Technical Basis for Phase 1 Remedial Action Levels (RALs)

Introduction

During a July 5, 2017 meeting with USEPA Region 2, the Lower Passaic River Cooperating Parties Group (CPG) presented an approach to (1) accelerate the completion of the 17-mile LPRSA Remedial Investigation (RI) and Feasibility Study (FS); (2) refocus the FS on the Upper 9 miles, recognizing a Record of Decision has been issued for the lower 8 miles; and (3) address the remediation of the upper 9 miles using a phased approach and adaptive management. USEPA Region 2 expressed an interest in continuing discussions on the approach and asked the CPG to provide further details. The CPG responded on July 14, 2017 by providing its Upper 9-mile Plan to USEPA Region 2. The USEPA responded on July 24, 2017 with a series of questions and specifically asked the CPG to provide a *"written statement of the technical basis supporting the proposed RALs be provided to EPA"* in advance of a future meeting proposed by USEPA Region 2. This document is provided in response to that request.

Conceptual Model for Developing RALs

COPC concentrations in the sediments of the upper 9 miles of the LPRSA vary over an extremely wide range. This range reflects sediment type, erosion/deposition history and exposure to downstream contamination via upstream transport processes. In general, the highest concentrations are located in fine sediment areas that are no longer subject to the net deposition that is the principal agent of recovery. Areas subject to significant net deposition and areas subject to cyclic erosion and deposition have the potential for recovery and have COPC concentrations that reflect the concentrations on recently deposited sediments originating from the water column. As stated by USEPA Region 2 in the 2014 Focused Feasibility Study (FFS) Remedial Investigation (RI) Report:

"As sediments deposit, they bring with them the particle-borne chemistry of the water column at the time of their deposition." (FFS RI Report at page 2-4).

The sediments largely responsible for the concentrations on depositing particles are those whose concentration is significantly above the ambient water column condition. This idea is grounded in the basic principle that net COPC flux is directed from higher to lower concentration. Sediments are a net source to the water where they have concentrations greater than found on particles depositing from in the water column. That source can be the continual diffusive flux that is driven by the magnitude of the concentration gradient, intratidal resuspension or the episodic erosion that might occur during high flow events.

A working hypothesis emerging from this principle is that remediating sediments with COPC concentrations higher than on the particles that deposit on the sediment will significantly reduce concentrations on those particles and accelerate concentration reductions in the remaining sediments.

Therefore, the Remedial Action Levels (RALs) developed for the Phase 1 remedial action in the Upper 9 miles aim to address sediment with the highest concentrations of 2,3,7,8-TCDD (TCDD) and PCBs (and all other co-located COPCs) and remove the sediment that is most responsible for driving risk and inhibiting recovery (i.e., those sediments with concentrations substantially greater than found on particles depositing from the water column).

Technical Basis for RALs

Two lines of evidence were evaluated in developing the RALs proposed for the Phase 1 remedial action: 1) 2,3,7,8-TCDD and total PCB concentrations in the recently deposited sediment in the upper 9 miles of the LPR; and 2) 2,3,7,8-TCDD and total PCB concentrations in the water column. As discussed below, both lines of evidence provide insight into the most appropriate RALs to select, but the data from the recently deposited sediment are considered the most reliable because they represent the levels of contaminants that have actually accumulated on the river bottom.

Recently Deposited Sediment Concentrations

The role of deposition as the principal agent of recovery is illustrated by the changes in 0-0.5 ft (surface) sediment 2,3,7,8-TCDD concentration in RM 1 to RM 7 areas that experienced significant net deposition between 1995 and 2011 (as estimated from bathymetric changes). Those changes are shown in Figure 1 for areas with 0.5 to 1 ft of net deposition and areas with greater than 1 ft of net deposition. In both categories, levels declined to somewhere between 200-300 pg/g. Thus, even modest deposition of between 0.03 and 0.06 ft/yr (0.95 to 1.9 cm/yr) is sufficient to support recovery. This recovery has been limited by sediment-based contaminant sources that keep depositing particles at relatively high concentrations. Had those concentrations been significantly lower, the recovery would have proceeded much more quickly. The deposition that has occurred will likely continue as the river evolves and responds to changing sea level, which rose about 0.3 cm/yr over the 1995 to 2010 period and is projected to rise more quickly in the future. Sea level rise can facilitate deposition through general deepening and the enhanced upstream transport of sediment resulting from further upstream propagation of the salt wedge. This process, coupled with the cyclic erosion and deposition at other locations, will allow recovery once the contaminant concentrations on water column particles are reduced through active remediation.

The levels found in the areas that experienced net deposition match the levels measured by USEPA Region 2 in a 2007-2008 study of COPC concentrations on recently-deposited sediment (i.e., sediments deposited from the water column no earlier than 6 months prior to the sampling). As seen on Figures 4-3 of the FFS RI Report (included here as Figure 2), the 2,3,7,8-TCDD concentrations in recently deposited sediment in the lower 8 miles fall between 200 and 300 pg/g, while the 2 samples collected between about RM 8 and RM 12 have concentrations of 460 and 540 pg/g.

USEPA Region 2's 2007-2008 study also provides information on the PCB levels in recently deposited sediment. Figure 3, which is from FFS RI Report Figure 4-12, shows levels of about 1 ug/g total PCBs in the RM 1 to RM 7 reach and, consistent with the findings for 2,3,7,8-TCDD, somewhat higher concentrations in the RM 8 to RM 12 reach of 1.4 and 1.6 ug/g.

Additional perspective on COPC levels expected in areas subject to net deposition is provided by the sampling of surface sediment that has deposited on the cap in the RM 10.9 Removal Area since the remedial action. These samples were analyzed for 2,3,7,8-TCDD, PCBs and phenanthrene. Most of the results for 2,3,7,8-TCDD are tightly grouped with an average of 211 pg/g (excepting 3 samples collected at the edge or on hardpan, the other 8 results range from 195 to 232 pg/g). Similarly, these 8 samples have tightly grouped total PCB concentrations that average 0.8 ug/g (range from 0.4 ug/g to 0.9 ug/g).

<u>Water Column Particulate Concentrations</u>

The levels on water column particulates were measured in two rounds of high volume sampling conducted by the CPG in 2011. Within the LPR, stations were located at RM 4.2 and RM 10.2. The utility of these data in establishing RALs is limited by the variability in the results of the two rounds, coupled with the fact that they reflect a combination of particles that were sourced from the river bed and from the watershed that may deposit on the river bottom or not settle and be transported through the system. Nevertheless, they provide some perspective on what might be the average condition.

At RM 4.2, the results of rounds 1 and 2 were 590 pg/g and 180 pg/g. At RM 10.2, they were 180 pg/g and 340 pg/g. The companion results for total PCBs are 1.3 ug/g and 0.4 ug/g at RM 4.2 and 0.7 ug/g and 0.9 ug/g at RM 10.2.

Summary

Taken as a whole, the available data for the upper 9 miles suggest that sediments with surface sediment 2,3,7,8-TCDD concentrations in the range of 200 to 400 pg/g and total PCB concentrations in the range of 0.7 to 1.6 ug/g are likely to be reflective of recent deposition and likely to have good recovery potential if the concentrations on depositing particles are significantly reduced.

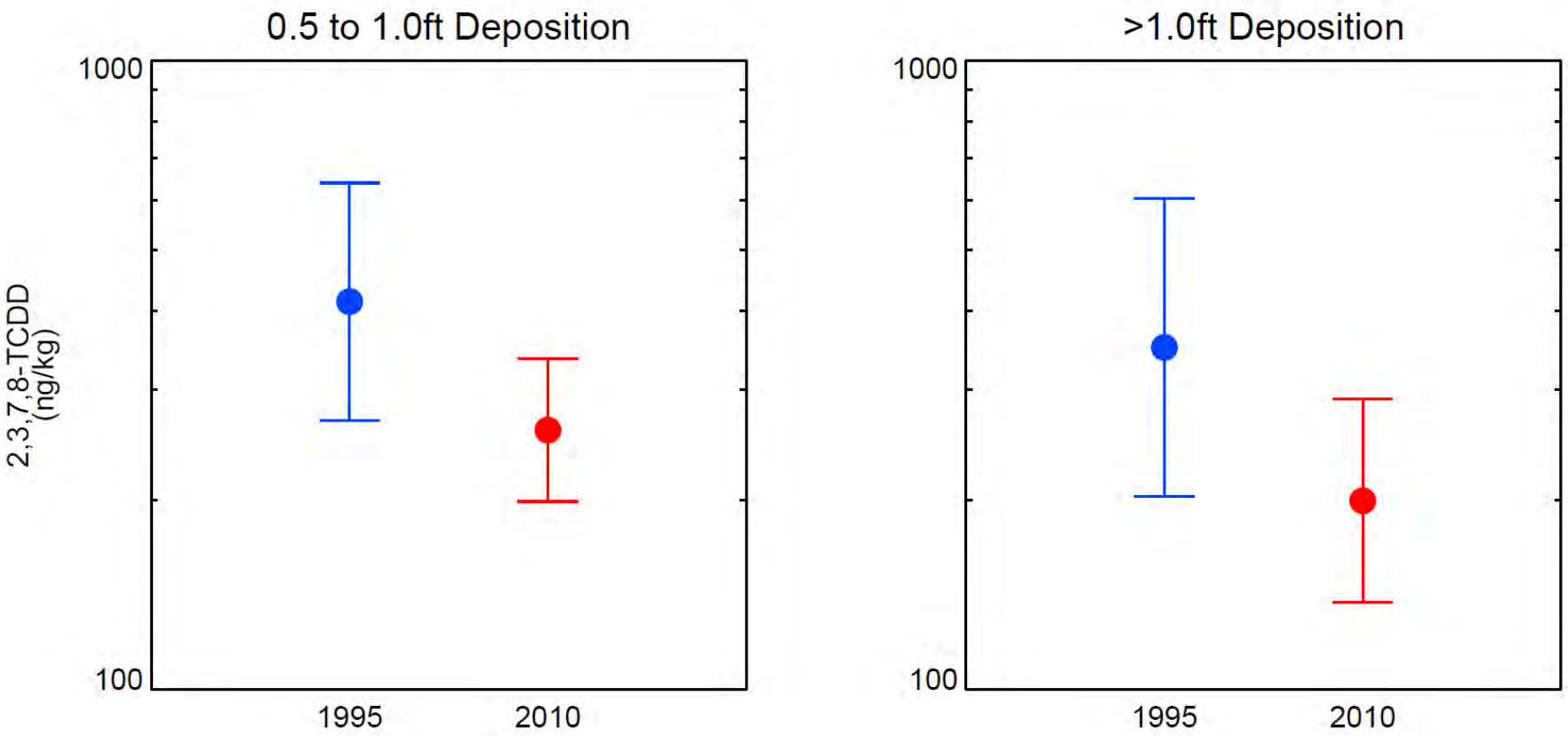
Conclusions

Using the conceptual model outlined here, an effective remedial approach would target sediments having COPC concentrations clearly above the levels indicative of recent deposition. This has the benefit of reducing the major sources of water column contamination and accelerating recovery in the sediments having natural recovery potential. Being clearly above the concentration levels indicative of recent deposition means being clearly above the ranges cited above (200 to 400 pg/g of 2,3,7,8-TCDD and 0.7 to 1.6 ug/g of total PCBs). Thus, this category includes sediments above 400 pg/g of 2,3,7,8-TCDD and 1.6 ug/g of PCBs. In the interest of being somewhat conservative in identifying such sediments, while not unduly targeting sediments with good recovery potential, it is proposed to set RALs of 300 pg/g for 2,3,7,8-TCDD and 1 ug/g for total PCBs.

The concordance between these values is supported by the correlation between them in surface sediments in the RM 8 to RM 12.3 reach. Figure 4 shows a plot of paired measurements with lines indicating values of 300 pg/g for 2,3,7,8-TCDD and 1 ug/g for total PCBs. These lines cross in the center of the data cloud indicating that on average, particles with 300 pg/g of 2,3,7,8-TCDD have 1 ug/g of total PCBs.

While the existing uncertainty precludes an accurate estimate of the area exceeding the RALs, the analysis of the data suggests that more than 30% of the area in the region between RM 8 and RM 12.3 would be targeted. A simple way to look at the proposed RALs is by the raw statistics of the sediment data for the RM 8 to RM 12.3 reach. The “2010” data set includes 213 samples of the top 6 inches. Of these, 109 have 2,3,7,8-TCDD concentration of 300 pg/g or greater and 104 have less than 300 pg/g. The average concentration of the samples in the first category is 4,650 pg/g. Those in the second category average 108 pg/g. Thus, remediation based on the proposed RALs will achieve a substantial reduction in concentration assuming that the sediments in the two categories can be accurately identified through pre-design sampling. In addition to greatly and rapidly reducing risk, the substantial reductions in concentration achieved by Phase 1 of this adaptively managed remedy should accelerate recovery of the remaining sediments because the sediments that inhibit recovery will have been actively remediated.

Because this is an interim remedy, no proposed remedial goals (PRGs) are required at this time. Based on the refined understanding of the river that will be achieved by monitoring the impact of Phase 1, a second ROD can be developed that will set PRGs and determine what, if any, additional work is need to complete the remediation of the upper 9 miles.



Plot shows the arithmetic average calculated in natural log space with +/- two standard errors for data collected between RM 1 and RM 7. The 1995 dataset includes data collected between 1995 – 1999 and the 2010 dataset includes data collected between 2005 – 2013. Differences between 1995 and 2011 bathymetry surveys were used where available. Outside the coverage of the 2011 bathymetry data, differences between 1995 and 2007 bathymetry surveys were used.

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\\BOSTON1\Jobs\Passaic_CPG\ANALYSIS\Sed_Char\Interpolations\k20160909_RI_draft2\plots\tcdd2378_adj\v1_gaussian\a5_lg_grid\scaling_2010_for_95_IC\copc_estimated_1995_data_include100_6panel_170808_statsplot.pdf

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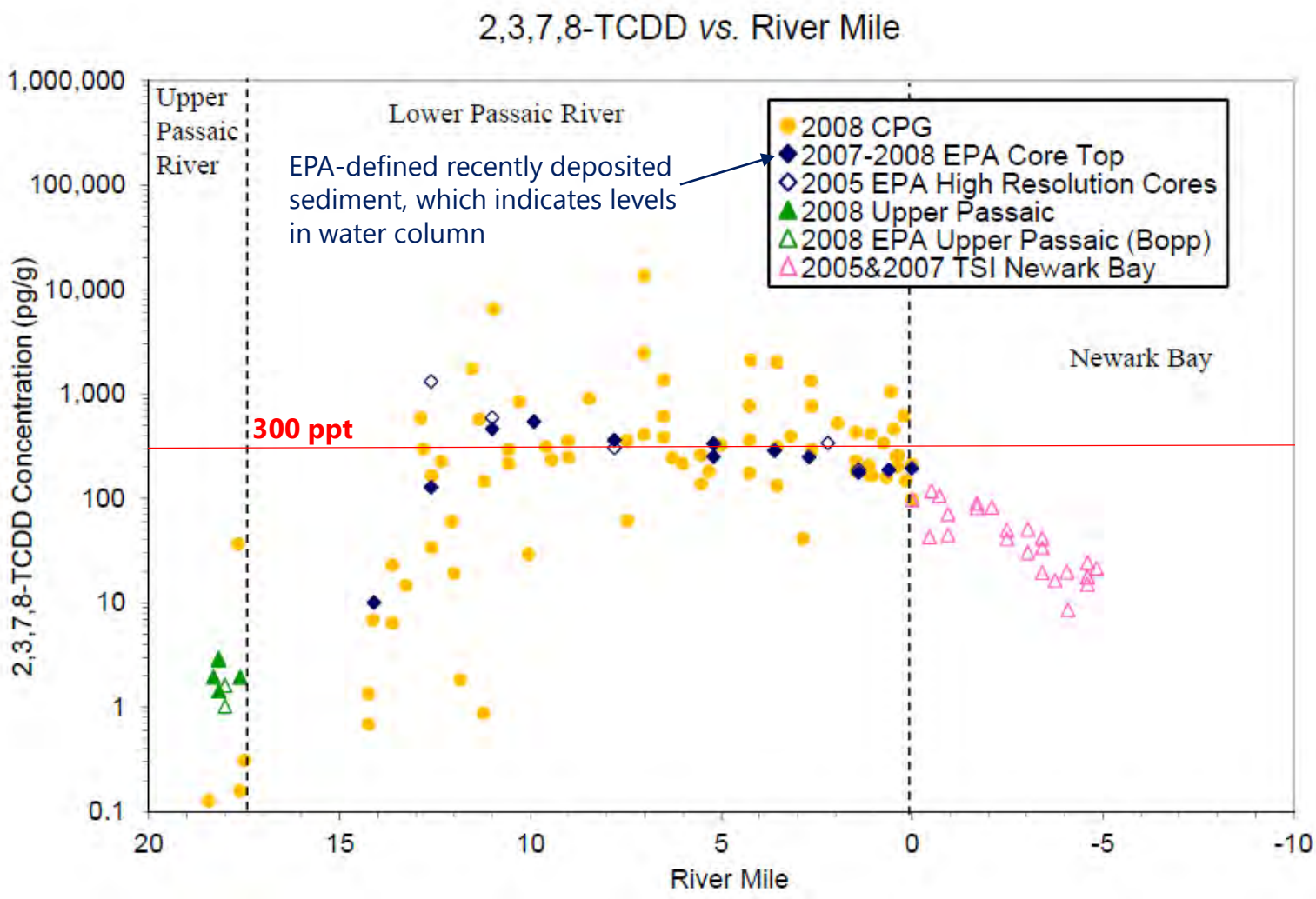
Figure 1
Change in Average Surface Sediment 2,3,7,8-TCDD Concentration in Areas Between RM 1 and RM 7 That Experienced Net Deposition Between 1995 & 2011



"…2,3,7,8-TCDD concentration in recently-deposited sediments vary less than a factor of 3 from RM 2 to RM 12 (note in blue diamonds on the upper diagram in Figure 4-3)." – FFS RI Report at Page 4-3.

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Figure 2
2,3,7,8-TCDD Concentration in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River (Extracted from FFS RI Report Figure 4-3)

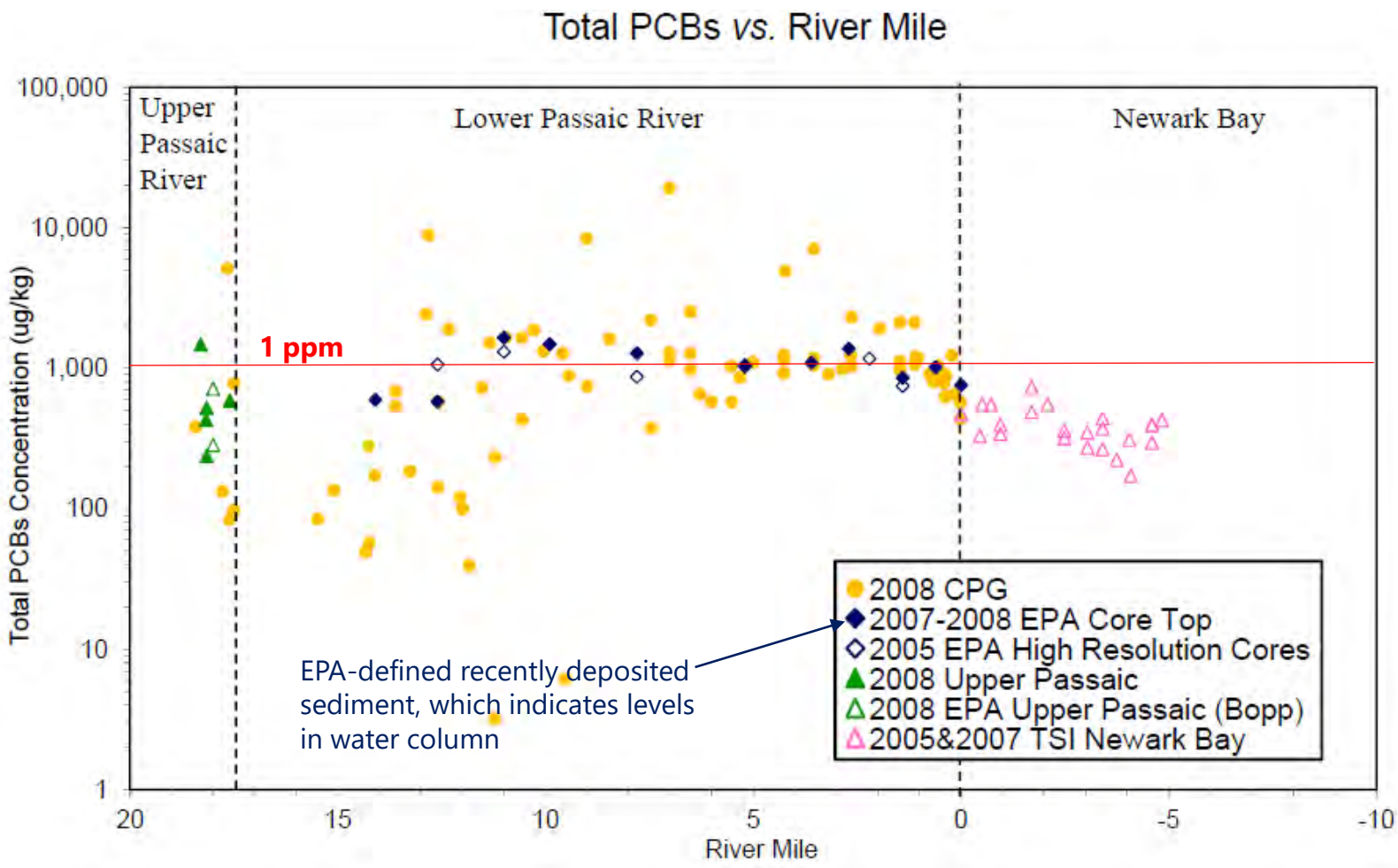

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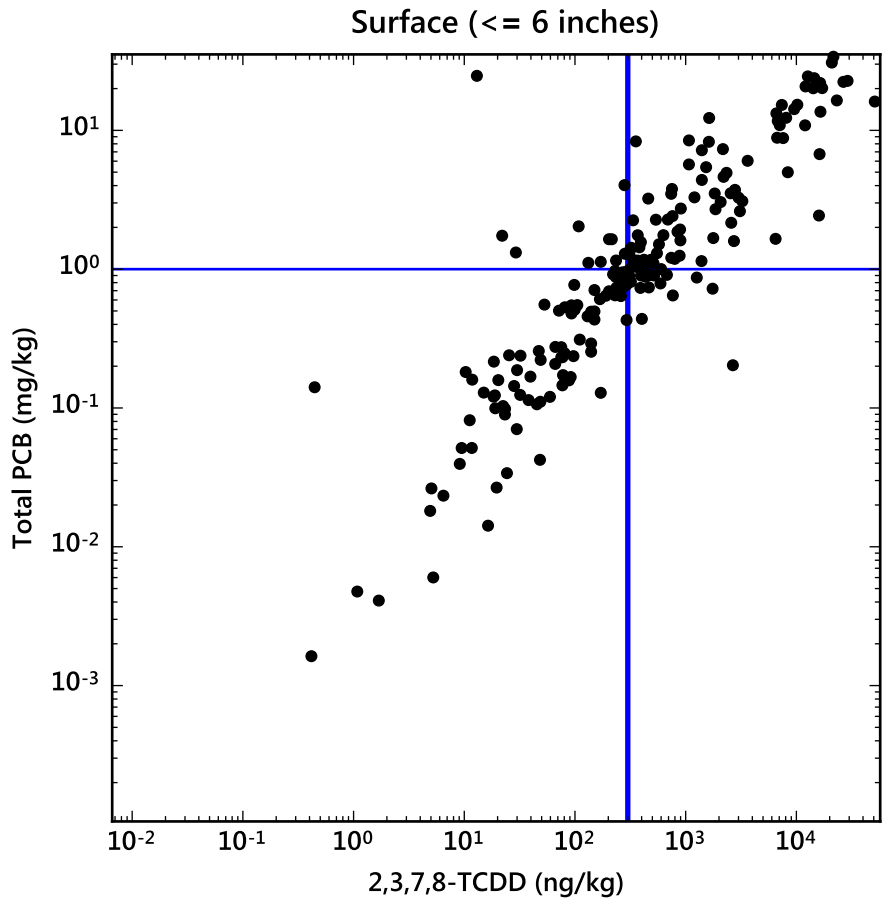
Figure 3
Total PCBs in Recently-Deposited Sediments in the Lower Passaic River, Newark Bay and the Upper Passaic River (Extracted from FFS RI Report Figure 4-12)



Post 2005 data used. Surface is a depth 6 inches or less

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File Path: N:/Projects/Passaic_CPG/ANALYSIS/RIFS_draft2/python/sed_correlation_mapping_data_multi_depths_plotter_fig_3.py

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Figure 4

Correlation of Paired Total PCB and 2,3,7,8-TCDD Concentrations in Surface Sediments Between River Miles: RM 12.3 and 8