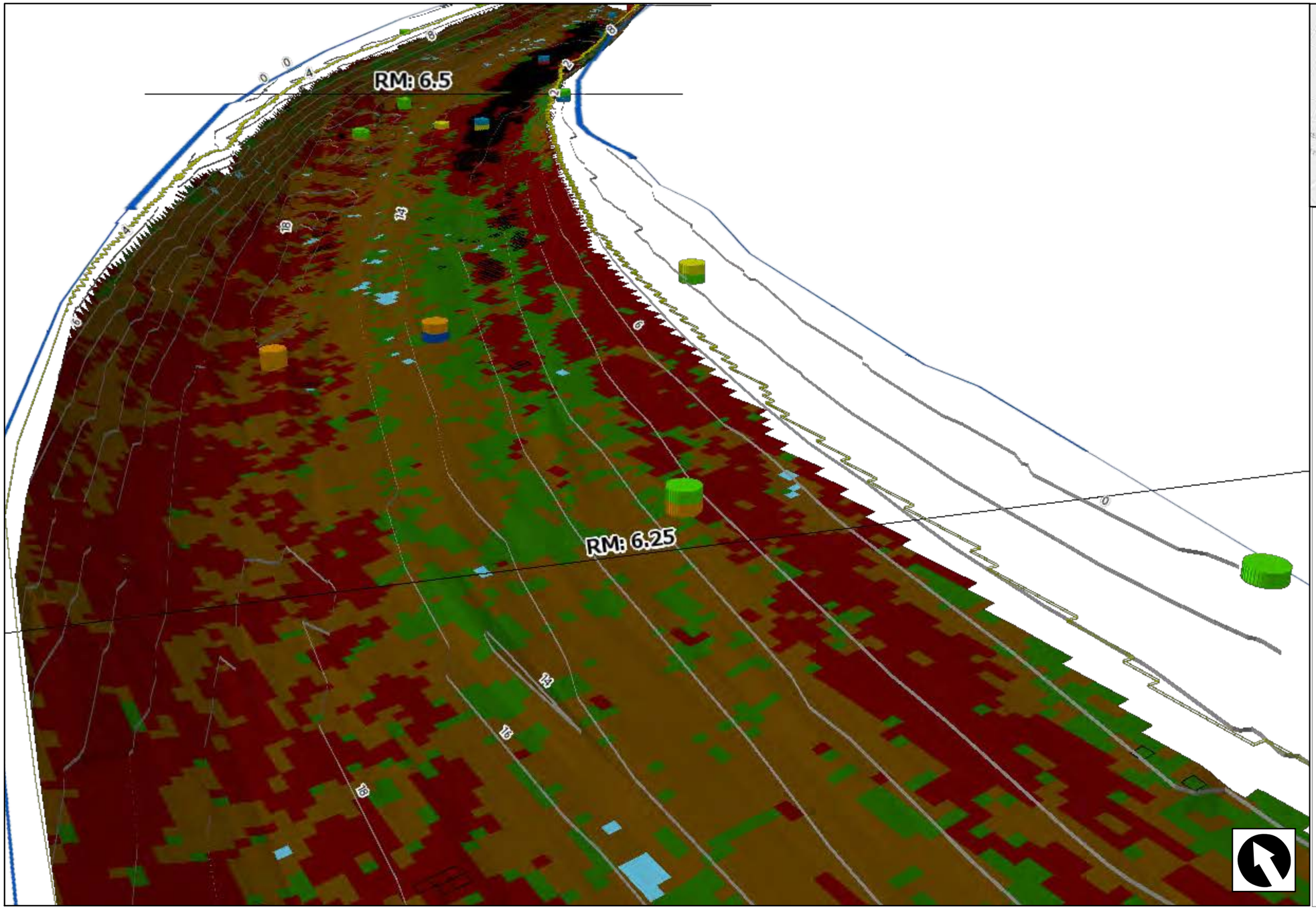
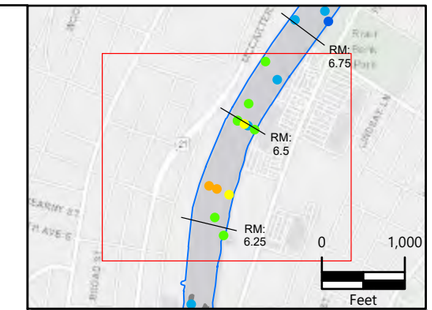
Figure 4-6c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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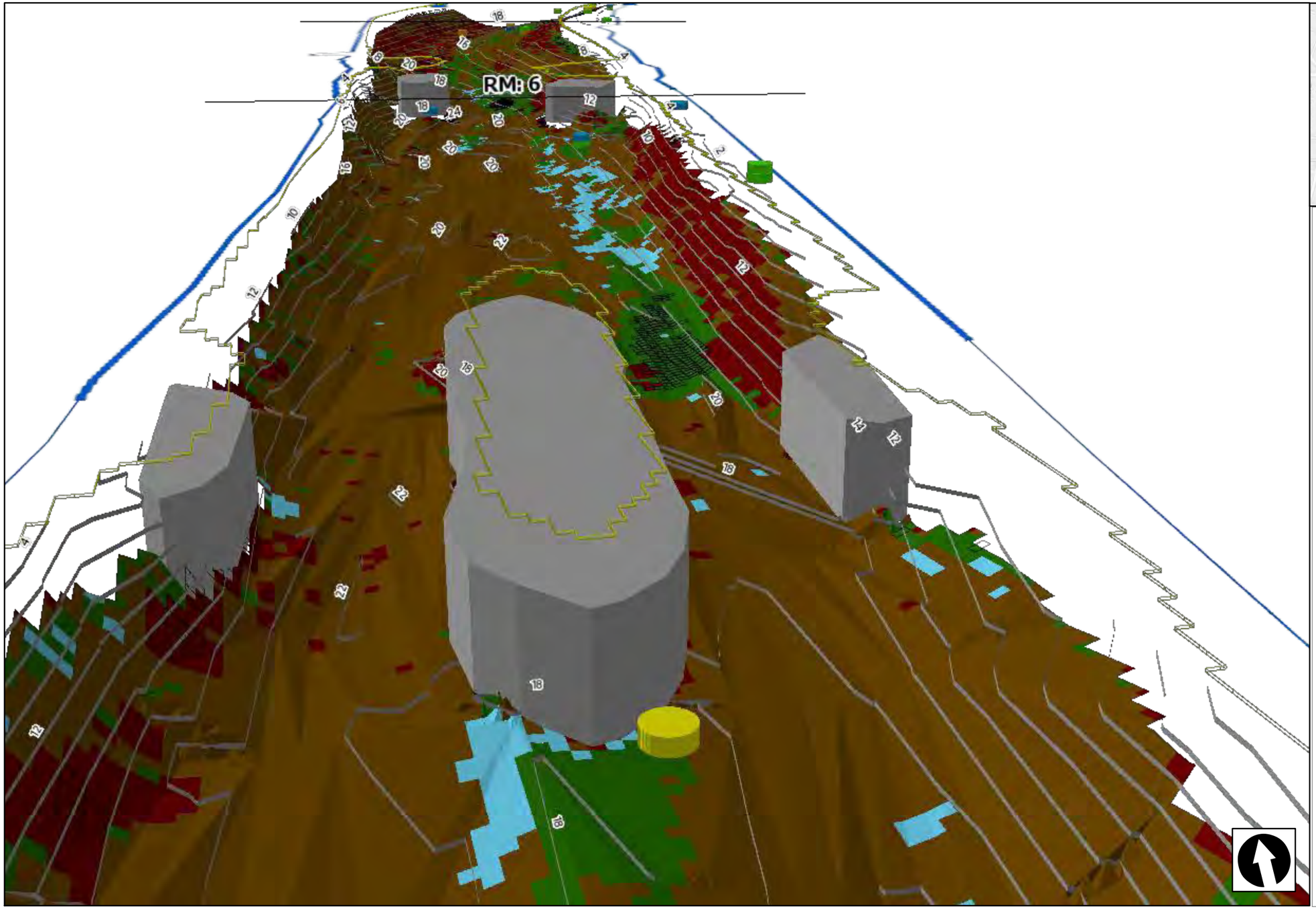
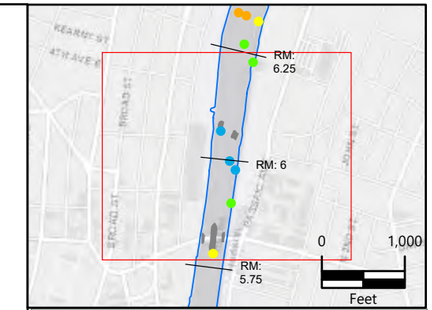
Figure 4-6d

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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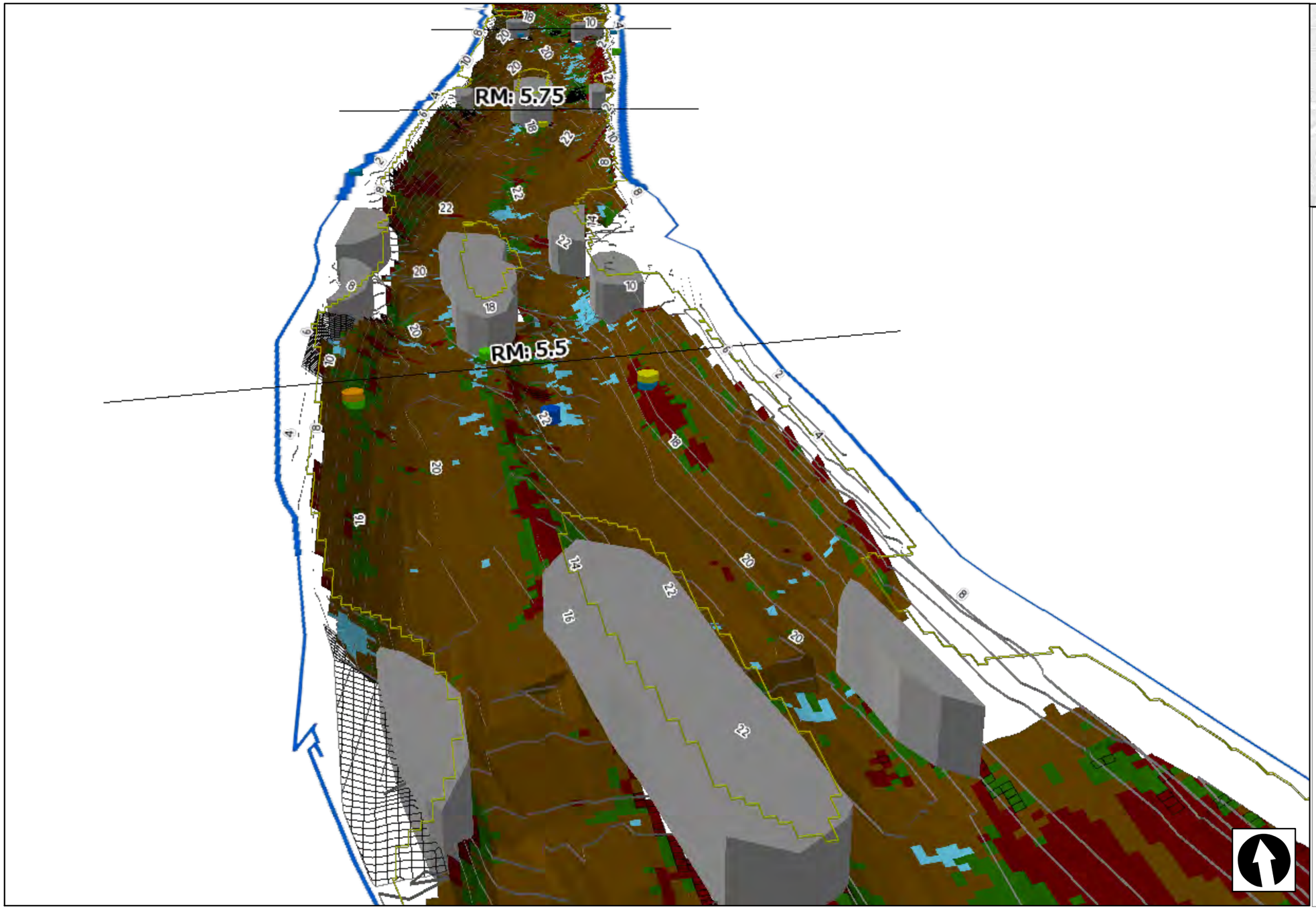
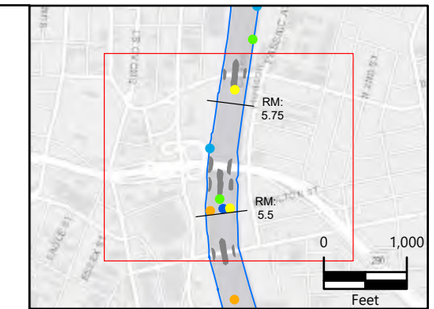
Figure 4-6e

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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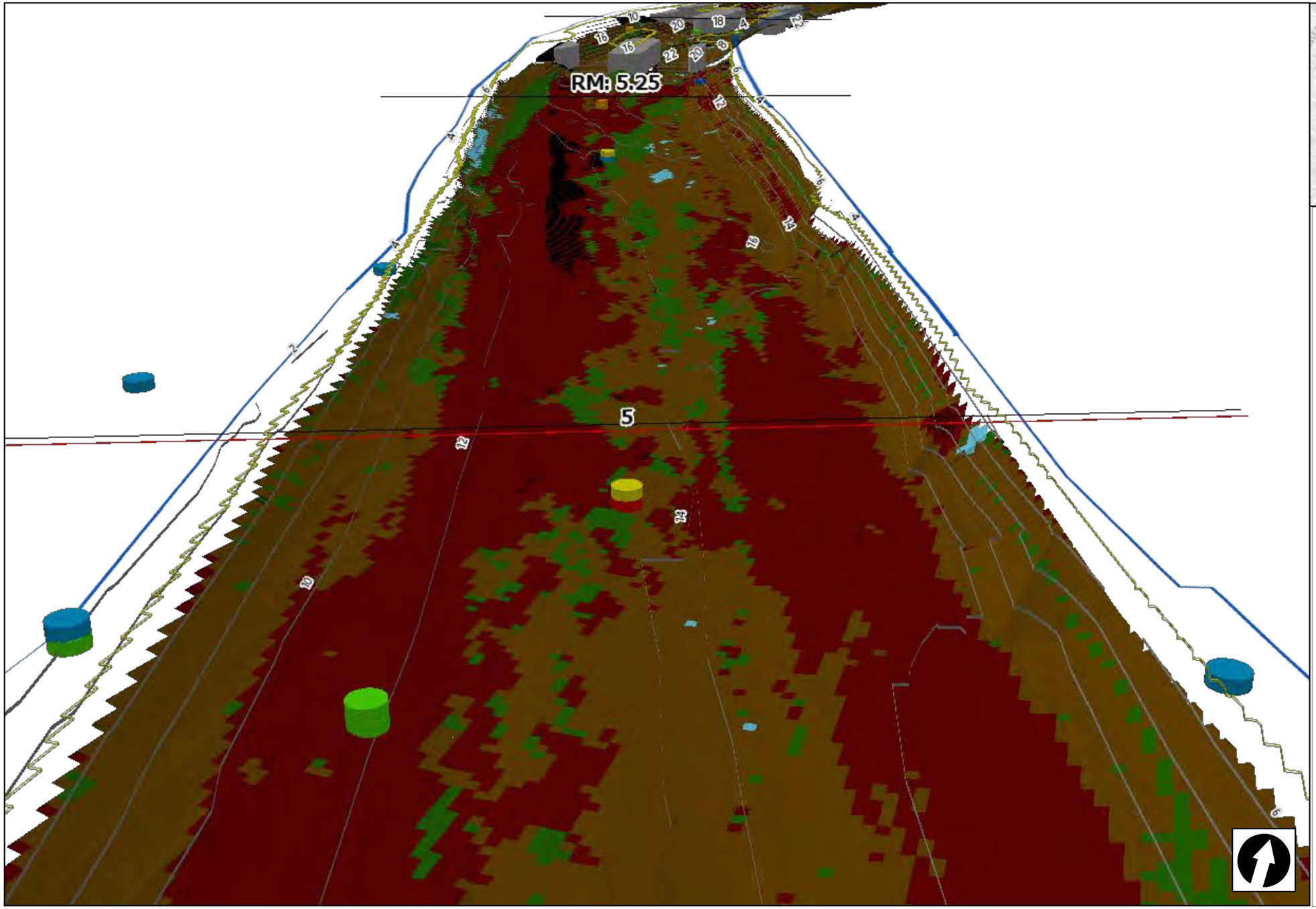
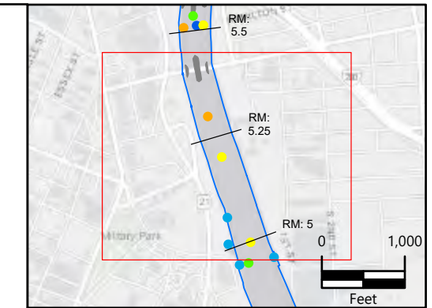
Figure 4-6f

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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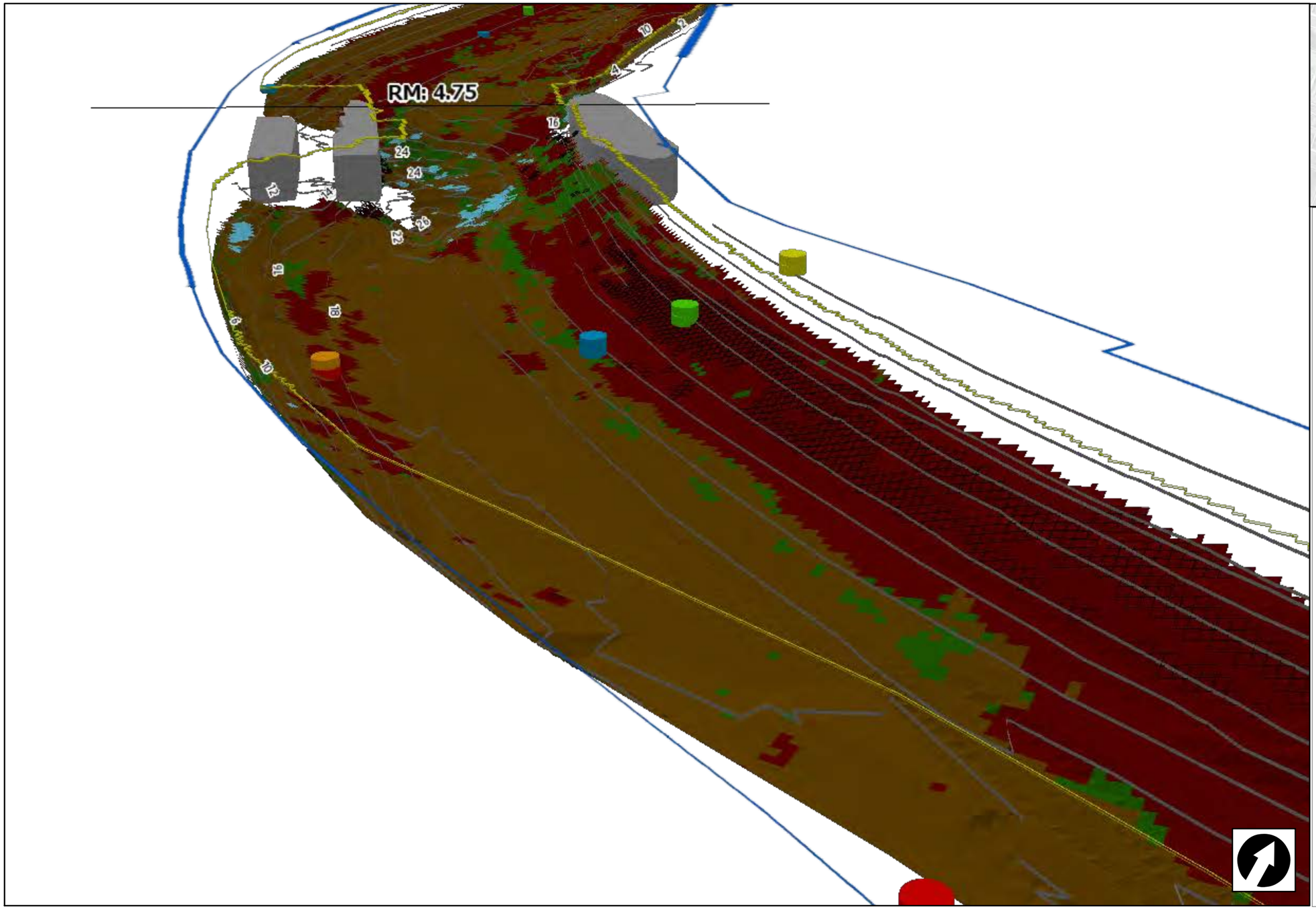
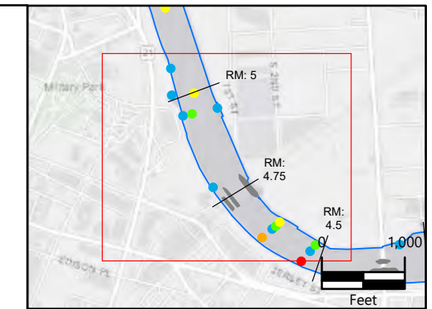
Figure 4-6g

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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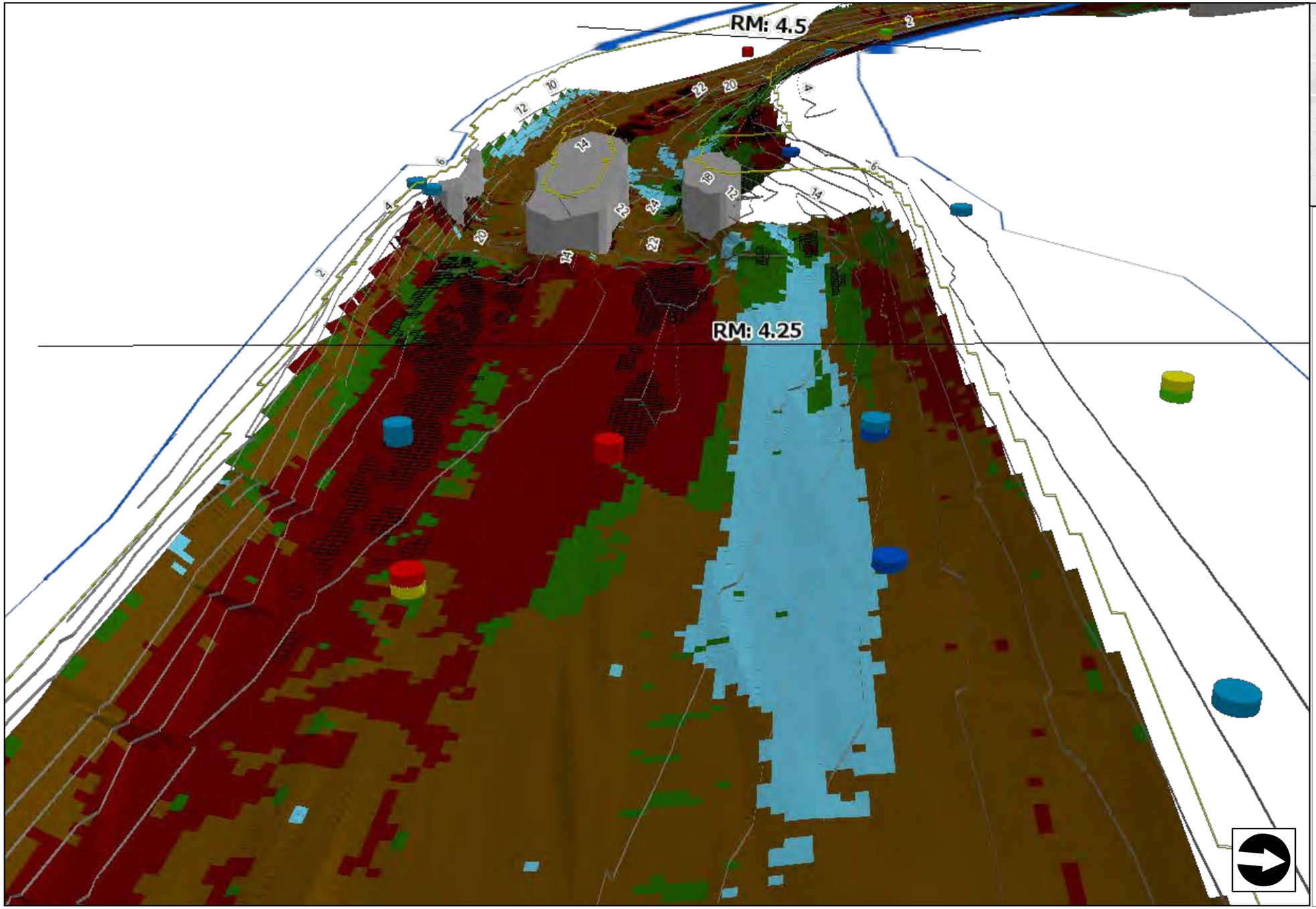
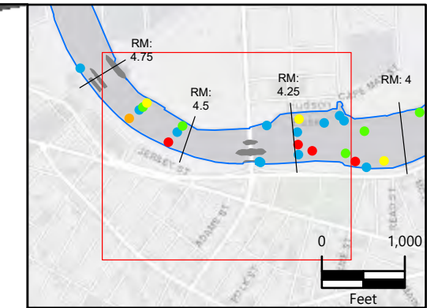
Figure 4-7a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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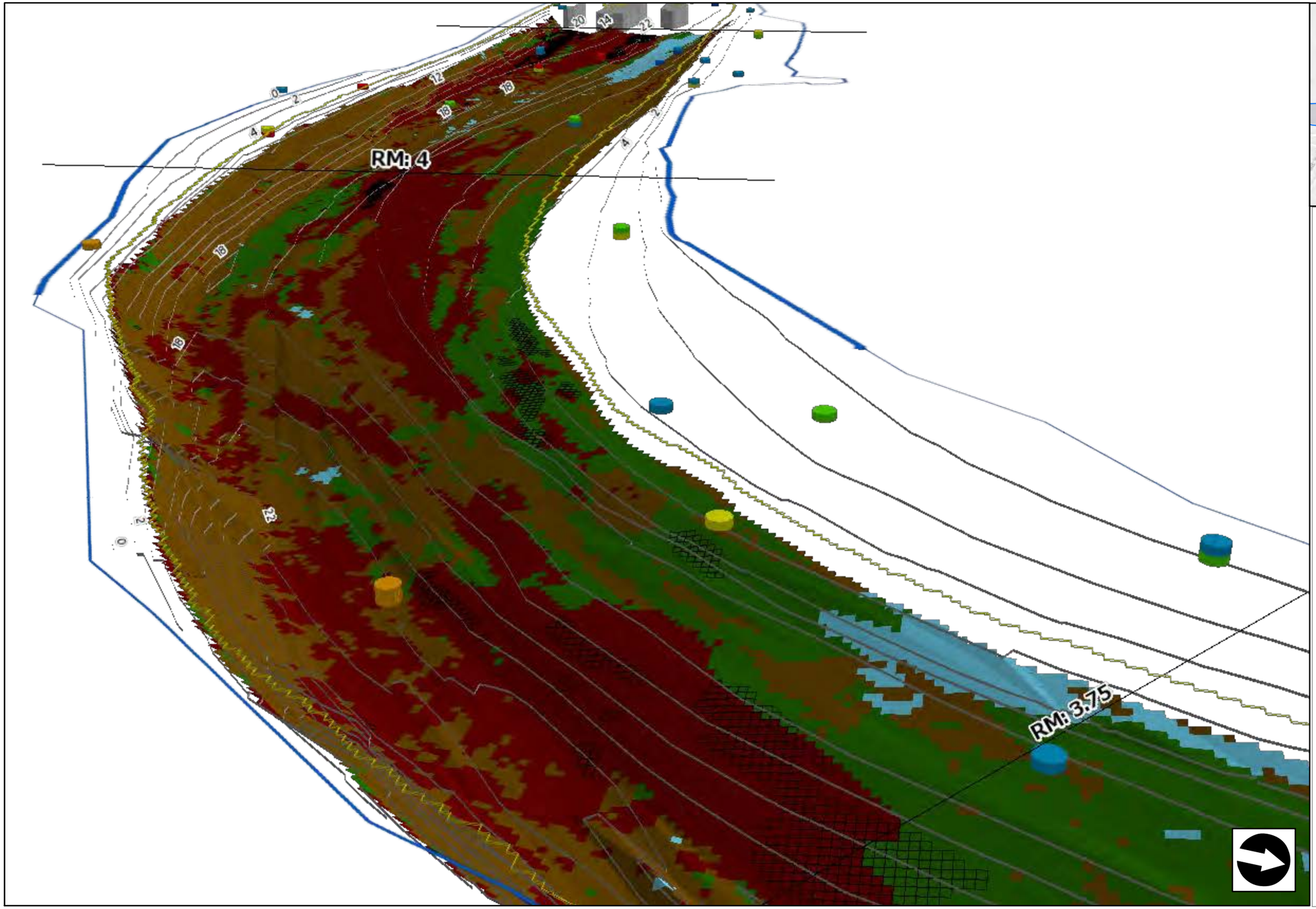
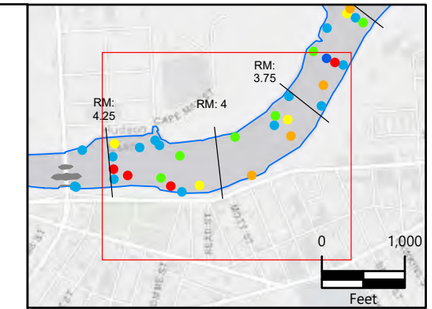
Figure 4-7b

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
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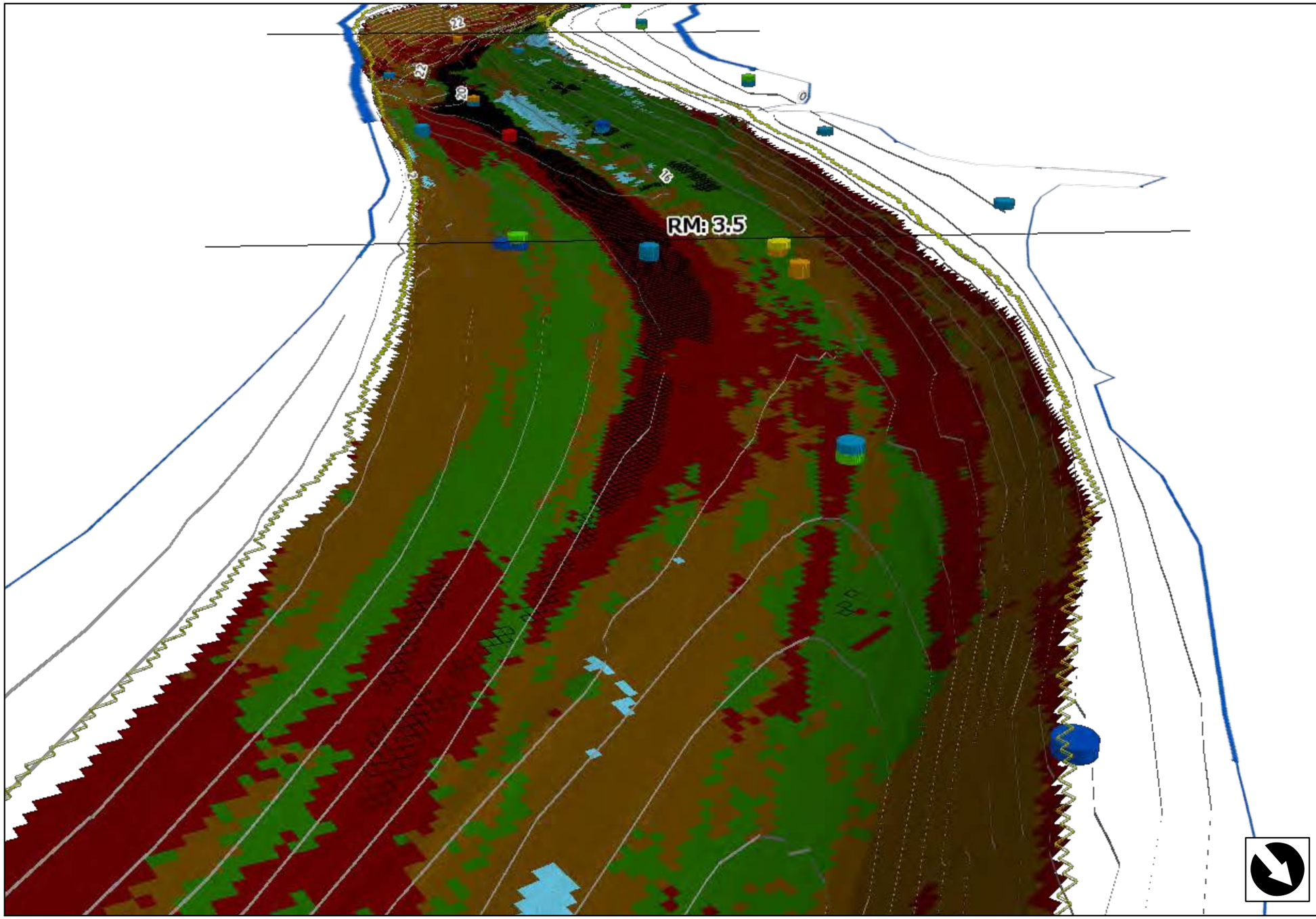
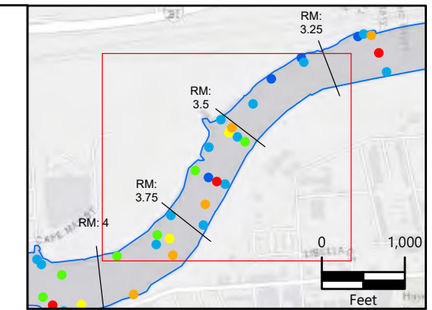
Figure 4-7c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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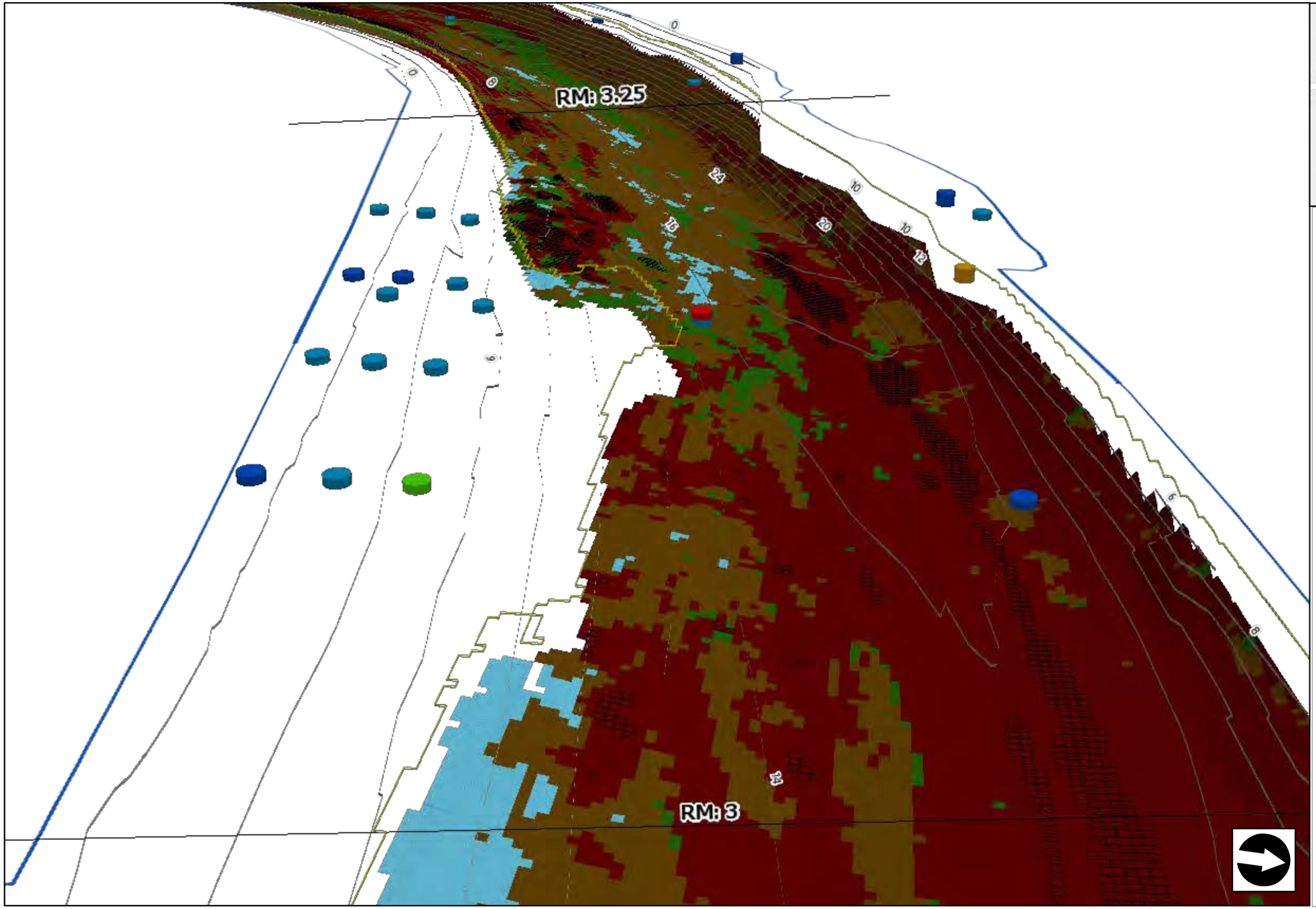
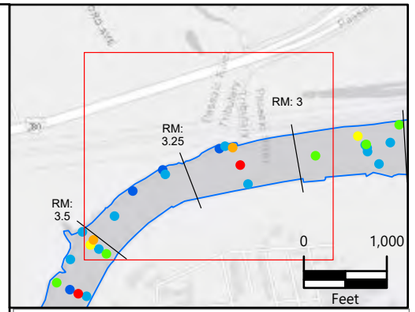
Figure 4-7d

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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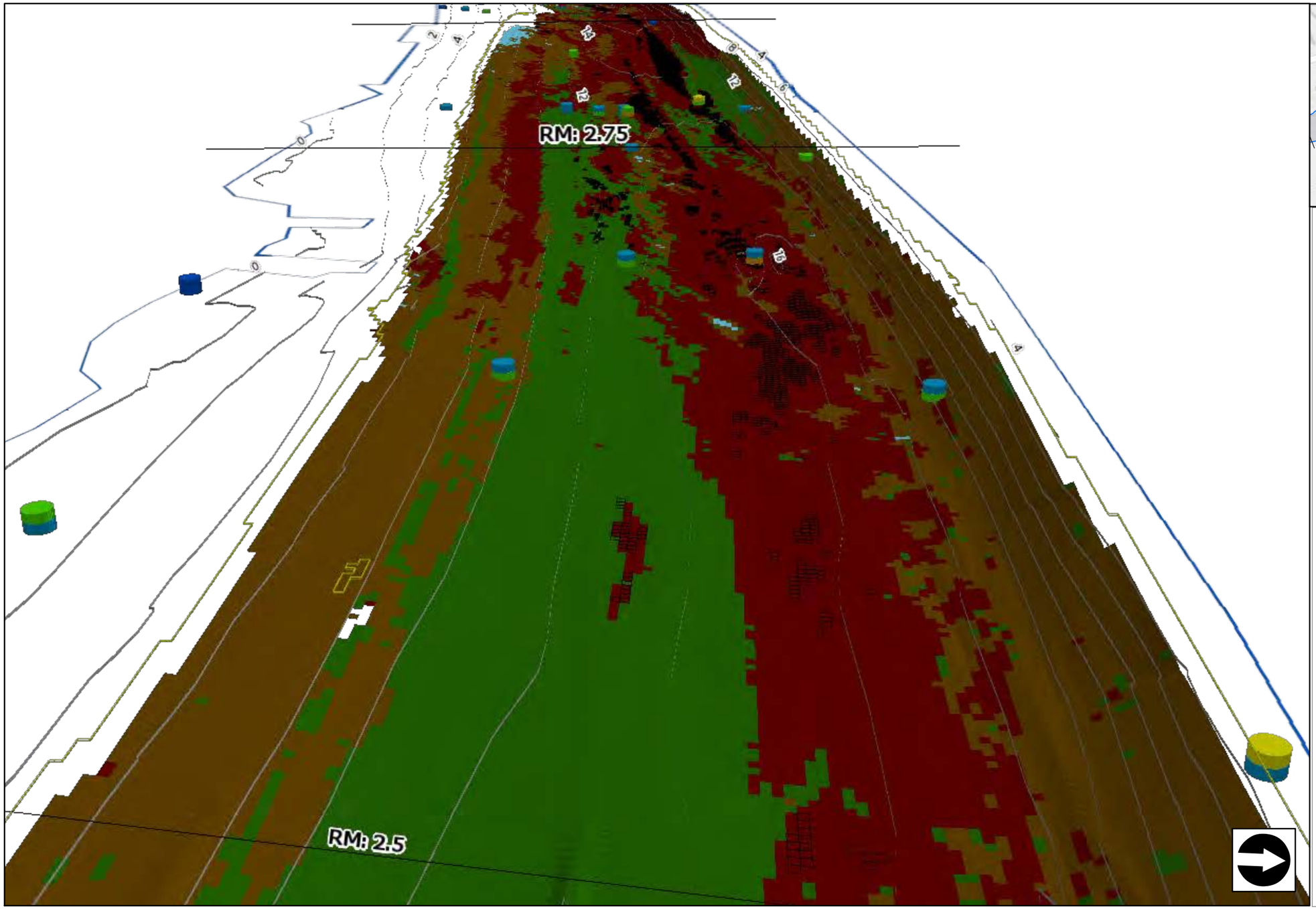
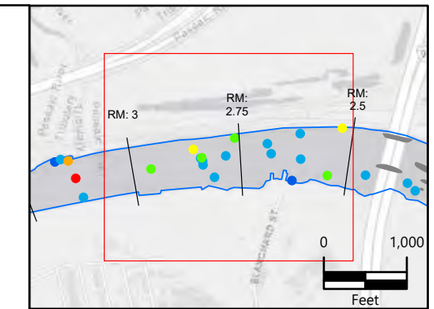
Figure 4-7e

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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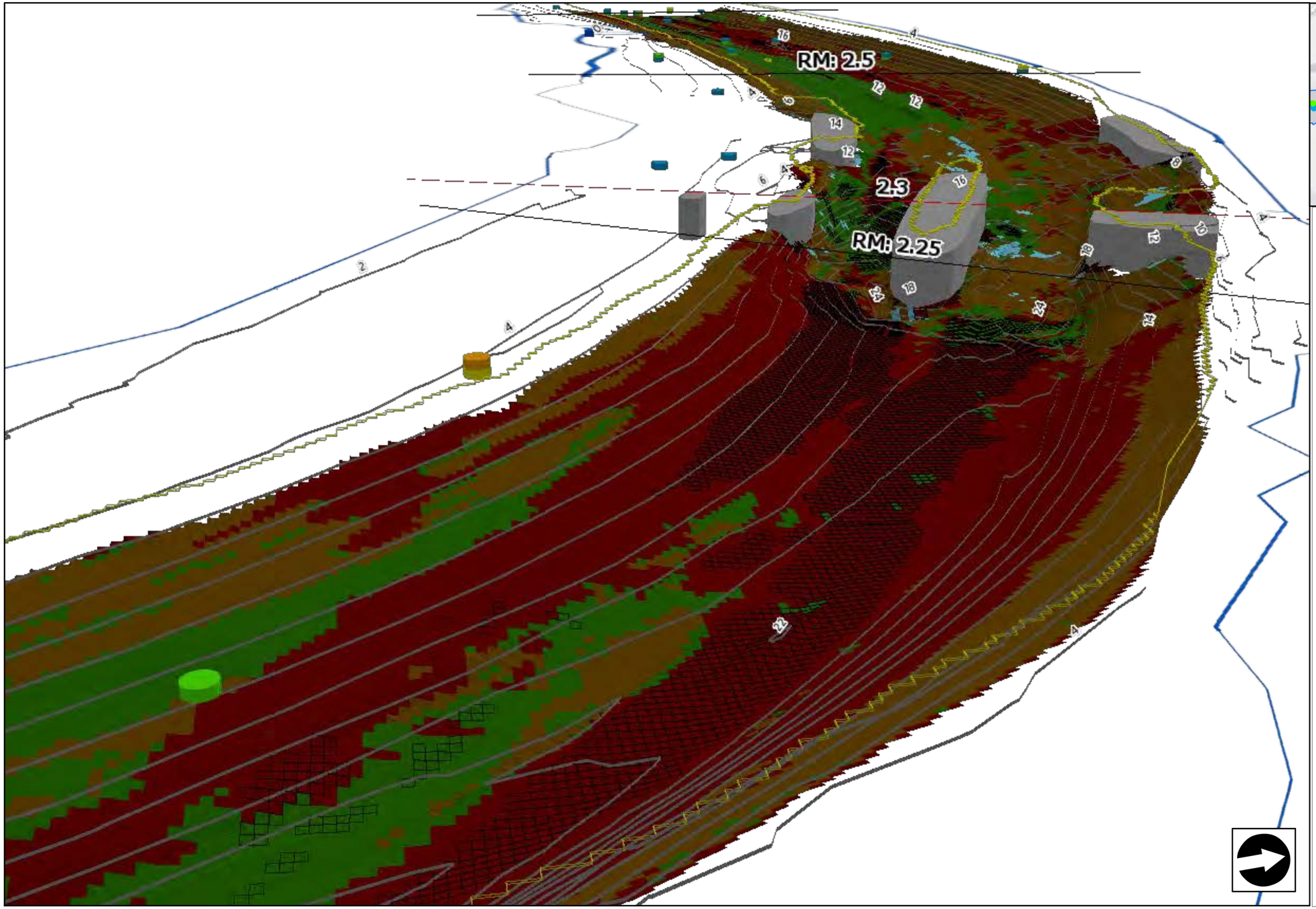
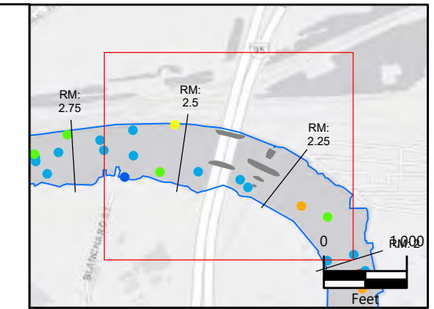
Figure 4-7f

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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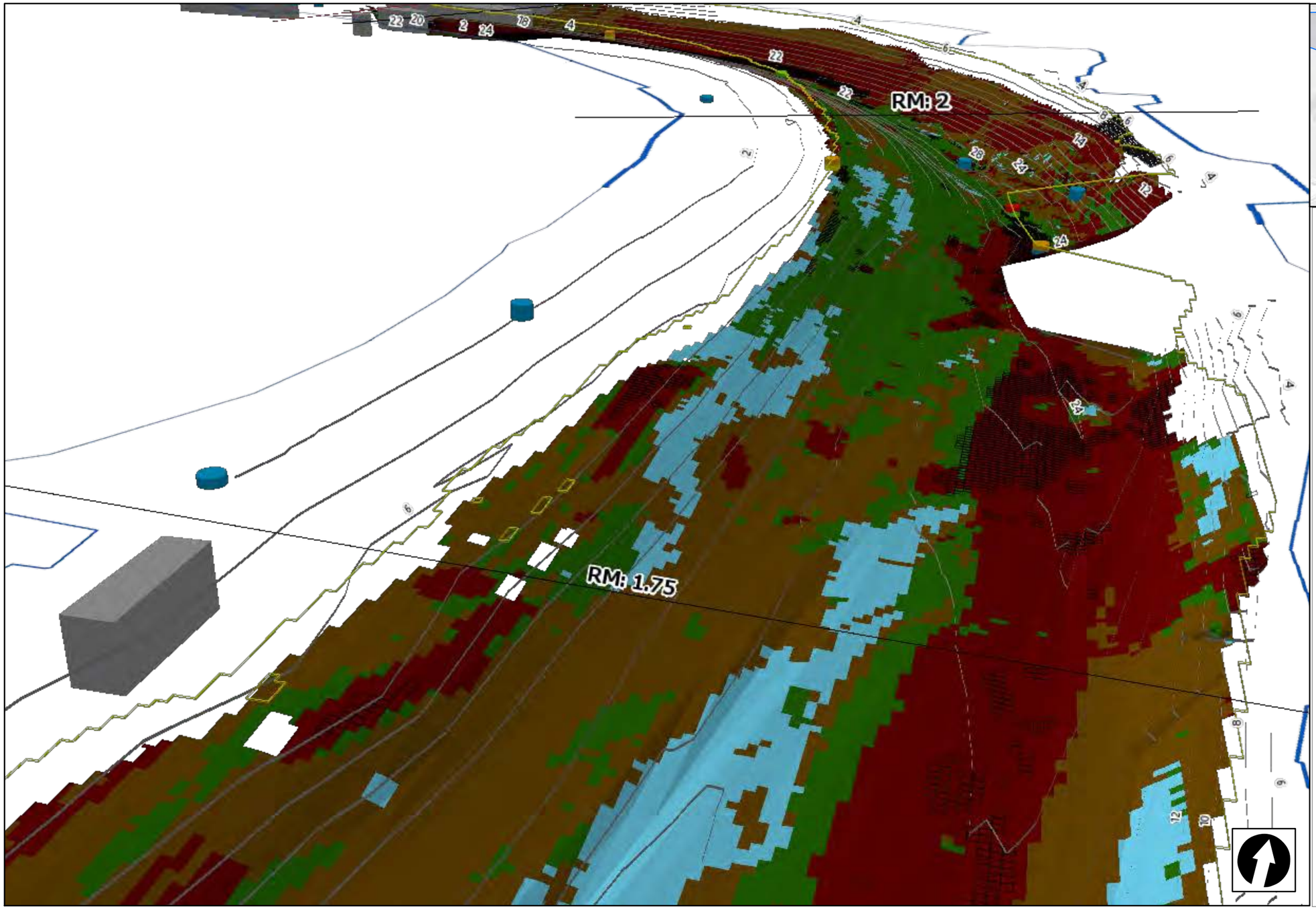
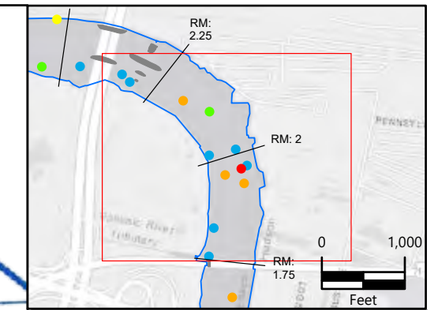
Figure 4-7g

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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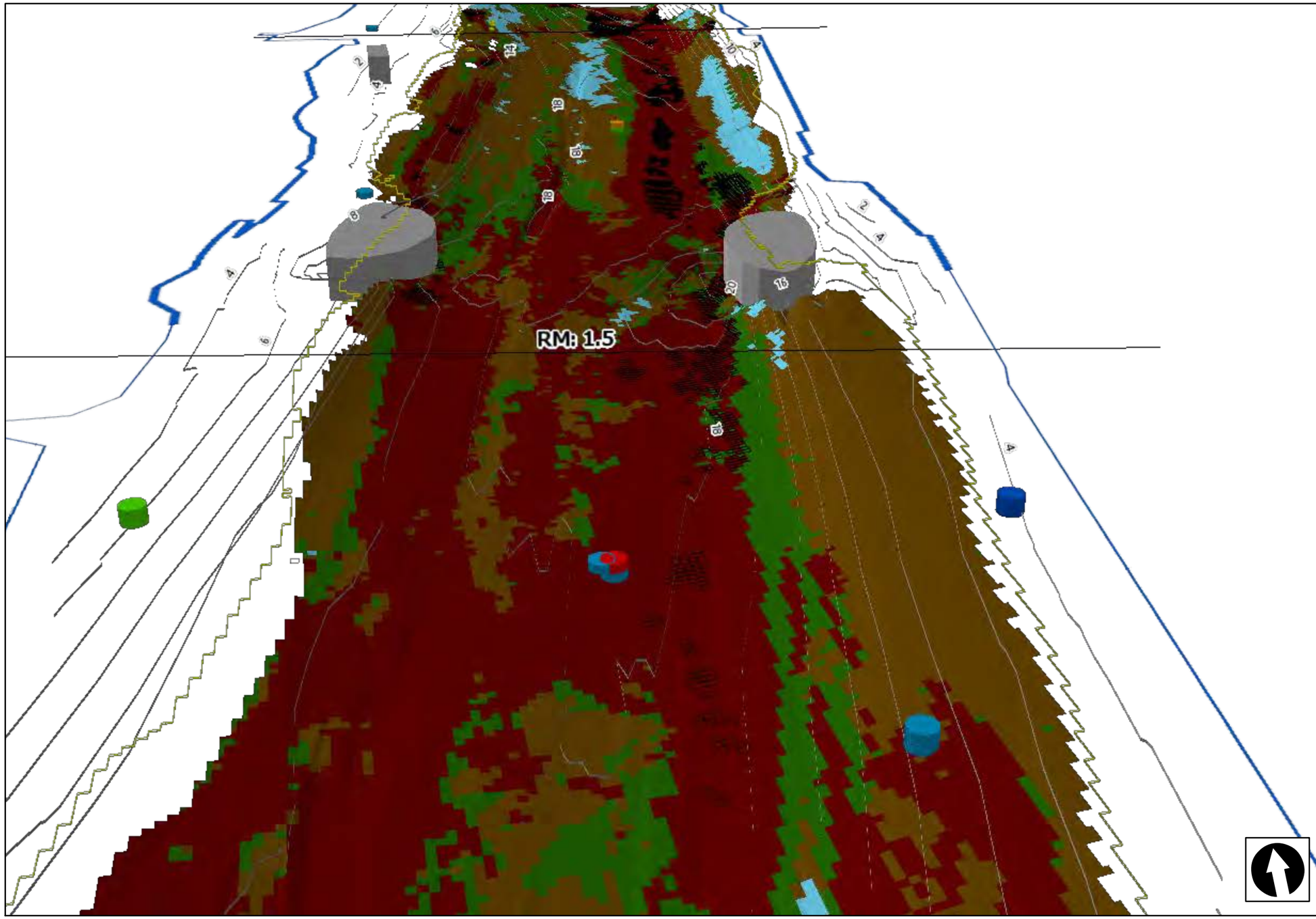
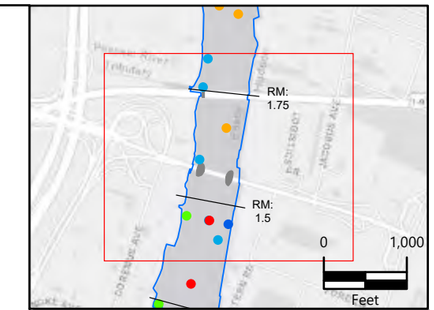
Figure 4-8a

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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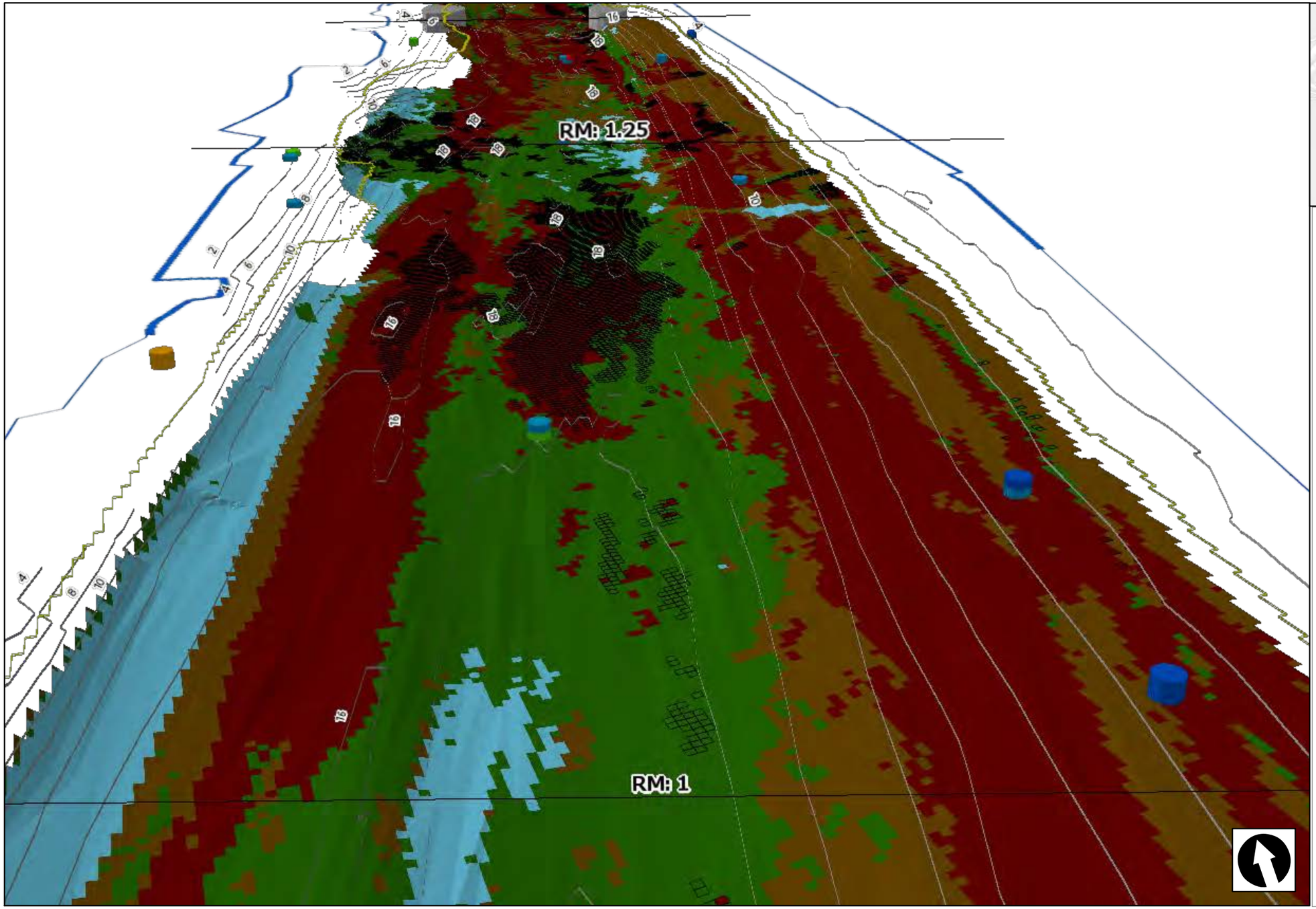
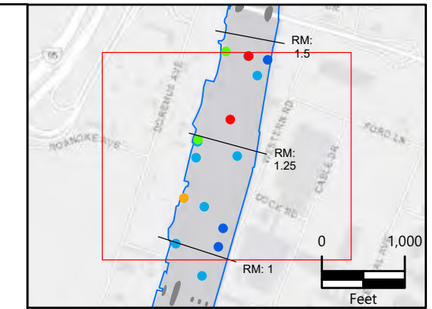
Figure 4-8b

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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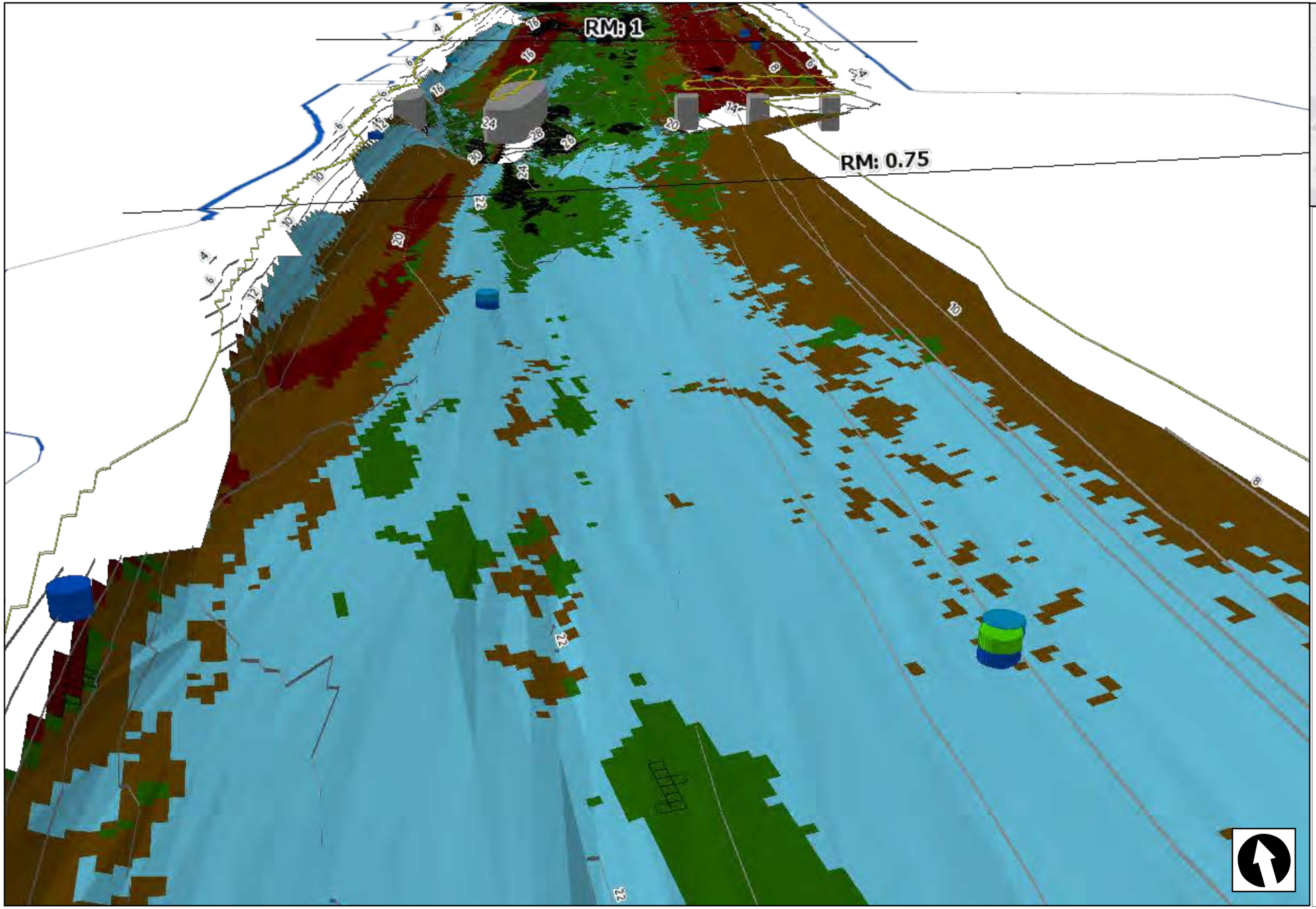
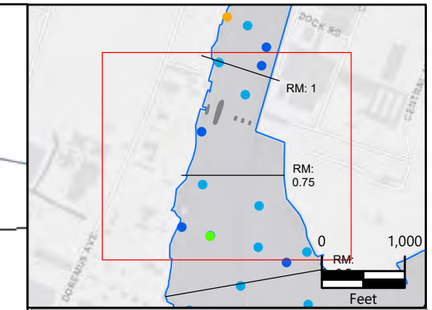
Figure 4-8c

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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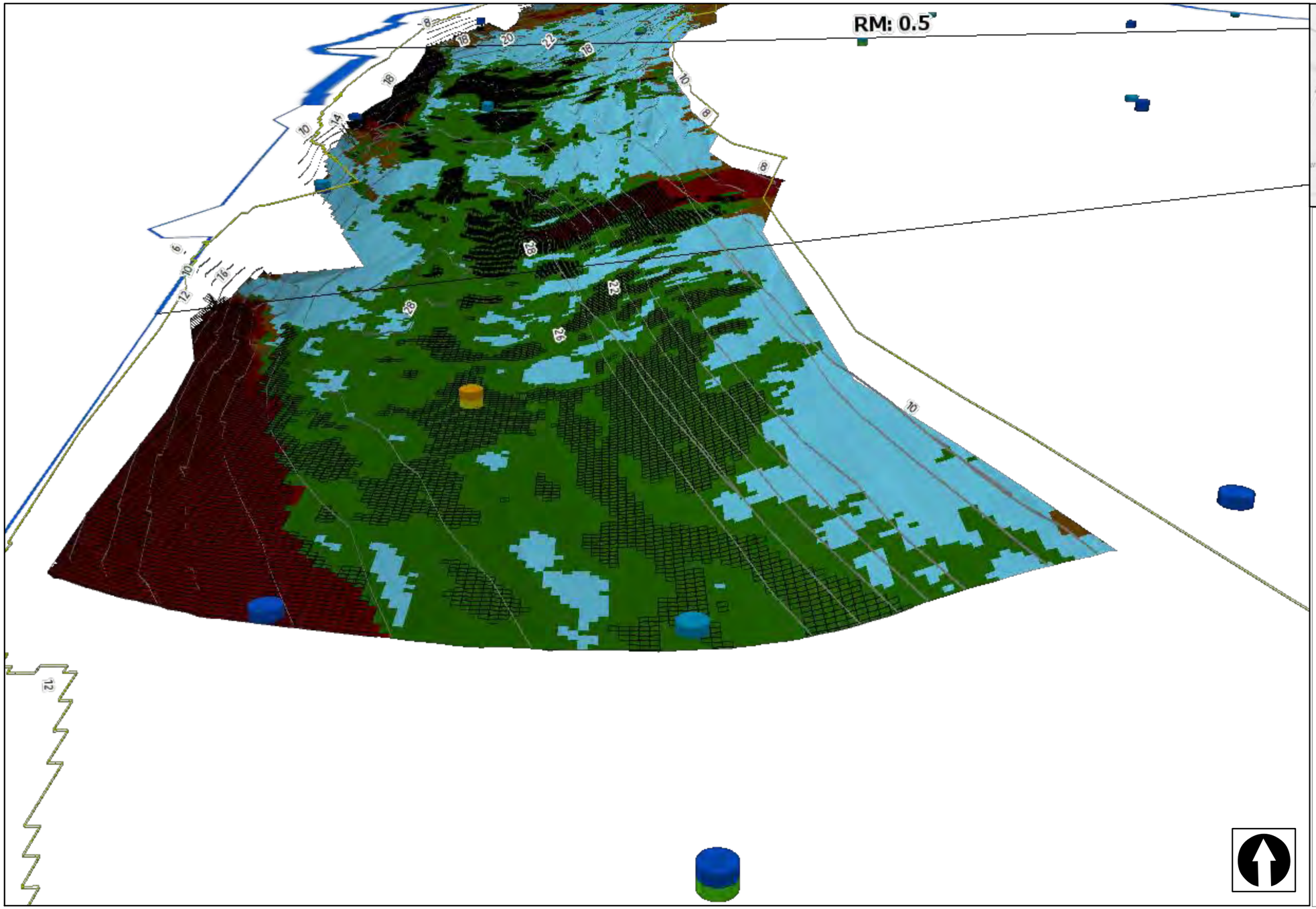
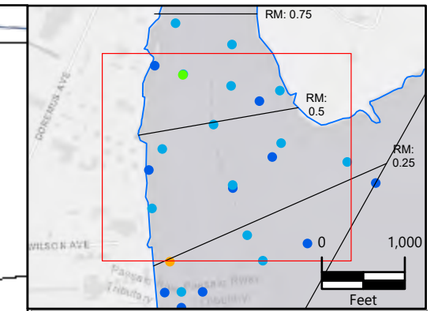
Figure 4-8d

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

HMW PAH Concentration (mg/kg)

- 0 - 15
- 15 - 30
- 30 - 40
- 40 - 50
- 50 - 80
- >80

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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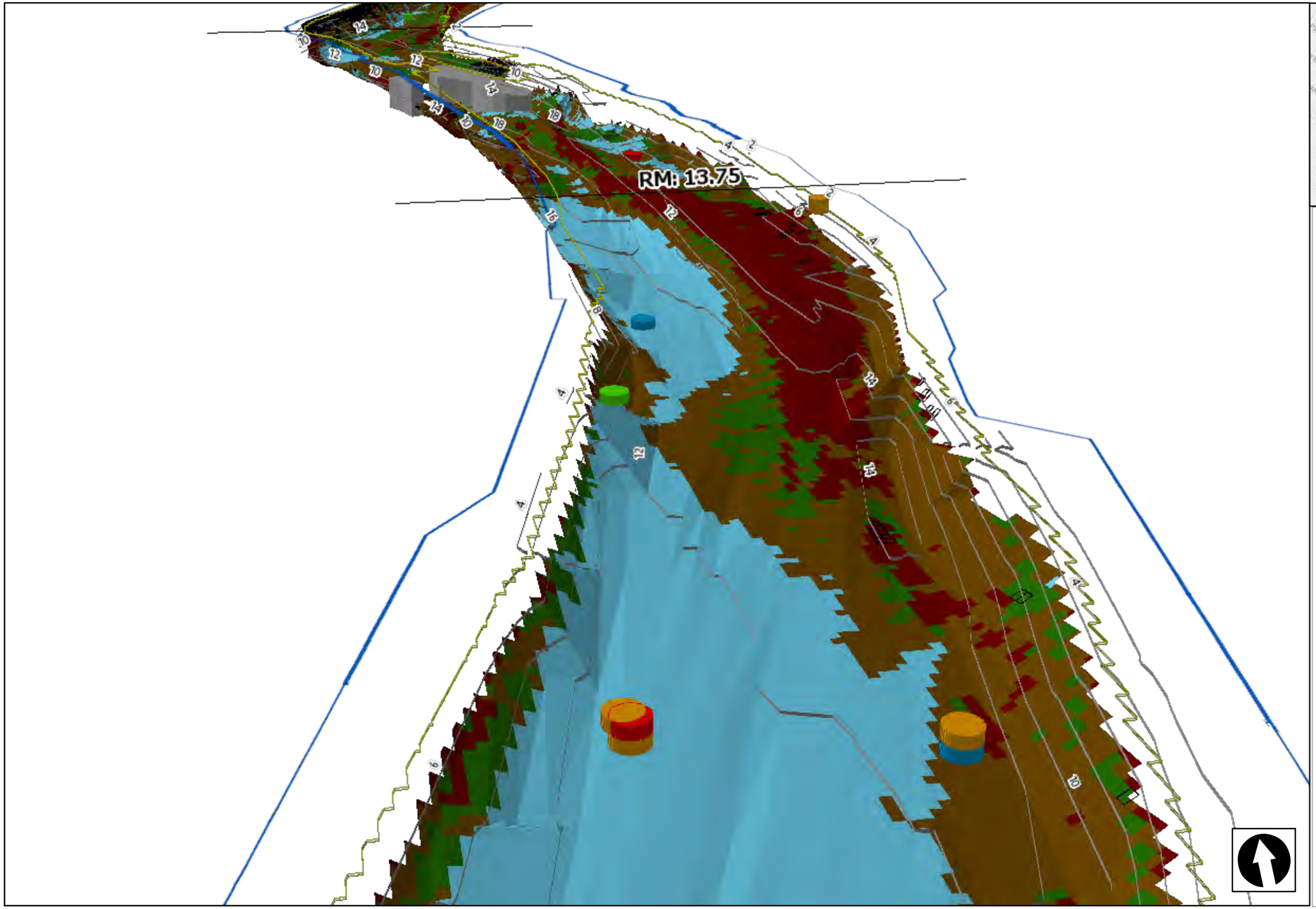
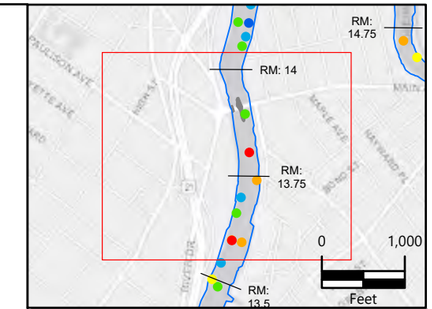
Figure 4-8e

HMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

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Bathymetry categories are described in Section 4.1. The multi-beam bathymetry data evaluated at the 5-foot by 5-foot resolution shown here is used to distinguish differences greater than 6 inches between surveys. See Appendix A for a discussion of bathymetric uncertainty. White areas have no bathymetric change category. Contour labels are feet below mean sea level (NGVD 29). Cores located in the TCRA Area were subjected to remediation in 2013-2014.

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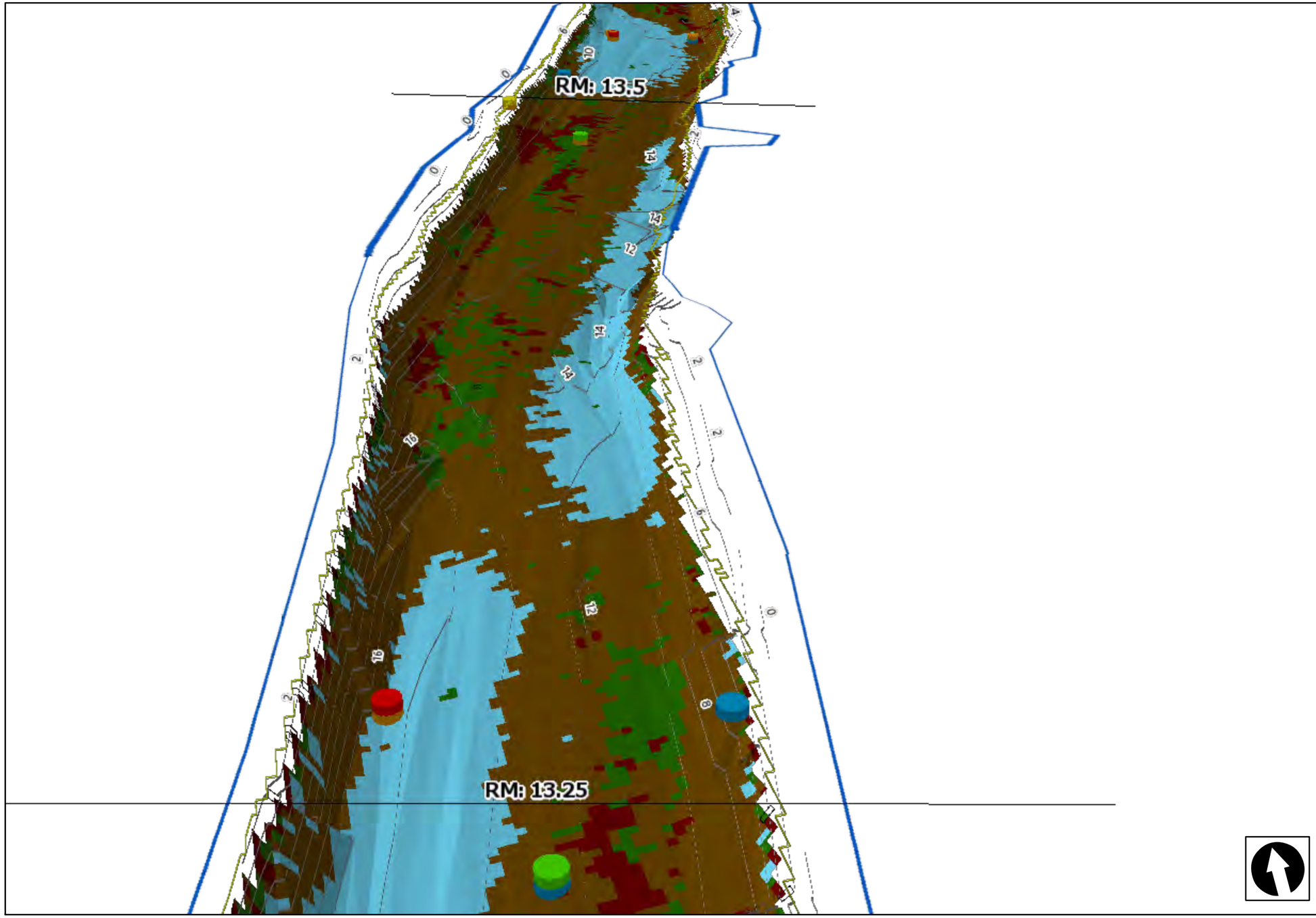
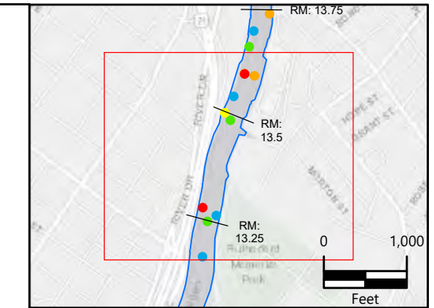
Figure 5-1a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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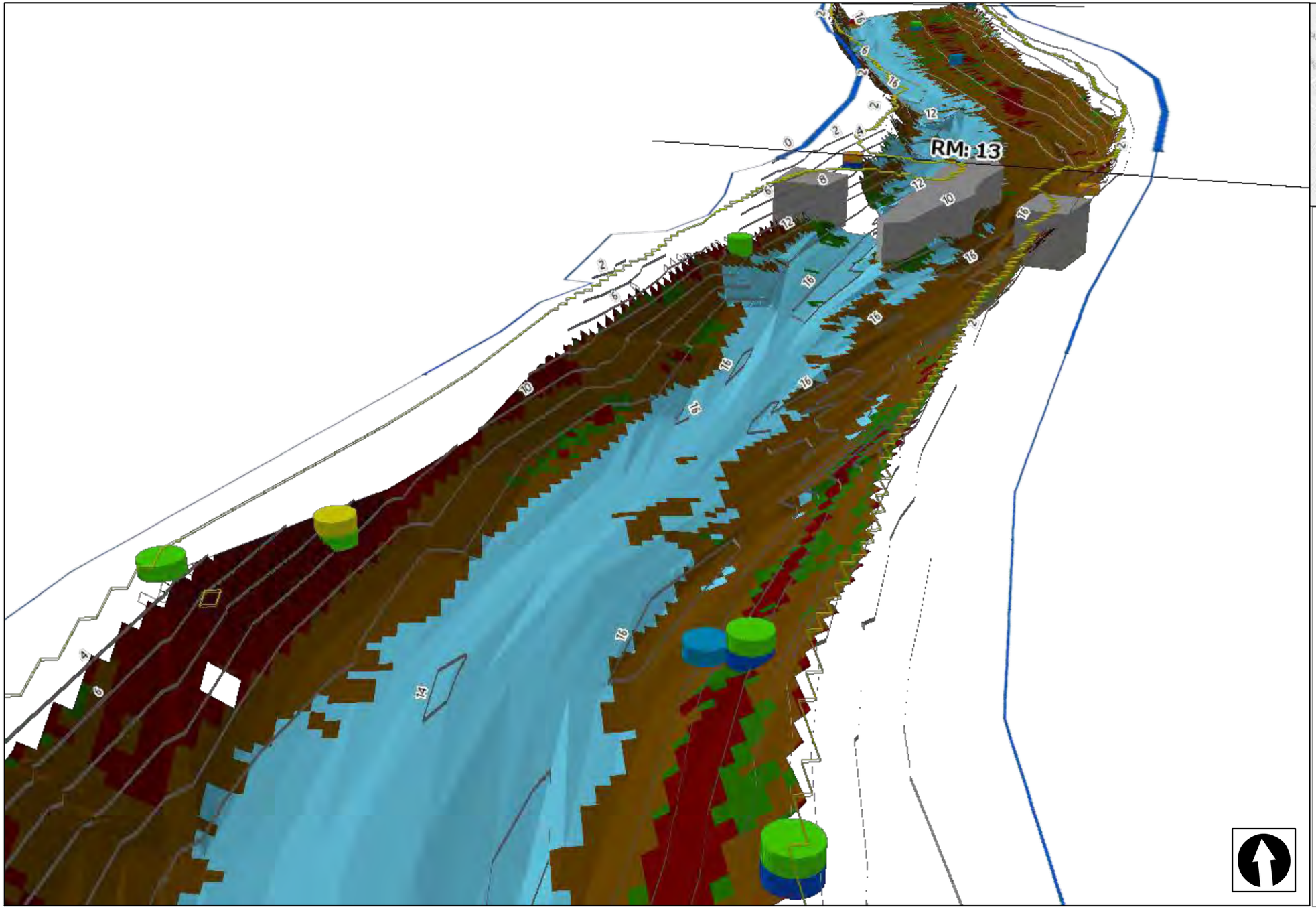
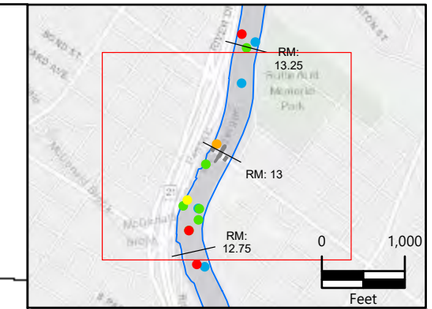
Figure 5-1b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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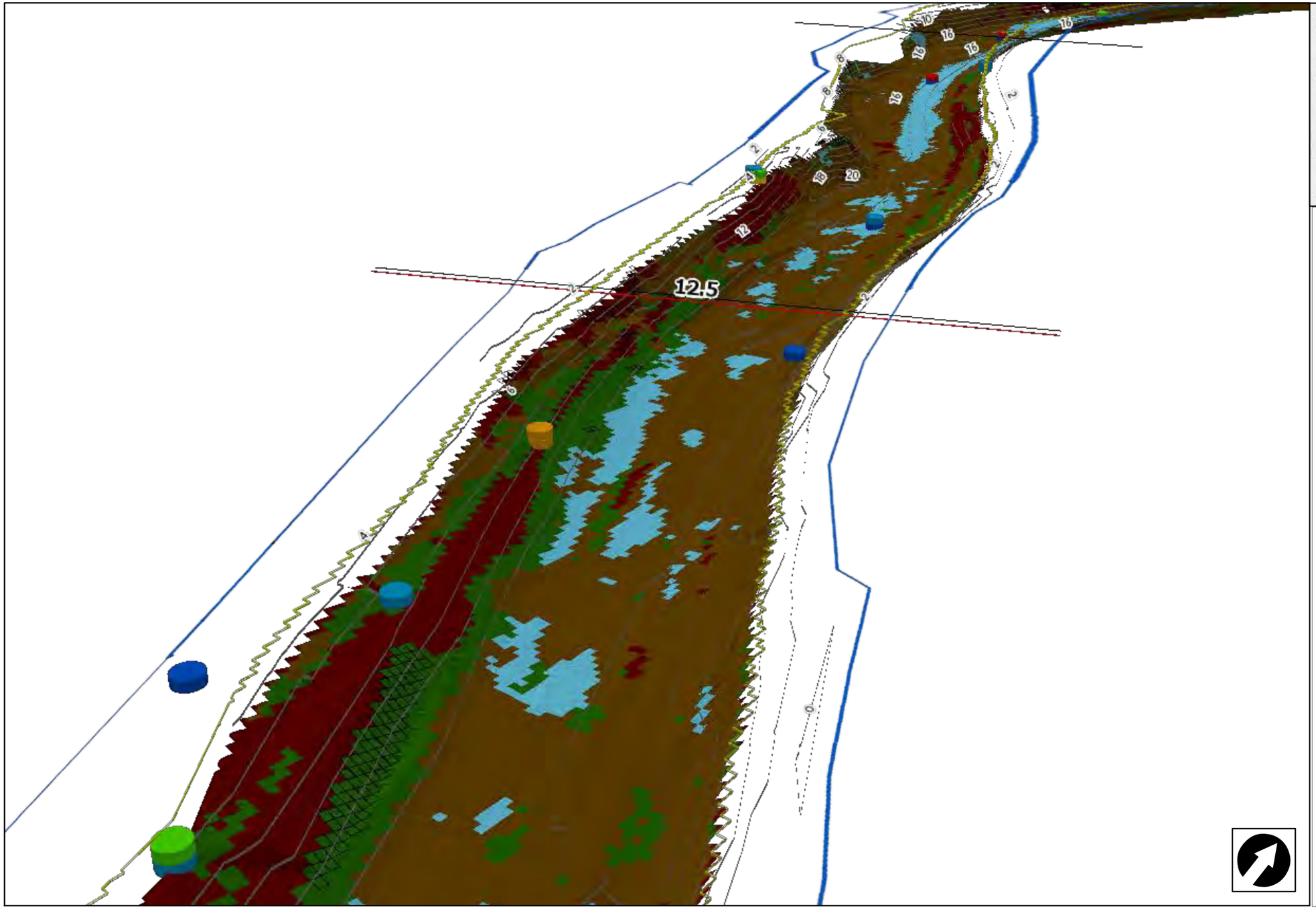
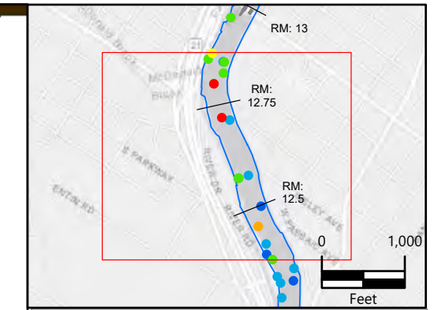
Figure 5-1c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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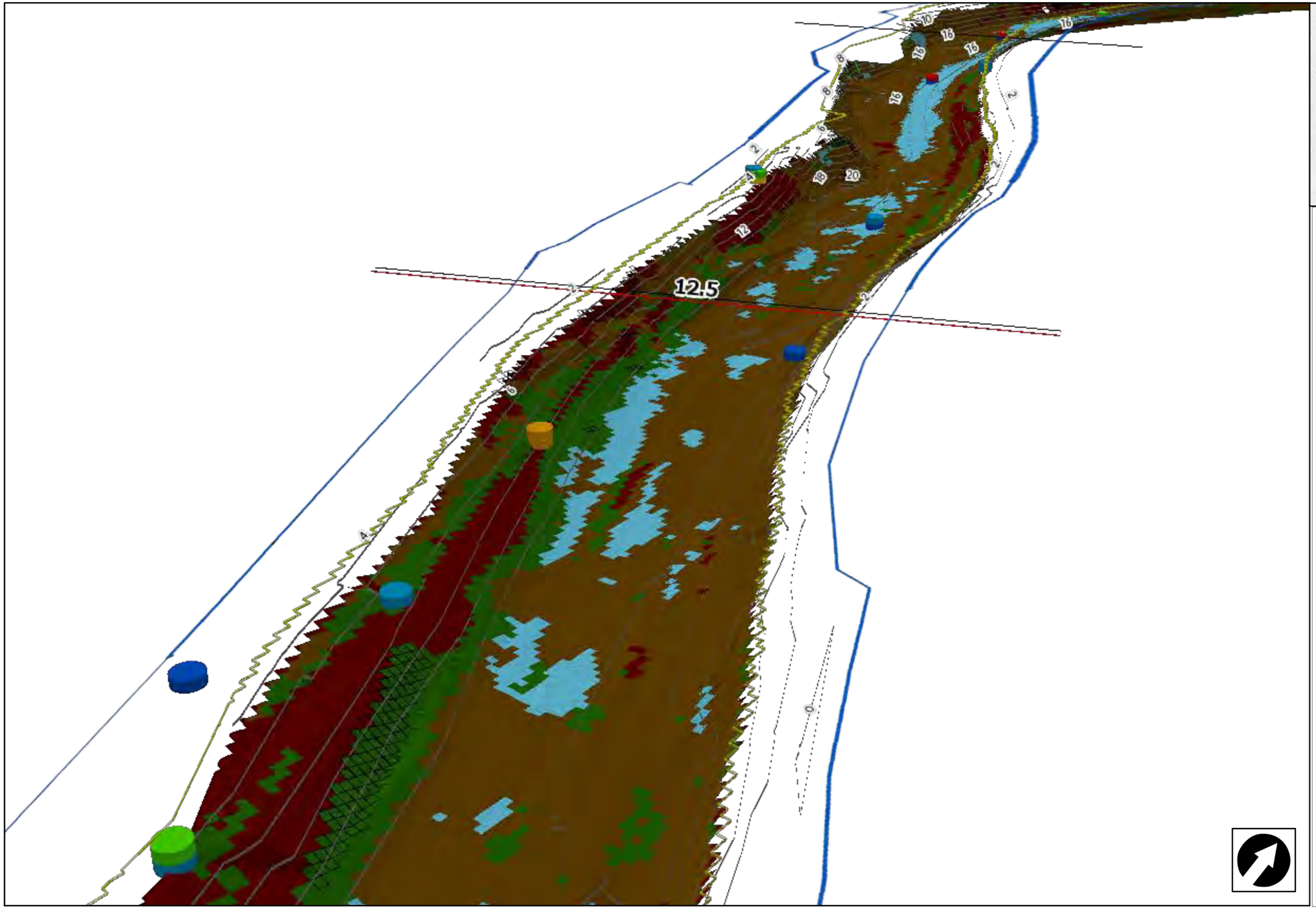
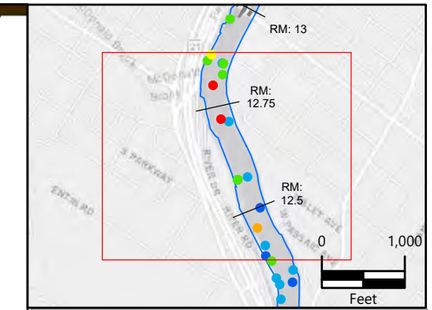
Figure 5-1d

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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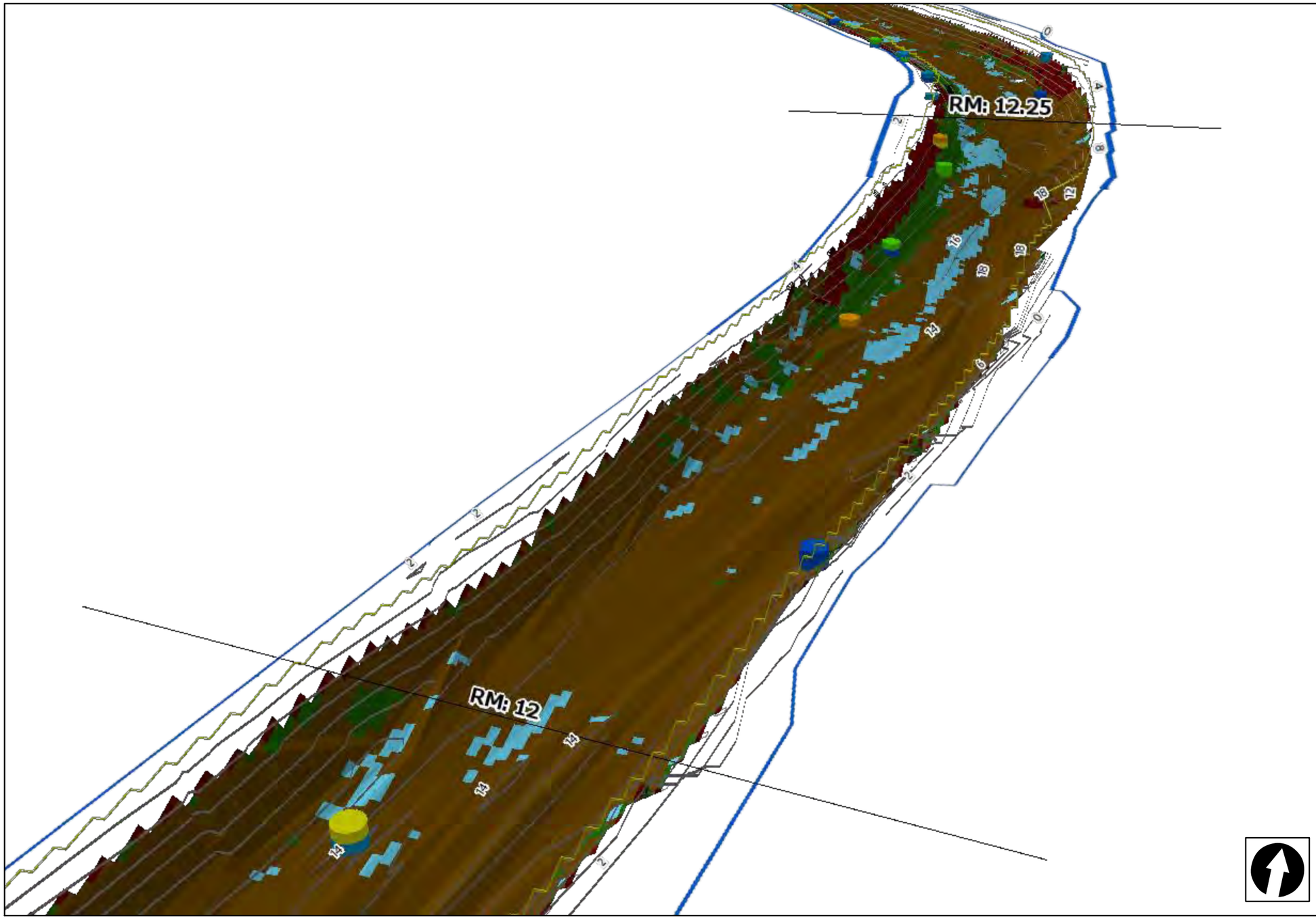
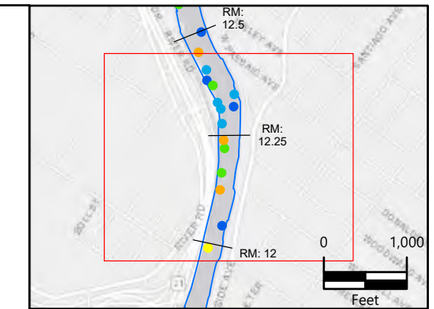
Figure 5-2a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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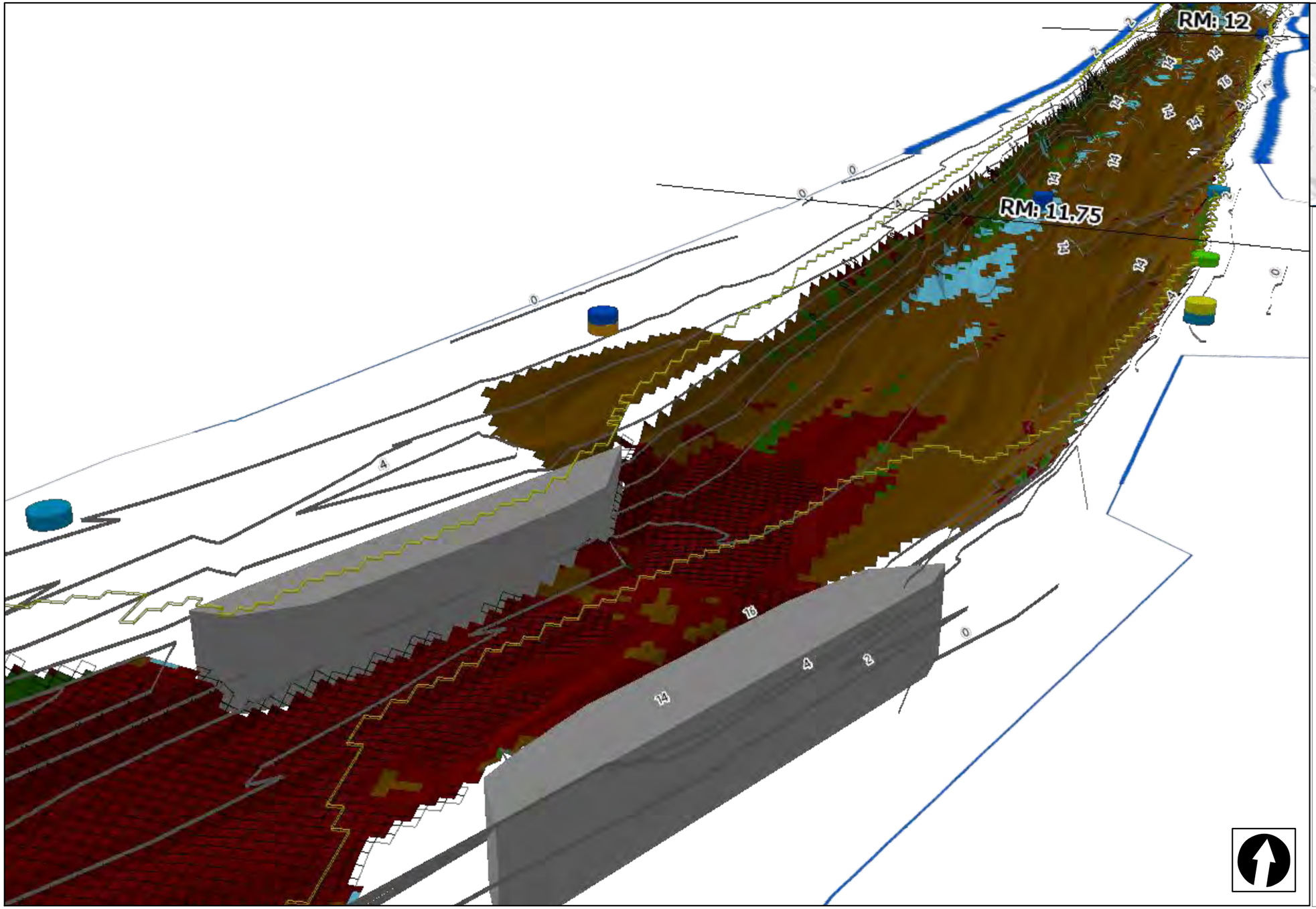
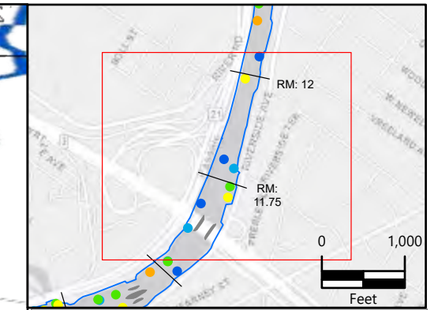
Figure 5-2b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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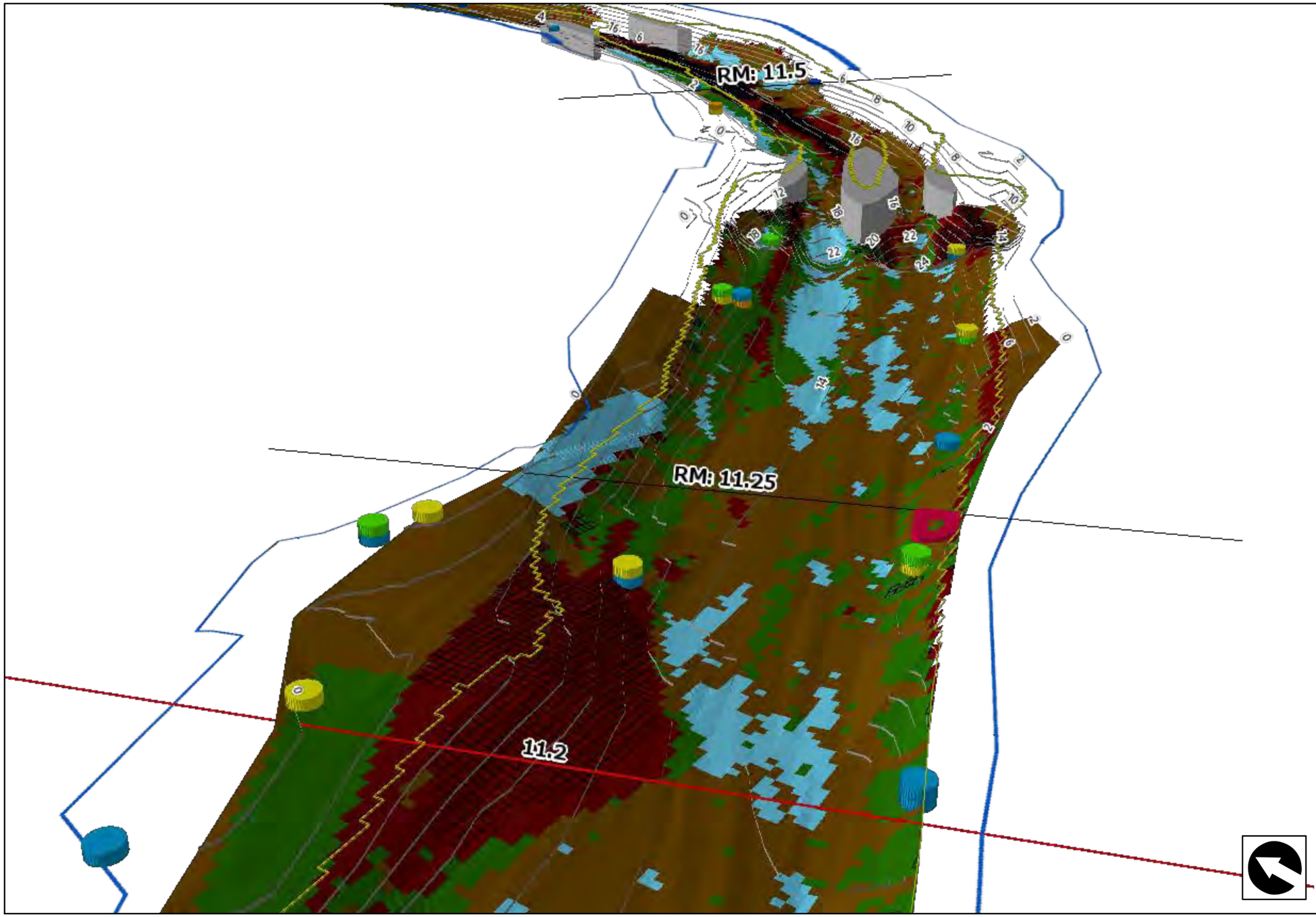
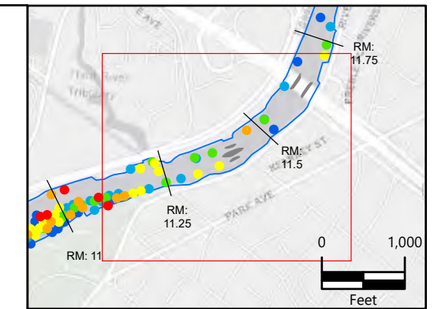
Figure 5-2c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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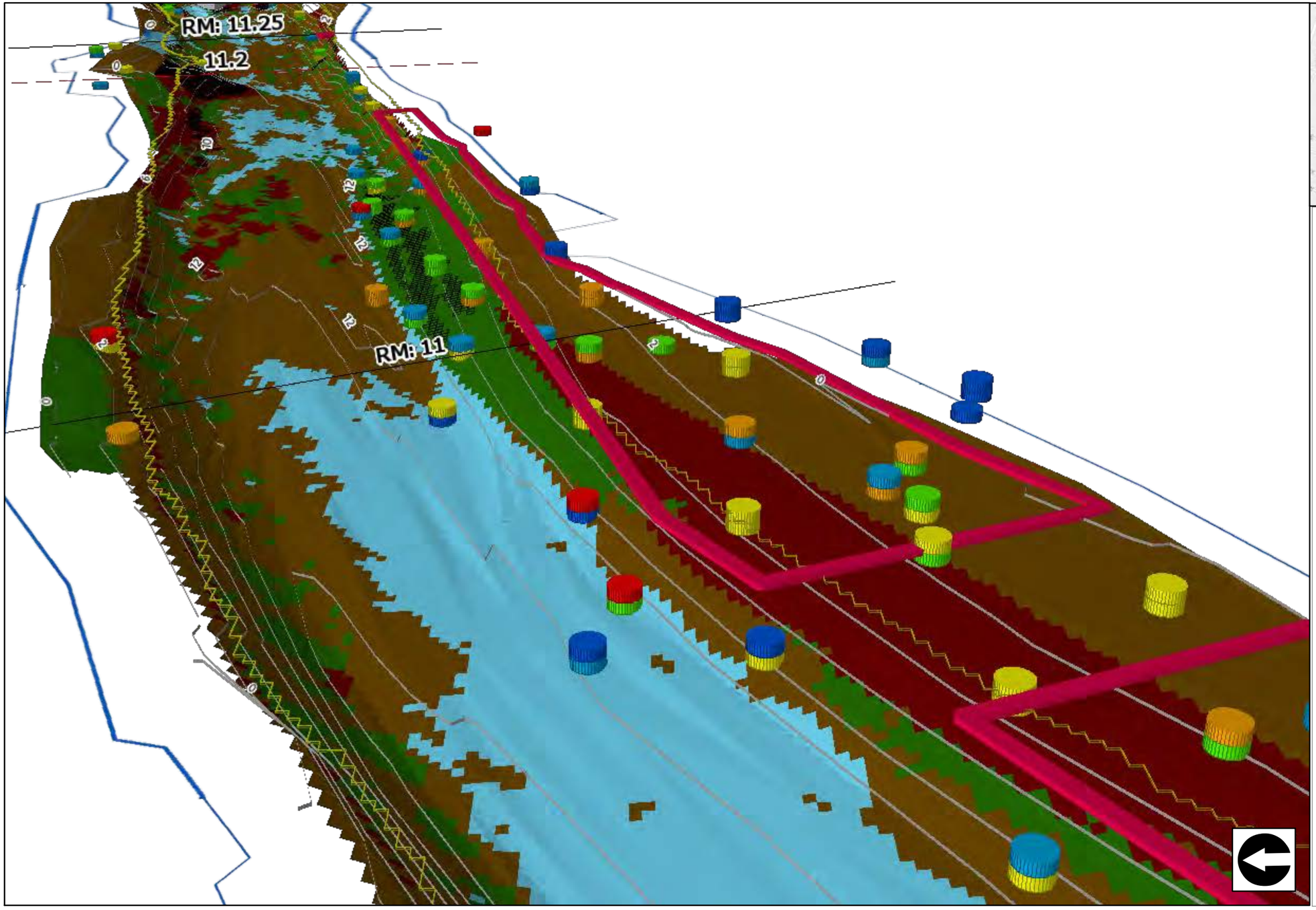
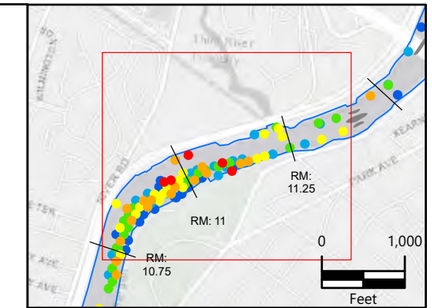
Figure 5-2d

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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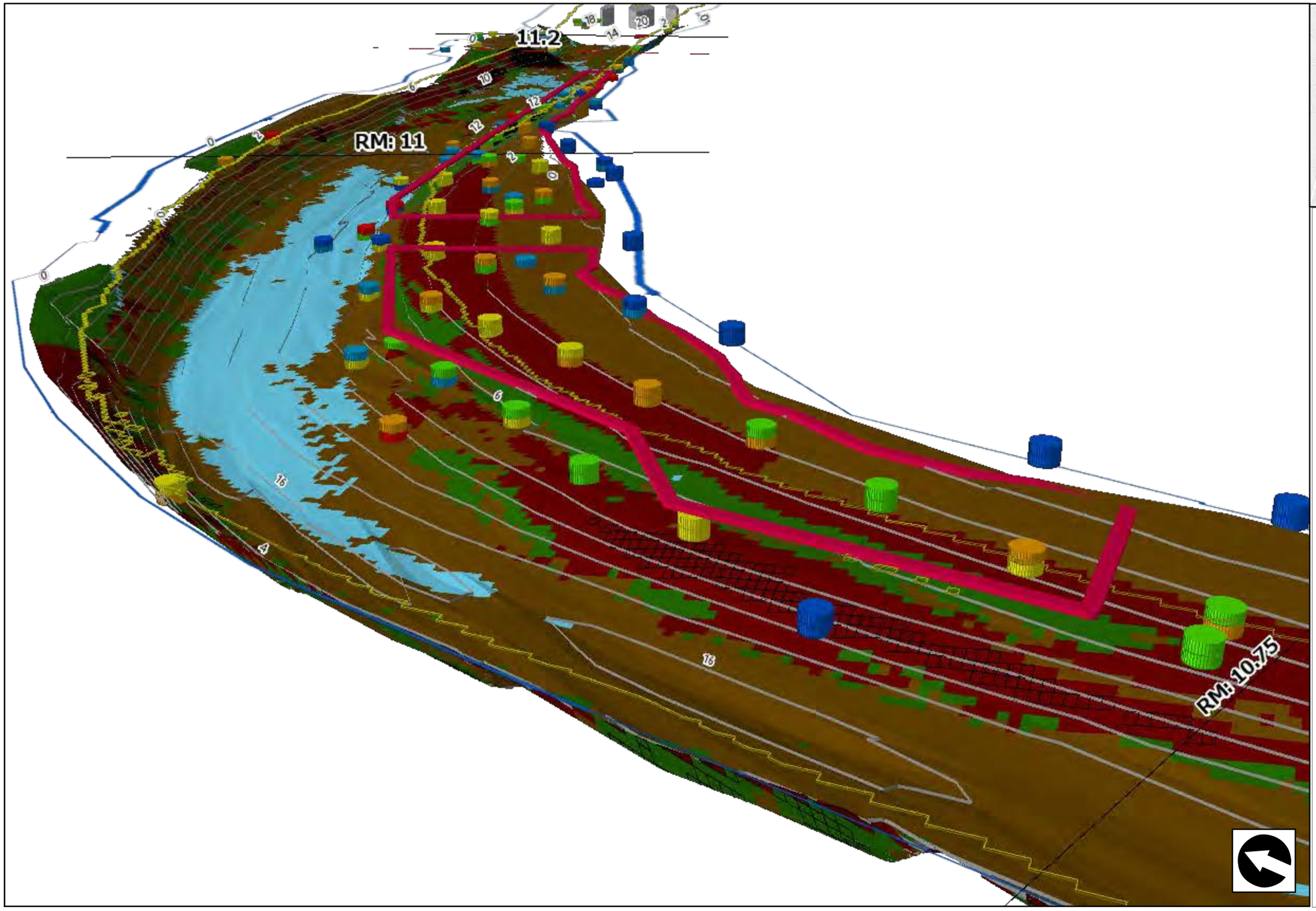
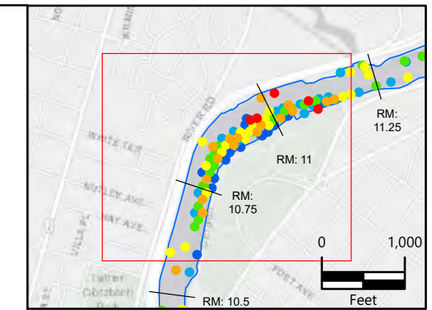
Figure 5-3a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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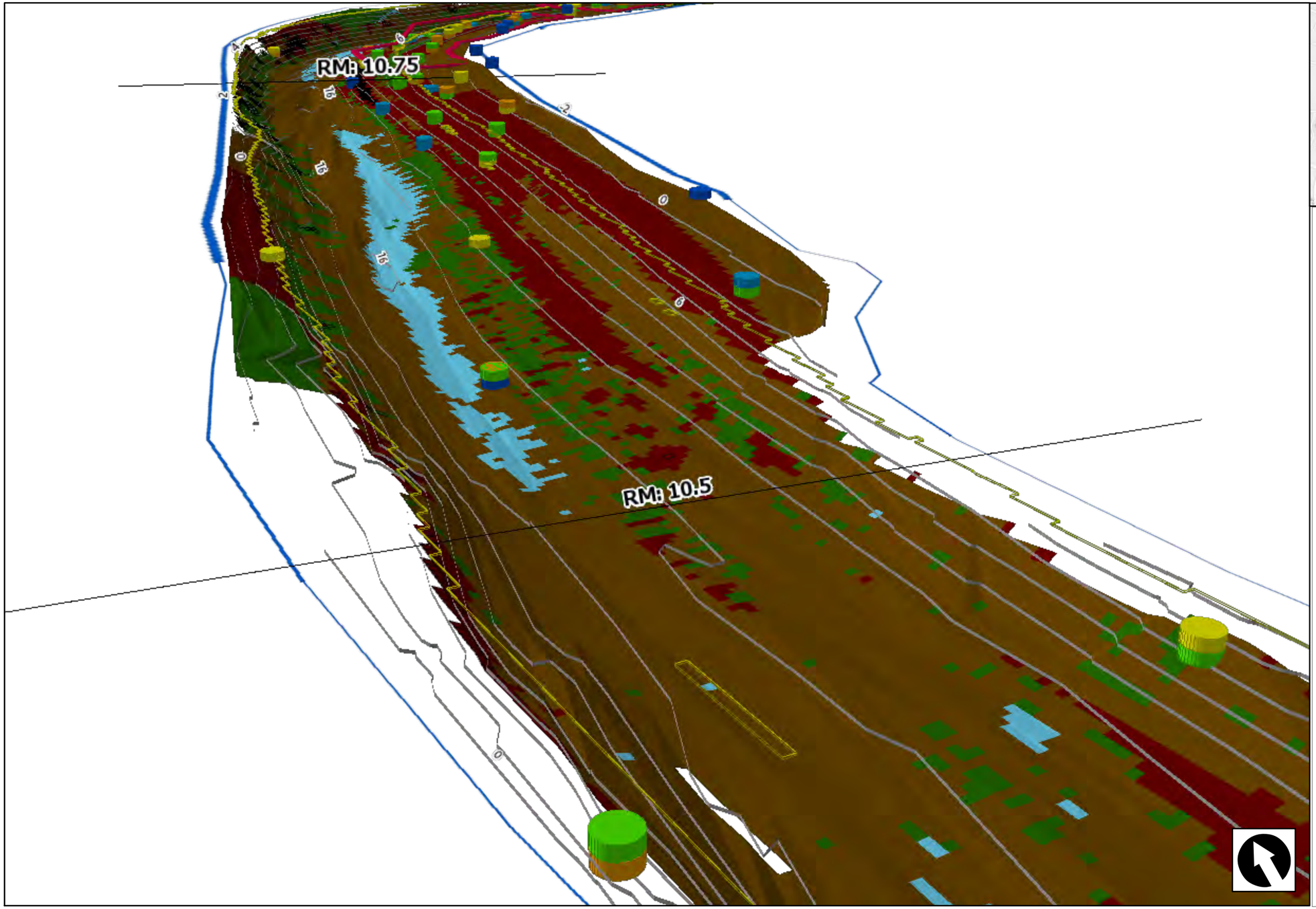
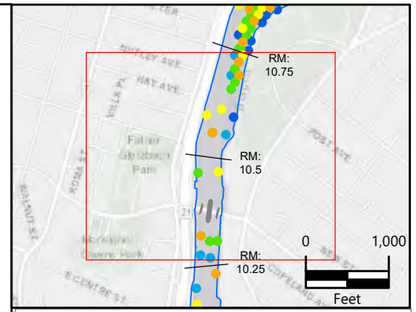
Figure 5-3b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- TCRA Remediated in 2013-2014
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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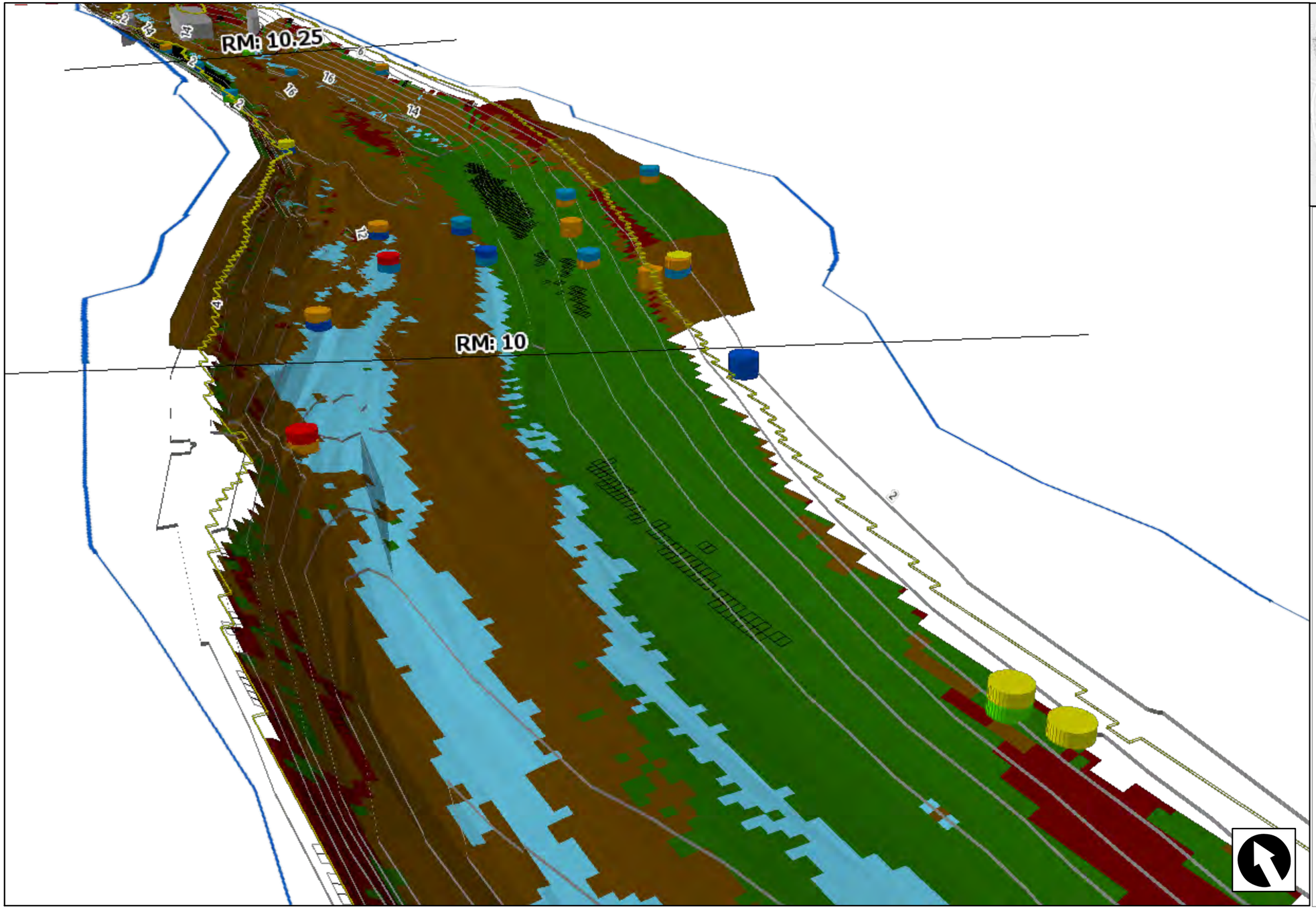
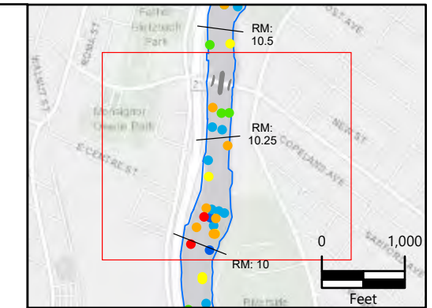
Figure 5-3c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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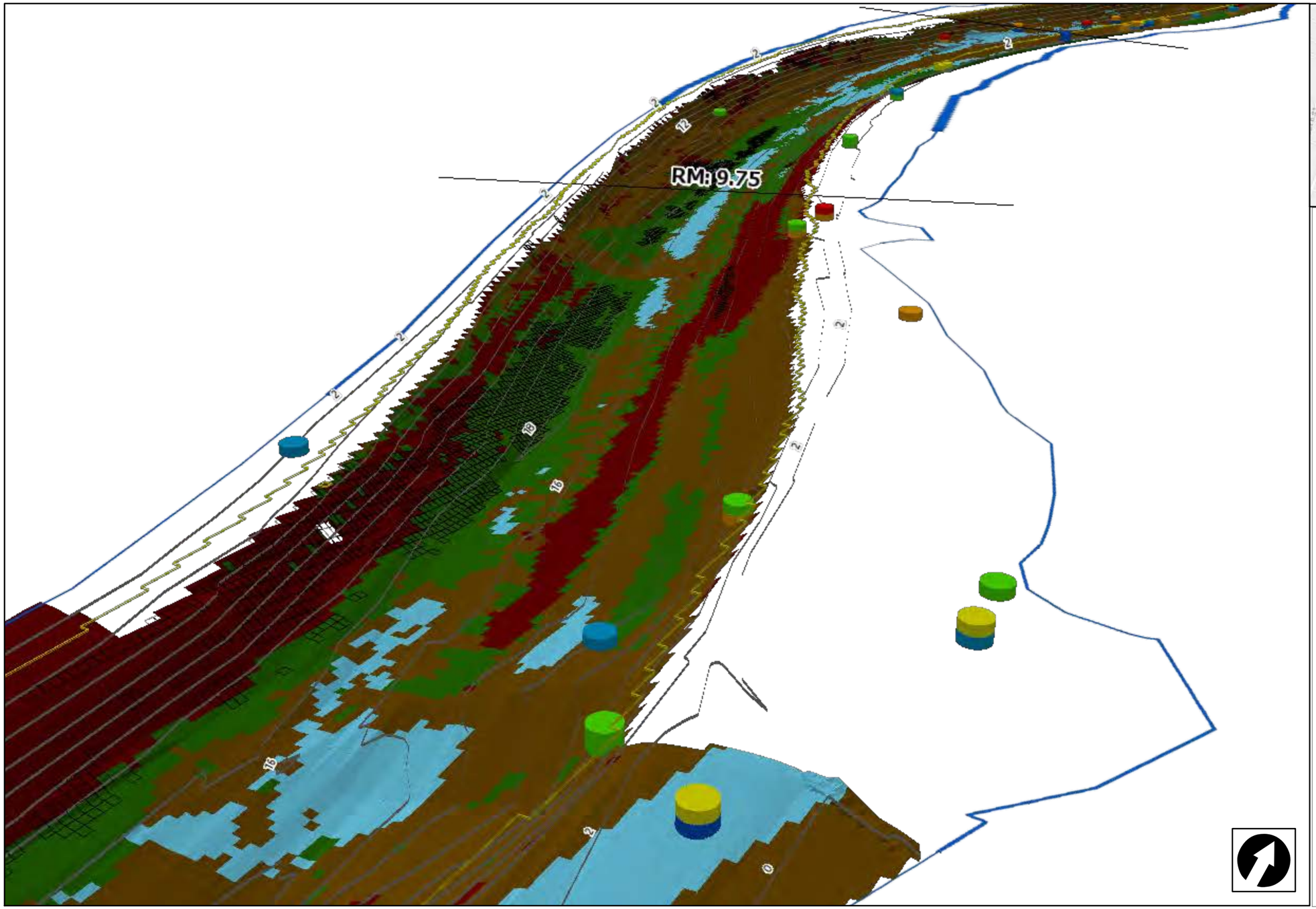
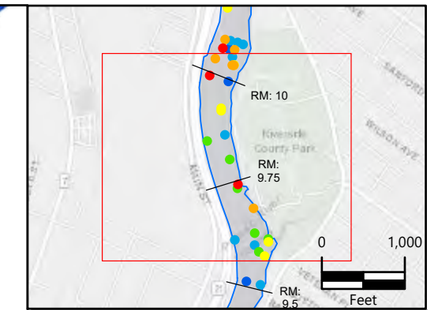
Figure 5-4a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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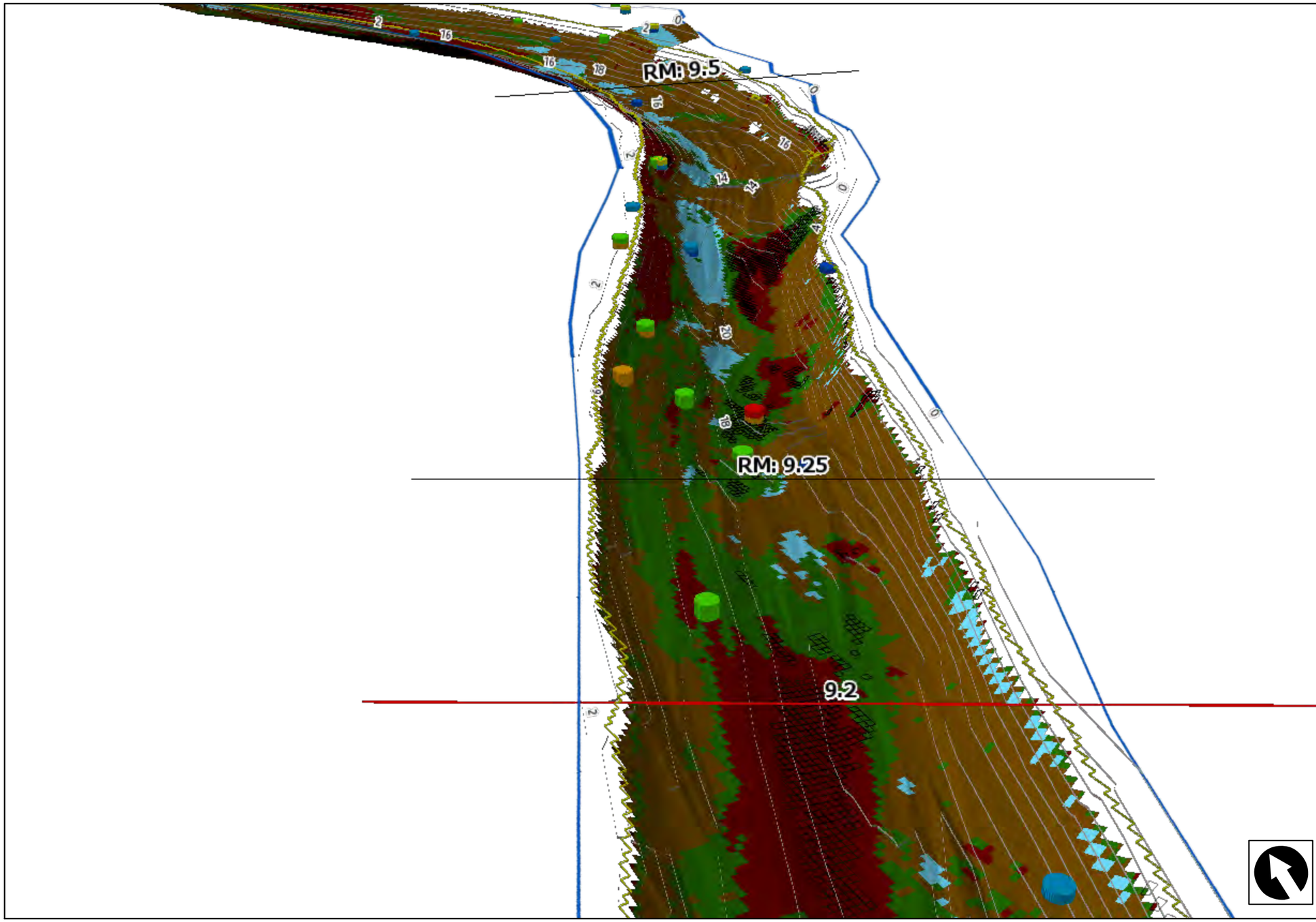
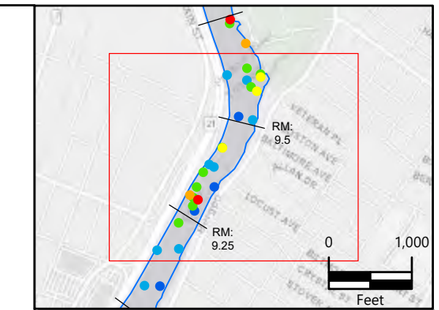
Figure 5-4b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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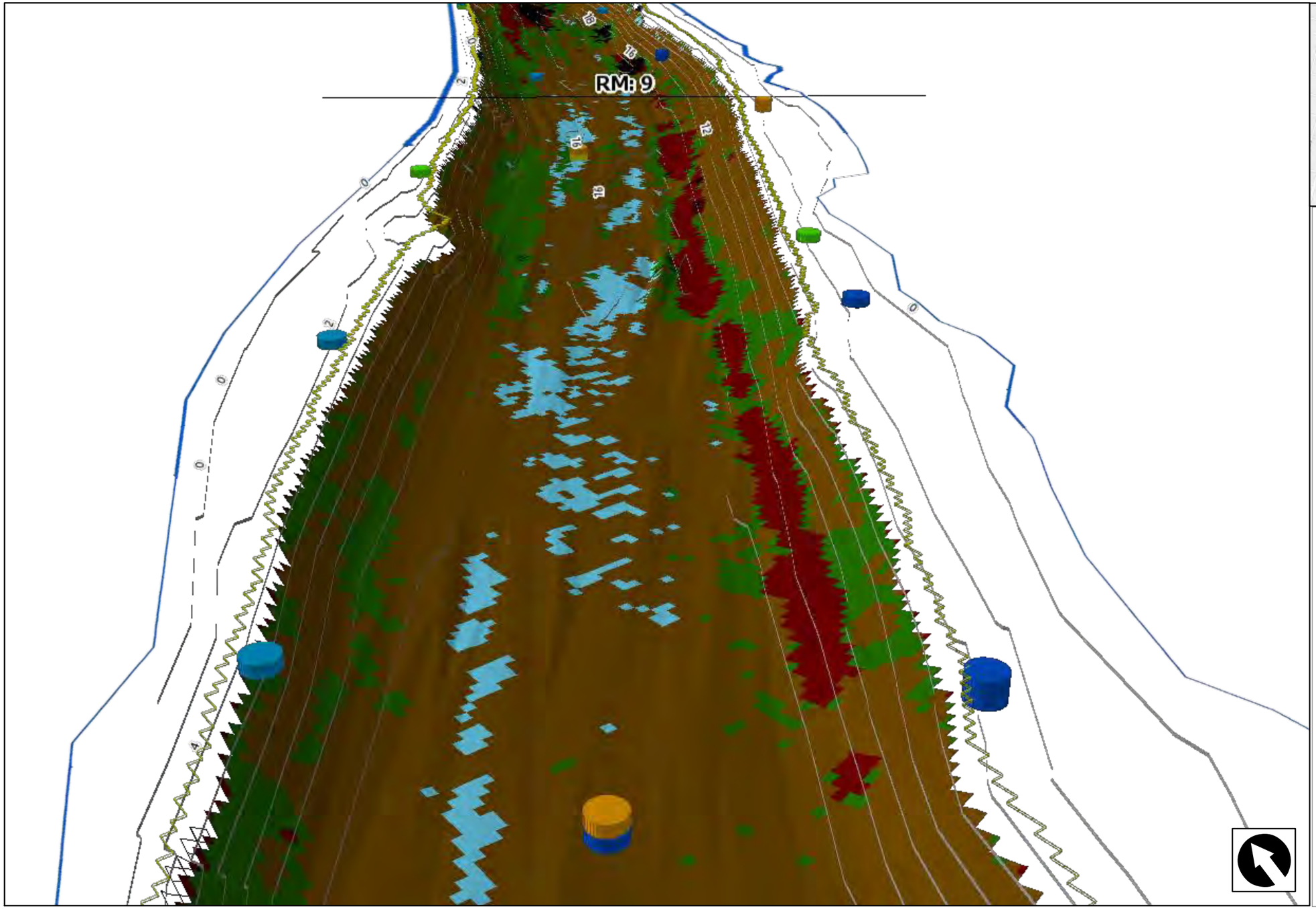
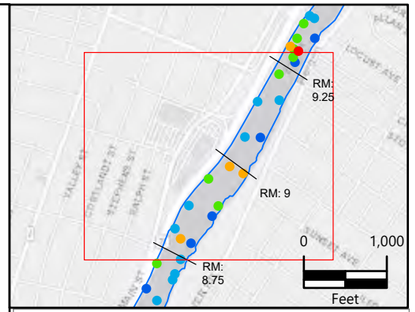
Figure 5-4c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
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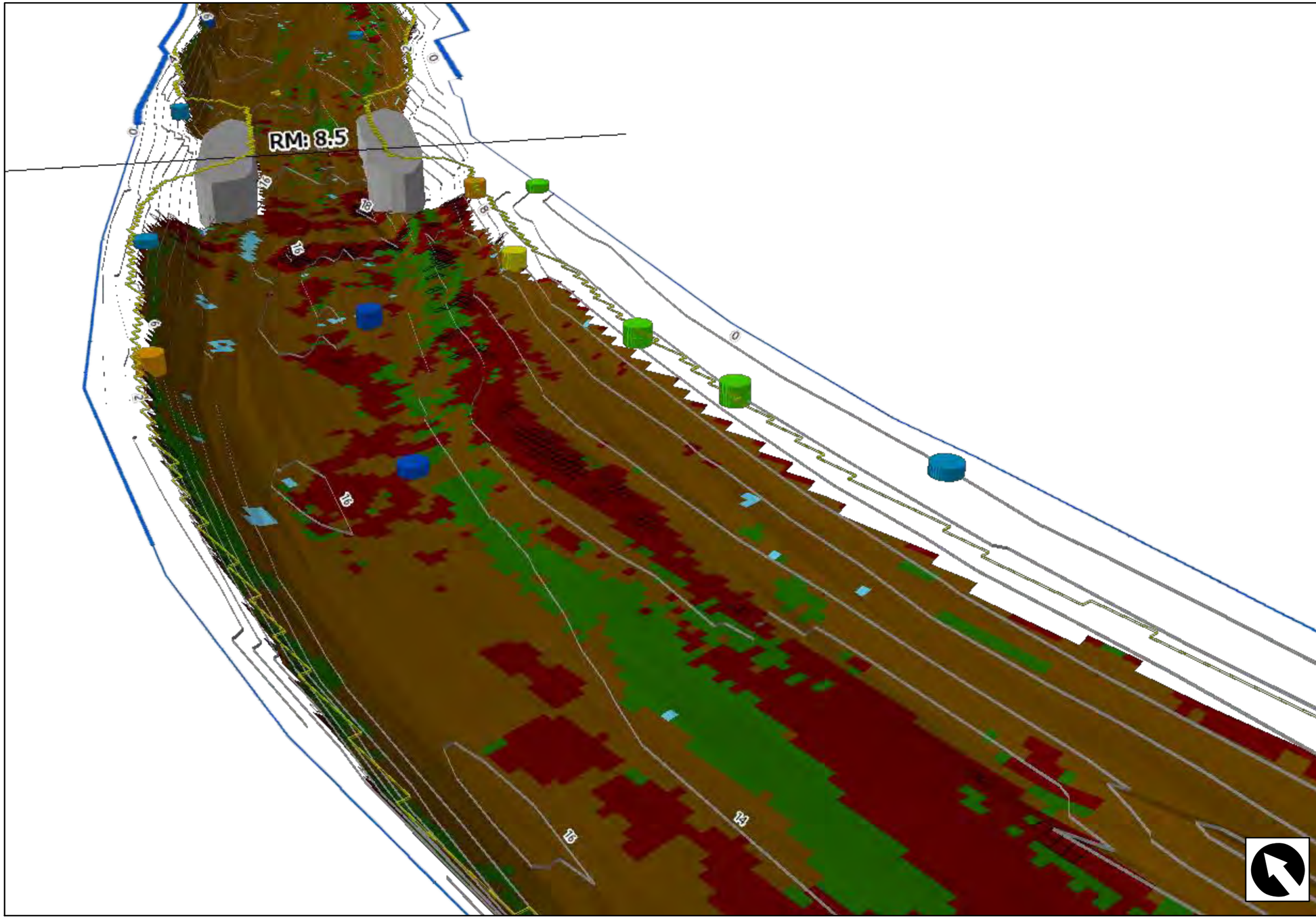
Figure 5-5a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study



LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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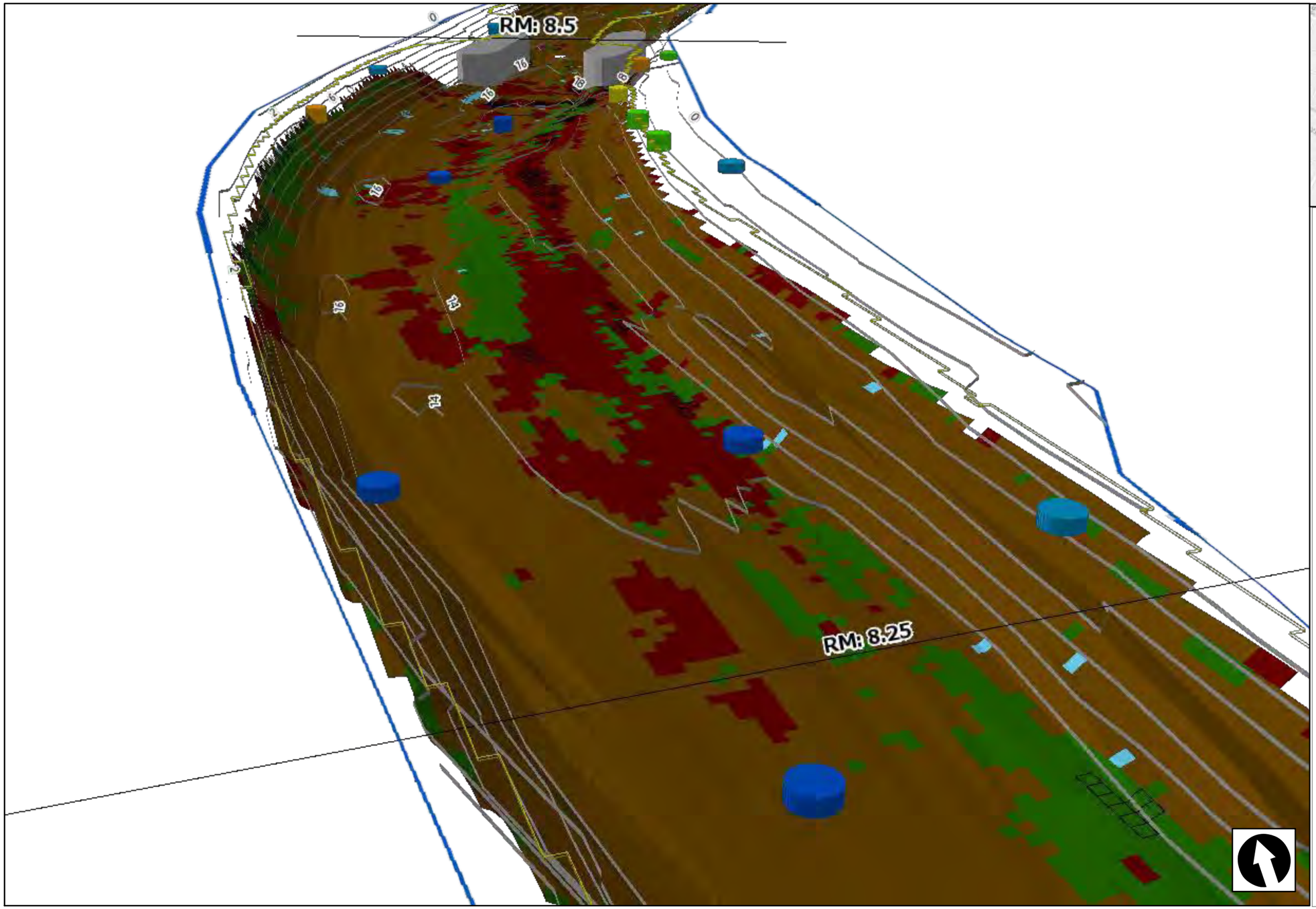
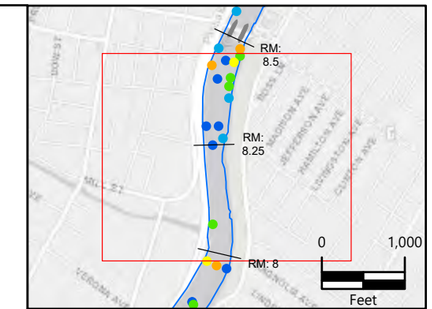
Figure 5-5b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

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- Depositional from 2007 to 2012
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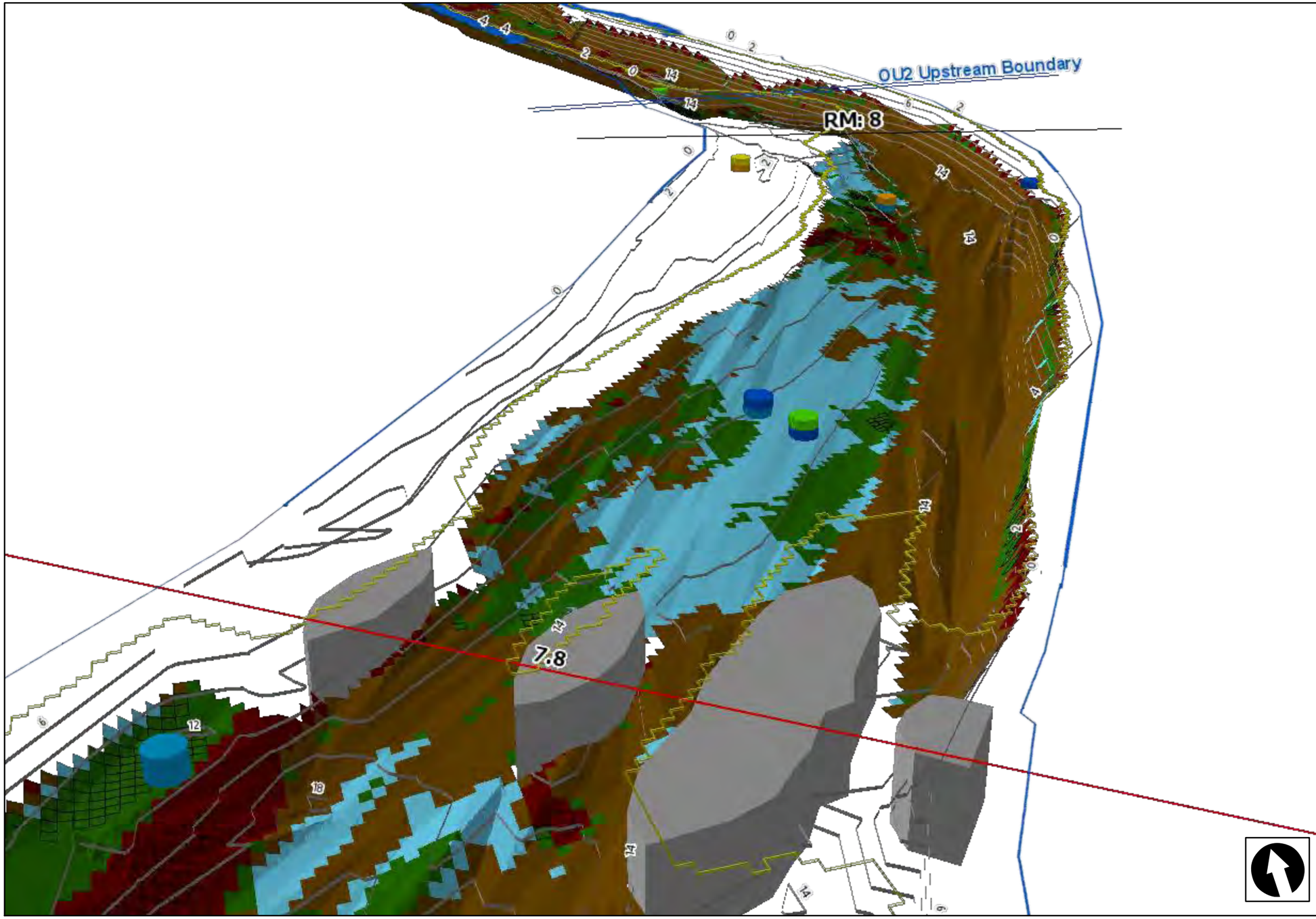
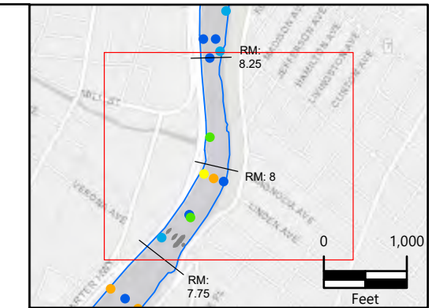
Figure 5-5c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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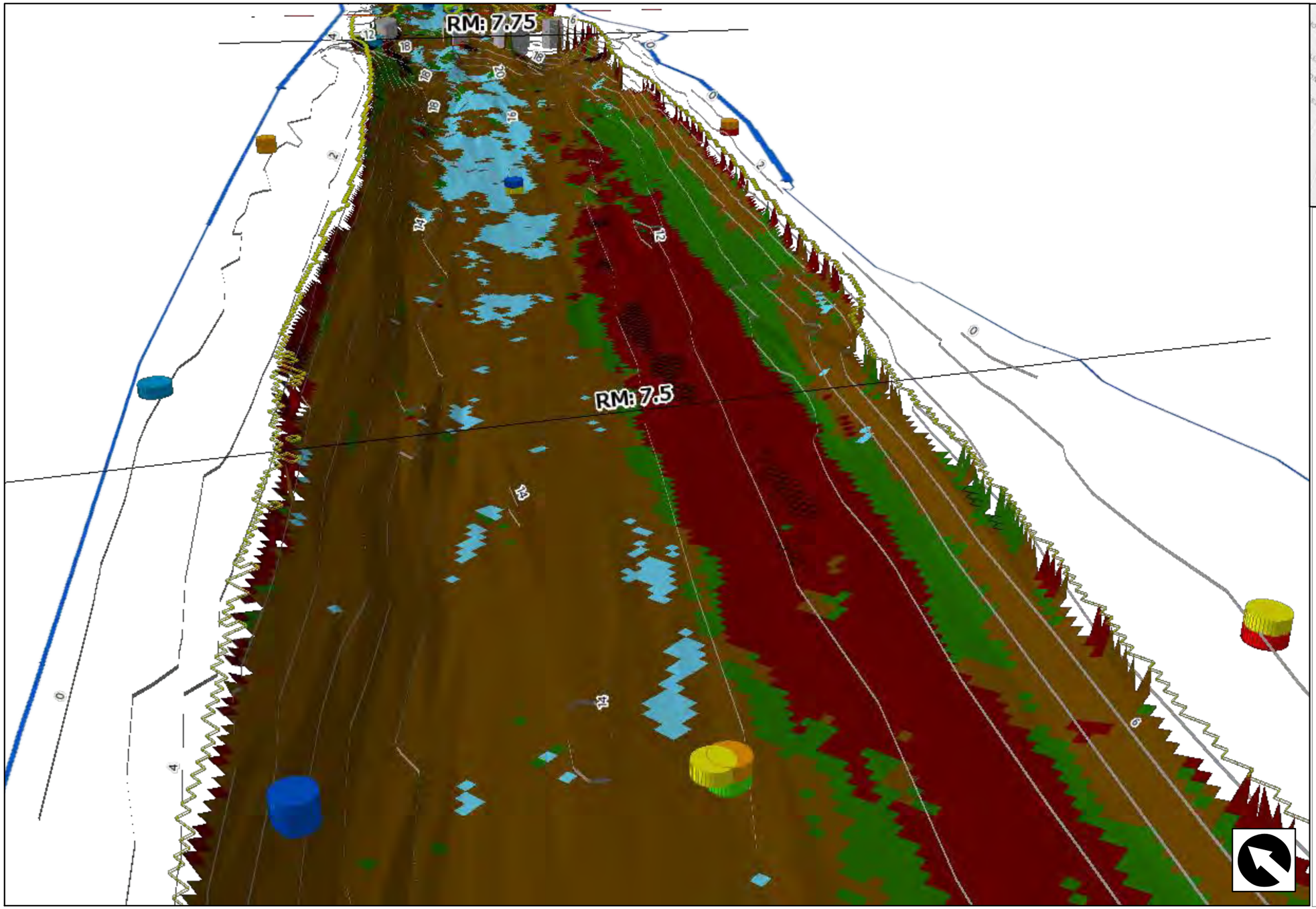
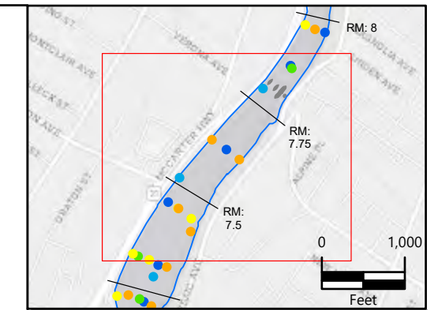
Figure 5-5d

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

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- 2 - 4
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- 6 - 8
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Bathymetric Change Category *

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- Depositional from 2007 to 2012
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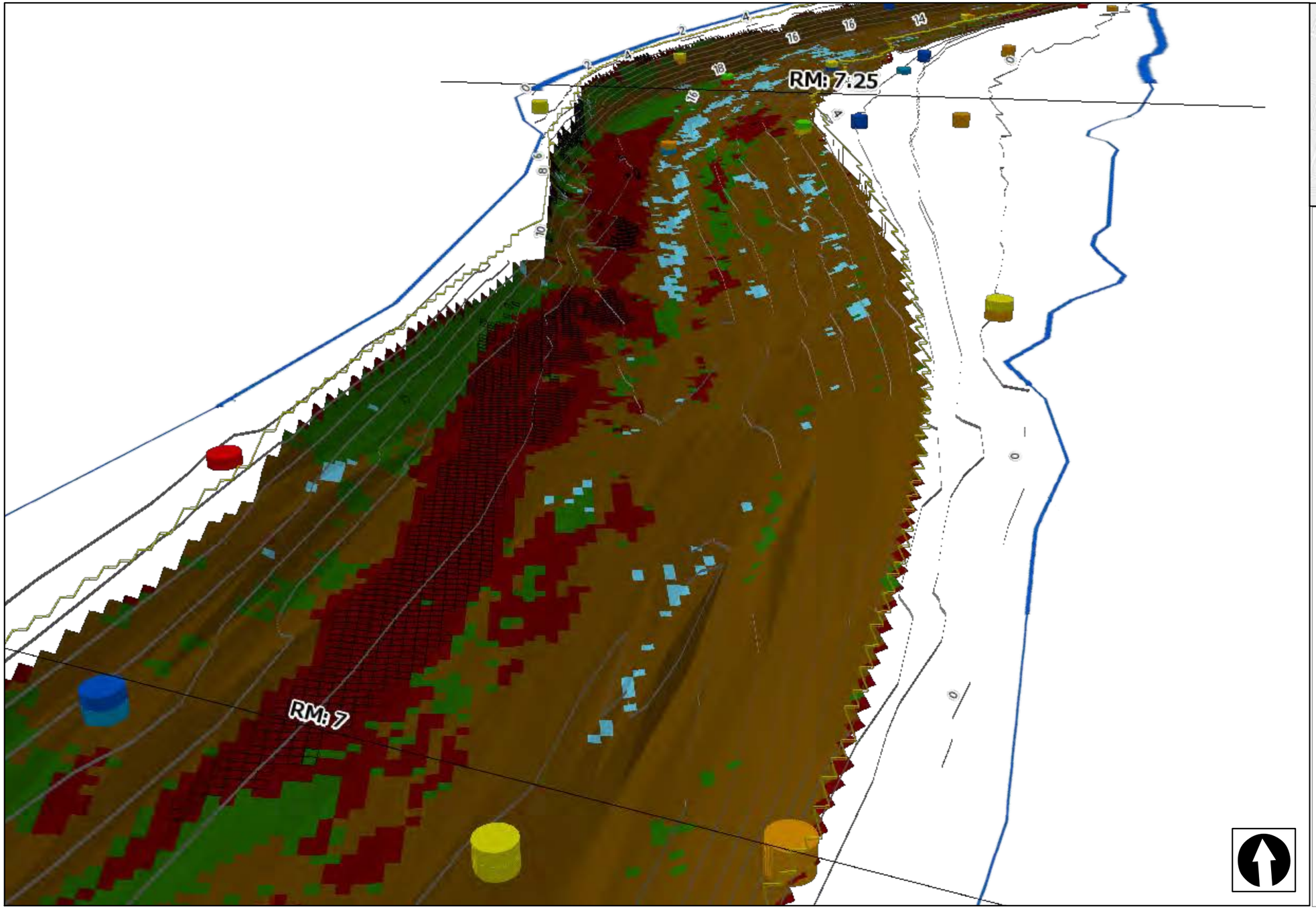
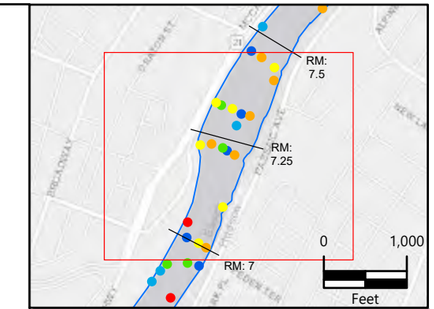
Figure 5-6a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
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Bathymetric Change Category *

- Erosional from 2007 to 2012
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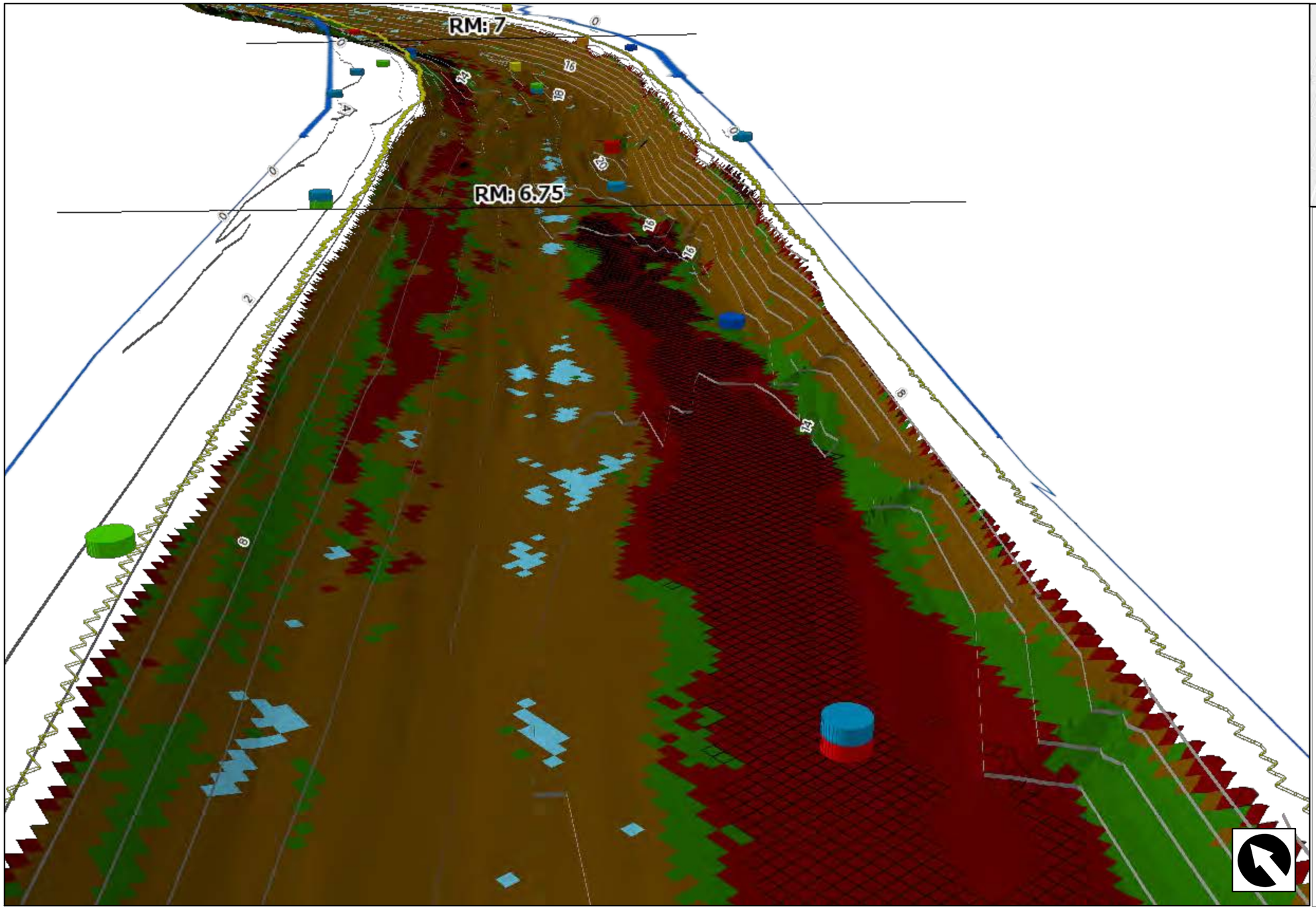
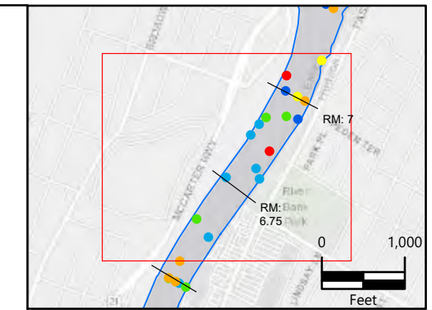
Figure 5-6b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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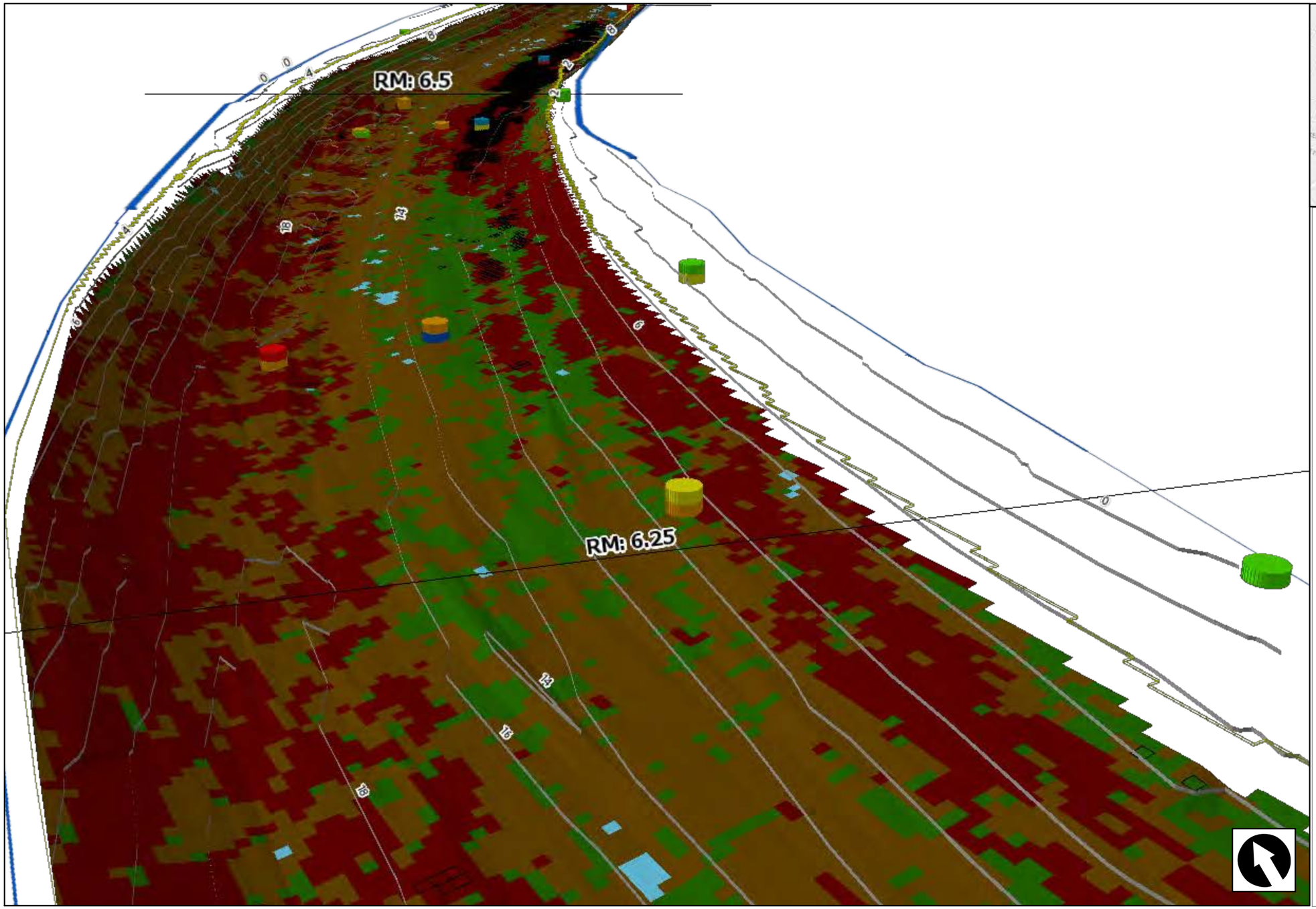
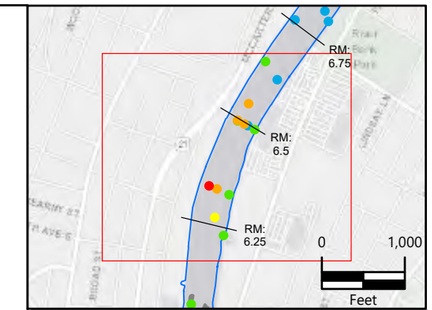
Figure 5-6c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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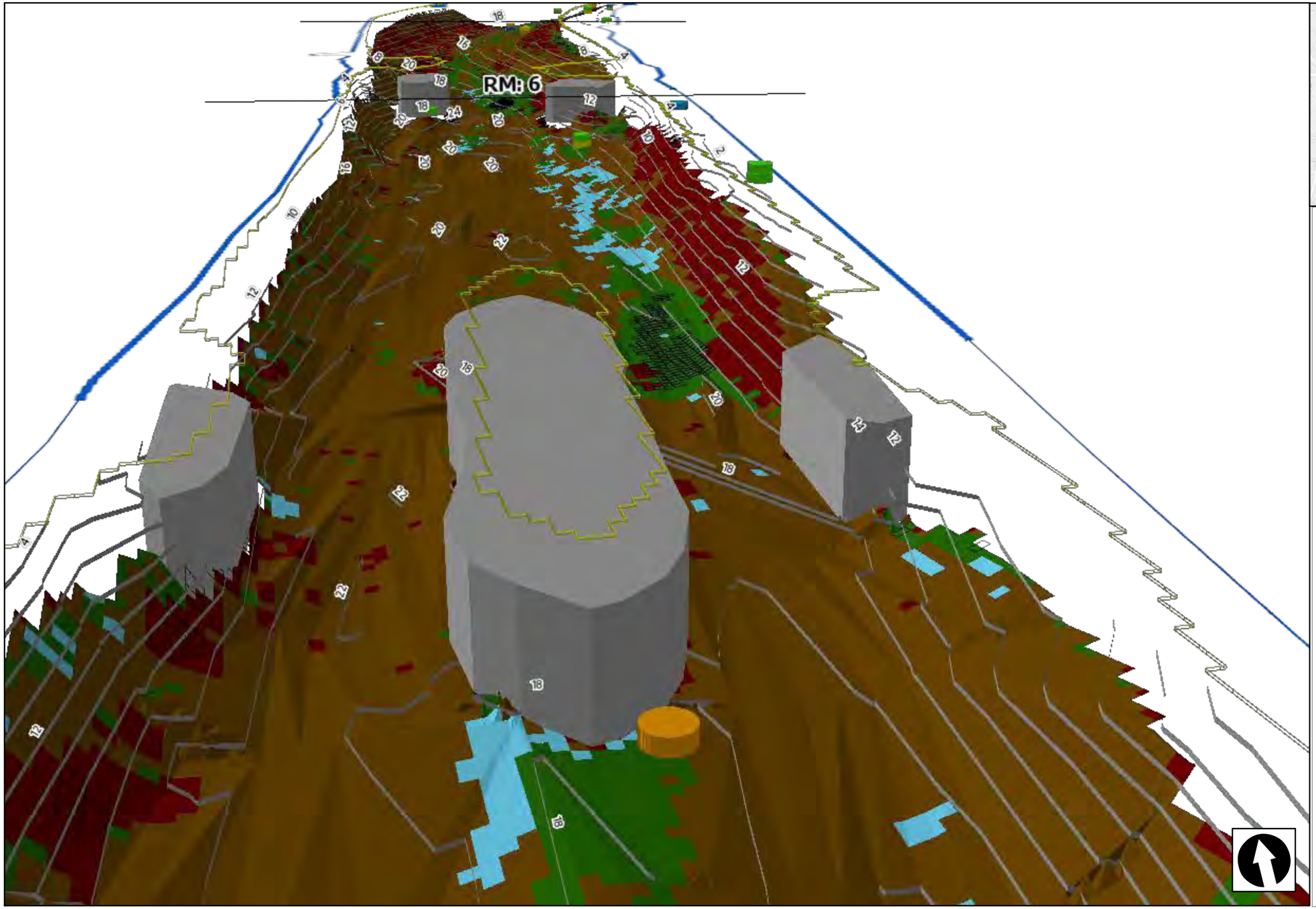
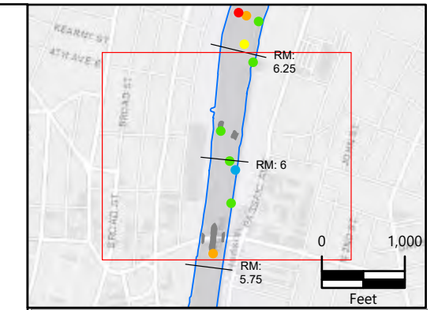
Figure 5-6d

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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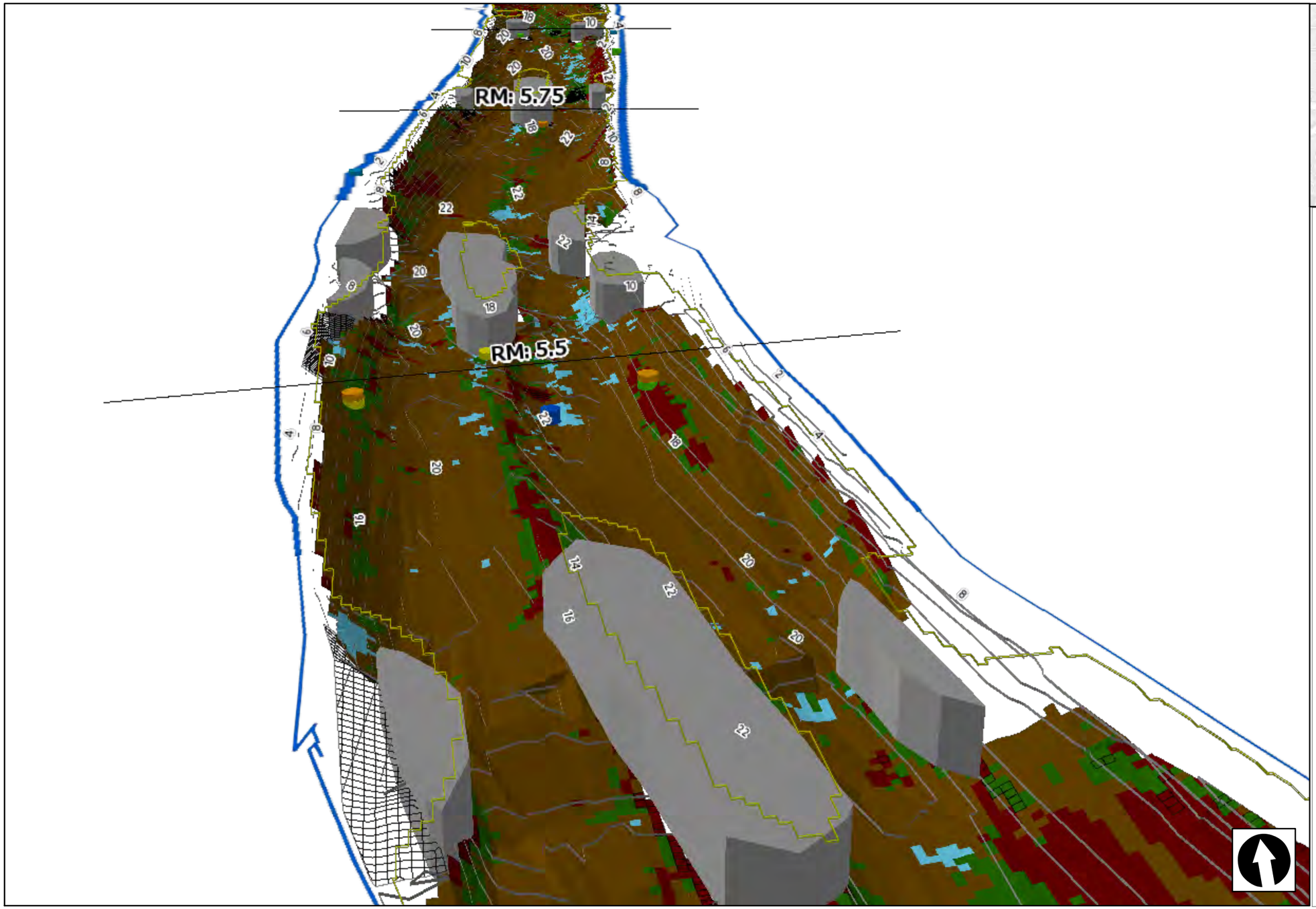
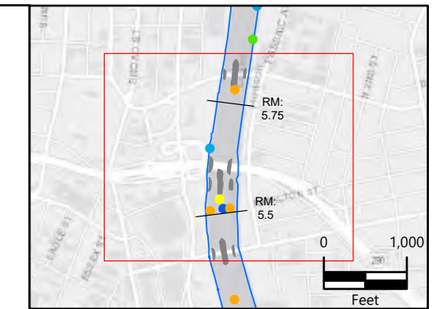
Figure 5-6e

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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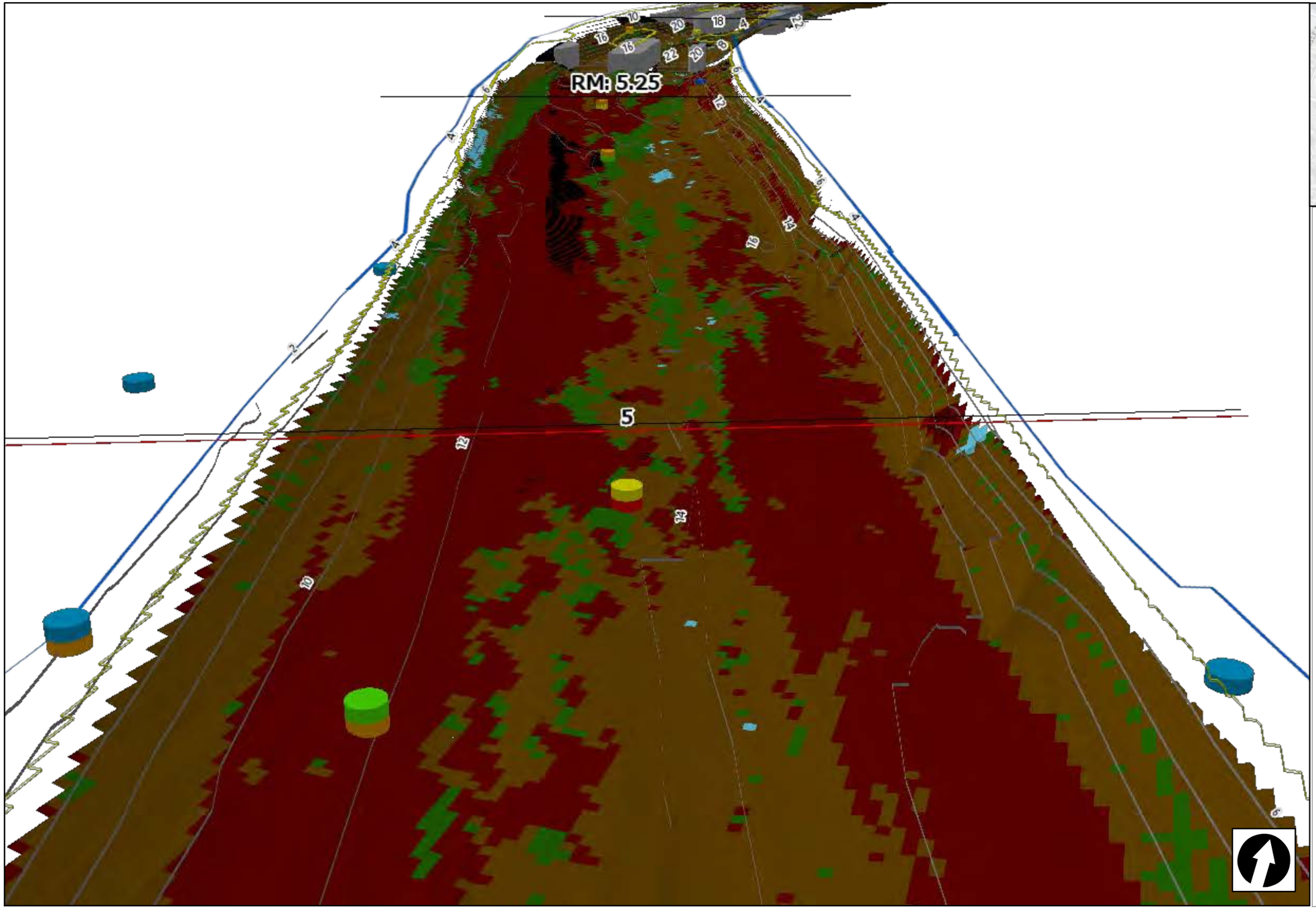
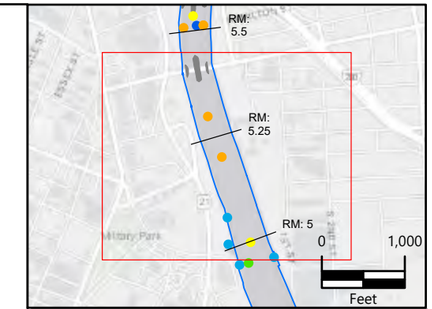
Figure 5-6f

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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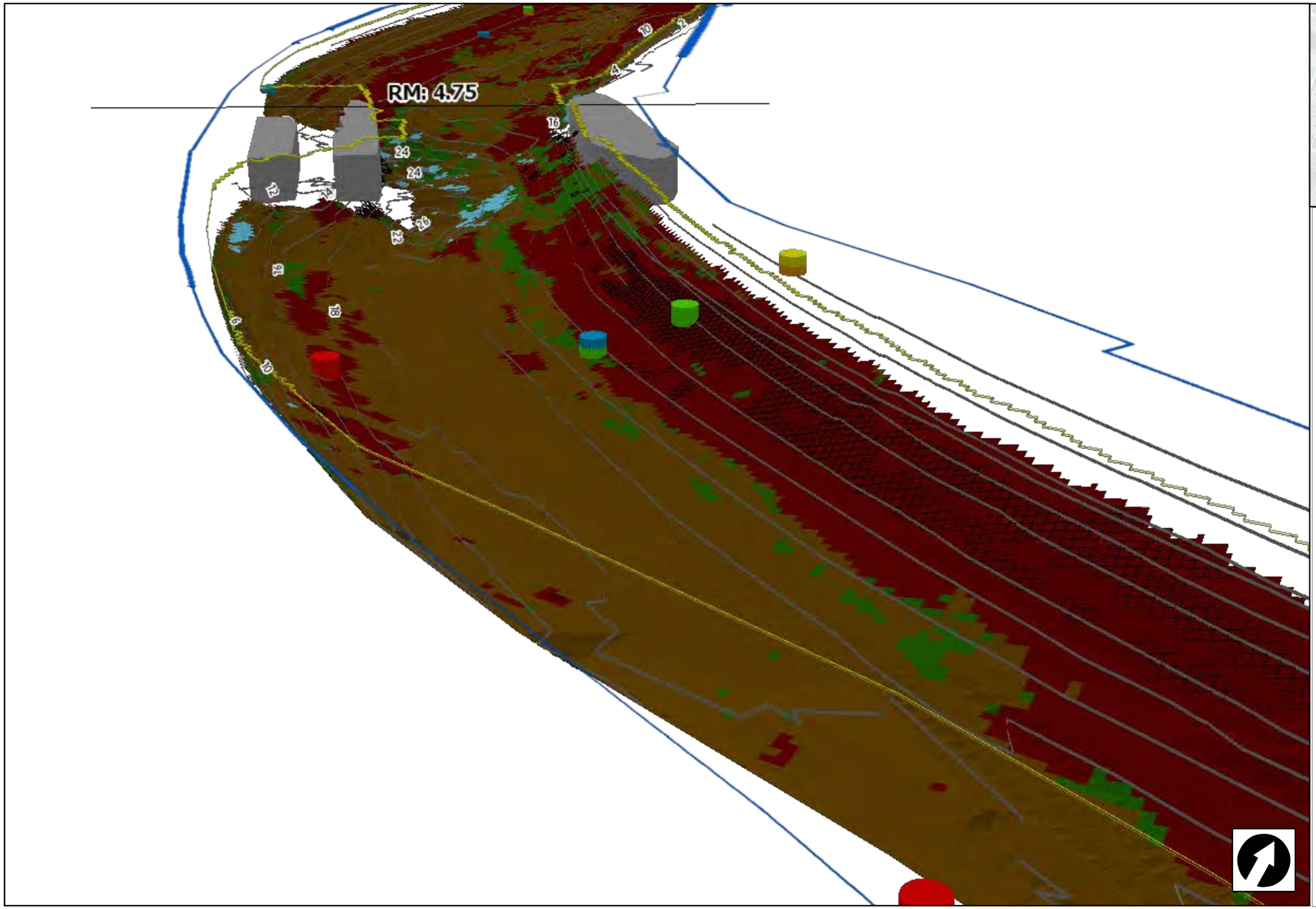
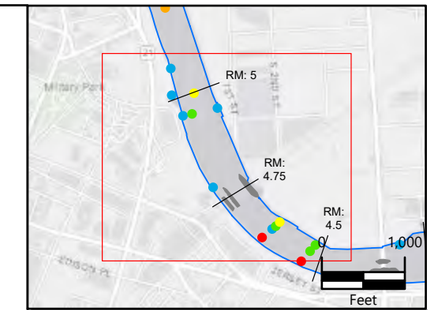
Figure 5-6g

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
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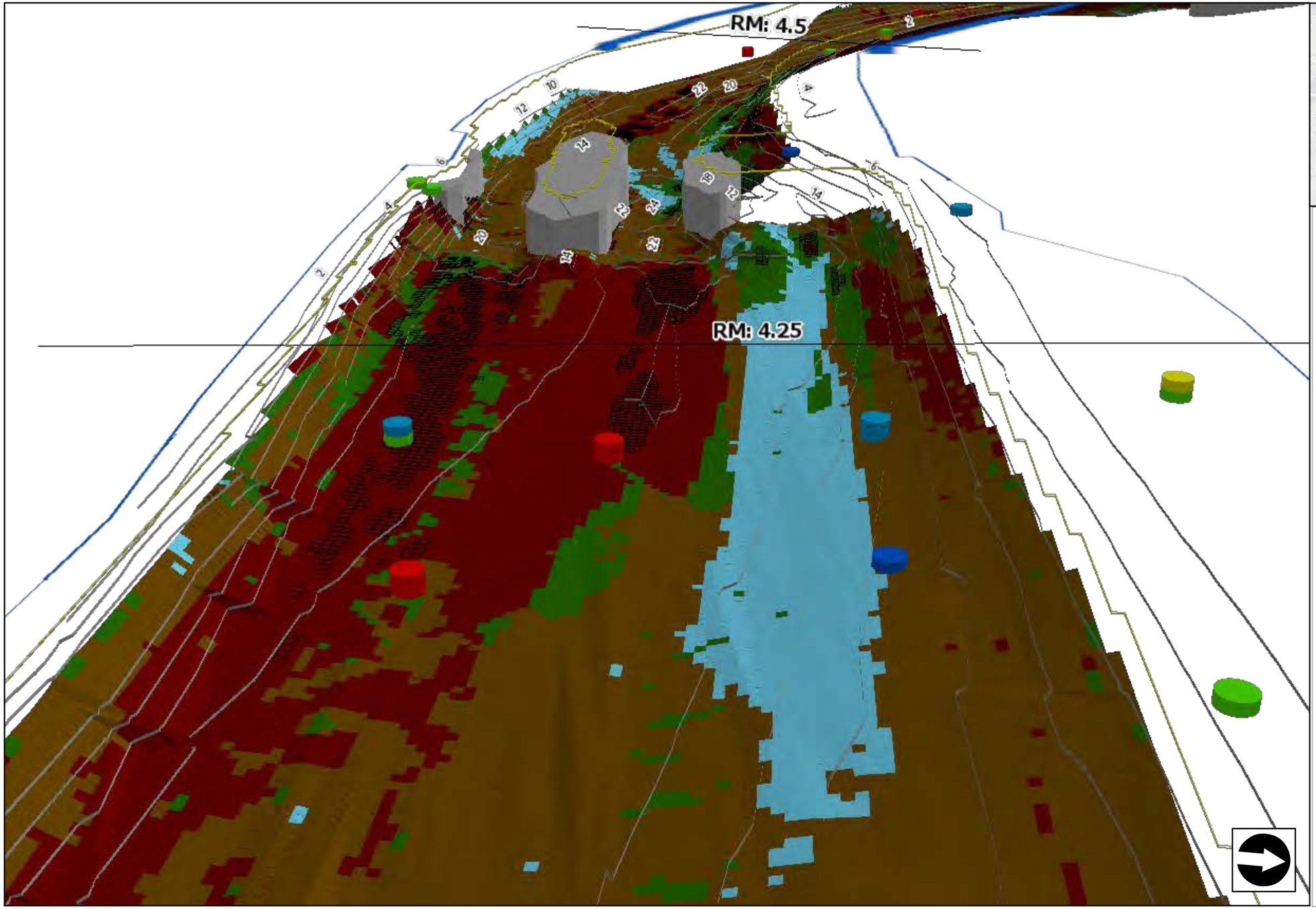
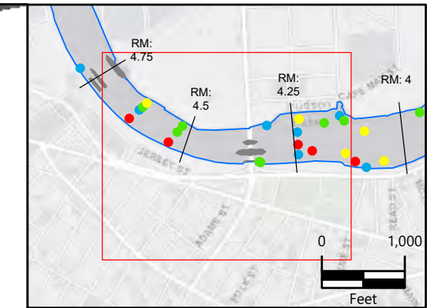
Figure 5-7a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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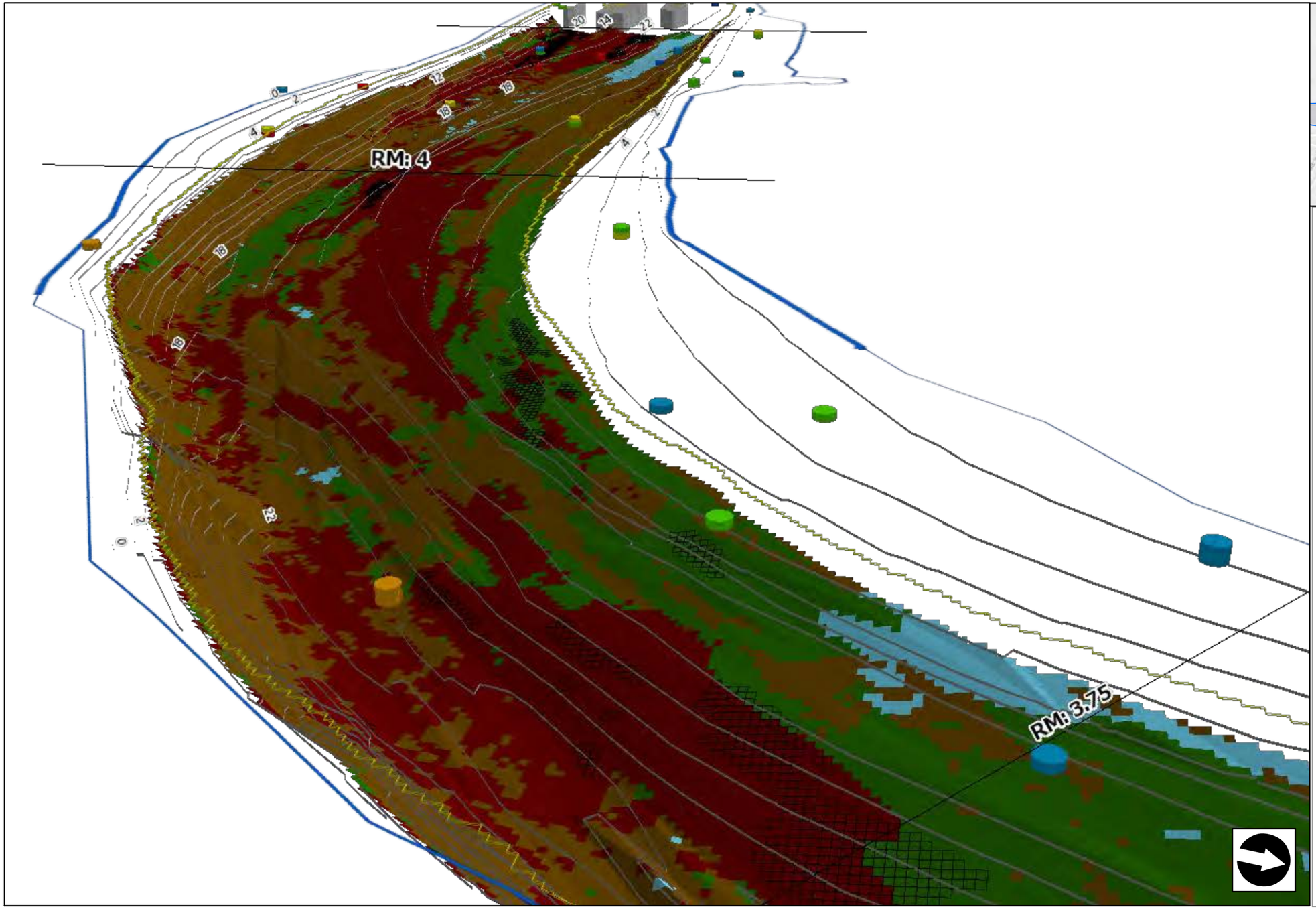
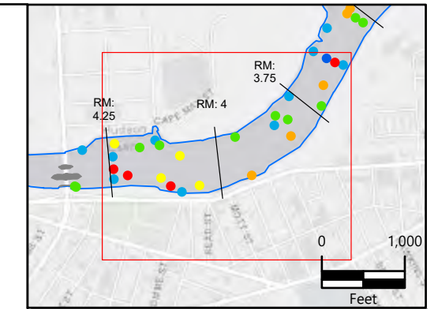
Figure 5-7b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
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NOTES:
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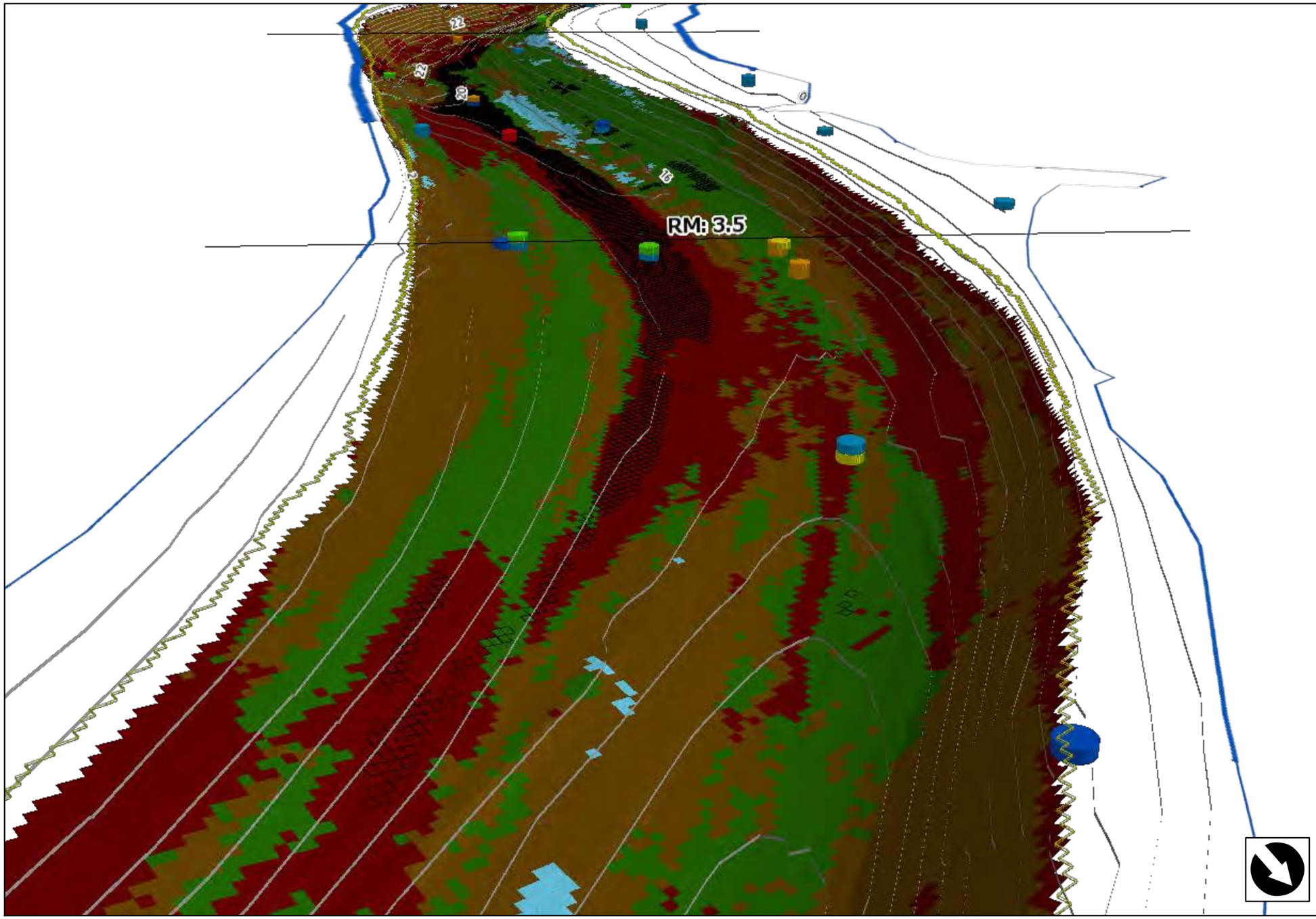
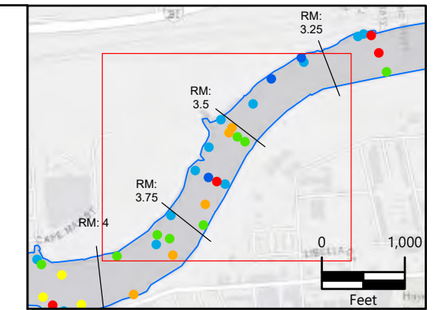
Figure 5-7c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

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- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
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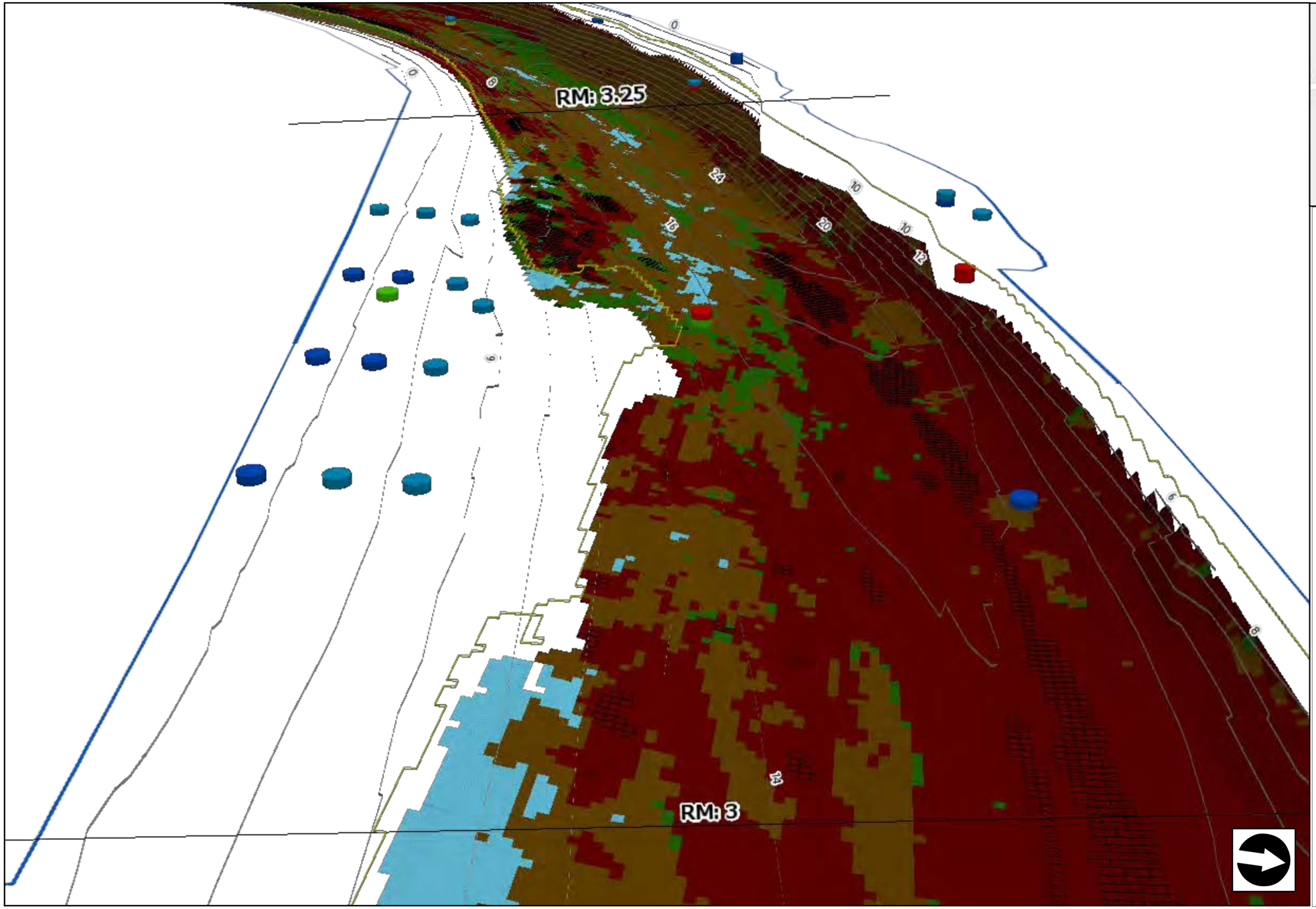
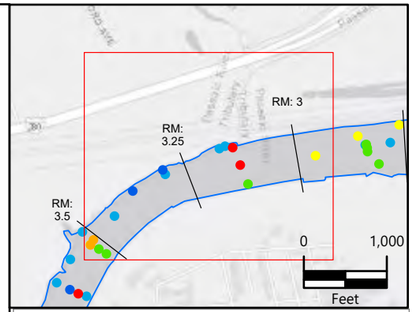
Figure 5-7d

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
- Erosion and Deposition
- Depositional from 2007 to 2012
- Change <= 6" / Temporarily Depositional

NOTES:
The inset map shows only the 0 - 0.5 feet slice, therefore locations with only a subsurface slice are not shown. In the 3D map, the top core slice is 0 - 0.5 feet and the bottom slice is 0.5 - 1.5 feet. This map displays a vertical exaggeration of 10x. Mudline elevations were not available for the samples outside of the extent of the bathymetry. The elevations for these samples were set to +2 NGVD 29 to allow them to be mapped.
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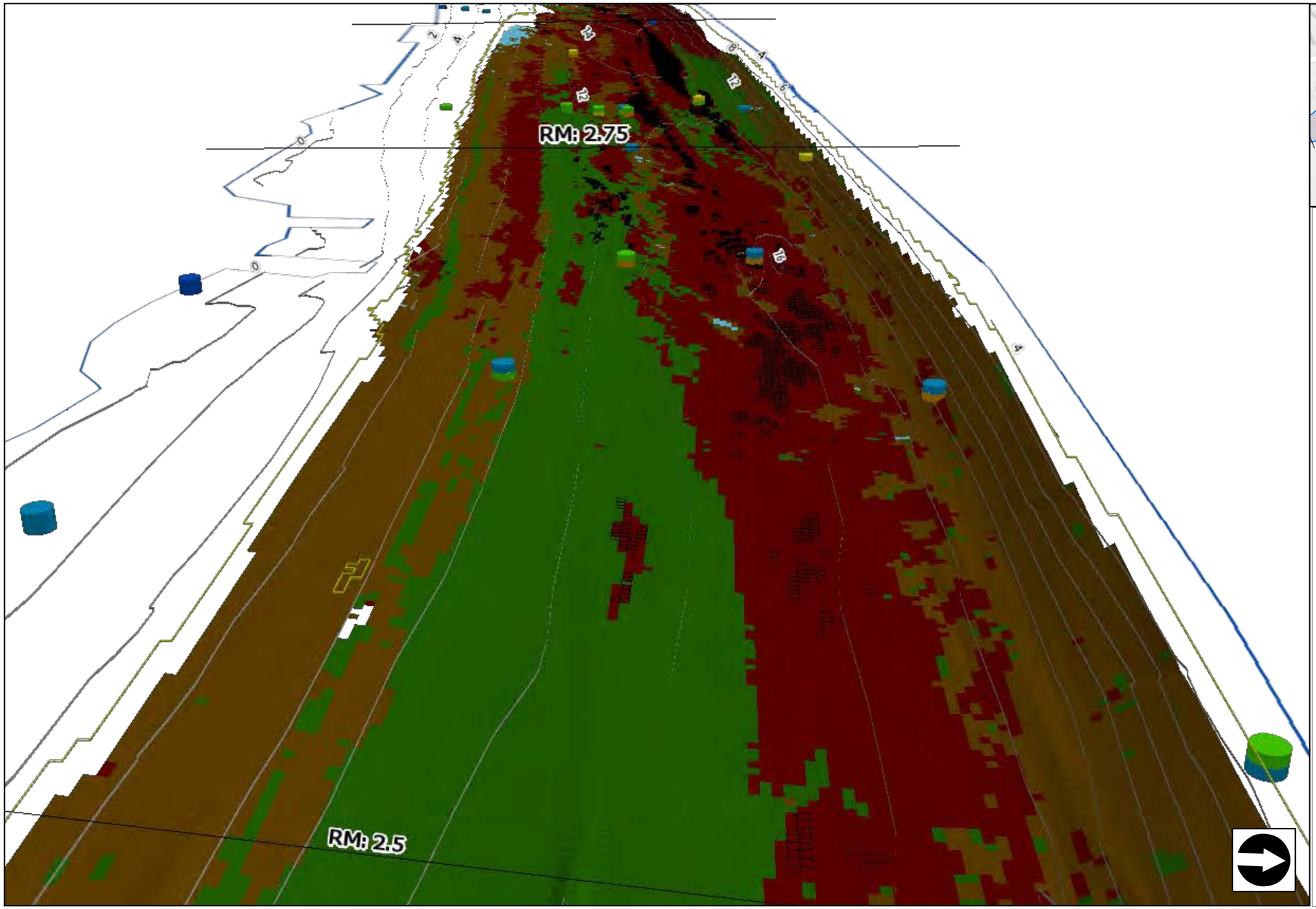
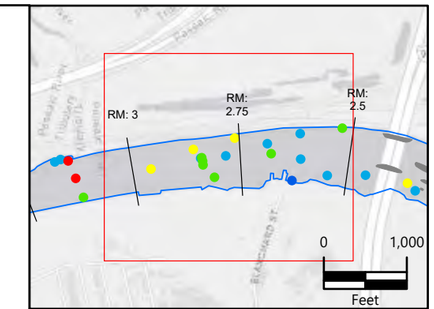
Figure 5-7e

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

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- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

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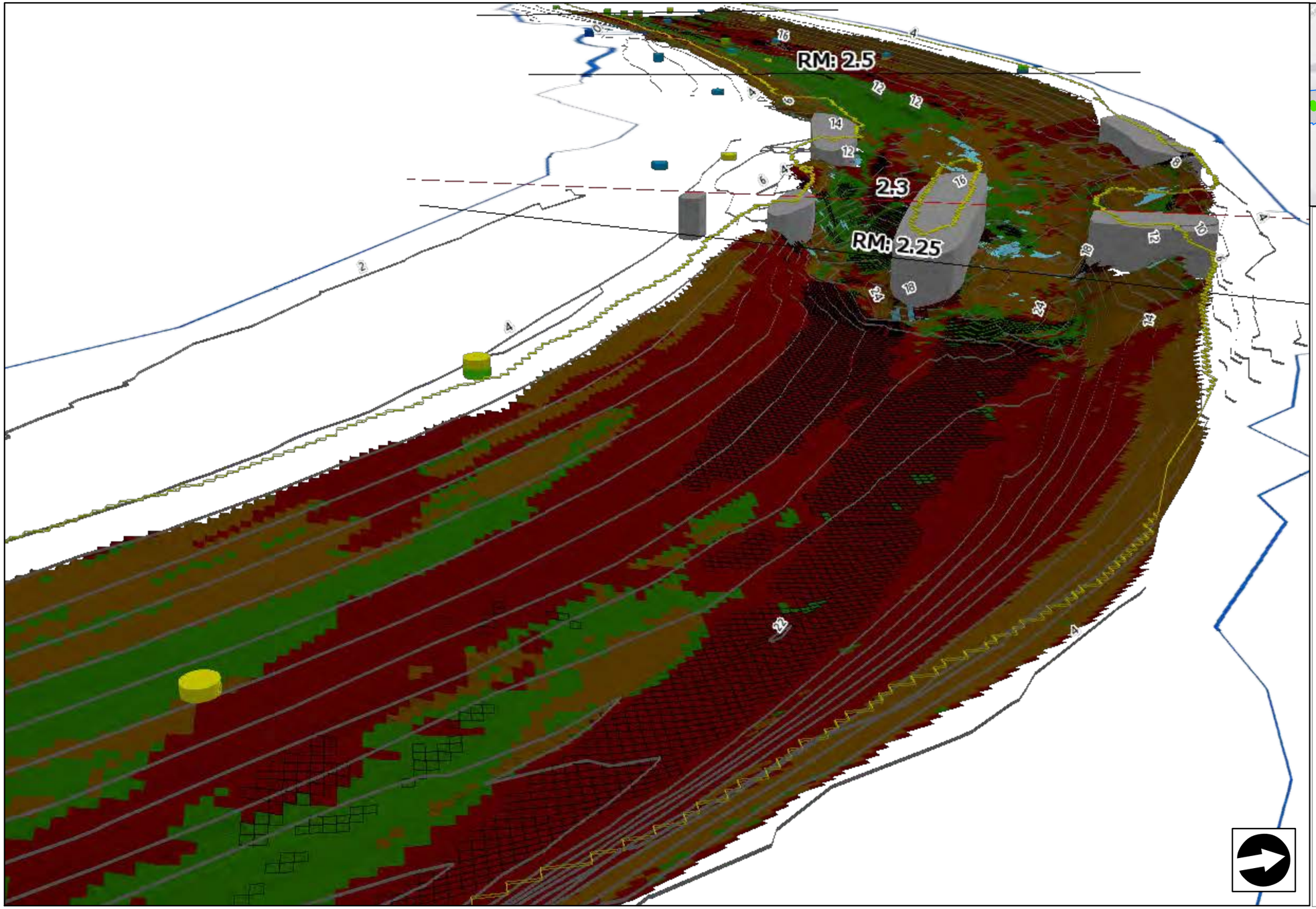
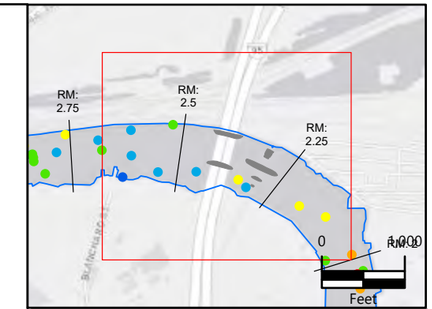
Figure 5-7f

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

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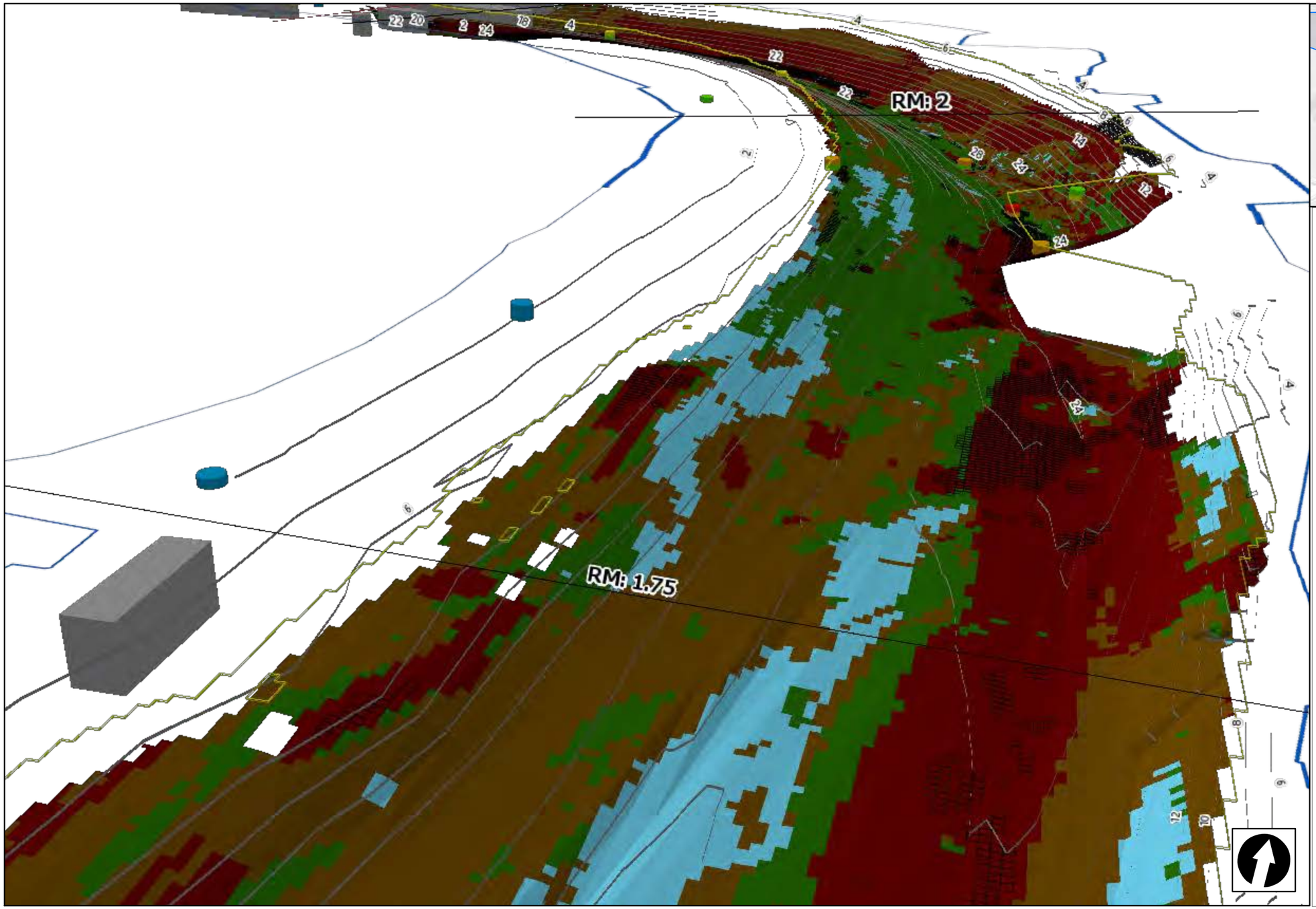
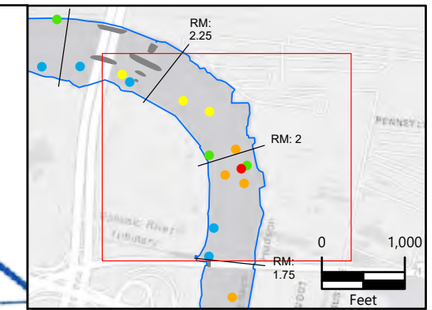
Figure 5-7g

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

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- 8 - 20
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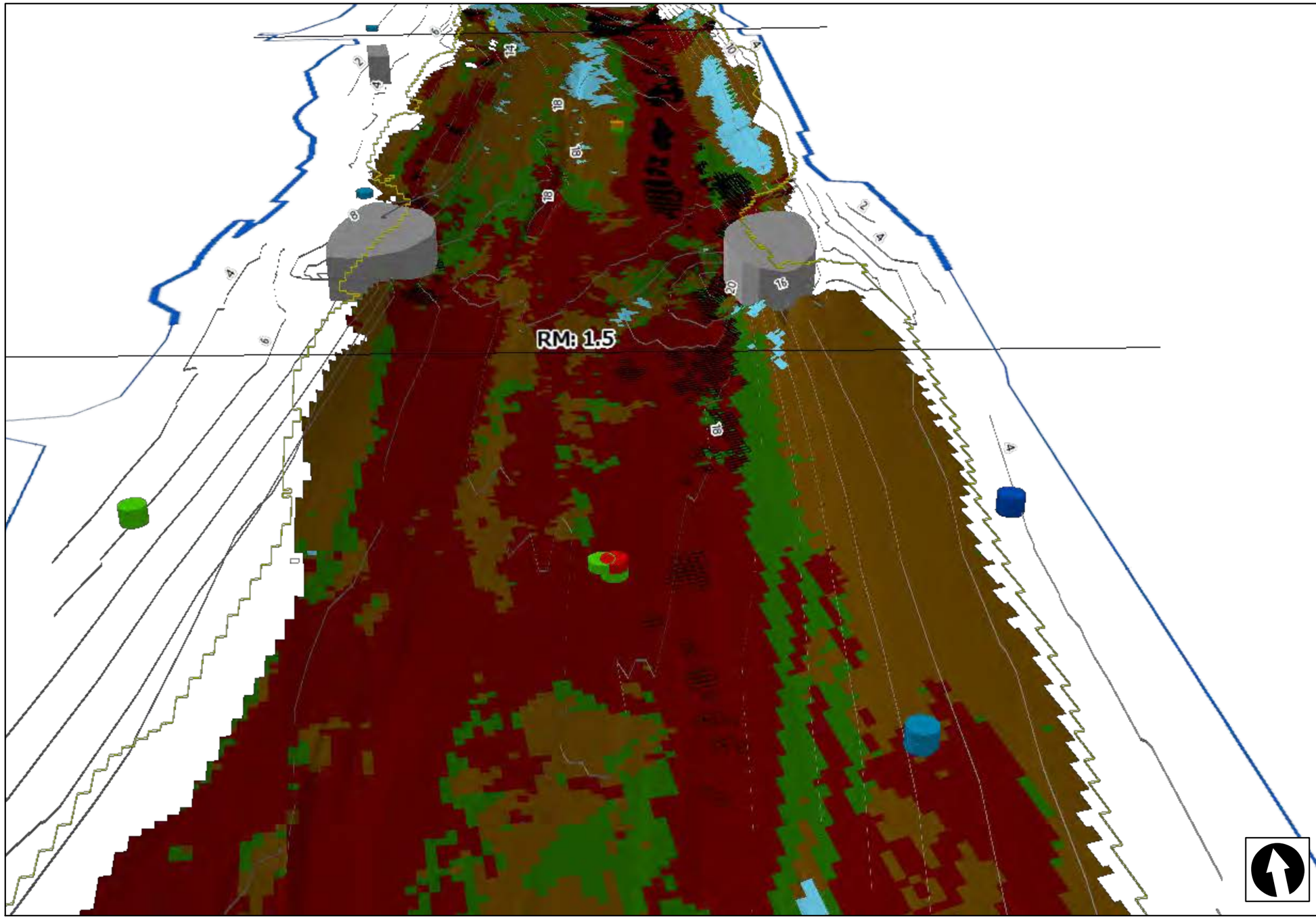
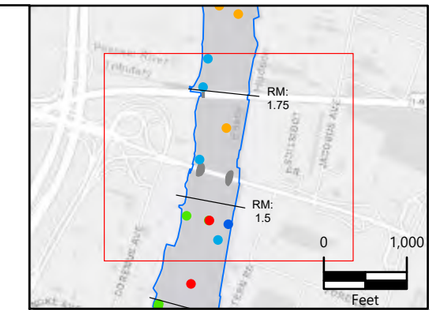
Figure 5-8a

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
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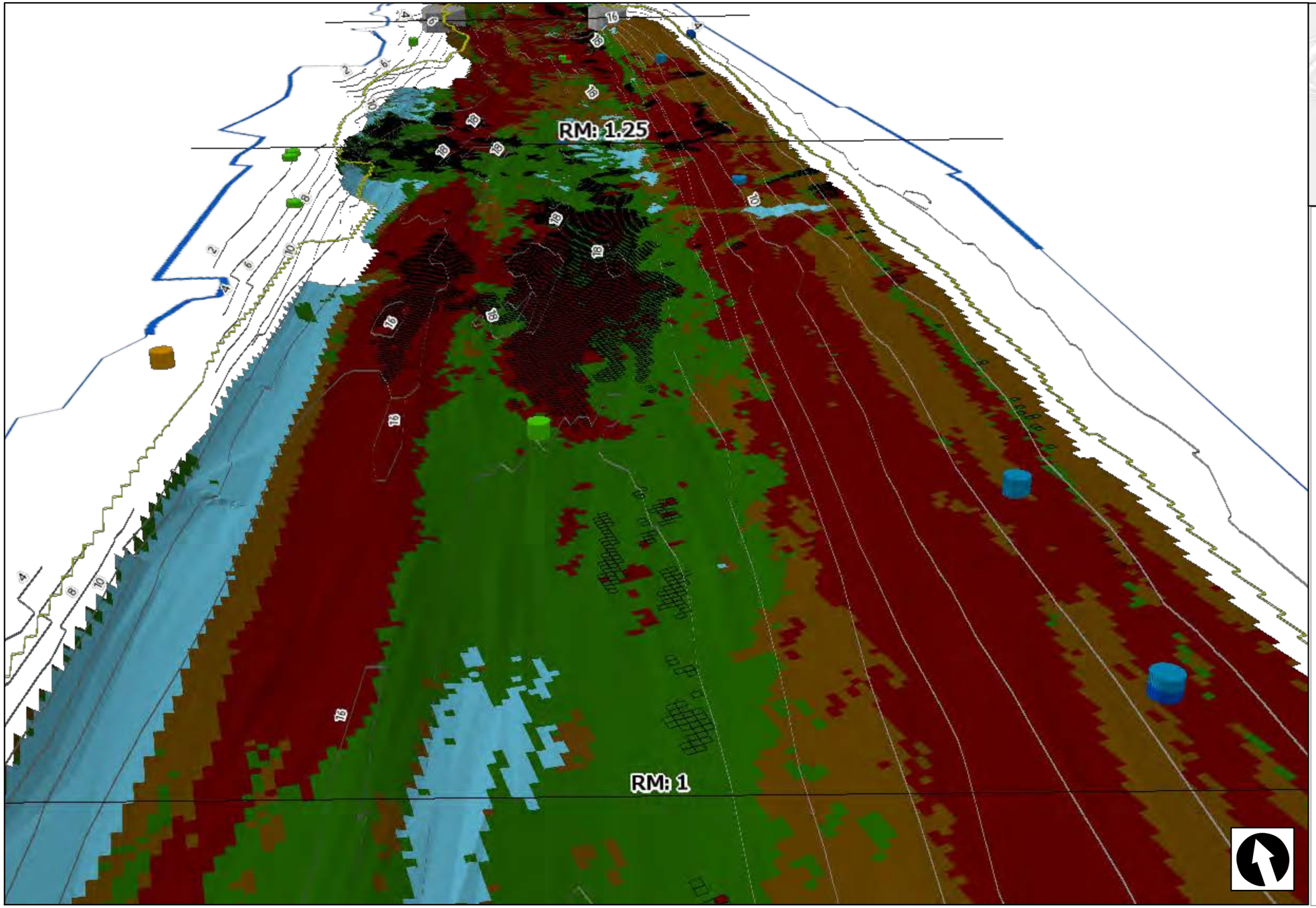
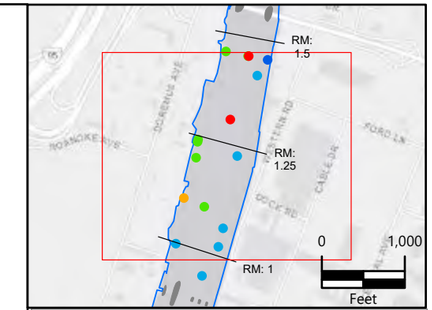
Figure 5-8b

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

Bathymetric Change Category *

- Erosional from 2007 to 2012
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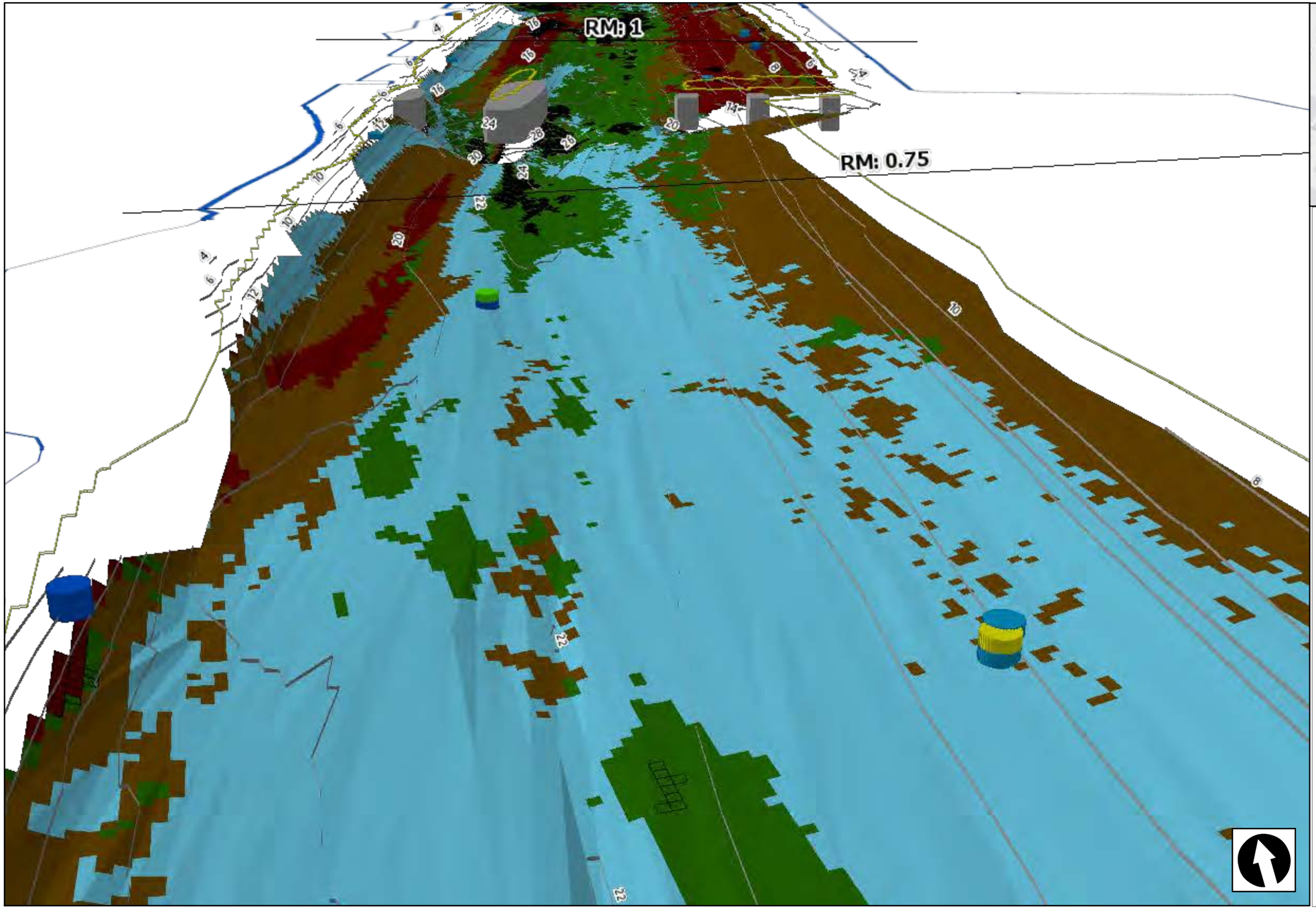
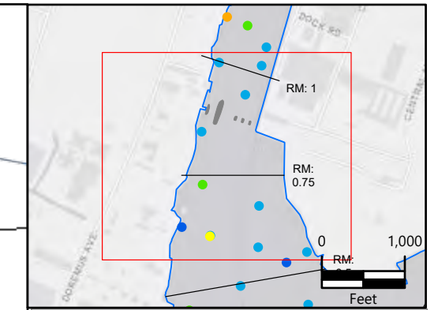
Figure 5-8c

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study





LEGEND:

- Bathymetric Contours in feet (NGVD 29)
- Subreach Boundary
- Shoreline
- Multi-Beam Extent
- Abutment
- >1.5 feet of Erosion

LMW PAH Concentration (mg/kg)

- 0 - 2
- 2 - 4
- 4 - 6
- 6 - 8
- 8 - 20
- >20

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Figure 5-8d

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

Remedial Investigation Report

Lower Passaic River Study Remedial Investigation/Feasibility Study

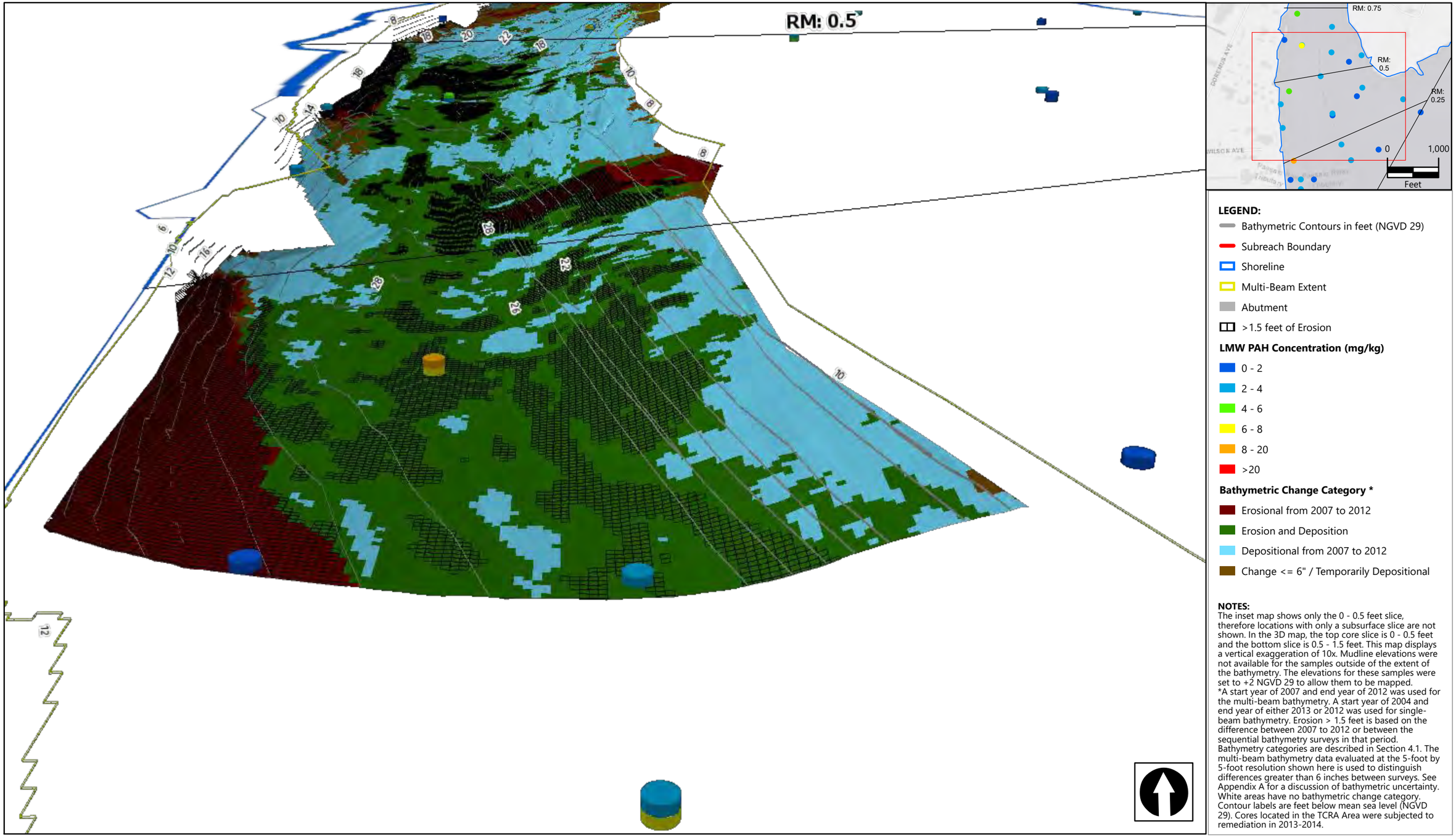

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Figure 5-8e

LMW PAH Surface and Subsurface Sediment Concentrations over Erosion-Deposition Patterns

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Lower Passaic River Study Remedial Investigation/Feasibility Study

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Figure 6-1a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 6-1b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

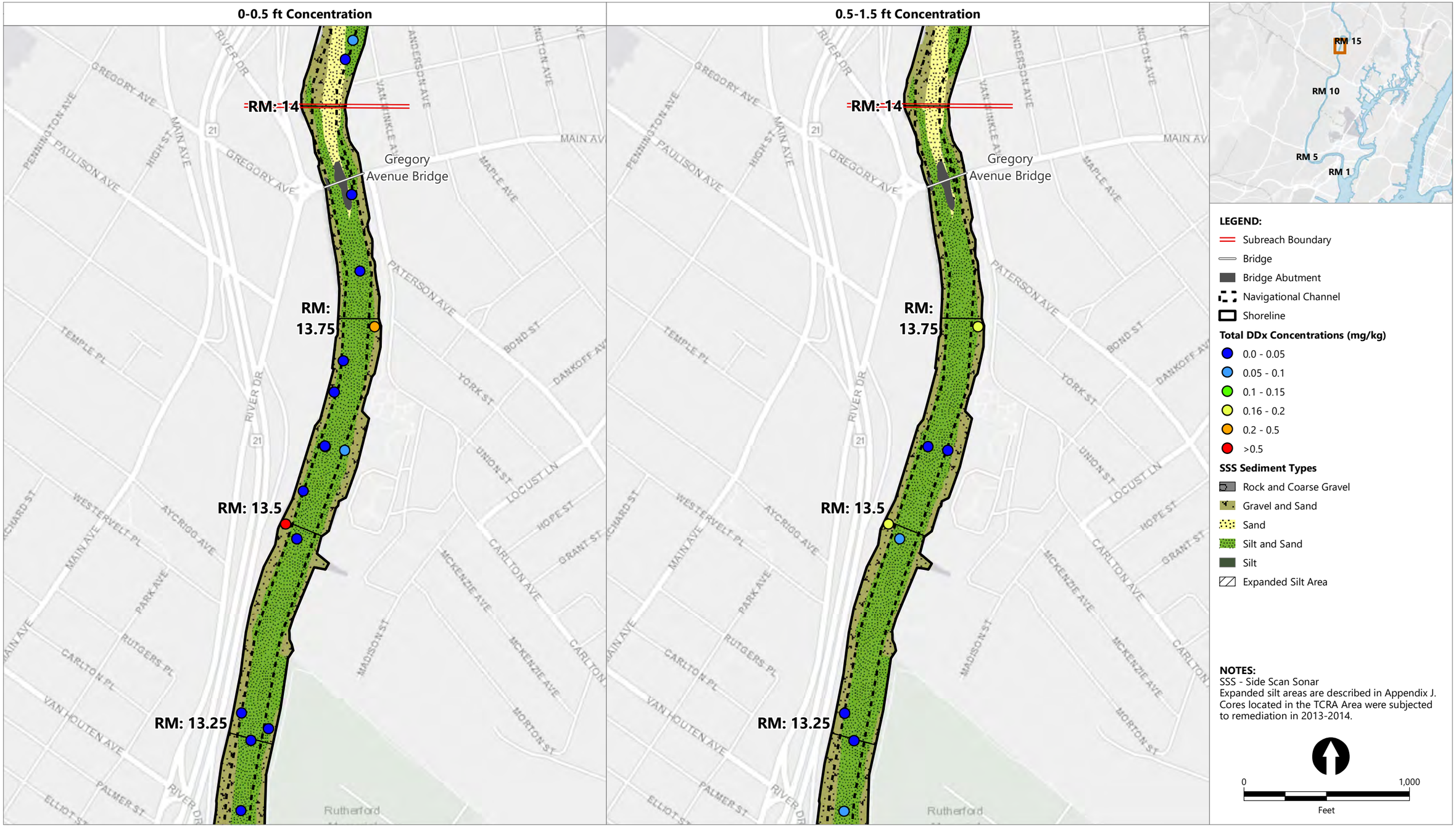

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Figure 6-2a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Figure 6-2b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Figure 6-3a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 6-3b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 6-4a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Figure 6-5a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Lower Passaic River Study Area Remedial Investigation/Feasibility Study

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Figure 6-5b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Figure 6-6a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 6-6b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Figure 6-7a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

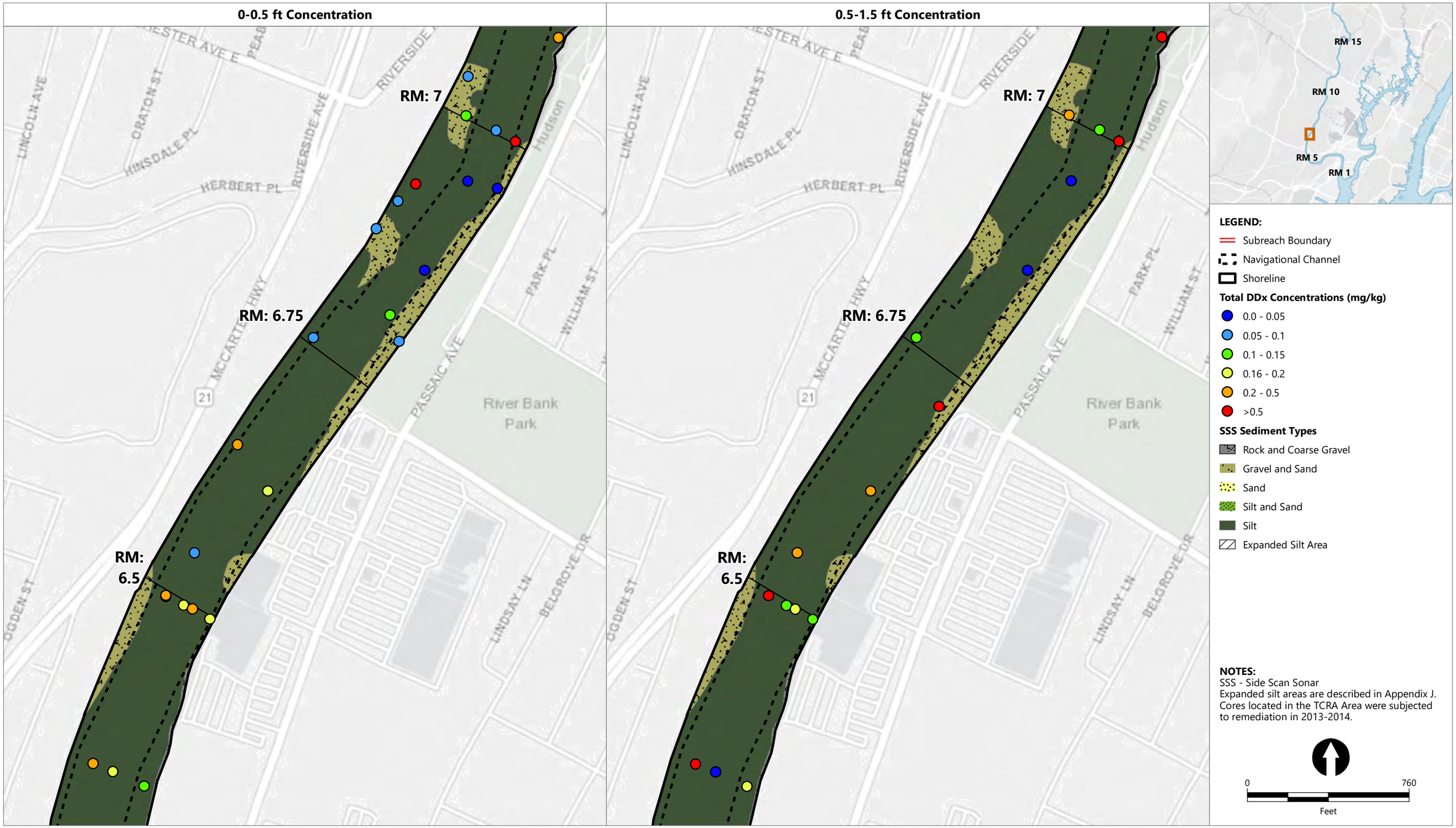

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Figure 6-7b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

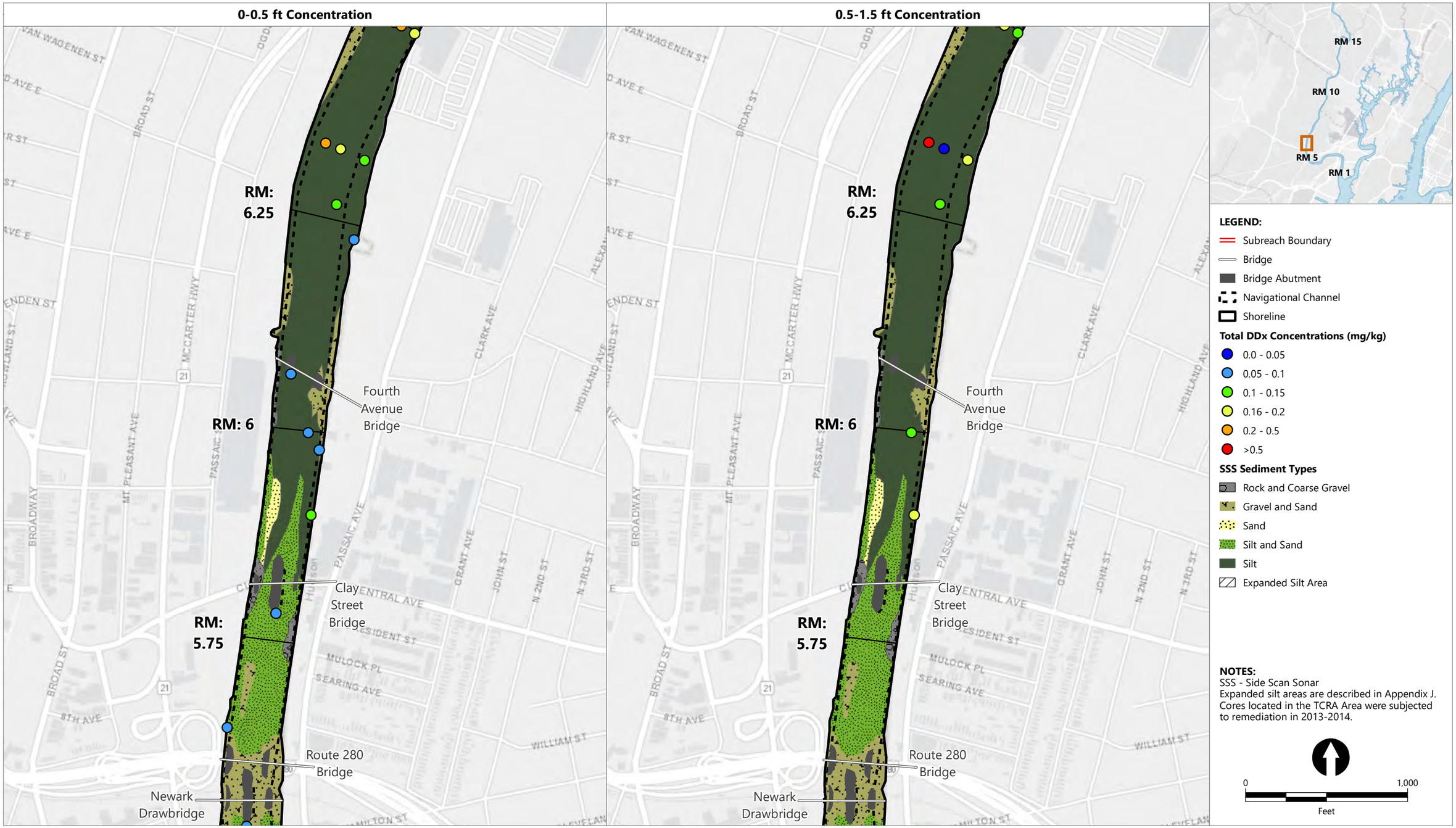

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Figure 6-7c
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

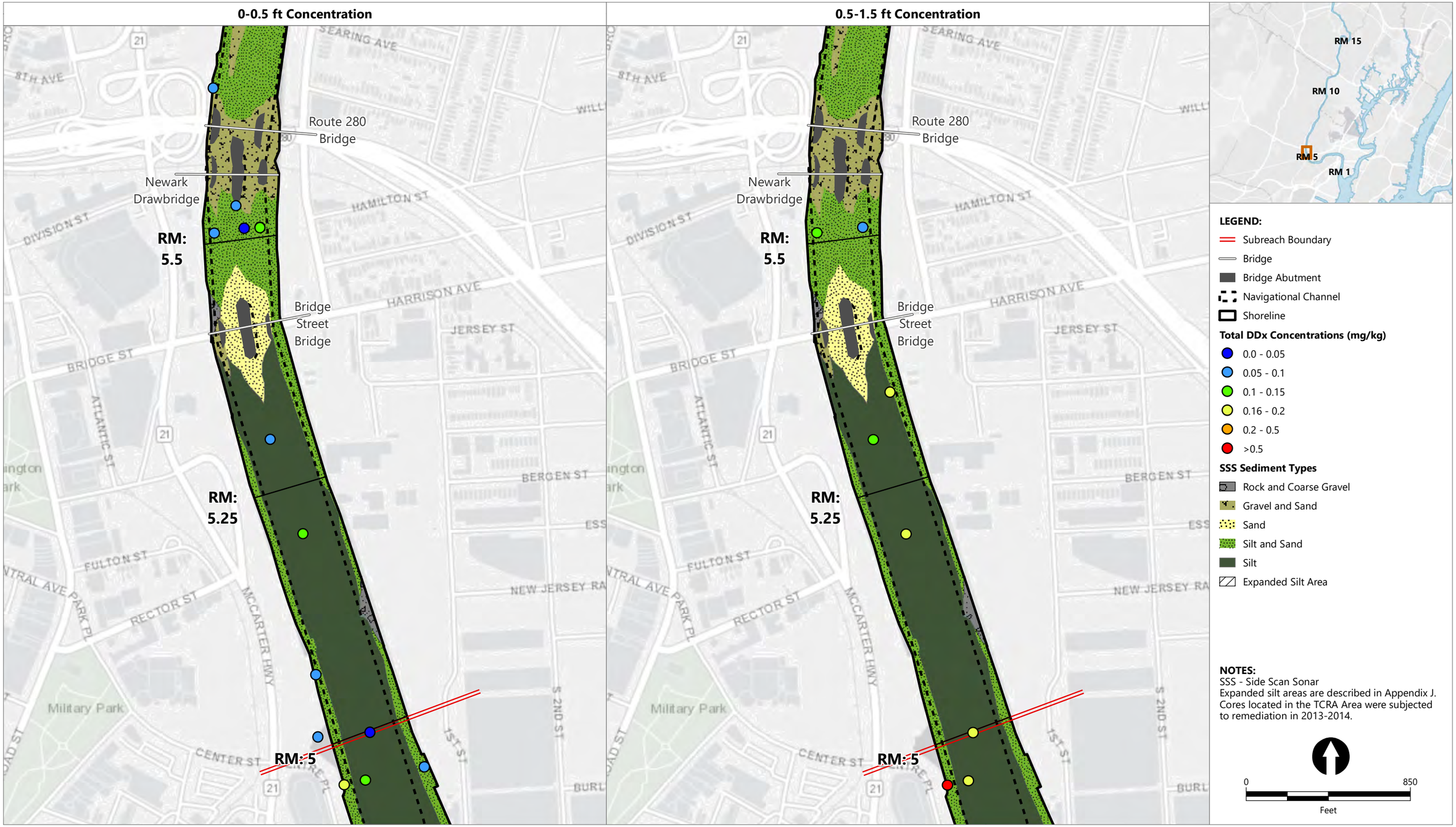

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Figure 6-7d
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 6-8a
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 6-8b
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

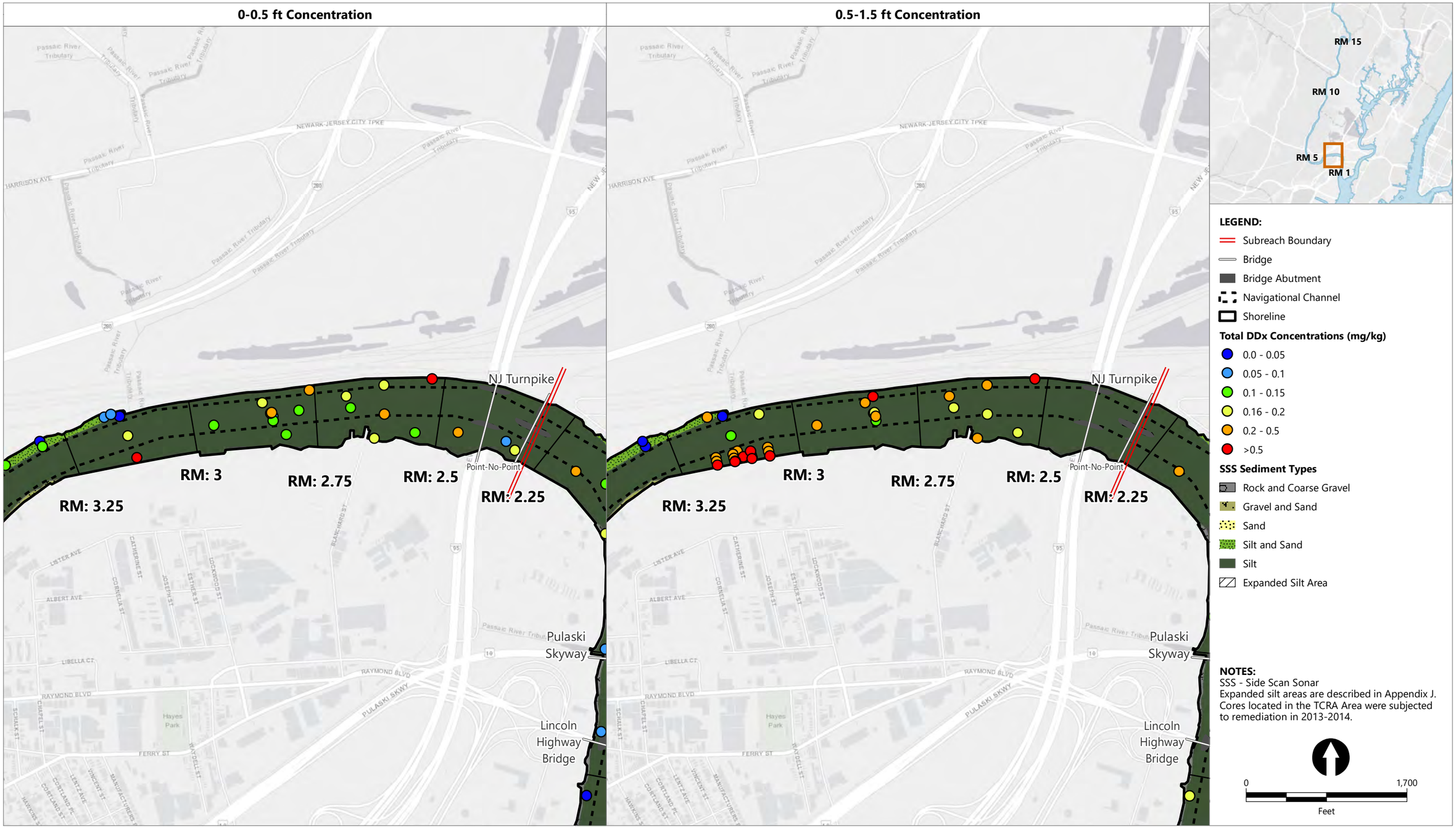

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Figure 6-8c
Surface and Subsurface Total DDx Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

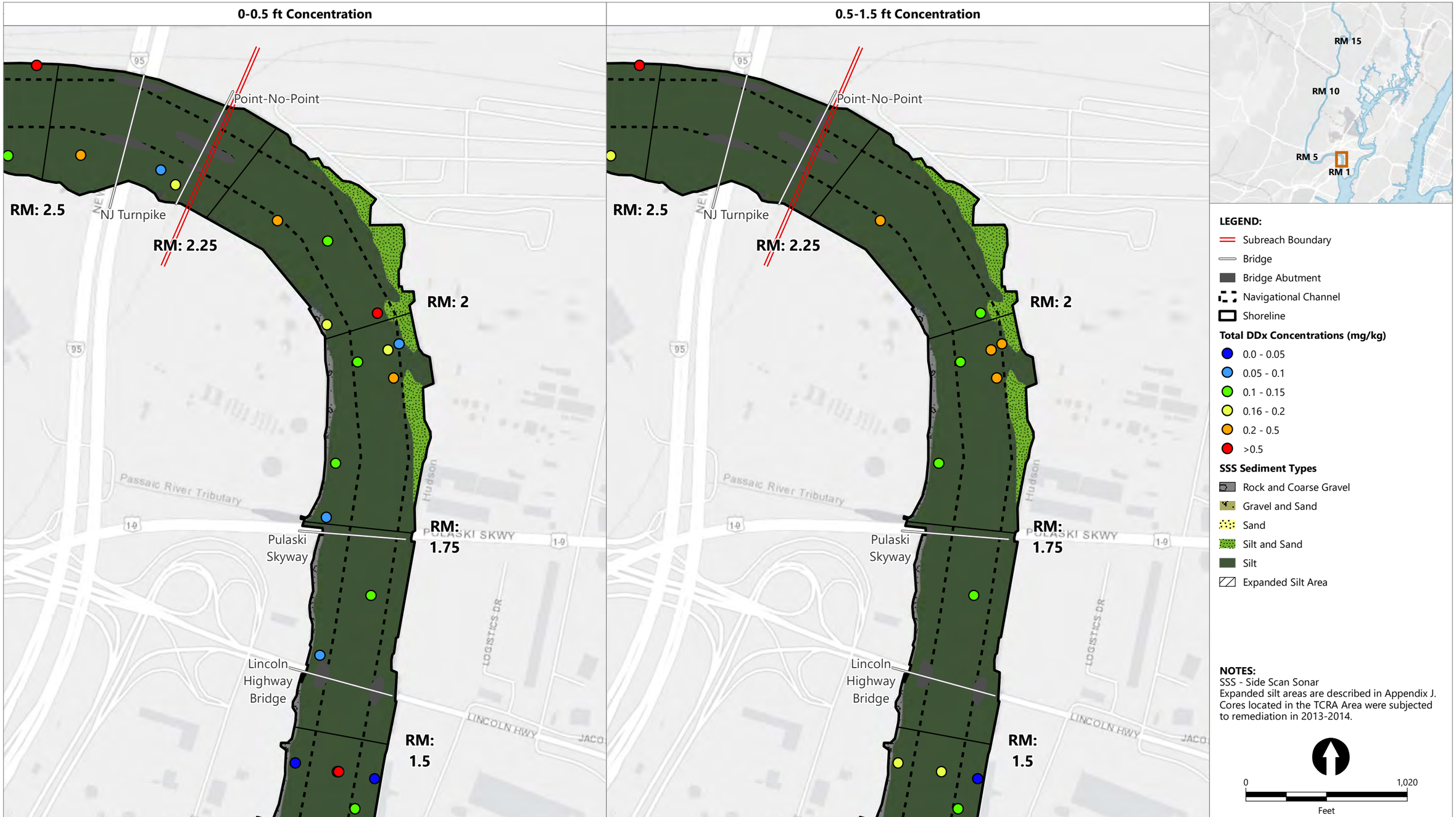

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Figure 6-9a
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Surface and Subsurface Total DDx Concentrations Over Sediment Type
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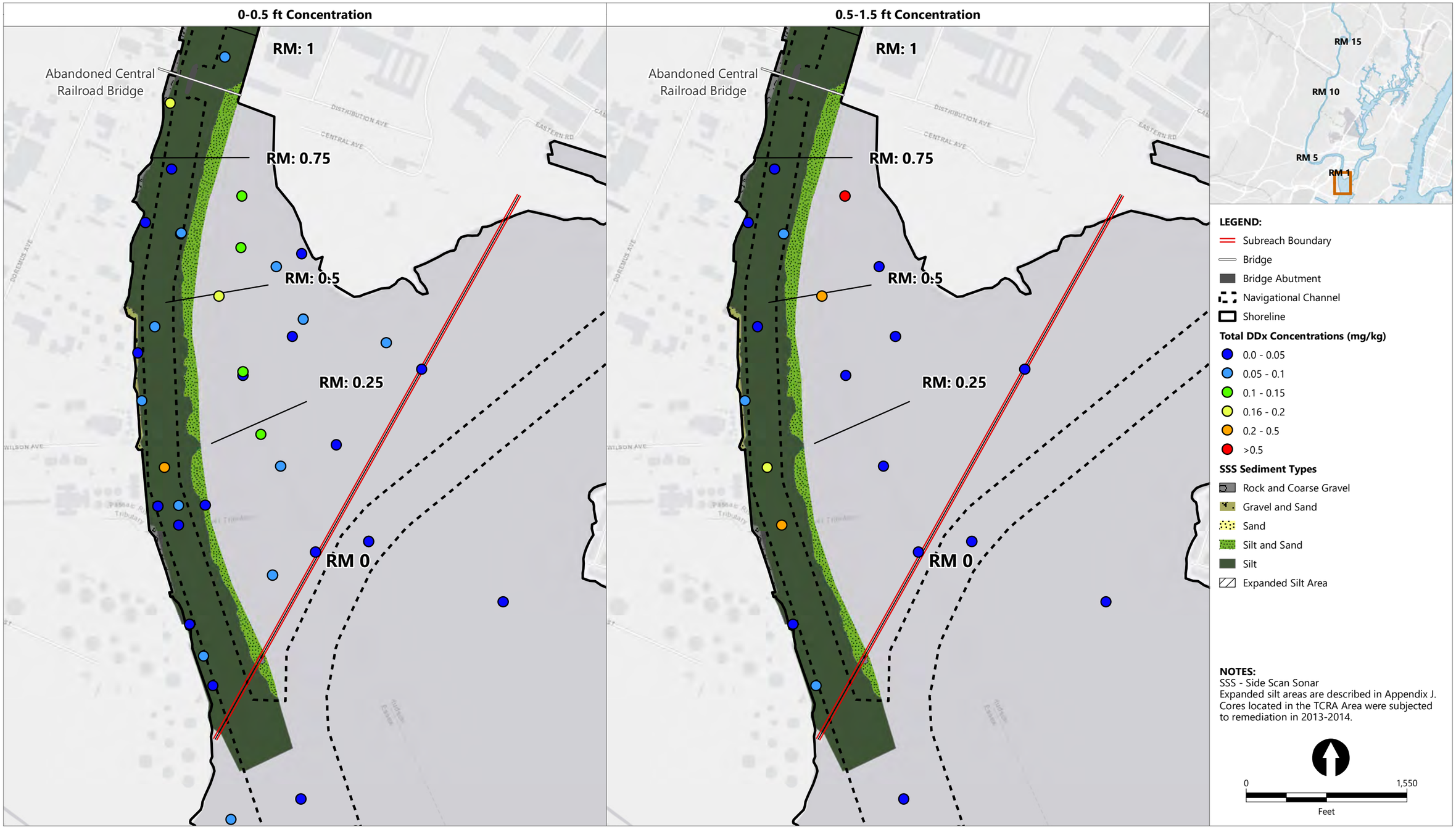

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Figure 6-9c
Surface and Subsurface Total DDx Concentrations Over Sediment Type
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Figure 7-1a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-1b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

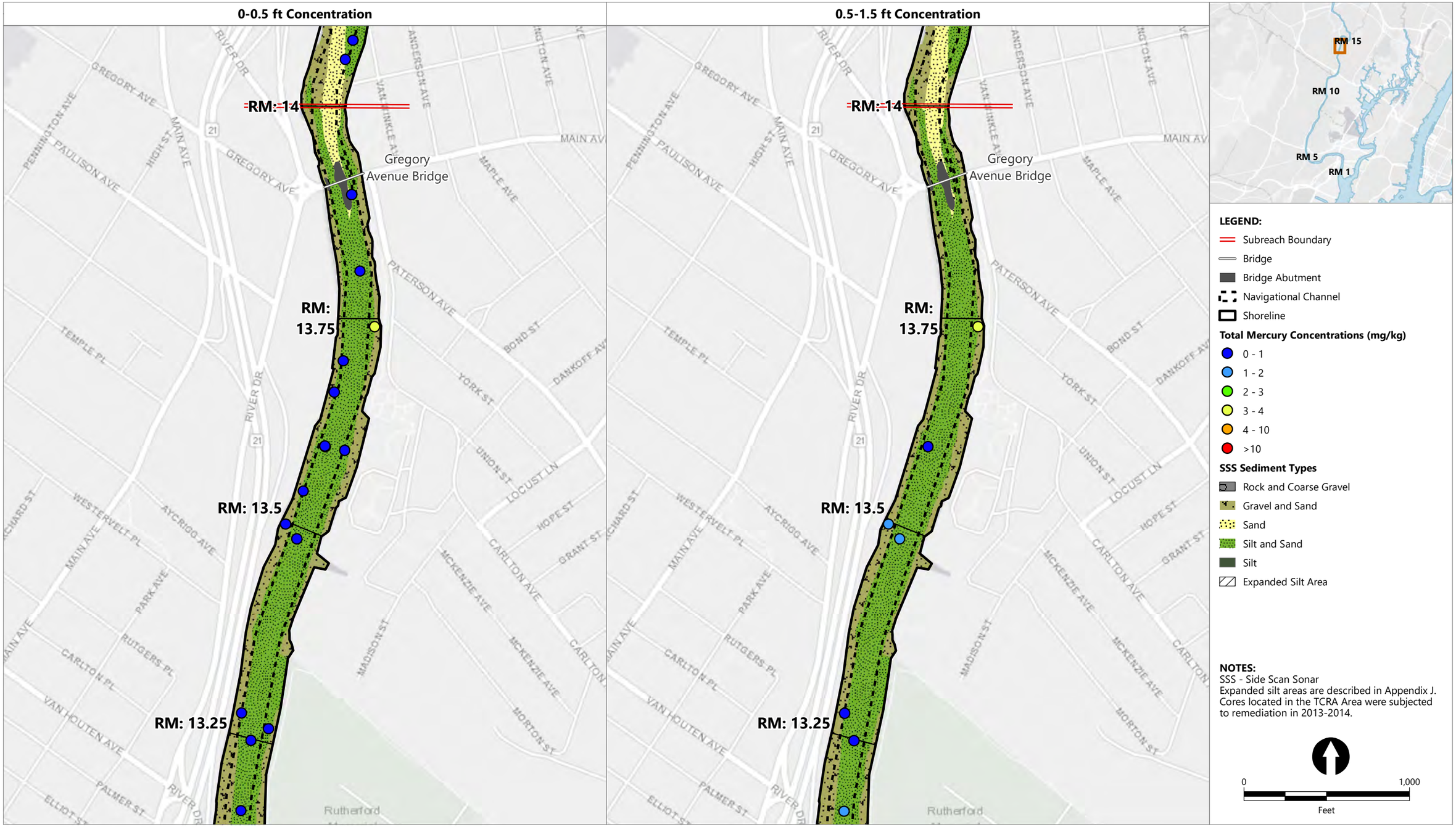

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Figure 7-2a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
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Figure 7-2b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-3a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-3b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-4a

Surface and Subsurface Total Mercury Concentrations Over Sediment Type

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Figure 7-5a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
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Figure 7-5b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-6a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

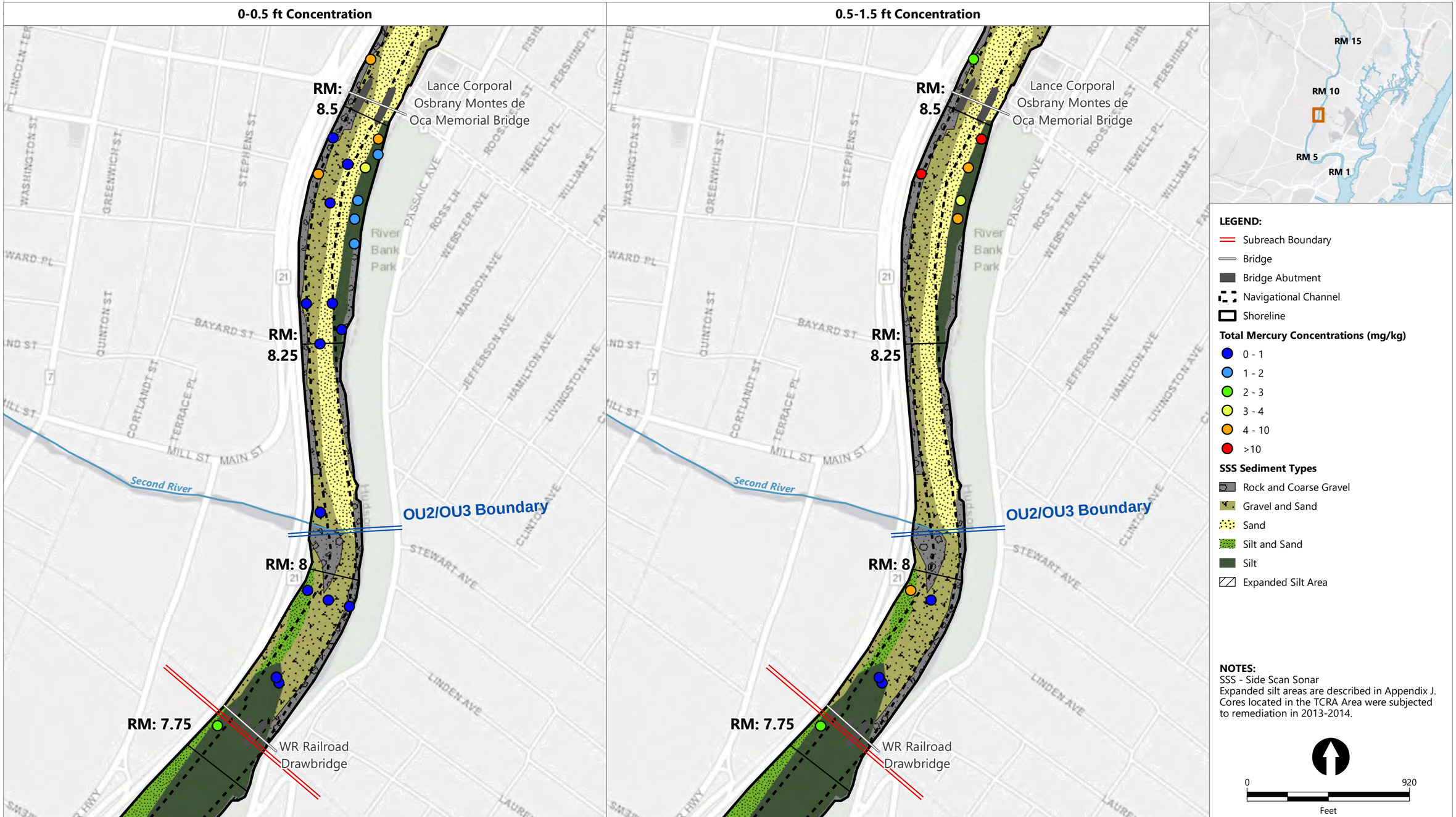

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Figure 7-6b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-7a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

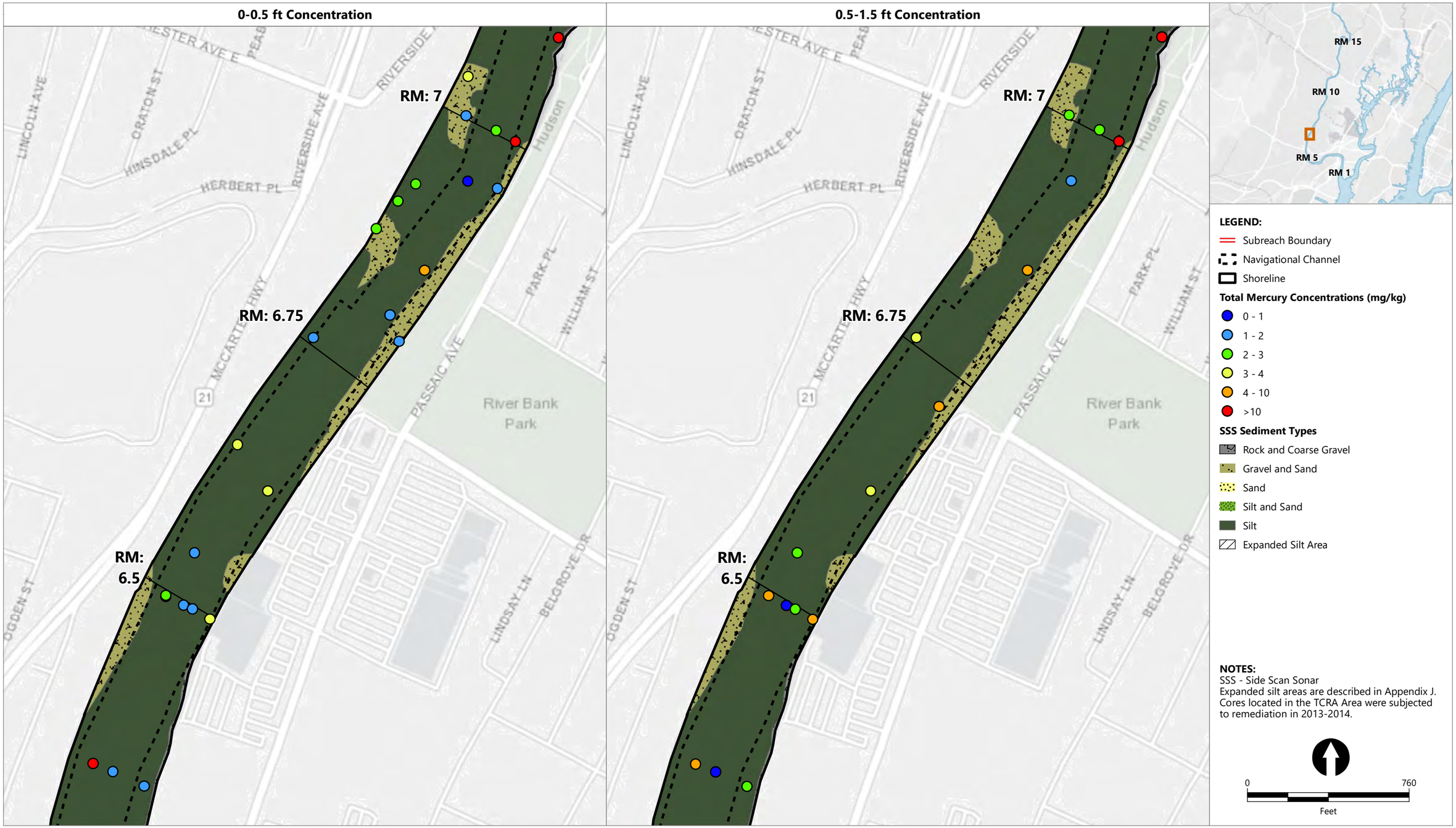

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Figure 7-7b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

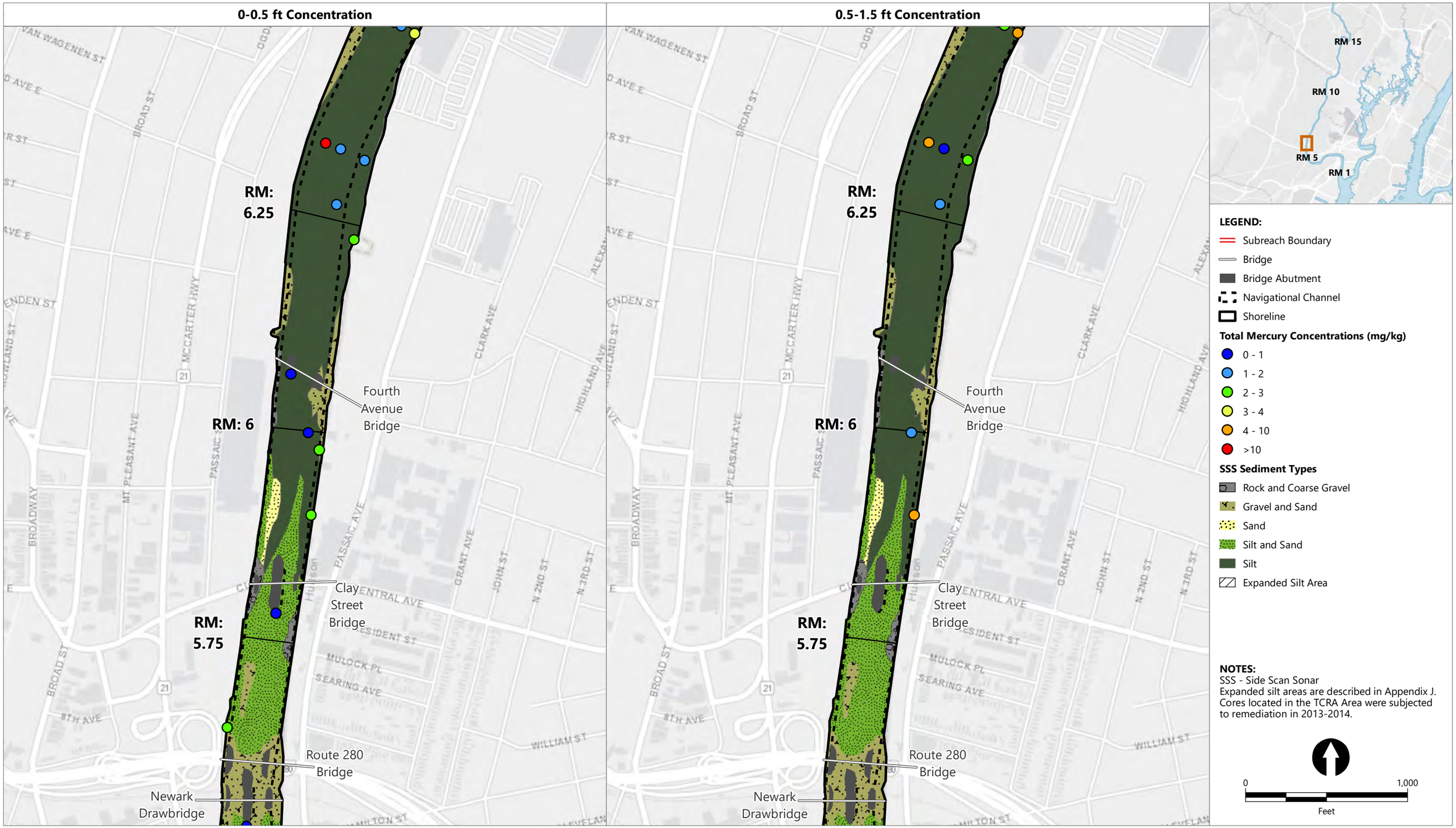

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Figure 7-7c

Surface and Subsurface Total Mercury Concentrations Over Sediment Type

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

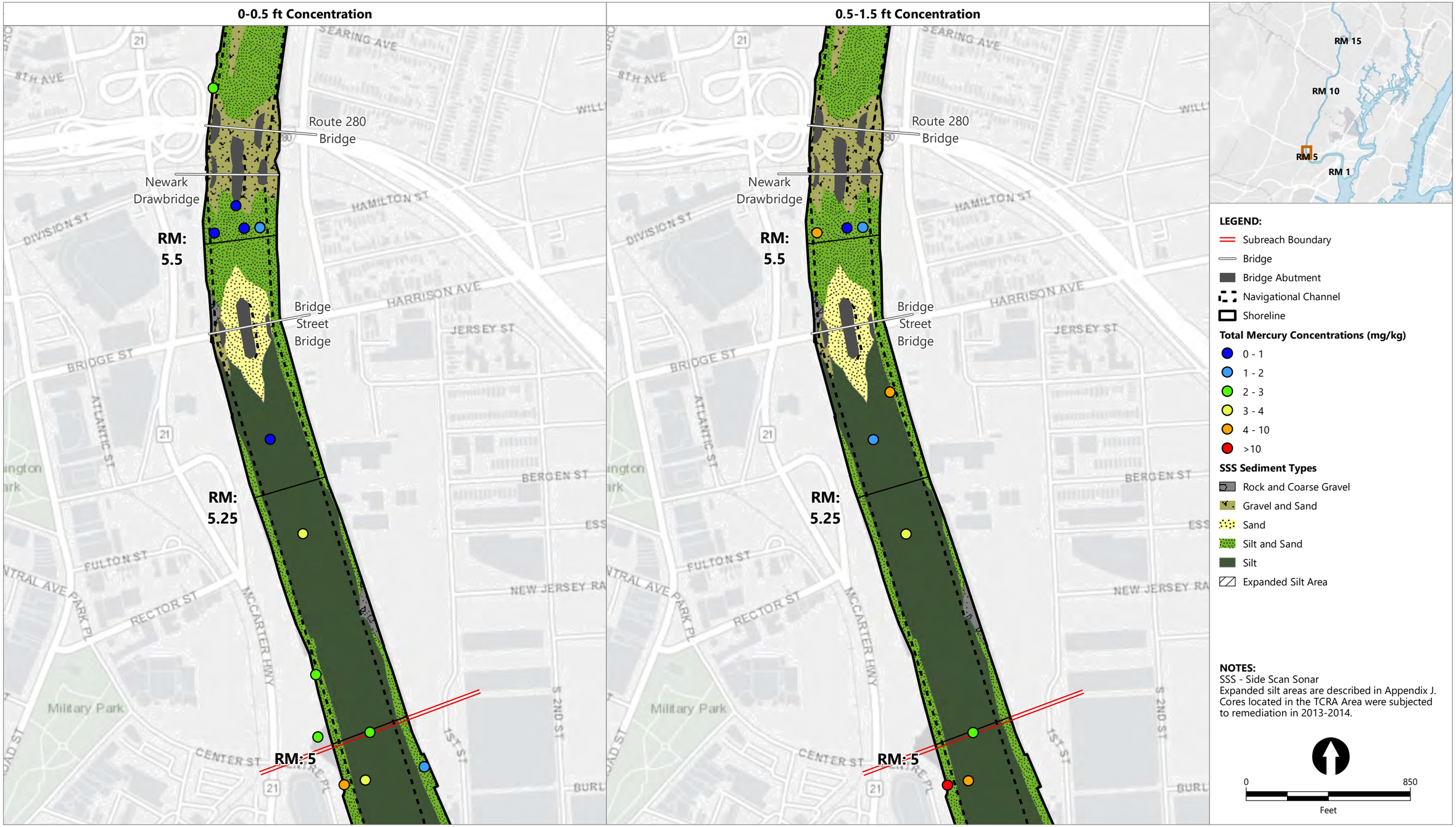

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Figure 7-7d
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 7-8a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

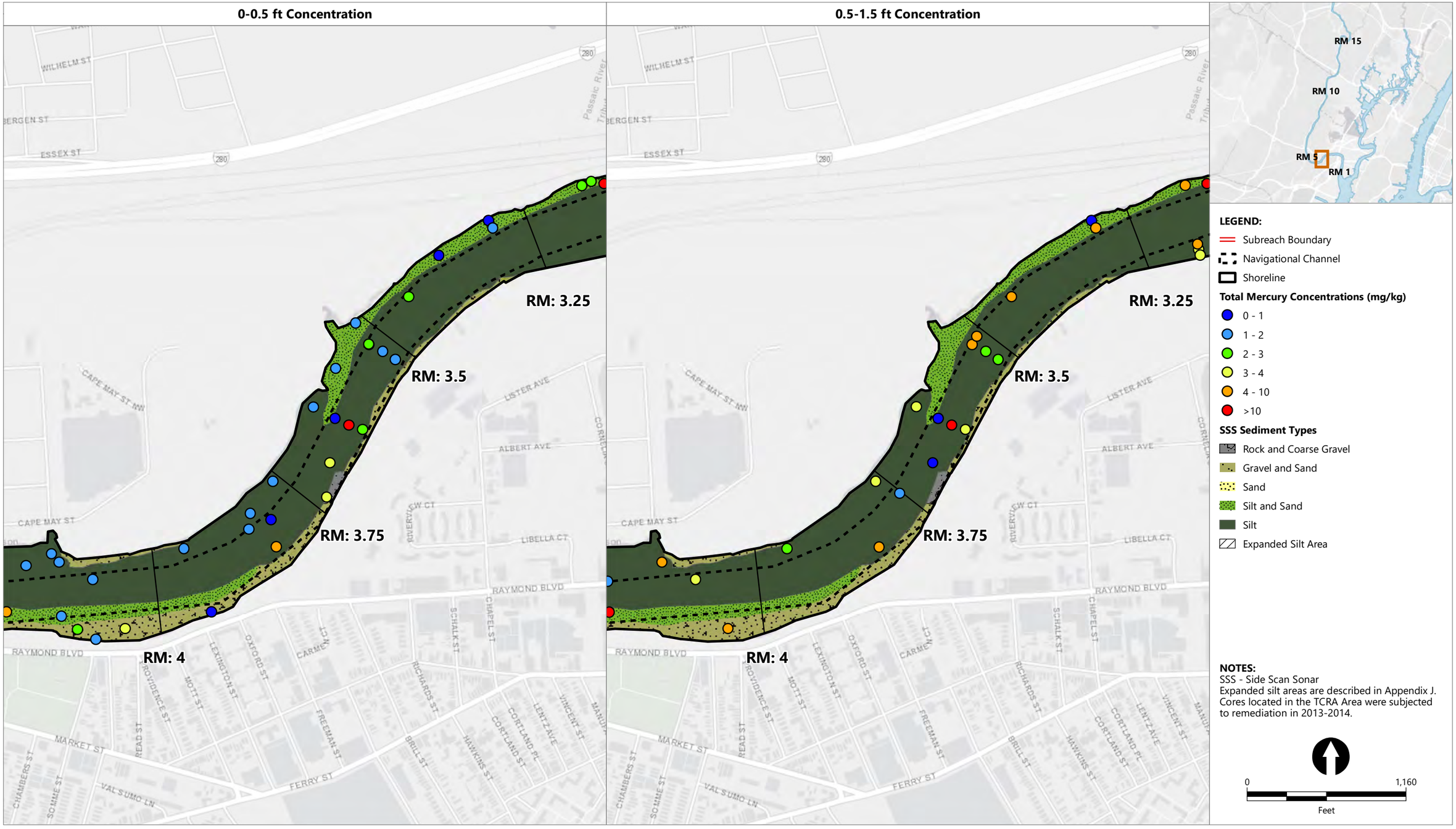

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Figure 7-8b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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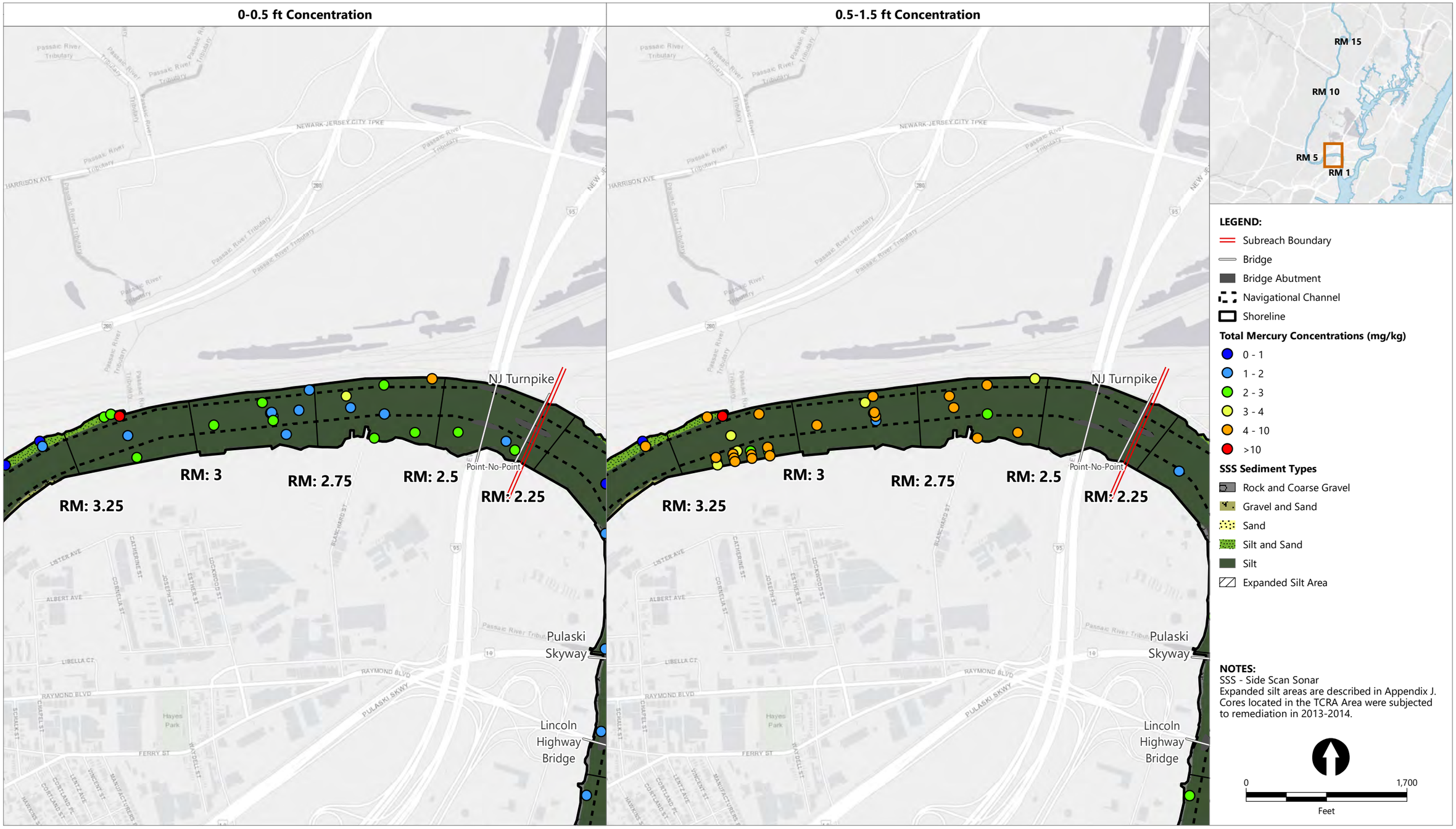

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Figure 7-8c
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
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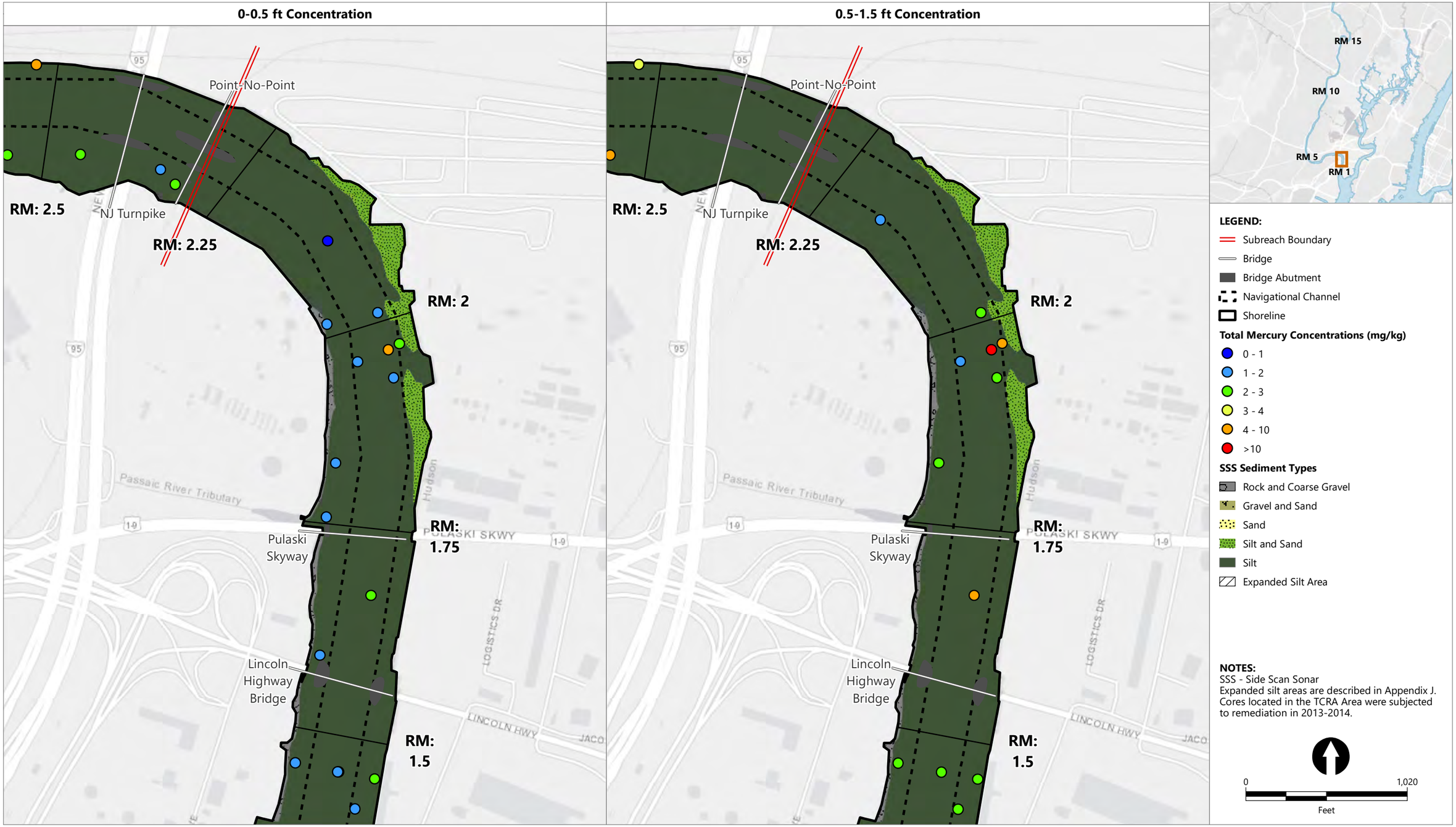

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Figure 7-9a
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
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Figure 7-9b
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

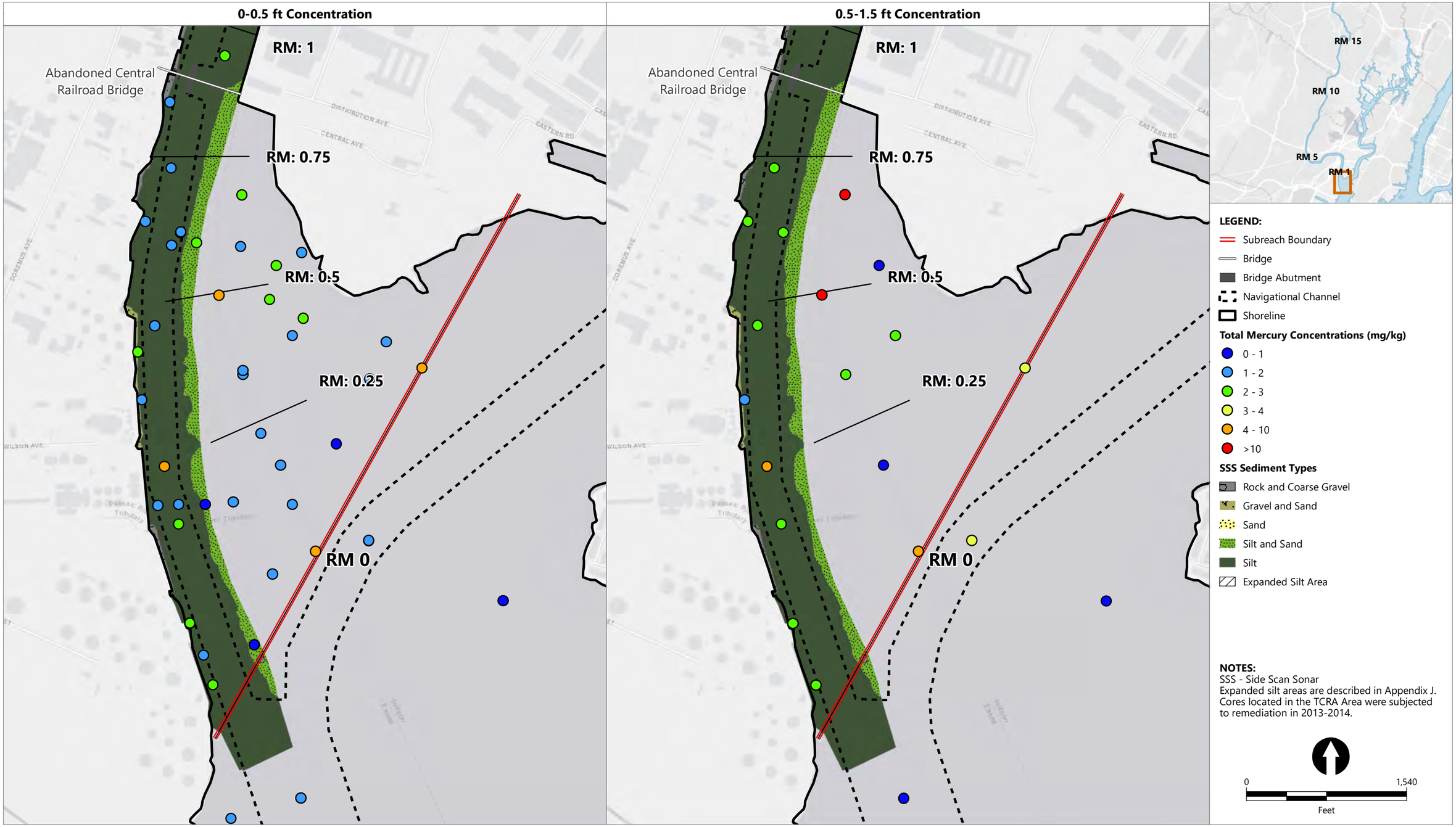

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Figure 7-9c
Surface and Subsurface Total Mercury Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 8-1a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-1b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

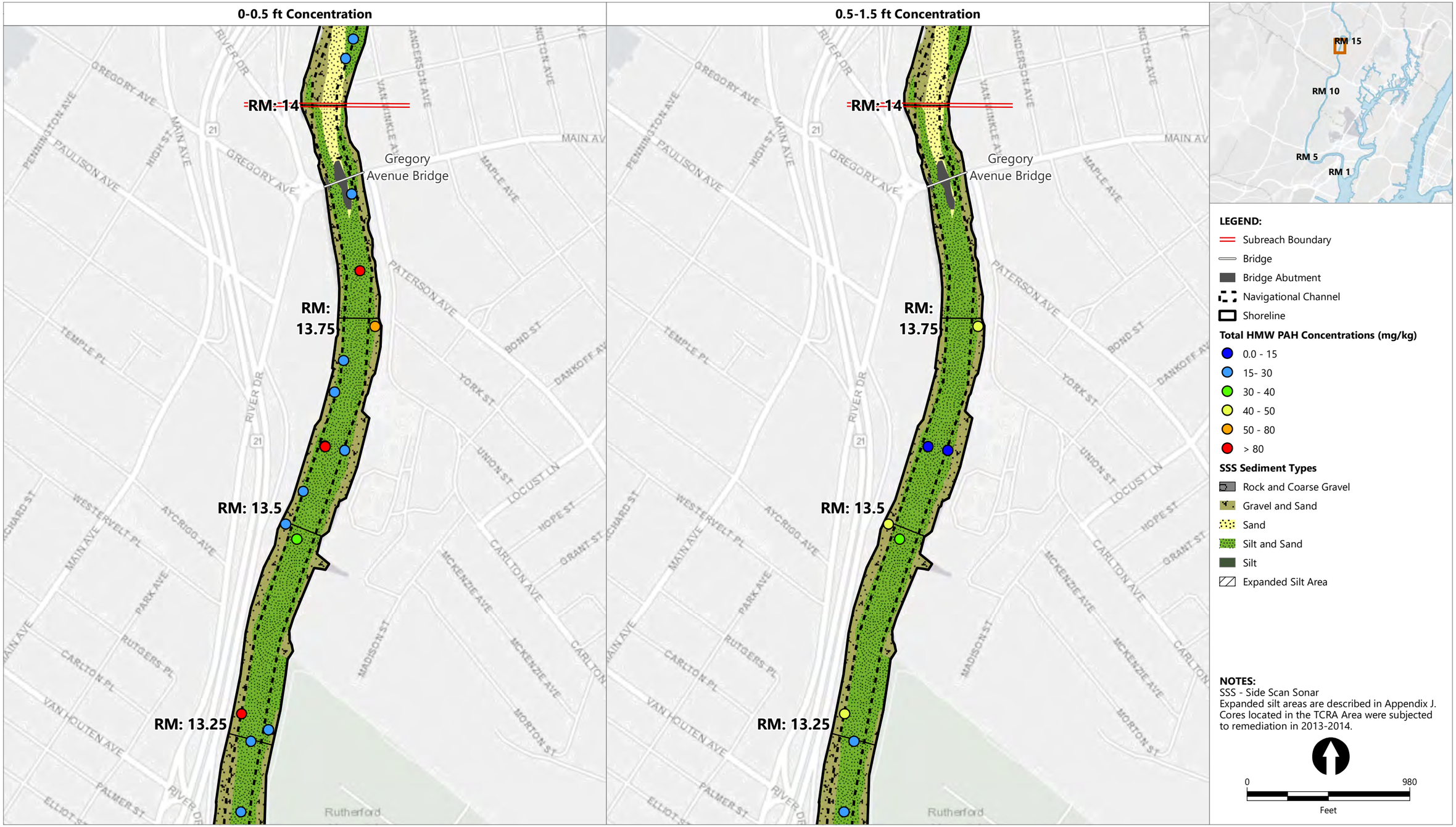

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Figure 8-2a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-2b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 8-3a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 8-3b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-4a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-5a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-5b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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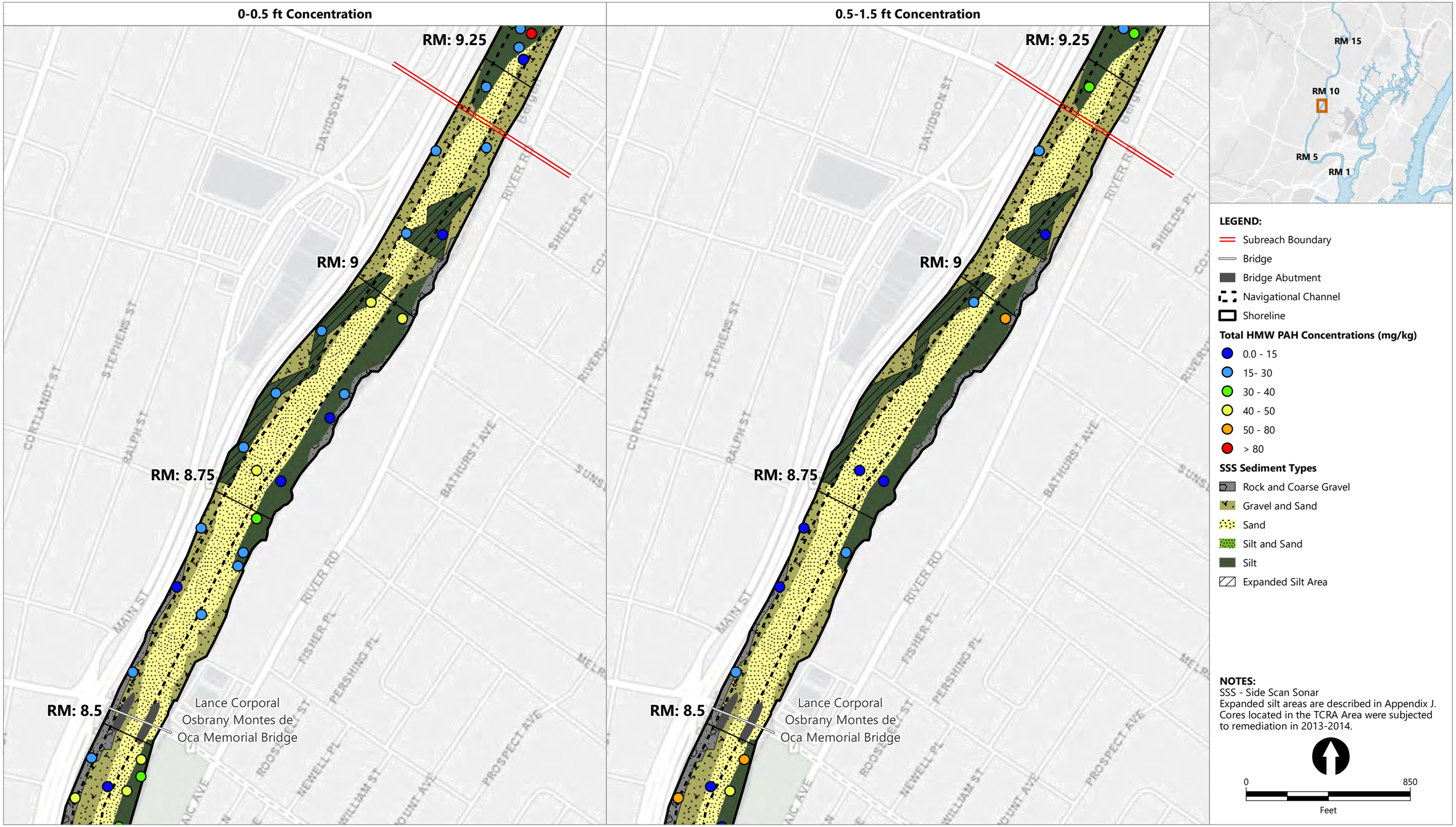

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Figure 8-6a

Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type

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Figure 8-6b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-7a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
Remedial Investigation Report
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Figure 8-7b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

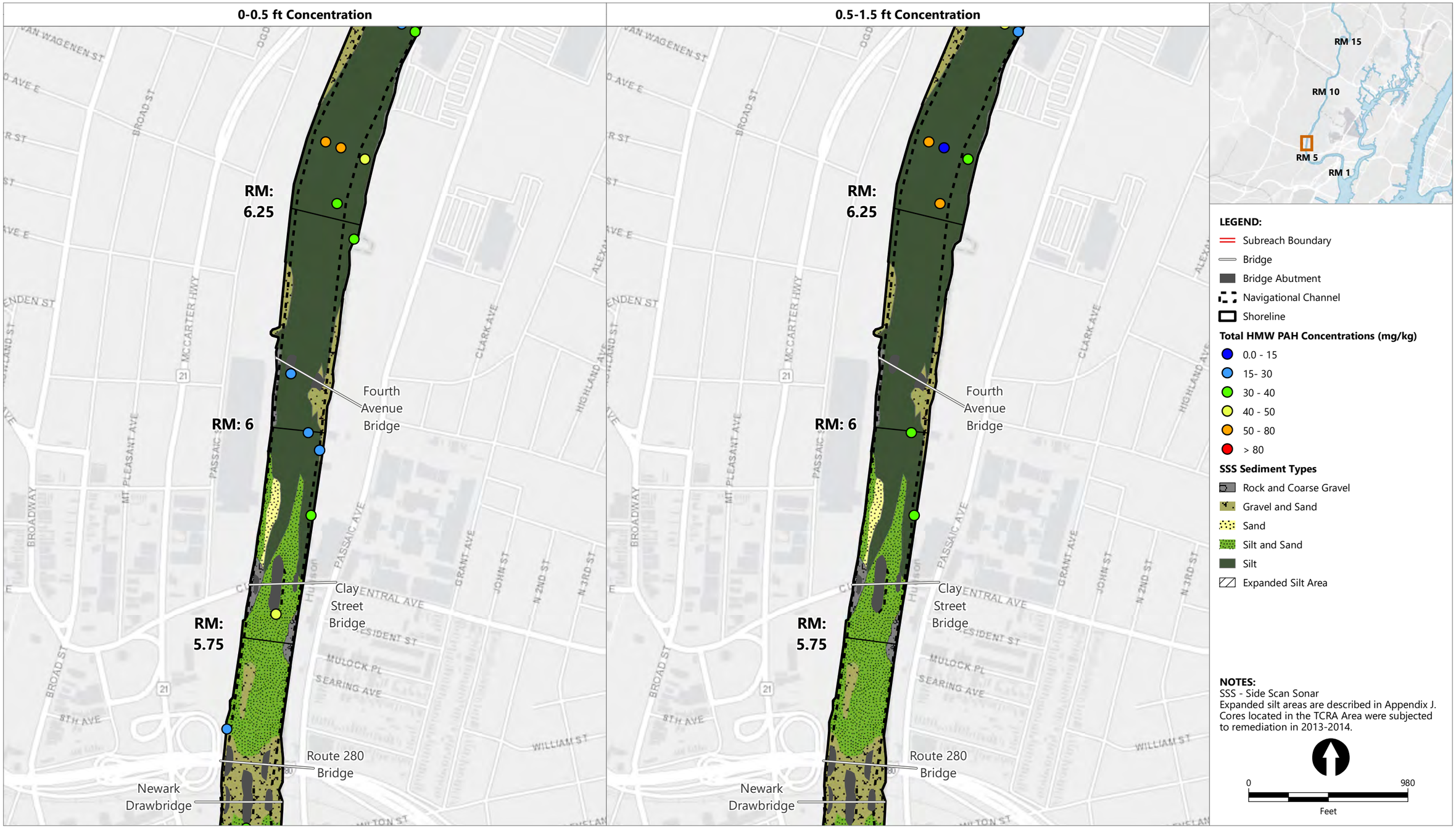

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Figure 8-7c

Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type

Remedial Investigation Report

Lower Passaic River Study Area Remedial Investigation/Feasibility Study

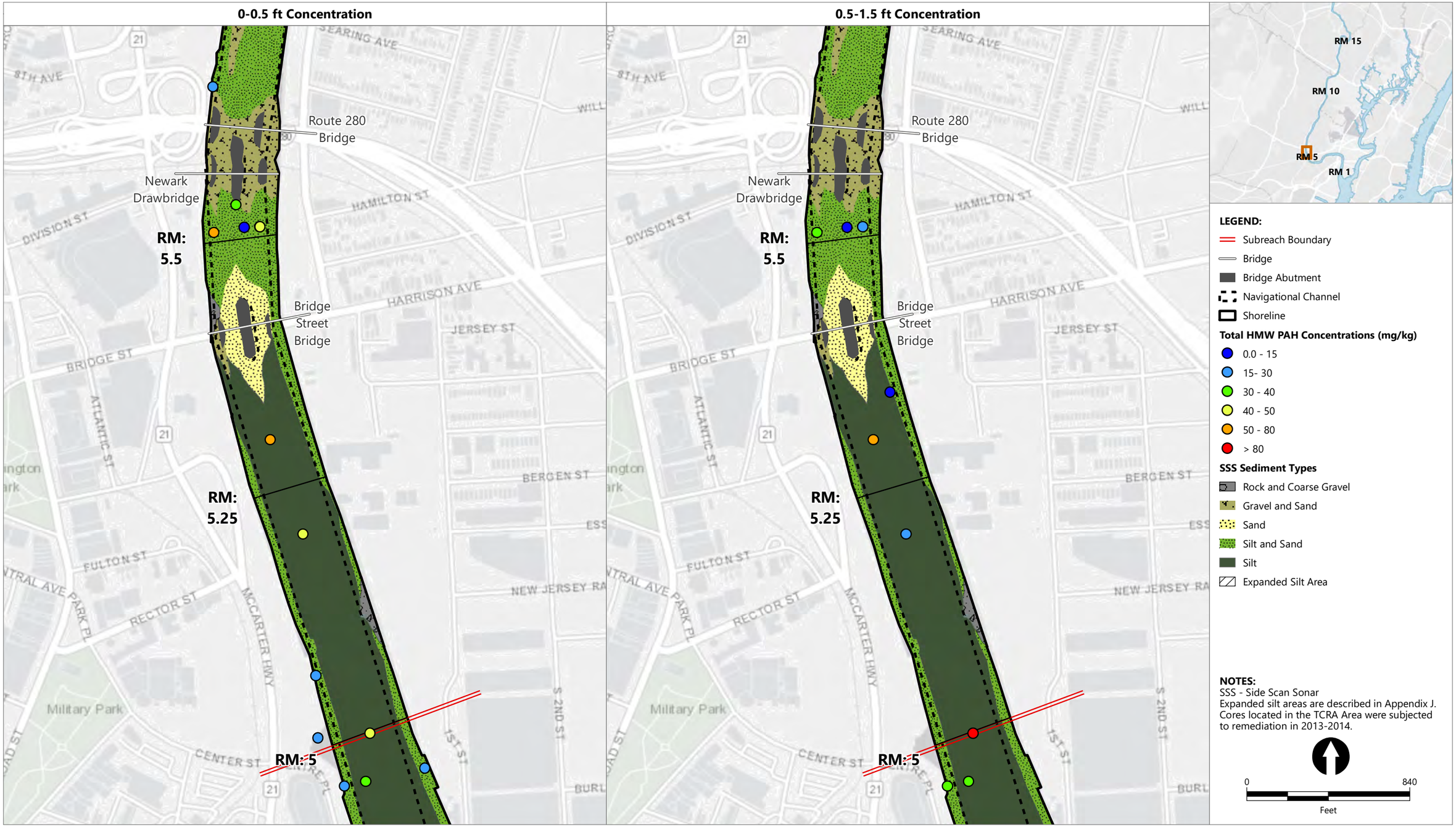

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Figure 8-7d
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-8a
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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Figure 8-8b
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
Remedial Investigation Report
Lower Passaic River Study Area Remedial Investigation/Feasibility Study

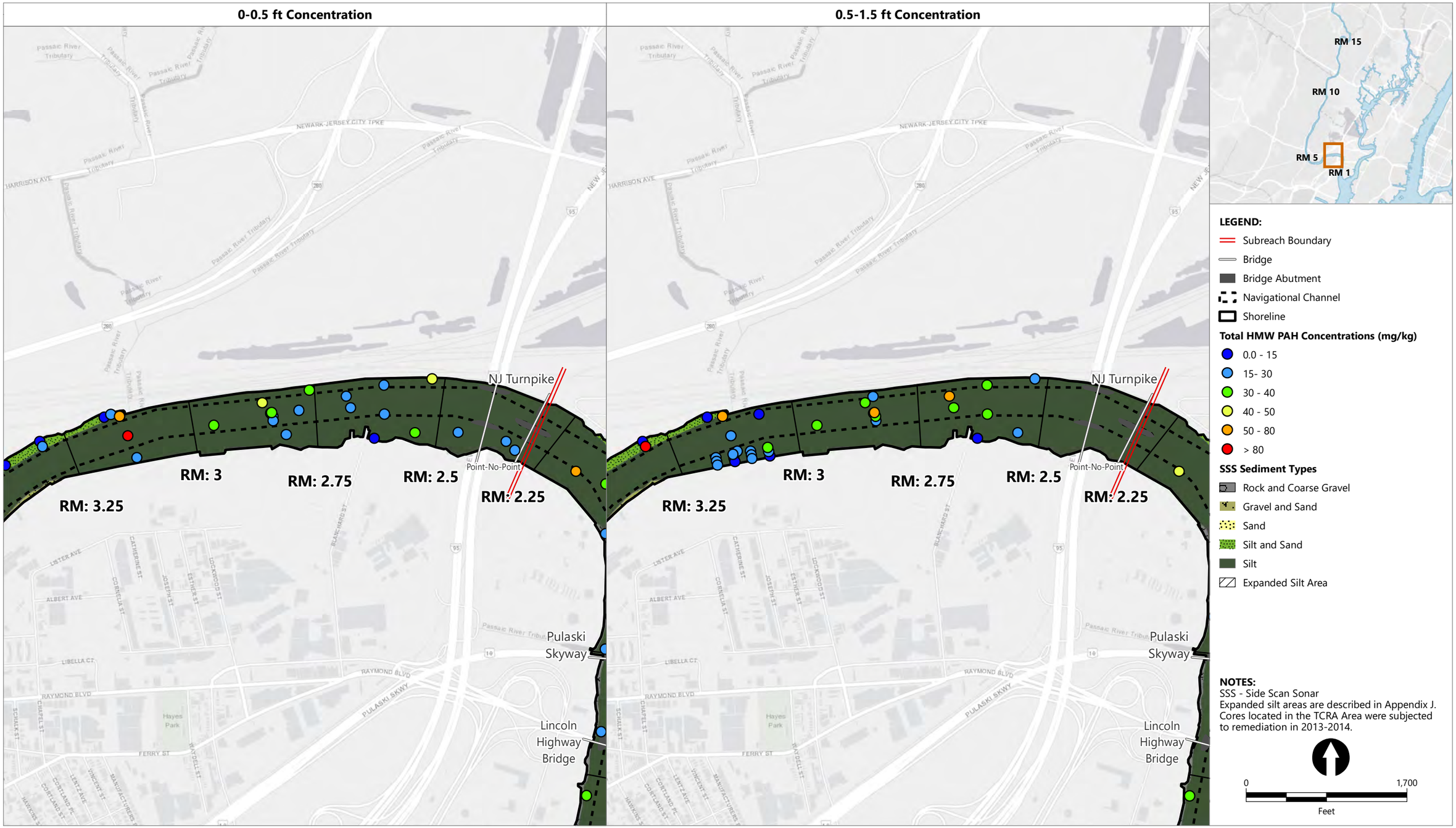

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Figure 8-8c
Surface and Subsurface Total HMW PAH Concentrations Over Sediment Type
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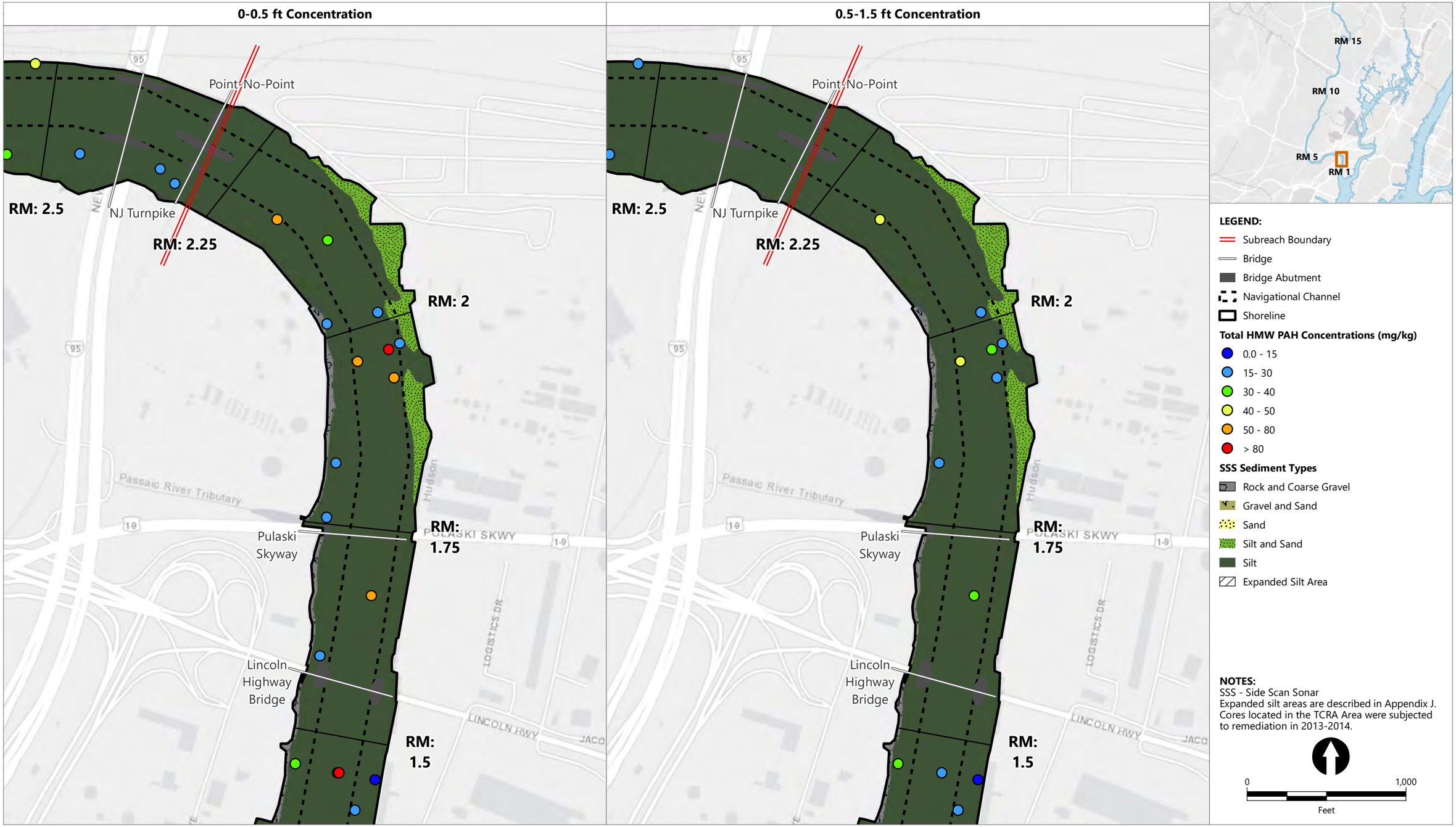

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Figure 8-9a
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Figure 8-9b
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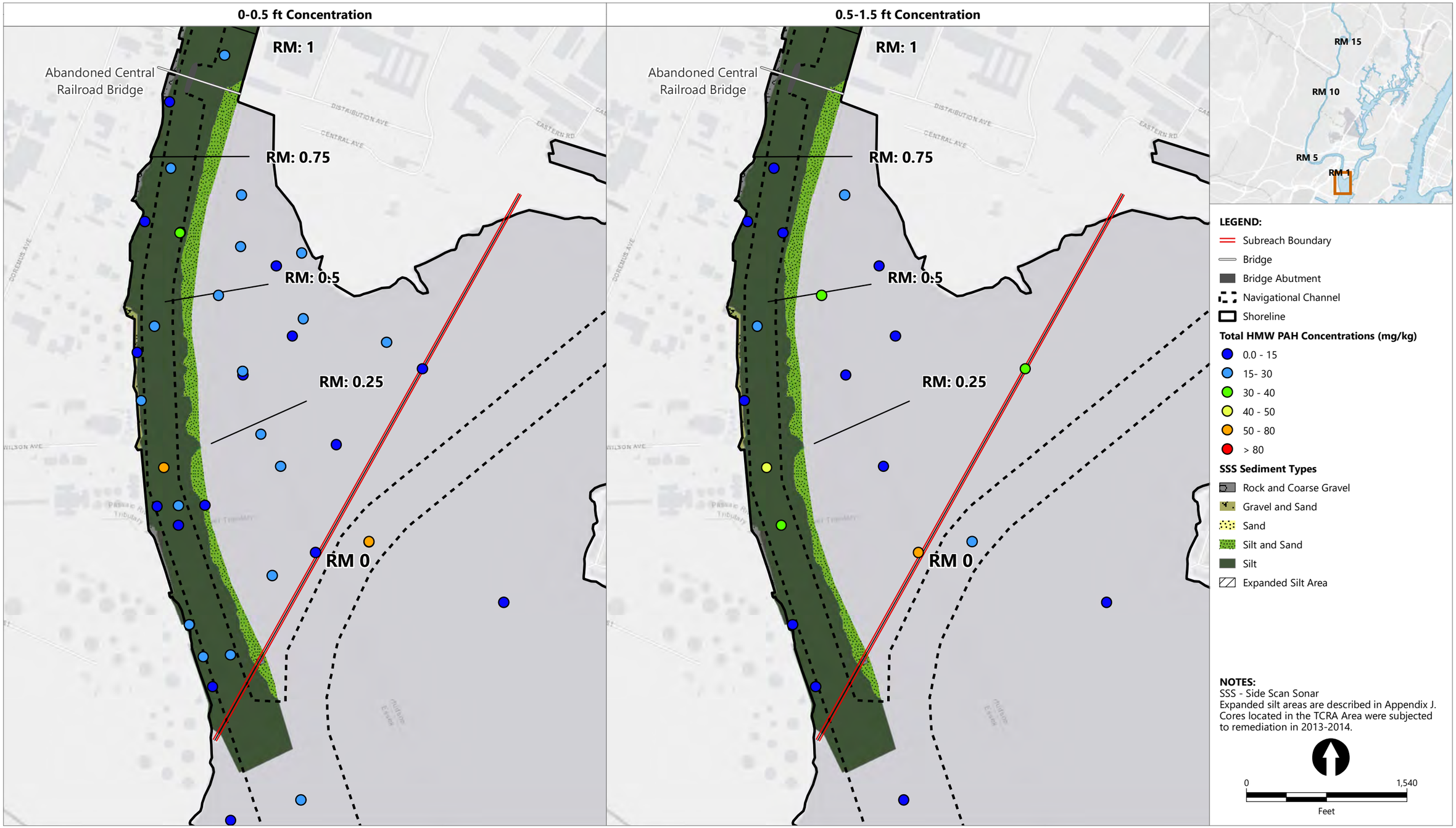

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Figure 9-1a
Surface and Subsurface Total LMW PAH Concentrations Over Sediment Type
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Figure 9-1b
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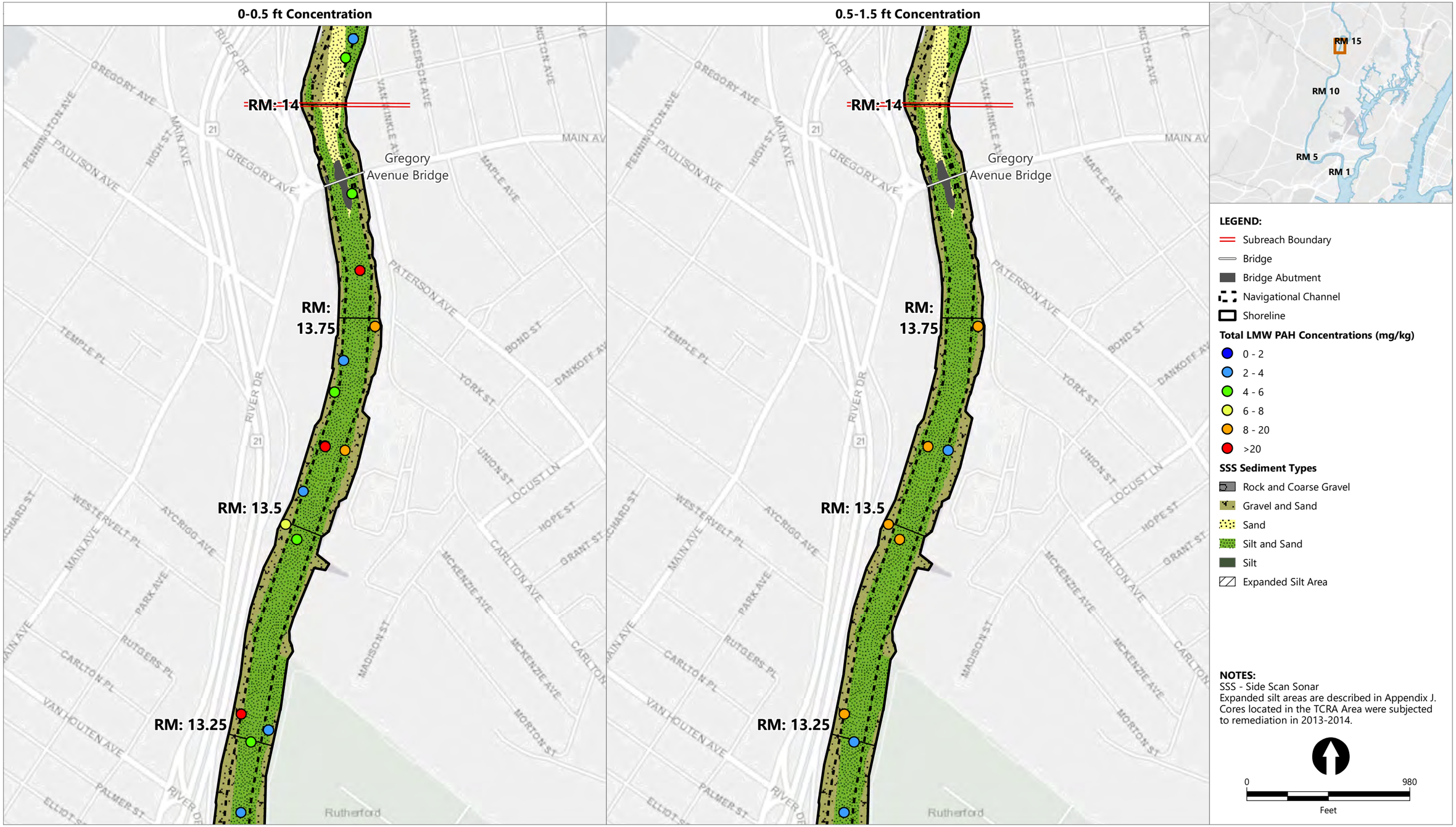

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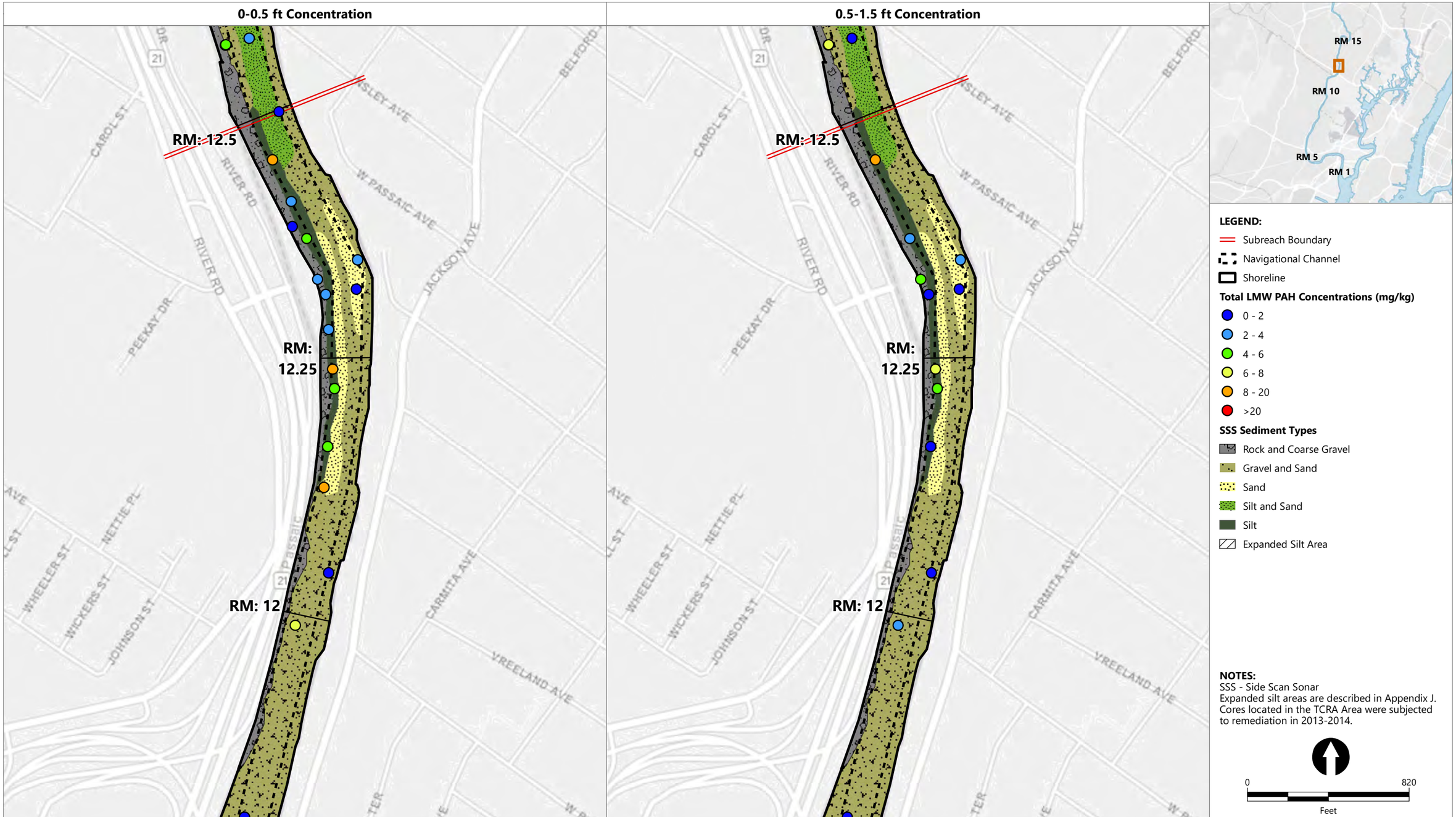

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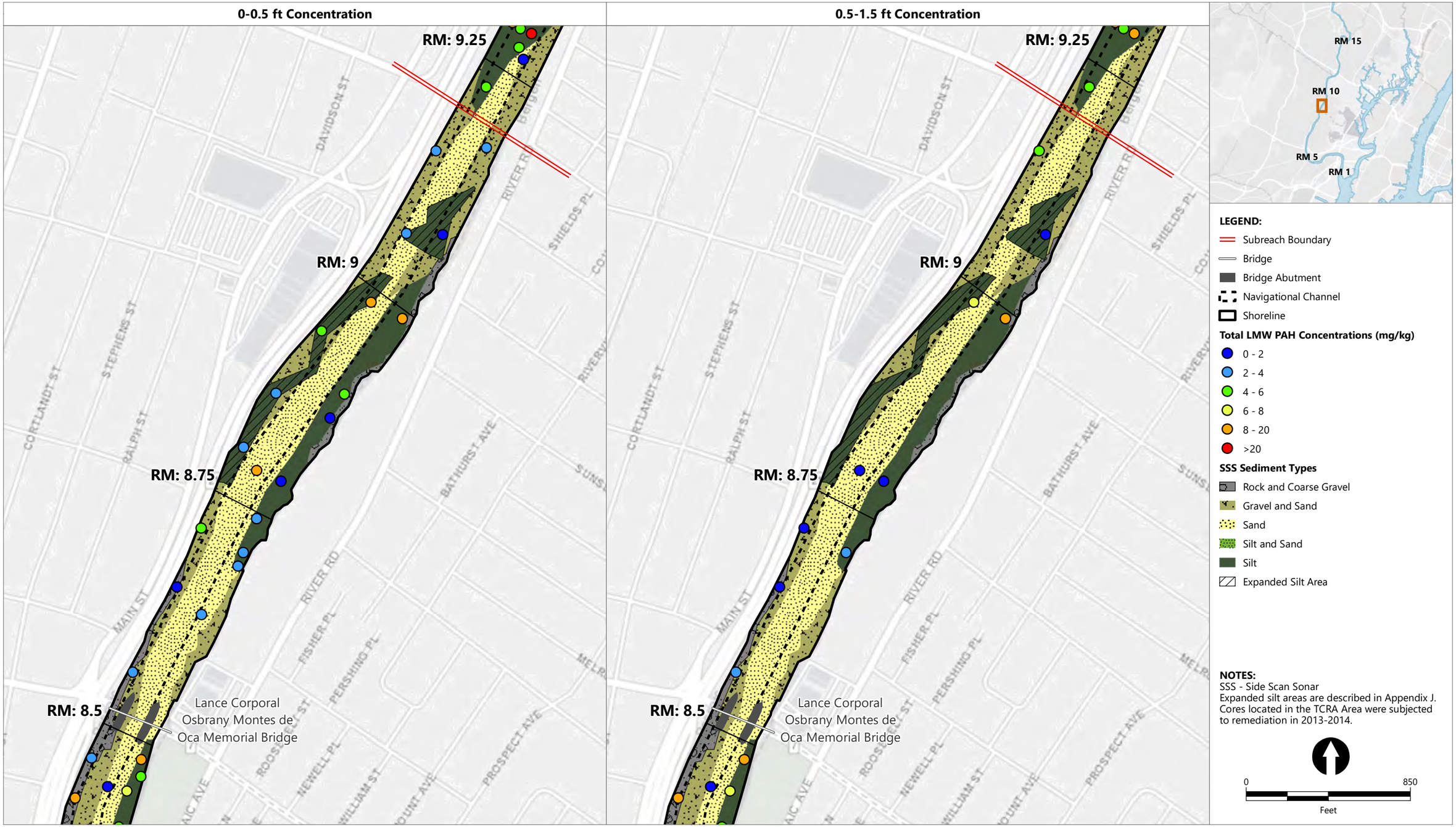

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Figure 9-7c

Surface and Subsurface Total LMW PAH Concentrations Over Sediment Type

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Figure 9-7d
Surface and Subsurface Total LMW PAH Concentrations Over Sediment Type
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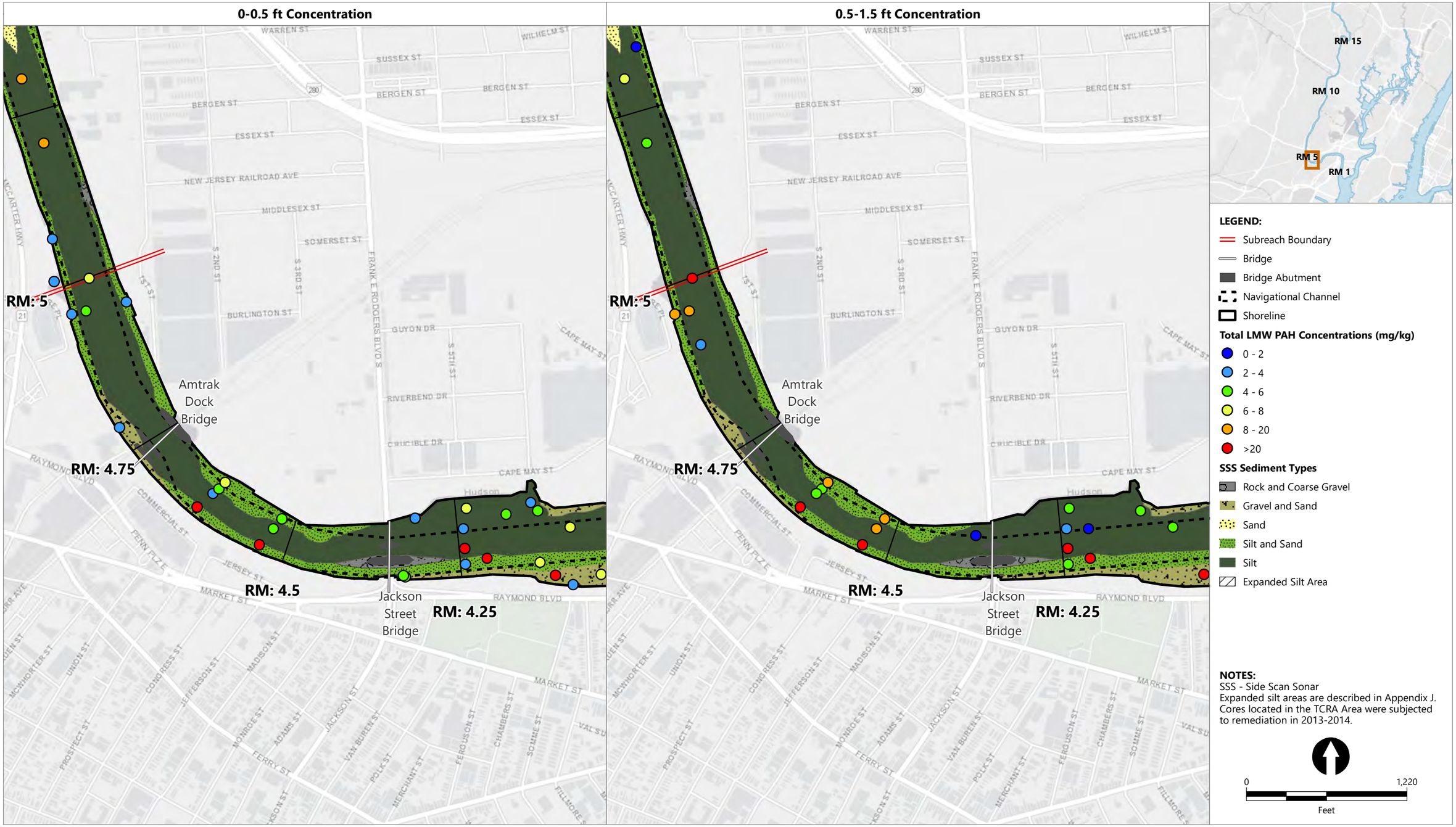

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Figure 9-8a
Surface and Subsurface Total LMW PAH Concentrations Over Sediment Type
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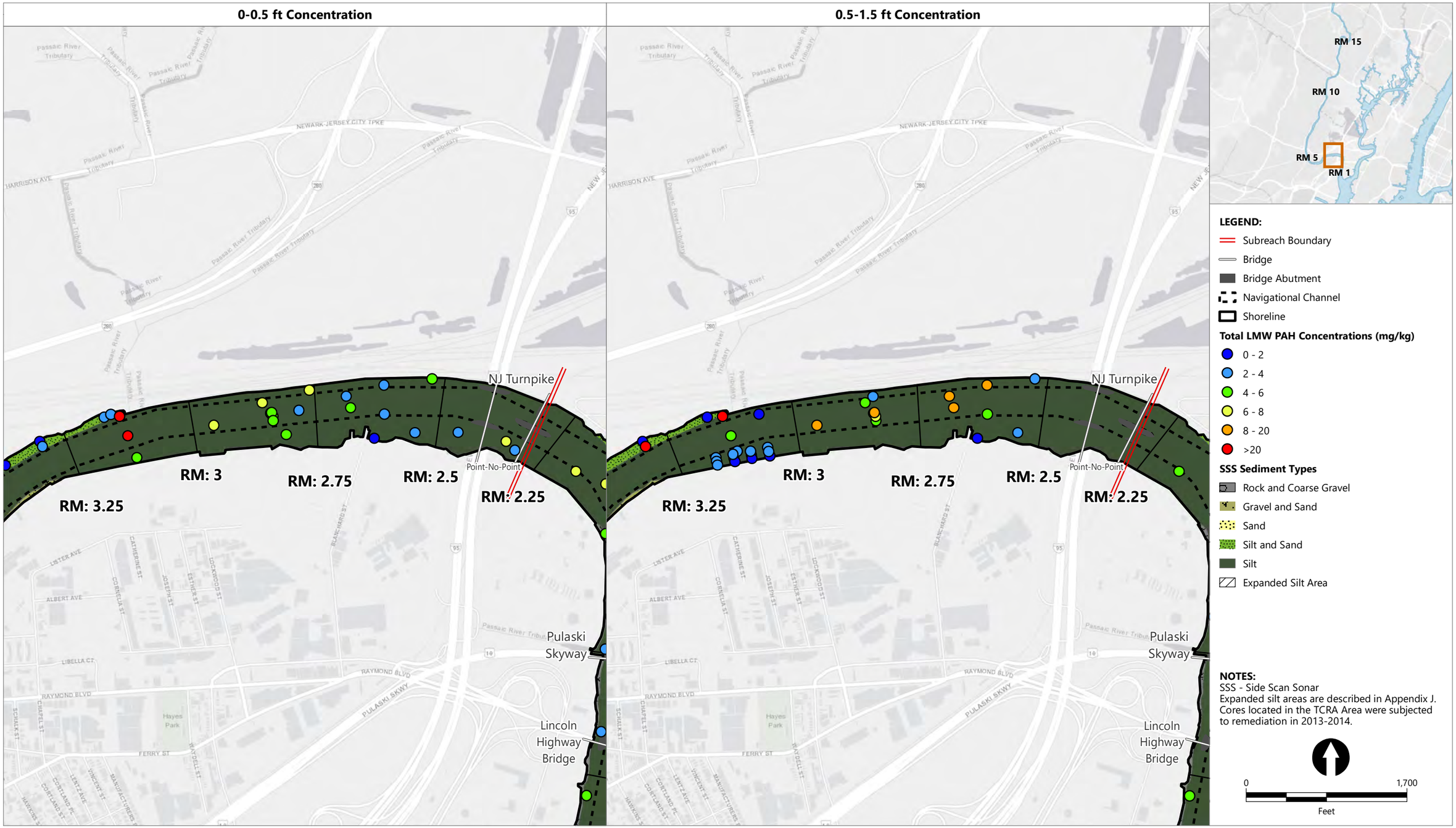

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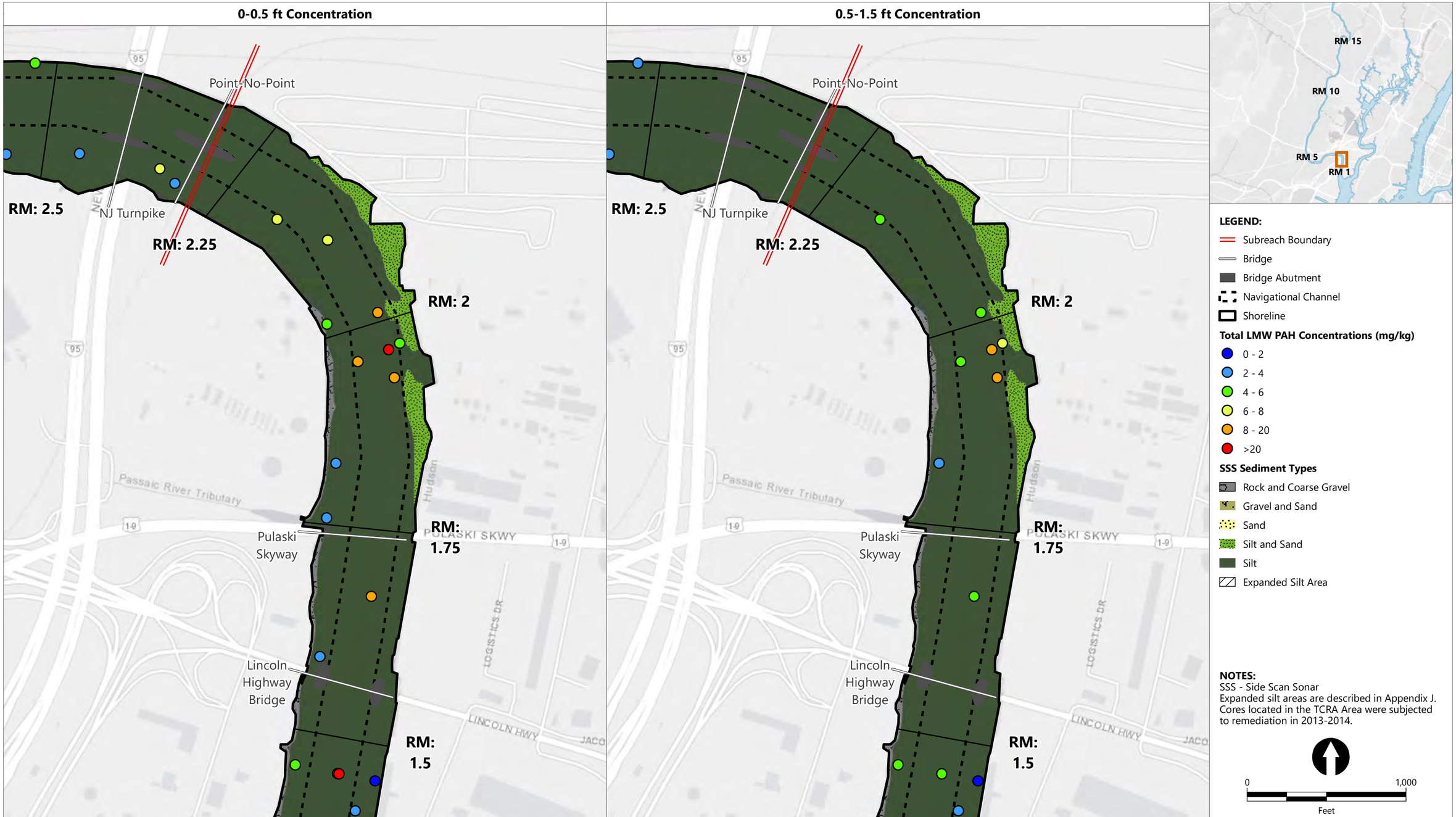

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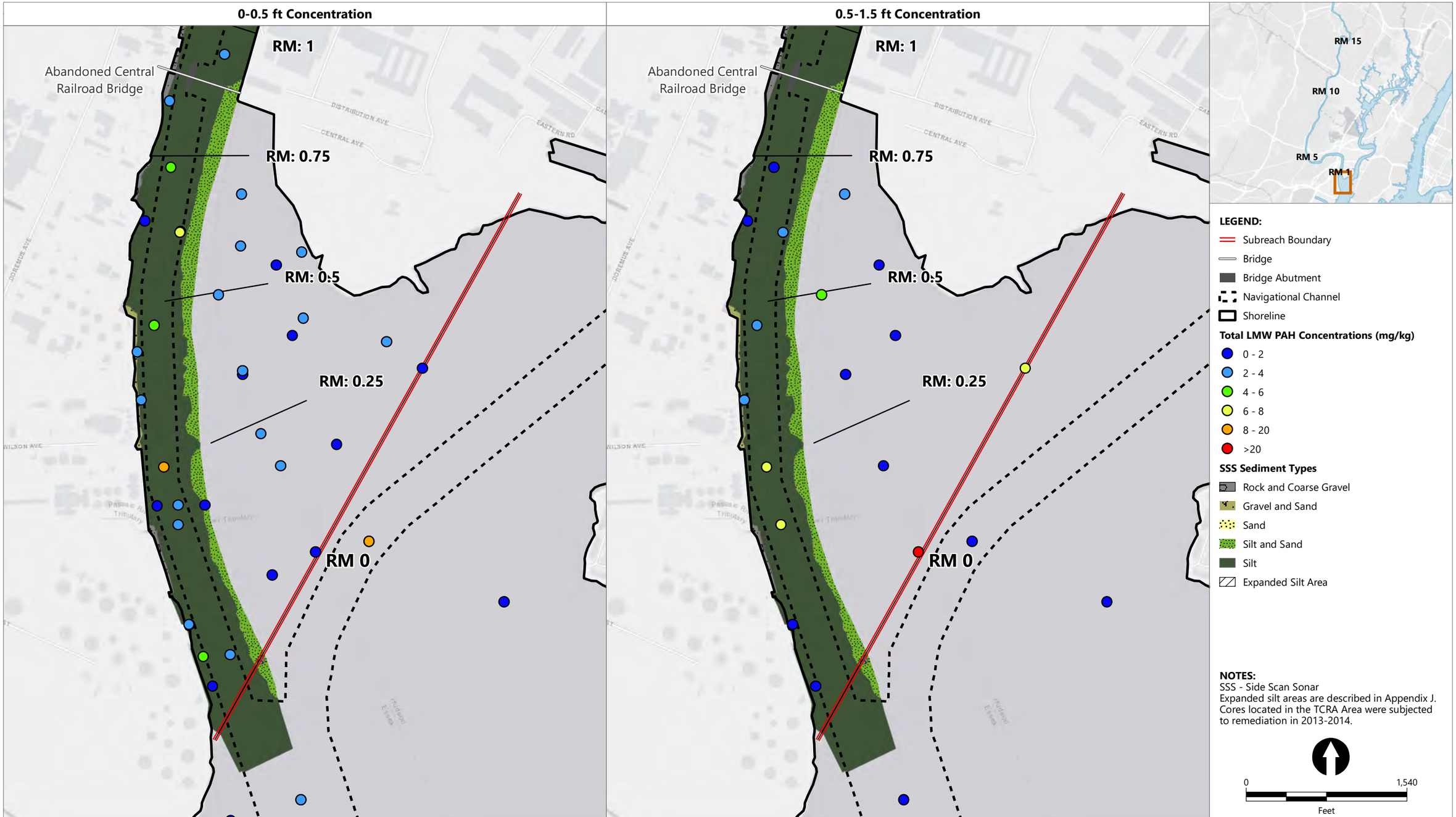

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Appendix L
Hydrodynamic Model of the LPR

Cooperating Parties Group

LOWER PASSAIC RIVER RI/FS
NEWARK, NEW JERSEY

APPENDIX L

HYDRODYNAMIC MODEL OF THE LOWER PASSAIC RIVER

moffatt & nichol

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1.0 INTRODUCTION

In the Administrative Settlement Agreement and Order on Consent ("Settlement Agreement") entered into by the United States Environmental Protection Agency ("EPA") and the Cooperating Parties Group (the "Settling Parties" or "CPG"), it was agreed that the CPG will conduct the Remedial Investigation and Feasibility Study ("RI/FS") begun by the EPA on the Lower Passaic River Study Area. This RI/FS includes conducting the Modeling Work Plan ("MWP") for the Lower Passaic River (LPR) and Newark Bay (NB) as defined in (HQI, 2006a; 2006b).

In a letter of June 12, 2008, EPA approved the proposed CPG Modeling Team ("CPG-MT") of Moffatt & Nichol and Deltares to conduct the MWP, specifically for components Hydrodynamics, Sediment Transport and Contaminant Fate and Transport. Windward Environmental was separately retained by the CPG to conduct the Bioaccumulation Modeling of the MWP. In August 2012, the CPG modified the structure of the Modeling Team incorporating Anchor QEA as the consultant responsible for the Contaminant Fate and Transport component.

The activities of the CPG-MT started in July 2008, with a 'Modeling Transfer Meeting' held with the EPA and HydroQual. During this meeting, HQI presented the status of the models to be used for the RI/FS, and an initial transfer of the computer models was made to the CPG-MT.

This report presents the work performed by the CPG to refine and calibrate/validate the hydrodynamic model for the Lower Passaic River. The modeling work for this component is an extension of the work already completed by HydroQual, Inc (HQI, 2008). The model developed and calibrated by HQI was accepted by EPA and the final report was submitted (HydroQual 2008). The CPG modeling team conducted extensive tests on the existing HQI model. In addition, work was done to further the applicability of the model through new developments and to provide information useful to the understanding of the Lower Passaic River and Newark Bay system. The investigations, developments, and analyses described herein represent the application of this model to complete the LPR/NB RI/FS modeling program.

2.0 REVIEW AND SUMMARY OF HYDRODYNAMIC MODEL AND INPUTS FROM HQI/EPA

A series of three submittals were made by HQI to the CPG containing model setups for the completed hydrodynamic modeling effort. In addition, a number of interim transfers of data and input files occurred in order to clarify and resolve issues with the models.

2.1 Calibration Setup

Four model setups corresponding to the four calibration periods were submitted by EPA/HQI to the CPG corresponding to those used and described in the Final Hydrodynamic Modeling Report (HQI, 2008). These model setups were designed to coincide with the four major periods of data collection within the Passaic River and Newark Bay reported in the Final Hydrodynamic Modeling Report (HQI, 2008). HydroQual (2008) presents the model calibration/validation results for these periods. The conclusion is that the model as presented is considered to be calibrated and can be used to proceed with additional simulations of the hydrodynamics and other modeling components.

The hydrodynamic module, ECOM was developed by Blumberg and Mellor (1980, 1987). This model uses a mode splitting technique to separate the vertically integrated equations from the vertical structure of the solution (Simons, 1974 and Madala and Piacesk, 1977). This allows for faster computational time while still maintaining the accuracy in an explicit solution of the momentum equations (external mode). The model is run in a single precision environment which allows for faster computational times. Source code for the ECOM model was submitted with the model setup of the aforementioned four simulated periods used for calibration/validation.

HQI provided time-series output files for the 2004 calibration simulation upon request. This simulation had a duration of 66 days. In addition, time-series output files for the first 30-day period of the Water Year 1995 (WY95) period and map files for the first 10 days of the WY95 period were also provided. These output files were used to determine that HQI results of the calibration periods could be reproduced exactly. Through extensive portability testing, it was found that the only way of exactly reproducing the results of the HQI models was to use the executable provided with the code. Portability issues with ECOM are tied to both the workstation operating system libraries as well as the compiler versions. Differences between the results from the same simulations using executables created using different compiler versions and under different platforms were intermittent and did not increase with the duration of the run. Differences seemed to be more pronounced in specific areas of the grid. HQI reported that portability could be improved with the increase of the smoothing parameter HORCON (horizontal viscosity) in some of these areas. The executable for the calibration runs was compiled using the PGI Fortran compiler version 6.0.8.

For each calibration period, a brief discussion of the input sources and data comparison is included in the following sections. Details of the model setup, sensitivity, and calibration

are not included, as they are discussed at length in the Final Hydrodynamic Modeling Report (HQI 2008).

2.1.1 Model Grid

The LPR model grid is specified in an orthogonal curvilinear coordinate system. The model grid in the vicinity of Newark Bay and the Lower Passaic River is shown in Figure 2-1. The model is made up of elements from i=1 to 74 and j=1 to 268. The LPR grid was created from the original SWEM and CARP models (HQI, 2008), however the CARP model did not have sufficient resolution in the Passaic River as it was meant for a more regional application. The LPR model has resolution in the lower miles of the Passaic of approximately 60 m by 180 m. A maximum of four grid cells are used to represent the Passaic River laterally (except for a short stretch of about 0.25 miles in the Harrison Reach where up to 6 grid cells are present) with approximately 10 grid cells representing a river mile along the river. The cross-channel resolution decreases up-river. Near Dundee Dam, only two grid cells are defined across the river, and 4 rows of grid cells are used to define a river mile.

In an orthogonal curvilinear system, the less orthogonal the grid cells are, the more error is introduced to the computations. It is therefore advantageous to construct a model with as orthogonal grid cells as possible. In some areas of the LPR model, the deviation from orthogonality is greater than 25%, including some areas in the Passaic River (Figure 2-2). Near the offshore boundary, the orthogonality shows a 15% deviation from orthogonal. Slight degrees of non-orthogonality are generally acceptable in computations. A detailed assessment of the error associated to non-orthogonality of the LPR model grid was not carried out under this study.

2.1.2 Bathymetry

There were three sets of model bathymetry inputs developed by EPA (HQI 2008) for the calibration simulations. The water year (WY) 1995 and WY1996 calibration periods used the TSI bathymetric survey data compiled in 1995 for the first eight miles of the LPR. For the rest of the LPR, the survey from 2004 (USACE) was used. This bathymetry remained unchanged within the model until the 2004 calibration period.

The Hackensack River was defined using the USACE survey data compiled in the mid-1990's. This remained unchanged within the model throughout the calibration periods. Bathymetry within Newark Bay and the Kills was defined for the (pre-1999) WY1995 and WY1996 calibration periods using USACE survey data. This was modified for the 2000-2002 and 2004 calibration periods using survey data from the Harbor Deepening Projects between 1999 and 2004.

The bathymetry used in the model for the Lower Passaic River is shown in Figure 2-3 through Figure 2-5 for each period. Similarly, bathymetry for Newark Bay is shown in Figure 2-6 through Figure 2-8. Especially in the Passaic River, it is noted that the bathymetry shows very strong gradients between neighboring cells in many locations in

the WY1995 model bathymetry. In addition, the former navigation channel within the Passaic River is in some places only defined by one grid cell for the Passaic River bathymetries used from WY1995 through WY2002. This can cause certain issues with the velocities and shear stresses in the model as a narrowly defined channel may cause higher shear stresses on the banks than would be reasonably anticipated. Following discussion with HQI, it was decided that it would be appropriate to change the model to a more smoothly constructed bathymetry which is more representative of the observed WY1995 bathymetry and re-validate the model using these conditions.

One specific requirement for ECOM is that initial depth at every computational cell is set to be greater than zero. Otherwise, the cell is given a mask value and is treated as a permanent dry point. This issue is apparent to a minor extent in the half mile immediately downstream of Dundee Dam where the measured bathymetry is above the vertical datum (MSL) used in the model (Figure 2-9). In order to implement boundary conditions at the Dundee Dam, it was necessary for the bathymetry to be significantly deepened, to a depth of 0.25 MSL (Figure 2-10). This could potentially invalidate the model results in the upper portions of the river, as the model depth is inconsistent with reality, and the water surface slope cannot develop in the way expected. The model has not been calibrated or validated in this stretch due to the lack of suitable data.

2.1.3 Boundary Conditions

Boundary conditions were applied at the offshore boundary of the model located in New York Bight. Surface elevation, temperature, and salinity boundary conditions were applied. Three components of the sea surface elevation were included, the effect of long-term circulation due to the cross-shelf slope, the tidal fluctuations, and sub-tidal meteorological forcing. The sea-surface elevation was specified at hourly time intervals.

The cross-shelf gradient was specified as a constant 13 cm gradient along the Nantucket Shoals boundary and a 11 cm gradient along the Cape May shelf break section of the southern boundary. This was based on the work done by Hopkins and Dieterle (1983) and Blumberg and Galperin (1990). These constants were based on the analysis done for August 1978, a typical summertime period. In both the papers cited, these conditions were applied for a summer average circulation study.

Astronomical tides were implemented with eight primary constituents extracted using the global tidal model, TPXO.2 developed by Oregon State University (Egbert et al., 1994). The tidal synthesis program included with TPXO.2 was used to generate the predicted time-series for each boundary point. This synthesis program uses interpolation of the tidal admittances in the diurnal and semi-diurnal bands to include 9 additional mirror constituents ($2N_2$, MU_2, NU_2, I_2, T_2, J_1, NO_1, OO_1, RHO_1). It also adds the long-period constituents MF, MM, SSA using the standard equilibrium forms. The time-series generated for the offshore points was generated with a time interval of 1 hour. Figure 2-11 shows that tides generated with a 1 hour time step vs. a 15 minute time step can sometime miss portions of the tidal signal especially near the tidal peaks. However, these missing

portions typically only amount to fractions of an inch in the tidal signal and any artifact in results are therefore expected to be negligible.

Sub-tidal variability is included as a 35-hour low-pass filter of the observed water levels at Cape May, Sandy Hook, and Montauk. It was found that this variability is fairly constant spatially, and is implemented as an addition to the entire model boundary condition.

A modified form of the Sommerfield radiation boundary conditions (Blumberg and Kantha, 1985) is also applied across the Cape May shelf-break function. This allows long waves to propagate and advect through the boundary.

Salinity and temperature boundary conditions are specified monthly. They were obtained from World Ocean Atlas 1998 (WOA98), published by NOAA, which are gridded data at one-degree resolution. They were adjusted to match the monthly mean temperature and salinity in the Long Island Sound, the New York Bay, and the Hudson River. The conditions are identical for each calibration period and only include seasonal variations. It suffices to say that the offshore salinity and temperature boundary conditions are essentially calibrated to conditions inside the model. From the Final Hydrodynamic Modeling Report (HQI, 2008), a value of 2.0 was subtracted from the WOA98 dataset at the boundary in order to obtain appropriate results within the model interior.

2.1.4 Discharge Conditions

The Final Hydrodynamic Modeling Report (HQI, 2008) states that fresh water inflows from 25 rivers and tributaries were implemented in the model. These data were compiled from 24 verified USGS surface water gauges for New York, New Jersey, and Connecticut. For some cases, sources that were located close to each other were implemented within the same computational grid cell for the hydrodynamic model.

HQI (2008) did a detailed analysis of the importance of the discharge temperature. The final calibration used prescriptions of a 3-day moving average of the air temperature at Newark International Airport. All other temperature inputs were based on surface temperature measured at the NOAA Battery station with missing data filled in from the Bergen Point West Reach station.

Wastewater flows from 99 wastewater treatments plants and discharges due to combined sewer outflows, and stormwater runoff at 1297 grid locations were implemented within the model for a total of 1396 inputs. The runoff volumes were computed using RAINMAN (proprietary HQI software) for New York and Northern New Jersey. Rainfall Runoff Modeling Program (RRMP) outputs were used for Connecticut and Southern New Jersey inputs to the model. These models were driven by rainfall records.

All discharge inputs to the model were specified daily. Discharge inputs to the model are specified in the top two sigma layers in the model, 50% in Layer 1 and 50% in Layer 2.

The Final Modeling Report (HQI, 2008) indicates that three major tributaries to the Passaic River, the Second River, the Third River, and McDonald Brook, are ungauged and are described as implemented in the model similar to stormwater runoff using the RAINMAN landside model to develop the inputs.

2.1.5 Meteorological Conditions

Both wind stress and heat flux conditions were implemented in the calibration models. Wind stress is computed from the wind speed and direction. The air temperature, relative humidity, barometric pressure, cloud cover and shortwave radiation are specified for the heat flux computations. All data is specified hourly within the model. The data used to construct the input conditions was obtained from five local airports, and several buoys. Wind conditions were interpolated to the grid and specified as spatially varying hourly data for the duration of the model. The heat flux conditions were specified as a constant value for the entire model domain in a time varying series.

2.1.6 Model-Data Comparisons

As mentioned previously, the hydrodynamic model performance was calibrated by HQI (HydroQual, 2008) using data from a number of different sources, and at various locations and time-periods. These datasets are summarized here to provide an overview of the extensive model calibration and validation undertaken by HQI. The datasets include:

- Quarterly temperature and salinity data collected by the Meadowlands Environmental Research Institute in the Hackensack River from 1993 onwards.

- Data were collected by Tierra Solutions, Inc. (TSI) in the Lower Passaic River during 1995-1996. Data consisted of bottom-mounted moorings measuring temperature, salinity and current meters. Transect survey data were also available. Both moored and transect data were measured at several locations within the lower 8 miles of the LPR (see Figure 4-2 in HydroQual, 2008).

- Data collected by IMCS of Rutgers University between 2000 and 2002 was used to calibrate the model in the Kills and Newark Bay. The data were collected at two locations within Newark Bay, in the Arthur Kill and Kill van Kull near their confluence with Newark Bay, and in the Arthur Kill near its confluence with Raritan Bay (see Figure 4-4 in HydroQual, 2008). These data sets were the same ones used by Pence (2004) to examine the model constructed for the region. These data included bottom mounted ADCP, bottom mounted temperature, conductivity, and pressure sensors. The sensors were rotated throughout the deployment, so there were significant gaps in the data for this time period. Two periods were chosen for calibration and validation of the Newark Bay system.

- Data collected by IMCS of Rutgers University in the Lower Passaic River in 2004. The data were collected at various locations within the lower 8 miles of the LPR (see Figure 4-5 in HydroQual, 2008). These data included measurements from

bottom mounted ADCPs, pressure sensors, and surface and bottom mounted temperature and salinity sensors.

2.1.7 Output

As described, output was provided by HQI for two of the periods. Subsequently, output was provided for the WY1996, and the calibration period in 2000.

2.2 10 Year Simulation

The necessary inputs to carry out a continuous 10-year simulation spanning the period from WY1995 through WY2004were delivered by HQI to the CPG modeling team in December 2008. This submittal also included sensitivity tests, calibration runs, implementation of sediment heat flux, and tests on the wetting and drying implementation. This section addresses the input setups for the 10-year simulation.

2.2.1 Model Grid

The model setup for the 10-year simulation included a few changes to the grid. The orientation of the computational domain in the Hackensack River was altered north of the Meadowlands. The number of grid cells remained the same, but the orientation of the computational grid was altered. Figure 2-12 shows the changes in terms of computational domain and Figure 2-13 shows the differences in the computational grid for the calibration periods and the 10-year simulation. Changes in the model grid were explained in the Semiannual Modeling Meeting with EPA that took place in March 2009. The original model grid configuration involved a rotation of the Hackensack River in model-space. This was a purely computational heuristic implemented to reduce computation time. The grid used in the 10-year simulation did not retain this rotation of the grid. It should be noted that the model results were unaffected by this change to the model grid.

2.2.2 Model Bathymetry

The model bathymetry used for the 10-year setup is the same as that used in the calibration with the notable exception of the area in the Hackensack River where the grid orientation was altered. The bathymetry within the Lower Passaic River remained constant from WY1995 through WY2002. The bathymetry changed within the Kills and Newark Bay for WY2000 to incorporate the change in bathymetry as a consequence of the deepening of the navigation channel undertaken by the US Army Corps of Engineers during this period. Bathymetric changes associated with the changes in grid orientation in the Hackensack River are shown in Figure 2-14 and Figure 2-15. Changes in the bathymetry in this region were marginal.

2.2.3 Offshore Boundary Conditions

The offshore sea surface elevation conditions for the 10-year simulation were identical to those used for the calibration conditions. They are specified monthly and are the same for each yearly period.

2.2.4 Discharge Conditions

There were 29 river discharges implemented within the 10-year model simulation as opposed to the 26 implemented within the calibration runs. These additional 3 discharges correspond to the Second and Third Rivers and McDonald Brook which were not included in the calibration run. Diffuser inputs (WWTP, CSO, SWO) are changed in two locations, the RAINMAN inputs 75 and 611 located in grid cells I,J = 48,83 and I,J = 52,77. These points are not close to the LPR and NB domain and the changes to the inputs are therefore considered marginal.

2.2.5 Meteorological Conditions

The meteorological inputs for the 10-year simulation are identical to those used for the calibration conditions.

2.3 2005 Verification Period

Model inputs for an additional period corresponding to water year 2005 was prepared by HQI. The model performance during this period was compared by the CPG-MT against data collected by Dr. Chant at Rutgers University (IMCS) during 2005. This included limited data collected during a significant storm event in April 2005. The data included fixed moorings at six mooring locations in the lower 6 miles of the LPR during Fall 2004, Winter 2005, and Summer of 2005. The mooring deployments that are focused on in this analysis were deployments (DOT) 2 and 3 in Winter and Summer of 2005, respectively. These mooring locations are shown in Figure 2-16 and Figure 2-17 and were distributed in the lower 8 miles of the LPR. The types of sensors at each location in the two deployments are shown in Figure 2-18 and Figure 2-19 as provided by IMCS at Rutgers University. Shipboard surveys were also conducted in the LPR and NB. There were a total of 12 cruises conducted from the summer of 2004 through the summer of 2005. No moorings were present during the storm event of 2005, so the only verification for high flow conditions is the data collected during the shipboard surveys.

Using data collected at the mooring locations, time-series of model and data are presented in order to compare model performance. For all comparisons, model velocities were extracted in model space, so that the dominant velocities along the channel are the V velocities in the model. The magnitudes of the velocities were computed and assigned a sign based on the channel direction. The magnitude of the measured data was computed in the same way. Therefore, all velocities shown have positive values during flood and negative values during ebb.

Figure 2-20 shows the discharge conditions during Deployment 2. This period starts with moderately high flow conditions of ~120 m^3/s (at Little Falls) declining to relatively average flows towards the end of the deployment. During Deployment 2, ADCP current measurements were taken at Station M2a, and ADP measurements were taken at Station M2b. Station M2a was moored in the channel, while Station M2b was moored near the bank. Figure 2-21 shows the comparison of surface and bottom velocities for Station M2a, which is located within the channel. The model performance metrics in terms of the absolute and relative RMS errors and the coefficient of determination are also shown. The model at this location tends to somewhat over-estimate the surface velocities during flood, and underestimate the ebb velocities during neap. The relative RMS error however, is less than 10%, and the coefficient of determination relatively high at 0.89. At the bottom bin, the model appears to under-predict the flood velocities, while the ebb velocities are relatively comparable to data. Overall, model results for currents compare reasonably well to data at this channel location.

Figure 2-22 shows the comparison of surface and bottom velocities for Station M2b, which is located on the shallows of the river. The model does not perform as well at this location as in the channel. The relative RMS error between model and data at Station M2b is slightly greater than 10% with relatively lower R^2 of 0.63 for both surface and bottom. Model results for the surface layer appears to compare better than the bottom layer which is typically under-predicted, especially the peak ebb velocities. In addition, during the high-flow period at the beginning of the deployment, there is a phase difference in the timing of slack water between the model and the data. These limitations in model performance may be related to artifacts of grid resolution.

In addition to velocity, salinity data were collected at 1 m from the surface and 1 m from the bottom at 6 locations as shown in Figure 2-16. Model salinity was compared to these measurements for available reliable data. Figure 2-23 shows the salinity comparisons at M1. The model appears to match the observed salinity conditions at this location during spring tide reasonably well. However, the salinity conditions during flood tide in neap conditions is significantly under-estimated. The relative RMS error between the model-predictions and observations is nearly 20% at both the surface and the bottom. Figure 2-24 shows salinity comparisons for station M2a. Data near the bottom was unreliable during this time period and is not displayed. The surface layer compares well but does appear to not capture the peaks of the salinity. The relative RMS error is over 15%. Figure 2-25 shows comparisons at Station M3. The surface layer compares well with a relative RMS error of less than 10%, while the model appears to predict less saline conditions in the bottom layer than observed, more so during neap (before December 4th and around December 22nd). During spring (around December 15th), near-bottom salinity calculated by the model is more comparable to the data. Figure 2-26 shows similar comparisons at Station M4. The data in the bottom layer were unreliable, and are not shown. In the surface layer, both the data and the model show primarily fresh conditions in this time period. The model reproduces the change from fresh to more saline conditions around December 18th. Similarly, the salinity conditions at Station M5 are shown Figure 2-27. The model correctly predicts fresh-water conditions during most of this time period, while capturing

the change from fresh to more saline conditions around during the low flow periods around December 24th.

Discharge conditions during Deployment 3 are very low – with maximum discharges of about 30 m^3/s as shown in Figure 2-28. Velocities during this deployment were collected at Station M1. From the diagram shown in Figure 2-17 it appears that the mooring of the ADP was located not in the center of the channel but more towards the edge of the channel. Figure 2-29 shows the comparison of surface and bottom velocities for Station M1. The model tends to show greater ebb-dominant currents than noted in the data at the surface, especially during neap; the model tends to under-predict flood velocities and over-predict ebb velocities. However, the overall relative RMS error at the surface is just about 6%. In contrast, the model consistently under-predicts the near-bottom velocities during both flood and ebb, with a relative RMS error of over 9%. These features are indicative of flow patterns expected on the shallows of the LPR rather than in the channel; this may be an artifact of the grid resolution, with the model reproducing features more representative of the shallows. Figure 2-30 shows the comparison of measured and model-calculated surface and bottom velocities for Station M2a within the channel. In general, surface currents appear very well correlated with the data, although the peaks during both flood and ebb seem to be over-estimated resulting in a relative RMS error of over 11%. In the bottom layers, the model appears to capture the flood velocities, while overestimating the ebb currents for an overall relative RMS error of about 10%.

Salinity comparisons during DOT3 are shown in Figure 2-31 through Figure 2-36. CTD sensors were only present in the surface layer at M1 and near the bottom at M6. Some of the data appears unreliable, for example the latter half of the near-bottom time-series at M2a which shows limited intra-tidal variability as well as values lower than surface measurements (Figure 2-32), the flat-lining noted towards the end of the time-series in the near-bottom measurements at M3 and M4 (Figure 2-33 and Figure 2-34). In addition, the near-bottom salinity at M5 (Figure 2-35) does not have the intra-tidal variability seen in other near-bottom stations. Overall, salinity results for these low-flow conditions appear to compare well with measured values. The model reproduces the major features seen in the data – intra- and inter-tidal variability, and the response to the flow event of July 10th.

In addition to comparing model performance to long-term time-series measurements at fixed locations during moderate to below-average flow conditions, the model performance was assessed during an extreme river flow event on April 5, 2005 when the flow at Little Falls peaked at about 12,000 cfs. A series of shipboard measurements of salinity performed by Dr Chant of Rutgers University within LPR and NB provide a snapshot of the salinity distribution within the LPR and NB and information to assess the response of the salt wedge to the elevated river flow. Figure 2-37 shows a comparison of the measured and model-calculated salinity distribution longitudinally within the LPR and NB. The model results were extracted at 15:30 on 5 April 2005, corresponding to the period when the measurements were taken. KM 0 on the x-axis corresponds to the beginning of the survey in the southern part of Newark Bay and not the mouth of the Passaic; according to this frame of reference the mouth of the LPR is at approximately KM 7. This is so as to be able to compare the full results of the shipboard survey. This flow event was preceded by a

period of relatively low flows during which the salt front is expected to have been located well within the LPR. As seen in the data, due to the elevated river flow, the salt front is pushed down to the mouth of the LPR, a trend captured by the model as well. Both the location of the salt front as well as the salinity values in NB are well reproduced by the model.

The qualitative comparison of the model to the 2005 data collection efforts (both moored and shipboard surveys) indicates that the model performs well under varying conditions. Specifically, the comparison of the post-storm salinity contours indicates that the model reproduces the density structure in the system even under storm events with a return period close to 10 years. The comparison to the time-series data also shows that the model is able to capture the gradual process of salinity intrusion up-estuary during the low-flow periods following higher flows.

In addition to the model-data comparisons of velocity and salinity for the individual layers in the water column using the moored deployment data, model performance has also been assessed relative to the vertical gradient in velocity, salinity, and mass flux. This is of relevance because of the depth-dependent residual transport of suspended and dissolved matter. Therefore, it is important to quantify how strong the tidal-residual near-bottom upstream or near-surface downstream residual mass transport of (eroded) sediment is. The stronger this residual mass transport, the more suspended sediment may leave or enter the Passaic river. Figure 2-38 shows the flow at Little Falls (top panel), the comparison of model and data for the surface-bottom along channel velocity gradient (panel A), the surface-bottom salinity gradient (panel B), and the instantaneous salt flux (calculated as product of velocity and salinity) for near surface (panel C) and near-bottom (panel D). From these comparisons, it can be seen that in the surface layer, the model transports similar salt mass during neap tides as noted in the data but more salt mass during spring tides than noted in the data. Near the bottom of the water column, the mass transport appears to be similar over the entire spring-neap cycle. These comparisons suggest that the model performs reasonably well in reproducing the salt flux during most conditions and depth-intervals; the main exception is the surface depth-interval during spring tides where the model tends to over-predict during both ebb and flood.

2.4 Additional water year inputs provided by HQI

In addition to the 10-year setup described previously (from WY1995 through WY2004), and the inputs for WY2005, HQI also developed inputs for additional years. In particular, the following set of inputs were provided for the model:

- WY2006
- WY2007
- WY2008
- WY2009

- WY2010
- WY2011
- WY2012
- WY2013

The model bathymetry provided for WY2008 onwards reflects the post-dredge conditions of the NY-NJ Harbor deepening project within the navigation channels of NY harbor, the Kill van Kull, Arthur Kill, and Newark Bay.

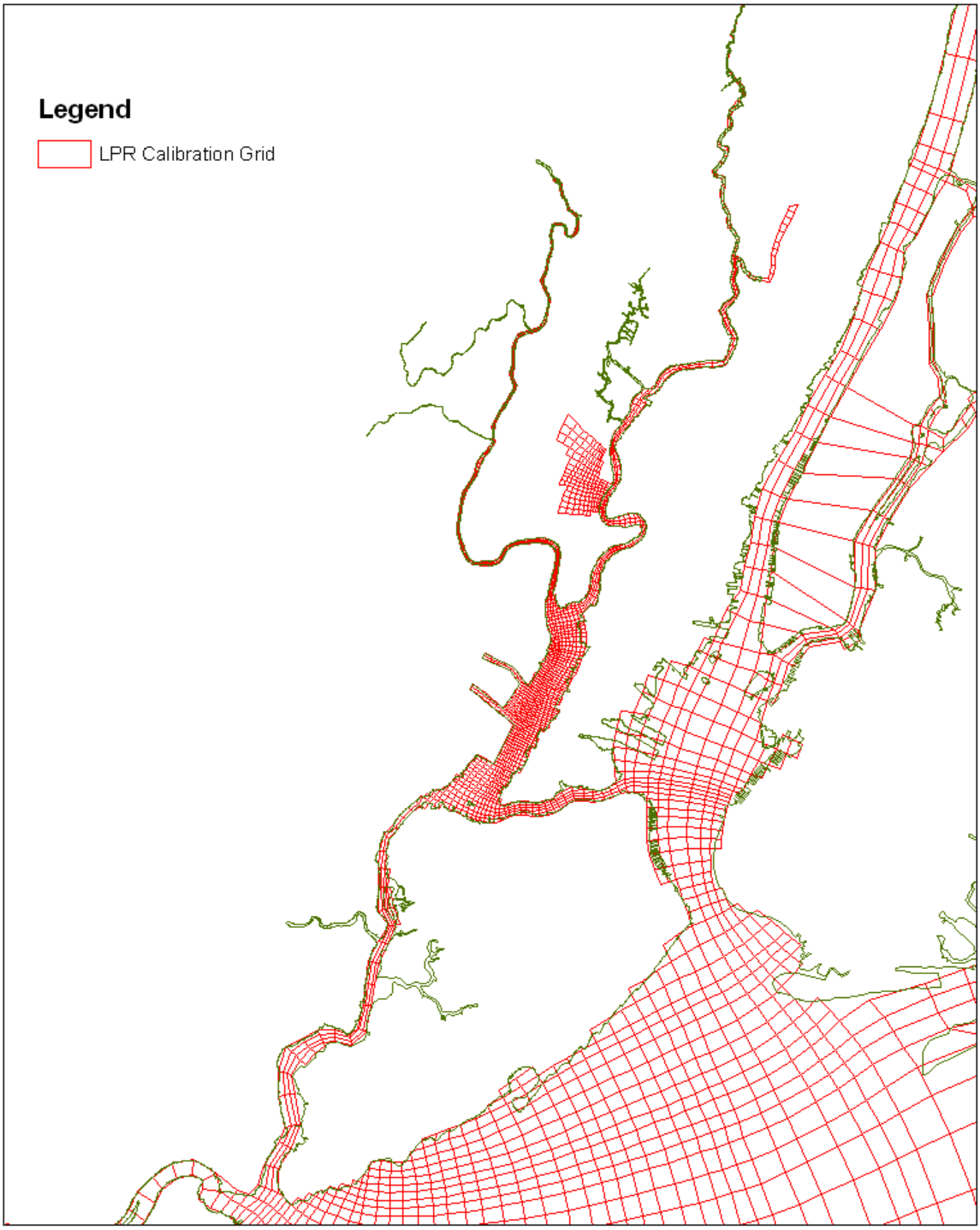


Figure 2-1: Calibration Model Grid

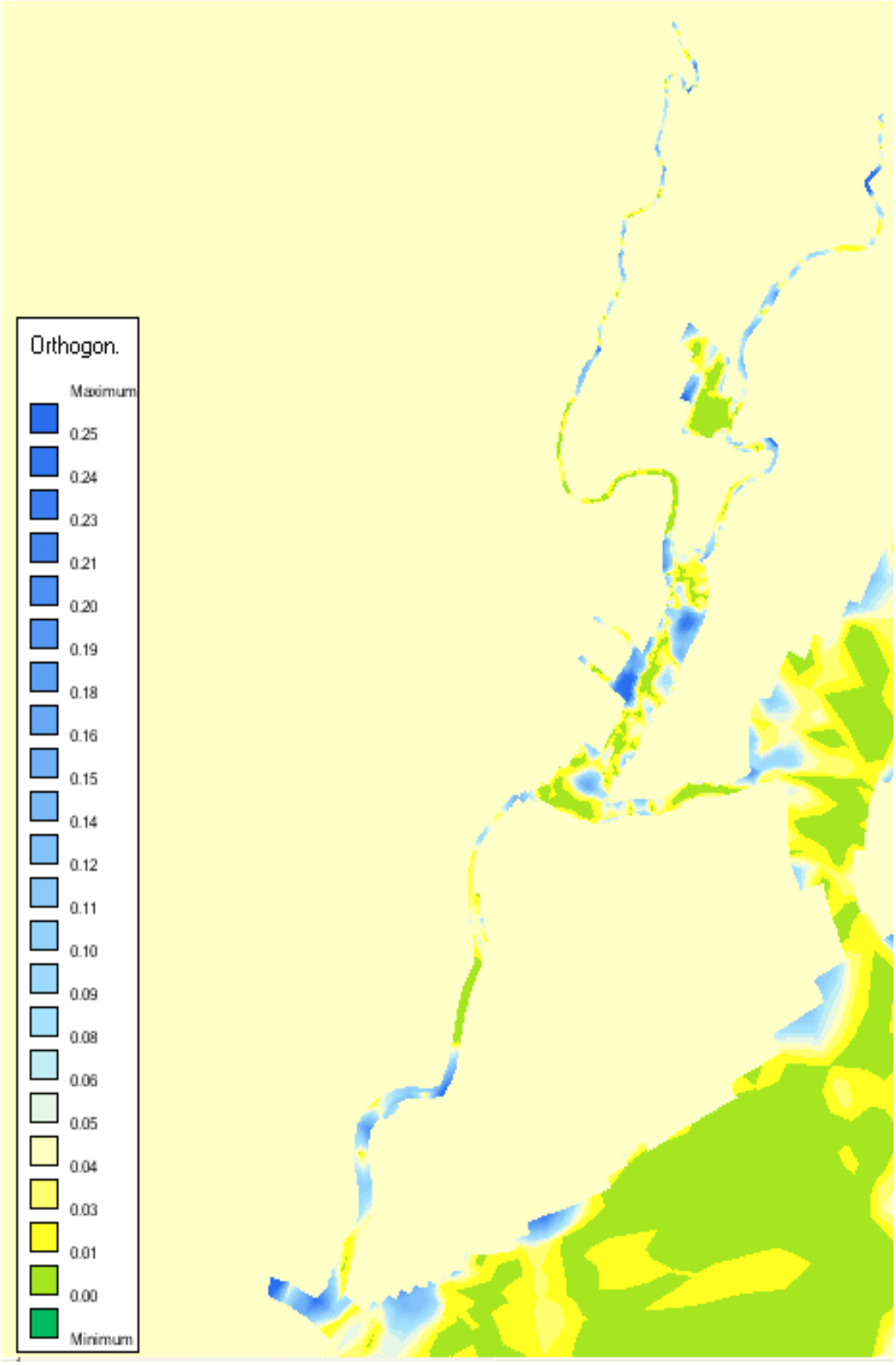


Figure 2-2: Orthogonality in LPR

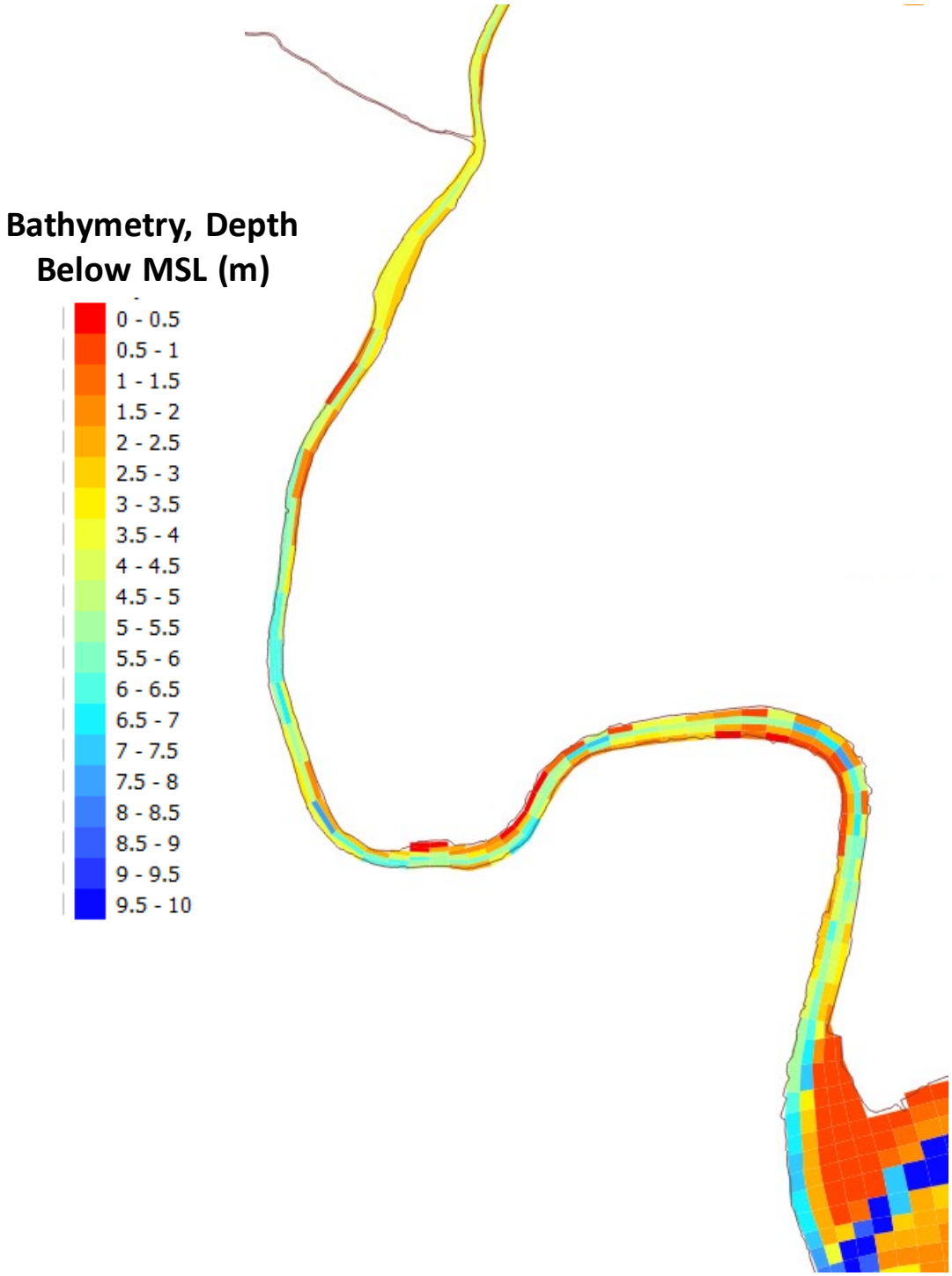


Figure 2-3: Passaic River Bathymetry (1994)

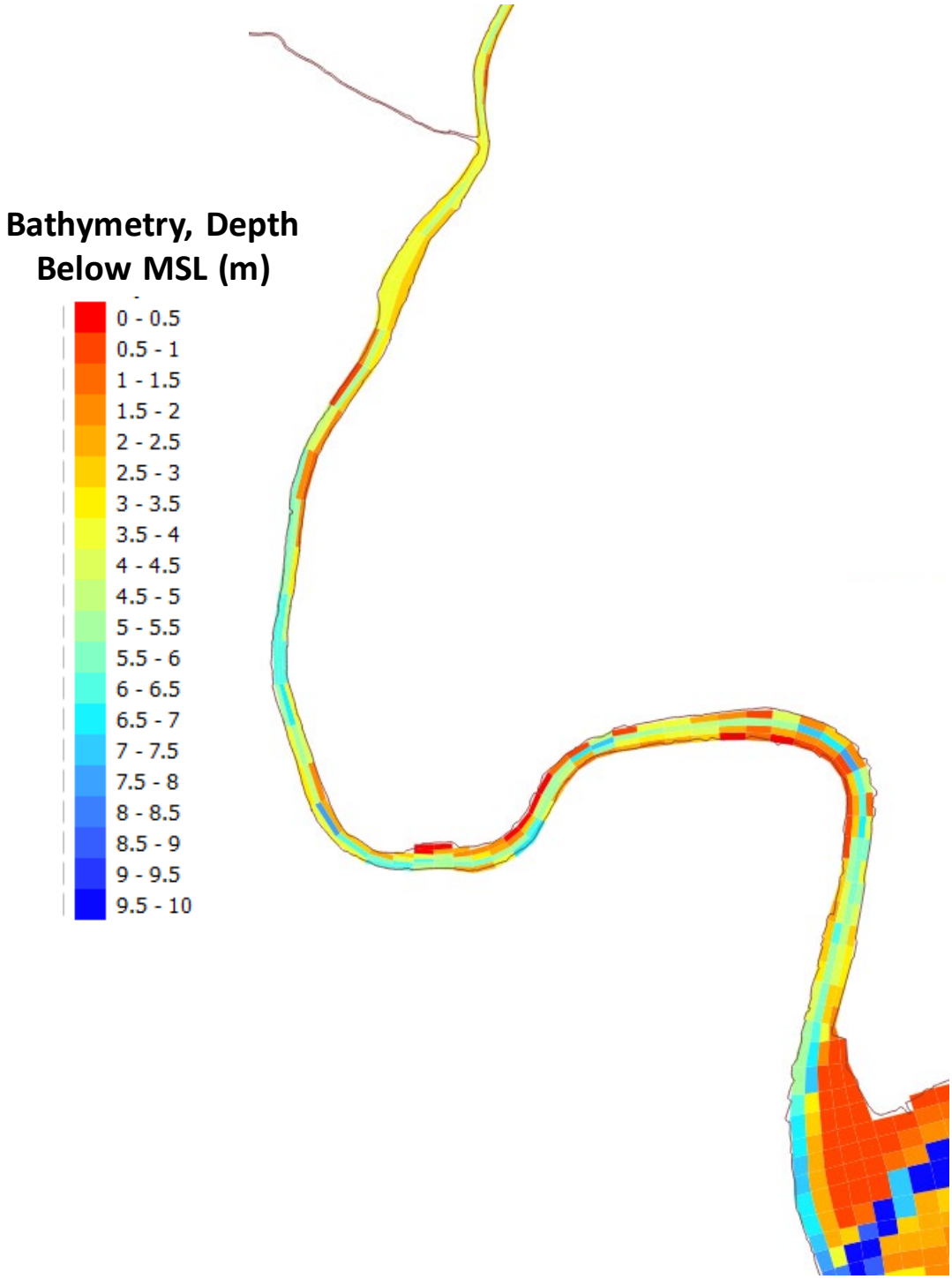


Figure 2-4: Passaic River Bathymetry (2000-2002)

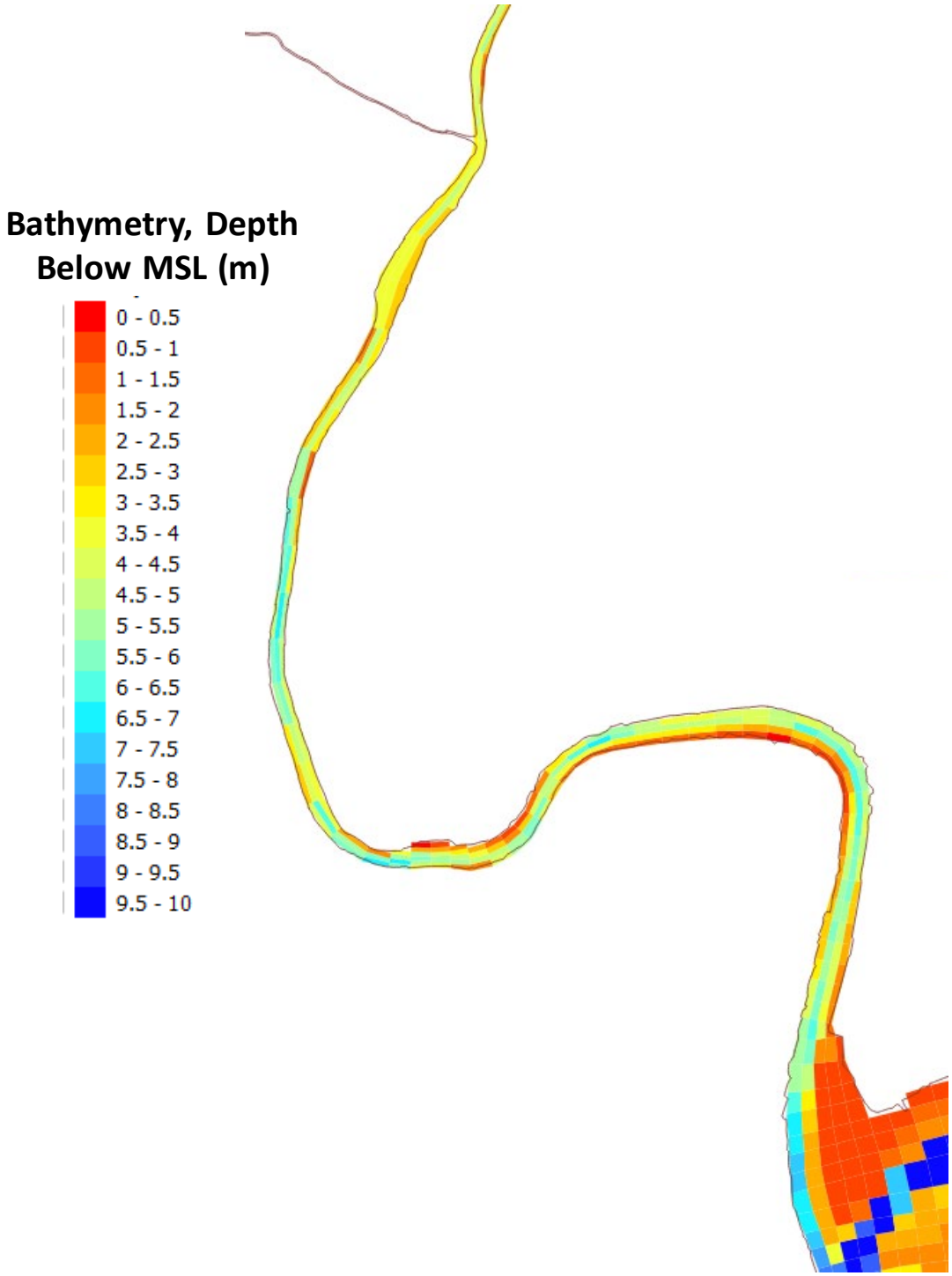


Figure 2-5: Passaic River Bathymetry (2004)

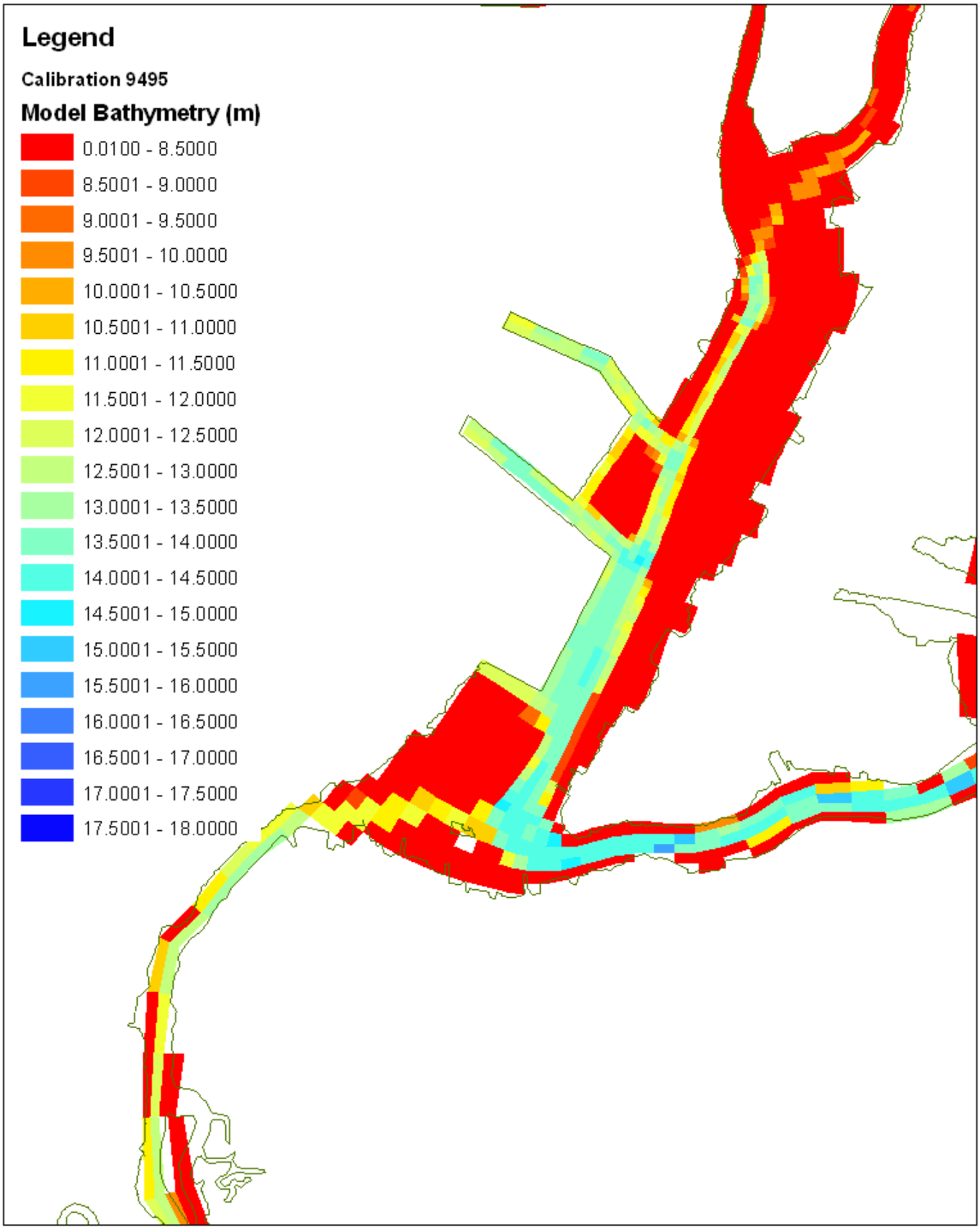


Figure 2-6: Newark Bay Bathymetry (1994)

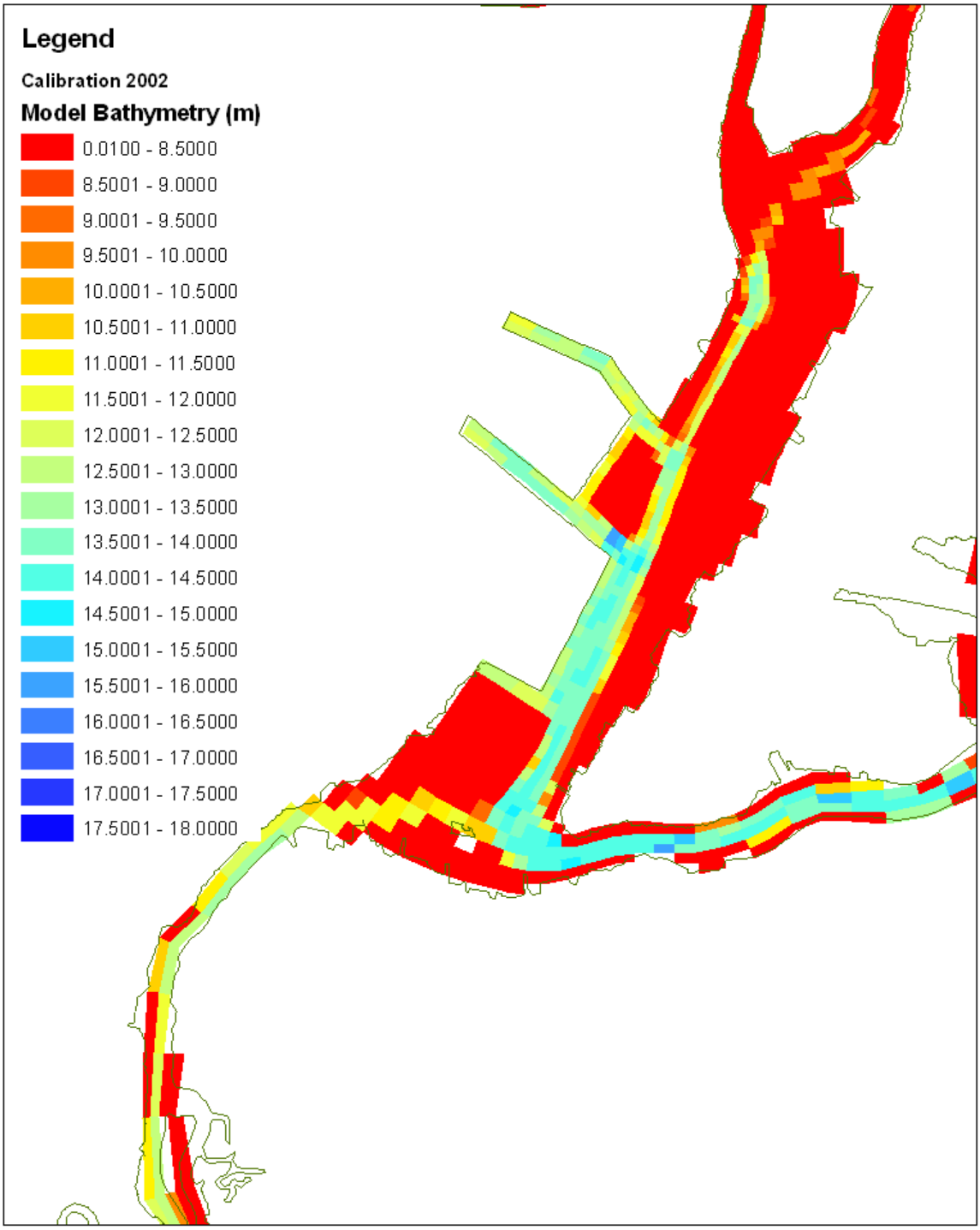


Figure 2-7: Newark Bay Bathymetry (2000-2002)

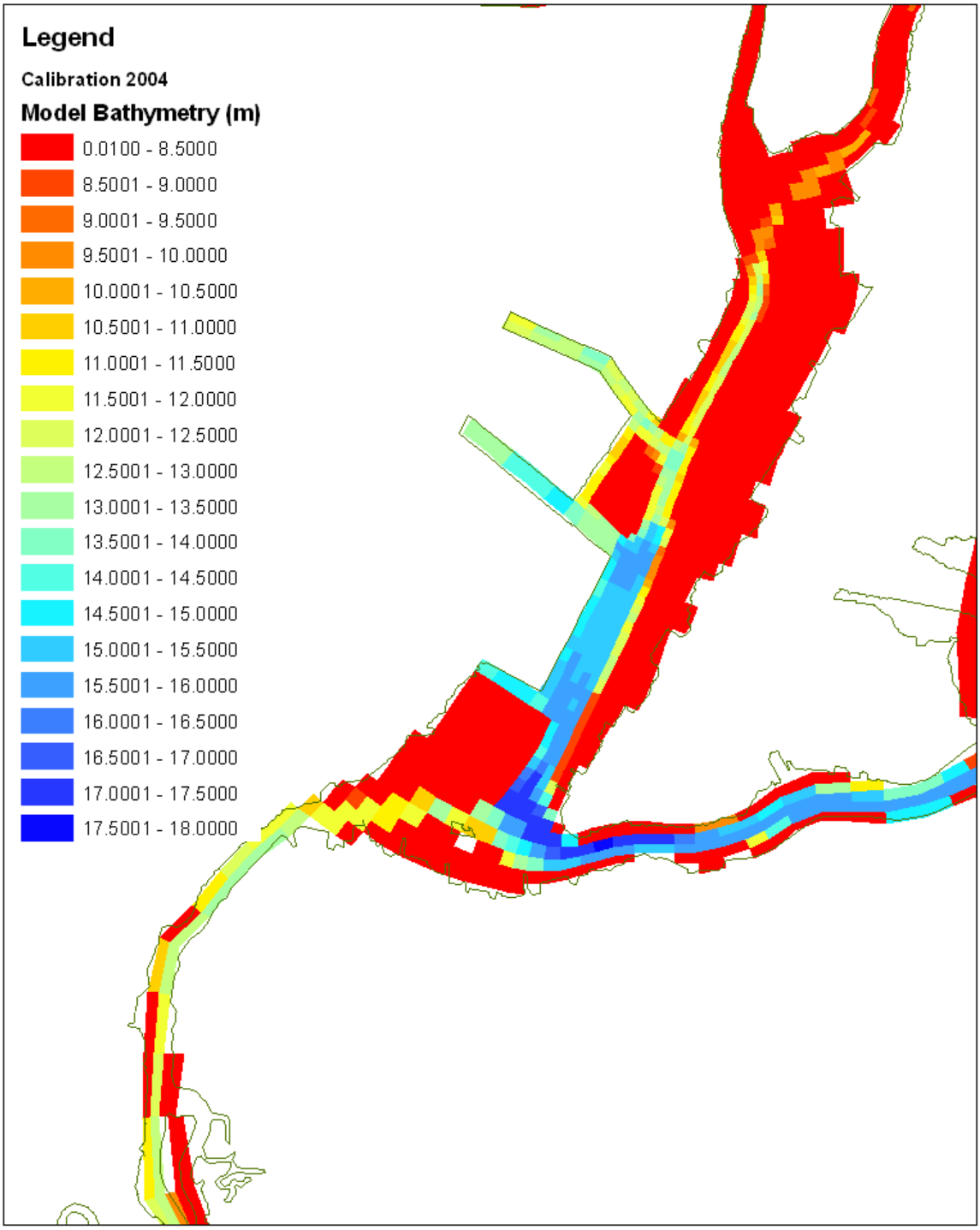


Figure 2-8: Newark Bay Bathymetry (2004)

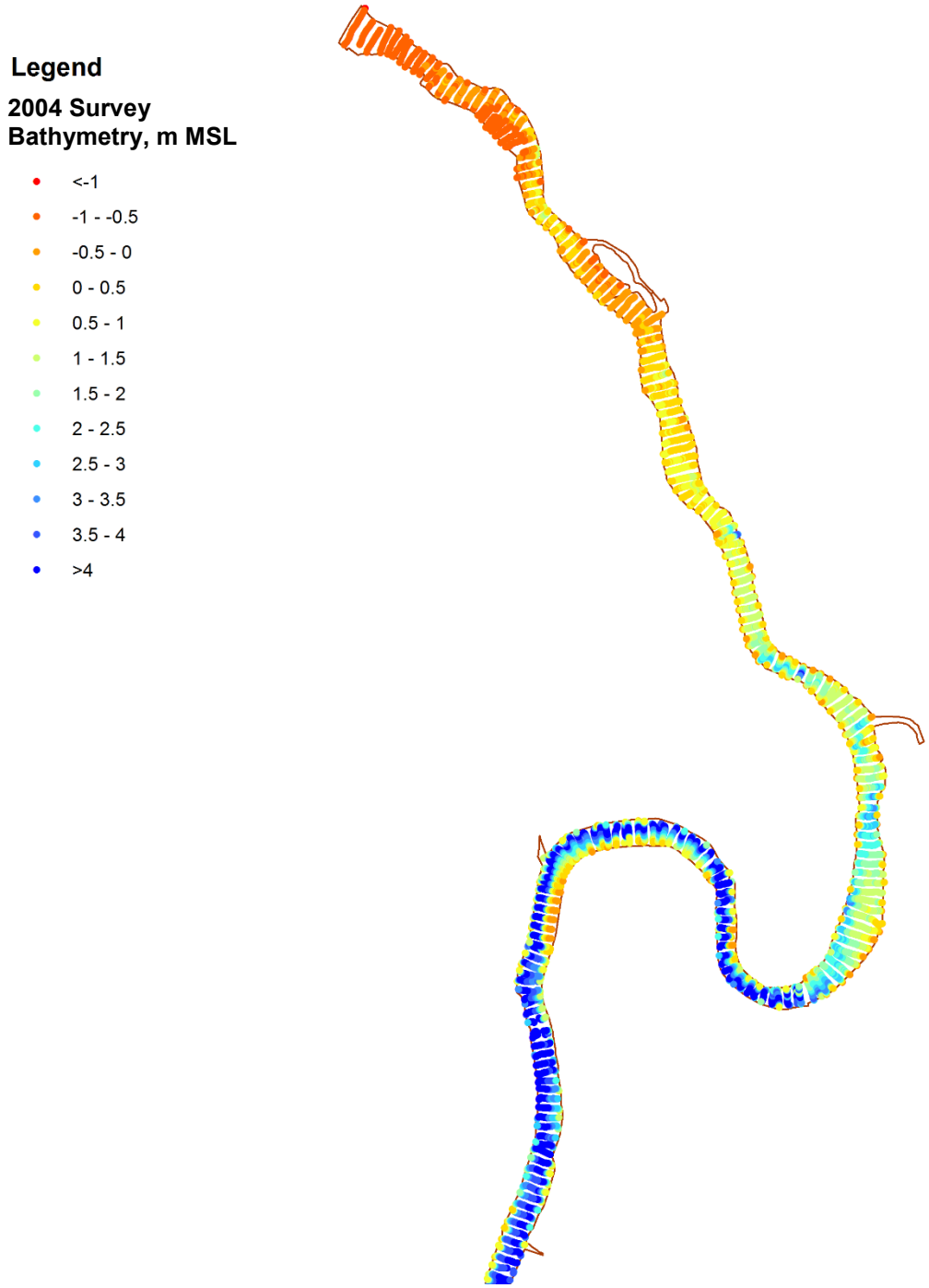


Figure 2-9: 2004 Bathymetry Upper Passaic

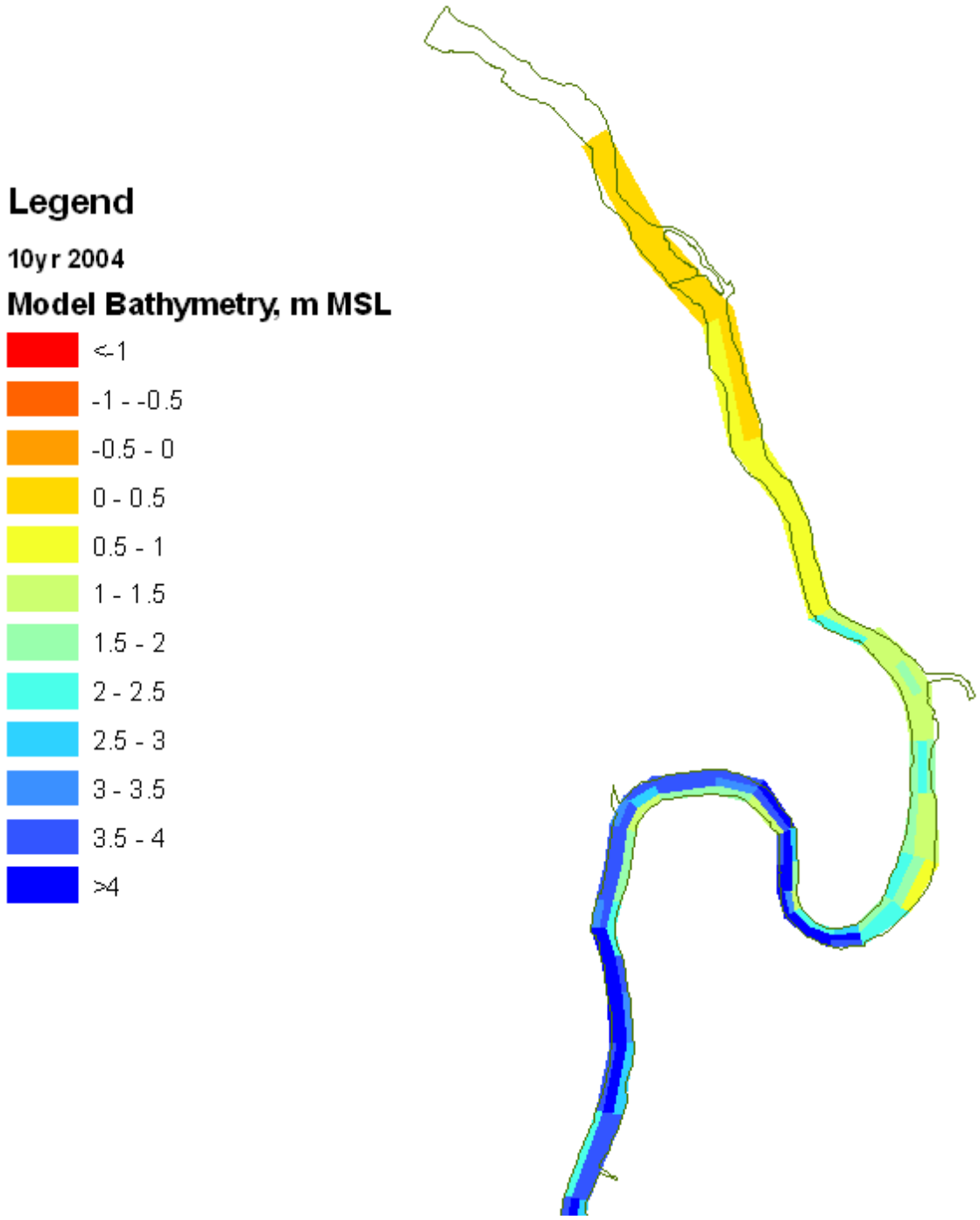


Figure 2-10: Model Bathymetry Upper Passaic

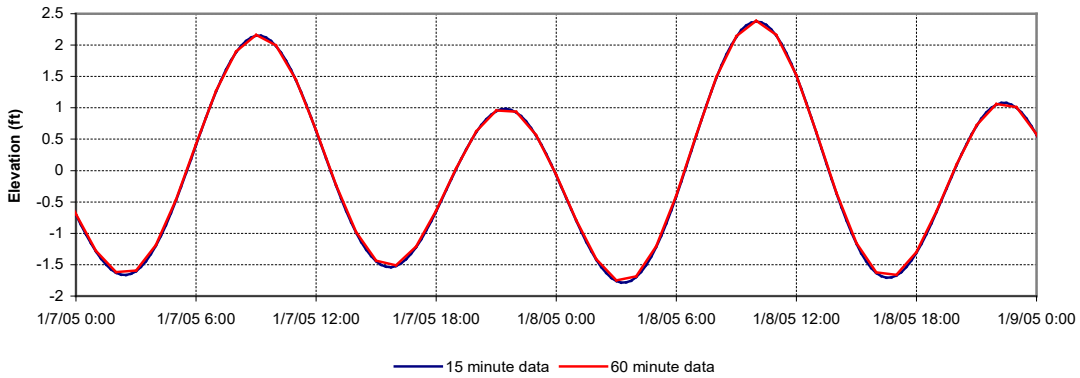


Figure 2-11: Differences in 15 minute and 60 minute elevation data

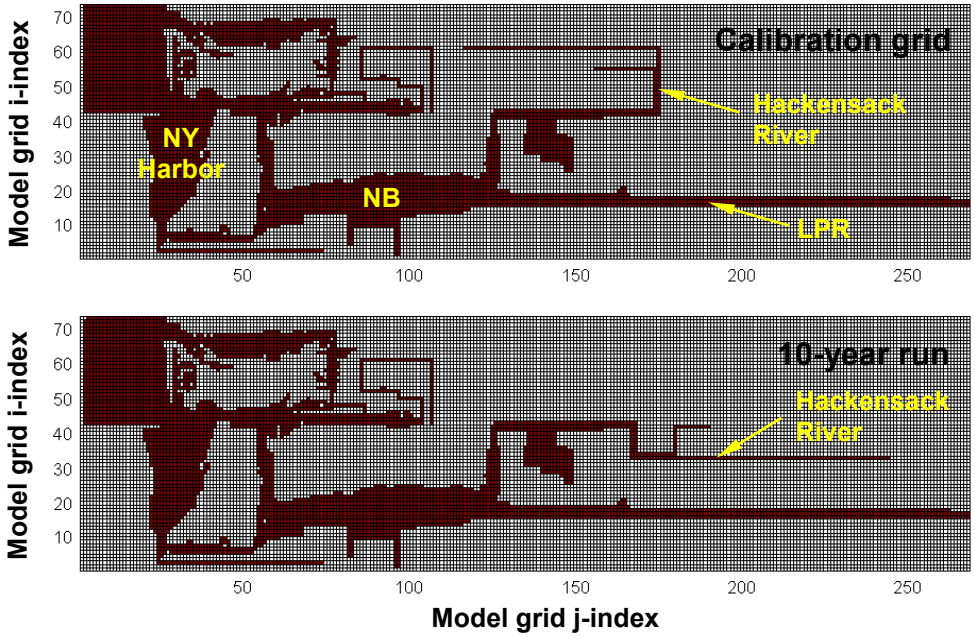


Figure 2-12: Changes in computational domain from calibration to 10 year run. Model domain plotted in IJ index-space. Red cells indicate cells included in computational domain.

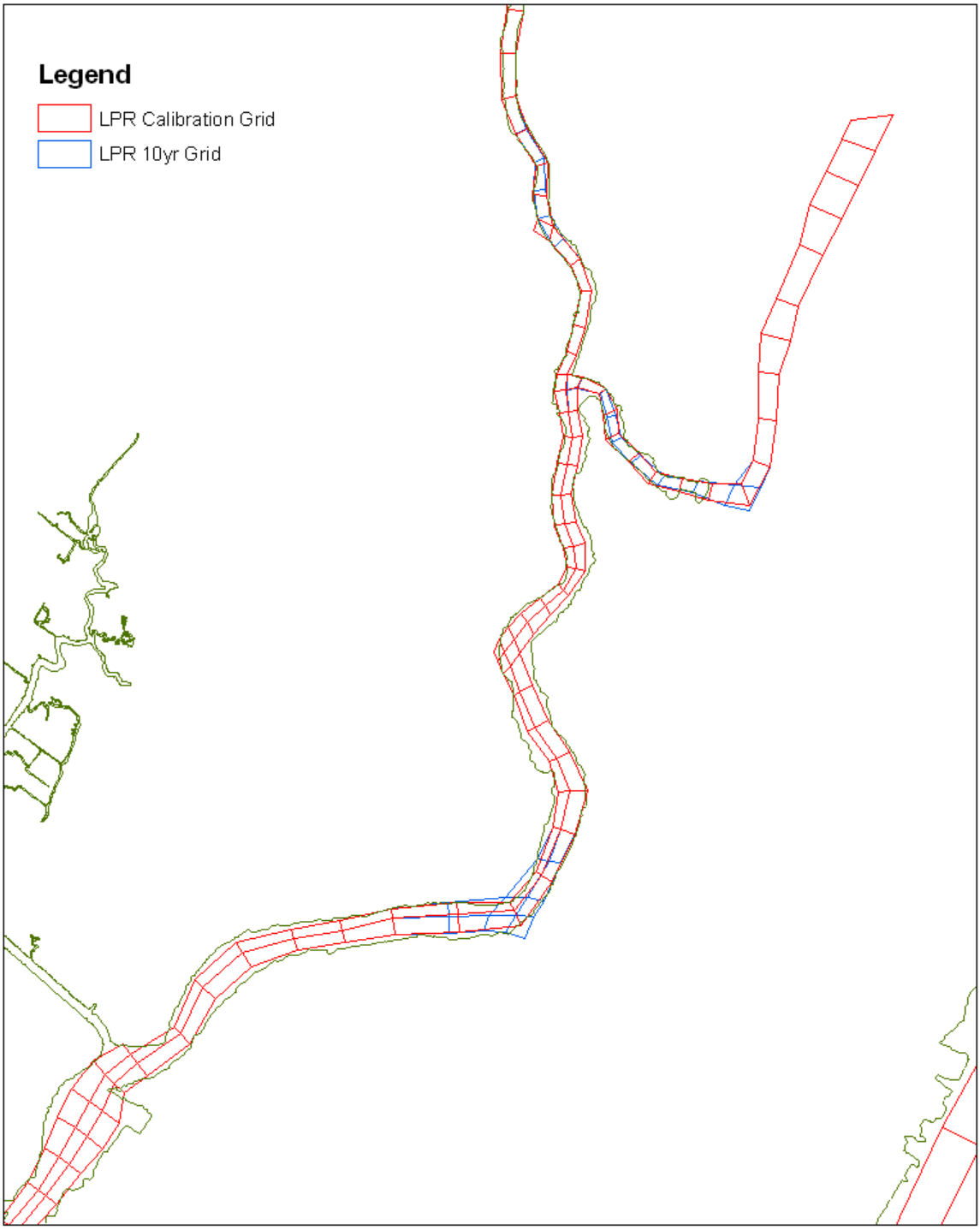


Figure 2-13: Changes in model configuration between calibration and 10 year simulation

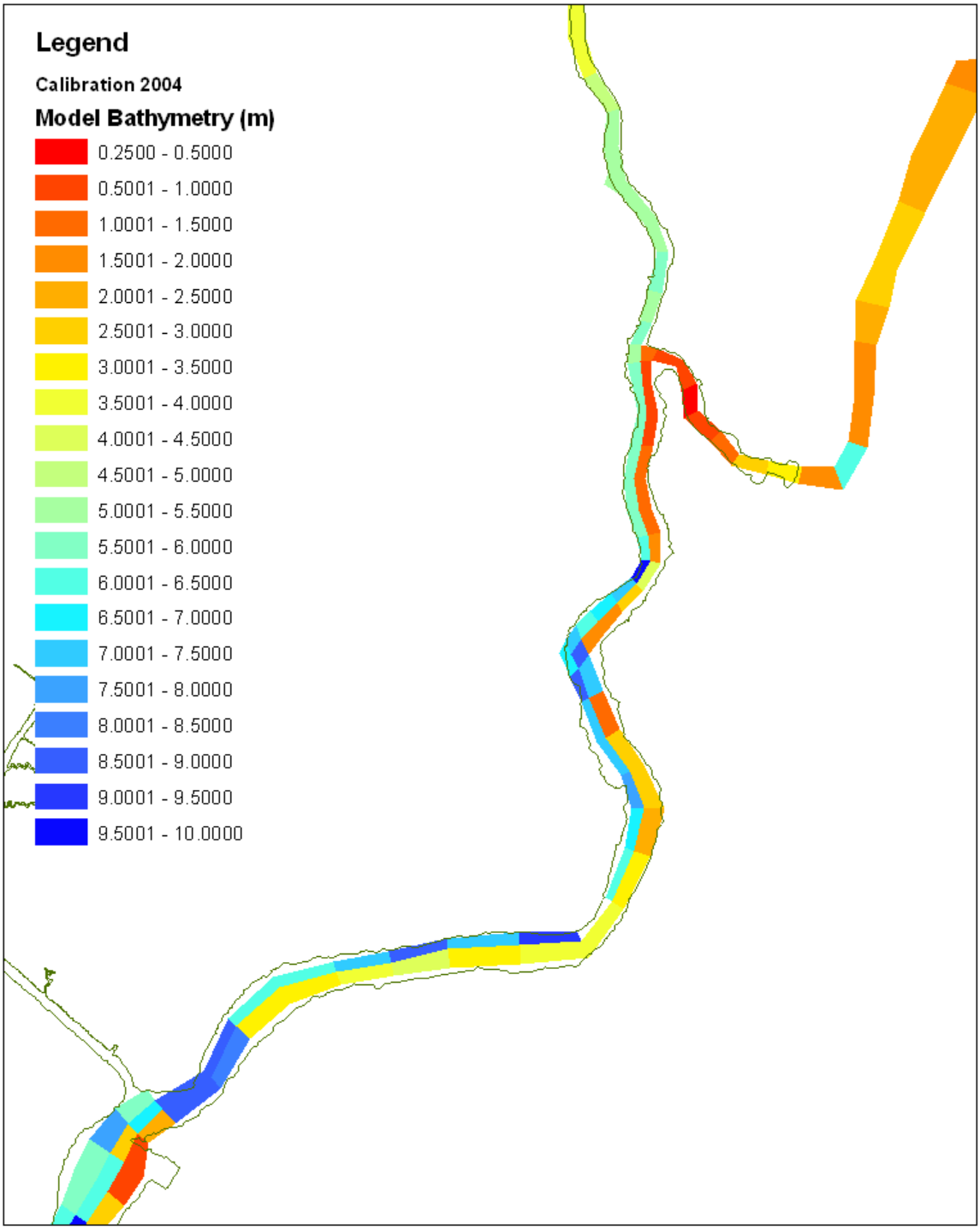


Figure 2-14: Model Bathymetry Calibration

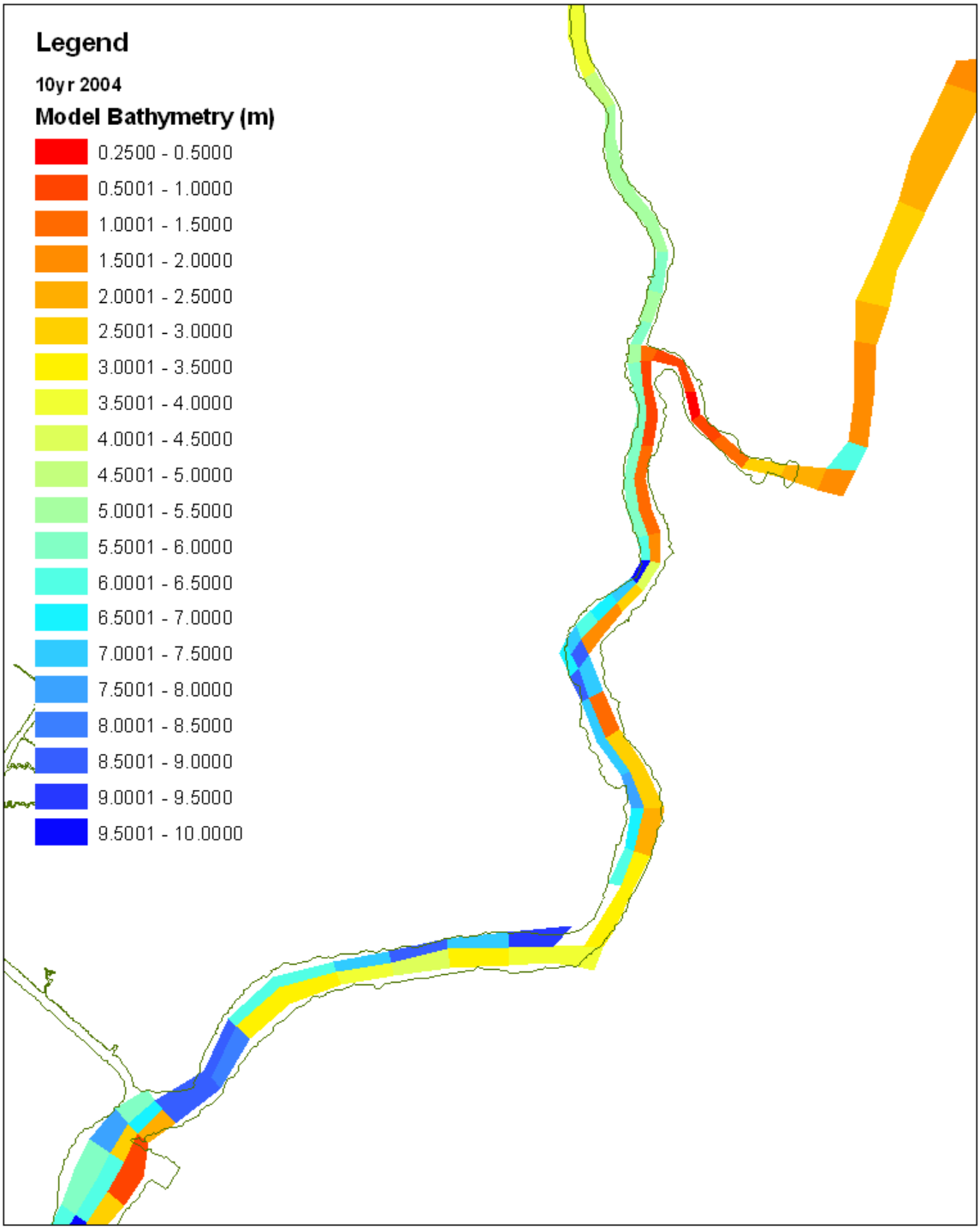


Figure 2-15: Model Bathymetry 10 year simulation

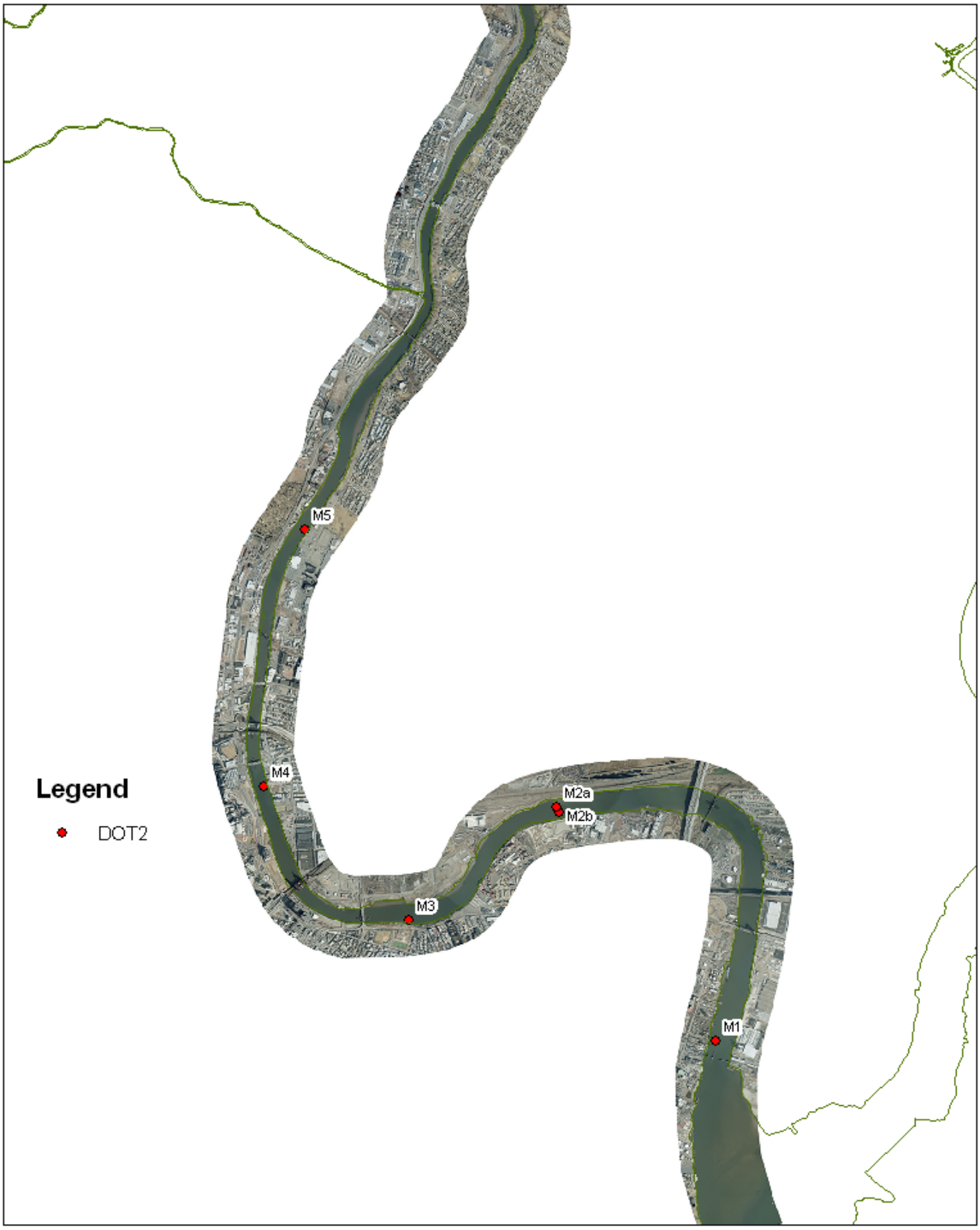


Figure 2-16: Stations used in deployment 2 (DOT2)

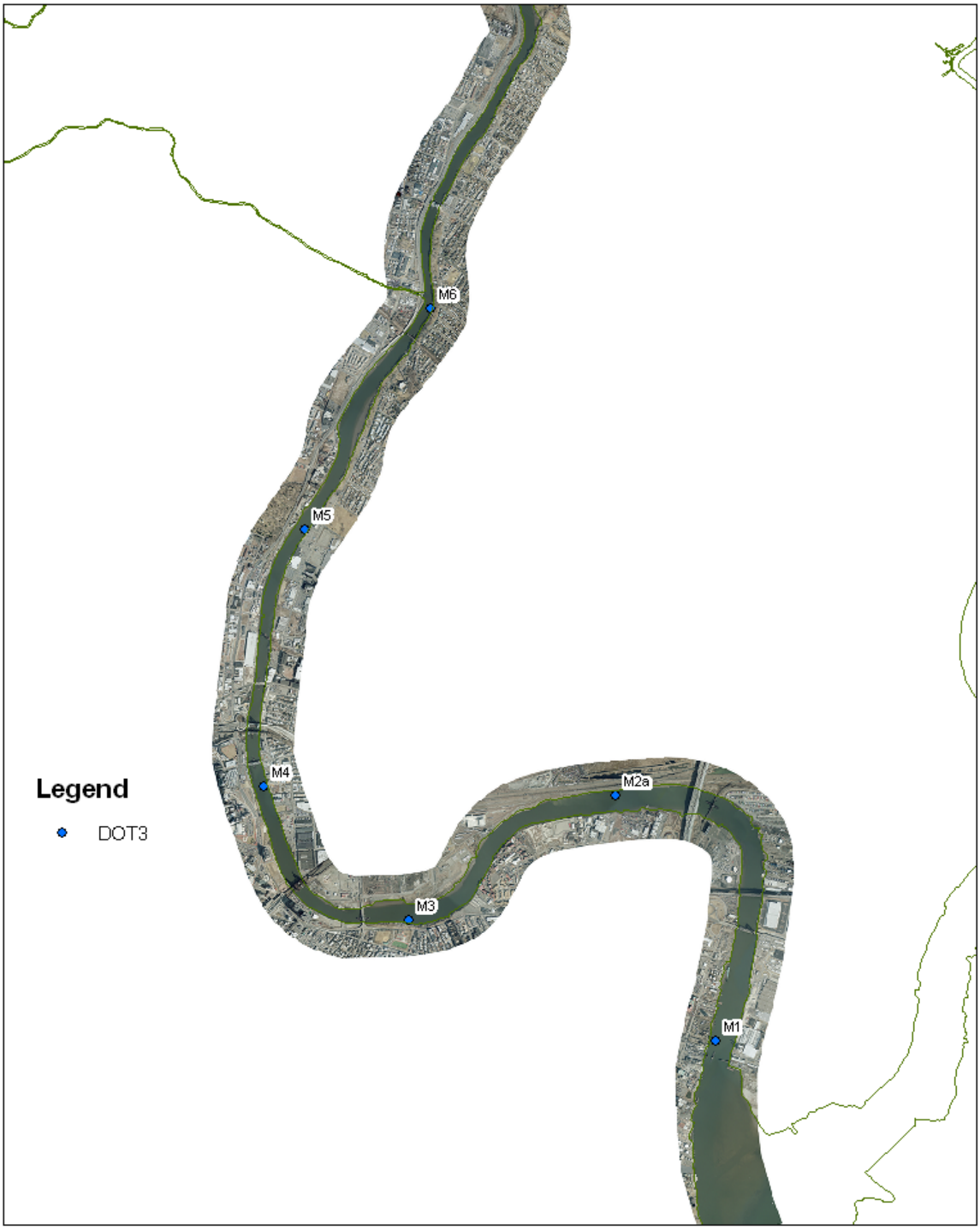


Figure 2-17: Stations used in deployment 3 (DOT3)

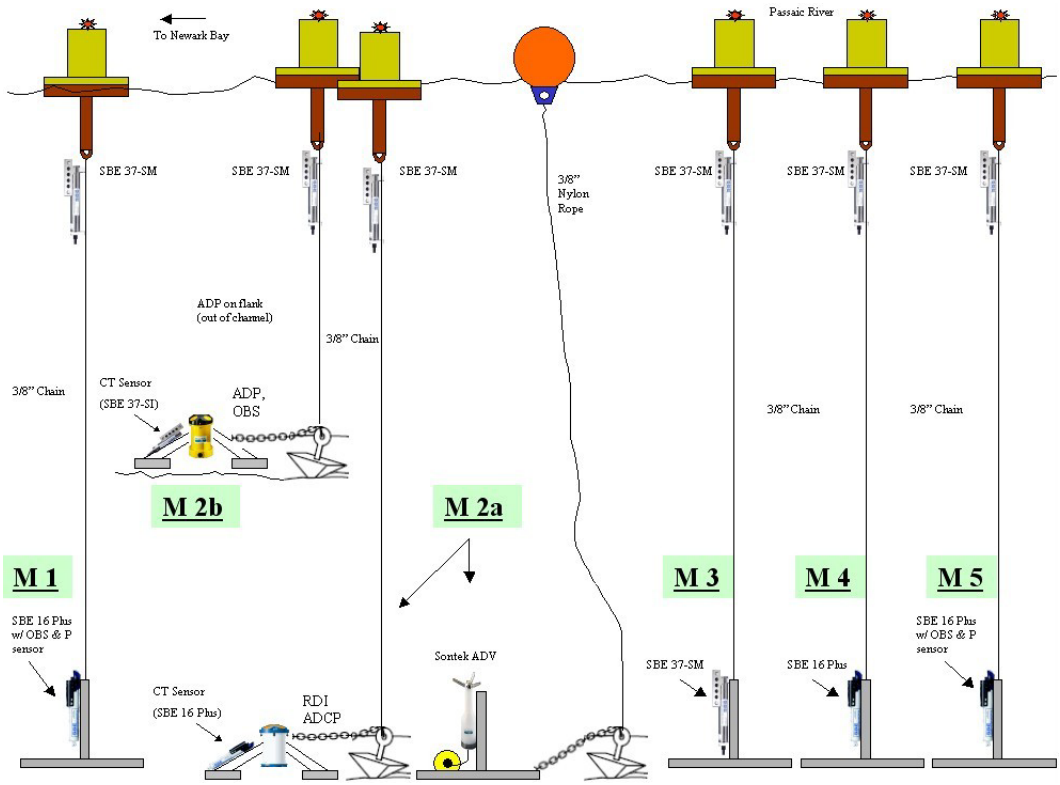


Figure 2-18: Mooring descriptions for deployment 2

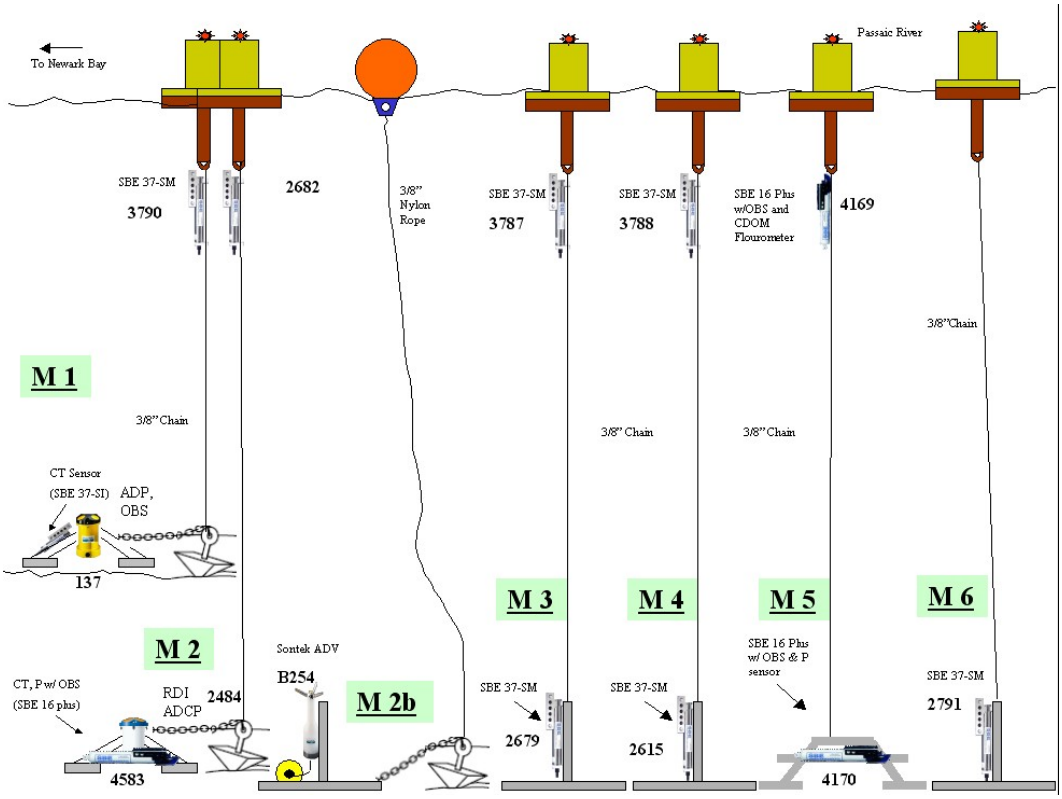


Figure 2-19: Mooring descriptions for deployment 3

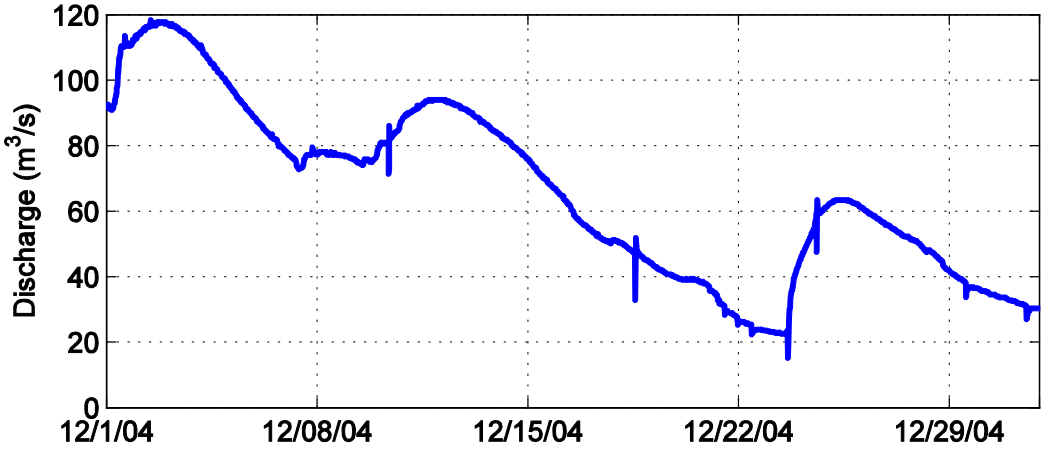


Figure 2-20: 15-minute discharge recorded at the USGS station at Little Falls during DOT2

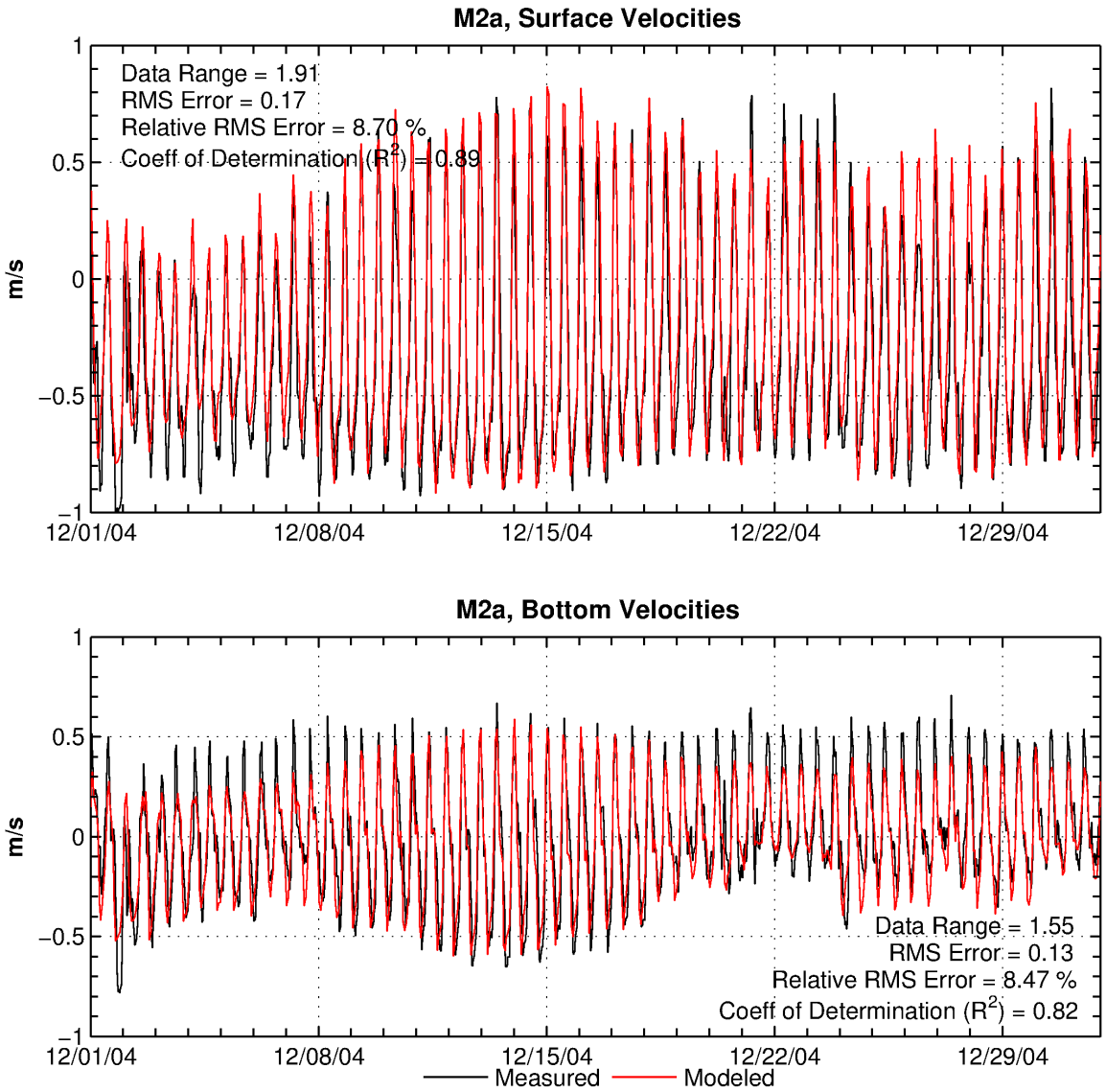


Figure 2-21: Currents near the surface and bottom at station M2a during DOT2

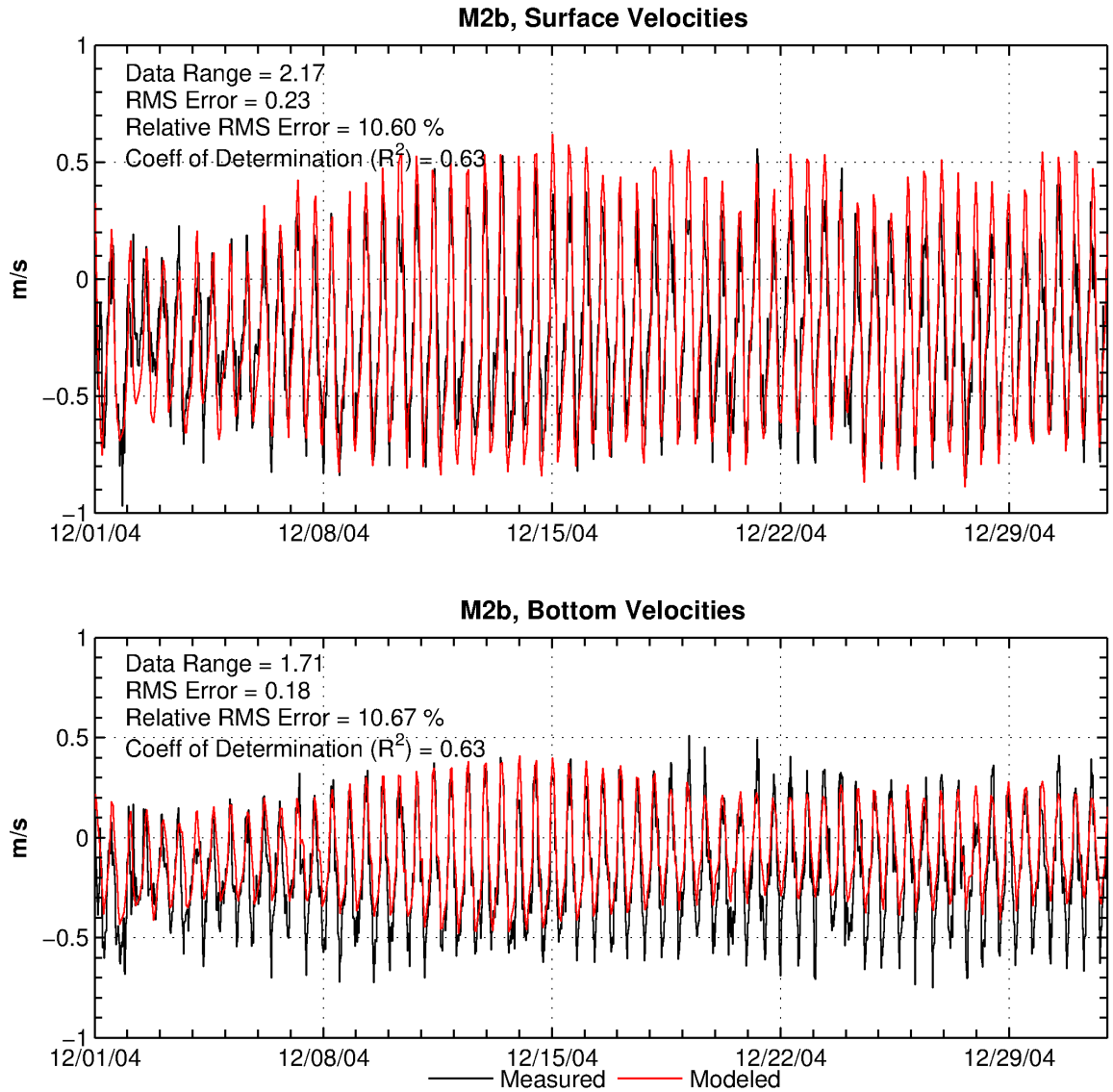


Figure 2-22: Currents near surface and bottom at station M2b during DOT2

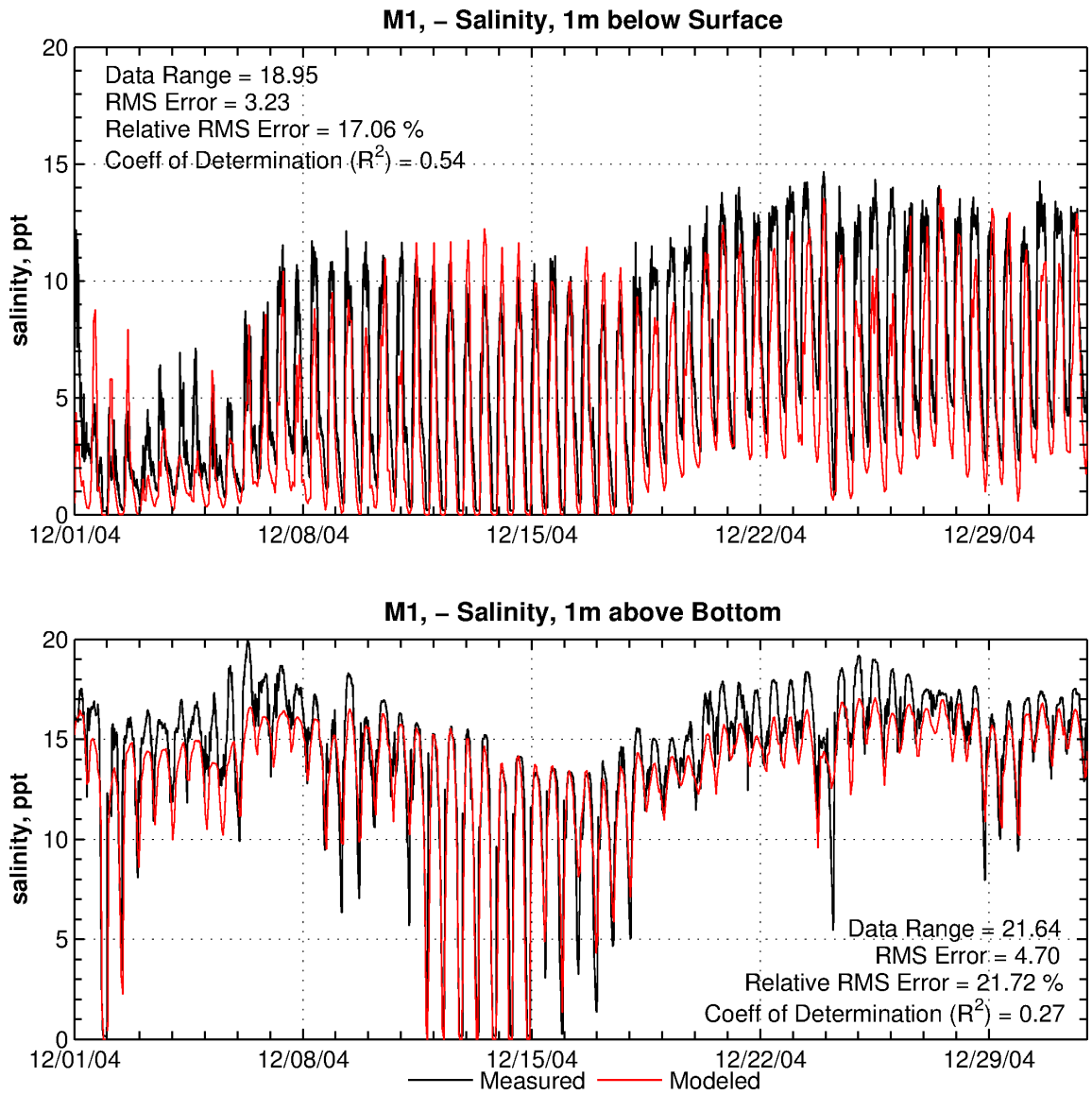


Figure 2-23: Salinity at surface and bottom for M1 during DOT2

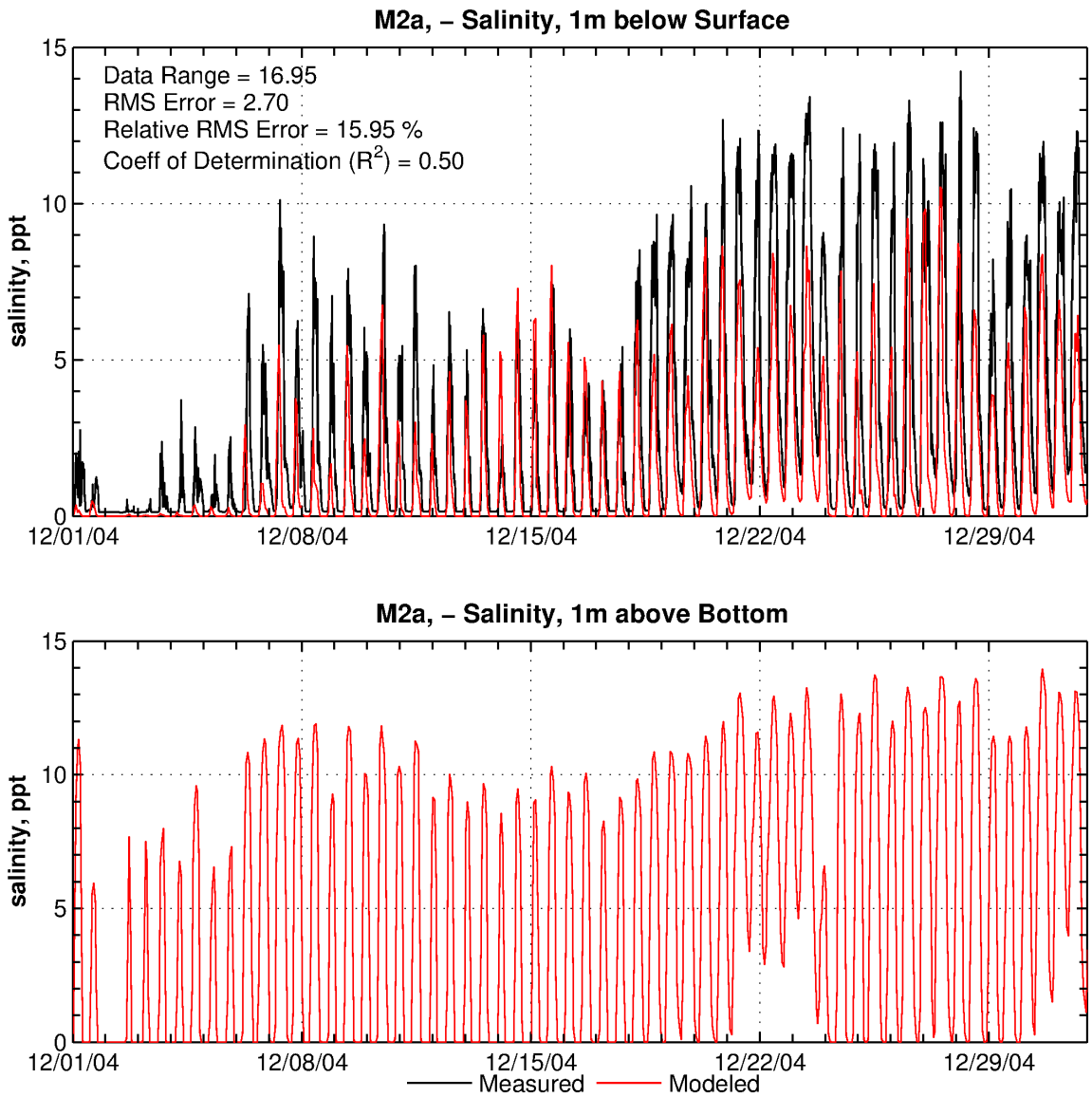


Figure 2-24: Salinity at surface and near-bottom for station M2a during DOT2

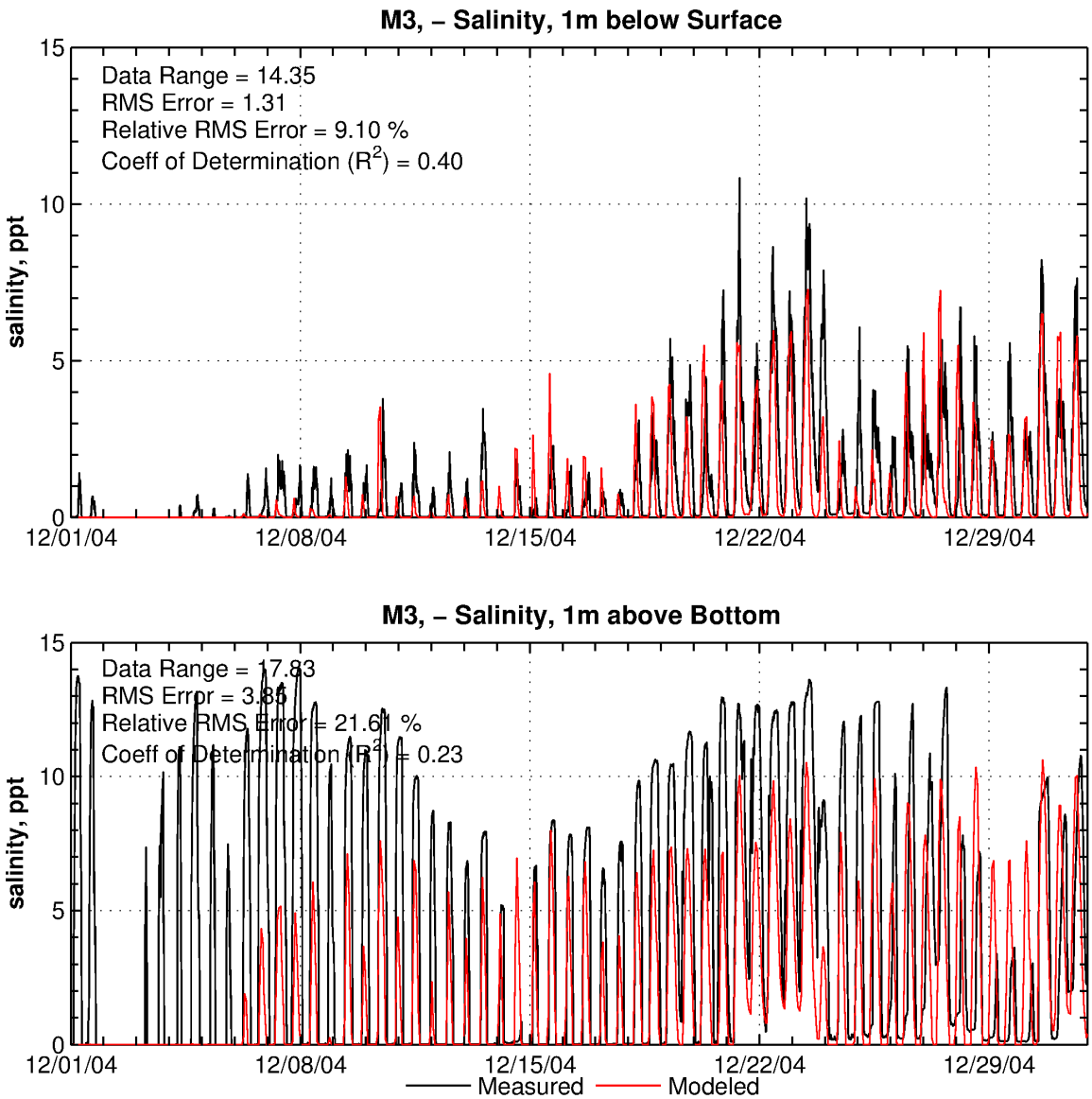


Figure 2-25: Salinity at surface and bottom for Station M3 during DOT2

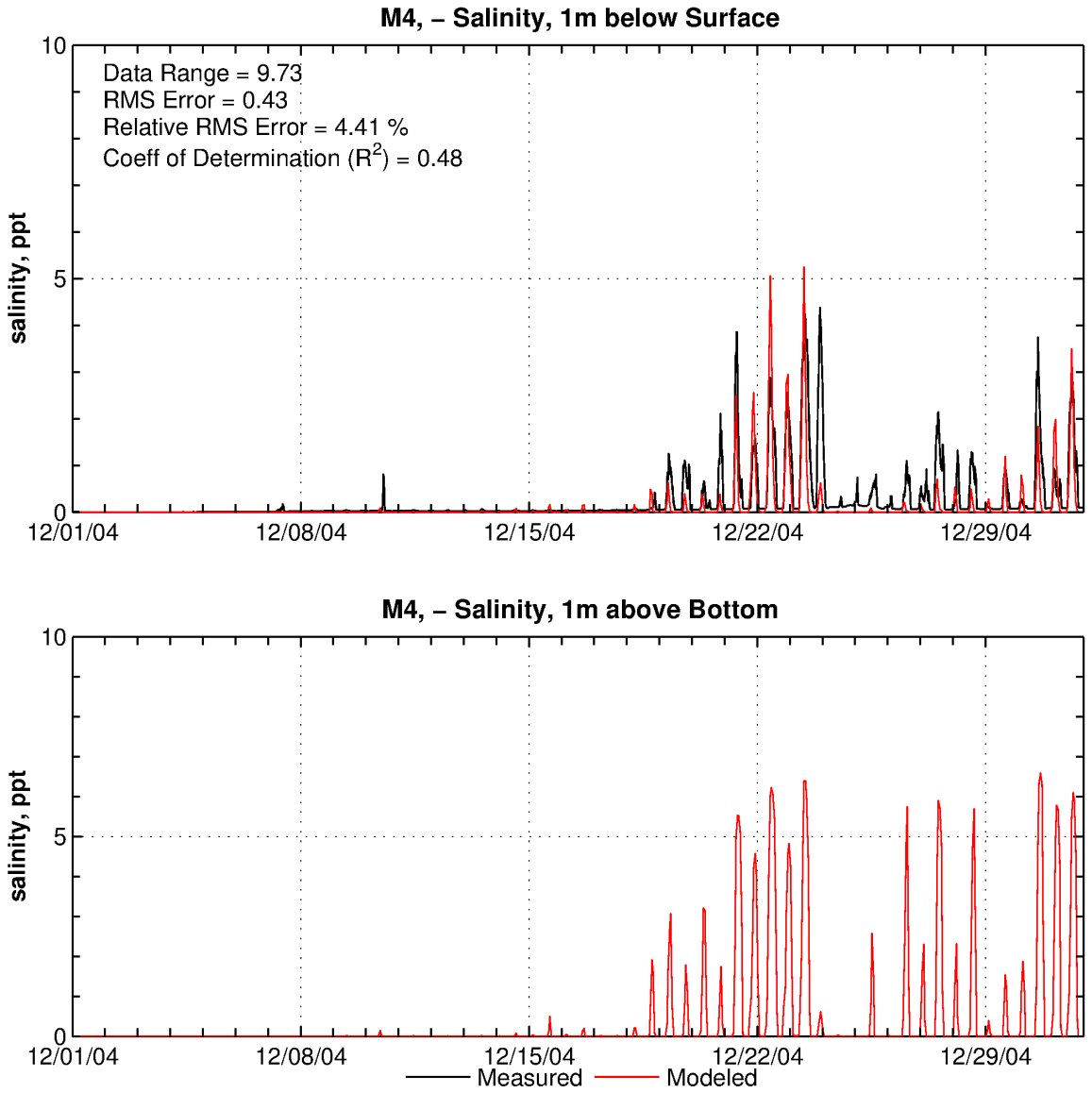


Figure 2-26: Salinity at the surface and bottom for station M4 during DOT2

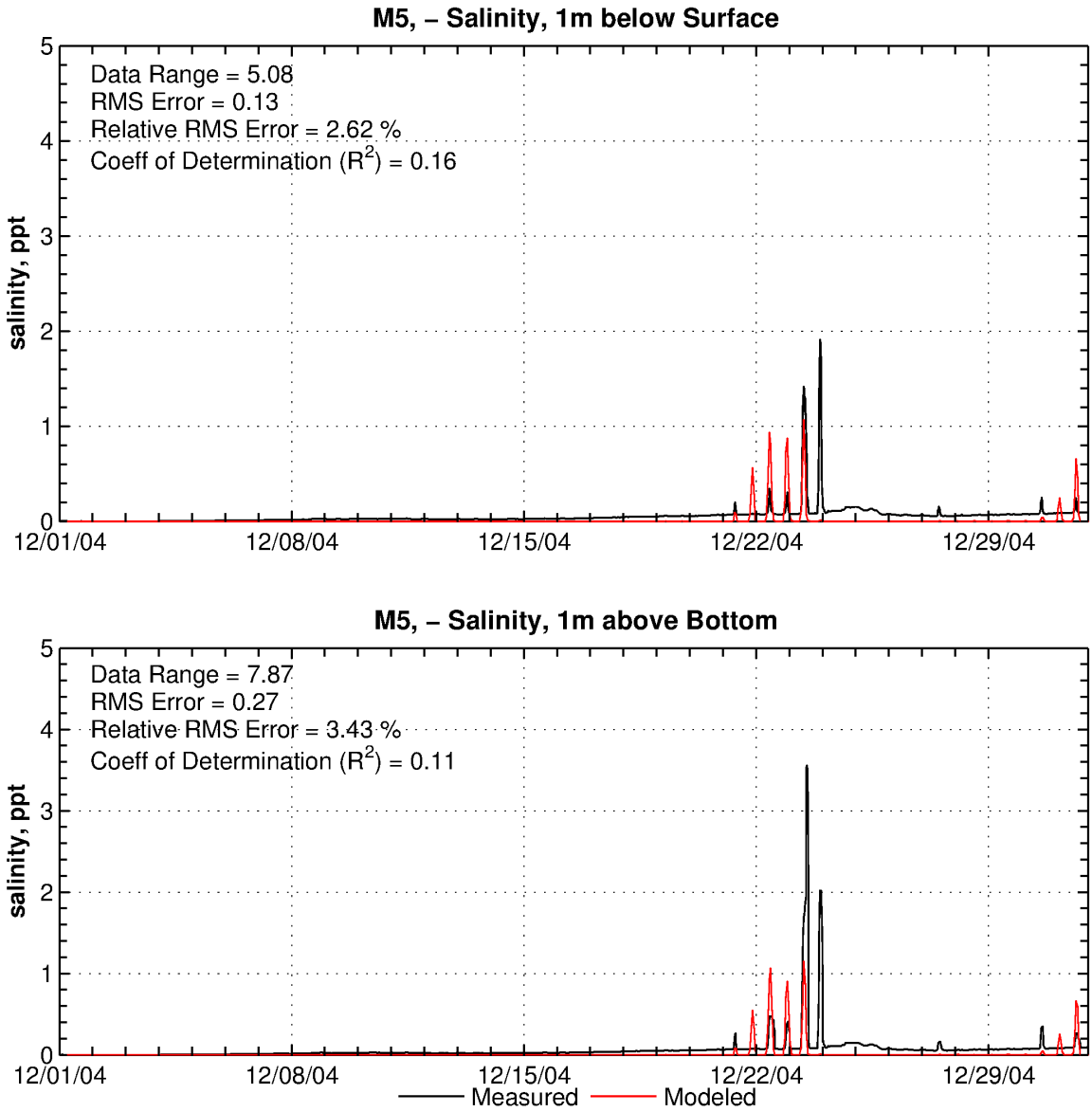


Figure 2-27: Salinity at surface and bottom for station M5 during DOT2

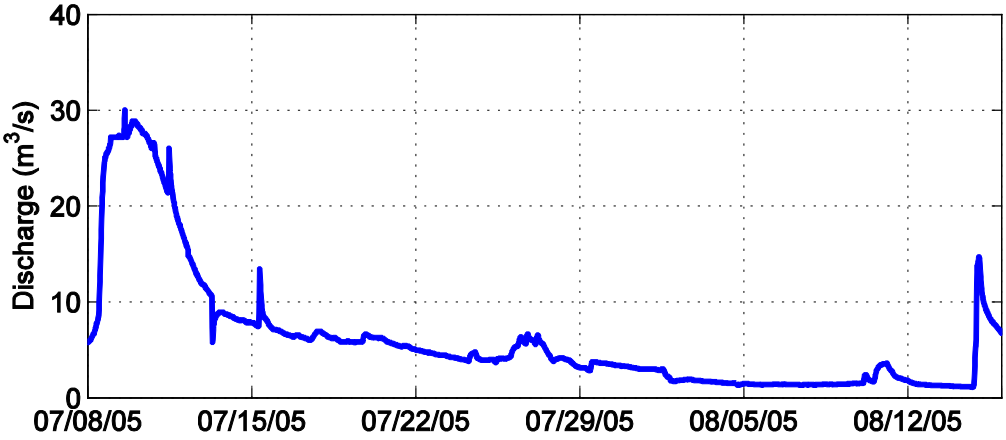


Figure 2-28: 15-minute discharge recorded at the USGS station at Little Falls during DOT3

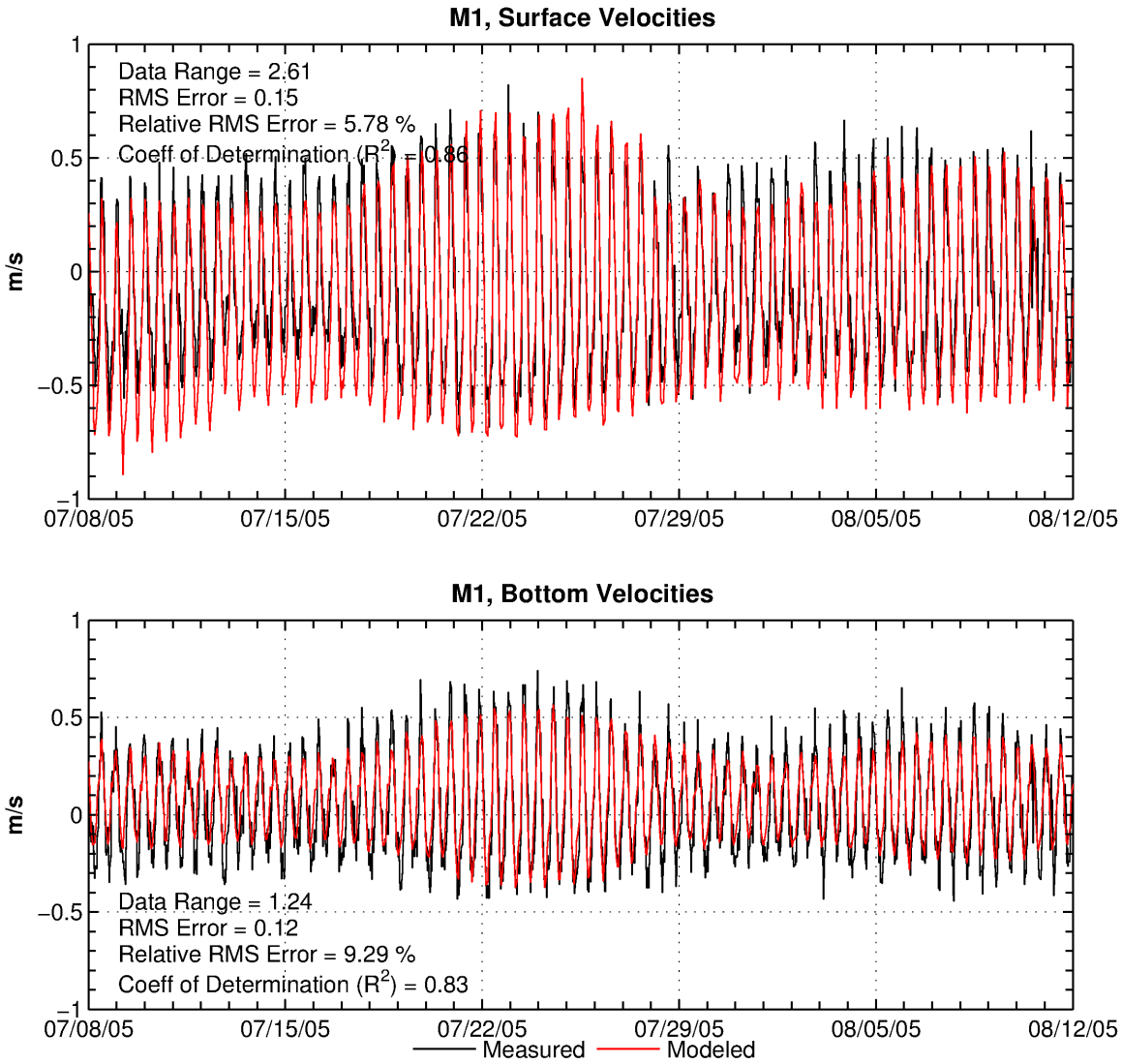


Figure 2-29: Surface and bottom velocities for M1 during DOT3

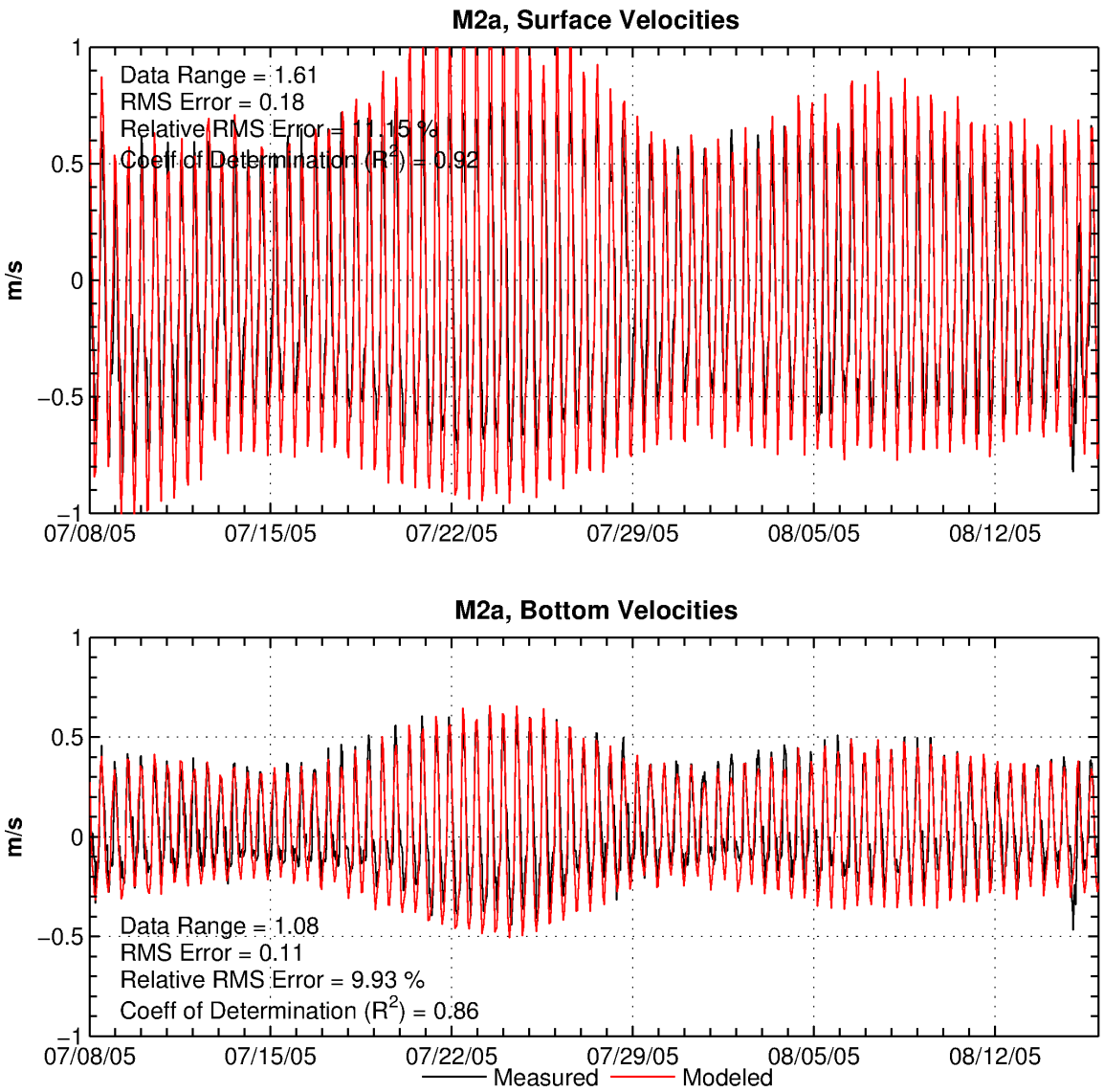
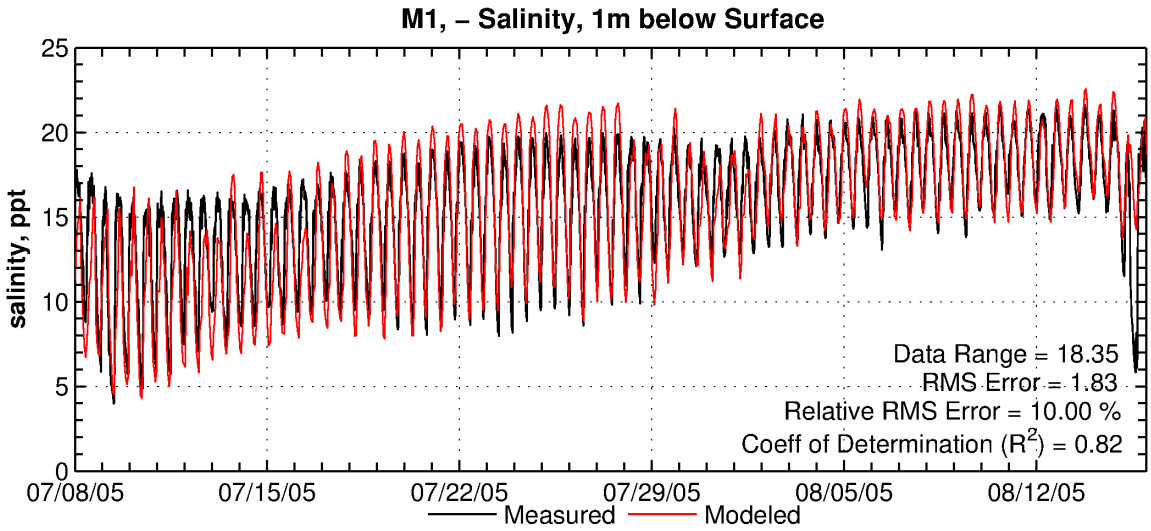


Figure 2-30: Surface and bottom velocities for M2a during DOT3



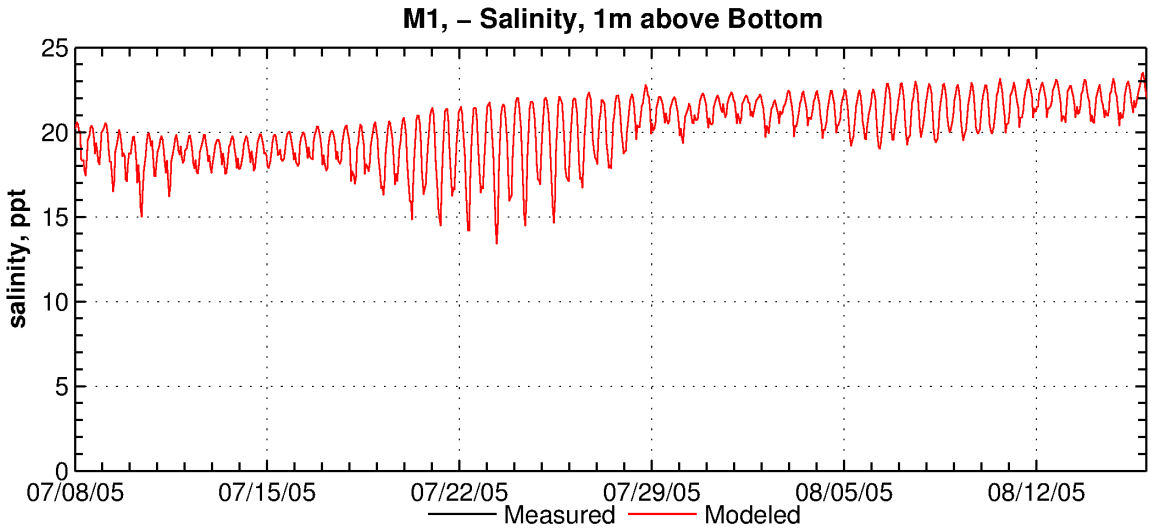


Figure 2-31: Surface salinity at M1 during DOT3

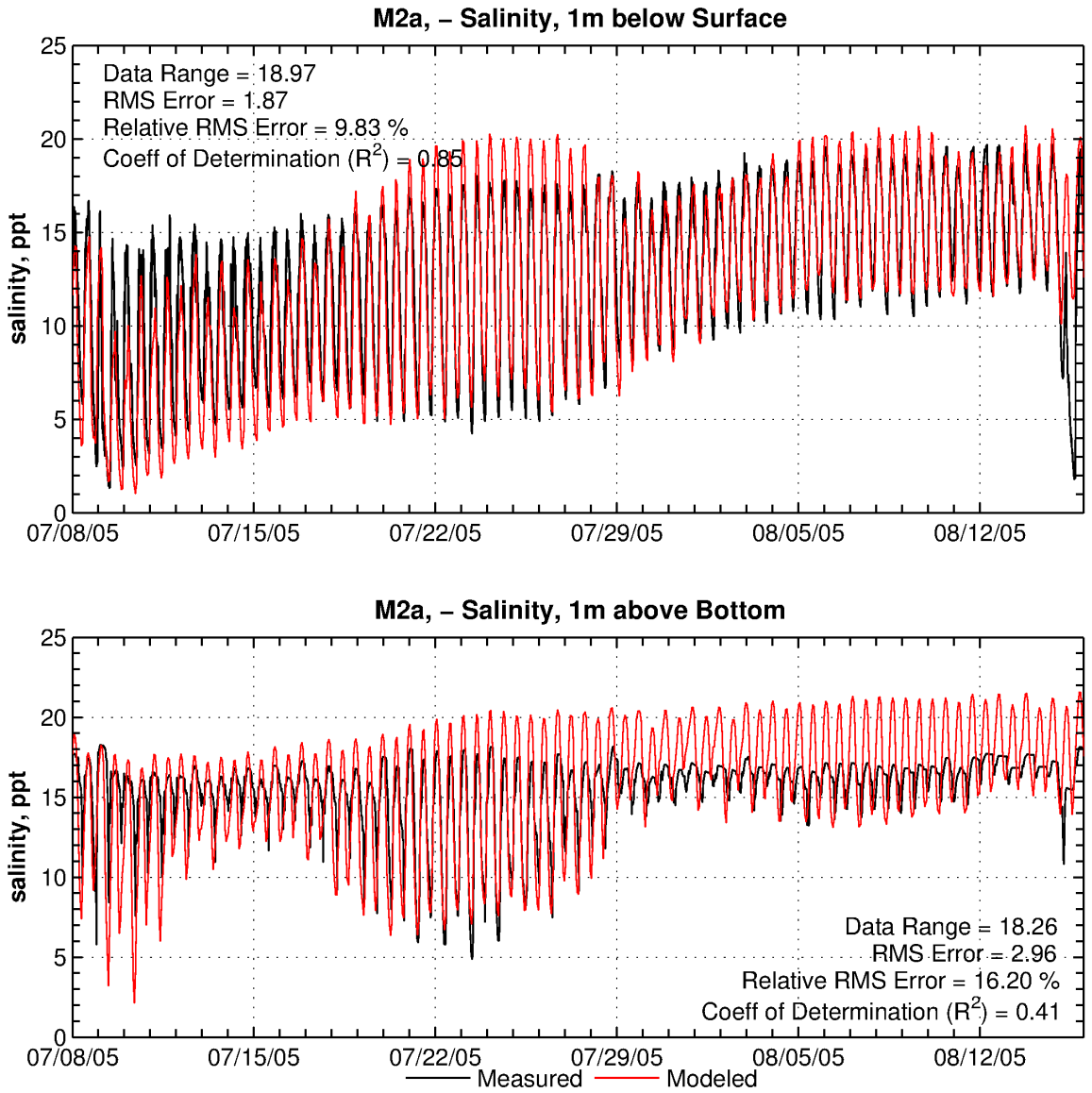


Figure 2-32: Salinity near the surface and bottom for Station M2a during DOT3

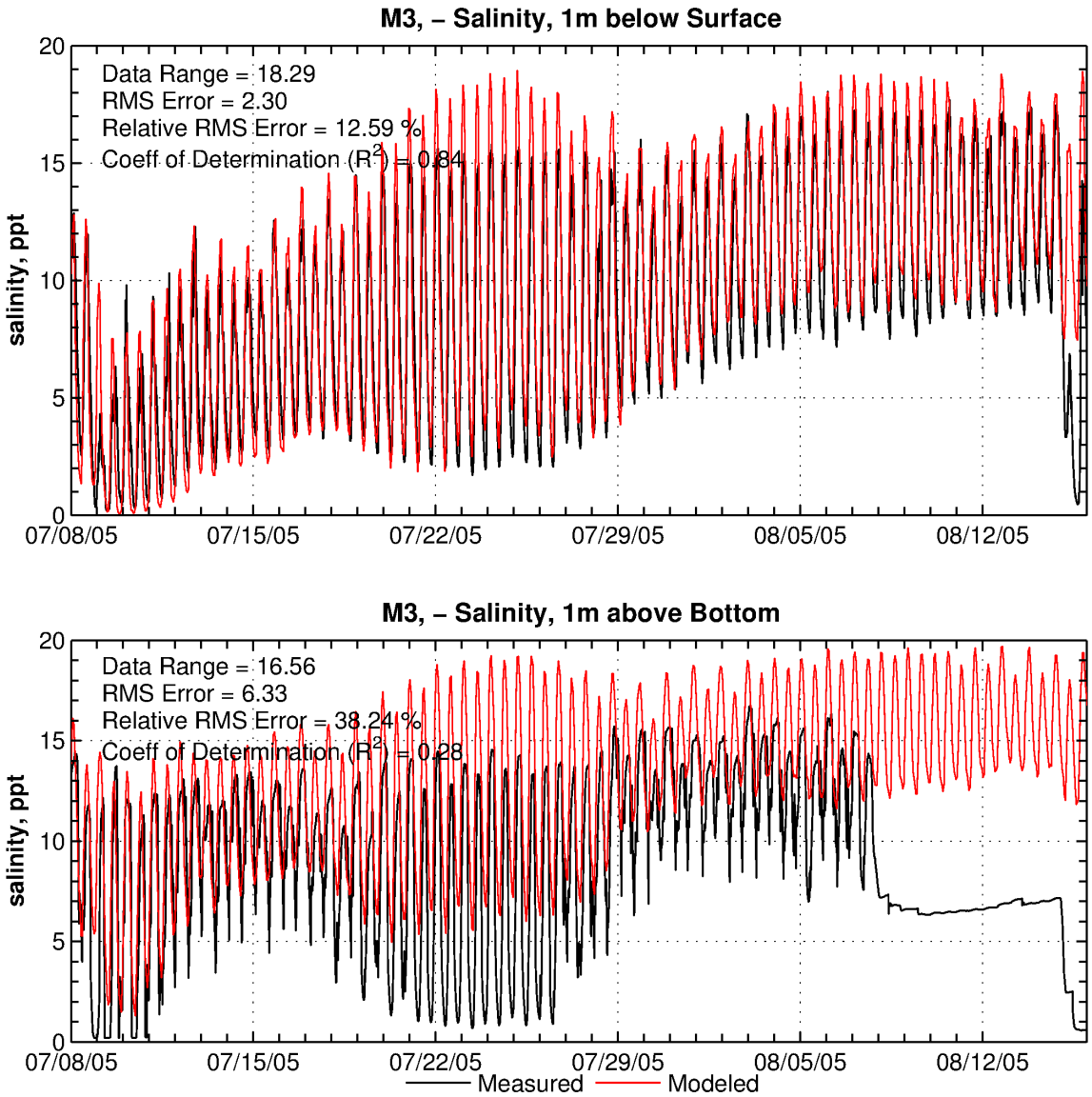


Figure 2-33: Salinity near the surface and bottom for station M3 during DOT3

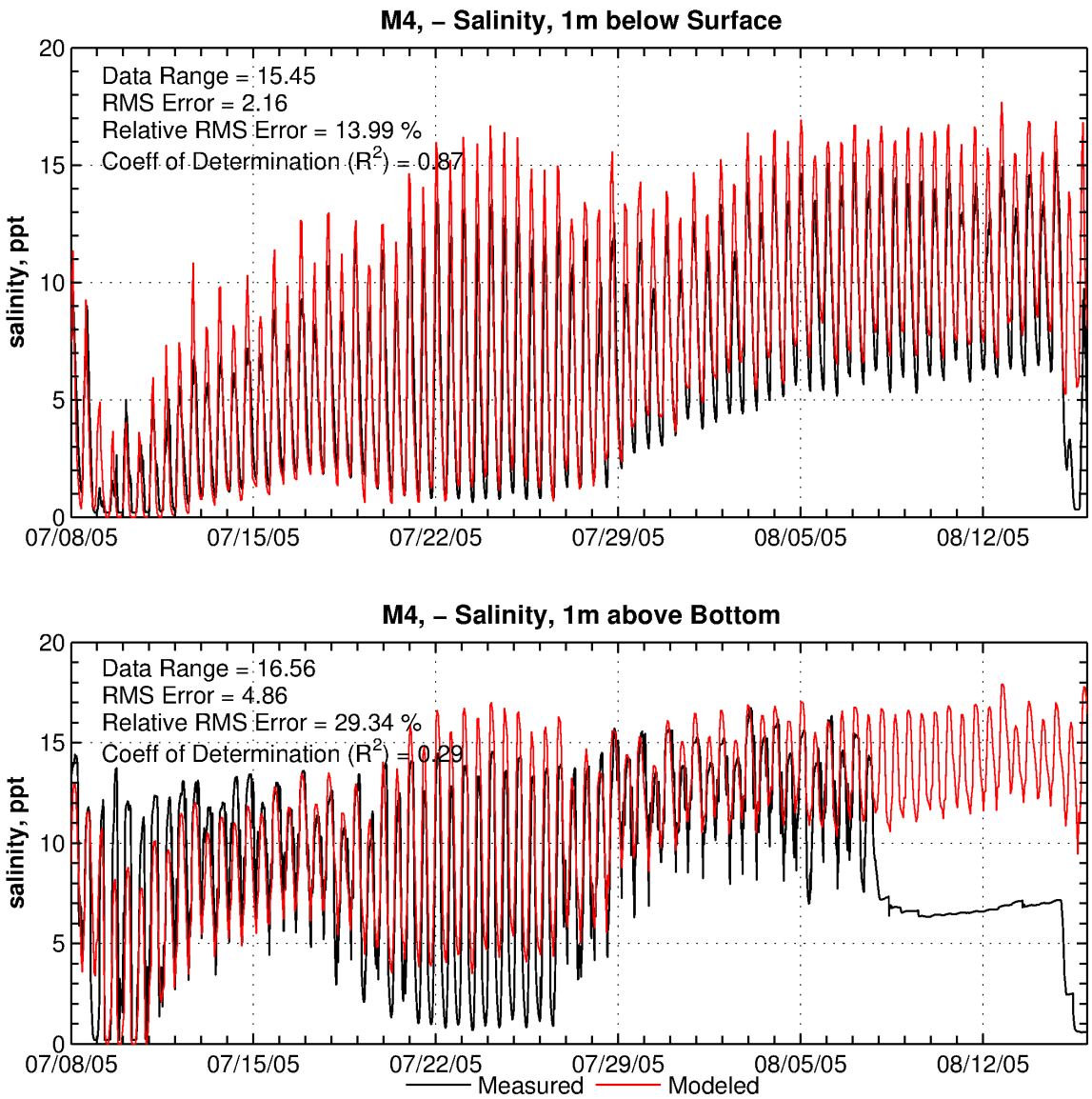


Figure 2-34: Salinity near the surface and the bottom for station M4 during DOT3

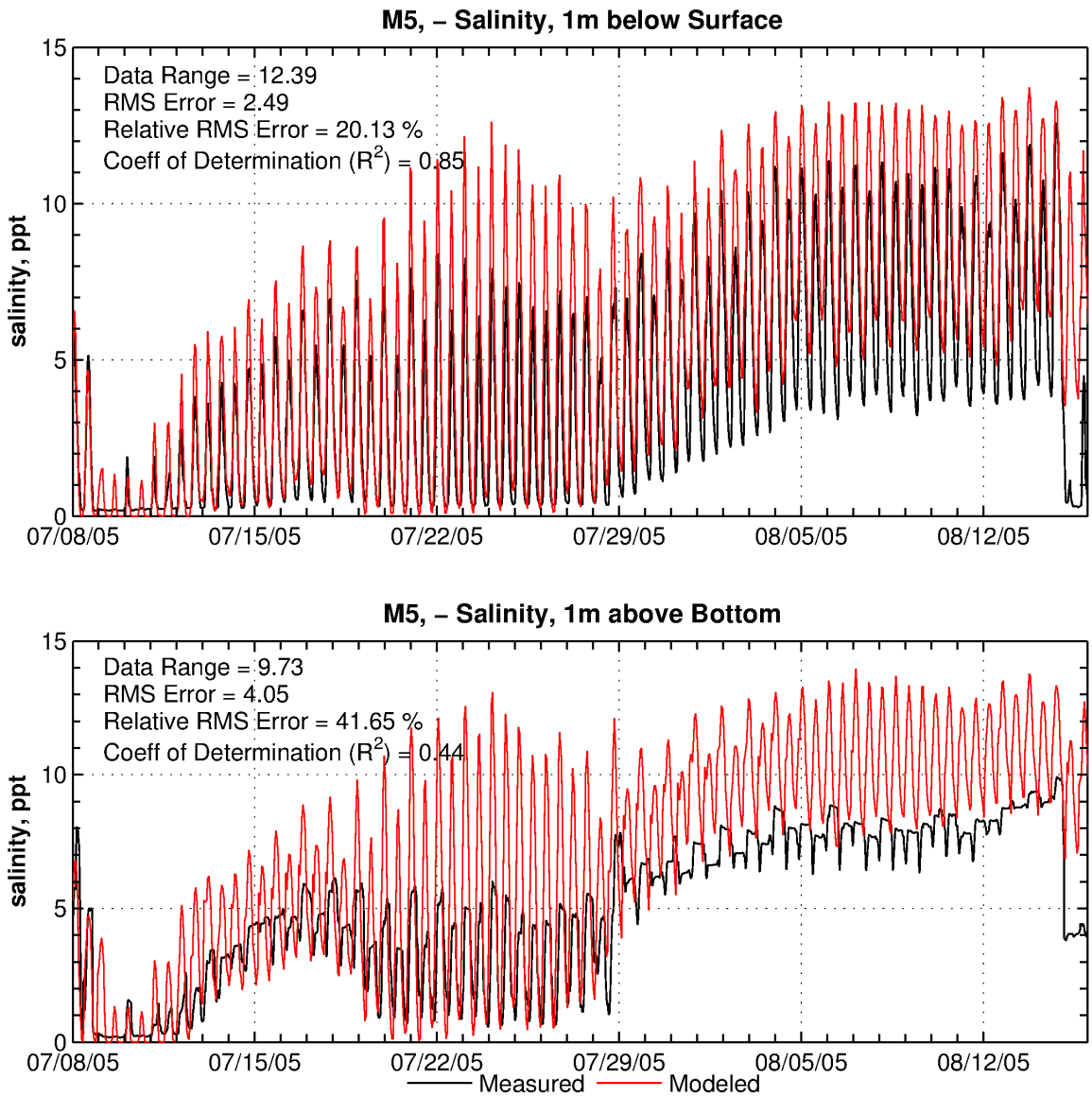


Figure 2-35: Salinity near the surface and bottom for station M5 during DOT3

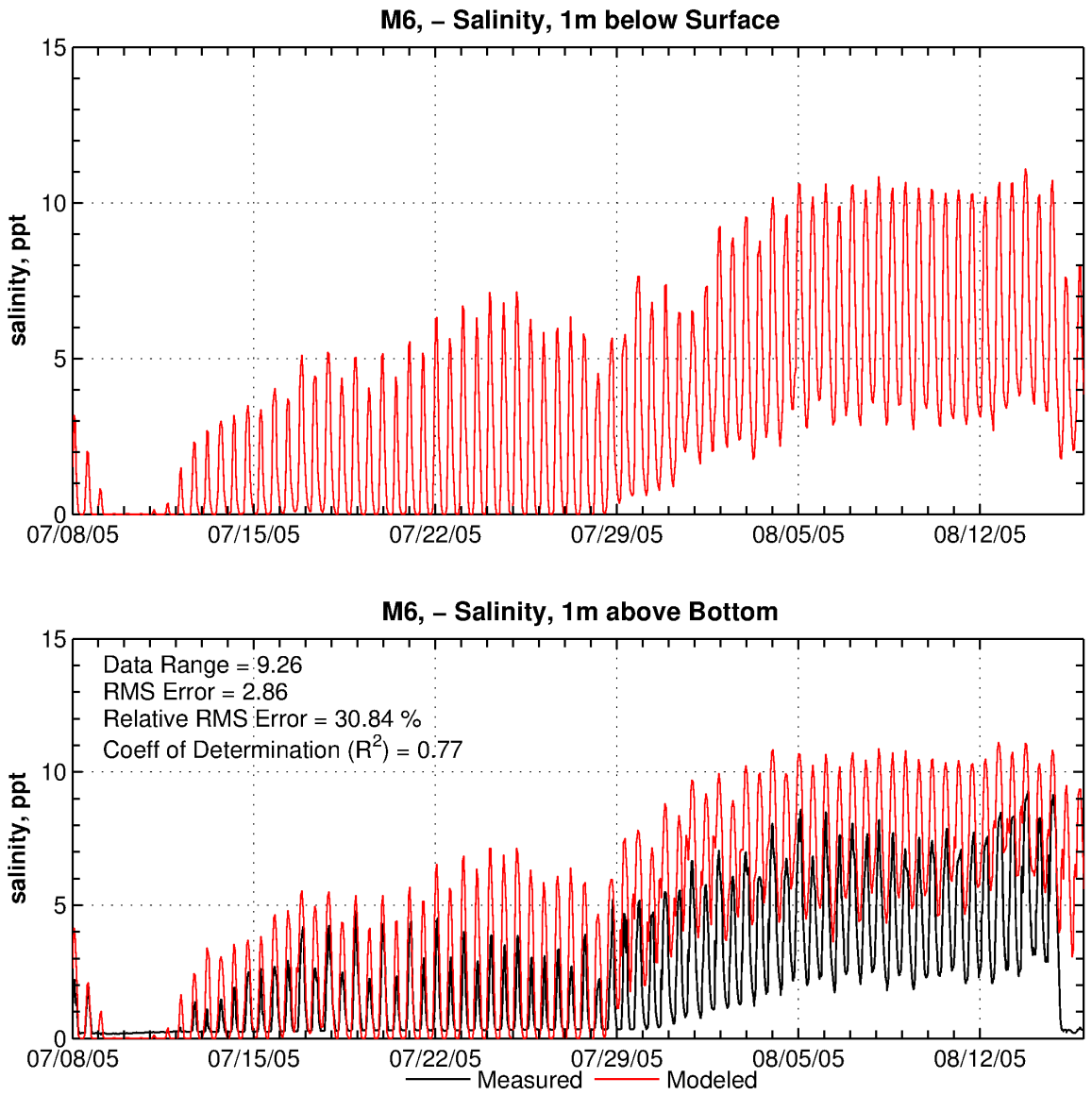


Figure 2-36: Near-bottom salinity for station M6 during DOT3

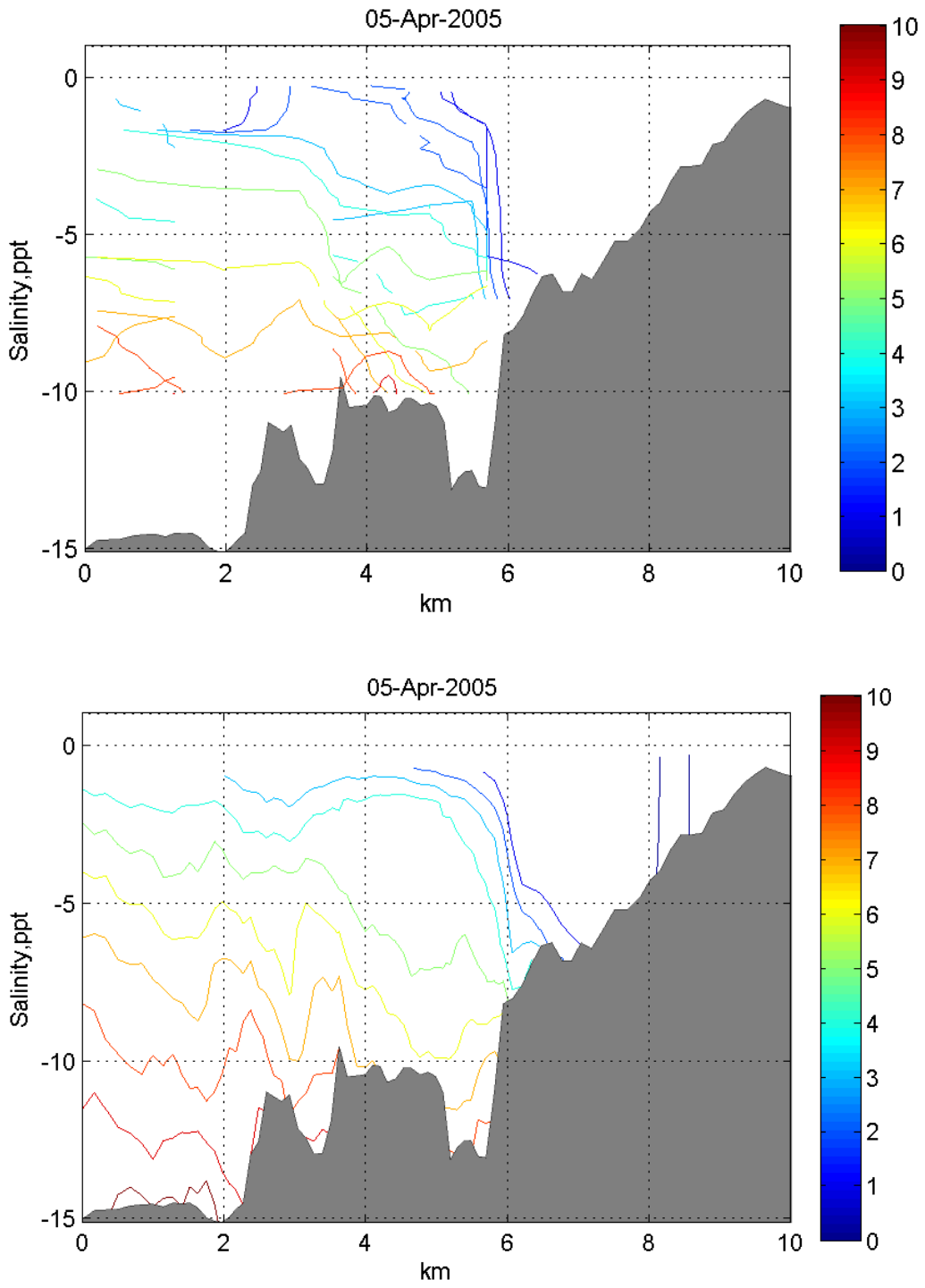


Figure 2-37: Salinity contours measured (top) and modeled (bottom) on 5 April 2005

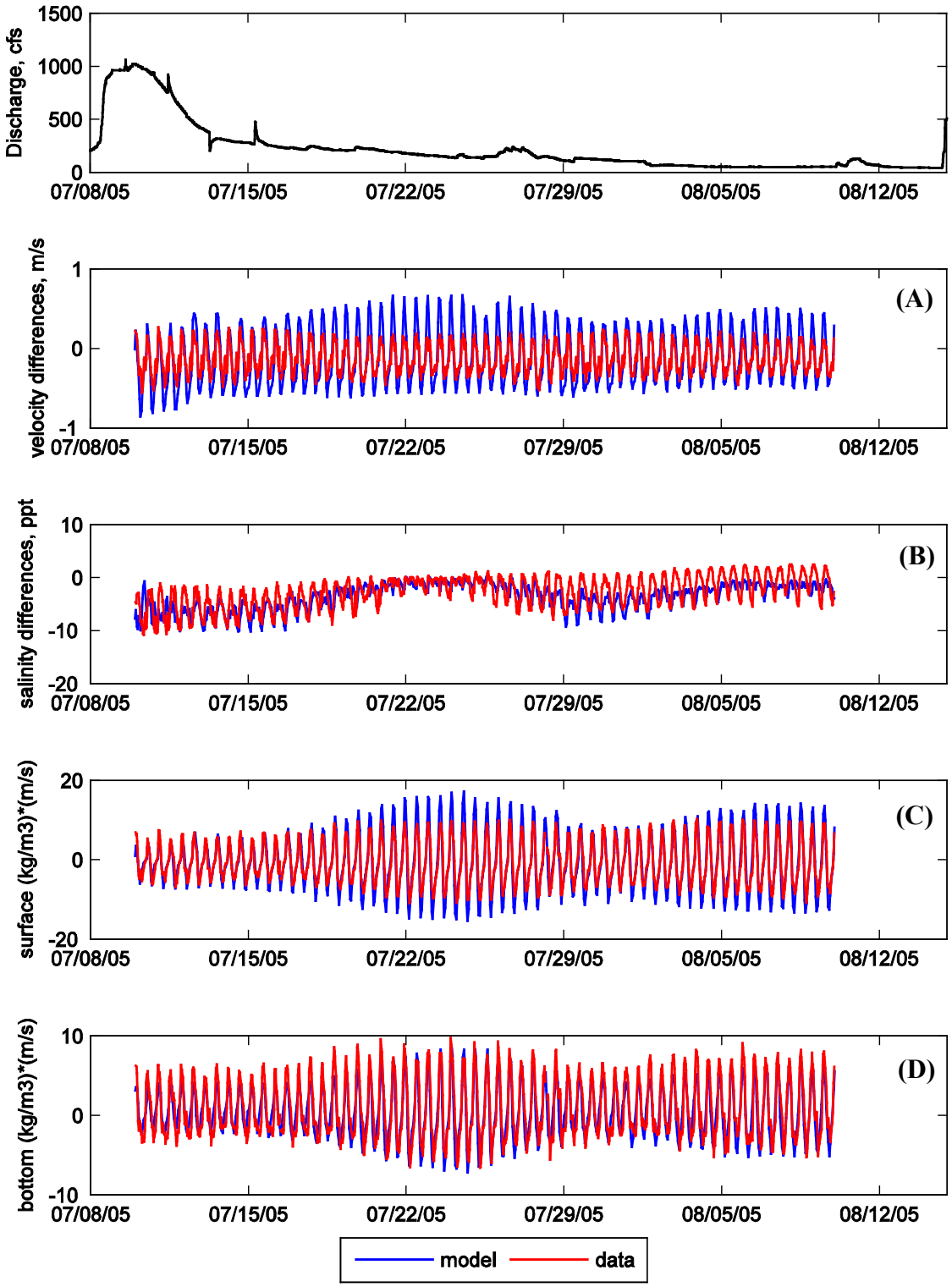


Figure 2-38: Comparison of measured and calculated surface-bottom velocity gradient (A), salinity gradient (B), and the near-surface (C) and near-bottom (D) instantaneous salt flux at M2a during DOT3

3.0 ADDITIONAL MODEL SETUPS: TRUNCATED GRID AND HIGH-RESOLUTION GRID

3.1 Truncated Grid

As described in the previous section, the hydrodynamic model domain included a vast area beyond the extent of the LPR and NB (referred to as the full grid). In order to facilitate model runs with faster run times for simulations including other modules (sediment transport and contaminant fate and transport), the full grid model was used to develop a localized model referred to as the truncated grid model. The truncated grid model setup limits the model domain to a localized area surrounding Newark Bay and the Passaic River.

Previous modeling work in the area (Pence, 2004) involved a model with similar extents but higher resolution than the existing LPR model. In addition, HQI used a model with similar domain for their capping study as part of the Draft Focused Feasibility Study (MPI 2007). A model setup with a similar domain was also developed in parallel by HQI in the interest of computational efficiency for the sediment transport model (Louis Berger Group, 2014).

3.1.1 Extent

The truncated grid model domain includes the 17.4-mile tidal stretch of the LPR extending from Dundee Dam to the mouth at Newark Bay, the Hackensack River (including the Meadowlands wetlands) from Oradell Dam to its mouth at Newark Bay, Newark Bay, and the tidal entrances to Newark Bay, namely the Arthur Kill extending to Raritan Bay and the Kill van Kull extending to upper New York bay. The model grid is shown in Figure 3-1.

3.1.2 Resolution

The resolution of the truncated model was maintained from the full LPR model. No additional resolution was added.

3.1.3 Bathymetric Sources

Bathymetry for the truncated model was maintained from the full LPR model as defined for the 10-year simulation or based on the bathymetry provided by HQI for the water years 2008 onwards, especially for the definition of the deepening project in Newark Bay. Section 5.1 describes additional modifications to the bathymetry that was introduced for the latest version of the model.

3.1.4 Boundary Conditions

Water level boundaries were specified at the southern end of the Arthur Kill and the eastern end of the Kill van Kull. These boundaries were constructed by extracting time-series at

hourly intervals from the full grid model. Similarly, salinity and temperature were extracted from the full grid model, interpolated to a z-grid, as required by ECOM standard boundary definition, and applied at the boundaries. Limitations intrinsic to the code of ECOM do not allow for alternate specifications such as velocity at the open boundaries. In order to obtain a well-posed and unique solution to partial differential equations such as parabolic or hyperbolic sets used within ECOM, a set of initial and boundary conditions for surface elevation and velocity are required. Without a boundary condition implementing a velocity condition, a unique solution to the problem may not be possible. This is especially the case when the boundaries are close to the project area. It was found that by specifying the boundaries in the way described above produces important differences in the discharge in the Arthur Kill, especially during neap tide, when compared to results from the LPR model. These differences dissipate within the model, and discharge through Newark Bay and the Passaic River seem to be unaffected by the specification of the boundaries in the truncated model.

The specification of boundary conditions for the truncated model as described above is similar to the setup and implementation of HQI in their truncated model as well as the implementation of Pence (2004). Using a discharge boundary condition at the end of the Arthur Kill rather than a water level boundary condition may give a better representation of the conditions in the Arthur Kill although this solution will still not contain the momentum component. However, alternate boundary conditions were not implemented with the model due to the limited impact of this artifact on model performance within the LPR.

3.1.5 Discharge conditions

Discharge boundary conditions from rivers and CSOs were kept the same as in the full grid model.

3.1.6 Meteorological forcings

Due to the limited domain of the model, following literature review and discussions with HQI, the meteorological forcings for the truncated grid model were modified from its representation in the full grid model. Due to its limited spatial extent, the spatially-varying wind field that is used in the full grid model is not specified for the truncated grid model . In addition, the construction of the spatially varying wind field in the full grid model was performed using data from Newark (EWR), JFK, Atlantic City, Albany Airport, Bridgeport Airport, and some offshore buoys.

It is worth noting that in Pence (2004), an hourly wind field from Bergen Point NOAA station was used to drive a model with similar extents to the truncated grid model. A comparison of the wind fields at Bergen Point and Newark Airport is found in Figure 3-2. Some short-term deviations mainly in wind speed are apparent between the data at the two locations. However, for purposes of this modeling effort, the use of EWR wind fields is required as the time period of collection is longer than the record at Bergen Point. It is noted however, that since the wind field in Bergen Point is not used, wind stresses in the

model may not be locally as accurate. Accordingly, the wind field in the truncated grid model is specified as a spatially constant but temporally varying input based on the EWR data.

3.2 High-Resolution Model

In addition to the truncated model, a high-resolution hydrodynamic model was developed in order to better quantify the distribution of velocities and shear stresses within the LPR, mainly to support the system understanding analyses for sediment transport. The increased resolution was necessary to resolve features and processes such as secondary flow in river bends, cross-channel variability in flow patterns, and the presence of in-river structures such as bridge abutments. While the spatial extent of the high-resolution hydrodynamic model was maintained the same as the previously described truncated model, the resolution was increased by roughly 4-5 and 2-3 times in the longitudinal and lateral directions, respectively, in the LPR (average high-resolution grid size in the LPR is 18 m wide and 42 m long). The model bathymetry within the LPR was based on the USACE single-beam survey conducted in 2004.

The model was calibrated to the hydrodynamic data (water levels, velocities, and salinity) collected by Rutgers University in 2004 (dataset also used for the calibration of the LPR/NB hydrodynamic model; HydroQual 2008) which covered flows ranging from a few hundred cfs to 3000 cfs (for comparison the long-term average flow at Dundee Dam is estimated as 1200 cfs). The trade-off for higher grid resolution is increased simulation times, and consequently the high-resolution model could not be applied for a long-term simulation. Rather, the calibrated model was applied to a series of constant river discharges covering typical spring-neap tidal cycles to obtain shear stress maps under varying conditions. These maps also formed the basis of a look-up table of predicted shear stresses as a function of tide and discharge, which was used to estimate shear stresses for the high-resolution grid over a 20-year period beginning in 1989. These maps were used for an assessment of the spatial and temporal distribution of shear stresses and to inform the system understanding analyses.

Note that although a constant bathymetry (corresponding to the 2004 time-frame) was used in the high-resolution model, in general, within the LPR, changes in bathymetry are small compared to the overall water depth, even after an extreme event such as Hurricane Irene. Hence, yearly variations in bathymetry will not strongly affect the overall flow patterns, although locally flow velocities and bed shear stresses may be affected.

3.2.1 Extent

The extent of the high-resolution model is similar to the extent of the truncated grid model. The model extends to Dundee Dam in the Passaic River, and Oradell Dam in the Hackensack River. The two offshore boundaries are located at the eastern end of the Kill van Kull and the southern end of the Arthur Kill. The model grid is shown in Figure 3-3.

3.2.2 Resolution

The resolution of the model was increased throughout the model from the resolution of the truncated model grid. Twelve grid cells represent the cross-section of the Passaic River in the lower sections. Three to four grid cells represent each tenth of a mile in the lower sections of the Passaic River. Within Newark Bay, about 20 grid cells represent the model across the northern section of the Bay. In comparison, the truncated grid includes only 12 grid cells to represent this region. The resolution in the upper portions of the Hackensack was kept the same as in the truncated grid model in order to save on computational time and also because this sub-domain is beyond the area of interest for the LPR. Overall, the high-resolution model contains approximately 12,500 grid cells. Because of the increased resolution, the time step of the model also needed to be reduced to 5 seconds in order to maintain numerical stability.

3.2.3 Bathymetric Sources

The high-resolution model bathymetry was currently constructed to simulate 2005 conditions. Within the Passaic River, the 2004 USACE single beam survey was used for the entire length of the Passaic River. Within Newark Bay, model bathymetry was based on a combination of channel surveys conducted by USACE in 2005, and a survey from Tierra Solutions in 2005 (Tierra, 2005). The Arthur Kill and Kill van Kull were constructed from USACE surveys from 2005. Table 3-1 shows the time and sources of the bathymetry sources used in the high-resolution model. Bathymetry for the Lower Passaic River and Newark Bay is found in Figure 3-4 and Figure 3-5.

Table 3-1: Bathymetry Sources

Survey	Source	Date
Channel Survey – Arthur Kill	USACE	Aug 2005
Channel survey - Newark Bay	USACE	Aug - Oct 2005
Channel survey - Kill van Kull	USACE	Oct 2005
Newark Bay – bank to bank	Tierra, 2005	Oct 2005
Hackensack River	HQI model	Surveys from mid-90s
Passaic River	USACE	2004

3.2.4 Boundary Conditions

Water level boundaries were specified at the southern end of the Arthur Kill and the eastern end of the Kill van Kull. These boundaries were constructed by extracting time-series at hourly intervals from the full grid model. Similarly, daily averages of the salinity and temperature were extracted from the LPR model, interpolated to a z-grid, and applied at the boundaries.

3.2.5 Discharges

Discharge inputs and locations were maintained from the full grid model. They were interpolated to the nearest high resolution grid cell.

3.2.6 Meteorological Forcings

Similar to the truncated grid model, the extent of the high-resolution model does not justify the use of spatially varying wind conditions given the amount of wind data available. A spatially constant wind was used varying in time throughout the model.

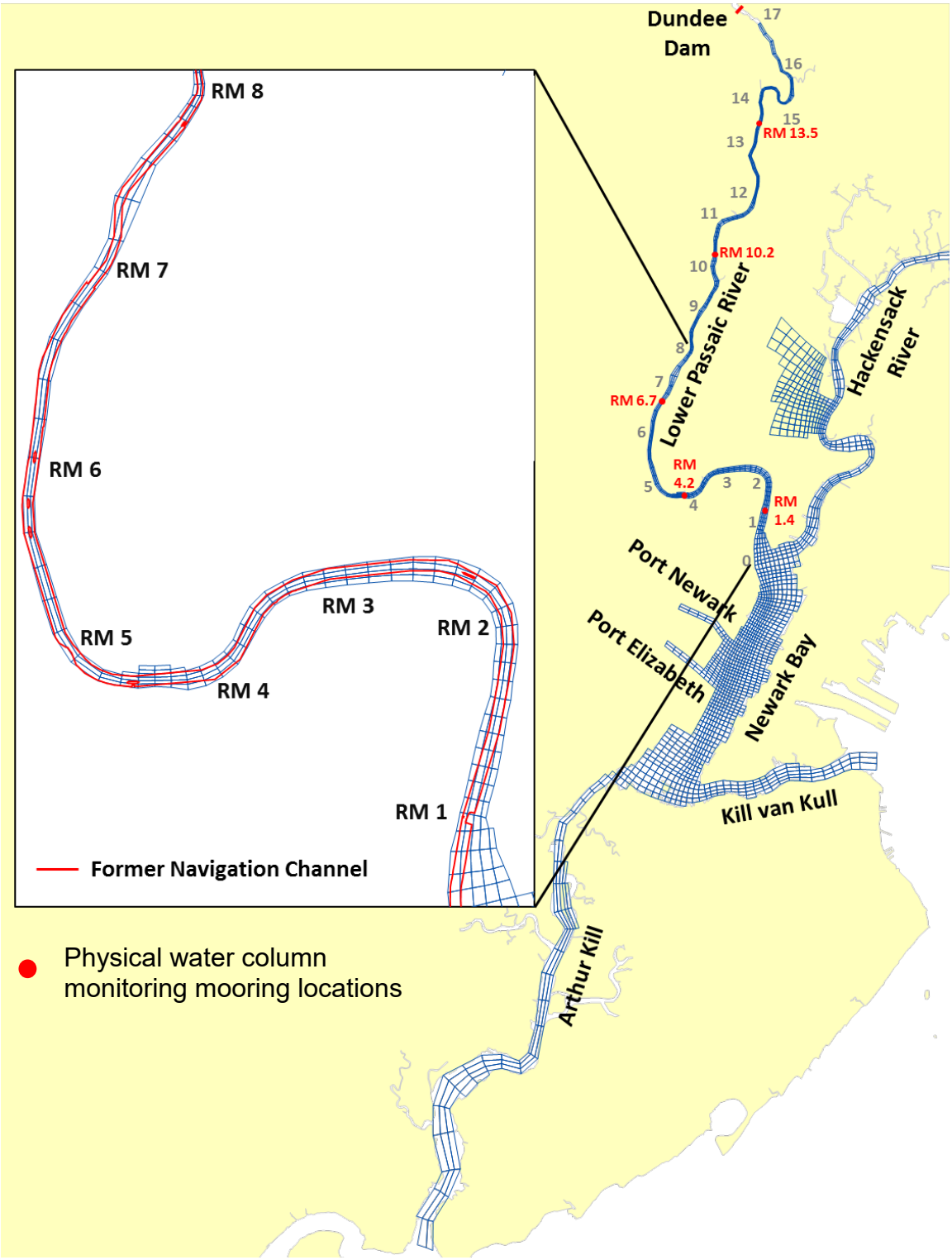


Figure 3-1: The Lower Passaic River and Newark Bay truncated model domain.

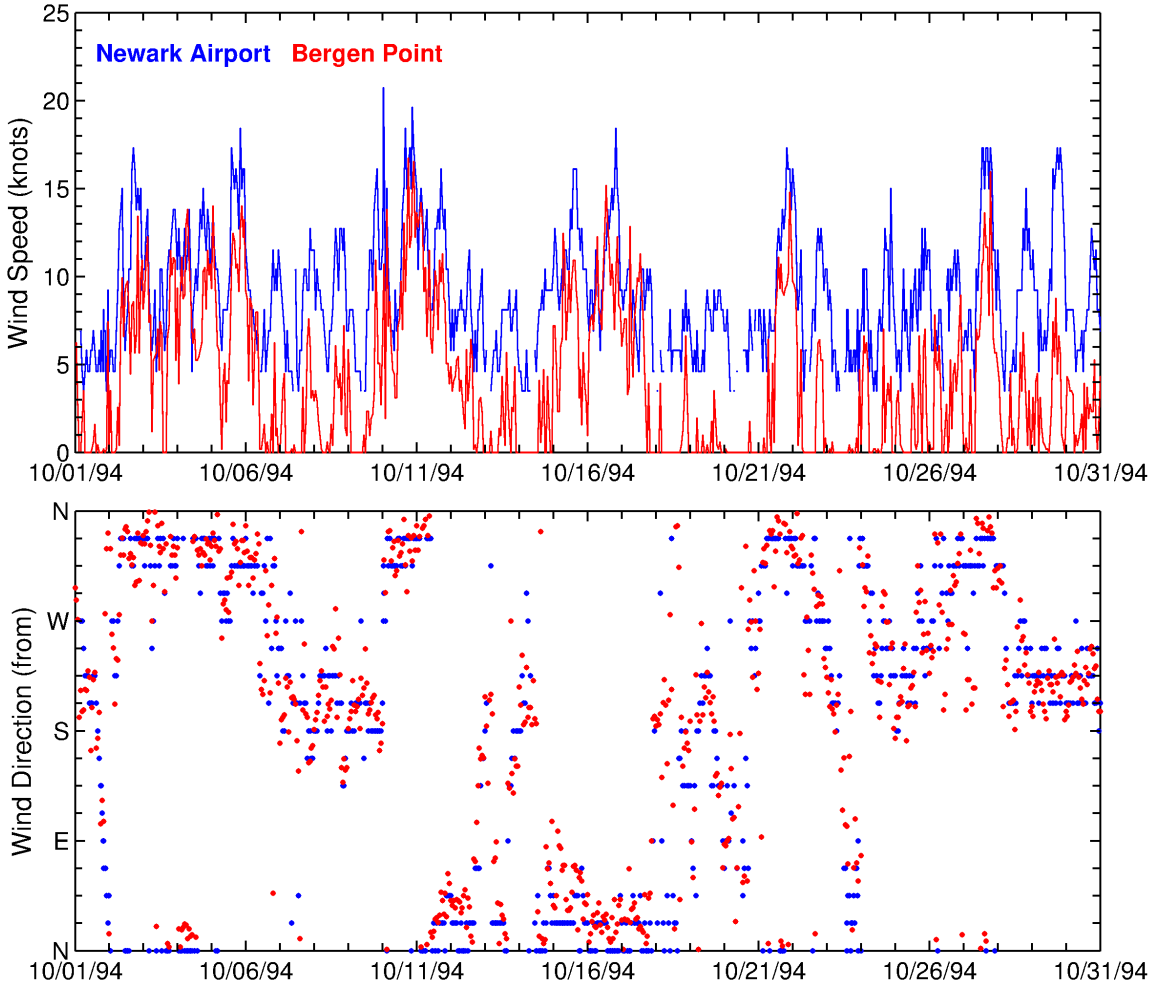


Figure 3-2: Wind Speed (top) and direction (bottom) at Newark Airport and Bergen Point

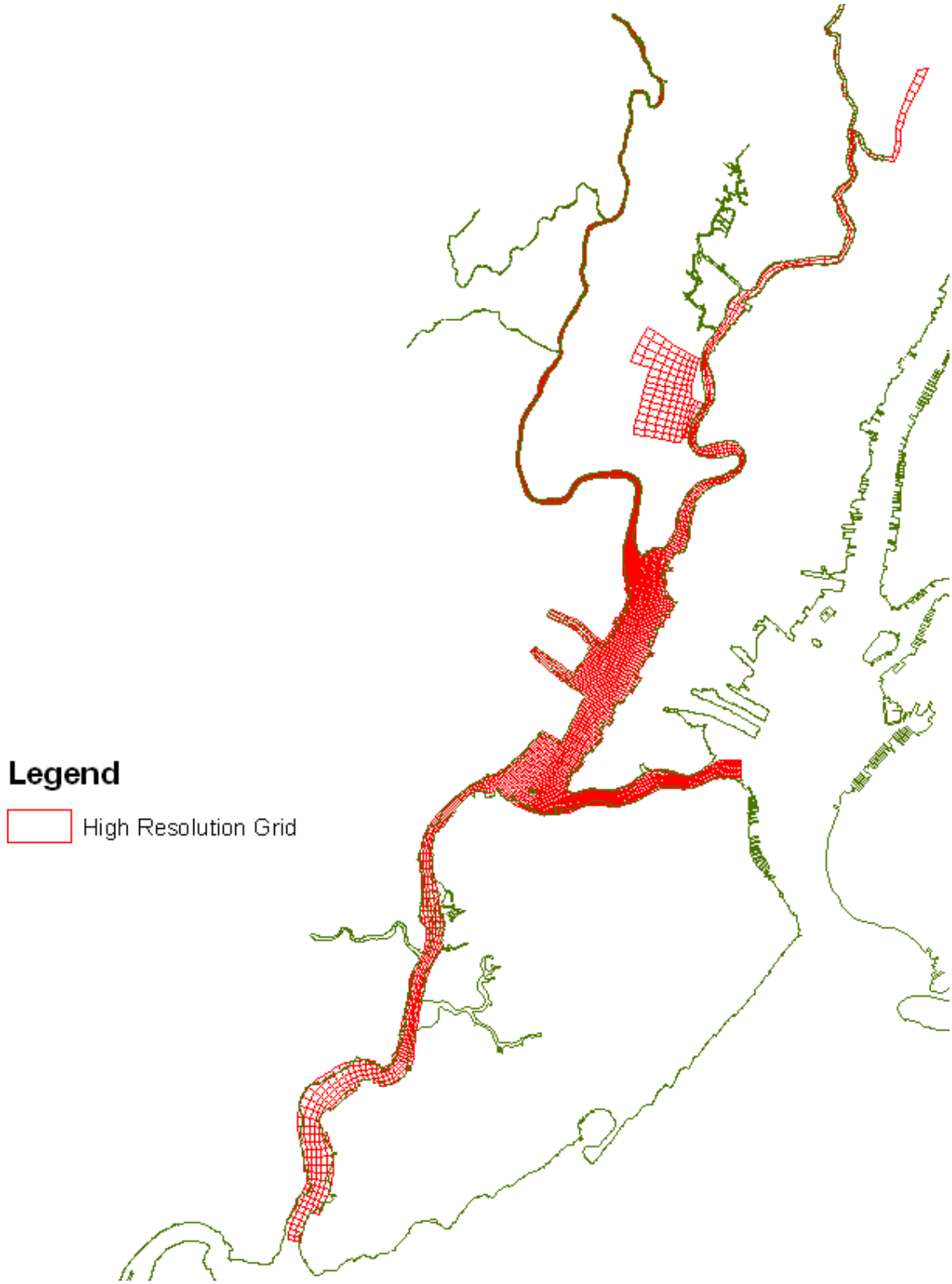


Figure 3-3: High-resolution Model

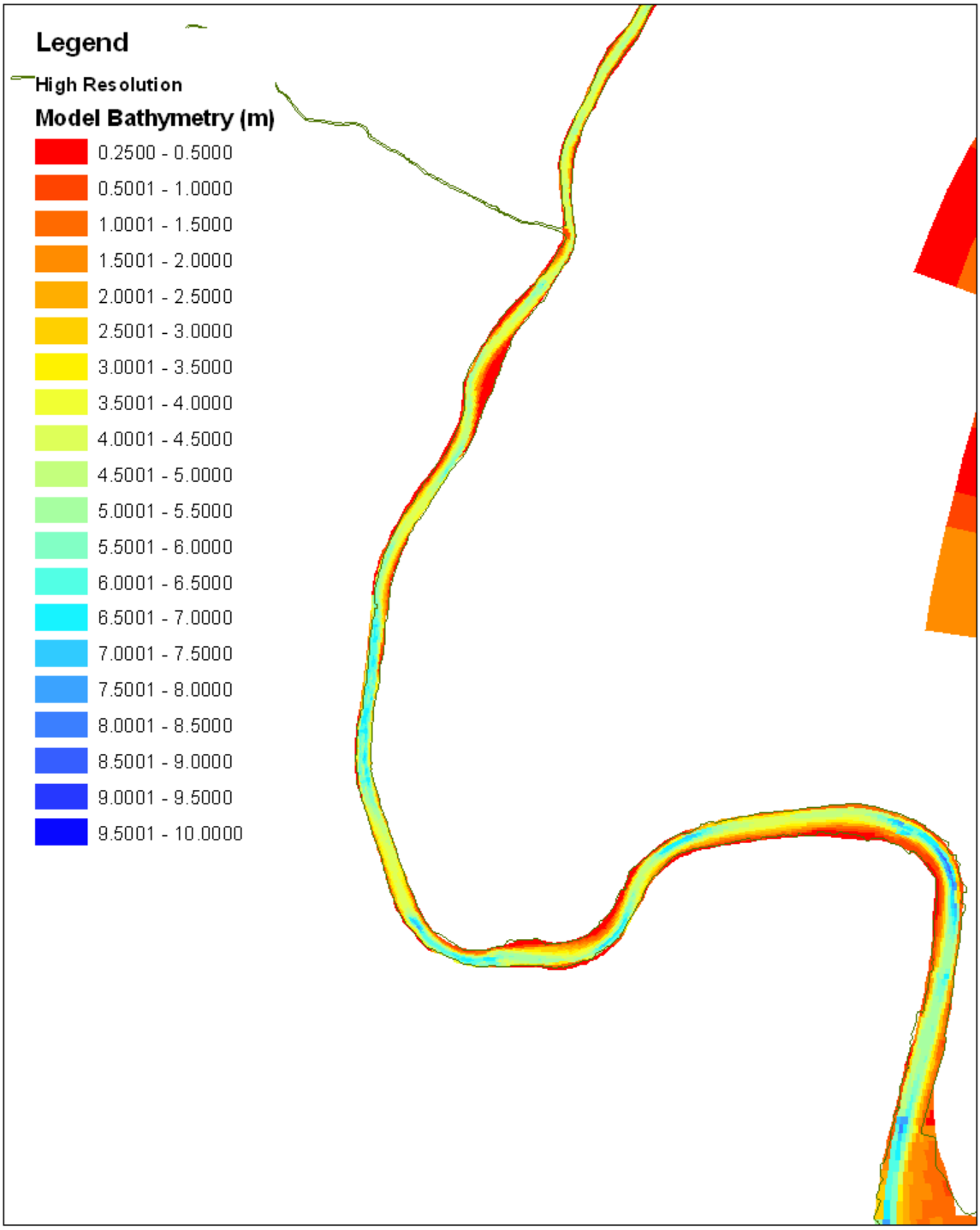


Figure 3-4: High-resolution Bathymetry in the Passaic

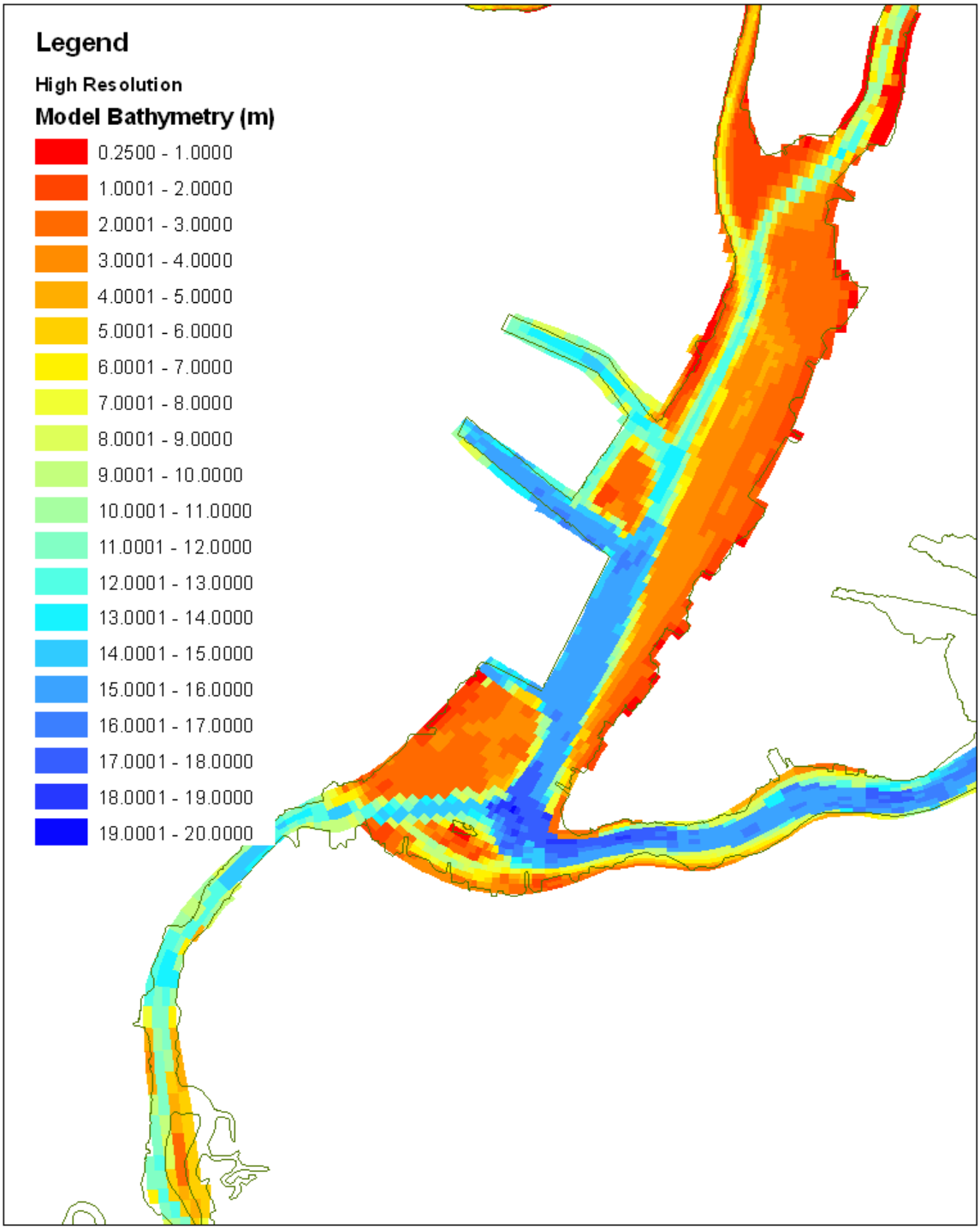


Figure 3-5: High-resolution Bathymetry in Newark Bay

4.0 ANALYSIS OF SALT FRONT DYNAMICS BASED ON 10 YEAR SIMULATIONS OF THE LPR MODEL

The location of the salt front is indicative of a transition of the LPR from a tidal estuarine system to a tidal riverine system. The location of the salt front varies spatially and temporally. The hydrodynamic (HD) model was used for an analysis examining the dynamics of the salt front location. The analysis involved first determining the salt front location time-series using the results from an ECOM model simulation over water years 1995 through 2004. Figure 4-1 shows the river discharges in the LPR during the aforementioned period.

The salt front location in estuaries typically coincides with the estuarine turbidity maximum (ETM; Postma 1967, Geyer et. al. 2004), an area of enhanced suspended sediment concentrations and deposition. At the salt front, the positively buoyant freshwater flow converges with and flows overtop the saltier upstream flow creating a distinctive salt wedge. An example of the salt wedge in the LPR during near average flow conditions (~900 cfs) and high flow conditions (~9,000 cfs) in the LPR is given in Figure 4-2 and Figure 4-3. The salt front is seen to be located in the vicinity of RM 6 during average flow conditions (Figure 4-2), moving down-estuary with increasing discharge to the mouth of the LPR during high-flow conditions (Figure 4-3).

Preferential sediment deposition occurs at the salt front as a result of the convergence of estuarine and fluvial transport processes within the water column (Geyer et. al. 2004). Therefore, the ETM zone and therefore the salt front plays an important role in the fate and transport of sediments in the LPR system. In this analysis, the location of the salt front as well as its variability due to tides, and river discharge was investigated for the model simulation for WY1995 through WY2005. In the remainder of this section the methodology for calculating the salt front location, extent, and excursion is presented, followed by the results from the analysis. For discussion purposes, the salt front is taken to be the location of the 2 ppt isohaline calculated separately at the surface and at the bottom of the water column. During normal tidal and discharge conditions, the salt front is within the LPR, at a location dependent on the freshwater discharge, inter-tidal timing (spring/neap), intra-tidal timing (flood/ebb), and offshore set-up/set-down events. In the following paragraphs and figures although the term ETM has been used interchangeably instead of salt front the analysis presented here does not deal with sediments and therefore is mainly referring to the salt front location.

Model results from the 4 grid cells across the river (i=16 to 19) extending from Newark Bay to river mile 16 (j=110 to 267) were used exclusively in the salt front analysis. The steps in computing the salt front location in the river are as follows:

- At the surface, the salt front location is selected as the farthest downstream grid cell where the salinity in the top layer is equal to 2 ppt.

- At the bottom, the salt front location is selected as the farthest upstream grid cell where the salinity is equal to 2 ppt.

- The salt front location for the entire river is then computed as the average between the surface and bottom location.

Two additional concepts relevant to the salt front analysis are the salt front excursion (range of salt front location over a tidal cycle) and salt front extent (difference between the surface and bottom 2 ppt salinity isopleth). It is of note that the methodology used here to calculate the salt front is not applicable to determining the salt front in Newark Bay due to the complex circulation patterns within the bay. In cases where the discharge is high enough to push the salt front into Newark Bay (Figure 4-3) it suffices to say that the salt front resides in Newark Bay.

The model results of the 11 year simulation indicate that the location of the salt front ranges from Newark Bay to river mile 13. Histograms of the location of the salt front, shown for three separate simulation periods, WY1995-WY1999, WY2000-WY2002, WY2003-WY2005, where the model bathymetry remained constant during the duration of the simulation, show that the salt front shifts upstream and downstream throughout each time period (Figure 4-4). However, each of the histograms shows a high occurrence rate between river miles 4 and 5. It is apparent from Figure 4-4 that the mean location of the salt front is further upstream during WY2000-20002 than WY2003-2005. It will be shown later that difference in the location of the salt front over these time periods can be related to the discharge, as relatively low-flow conditions persisted during WY2000 to WY2002 allowing the salt wedge to be pushed further upstream than during WY2003 to WY2005.

Over the duration of a tidal cycle (12.42 hours) the location of the salt front shifts upstream and downstream due to tidal motion. During flood, the salt front is pushed upstream by tidal currents and conversely during ebb, the salt front is pushed back downstream due to the tidal currents. The apparent correlation ($r = 0.933$) between the high frequency variability in the location of the salt front and the tidal forcing is shown in Figure 4-5. The magnitude of the tidal excursion is controlled by the tidal range – during spring tides, the salt front excursion reaches 5 miles (Figure 4-6) and conversely during neap tides, the salt front excursion can be as low as 2 miles. The relationship between the tidal range and salt front excursion was found to be linear and is shown in Figure 4-7. It should be noted here that the salt front excursion is also influenced by the discharge rate in the river and high discharges lessen the impact of the tide on the variability of the location of the salt front. This effect will be shown in the model results, where it is easier to isolate the impact of discharge on salt front excursion.

The extent of the salt front (defined as the difference in the salt front location at the surface and bottom of the water column) is influenced by the tides, as the extent generally expands during ebb and contracts during flood. This tidal effect is visible in Figure 4-8, which shows that during ebb the location of the 2 ppt salinity isopleth at the surface of the water column is generally further downstream than the 2 ppt isopleth near the river bed. During flood, the saltier water from Newark Bay pushes the salt wedge further upstream and in general results in steep salt front and a smaller extent as the vertical stratification in salinity is reduced.

The variability of the salt front extent on longer time scales was investigated by comparing the low-passed salt front extent to the tidal range and discharge in the river. The low-pass filtering was implemented using a Fourier analysis of the salt front location time-series. The time-series of the salt front location was parsed through a Fast Fourier Transform (FFT) to decompose the time-series signal into its underlying harmonic constituents. The major constituents returned from this analysis represent dependencies of the salt front location with the semi-diurnal tides, discharge, lunar phase (spring-neap), offshore set-up and set-down events, etc., with each constituent characterized by a unique frequency or period. In order to filter out the effect of the tides from the salt front location, the constituents from the FFT were low-pass filtered to exclude harmonics with frequencies greater than 0.2/day, i.e. with period less than 5 days. The remaining constituents, representing the dependency of the salt front with discharge and other low frequency forcings, were parsed through an inverse FFT to reconstitute the time-series of salt front locations, and plotted against the corresponding daily Dundee Dam discharge in Figure 4-9. It is evident from Figure 4-9 that the salt front extent is larger during high discharge events and neap tides than during low-flow periods and spring tides.

The impact of river discharge on the location of the salt front was briefly discussed earlier. As evident from the histograms from WY2000 to WY2002 and WY2003 to WY2005 (Figure 4-4), during low-flow periods, the salt front moves upstream and during high-flow periods the salt front shifts downstream. This effect can be clearly seen in Figure 4-10 where the river discharge and the low-passed location of the near-bottom salt front are plotted as a time-series for several months in 1996 and 1997. During the large discharge event on October 23, 1996 the salt front exits the LPR and moves into Newark Bay. In contrast during low flow conditions over the month of October in 1997 the salt front reaches as far upstream as river mile 10. The location of the low-passed salt front plotted versus the river discharge in Figure 4-11 shows that as the discharge in the river increases the location of the salt front moves downstream. The relationship between the river discharge and low-passed salt front location is often described by a power law (Geyer et al. 2004). However, in the LPR a logarithmic relationship provided a better fit to the data, especially for high discharge events. Figure 4-11 shows the logarithmic and power curves obtained from regression analysis in addition to the low-passed salt front results. The model results and logarithmic relationship indicate that the low-passed location of the salt front exits the LPR at approximately 9,000 cfs. However, the salt front may exit the LPR during ebb at lower discharges since the tidal excursion of salt front typically ranges from 2 to 5 miles.

4.1 Summary of findings

Following are the main findings from the salt front analysis presented above:

- The salt-front is situated up-estuary of RM 5 when discharge at Dundee Dam is below the annual average of 1,200 cfs (HydroQual 2006a; 1,140 cfs at Little Falls with drainage-area proration to calculate discharge at Dundee Dam).
- The salt-front location is pushed seaward with increasing flow and at 2,000 cfs it is found on average near RM 3. During a 1-year return flow of about 6,000 cfs, the

salt front is pushed below RM 2, while a 5-year return flow of about 10,000 cfs pushes the salt front below RM 1, where the river widens rapidly.

- The location of the salt front is also a function of the tidal cycle, moving up-estuary during flood and moving down-estuary during ebb, with tidal excursion lengths on the order of 2 to 5 miles from low to high tide.
- The salt front location is also a function of spring-neap cycle, on average (tidally averaged) further up-estuary on neap than on spring, primarily due to higher vertical mixing and lesser salinity stratification as well as higher tidal prism during spring tides than neap tides.

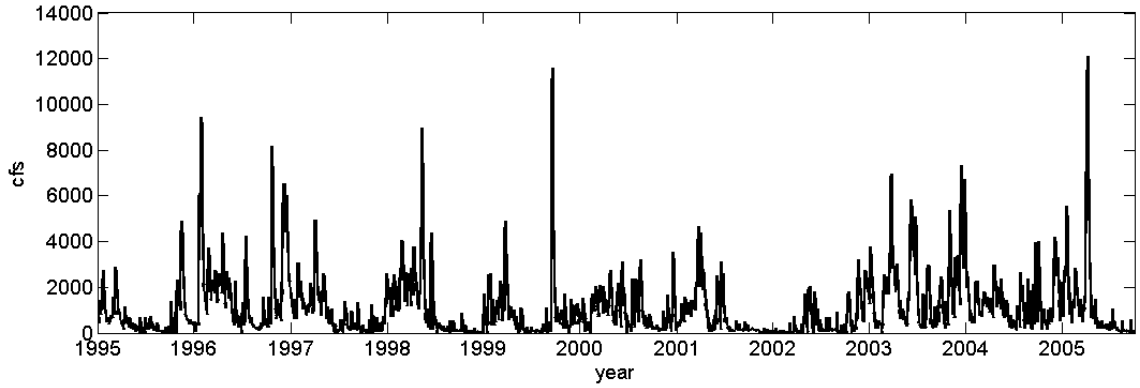


Figure 4-1: LPR discharge as measured by the USGS Little Falls gage station.

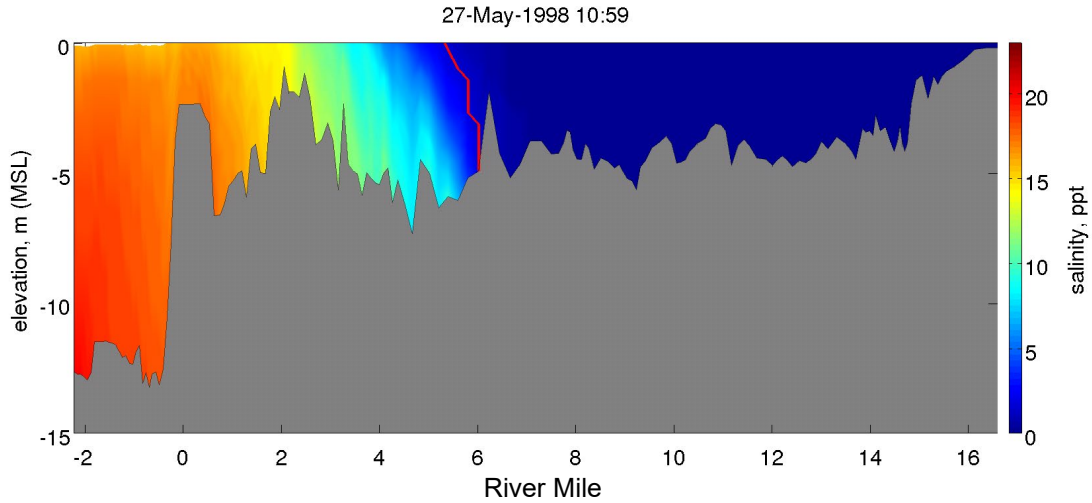


Figure 4-2: Salinity distribution and 2 ppt contour (red line) during typical flow conditions and tidal ebbing.

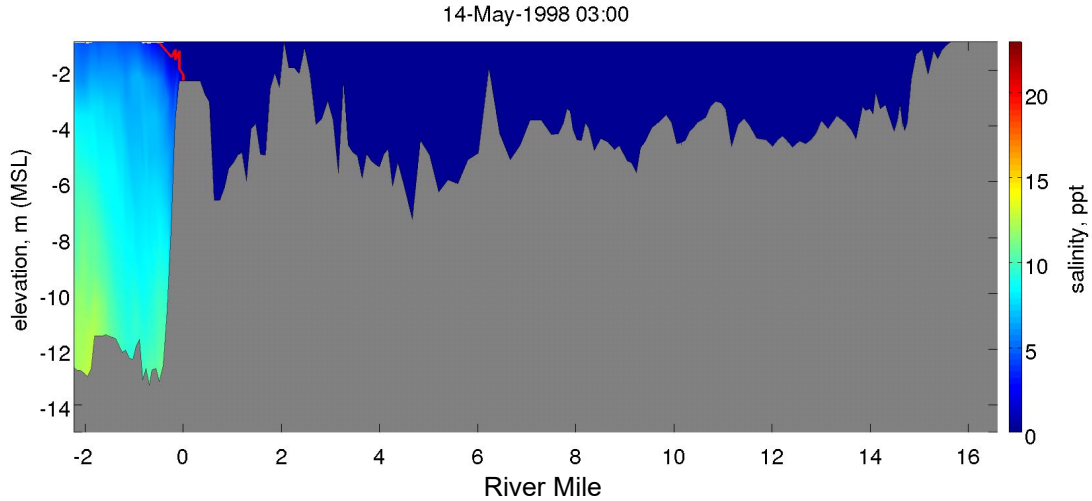


Figure 4-3: Salinity distribution and 2 ppt contour (red line) during a high flow event.

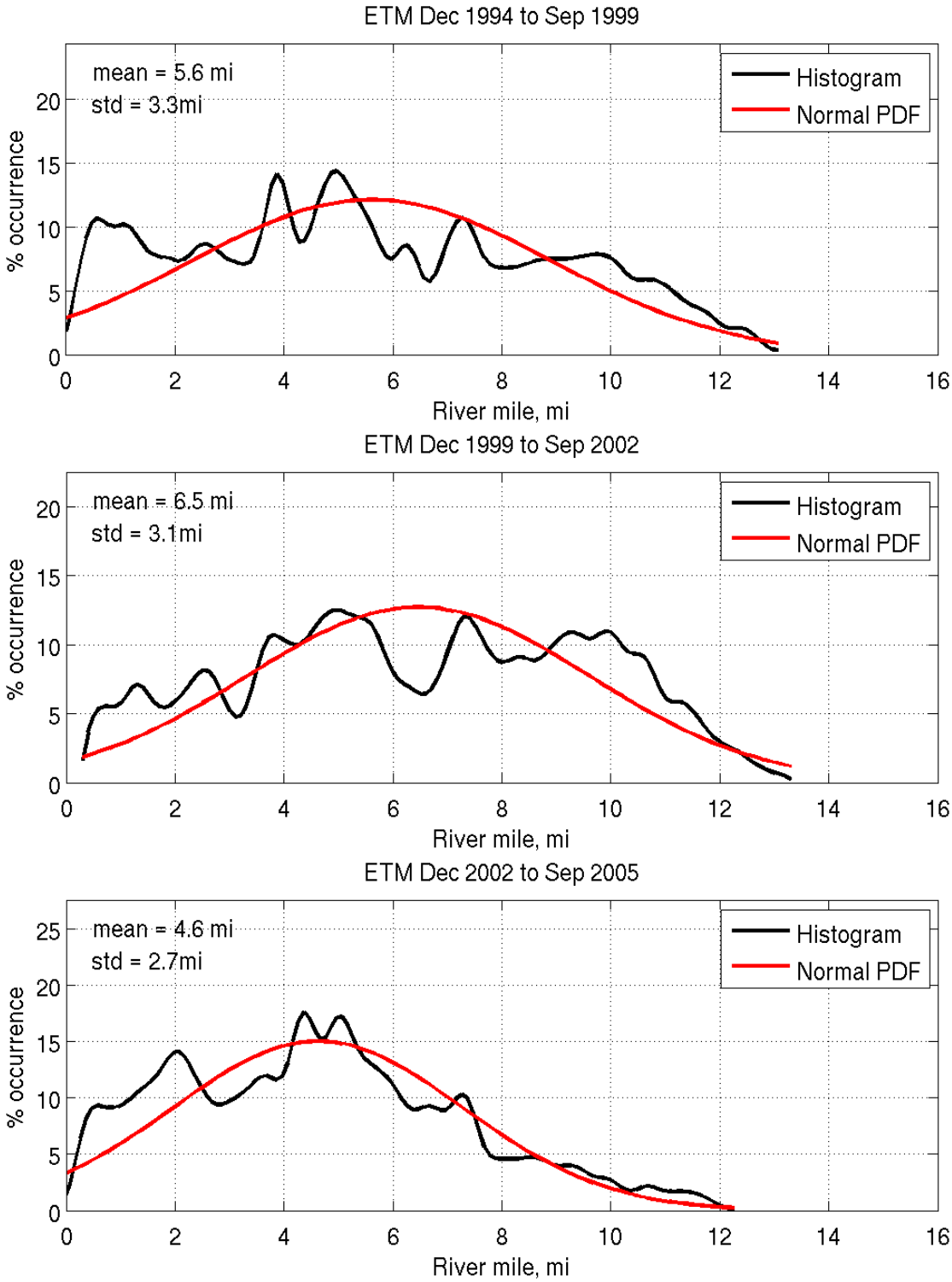


Figure 4-4: Salt-front location during each model period with the same bathymetry.

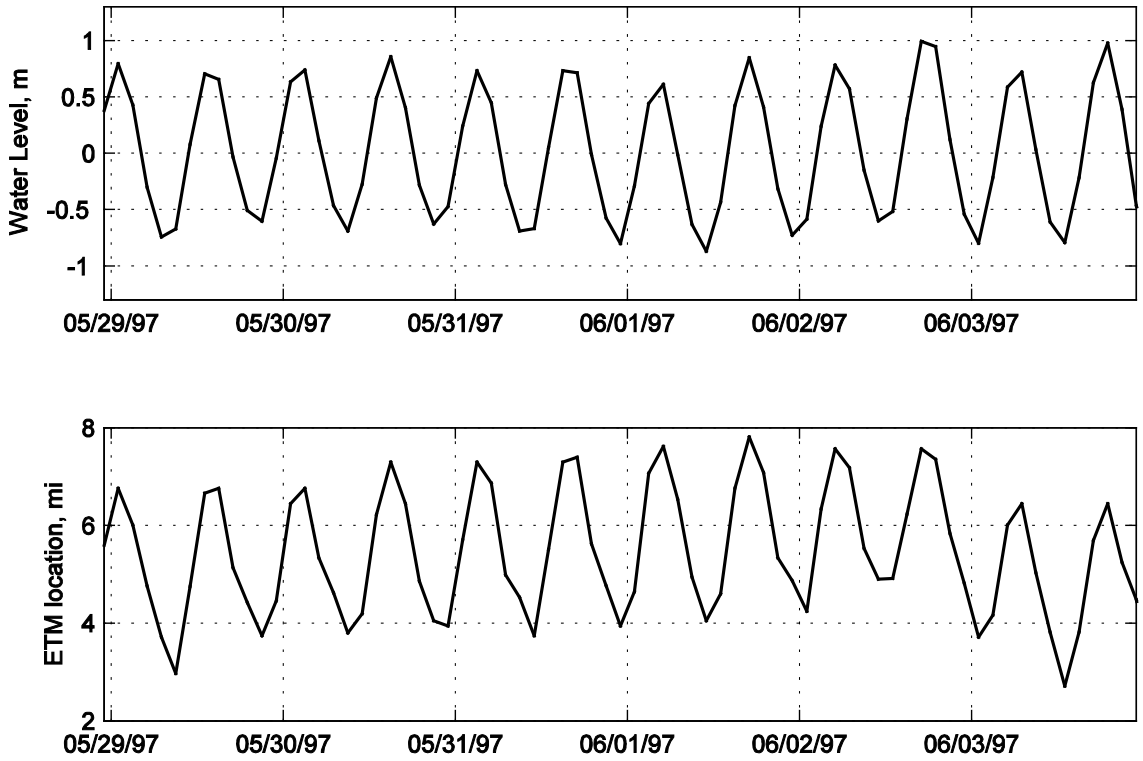


Figure 4-5: High frequency salt-front variability

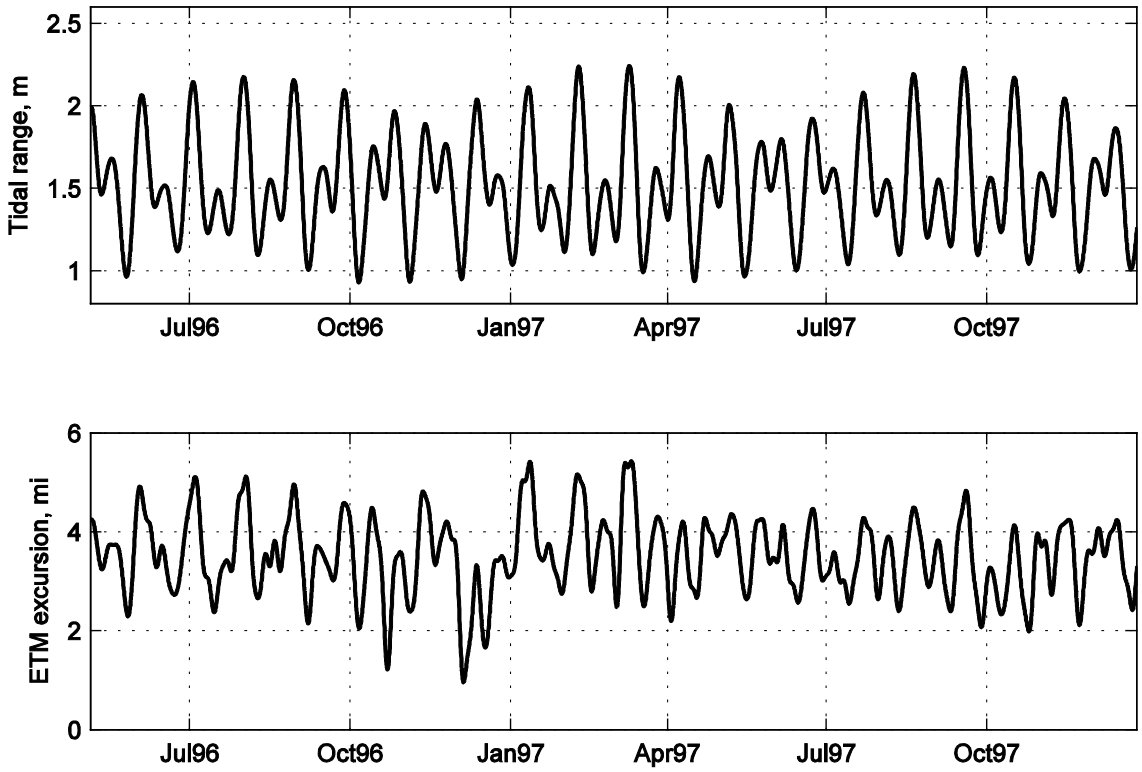


Figure 4-6: Salt-front excursion and tidal range

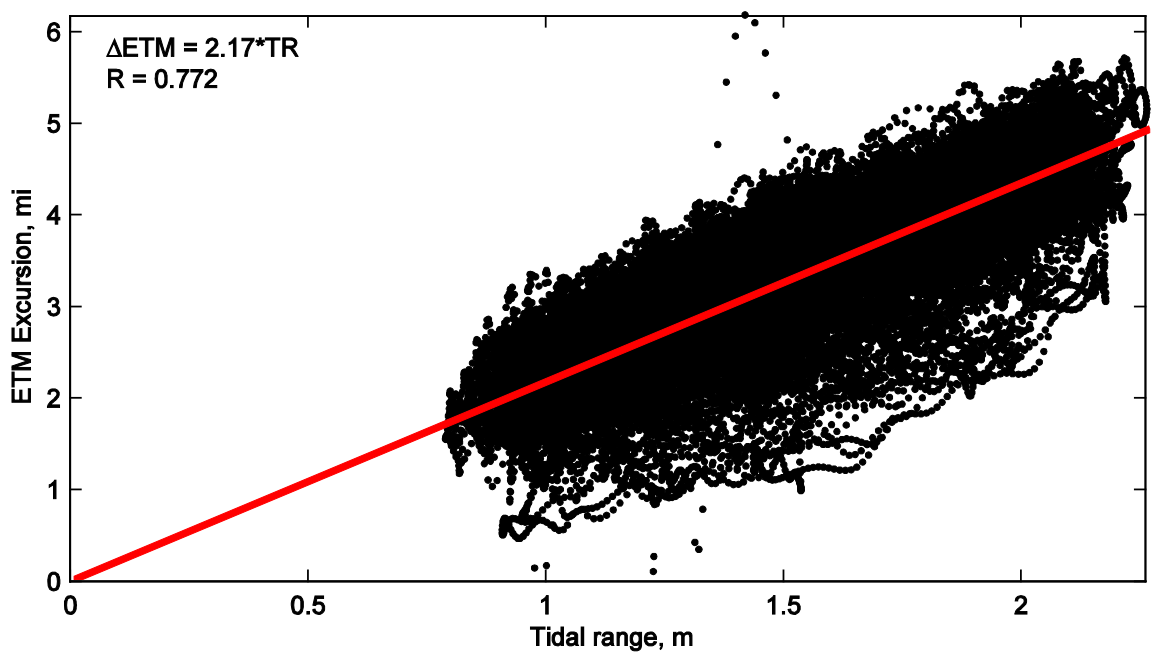


Figure 4-7: Correlation between salt-front excursion and tidal range

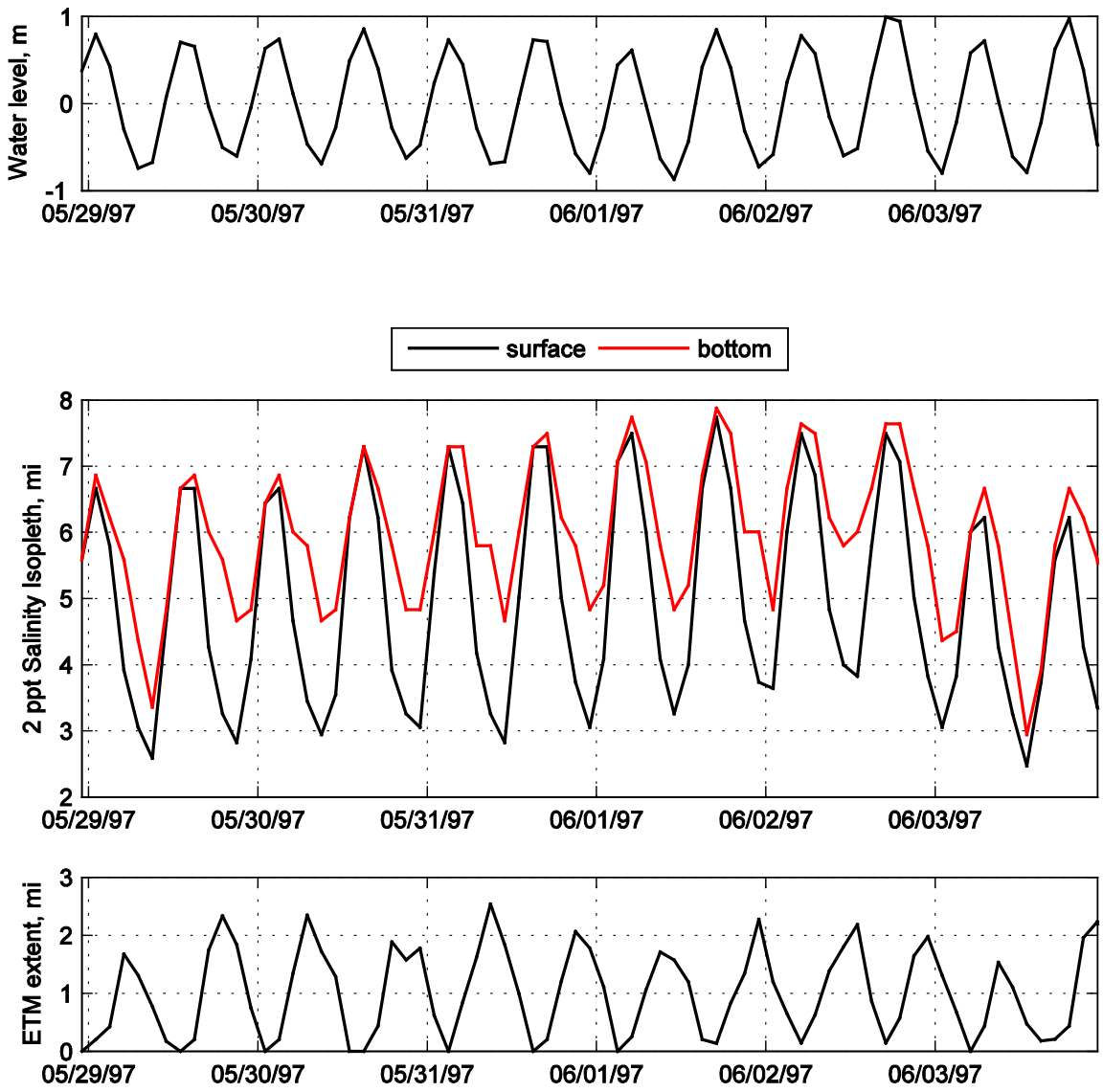


Figure 4-8: High frequency variability of salt-front extent

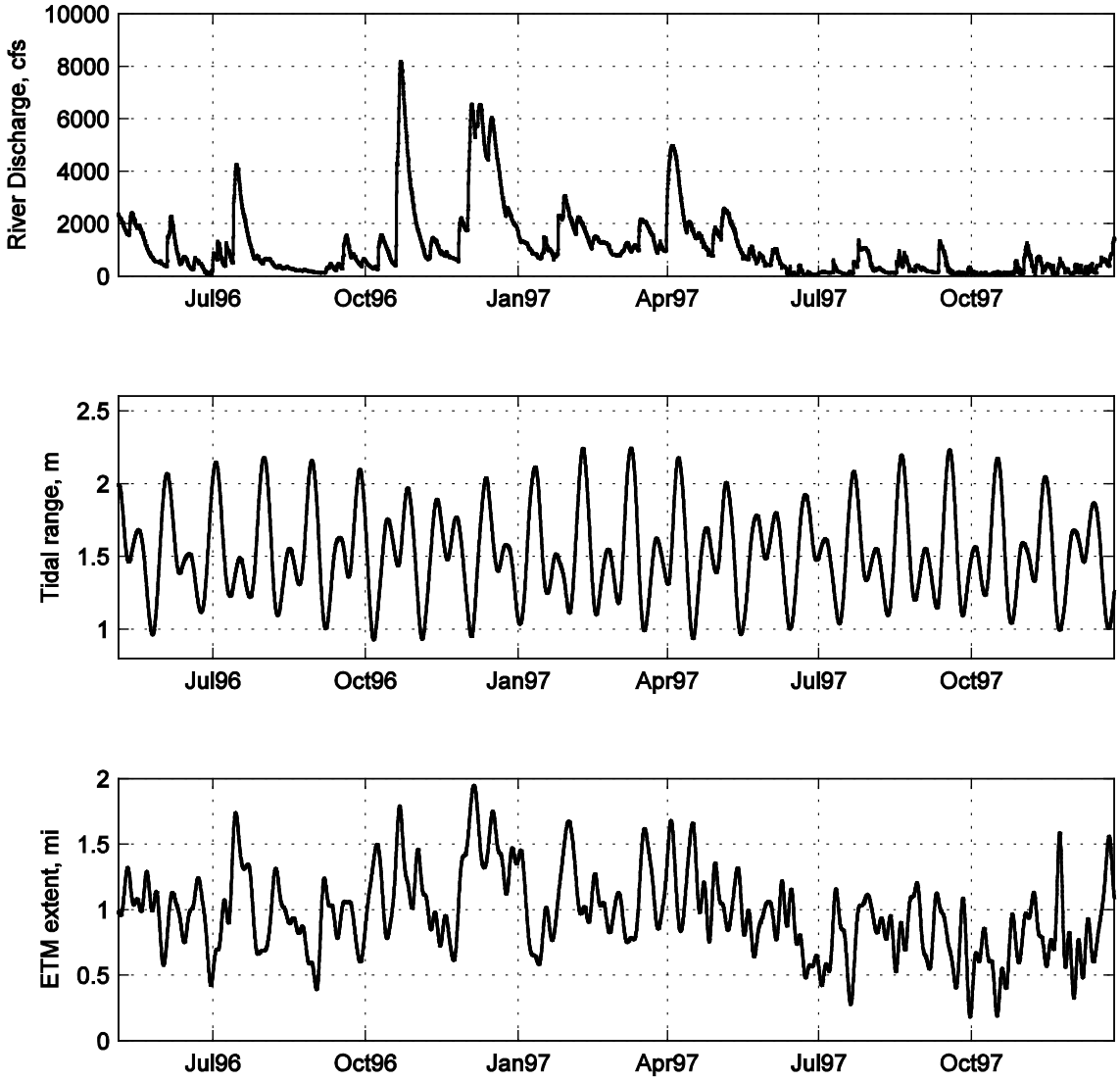


Figure 4-9: Low frequency variability in the salt-front extent

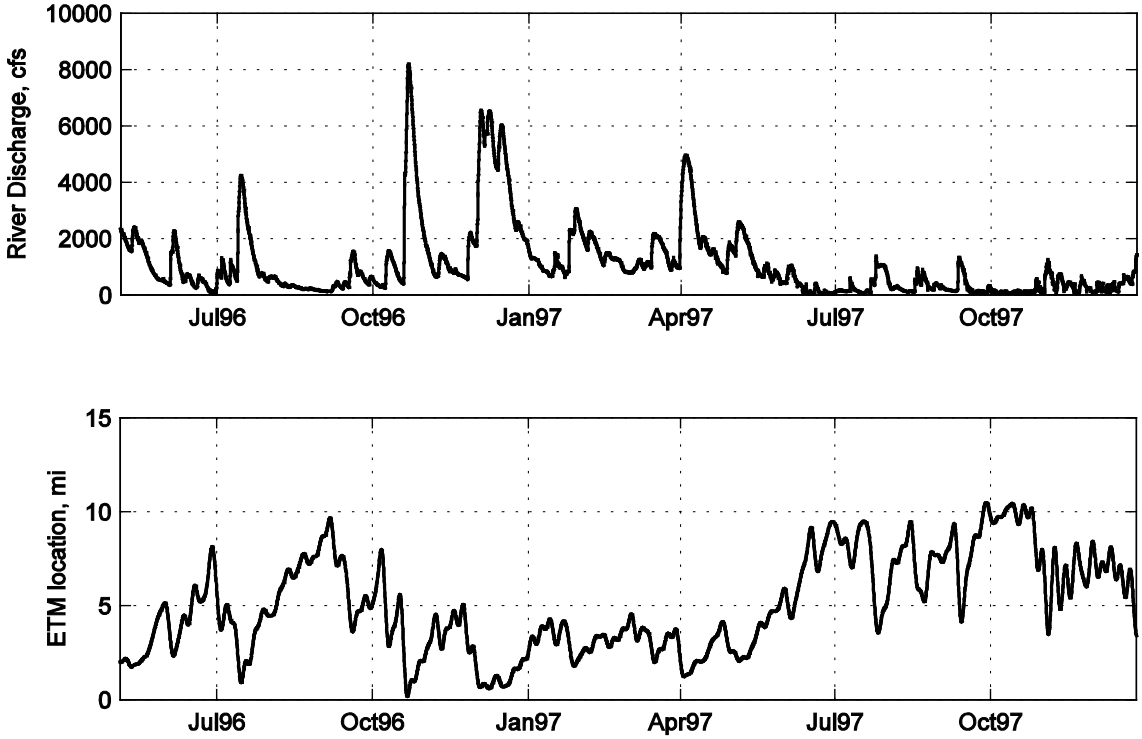


Figure 4-10: Low frequency variations in the salt-front location

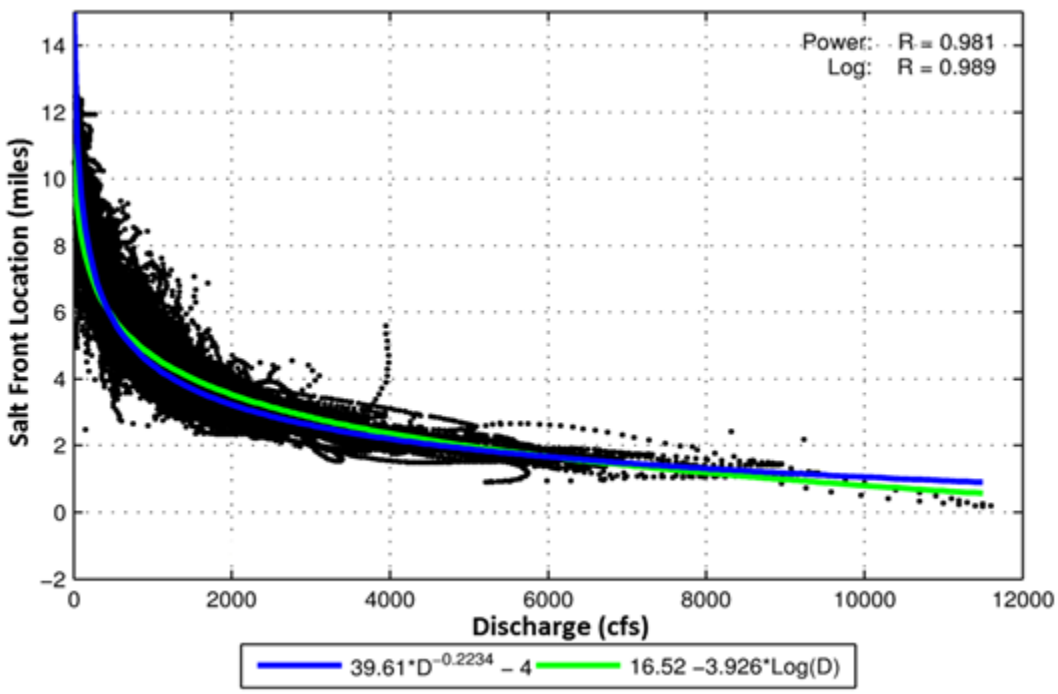


Figure 4-11: Correlation between low-passed salt-front location and discharge. Power and log curves were fitted to the low-passed salt-front location

5.0 CHANGES TO MODEL INPUTS

Section 2.0 described the model inputs developed by EPA/HQI as part of the model application and calibration. These inputs were maintained as developed by HQI with the exception of the model bathymetry. Changes to the model bathymetry are described in the following section.

5.1 Bathymetry

The Passaic River bathymetry used in the hydrodynamic model was originally developed using the USACE 2004 single-beam bathymetry dataset by Region 2 as part of the FFS model. Although the sediment transport (ST) and contaminant model results using this bathymetry were generally consistent with data on various calibration metrics, some inconsistencies were observed in certain localized cases, such as the morphological behavior in the vicinity of the shoal at RM 7.5 In the ST model, the entire cross-section at RM 7.5 including channel and shoal showed mostly depositional behavior during low-flow as well as some high-flow years, whereas the data, especially the recent multi-beam surveys showed erosional trends during the high-flow years. This depositional trend also translated into a burial and recovery of surficial contaminant concentrations within the contaminant fate and transport model. Especially on the shoal at RM 7.5, this was inconsistent with the recent sediment coring data which showed high surficial sediment concentrations with no sign of recovery. Review of the initial model bathymetry indicated the possibility of an improvement in model performance in this regard.

Figure 5-1shows two cross-sections looking upstream at RM 7.5 of several bathymetry datasets along with the model bathymetry across the corresponding rows of model cells. The bathymetry data show the deepest part of the channel located along the western edge of the river, with shallower depths along the shoal on the eastern edge of the river. However, the model bathymetry shows a relatively uniform depth across the cross-section which is too deep compared to the data at the shoal, and also over-estimates the cross-sectional area of the river compared to the data. The bias in cross-sectional area between the model and the data would result in lower flow velocities in the model and therefore provides a likely explanation of the depositional tendency noted in the initial ST model application. Therefore, the USACE 2004 single-beam bathymetry dataset was analyzed and used to develop the model bathymetry within the LPRSA.

To develop a more representative model bathymetry, the 2004 data was converted from the NGVD29 to Mean High Water (MHW) datum, and merged together with the coastline data which represent zero elevation with respect to MHW. These data were interpolated to a raster surface, and the raster points overlaying each model grid-cell were averaged to obtain the representative bathymetry for that cell. The resultant model bathymetry, which was finally converted back to the model MSL datum, was found to match the river-volume calculated from data much more closely than the earlier version of the model bathymetry.

The revised model bathymetry which is also shown in Figure 5-1 can be seen to better represent survey data, especially on the shoal. It must be noted that despite the revisions,

artifacts associated with the spatial resolution of the model grid are apparent in the model bathymetry. For instance, as seen in Figure 5-1, the 0.5 mile stretch of the LPR at RM 7.5 where the former navigation channel meanders from the center of the cross-section to the western edge and then back to the center is represented by only 2 rows of cells. As such, the bathymetry developed for a model cell in the center of the cross-section (for instance the middle cell in the row of cells with J=155 in Figure 5-1) represents the higher depths in former navigation channel at the southern end of the cell as well as the shallower depths at the northern end of the cell since the channel migrates to the western edge of the cross-section. The resulting average model bathymetry while good at preserving the total cross-sectional volume over the length-scale of a row of model cells, is still a poor approximation of the river bathymetry over smaller length scales.

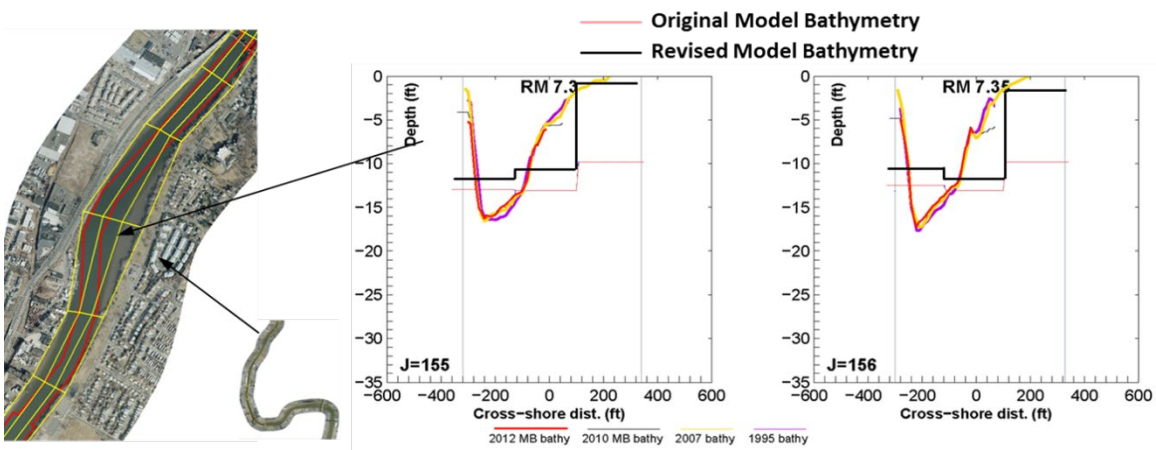


Figure 5-1: Comparison of bathymetric data with the model input bathymetry at RM 7.5

6.0 MODEL VALIDATION

The hydrodynamic model performance with the revised bathymetry was assessed by comparing the model results to the following datasets that included measurements of salinity and velocity:

- Physical Water-Column Monitoring (PWCM) dataset from Fall 2009
- PWCM dataset from Spring 2010
- High-flow event salinity transect collected on March 16, 2010
- Chemical Water-Column Monitoring (CWCM) data from 2012

Note that these comparisons are based on the truncated grid model application.

6.1 Fall 2009 PWCM data

Hydrodynamic data at five different locations within the Lower Passaic River was collected as part of CPG's Fall-2009 PWCM program. Bottom-mounted moored ADCP's at RM 1.4, 4.2, 6.7, 10.2 and 13.5 (see Figure 3-1 for the mooring locations) were used to record current velocities throughout the water-column over 0.5 meter vertical bins. Salinity, temperature, and water depth data were also collected using CTD sensors at the water column surface and bottom at these locations.

6.1.1 Water Levels

A tidal constituent analysis was performed on the water-level predictions and observations, and a comparison of the amplitudes and phases of the major constituents (M2, N2, S2, and K1) between the two is presented in Table 6-1 through Table 6-4 respectively. The amplitudes as well as the phases of the all of the major constituents appear to be in very close agreement at all five stations within the LPR. This indicates that the model is able to reproduce the tidal variability in water-levels within the LPR.

Table 6-1: Comparison of Harmonic Constants for Water Level – M2 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.69	214	0.67	212
RM 4.2	0.69	220	0.71	219
RM 6.7	0.78	259	0.76	254
RM 10.2	0.64	201	0.64	194
RM 13.5	0.74	237	0.75	229

Table 6-2: Comparison of Harmonic Constants for Water Level – N2 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.11	208	0.11	200
RM 4.2	0.12	217	0.12	212
RM 6.7	0.12	267	0.11	259
RM 10.2	0.12	199	0.12	182
RM 13.5	0.13	240	0.13	224

Table 6-3: Comparison of Harmonic Constants for Water Level – S2 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.11	227	0.11	236
RM 4.2	0.11	228	0.12	240
RM 6.7	0.14	270	0.13	275
RM 10.2	0.12	227	0.12	227
RM 13.5	0.13	253	0.13	252

Table 6-4: Comparison of Harmonic Constants for Water Level – K1 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.11	86	0.09	70
RM 4.2	0.11	89	0.09	73
RM 6.7	0.11	109	0.1	93
RM 10.2	0.11	77	0.09	59
RM 13.5	0.11	97	0.09	78

6.1.2 Currents and Salinities

Harmonic Constituent Analysis

A harmonic constituent analysis was also performed on the computed and observed current velocities at the five stations within the LPR. The amplitudes and phases of the four tidal constituents – M2, N2, S2, and K1, are presented in Table 6-5 through Table 6-8 respectively. The harmonic constituents were extracted from the time-series of measured and predicted currents at the bottom ADCP bin, the surface ADCP bin, and at mid-depth separately. The model is found to somewhat overestimate the amplitude of the dominant M2 component, by about 10-20% at the surface to about 20-40% at the bottom. The predicted current phases at all the stations within the LPR however appear consistent with data. The comparison of the N2, S2, and K1 components shows that predicted amplitudes of the smaller constituents are mostly consistent with observations, although there appears to be a small phase lag in the model predictions at these lesser harmonics.

Table 6-5: Comparison of Harmonic Constants for Velocity – M2 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.51	156	0.57	157
	Mid-Depth	0.44	157	0.53	158
	Bottom	0.33	151	0.42	153
RM 4.2	Surface	0.42	176	0.56	153
	Mid-Depth	0.34	176	0.54	161
	Bottom	0.26	178	0.46	168
RM 6.7	Surface	0.4	167	0.5	157
	Mid-Depth	0.4	170	0.47	158
	Bottom	0.35	173	0.43	159
RM 10.2	Surface	0.33	171	0.4	163
	Mid-Depth	0.31	171	0.38	163
	Bottom	0.29	172	0.35	163
RM 13.5	Surface	0.15	180	0.2	171
	Mid-Depth	0.14	180	0.22	176
	Bottom	0.13	180	0.18	172

Table 6-6: Comparison of Harmonic Constants for Velocity – N2 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.12	163	0.1	148
	Mid-Depth	0.11	162	0.09	148
	Bottom	0.09	160	0.09	151
RM 4.2	Surface	0.1	160	0.13	149
	Mid-Depth	0.08	172	0.12	155
	Bottom	0.07	184	0.08	165
RM 6.7	Surface	0.08	168	0.09	155
	Mid-Depth	0.08	172	0.09	156
	Bottom	0.07	172	0.08	159
RM 10.2	Surface	0.06	173	0.07	160
	Mid-Depth	0.06	174	0.07	161
	Bottom	0.06	176	0.06	162
RM 13.5	Surface	0.03	188	0.03	172
	Mid-Depth	0.03	186	0.06	149
	Bottom	0.02	186	0.03	175

Table 6-7: Comparison of Harmonic Constants for Velocity – S2 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.12	177	0.1	175
	Mid-Depth	0.1	176	0.09	176
	Bottom	0.08	175	0.08	177
RM 4.2	Surface	0.12	187	0.13	175
	Mid-Depth	0.09	189	0.12	182
	Bottom	0.07	198	0.09	190
RM 6.7	Surface	0.08	177	0.1	173
	Mid-Depth	0.08	181	0.09	176
	Bottom	0.07	186	0.09	179
RM 10.2	Surface	0.07	185	0.08	180
	Mid-Depth	0.06	185	0.08	181
	Bottom	0.06	186	0.07	181
RM 13.5	Surface	0.03	190	0.04	181
	Mid-Depth	0.03	189	0.04	194
	Bottom	0.03	190	0.04	185

Table 6-8: Comparison of Harmonic Constants for Velocity – K1 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.05	13	0.02	344
	Mid-Depth	0.04	11	0.04	7
	Bottom	0.03	8	0.03	9
RM 4.2	Surface	0.03	35	0.04	352
	Mid-Depth	0.03	32	0.03	1
	Bottom	0.02	28	0.03	13
RM 6.7	Surface	0.03	35	0.03	354
	Mid-Depth	0.03	35	0.03	2
	Bottom	0.02	49	0.03	9
RM 10.2	Surface	0.02	29	0.02	5
	Mid-Depth	0.02	31	0.02	6
	Bottom	0.02	31	0.02	7
RM 13.5	Surface	0.01	42	0.01	16
	Mid-Depth	0.01	41	0.01	30
	Bottom	0.01	42	0.01	24

Time-Series Comparisons

The time-series of surface and bottom velocities and salinities at the five Fall PWCM locations based on model results and the corresponding data from the nearest measured bin are shown in Figure 6-1 through Figure 6-5. The model is found to reasonably capture the movement of the salt front into the river as both the bottom salinity as well as the surface salinity show good agreement with data as far upstream as RM 10.2. The model performance metrics in terms of the RMSE, relative RMSE, and the coefficient of determination of the model predictions are also shown in these figures.

In the comparison of the velocity time-series, the upstream currents at flood tides are considered positive, and the downstream currents during ebb flow are considered negative. The model appears to over-predict the currents more significantly at RM1.4 and RM4.2 especially at the surface, with a relative RMS error between model and data of almost 20%.

The model performance improves further upstream, with the increased dominance of fresh-water flow, and there is much better agreement in surface and bottom current velocities between model and data with a relative RMS error of only about 5%.

6.2 Spring 2010 PWCM data

Hydrodynamic data is also available from ADCP and CTD deployments as part of the Spring PWCM in 2010 at River Miles 1.4, 4.2, 6.7, 10.2, and 13.5 within the LPR. The harmonic constituents of water-level measurements and model predictions at these locations were computed, and are presented in Table 6-9 through Table 6-12.

6.2.1 Water Levels

The results of a harmonic constituent analysis of the predicted and observed water-levels during the Spring 2010 PWCM is shown in Table 6-9 through Table 6-12 for tidal constituents M2, N2, S2, and K1 respectively. For the M2 constituent, the model-predictions and observations generally appear to be in very good agreement, although the model appears to under-estimate the amplitudes of the M2 component by about 5% at RM 1.4 and RM 4.2 Similarly, the model is also able to reproduce very well the observed amplitudes of the N2, S2, and K1 components, although there is appears to be a small phase lag in the model especially at RM 10.2 and RM 13.5.

Table 6-9: Comparison of Harmonic Constants for Water Level – M2 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.65	297	0.61	296
RM 4.2	0.78	241	0.74	240
RM 6.7	0.79	246	0.76	243
RM 10.2	0.66	316	0.67	308
RM 13.5	0.67	316	0.69	308

Table 6-10: Comparison of Harmonic Constants for Water Level – N2 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.09	290	0.09	282
RM 4.2	0.16	231	0.16	228
RM 6.7	0.16	240	0.16	231
RM 10.2	0.11	325	0.1	306
RM 13.5	0.13	328	0.11	311

Table 6-11: Comparison of Harmonic Constants for Water Level – S2 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.09	310	0.1	320
RM 4.2	0.13	267	0.14	272
RM 6.7	0.12	274	0.14	275
RM 10.2	0.08	336	0.09	334
RM 13.5	0.07	338	0.09	334

Table 6-12: Comparison of Harmonic Constants for Water Level – K1 Component

Location	Observed		Predicted	
	Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	0.11	130	0.08	117
RM 4.2	0.12	99	0.09	85
RM 6.7	0.12	102	0.09	86
RM 10.2	0.1	142	0.09	122
RM 13.5	0.1	143	0.09	121

6.2.2 Currents and Salinities

Harmonic Constituent Analysis

A harmonic analysis was performed on the computed and observed current velocities at the Spring 2010 PWCM locations within the LPR. The amplitudes and phases of the four tidal constituents – M2, N2, S2, and K1, are presented in Table 6-13 through **Table 6-16 respectively. The amplitudes of these major components are in general found to be in good agreement with data at all the locations, although the model tends to slightly over-predict the M2 amplitudes in the near-bottom layers. The predicted phase of the M2, N2, and S2 components also compare reasonably well with the observations.**

Table 6-13: Comparison of Harmonic Constants for Velocity – M2 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.53	160	0.55	158
	Mid-Depth	0.4	159	0.46	154
	Bottom	0.26	151	0.33	148
RM 4.2	Surface	0.43	162	0.55	152
	Mid-Depth	0.35	167	0.48	159
	Bottom	0.27	172	0.39	164
RM 6.7	Surface	0.41	166	0.46	159
	Mid-Depth	0.39	169	0.43	160
	Bottom	0.34	172	0.38	162
RM 10.2	Surface	0.31	171	0.37	165
	Mid-Depth	0.29	172	0.35	165
	Bottom	0.26	173	0.31	165
RM 13.5	Surface	0.16	180	0.19	178
	Mid-Depth	0.13	180	0.17	177
	Bottom	0.11	180	0.16	174

Table 6-14: Comparison of Harmonic Constants for Velocity – N2 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.1	156	0.11	148
	Mid-Depth	0.1	151	0.1	142
	Bottom	0.08	150	0.09	140
RM 4.2	Surface	0.1	162	0.13	144
	Mid-Depth	0.08	168	0.11	154
	Bottom	0.07	167	0.08	161
RM 6.7	Surface	0.09	166	0.1	155
	Mid-Depth	0.09	168	0.1	157
	Bottom	0.08	170	0.09	156
RM 10.2	Surface	0.07	174	0.09	164
	Mid-Depth	0.07	174	0.08	164
	Bottom	0.06	174	0.07	165
RM 13.5	Surface	0.04	188	0.06	179
	Mid-Depth	0.03	179	0.06	179
	Bottom	0.03	182	0.04	175

Table 6-15: Comparison of Harmonic Constants for Velocity – S2 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.08	191	0.1	191
	Mid-Depth	0.07	196	0.09	191
	Bottom	0.05	195	0.07	192
RM 4.2	Surface	0.06	187	0.1	186
	Mid-Depth	0.06	200	0.09	193
	Bottom	0.05	208	0.07	198
RM 6.7	Surface	0.06	197	0.08	194
	Mid-Depth	0.06	200	0.08	198
	Bottom	0.06	204	0.07	199
RM 10.2	Surface	0.05	203	0.07	200
	Mid-Depth	0.04	202	0.06	201
	Bottom	0.04	204	0.06	201
RM 13.5	Surface	0.02	223	0.03	221
	Mid-Depth	0.02	209	0.03	224
	Bottom	0.02	212	0.03	214

Table 6-16: Comparison of Harmonic Constants for Velocity – K1 Component

Location		Observed		Predicted	
		Amplitude (m)	Phase (degrees)	Amplitude (m)	Phase (degrees)
RM 1.4	Surface	0.03	23	0.04	357
	Mid-Depth	0.04	15	0.03	355
	Bottom	0.03	6	0.02	340
RM 4.2	Surface	0.03	14	0.03	354
	Mid-Depth	0.03	24	0.03	3
	Bottom	0.02	29	0.03	12
RM 6.7	Surface	0.03	15	0.03	6
	Mid-Depth	0.03	25	0.03	9
	Bottom	0.03	39	0.02	8
RM 10.2	Surface	0.03	30	0.02	13
	Mid-Depth	0.02	30	0.02	11
	Bottom	0.02	33	0.02	10
RM 13.5	Surface	0.01	54	0.02	48
	Mid-Depth	0.01	59	0.01	52
	Bottom	0.01	55	0.01	43

Time-Series Comparisons

Figure 6-6 through Figure 6-15 show the time-series comparison of velocities and salinities between model and data at the five measurement locations within the LPR. For each location, the 4-month long deployment is plotted over two pages to better illustrate the intra-tidal variability. While the salinity data at RM 1.4 appears to be unreliable towards the latter half of the deployment with abrupt changes in reported values and inexplicable trends in bottom and surface salinities, the model results in general seem to compare reasonably well with data. The model reasonably captures the onset of salt-water flow at all the locations towards the end of the high river-flow period.

The model-predicted currents also coincide greatly with the data at both the bottom and surface at most locations, with a relative RMS error averaging around 5%. The most significant exception is at RM 4.2, where the model appears to over-predict the ebb

velocities at the surface as well as bottom resulting in a higher relative RMS error of about 10%.

6.3 March 2010 high-flow transects

On March 16, 2010, the flow over Dundee Dam peaked at 16,300 cfs, which is the equivalent of a 1 in 25-year event in the LPR, providing an opportunity to measure the response of the river under such extreme high flow conditions. Dr. Robert Chant of the Institute of Marine and Coastal Science, Rutgers University conducted a series of longitudinal transects along the thalweg in the LPR and within the navigation channel in NB during the peak of the storm event. The data consists of CTD and OBS casts measuring the water depth, temperature, salinity and SS concentration (OBS measured, converted to SS concentration by means of an OBS-SS concentration relationship) over depth in the water column. A total of three such longitudinal transects were collected over half a tidal cycle, with the first transect collected at the beginning of the ebb tide, the second transect collected around the middle of the ebb tide, and the third transect collected around the following low-water slack.

The model application and comparison to the salinity measured in this event are a measure of the model's capability to capture the response of the river to such extreme high-flow events and represents the model calibration to salinity conditions in the LPR under high-flow conditions. The model results for salinity over the period corresponding to the collection of the three transects have also been plotted along the longitudinal axis of the LPR and NB and compared to the data as shown in Figure 6-16 through Figure 6-18. The model reproduces the salt front location approximately at the same location as seen in the data with some minor discrepancies. The model-calculated salt front is about quarter mile down-estuary in case of transect #1, and about half-mile up-estuary in case of transects #2 and #3 when compared to the salt front location seen in the data.

6.4 Chemical Water-Column Monitoring (CWCM) data

The water samples collected as part of the CWCM program were characterized for salinity in addition to contaminant concentrations. Since the water samples were collected over a range of discharge (ranging from ~200 cfs to 4000 cfs) and tidal conditions (with measurements over the tidal cycle as well as spring-neap cycle), and with several measurements at several locations within the LPR, these measurements have also been used to provide an additional dataset to judge the performance of the HD model with respect to reproducing the salinity in the LPR.

The comparison of the measured salinity versus the model-calculated salinity for the various events and locations is presented in Figure 6-19. As observed from the figure the model performs well in reproducing the salinity measurements in most events and locations. Only during Routine Event 1 and High-Flow Event 1 does the model show an apparent bias relative to the measured salinity, tending to over-predict during routine event 1 and under-predicting during High-Flow Event 1. Both these discrepancies may be a consequence of minor temporal differences between the model and data which are

exacerbated during episodic events with elevated river flows such as during High-Flow Event 1, but also during Routine Event 1 which occurred during a flow event when river flow at Dundee Dam reached ~3000 cfs and which was preceded by about a month with flows less than 1000 cfs.

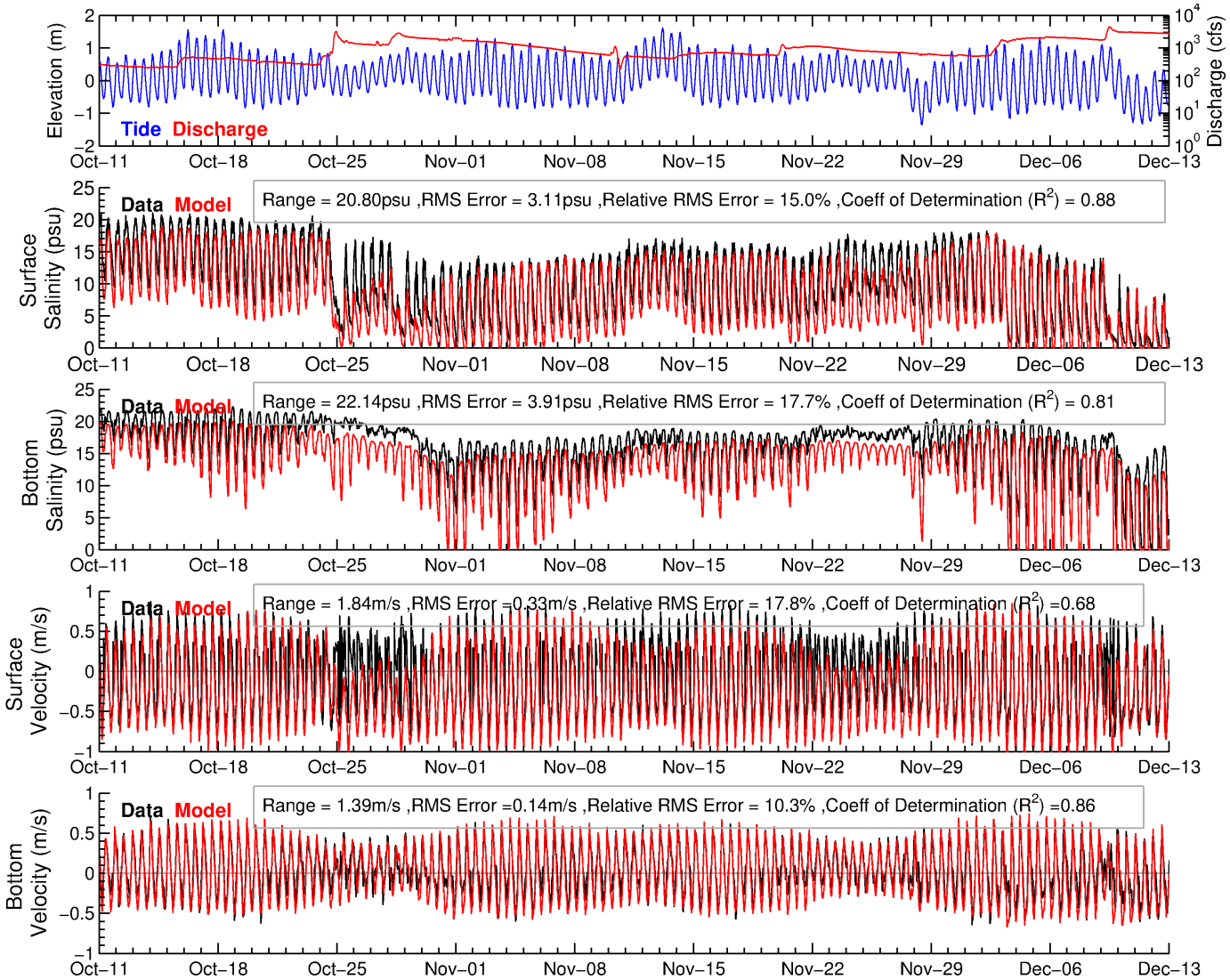


Figure 6-1: Comparison of model and data velocities and salinities at RM 1.4 for the Fall 2009 PWCM period.

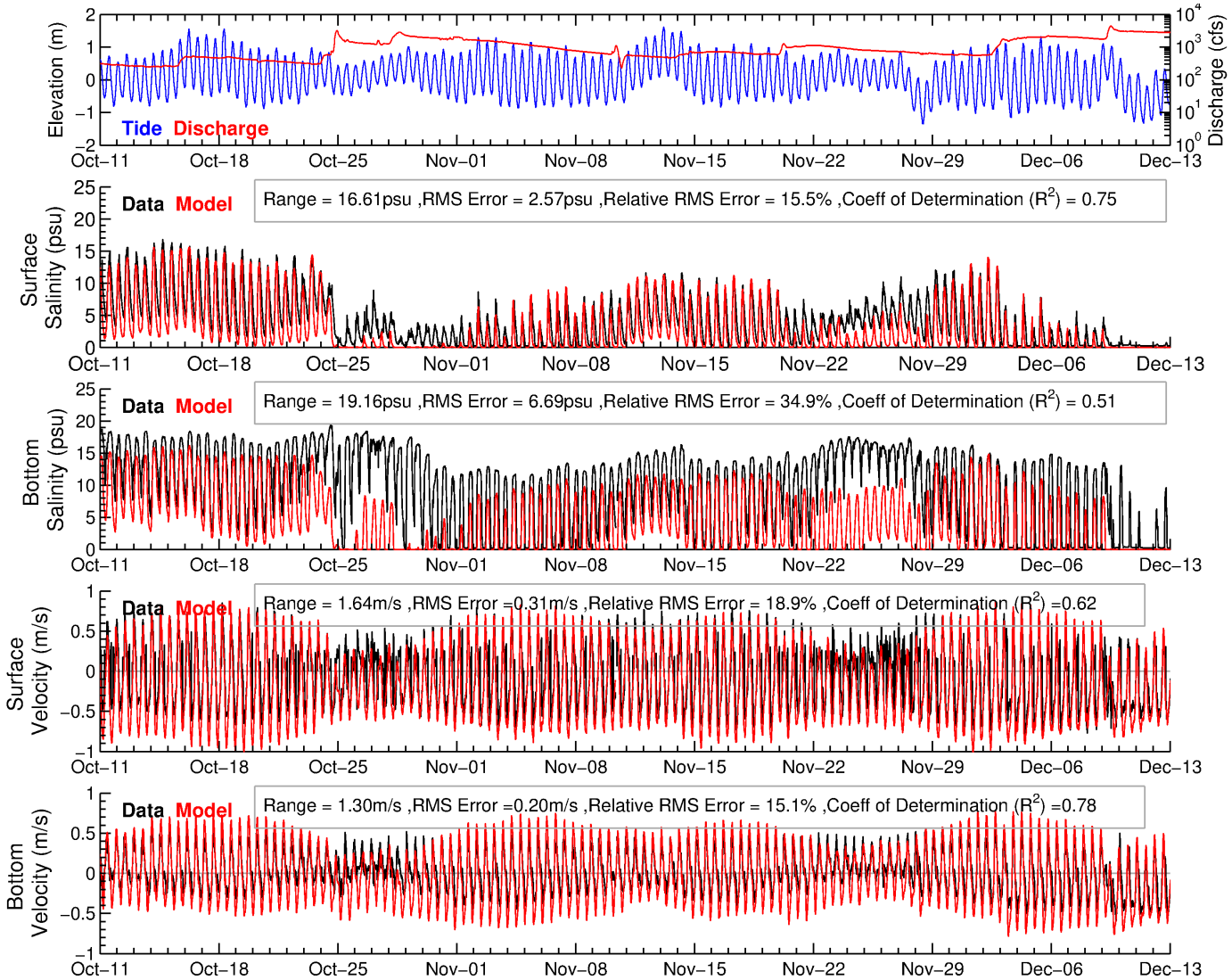


Figure 6-2: Comparison of model and data velocities and salinities at RM 4.2 for the Fall 2009 PWCM period.

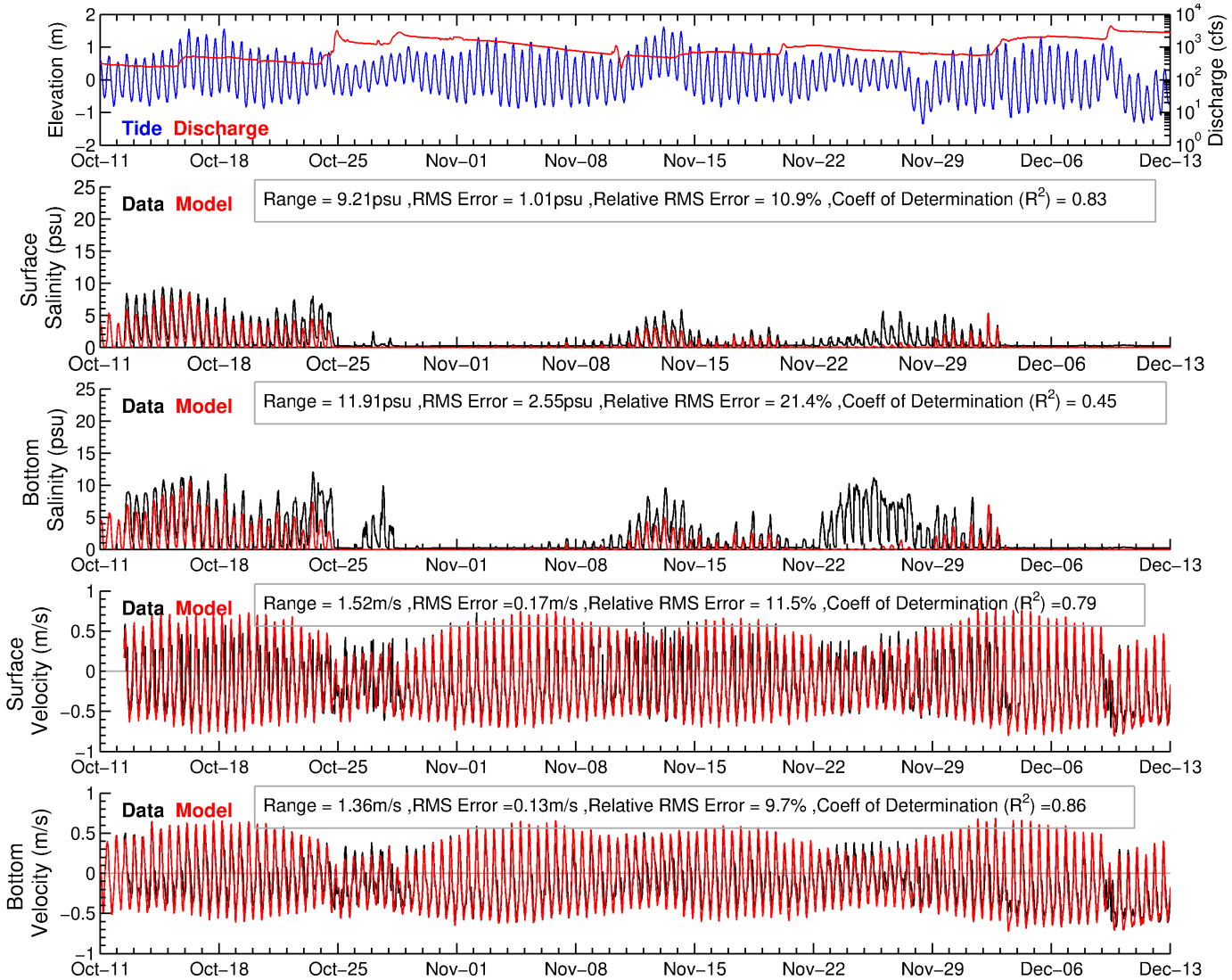


Figure 6-3: Comparison of model and data velocities and salinities at RM 6.7 for the Fall 2009 PWCM period.

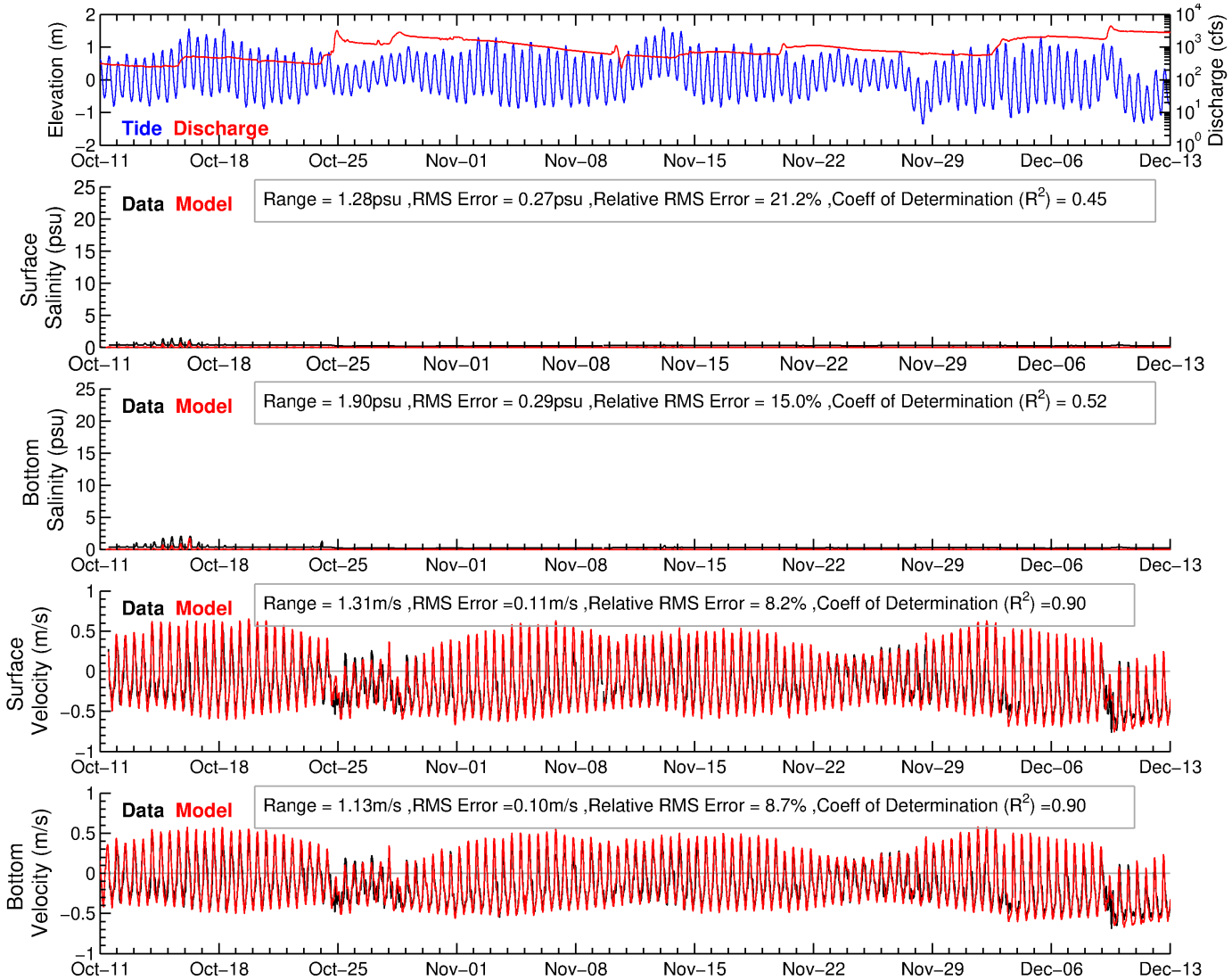


Figure 6-4: Comparison of model and data velocities and salinities at RM 10.2 for the Fall 2009 PWCM period.

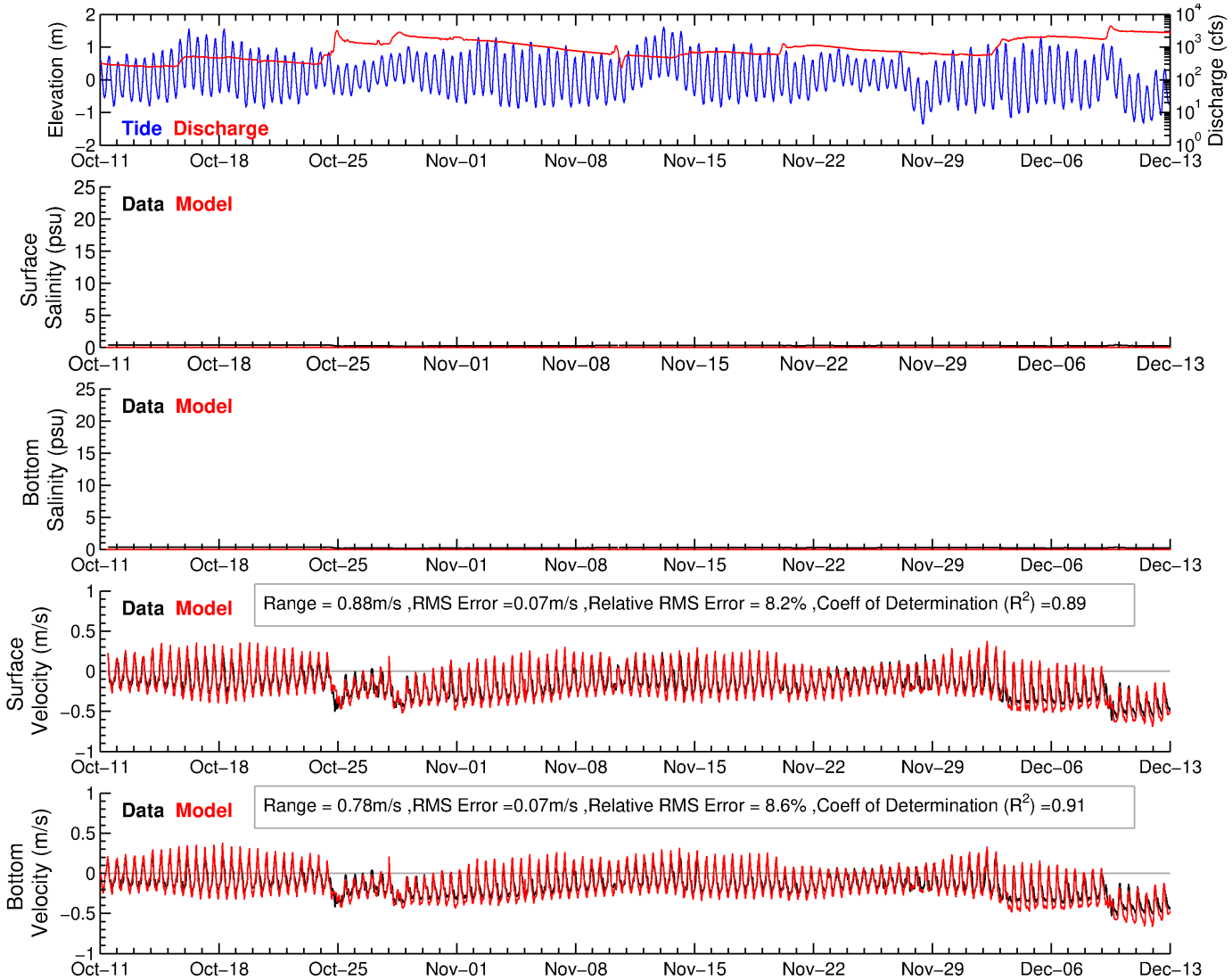


Figure 6-5: Comparison of model and data velocities and salinities at RM 13.5 for the Fall 2009 PWCM period.

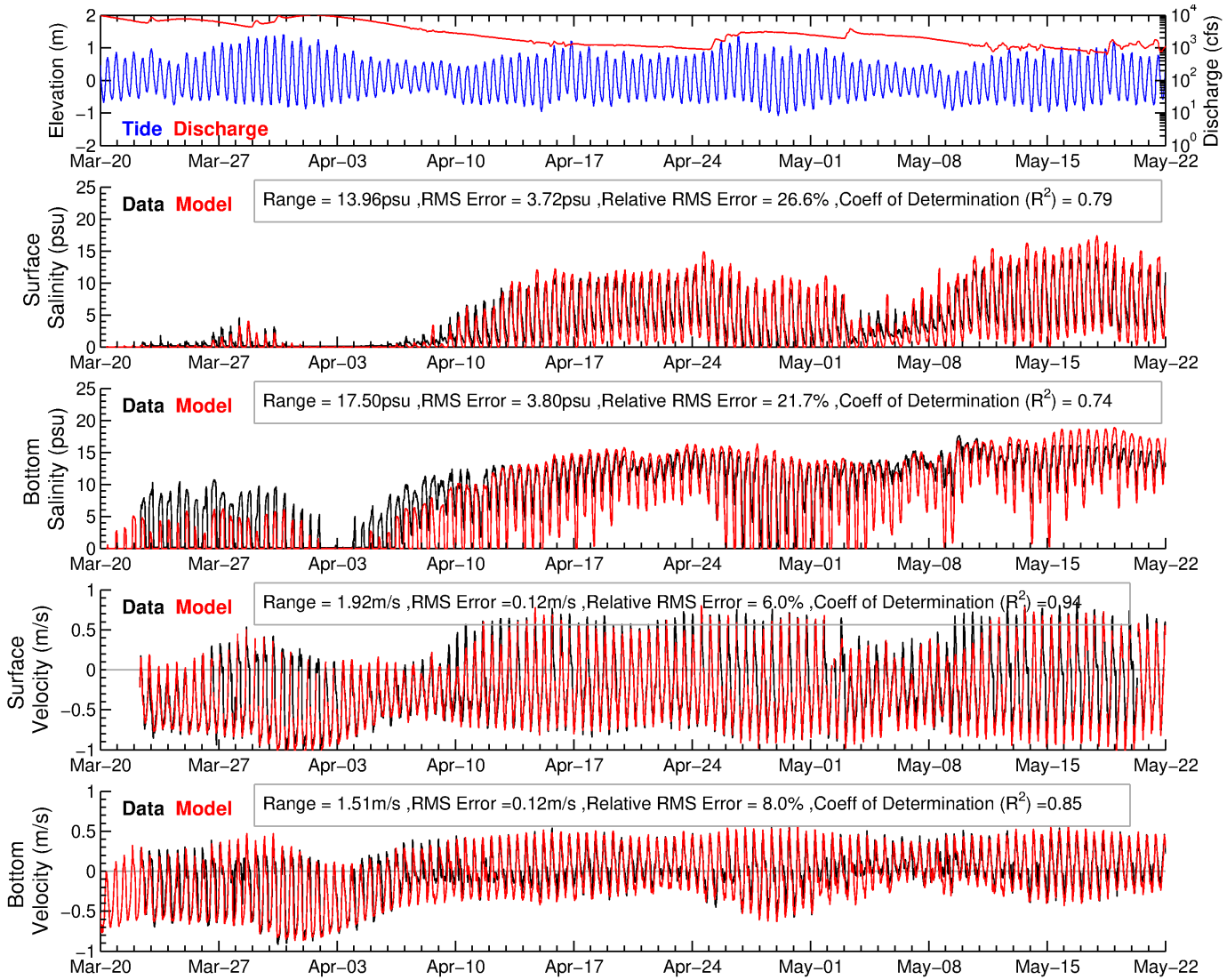


Figure 6-6: Comparison of model and data velocities and salinities at RM 1.4 for the Spring 2010 PWCM period.

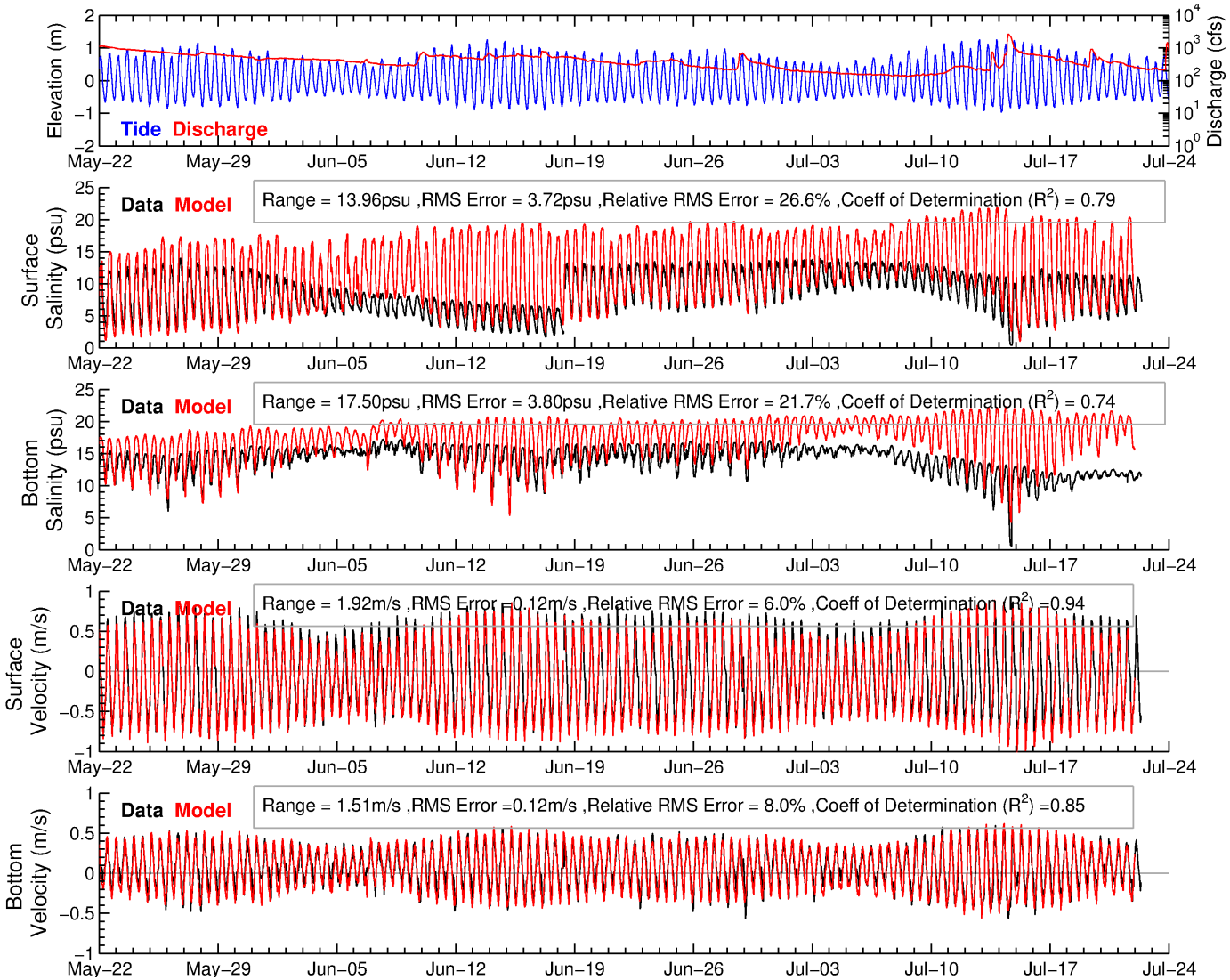


Figure 6-7: Comparison of model and data velocities and salinities at RM 1.4 for the Spring 2010 PWCM period (Contd.).

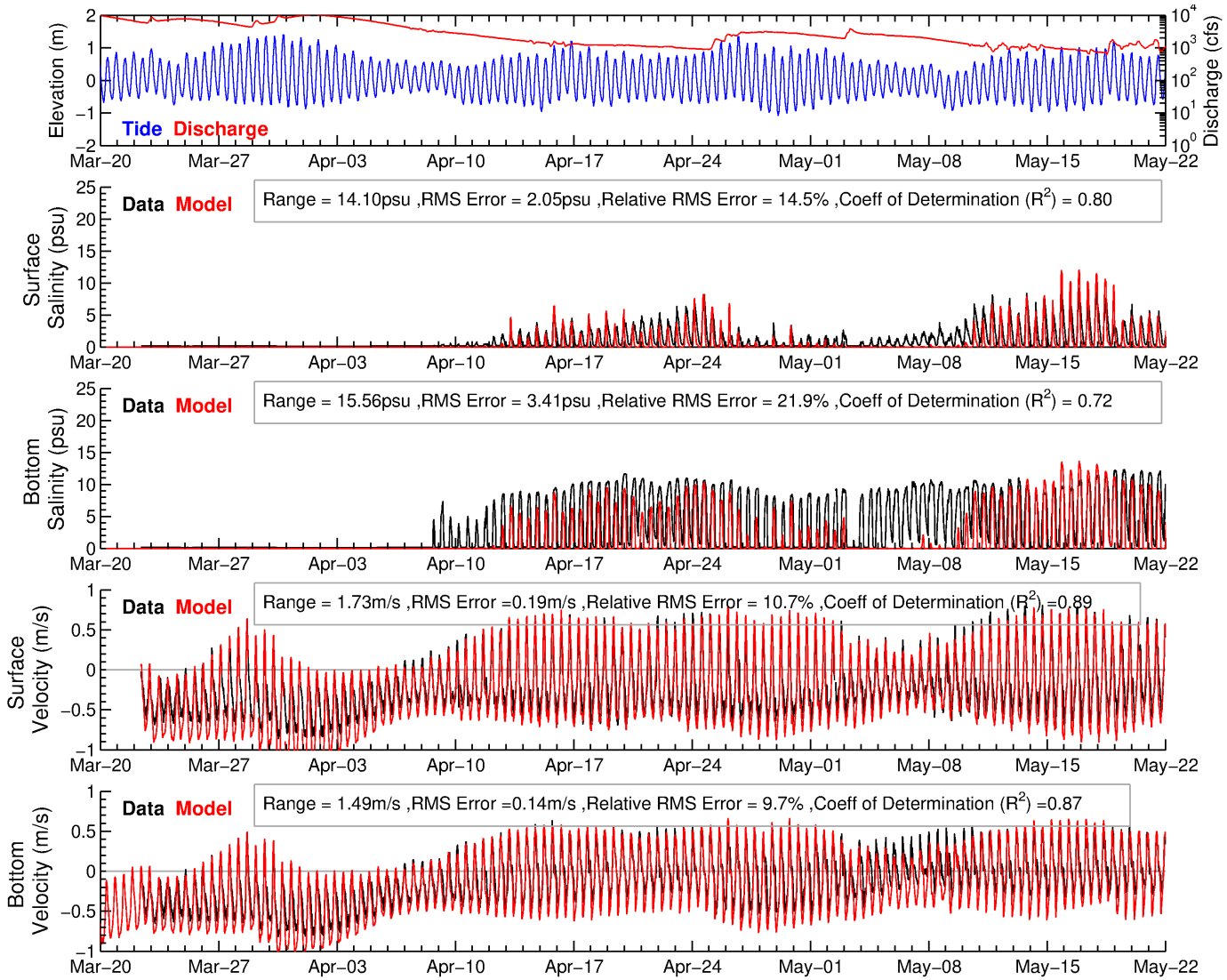


Figure 6-8: Comparison of model and data velocities and salinities at RM 4.2 for the Spring 2010 PWCM period.

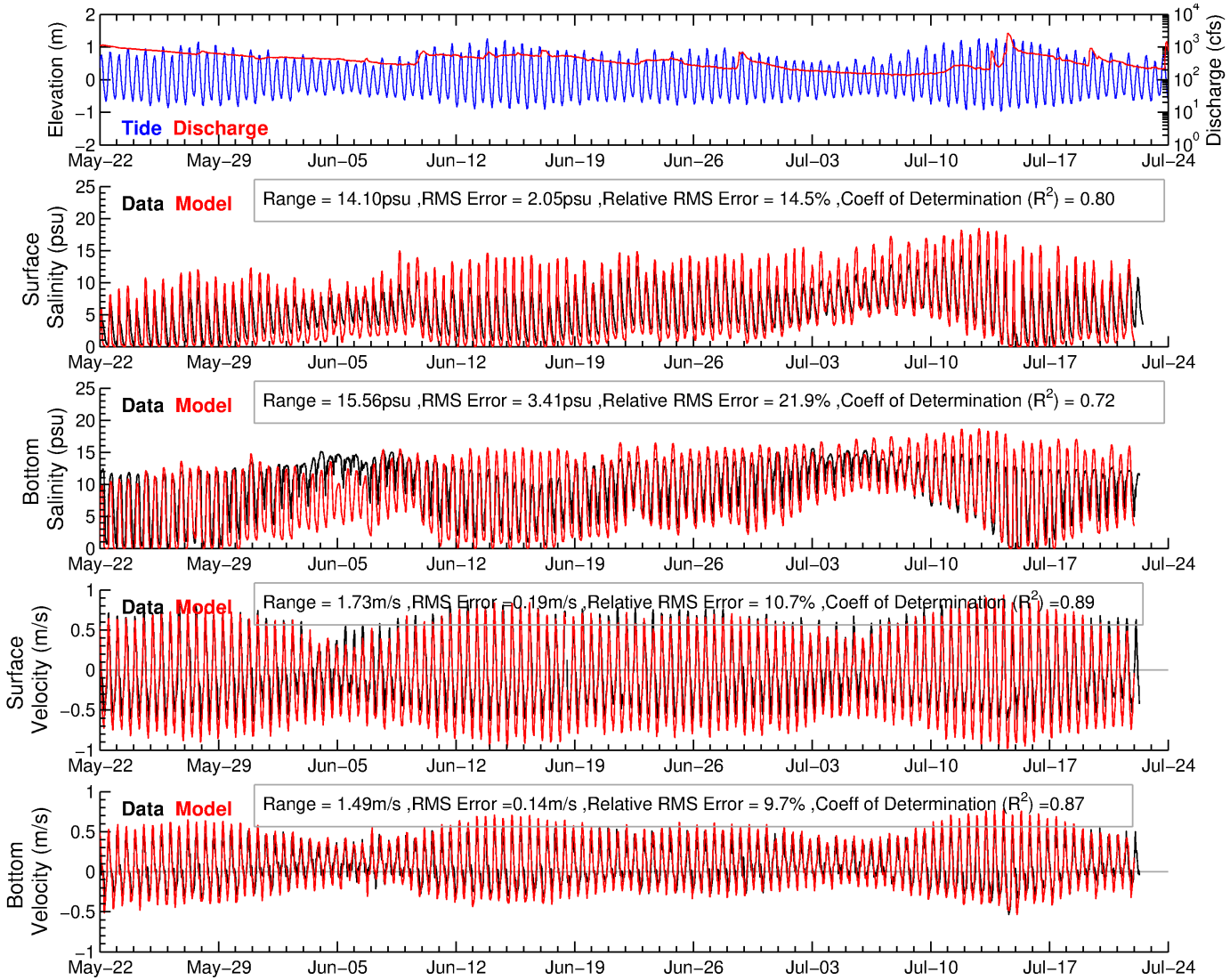


Figure 6-9: Comparison of model and data velocities and salinities at RM 4.2 for the Spring 2010 PWCM period (Contd.).

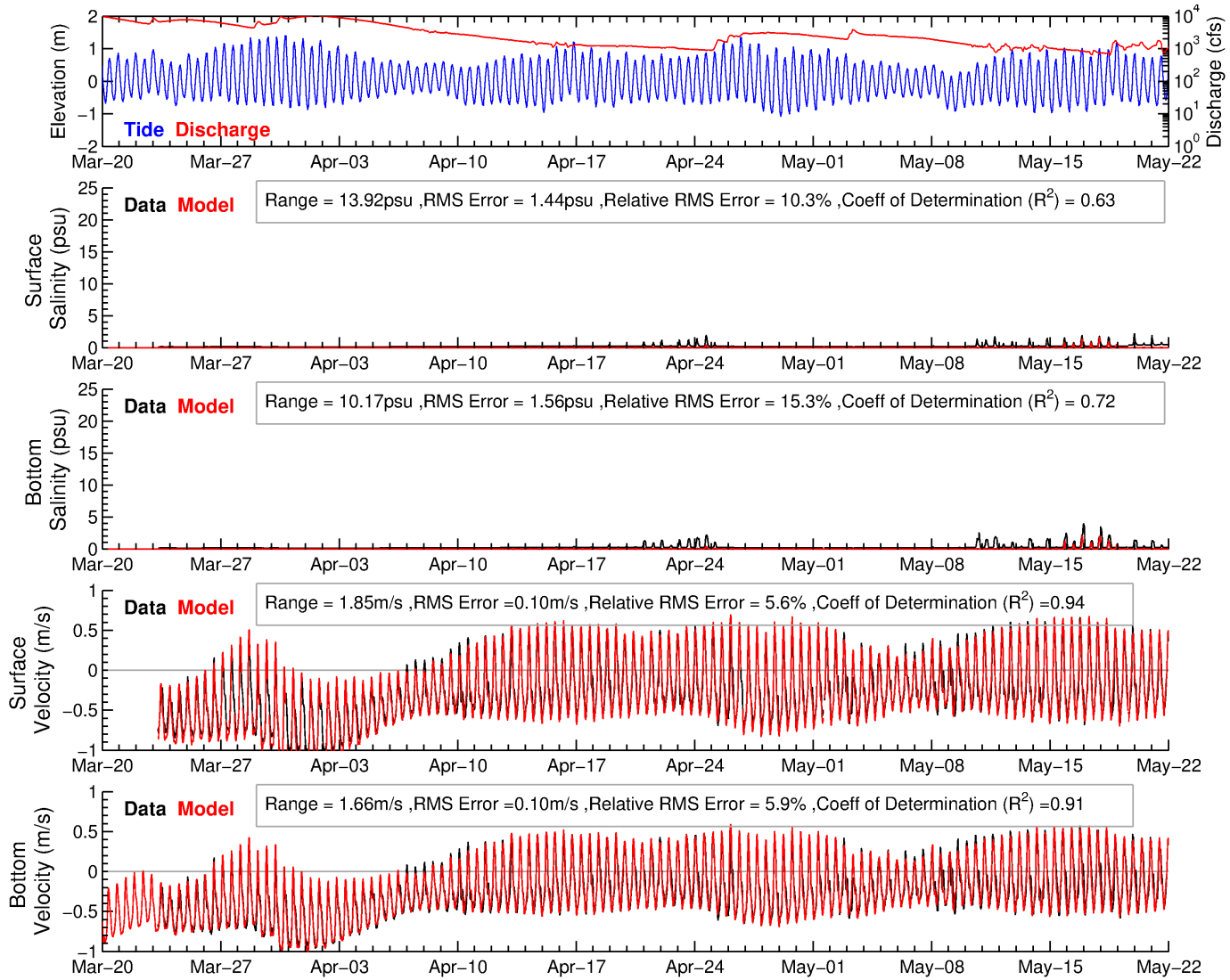


Figure 6-10: Comparison of model and data velocities and salinities at RM 6.7 for the Spring 2010 PWCM period.

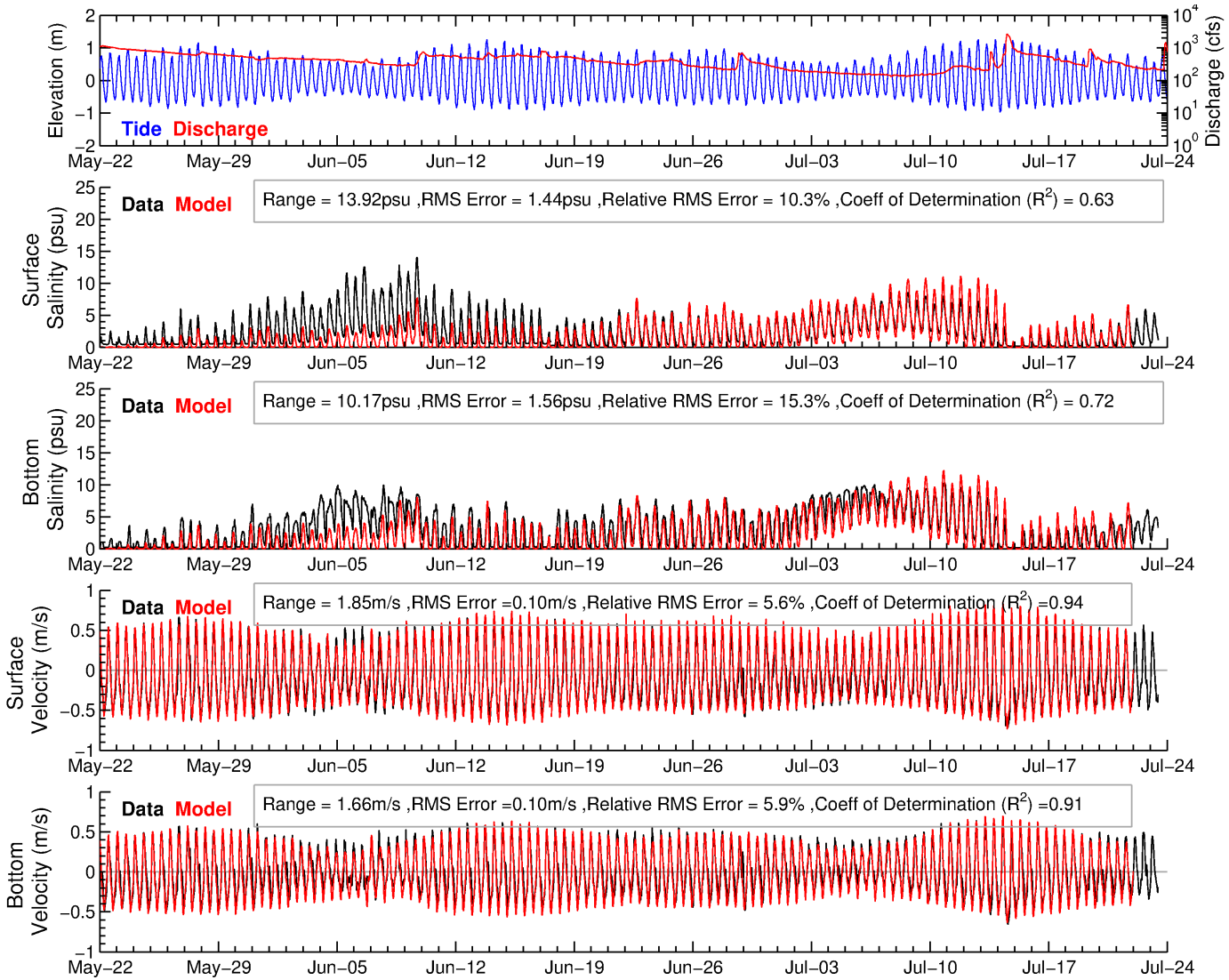


Figure 6-11: Comparison of model and data velocities and salinities at RM 6.7 for the Spring 2010 PWCM period (Contd.).

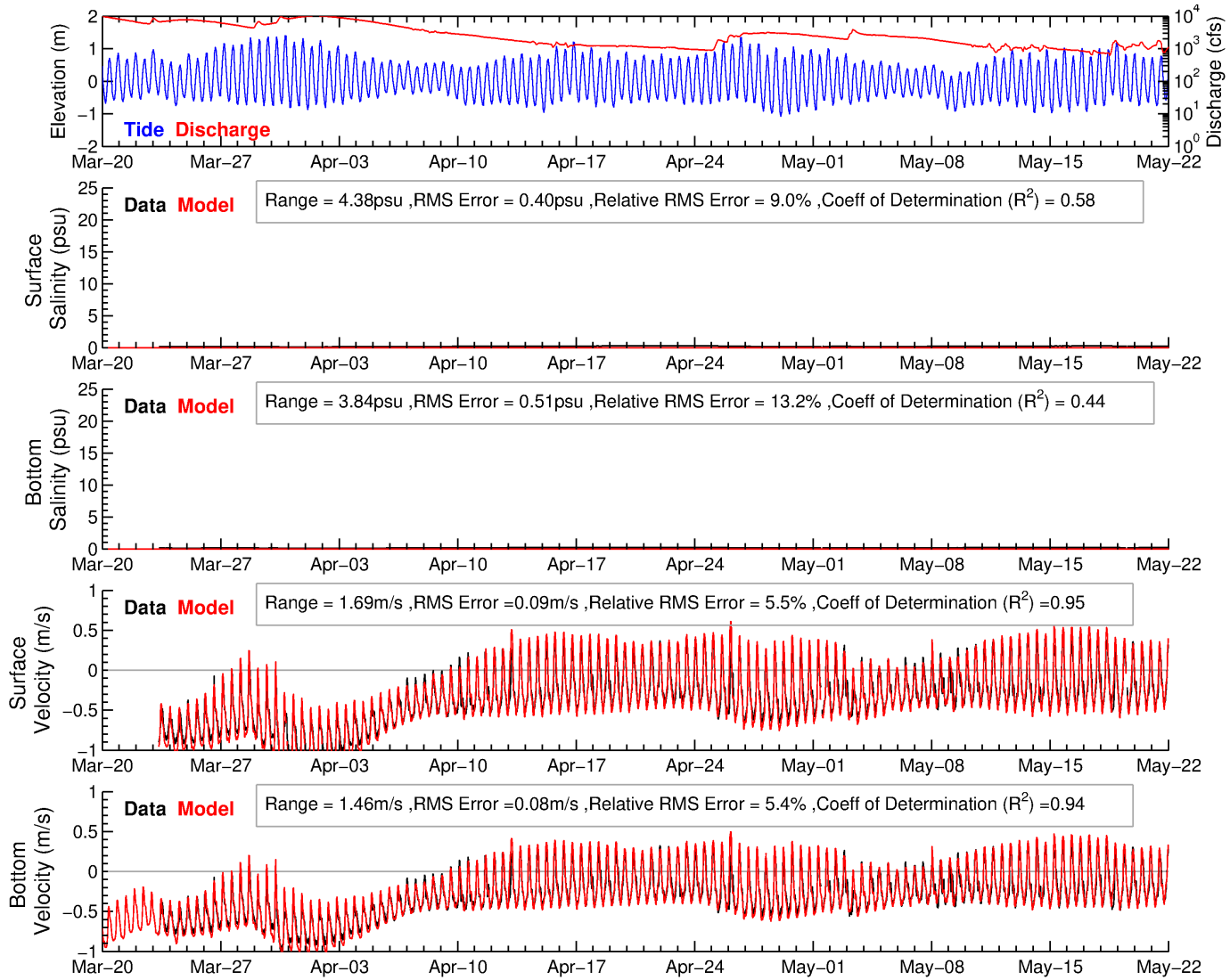


Figure 6-12: Comparison of model and data velocities and salinities at RM 10.2 for the Spring 2010 PWCM period.

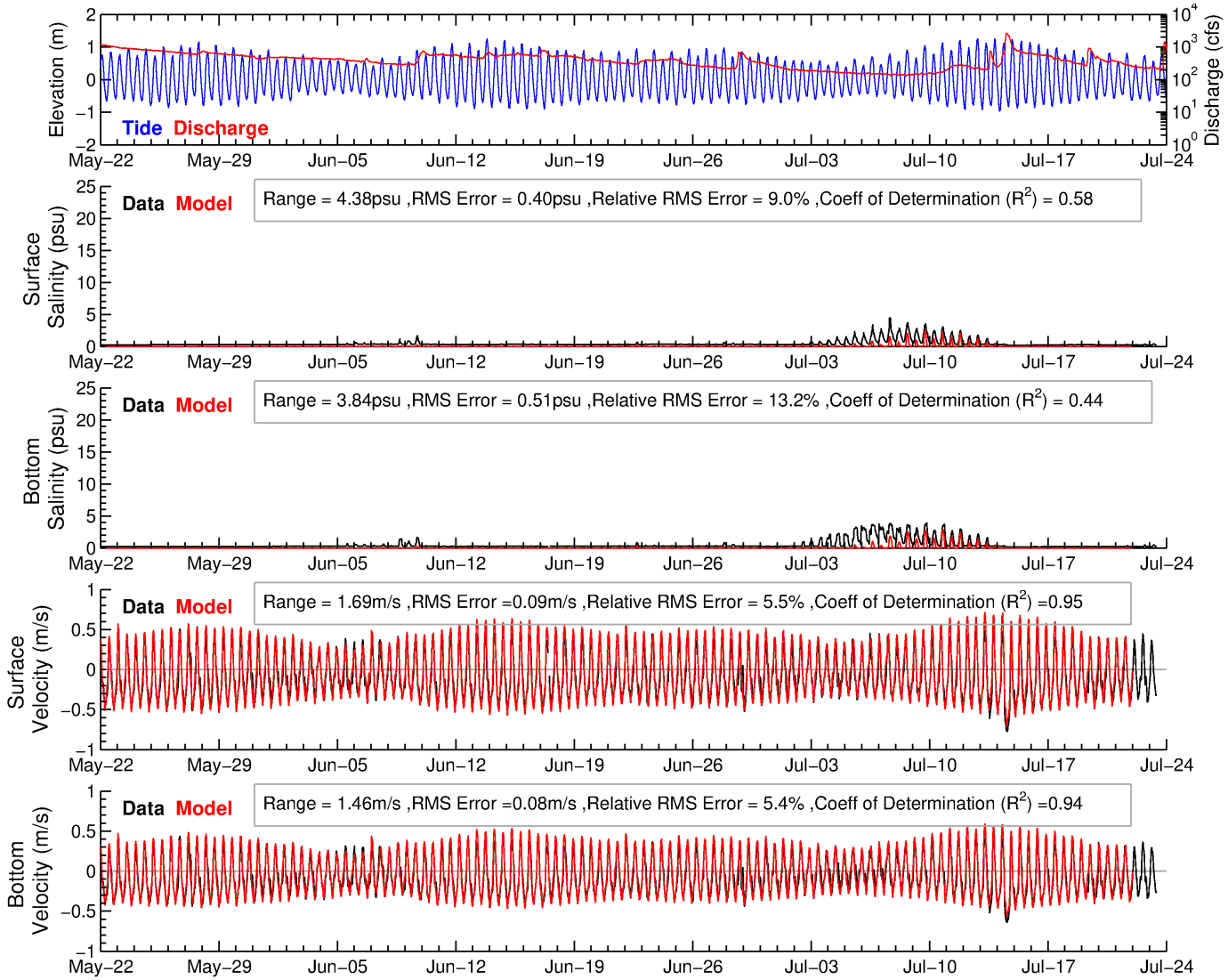


Figure 6-13: Comparison of model and data velocities and salinities at RM 10.2 for the Spring 2010 PWCM period (Contd.).

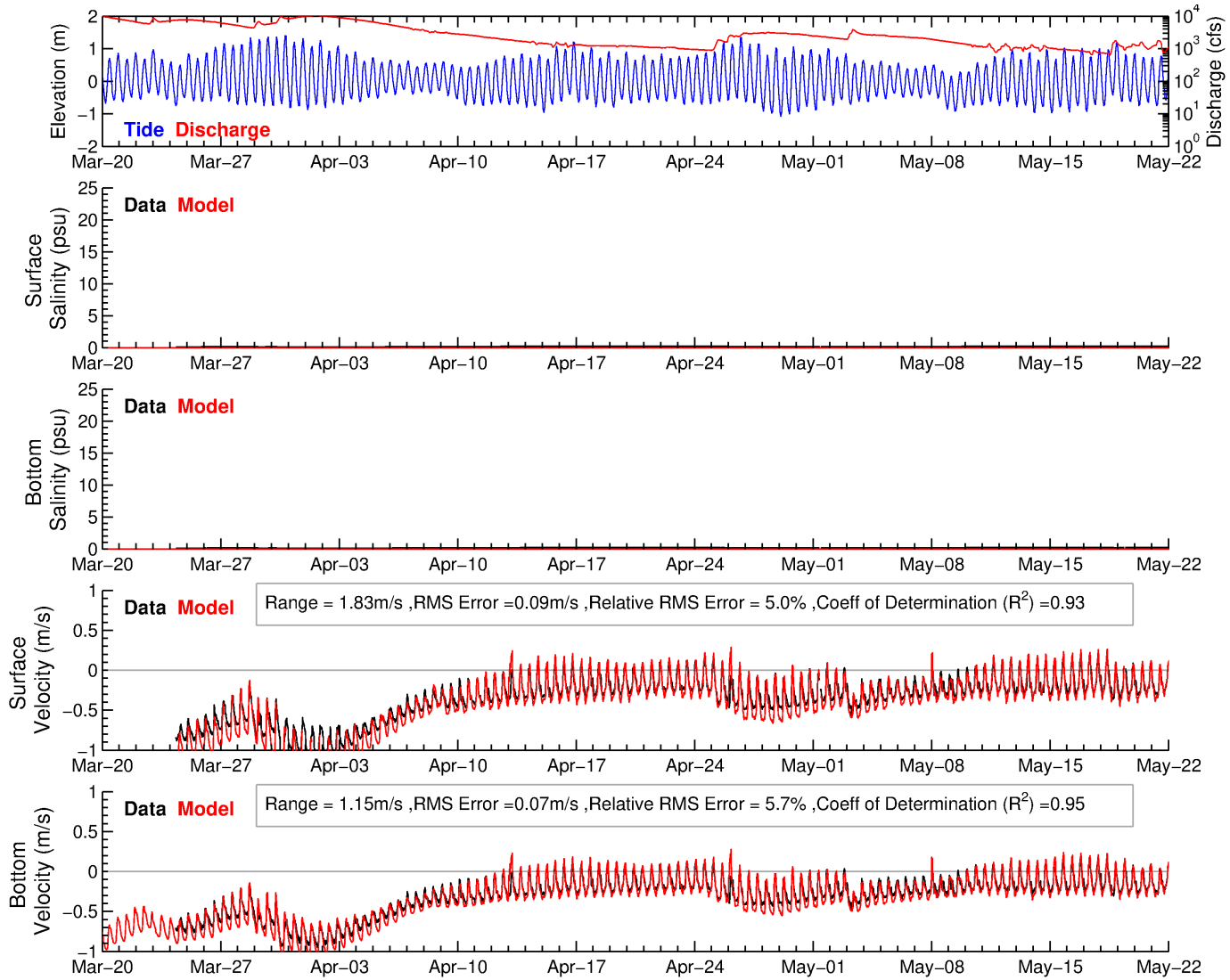


Figure 6-14: Comparison of model and data velocities and salinities at RM 13.5 for the Spring 2010 PWCM period.

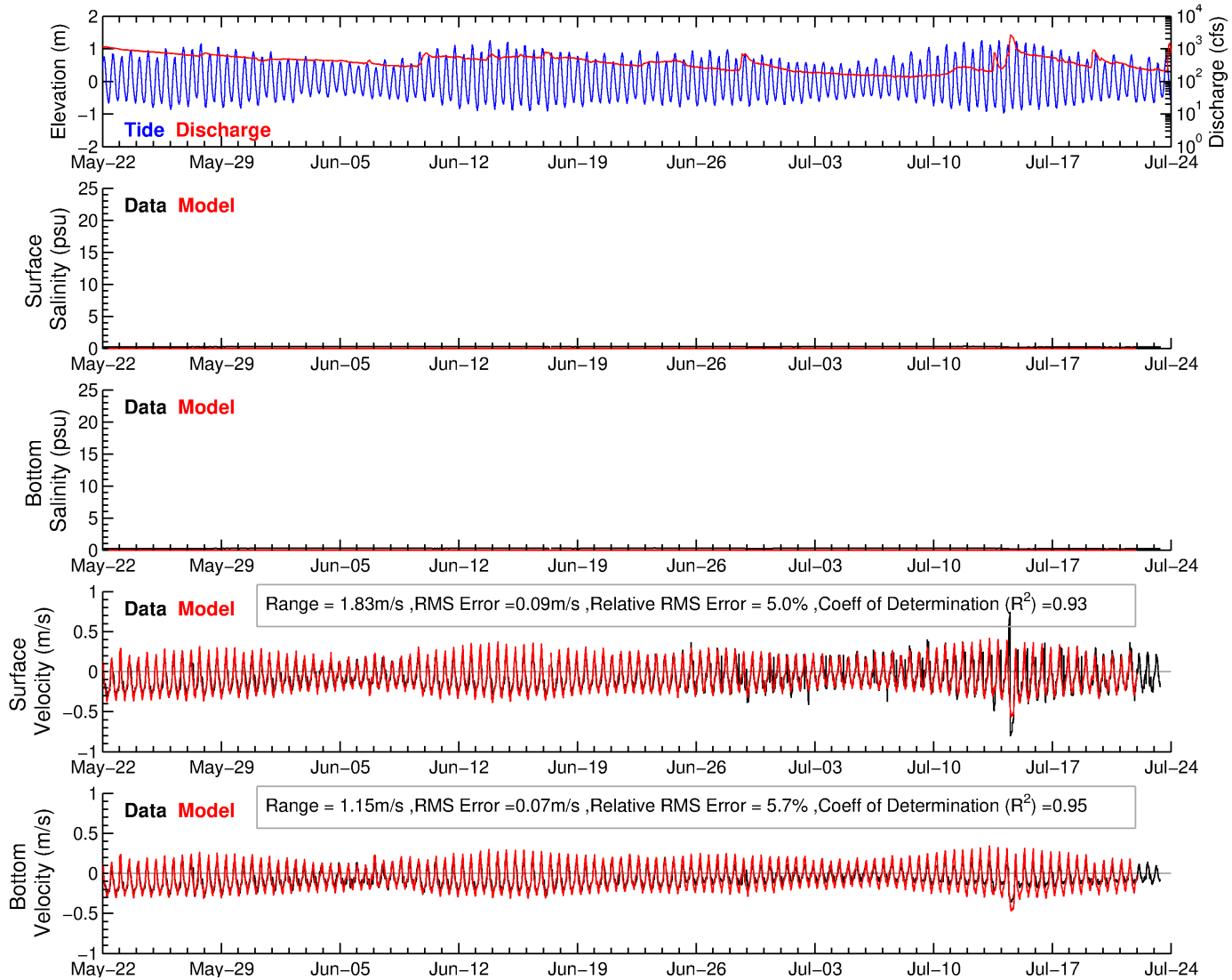


Figure 6-15: Comparison of model and data velocities and salinities at RM 13.5 for the Spring 2010 PWCM period (Contd.)

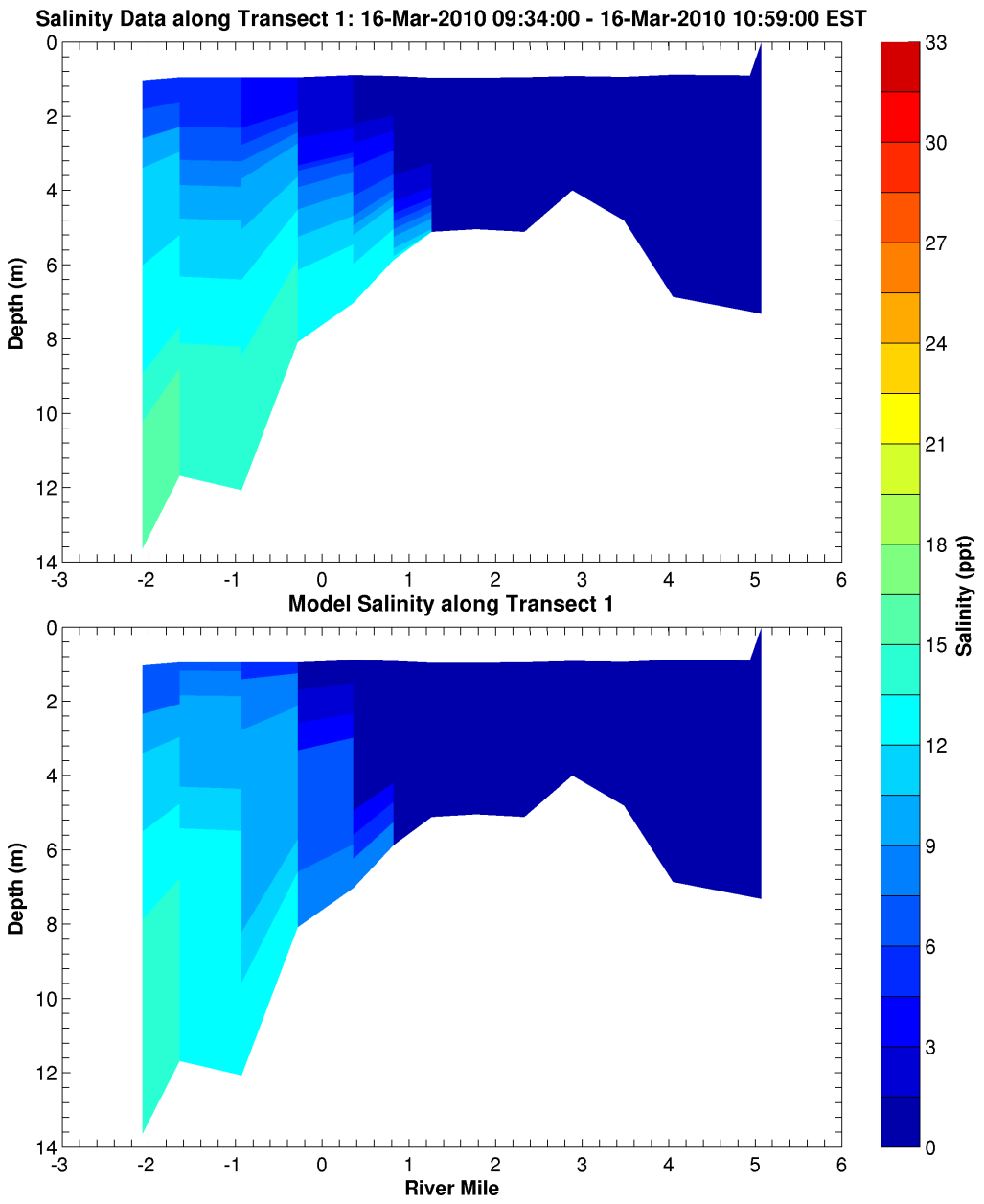


Figure 6-16: Transects of salinity along the longitudinal axis of the LPR and NB on March 16, 2010 (Transect #1); Data (upper panel) and model (lower panel).

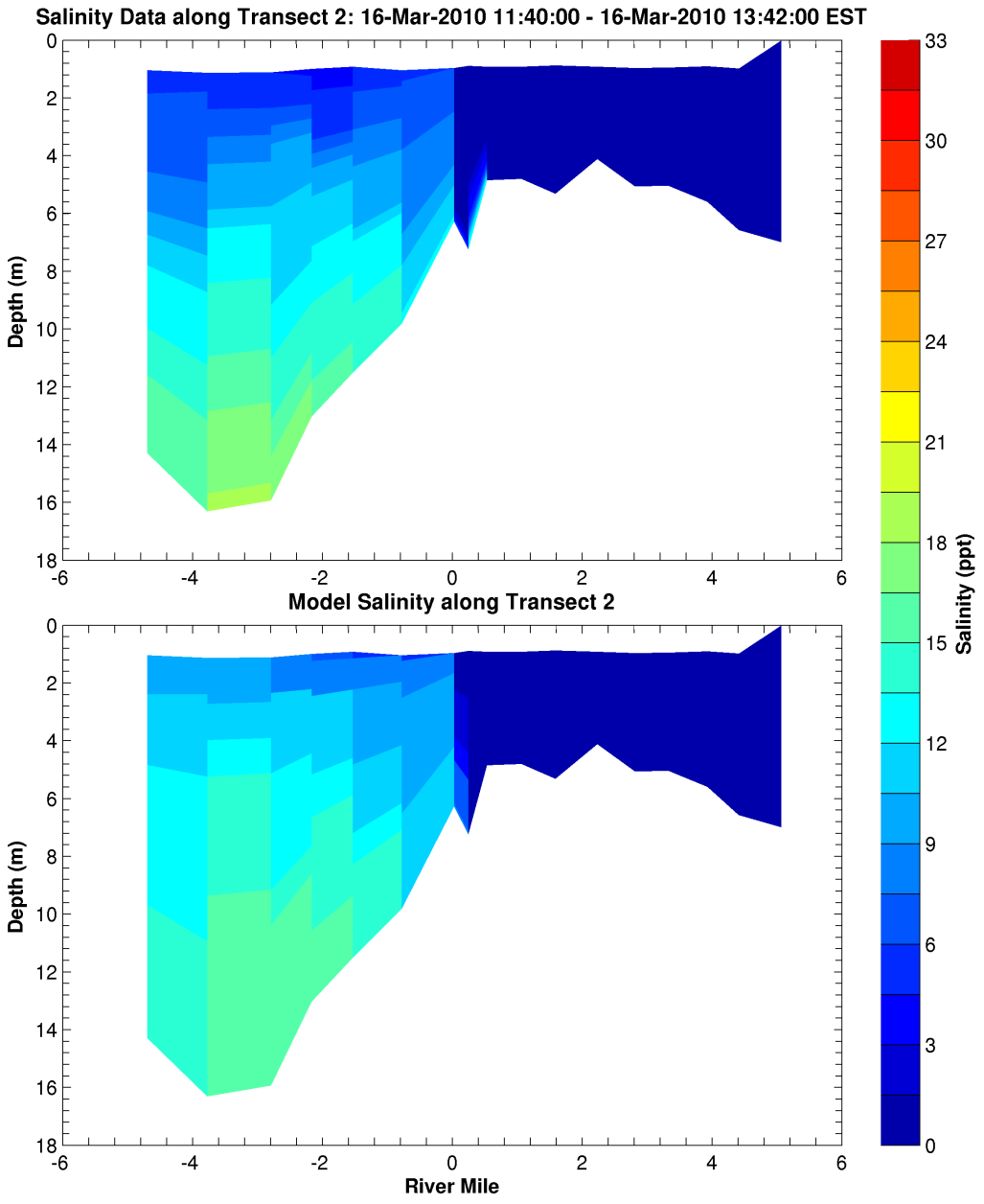


Figure 6-17: Transects of salinity along the longitudinal axis of the LPR and NB on March 16, 2010 (Transect #2); Data (upper panel) and model (lower panel).

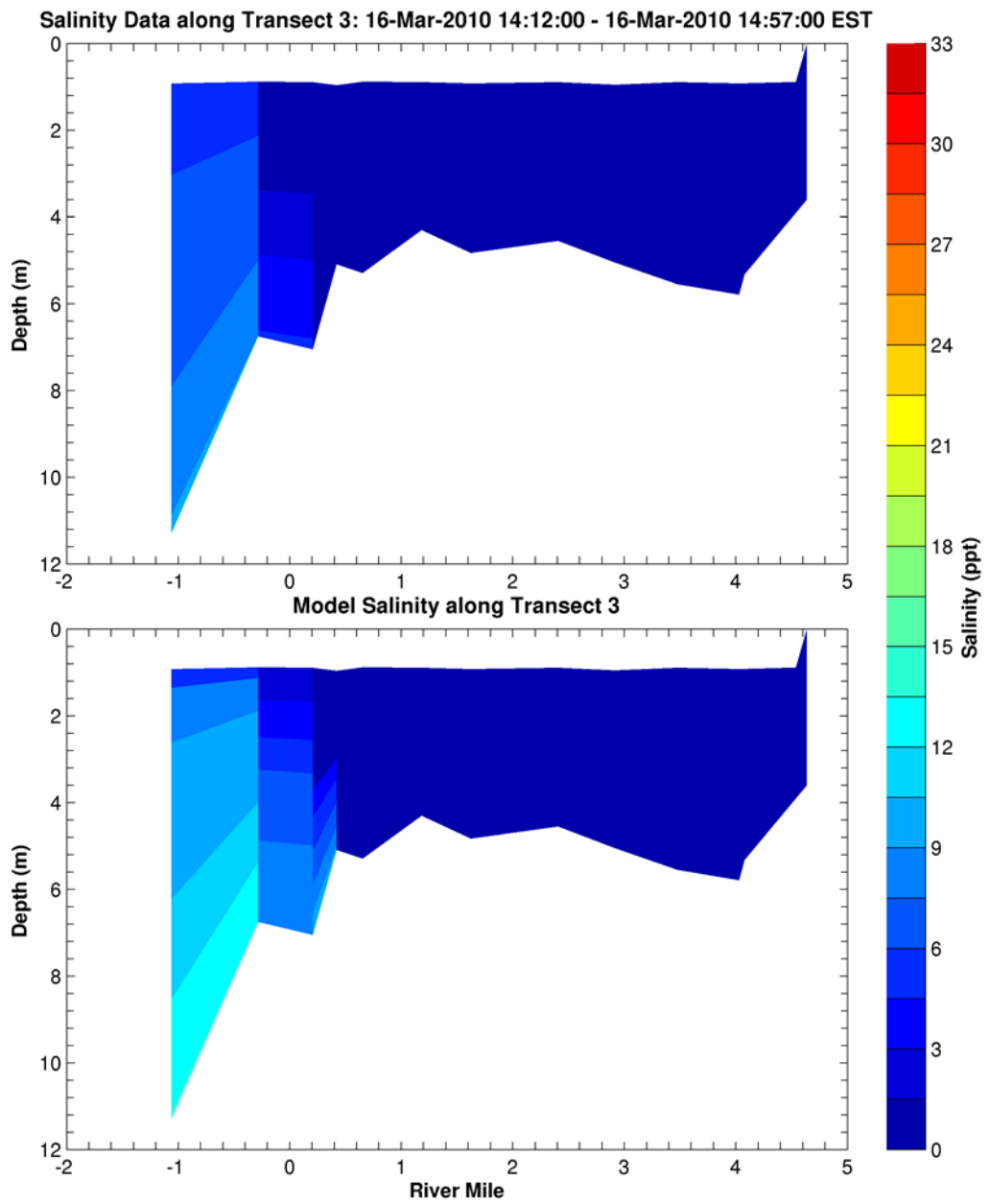


Figure 6-18: Transects of salinity along the longitudinal axis of the LPR and NB on March 16, 2010 (Transect #3); Data (upper panel) and model (lower panel).

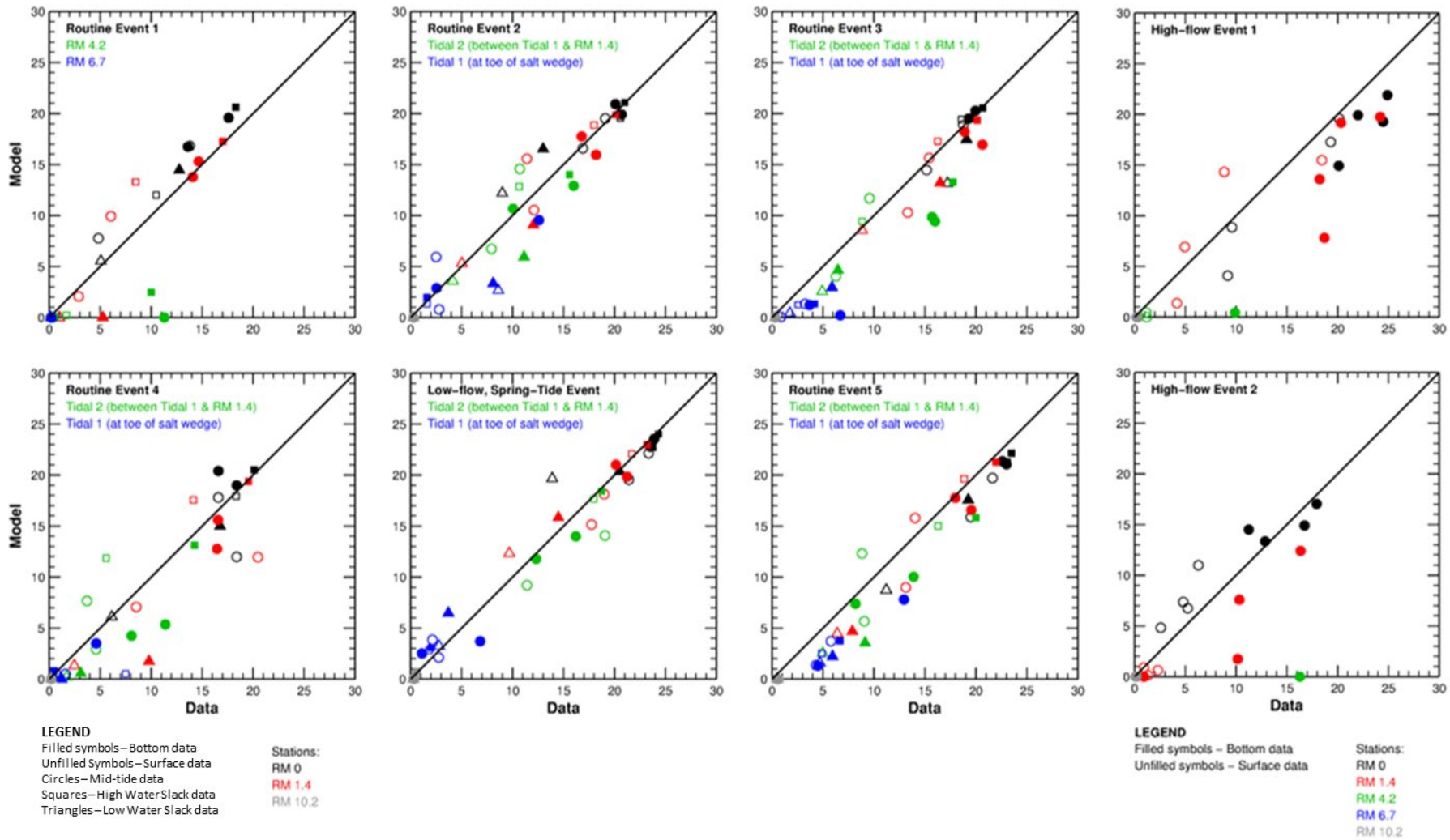


Figure 6-19: Comparison of measured and simulated salinities during the CWCM program.

7.0 SUMMARY

The hydrodynamic model application to the Lower Passaic River and Newark Bay was originally developed by HydroQual (2008). The model source code, inputs, and setup was transferred to the CPG-MT for adoption for the RI/FS of the LPR. The model setup and inputs were reviewed and evaluated for an assessment of the model's ability to reproduce various fate and transport processes in the LPR. As part of the extension of the model application to the RI/FS of the LPR, the model has subsequently been refined by the CPG with respect to its bathymetry inputs within the LPR. The model was also applied to additional periods beyond its original application documented in HydroQual (2008) in order to evaluate its performance against various metrics.

Model performance was assessed against several metrics such as currents, salinity, and water levels using data from various monitoring efforts in the LPR. The monitoring datasets include the Fall 2009 PWCM and Spring 2010 PWCM, and the CWCM program implemented as part of the RI/FS of the LPR, as well as ancillary datasets from other parties such as Rutgers University. The model performance was evaluated against data at various locations in the LPR, and over a wide range of flow conditions ranging from a 1 in 25-year event (16,000 cfs) to extremely low flow conditions ranging over a few hundred cfs. Model performance was also evaluated over various temporal scales ranging from tidal time-scales, to spring-neap cycles, and including episodic high-flow events. Model performance against measured metrics was also assessed quantitatively. The model performance evaluation did not involve any further calibration or parameter adjustment beyond that established during the model calibration documented in HydroQual (2008). Therefore, the model performance documented in this appendix represents a validation of model performance. In general, the model was able to reasonably reproduce various metrics and processes apparent in the data.

The model was also used for further analyses such as an assessment of salt front dynamics, and a high-resolution model developed for an assessment of the shear stress regime in the LPR under various tidal and river flow conditions. The results of these analyses have been used to inform the system understanding of hydrodynamics and sediment transport in the LPR, and to support the conceptual site model of the LPR. The calibrated and validated hydrodynamic model has been subsequently used to model sediment transport (described in Appendix M), organic carbon transport (described in Appendix N), and contaminant fate and transport (described in Appendix O) of this report.

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ATTACHMENT A: FREQUENCY ANALYSIS OF FLOWS AT LITTLE FALLS

An analysis of flow return period was carried out using the flow records from the USGS Little Falls gage station spanning from 1896 to 2012. The historical record included a 34,000 cfs event in 1903 that was reported by USGS as having been affected by dam failure. Expected discharge values corresponding to different return periods were calculated excluding this event, based on a best fit of the discharge peaks to a Fisher Tippett Type II (k=10) distribution. To quantify the possible effect of the uncertainty in the magnitude of the 1903 event, a separate analysis including the discharge peak in 1903 was performed. The results of the analyses are presented in Table A-1. There are some apparent differences between the two estimates arising from the shape of the best fit distribution curves. Significantly, the estimated 100-year (1% Annual Exceedance Probability) flow increases from about 22,000 cfs to approximately 25,000 cfs with the inclusion of the 1903 event in the extreme value analysis.

Table A-1: Estimated flow for different return periods at Little Falls.

Return Period (years)	Expected Discharge Value (cfs)	Expected Discharge Value (cfs) including 1903 event
2	7,156	6,978
5	10,485	10,397
10	12,906	13,129
25	16,237	17,225
50	18,920	20,807
100	21,777	24,898
200	24,829	29,584
500	29,194	36,852