December 2021
Newtown Creek Remedial Investigation/Feasibility Study

ANCHOR QEA

Development of Risk-Based Preliminary Remediation Goals

Prepared for the Newtown Creek Group

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Prepared for
The Newtown Creek Group

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Project Number: 211037-01.01
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ABBREVIATIONS

µmol/g	micromoles per gram
1:1	one to one
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
95% UCL	95% upper confidence limit of the mean
BERA	*Baseline Ecological Risk Assessment*
BHHRA	*Baseline Human Health Risk Assessment*
BSAF	biota-sediment accumulation factor
BW	body weight
C19-C36	C19-C36 aliphatic hydrocarbons
CBR	critical body residue
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFT	chemical fate and transport
CM	creek mile
COC	contaminant of concern
D/F	dioxin/furan
dw	dry weight
FS	Feasibility Study
FSZ	fish sampling zone
HQ	hazard quotient
kg	kilogram
mg/kg	milligrams per kilogram
mg/kg/day	milligrams per kilogram per day
NCG	Newtown Creek Group
ng/kg	nanograms per kilogram
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
RI	Remedial Investigation
RI Report	*Remedial Investigation Report*
RI/FS	Remedial Investigation/Feasibility Study
SLERA	screening level ecological risk assessment
SWAC	surface-weighted average concentration
TDI	total daily intake
TEQ	toxic equivalence quotient
TPAH (34)	total polycyclic aromatic hydrocarbon (34)
TPCB	total polychlorinated biphenyl

TRV	toxicity reference value
USEPA	U.S. Environmental Protection Agency
ww	wet weight

1 Introduction and Approach

This *Development of Risk-Based Preliminary Remediation Goals* provides supporting information for the development of the risk-based preliminary remediation goals (PRGs) presented to the U.S. Environmental Protection Agency (USEPA) on November 7, 2019. The risk-based PRGs have been developed for the three focus chemicals—hydrocarbons, total polychlorinated biphenyl (TPCB), and copper—as well as for dioxin/furan (D/F) and lead, based on the outcomes of the risk analyses presented in the USEPA-approved *Baseline Human Health Risk Assessment* (BHHRA; Appendix H of the *Remedial Investigation Report* [RI Report]; Anchor QEA 2019) and the *Baseline Ecological Risk Assessment* (BERA; Appendix I of the RI Report; Anchor QEA 2019). These five chemicals have been identified as contaminants of concern (COCs) for the Remedial Investigation/Feasibility Study (RI/FS) Study Area.[1] The risk-based PRGs have made assumptions with respect to the relationship between sediment and tissue chemical concentrations for purposes of development of these values. These assumptions will be revisited following completion of the chemical fate and transport (CFT) modeling, which is being performed as part of the FS process.

The BHHRA and the BERA evaluated risks to human health and the environment, respectively, for a number of different receptors and exposure pathways. In general, risk estimates were based on the following comparisons: tissue COC concentrations in receptors to critical body residue (CBR) toxicity thresholds; dietary intake of COCs to dose-based toxicity values; and direct measurements of COC-caused sediment toxicity. Ultimately, remedies at contaminated sediment sites like Newtown Creek are sediment-based (i.e., based on bulk sediment concentrations) and, for that reason, risk-based PRGs should also be sediment-based. Risk-based PRG development methods must convert risks estimated for a number of different COCs, receptors, and exposure pathways to sediment-based COC concentrations that will be protective of human health and the environment for all receptors and exposure pathways.

Depending on the exposure scenario and the receptor under evaluation, risk-based PRGs can be based on a surface-weighted average concentration (SWAC) of sediment COCs or based on a not-to-exceed sediment COC value for a given sample point. For example, recreational fishing and crabbing

[1] The Newtown Creek Superfund Site Study Area is described in the Administrative Order on Consent as encompassing the body of water known as Newtown Creek, situated at the border of the boroughs of Brooklyn (Kings County) and Queens (Queens County) in the City of New York and the State of New York, roughly centered at the geographic coordinates of 40° 42' 54.69" north latitude (40.715192°) and 73° 55' 50.74" west longitude (-73.930762°), having an approximate 3.8-mile reach, including Newtown Creek proper and its five branches (or tributaries) known respectively as Dutch Kills, Maspeth Creek, Whale Creek, East Branch, and English Kills, as well as the sediments below the water and the water column above the sediments, up to and including the landward edge of the shoreline, and including also any bulkheads or riprap containing the waterbody, except where no bulkhead or riprap exists, then the Study Area shall extend to the ordinary high water mark, as defined in 33 Code of Federal Regulations § 328(e) and the areal extent of the contamination from such area, but not including upland areas beyond the landward edge of the shoreline (notwithstanding that such upland areas may subsequently be identified as sources of contamination to the waterbody and its sediments or that such upland areas may be included within the scope of the Newtown Creek Superfund Site as listed pursuant to Section 105(a)(8) of the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]).

can occur throughout the Study Area, and the collected fish and crab move throughout the Study Area; therefore, it is appropriate to develop a SWAC-based PRG for the protection of human health where risks are driven by consumption of fish and crab caught in the Study Area. In this case, a risk-based PRG value is a sediment SWAC concentration for a specific COC that must be met to reduce tissue concentrations to levels that are protective of human health through the fish and crab consumption exposure pathway. In contrast, benthic macroinvertebrates are sessile organisms that are exposed to sediment-based COCs over a small area. In this case, a sediment-based PRG is a not-to-exceed COC concentration that should not be exceeded at any location, in order to protect the benthic community from direct exposure to higher concentrations of COCs in sediment.

Because the same COCs identified in the risk assessments are in many cases also found in the watersheds in the greater New York Harbor area, the development of final PRGs for the Study Area needs to consider the extent of any contribution of background COC concentrations to the Study Area, particularly if the contribution from background exceeds risk-based concentrations. As stated in the *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA 2005), "generally, under CERCLA, cleanup levels are not set at concentrations below natural or anthropogenic levels." As expressed in the 2002 guidance document *Role of Background in the CERCLA Cleanup Program* (USEPA 2002), "the contribution of background concentrations to risk associated with CERCLA releases may be important for refining specific cleanup levels for COCs that warrant remedial action." Finally, as stated in the 2017 *Remediating Contaminated Sediment Sites* guidance document (USEPA 2017), "at large contaminated sediment sites, it may be important to evaluate background concentrations and the potential for recontamination to determine the level of risk reduction and contaminant levels that can be achieved through the remedial action."

As described in the following sections for each of the five COCs, risk-based sediment PRGs have been developed for all the human health and ecological receptors, exposure pathways, and COCs for which there are unacceptable risks (e.g., recreational crabber and polychlorinated biphenyls [PCBs], or mummichog and copper). From those, the most protective risk-based PRG for each COC is selected as the risk-based PRG. An overall summary of the risk-based PRGs for TPCB, D/F, copper, and lead with supporting information is presented in Table 1-1. Table 1-1 includes the current Study Area-wide SWACs for TPCB, D/F, copper, and lead as these are used in the development of the PRGs as described in the following sections. For each of these four COCs, this table also includes a listing of the locations within the Study Area where exposure to that COC is greatest. Attachment A of this report provides live Excel tables used to calculate the Study Area-wide SWACs for all five COCs and figures showing the Thiessen polygons used in the SWAC calculations.

2 Polychlorinated Biphenyls

2.1 Human Health

The Newtown Creek RI/FS BHHRA evaluated multiple pathways by which people could be exposed to contaminants in the surface water and sediment. These pathways consisted of recreational exposure from boating, swimming, and fishing and crabbing (including consumption of fish and crab) in the creek, as well as the following: recreational use of the shoreline; occupational exposure of landside, dockside, and construction workers; unauthorized exposure for sailboat users and trespassers; and residential/occupational exposure during a flood event.

Of these, only consumption of striped bass, white perch, and blue crab by recreational anglers and crabbers resulted in cancer risks above USEPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}, or in noncancer hazards above USEPA's acceptable threshold of hazard quotient (HQ) = 1 (see BHHRA Tables 6-13 and 6-14 for striped bass, Tables 6-21 and 6-22 for white perch, and Tables 6-29 and 6-30 for blue crab). Review of these exposure pathways shows that, overall, threshold exceedances are greatest for the blue crab and are driven by the dioxin-like PCB congeners (expressed as TPCB toxic equivalence quotients [TEQs] 2005 for mammals), with a cancer risk of 4×10^{-4} and noncancer HQ of 20 for reproductive effects. For nondioxin-like PCB congeners in blue crab, the cancer risk is 1×10^{-4}, with a noncancer HQ of 10 for immune system effects (see BHHRA Table 6-31).

For striped bass and white perch, threshold exceedances are equal to or lower than those for blue crab and are driven by PCB congener TEQ 2005 (Mammal) and/or nondioxin-like PCB congeners (see Table 1-1 for a summary of the HQs and risk levels for all three exposure pathways). Lastly, it is noted that of all the contaminants contributing to the human health threshold exceedances, total dioxin-like PCBs and total nondioxin-like PCB congeners are the largest contributors.

Although threshold exceedances are driven by PCB congener TEQ 2005 (Mammal) and/or nondioxin-like PCB congeners, the risk-based PRG is developed for TPCB in sediment since this closely tracks the sediment concentrations of PCB congener TEQ 2005 (Mammal) and nondioxin-like PCB congeners. By developing a risk-based PRG for TPCB, if TPCB concentrations are reduced by an amount sufficient to reach the risk goal, the PCB congener TEQ 2005 (Mammal) and nondioxin-like PCB congeners will be reduced by approximately the same amount.

Given that crabbing can occur throughout the Study Area and given the range of movement of crab within the Study Area, the BHHRA assumed that exposure occurred on a Study Area-wide basis. Due to this, the human health TPCB risk-based PRG should be developed on a SWAC basis. Examination of the longitudinal profiles for TPCB in surface sediment and blue crab tissue, both as the PCB congener TEQ 2005 (Mammal) and as TPCB (see Figures 2-1, 2-2, and 2-3), indicates that there is a relationship between TPCB in sediment and blue crab tissue in the Study Area. For the FS process, a direct, one-to-one (1:1) relationship is assumed between TPCB in sediment and TPCB in blue crab. This relationship is conservative in that there likely is a component of TPCB in blue crab tissue that is driven by exposure to water column-based dietary intake, in addition to what is sediment-based.

Thus, the sediment-based human health PRG for TPCB is equal to the Study Area-wide TPCB SWAC that will reduce risks to a protective level, assuming the 1:1 relationship between tissue and sediment TPCB concentrations. The pre-remedy Study Area-wide SWAC for TPCB is 5.9 milligrams per kilogram (mg/kg) (see Table 1-1). Given the pre-remedy human health HQ of 20 based on PCB congener TEQ 2005 (Mammal) in blue crab, the pre-remedy TPCB SWAC needs to be reduced 20-fold to reach a target post-remedy HQ of 1 (since a 1:1 relationship between sediment and blue crab tissue concentrations is being used). Doing so results in a post-remedy Study Area-wide TPCB SWAC of 0.30 mg/kg. This also reduces the pre-remedy cancer risk from exposure to PCB congener TEQ 2005 (Mammal) in blue crab from 4×10^{-4} to 0.2×10^{-4}. Likewise, the pre-remedy cancer risk from nondioxin-like PCB congeners will be reduced from 1×10^{-4} to 0.05×10^{-4}. Thus, the total post-remedy cancer risk from dioxin-like plus nondioxin-like PCB congeners is 0.25×10^{-4} (or 2.5×10^{-5}), within USEPA's acceptable risk range of 1×10^{-4} to 1.0×10^{-6}.

Threshold exceedances for striped bass and white perch are the same as or lower than those for blue crab; therefore, PRGs developed based on the consumption of blue crab will be protective of human health from the recreational consumption of striped bass and white perch (see Table 1-1).

2.2 Ecological

The Newtown Creek RI/FS BERA evaluated risks to multiple ecological receptors from exposure to contaminants in surface water, sediment, and food using a tissue residue approach and a dietary approach applicable to the receptor and contaminant under evaluation. For TPCB, the tissue residue approach was used for aquatic biota (benthic macroinvertebrates [represented by polychaetes], bivalves, blue crab, striped bass, and mummichog). The dietary approach was used for representative birds feeding on aquatic biota (green heron, black-crowned night heron, belted kingfisher, double-crested cormorant, spotted sandpiper) and the raccoon from scavenging aquatic biota. The two approaches are described in the following sections.

2.2.1 Tissue Residue Approach

The BERA used concentrations of contaminants measured in the tissues of aquatic biota collected from throughout the Study Area for the tissue residue approach. The approach assumed a Study Area-wide exposure; that is, the 95% upper confidence limit of the mean (95% UCL) tissue contaminant concentration for each species collected from all fish sampling zones (FSZs) were used as the exposure point concentration. To evaluate potential risk, the BERA used two sets of CBRs for some of the contaminants. One set was selected by the Newtown Creek Group (NCG) from the U.S. Army Corps of Engineers Environmental Residue Effects Database (USACE 2013) and USEPA's

PCB Residue Effects Database (USEPA 2007); these are referred to as the NCG CBRs. The second set was selected by USEPA from the Lower Passaic River Risk Assessment (USEPA 2014); these are referred to as USEPA Region 2 CBRs. When the NCG CBRs were used, none of the contaminants were identified as COCs. When the USEPA Region 2 CBRs were used, a number of the contaminants, including TPCB, were identified as COCs.

To develop a risk-based PRG, exposure was assumed to be Study Area-wide, except for benthic macroinvertebrates. This is justified given the movement of fish and crab within Newtown Creek, and for bivalves, given that exposure is within the water column of a tidal waterway. A Study Area-wide exposure assumption is also consistent with the BERA risk evaluation. Due to this, the TPCB risk-based PRG can be developed on a SWAC basis for these receptors. For sessile benthic macroinvertebrates with localized sediment exposure, the PRG was developed as a not-to-exceed value. As described previously, the PRG was developed assuming a 1:1 relationship between sediment and tissue TPCB concentrations. This simplifying assumption is supported by an examination of the longitudinal profiles for TPCB in surface sediment (see Figure 2-1) and TPCB in the tissues of bivalves, blue crab, striped bass, and mummichog (see Figures 2-4 through 2-7).

For bivalves, blue crab, striped bass, and mummichog, the tissue residue-based HQs, when using the USEPA Region 2 CBRs, ranged from 3.9 for bivalves to 9.2 for mummichog (see Table 1-1). Therefore, a PRG based on protecting mummichog will be protective of striped bass, blue crab, and bivalves. Using the pre-remedy Study Area-wide SWAC for TPCB of 5.9 mg/kg and a target HQ of 1, the post-remedy, risk-based SWAC for TPCB is 0.64 mg/kg (see Table 1-1), a 9.2-fold reduction.

For benthic macroinvertebrates, there is a strong relationship between sediment and tissue concentrations for TPCB (compare longitudinal profile Figure 2-3 for sediment with Figure 2-8 for polychaetes). To develop a risk-based PRG that is protective of benthic macroinvertebrates, the USEPA Region 2 tissue TPCB CBR of 0.026 mg/kg for invertebrates is divided by the TPCB biota-sediment accumulation factor (BSAF) derived in the BERA for polychaetes (see Figure 2-9) of 0.02 to derive a not-to-exceed PRG value of 1.3 mg/kg (see Table 1-1). Note that the resulting not-to-exceed value of 1.3 mg/kg is highly uncertain given the uncertainty with the USEPA Region 2 lowest observed effect concentration CBR (see discussion in BERA Section 7.4.2). It is also noted that when the NCG no-observable-effect concentration CBR is used to evaluate potential risk to polychaetes in the BERA, the resulting HQ is 0.06 (see BERA Table 8-2), which is below the risk threshold of 1.0.

2.2.2 Dietary Approach

The BERA developed dietary intake exposure models for birds and the raccoon feeding on aquatic biota from the Study Area. The birds were selected to represent the following feeding guilds: piscivorous for the double-crested cormorant and belted kingfisher; piscivorous/insectivorous for the green heron and black-crowned night heron; and insectivorous for the spotted sandpiper. The raccoon was selected as a representative urban mammal that might scavenge on aquatic biota from the Study Area.

Using dietary-based toxicity reference values (TRVs) from the scientific literature for birds and mammals, potential risks from exposure to PCBs were identified for the spotted sandpiper (HQ = 1.7), the black-crowned night heron (HQ = 1.7), the green heron (HQ = 2.3), and the belted kingfisher (HQ = 1.8), but potential risk was not identified for the double-crested cormorant and the raccoon.

The HQs were calculated as shown in Equation 2-1:

Equation 2-1

$$HQ = TDI_{All}/TRV$$

where:

HQ	=	hazard quotient
TDI_{All}	=	total daily intake of contaminants from all dietary sources
TRV	=	toxicity reference value

The TRV is the avian TRV for TPCB of 0.58 milligram per kilogram per day (mg/kg/day) (see BERA Table 11-11a) and mammalian TRV for TPCB adjusted for the body weight (BW) of the raccoon to 0.098 mg/kg/day (see BERA Table 11-11b). The TDI_{All} is calculated as shown in Equation 2-2:

Equation 2-2

$$TDI_{All} = TDI_{water} + TDI_{sediment} + TDI_{biota}$$

where:

TDI_{All}	=	total daily intake of contaminants from all dietary sources
TDI_{water}	=	total daily intake of contaminants from drinking or incidental ingestion of surface water
$TDI_{sediment}$	=	total daily intake of contaminants from incidental ingestion of sediment
TDI_{biota}	=	total daily intake of contaminants from ingestion of biota

Because a portion of the risk to these birds is due to the consumption of biota in their diet (i.e., an indirect exposure pathway from sediment), a sediment-based PRG also has to be developed to be protective of receptors that are exposed to TPCB through the dietary pathway. Therefore, the dietary model is used to solve for a protective total daily intake (TDI) for biota and a protective TDI for sediment based on a sediment concentration (the PRG) that results in HQ = 1. As demonstrated in the BERA, the TDI of contaminants from water for birds is such a small portion of the overall TDI that it does not influence the calculation of the sediment-based PRG.

Since biota tissue concentrations need to be calculated, a TDI_{biota} for each dietary item is derived using a BSAF approach based on the relationship between sediment TPCB concentrations and TPCB in biota tissue. Specifically, for birds with polychaetes in their diet, pre-remedy measured sediment TPCB and polychaete tissue TPCB concentrations were used in the BERA to derive a BSAF of 0.02 (see Figure 2-9, which is a copy of BERA Figure 11-3a). For birds with mummichog in their diet, a BSAF is predicted from the pre-remedy sediment SWAC for TPCB of 5.9 mg/kg and the pre-remedy 95% UCL TPCB concentration measured in mummichog tissue of 4.86 mg/kg for a SWAC-based BSAF of 0.82 (4.86 mg/kg / 5.9 mg/kg = 0.82). A Study Area-wide exposure assumption is also consistent with the BERA risk evaluation.

The TDIs for the different types of dietary biota are calculated as shown in Equation 2-3:

Equation 2-3

$$\mathrm{TDI_{biota}} = ((\mathrm{C_{sediment}}\ \mathrm{x}\ \mathrm{BSAF})\ \mathrm{x}\ \mathrm{FB}\ \mathrm{x}\ \mathrm{IR}\ \mathrm{x}\ \mathrm{EMF_b})/\mathrm{BW}$$

where:

$C_{sediment}$	=	contaminant concentration in sediment (mg/kg) dry weight (dw) (in this case, the target PRG)
BSAF	=	biota-sediment accumulation factor, wet weight (ww) tissue concentration/dw sediment concentration (0.02 for polychaetes, 0.82 for mummichog)
FB	=	fraction of biota ingested as part of the diet (see BERA Table 11-10b)
IR	=	receptor ingestion rate on a dw basis (see BERA Table 11-10b)
EMF_b	=	exposure modifying factor for biota in the diet to account for seasonal exposure, site use, etc. (see BERA Table 11-10c)
BW	=	receptor body weight (kilogram [kg]) (see BERA Table 11-10b)

The TDI for incidental ingestion of sediment is calculated as shown in Equation 2-4:

Equation 2-4

$$TDI_{sediment} = (C_{sediment} \text{ x } FS \text{ x } IR \text{ x } EMF_s)/BW$$

where:

$C_{sediment}$	=	contaminant concentration in sediment (mg/kg) dw (in this case, the target PRG)
FS	=	fraction of sediment ingested as part of the diet (see BERA Table 11-10b)
IR	=	receptor ingestion rate on a dw basis (see BERA Table 11-10b)
EMF_s	=	exposure modifying factor for sediment to account for seasonal exposure, site use, etc. (see BERA Table 11-10c)
BW	=	receptor body weight (kg) (see BERA Table 11-10b)

TDI_{biota} and $TDI_{sediment}$ are calculated by solving for $C_{sediment}$ simultaneously using Equations 2-1 through 2-4 for a target HQ of 1 and using the TRV of 0.58 mg/kg/day. These calculations are provided in Attachment B of this report (see Attachment Tables B1a through B1d for the spotted sandpiper, B2a through B2e for the black-crowned night heron, B3a through B3e for the green heron, and B4a through B4d for the belted kingfisher).[2]

The outcome of running these analyses is summarized in Table 2-1, which for reference, also includes a summary of the baseline risk analyses for these birds from the BERA. For the spotted sandpiper, with a diet consisting of 100% polychaetes and incidental ingestion of intertidal sediment, the resulting TPCB risk-based PRG is 31 mg/kg. Because spotted sandpiper forage throughout the Study Area intertidal zone, this PRG is considered to be SWAC-based and applicable to only the intertidal areas. For the black-crowned night heron and green heron, with a diet consisting of 90% mummichog, 10% polychaetes, and incidental ingestion of intertidal sediment, the resulting TPCB risk-based PRGs are 2.0 and 1.5 mg/kg, respectively. Because the black-crowned night heron and green heron forage throughout the Study Area intertidal zone, and because a SWAC-based BSAF is used to calculate a mummichog TPCB tissue concentration (representing 90% of the black-crowned night heron and green heron diet), the PRG is considered to be SWAC-based and applicable to only the intertidal areas. The belted kingfisher diet used in the BERA consisted of 100% fish, of which 50% is mummichog and 50% is Atlantic menhaden, with incidental ingestion of sediment from throughout the Study Area, given its diving behavior when hunting prey. Because Atlantic menhaden are pelagic fish, their tissue concentration was kept consistent with that used in the BERA. The resulting TPCB risk-based PRG for the belted kingfisher is 1.5 mg/kg. The belted kingfisher can

[2] Note that the target HQ is set at 0.9999 in Attachment B to calculate the sediment PRGs.

forage throughout the Study Area; therefore, the PRG is considered to be SWAC-based and applicable Study Area-wide.

2.3 Selection of TPCB PRG

A summary of the TPCB PRGs is presented in Table 1-1. The human health post-remedy SWAC-based PRG is 0.30 mg/kg, based on recreational consumption of blue crab caught from throughout the Study Area. As shown in Table 1-1, the human health post-remedy risk-based SWACs for the consumption of striped bass and white perch are equal to or higher than that for blue crab. In addition, the post-remedy PRGs developed for the ecological receptors, whether based on a tissue residue or dietary approach, are higher than the human health-based PRG of 0.30 mg/kg. As discussed, the post-remedy not-to-exceed risk-based PRG of 1.3 mg/kg for benthic macroinvertebrates is based on a highly uncertain CBR selected by USEPA Region 2. TPCB is not identified as a COC for polychaetes when using the NCG CBR.

For the FS process, a post-remedy TPCB SWAC of 0.30 mg/kg is selected as the risk-based TPCB PRG.

3 Dioxin and Furan

The approach used to develop the risk-based PRGs for D/F is the same as that discussed in Section 2 for TPCB, except that for D/F, the BERA did not identify any risks to birds or mammals, but did for striped bass.

3.1 Human Health

The Newtown Creek RI/FS BHHRA evaluated multiple pathways by which people could be exposed to contaminants in the surface water and sediment. Of these, only the consumption of striped bass, white perch, and blue crab by recreational anglers and crabbers resulted in cancer risk above USEPA's acceptable risk level of 1×10^{-4} to 1×10^{-6}, or noncancer hazards equal to or above USEPA's acceptable threshold HQ = 1 for D/Fs (see BHHRA Tables 6-13 and 6-14 for striped bass, Tables 6-21 and 6-22 for white perch, and Tables 6-29 and 6-30 for blue crab). Review of these exposure pathways shows that, overall, threshold exceedances are greatest for the blue crab, with a cancer risk of 2×10^{-4} and noncancer HQ of 8 for reproductive effects. Given that crabbing can occur throughout the Study Area and given the range of movement of crab within the Study Area, the BHHRA assumed that exposure occurred on a Study Area-wide basis. Due to this, the human health total D/F TEQ 2005 (Mammal) should be developed on a SWAC basis. Examination of the longitudinal profiles for the total D/F TEQ 2005 (Mammal) in surface sediment and blue crab tissue (see Figure 3-1 and 3-2, respectively) indicates there is a relationship between the total D/F TEQ 2005 (Mammal) in sediment and blue crab tissue in the Study Area. For the FS process, a direct, 1:1 relationship is assumed between the total D/F TEQ 2005 (Mammal) in sediment and blue crab. This relationship is conservative in that there likely is a component of the total D/F TEQ 2005 (Mammal) in blue crab tissue that is driven by exposure to water column-based dietary intake, in addition to what is sediment-based.

The sediment-based human health PRG for the total D/F TEQ 2005 (Mammal) is equal to the Study Area-wide total D/F TEQ 2005 (Mammal) SWAC that will reduce risks to a protective level, assuming the 1:1 relationship between tissue and sediment total D/F TEQ 2005 (Mammal) concentrations. The pre-remedy Study Area-wide SWAC for the total D/F TEQ 2005 (Mammal) SWAC is 140 nanograms per kilogram (ng/kg; see Table 1-1). Given the pre-remedy human health D/F TEQ 2005 (Mammal) HQ of 8, the pre-remedy TPCB SWAC needs to be reduced 8-fold to reach a target HQ of 1 (since a 1:1 relationship between sediment and blue crab tissue concentrations is being used). Doing so results in a post-remedy Study Area-wide D/F TEQ 2005 (Mammal) SWAC of 18 ng/kg. This also reduces the pre-remedy cancer risk from exposure to D/F TEQ 2005 (Mammal) in blue crab from 2×10^{-4} to 0.25×10^{-4} (or 2.5×10^{-5}).

Because the threshold exceedances for striped bass and white perch are lower than those for blue crab, PRGs developed based on the consumption of blue crab will be protective of human health from the recreational consumption of striped bass and white perch.

3.2 Ecological

As described in Section 2.2, the BERA evaluated risks to multiple ecological receptors from exposure to contaminants in surface water and sediment using a tissue residue approach and a dietary approach. For D/F, the tissue residue approach was used for aquatic biota (benthic macroinvertebrates [represented by polychaetes], bivalves, blue crab, striped bass, and mummichog), and the dietary approach was used for representative birds feeding on aquatic biota, as well as the raccoon from scavenging aquatic biota. As presented in the BERA, no risks were identified for birds and mammals from exposure to D/F using the dietary approach, therefore, it is not necessary to develop risk-based PRGs for D/Fs based on bird and mammal exposure. However, because risks were identified for striped bass from exposure to D/F based on a tissue residue approach, a D/F risk-based PRG was developed as described in the following section.

3.2.1 Tissue Residue Approach

As described previously, the BERA used concentrations of contaminants measured in the tissues of aquatic biota collected from throughout the Study Area in the tissue residue approach, and assumed a Study Area-wide exposure (i.e., the 95% UCL tissue concentrations for each species collected from all FSZs were used as the exposure point concentration). As described for TPCB, two sets of CBRs were used for some of the contaminants to assess potential risk—one set selected by the NCG (NCG CBRs) and a second set selected by USEPA (USEPA Region 2 CBRs). When the NCG CBRs were used, none of the contaminants were identified as COCs. When the USEPA Region 2 CBRs were used, a number of the contaminants, including D/F, were identified as COCs. Note that the USEPA Region 2 CBR is for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), which was used to assess potential risks from exposure to this congener and was also used to assess potential risk from exposure to total D/F congeners on a TEQ basis for fish (see Table 1-1).

To develop a risk-based PRG for striped bass, exposure was assumed to be Study Area-wide. This is justified given the movement of striped bass within Newtown Creek. Therefore, the D/F risk-based PRG for striped bass can be developed on a SWAC basis. As previously described, the PRG was developed assuming a direct relationship between sediment and tissue D/F concentrations. This simplifying assumption is supported by an examination of the longitudinal profiles for D/F in surface sediment and striped bass tissue (see Figures 3-3 and 3-4).

The tissue residue-based HQs for 2,3,7,8-TCDD and the total D/F TEQ 1998 (Fish) are 1.7 and 2.8, respectively (see Table 1-1). Therefore, a SWAC based on the total D/F TEQ 1998 (Fish) will be protective of striped bass from exposure to D/F. Using the pre-remedy Study Area-wide SWAC for

D/F of 140 ng/kg and a target HQ of 1 (a 2.8-times reduction), the post-remedy, risk-based SWAC for total D/F TEQ 1998 (Fish) is 50 ng/kg (see Table 1-1).

3.3 Selection of Dioxin/Furan PRG

A summary of the risk-based D/F PRGs is presented in Table 1-1. The post-remedy human health SWAC-based PRG for total D/F congener TEQ 2005 (Mammal) is 18 ng/kg, based on recreational consumption of blue crab caught from throughout the Study Area. The ecological striped bass post-remedy SWAC-based PRG for total D/F congener TEQ 1998 (Fish) of 50 ng/kg is higher than the human health-based PRG. For the FS process, the post-remedy risk-based total D/F TEQ 2005 (Mammal) PRG is 18 ng/kg for the protection of human health. It is important to note that D/F TEQs are calculated using both mammalian and fish toxicity equivalency factors, but the total D/F TEQs using the two methods are essentially equivalent in both sediment and tissue in the Study Area.

4 Copper

Copper was not identified as a COC in the Newtown Creek RI/FS BHHRA. However, copper was identified as a COC in the BERA for blue crab and mummichog, based on tissue residues, and for mummichog and spotted sandpiper, based on dietary intake.[3] These risks, and the development of risk-based PRGs for copper, are described in the following sections.

4.1 Tissue Residue Approach

Using the tissue residue approach described in Section 2.2.1, the BERA identified copper as a COC for blue crab (HQ = 1.6) and for mummichog (HQ = 2.1) when using the USEPA Region 2 CBRs. As with other contaminants, copper was not identified as a COC when the NCG CBRs were used.

In contrast to TPCB and D/Fs, there are several factors that suggest an assumed relationship between copper sediment and tissue concentrations is not a useful basis for developing a risk-based PRG. One factor is the lack of a spatial trend in blue crab and mummichog copper tissue concentrations compared to clear spatial trends in copper sediment concentrations (see Figures 4-1 through 4-3). In addition, it is known that mummichog tend to inhabit a home range that is smaller than the Study Area, which (because of their incidental ingestion of sediment while foraging) suggests that spatial differences in sediment copper concentrations should result in spatially different dietary exposures. Therefore, as described in the following section, only a dietary approach was used to develop a mummichog risk-based PRG for copper.

4.2 Dietary Approach – Mummichog

In the BERA, mummichog exposure using a dietary approach was evaluated in the following two areas: Area 1, which consisted of FSZs 1, 2, and 3 (i.e., creek mile [CM] 2 plus Dutch Kills); and Area 2, which consisted of FSZs 4a, 4b, and 5 (i.e., CM 2+, Maspeth Creek, English Kills, and East Branch). The dietary exposure model for mummichog in the baseline analyses consisted of 50% polychaetes, 50% bivalves (as surrogate water column prey organisms), and incidental ingestion of sediment at 1% of the dietary intake (only while foraging on polychaetes). This approach resulted in an Area 1 HQ of 0.63 and an Area 2 HQ of 1.2. However, USEPA stipulated that the dietary exposure model for mummichog use the dietary exposure model from the screening level ecological risk assessment (SLERA), which included 100% polychaetes in the mummichog diet rather than the 50% polychaetes and 50% bivalve dietary exposure from the BERA (USEPA 2021). This alternative approach resulted in an Area 1 HQ of 0.60 and an Area 2 HQ of 1.1.

[3] While the concentrations of copper in porewater exceeded threshold values at five locations in CM 2+, this was not the case for locations in CM 0−2, except for one location at CM 0.78 (NC162) for which the porewater HQ was 1.05 (see BERA Figure 8-34). With a bulk sediment concentration for acid volatile sulfide of 138 micromoles per gram (μmol/g) and for the sum of simultaneously extracted metals (cadmium, copper, lead, nickel, and zinc) of 5.17 μmol/g for NC162, copper is not considered to be bioavailable.

The HQs were calculated as shown in Equation 4-1:

Equation 4-1

$$HQ = TDI_{All}/TRV$$

where:

TRV = the toxicity reference value for copper of 0.48 mg copper/kg ww/day obtained from the literature (see BERA Table 10-8)

And the TDI_{All} is calculated as shown in Equation 4-2:

Equation 4-2

$$TDI_{All} = TDI_{sediment\_} + TDI_{biota}$$

where:

TDI_{All} = total daily intake of contaminants from all dietary sources

$TDI_{sediment}$ = total daily intake of contaminants from incidental ingestion of sediment

TDI_{biota} = total daily intake of contaminants from ingestion of food items (polychaetes)

Examination of the spatial distribution in copper tissue concentrations for polychaetes (see Figure 4-4) supports the conclusion that differences in risk to mummichog between the two areas are likely due to spatial differences in copper sediment concentrations that are incidentally ingested by mummichog while foraging on polychaetes. While the concentrations of copper in the tissue of polychaetes contribute to the mummichog TDI, because these tissue concentrations are relatively constant throughout the Study Area, they are not contributing to the differences observed in risk between Area 1 and Area 2. The differences in sediment copper concentrations between the two areas account for the different risk estimates. Given this, a risk-based PRG was developed keeping polychaete tissue copper concentrations constant (at the maximum of the replicate averages at the Study Area stations included in the laboratory polychaete bioaccumulation tests, to be conservative) to calculate a TDI_{biota} and solving for a not-to-exceed sediment concentration (the PRG) from the $TDI_{sediment}$ at a target HQ = 1. The TDI_{biota} for polychaetes is calculated as shown in Equation 4-3:

Equation 4-3

$$TDI_{polychaetes} = (C_{polychaetes} \text{ x FB x IR})/BW$$

where:

$C_{polychaetes}$	=	maximum copper concentration of 2.64 mg/kg ww in polychaetes (see BERA Attachment A12a)
FB	=	fraction of biota in the mummichog diet (1.0 for polychaetes)
IR	=	mummichog biota ingestion rate on a ww basis (0.00108 kg biota ww/day)
BW	=	geometric mean of mummichog body weight from the Remedial Investigation (RI) Phase 2 biota surveys of 0.007 kg ww

This results in $TDI_{polychaetes}$ = 0.406 mg copper/kg BW wet weight (ww)/day.[4]

If the $TDI_{polychaetes}$ is held constant, the sediment contaminant concentration ($C_{sediment}$) can be solved for using Equation 4-4 for the $TDI_{sediment}$ simultaneously with Equations 4-1 through 4-3 for a target HQ of 1.

Equation 4-4

$$TDI_{sediment} = (C_{sediment} \text{ x FS x IR x } EMF_s)/BW$$

where:

$C_{sediment}$	=	contaminant concentration in sediment on a dw basis (mg/kg) (in this case, the PRG – converted from a ww)
FS	=	fraction of sediment in the diet set at 0.01
IR	=	mummichog ingestion rate on a ww basis (0.00108 kg biota ww/day)
EMF_s	=	exposure modifying factor for incidental ingestion of sediment set at 1.0 while foraging on polychaetes
BW	=	geometric mean of mummichog body weight from the RI Phase 2 biota surveys of 0.007 kg

These calculations are provided in Attachment B of this report (see Attachment Tables B5a through B5d) and result in a dry weight (dw) sediment concentration (the PRG) of 490 mg/kg.[5]

[4] Note that the calculations are performed in Excel or IDL prior to rounding; therefore, calculation using the rounded values may result in slightly different outcomes.

[5] Note that the target HQ is set at 1.0 in Attachment B to calculate the sediment PRG.

A summary of the calculations is presented in Table 4-1.

This risk-based PRG is considered to be a not-to-exceed concentration for any single location within the Study Area, given that it is driven by the concentration of copper in sediment, rather than the concentration of copper in tissue of mummichog diet (i.e., polychaetes). The relatively small home range for mummichog results in a small foraging range, which (is in turn) influenced by a smaller range of sediment copper concentrations. It should be noted that this PRG is based on using maximum dietary tissue concentrations in order to be conservative.

4.3 Dietary Approach – Birds and Mammals

Using the same approach described in Section 2.2.2, the BERA evaluated potential risks to birds and mammals from exposure to copper while foraging on aquatic biota from the Study Area. The birds were selected to represent different feeding guilds and consisted of double-crested cormorant, belted kingfisher, green heron, black-crowned night heron, and spotted sandpiper. The raccoon was selected as a representative urban mammal that might scavenge on aquatic biota.

HQs were calculated using Equation 2-1 and Equation 2-2 and the avian TRV for copper of 12.1 mg/kg/day (see BERA Table 11-11a) and mammalian TRV for copper (adjusted for the BW of the raccoon) of 19.3 mg/kg/day (see BERA Table 11-11b).

Using this approach, potential risks from exposure to copper were identified only for the spotted sandpiper (HQ = 1.04).

As discussed in Section 2.2.2, because a portion of the risk to the spotted sandpiper is due to the consumption of biota in its diet (i.e., an indirect exposure pathway from sediment), a sediment-based PRG also has to be developed to be protective for the spotted sandpiper exposed to copper through the dietary pathway. Therefore, the dietary model is used to iteratively back-calculate a protective TDI for biota and a protective TDI for sediment based on a sediment concentration (the PRG) that results in an HQ of 1 for this pathway as shown in Equation 2-3 (the TDI for water does not change).

Due to the foraging behavior of the spotted sandpiper, the TDI for biota is based on an assumed diet consisting of 100% polychaetes and the TDI for sediment is based on the incidental ingestion of intertidal sediment, which was set at 16% of the dietary intake (see BERA Table 11-10b). Due to the lack of a relationship between copper concentrations in polychaetes and surface sediment (see discussion in Section 4.2), a risk-based PRG for copper was developed keeping the TDI from biota constant (using the maximum copper concentration in polychaetes) and back-calculating a SWAC-based sediment concentration (the PRG) for a target HQ of 1.

The TDI for polychaetes is calculated as shown in Equation 4-5:

Equation 4-5

$$TDI_{polychaetes} = (C_{polychaetes} \text{ x } FB \text{ x } IR \text{ x } EMF_b)/BW$$

where:

$C_{polychaetes}$	=	maximum copper concentration of 2.64 mg/kg ww in polychaetes (see BERA Attachment A12a), converted to a dw based on the moisture content of polychaete tissue (average of 87.3%)
FB	=	fraction of biota in the diet set at 1.0 for polychaetes
IR	=	spotted sandpiper ingestion rate on a dw basis of 0.007 kg biota dw/day (see BERA Table 11-10b)
EMF_b	=	exposure modifying factor of 0.33 for spotted sandpiper ingestion of biota (polychaetes) to account for seasonal exposure, site use, and foraging on riprap in the intertidal zone (see BERA Table 11-10c)
BW	=	spotted sandpiper body weight of 0.0394 kg (see BERA Table 11-10b)

This results in $TDI_{polychaetes}$ = 1.22 mg copper/kg BW/day.

If the TDI for polychaetes is held constant, the sediment contaminant concentration ($C_{sediment}$) can be solved for using Equation 4-6 for $TDI_{sediment}$ simultaneously with Equations 2-1, 2-2, and 4-5 for a target HQ of 1:

Equation 4-6

$$TDI_{sediment} = (C_{sediment} \text{ x } FS \text{ x } IR \text{ x } EMF_s)/BW$$

where:

$C_{sediment}$	=	contaminant concentration in sediment on a dw basis (mg/kg) (in this case, the PRG)
FS	=	fraction of sediment in the diet set at 0.16 (see BERA Table 11-10b)
IR	=	spotted sandpiper ingestion rate of 0.007 mg biota/kg BW/day (see BERA Table 11-10b)
EMF_s	=	exposure modifying factor for spotted sandpiper incidental ingestion of sediment set at 0.33 to account for seasonal exposure, site use, and foraging on riprap in the intertidal zone (see BERA Table 11-10c)

These calculations are provided in Attachment B of this report (see Attachment Tables B6a through B6d) and result in a dw sediment concentration (the PRG) of 1,150 mg/kg.[6] Because spotted sandpiper forage in the intertidal zone only, this PRG is only applicable to the intertidal zone. In addition, because spotted sandpiper can forage throughout the intertidal zone, the PRG is considered to be SWAC-based.

A summary of the calculations is presented in Table 4-2, which for reference, also presents the baseline risk analyses from the BERA for the spotted sandpiper.

4.4 Selection of Copper PRG

A summary of the copper PRGs is presented in Table 1-1. As described in Section 4.1, the lack of a relationship between sediment and tissue copper concentrations does not support development of a PRG using tissue residues. Using a dietary approach, the copper not-to-exceed risk-based PRG for mummichog is 490 mg/kg and for the spotted sandpiper is a SWAC-based PRG of 1,150 mg/kg. For the FS process, the not-to-exceed PRG of 490 mg/kg is selected.

[6] Note that the calculations are performed in Excel or IDL prior to rounding; therefore, calculation using the rounded values may result in slightly different outcomes.

5 Lead

Lead was not identified as a COC in the Newtown Creek RI/FS BHHRA, but it was identified as a COC in the BERA for the spotted sandpiper using the dietary approach (lead was not identified as a COC in the BERA using the tissue residue approach). A summary of the risk analyses and development of a risk-based PRG for lead are presented in the following section.

5.1 Dietary Approach – Birds and Mammals

The BERA evaluated potential risks to birds and mammals from exposure to lead using the same dietary approach as described for copper (see Section 2.2.2, Equations 2-1 and 2-2, and BERA Tables 11-10a through 11-10c). Using dietary-based TRVs for lead from the scientific literature for birds and mammals (see BERA Tables 11-11a and 11-11b), potential risks from exposure to lead in the intertidal zone were identified only for the spotted sandpiper (HQ = 1.6).

Also as previously discussed (see Section 2.2.2), because a portion of the risk to the spotted sandpiper is due to the consumption of biota, a sediment-based PRG also has to be developed to be protective for the spotted sandpiper exposed to lead through the dietary pathway. Therefore, the dietary model is used to solve for a protective TDI for biota and a protective TDI for sediment based on a sediment concentration (the PRG) that results in an HQ of 1.

Similar to copper, due to the lack of a relationship between lead concentrations in surface sediment and polychaetes (see Figures 5-1 and 5-2, respectively), the risk-based PRG for lead is developed using the maximum lead concentration in polychaetes to calculate a $TDI_{polychaete}$ and back-calculating a SWAC-based sediment concentration (the PRG) from $TDI_{sediment}$ for a target HQ of 1. The $TDI_{polychaete}$ is calculated using Equation 4-5 and a maximum lead concentration of 0.23 mg/kg (ww) in polychaetes.

This results in a $TDI_{polychaete}$ = 0.11 mg/kg dw/day.

If the TDI for polychaetes is held constant, the sediment contaminant concentration ($C_{sediment}$) can be solved for using Equation 4-6 for $TDI_{sediment}$ simultaneously with Equations 2-1, 2-2, and 4-5 for a target HQ of 1.

This results in a dw sediment concentration (the PRG) of 340 mg/kg.[7] Again, because spotted sandpiper forage in the intertidal zone only, this PRG is only applicable to the intertidal zone, and because spotted sandpiper can forage throughout the intertidal zone, the PRG is considered to be SWAC-based.

[7] Note that the calculations are performed in Excel or IDL prior to rounding; therefore, calculation using the rounded values may result in slightly different outcomes.

These calculations are provided in Attachment B of this report (see Attachment Tables B7a through B7d).[8] A summary of the calculations is presented in Table 4-2, which for reference, also presents the baseline risk analyses from the BERA for the spotted sandpiper.

[8] Note that the target HQ is set at 0.9999 in Attachment B to calculate the sediment PRG.

6 Hydrocarbons

After a series of technical meetings, the NCG and USEPA agreed upon the use of PRGs for two classes of hydrocarbons, to be used together. A PRG for the C19-C36 aliphatic hydrocarbons (C19-C36) was set at 200 mg/kg, and a PRG for the total polycyclic aromatic hydrocarbon (34) (TPAH [34]) was set at 100 mg/kg. The derivation of these PRGs was included in a June 18, 2020 presentation by USEPA entitled *Newtown Creek Hydrocarbon Risk-Based PRG Derivation*. A modified version of this presentation (slides 4 through 8 have been removed, but no changes have been made to the other slides in the presentation) of USEPA's hydrocarbon PRG derivation is provided as Attachment C.

7 Recommendations

Based on the preceding analyses and technical agreements with USEPA, the following risk-based PRGs are proposed for use in the FS process:

- TPCB congener: a human health-based PRG SWAC = 0.30 mg/kg
- D/F TEQ (Mammal): a human health-based PRG SWAC = 18 ng/kg
- Copper: a mummichog-based PRG for a not-to-exceed = 490 mg/kg
- Lead: a spotted sandpiper-based PRG SWAC = 340 mg/kg (applied only to intertidal areas)
- Hydrocarbons: benthic invertebrate-based not-to-exceed PRGs for both C19-C36 aliphatics = 200 mg/kg and TPAH (34) = 100 mg/kg

Final cleanup goals will be developed during the FS and will consider site-specific background-based remedial goals in addition to risk-based remedial goals.

8 References

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Tables

Table 1-1
Development of Risk-Based Preliminary Remediation Goals

Contaminant Class	Receptor	Line of Evidence	Contaminant	Pre-Remedy Study Area-Wide BHHRA Cancer Risk or Noncancer HQ, or BERA HQ[1]	Pre-Remedy Study Area-Wide SWAC[a]	Post-Remedy Study Area-Wide PRG for a Target BHHRA and BERA HQ = 1	Post-Remedy PRG Basis	Post-Remedy Study Area-Wide BHHRA Cancer Risk for a Target Noncancer HQ = 1	Study Area Priority Locations Contributing to Exceedances
PCBs	**Human Health**								
	Recreational crabber	Dietary Intake (noncancer)	PCB congener TEQ (Mammal)	HQ = 20	5.9 mg/kg[b]	0.30 mg/kg[c]	SWAC	N/A	All Zones
	Recreational crabber	Dietary Intake (cancer)	PCB congener TEQ (Mammal)	Risk = 4 x 10^{-4}		N/A	N/A	Risk = 0.2 x 10^{-4} [o]	All Zones
	Recreational fisher white perch	Dietary Intake (noncancer)	Nondioxin-like PCB congener	HQ = 10		0.59 mg/kg[d]	SWAC	N/A	All Zones
	Recreational fisher white perch	Dietary Intake (cancer)	Nondioxin-like PCB congener/PCB TEQ	Risk = 1 x 10^{-4}		N/A	SWAC	Risk = 0.1 x 10^{-4} [p]	All Zones
	Recreational fisher striped bass	Dietary Intake (noncancer)	Nondioxin-like PCB congener	HQ = 20		0.30 mg/kg[e]	SWAC	N/A	All Zones
	Recreational fisher striped bass	Dietary Intake (cancer)	Nondioxin-like PCB congener	Risk = 2 x 10^{-4}		N/A	SWAC	Risk = 0.1 x 10^{-4} [q]	All Zones
	Ecological								
	Benthic macroinvertebrates	Tissue Residue	Total PCB congener	HQ < 1, 15		1.3 mg/kg[f]	Not to exceed	N/A	Turning Basin, English Kills
	Mummichog	Tissue Residue	Total PCB congener	HQ < 1, 9.2		0.64 mg/kg[g]	SWAC	N/A	Dutch Kills
	Blue crab	Tissue Residue	Total PCB congener	HQ < 1, 8.8			SWAC	N/A	All Zones (Dutch Kills, Turning Basin, English Kills)
	Striped bass	Tissue Residue	Total PCB congener	HQ < 1, 4.0			SWAC	N/A	All Zones
	Bivalves	Tissue Residue	Total PCB congener	HQ < 1, 3.9			SWAC	N/A	Maspeth Creek, Turning Basin, English Kills
	Green heron	Dietary Intake	Total PCB congener	HQ = 2.3		1.5 mg/kg[h]	SWAC	N/A	Dutch Kills
	Belted kingfisher	Dietary Intake	Total PCB congener	HQ = 1.8		1.5 mg/kg[h]	SWAC	N/A	Dutch Kills
	Black-crowned night heron	Dietary Intake	Total PCB congener	HQ = 1.7		2.0 mg/kg[h]	SWAC	N/A	Dutch Kills
	Spotted sandpiper	Dietary Intake	Total PCB congener	HQ = 1.7		31 mg/kg[h]	SWAC	N/A	Dutch Kills
Dioxin/Furan	**Human Health**								
	Recreational crabber	Dietary Intake (noncancer)	Total D/F congener TEQ (Mammal)	HQ = 8	140 ng/kg	18 ng/kg[i]	SWAC	N/A	All Zones
	Recreational crabber	Dietary Intake (cancer)	Total D/F congener TEQ (Mammal)	Risk = 2 x 10^{-4}		N/A	SWAC	Risk = 0.25 x 10^{-4} [r]	All Zones
	Ecological								
	Striped bass	Tissue Residue	Total D/F congener TEQ (Fish)	HQ < 1, 2.8		50 ng/kg[j]	SWAC	N/A	Dutch Kills, Fish Sampling Zone 3, English Kills
	Striped bass	Tissue Residue	2,3,7,8-TCDD	HQ < 1, 1.7			SWAC	N/A	Fish Sampling Zone 3, English Kills
Metals	**Ecological**								
	Mummichog	Tissue Residue	Copper	HQ < 1, 2.1	1,300 mg/kg	N/A[k]	N/A	N/A	All Zones
	Blue crab	Tissue Residue	Copper	HQ < 1, 1.6			N/A	N/A	All Zones
	Mummichog	Dietary Intake	Copper	HQ = 1.2		490 mg/kg[l]	Not to exceed	N/A	Maspeth Creek, East Branch, English Kills, Turning Basin
	Spotted sandpiper	Dietary Intake	Copper	HQ = 1.04		1,150 mg/kg[m]	SWAC	N/A	Maspeth Creek
Metals	Spotted sandpiper	Dietary Intake	Lead	HQ = 1.6	430 mg/kg	340 mg/kg[n]	SWAC	N/A	Dutch Kills, Maspeth Creek, English Kills

Table 1-1
Development of Risk-Based Preliminary Remediation Goals

Notes:

1 = For the tissue residue line of evidence, the first HQ is based on a Newtown Creek Group CBR, and the second HQ is based on a USEPA Region 2 CBR.

a = Pre-remedy SWAC Study Area-wide calculated from the Thiessen polygons used in the chemical fate initial conditions model and includes the FS shoreline sampling data and sediment characterization study data.

b = Pre-remedy SWAC for total PCB congeners used as the pre-remedy SWAC for PCB congener TEQ (mammal) and nondioxin-like PCB congeners, because they are closely correlated. For the same reason, post-remedy risk-based PRGs are developed for total PCB congeners.

c = Approximate post-remedy Study Area-wide SWAC for total PCB congeners needed to reach a target HQ of 1 based on PCB congener TEQ (Mammal) in blue crab (see BHHRA Table 6-29).

d = Approximate post-remedy Study Area-wide SWAC for total nondioxin-like PCB congeners needed to reach a target HQ of 1 based on PCB congener TEQ (Mammal) in white perch (see BHHRA Table 6-21).

e = Approximate post-remedy Study Area-wide SWAC for total PCB congeners needed to reach a target HQ of 1 based on PCB congener TEQ (Mammal) in striped bass (see BHHRA Table 6-13).

f = Approximate post-remedy not-to-exceed value based on a Study Area-wide BSAF of 0.02 (see BERA Table 11-12d), and highly uncertain USEPA Region 2 tissue LOEC CBR for invertebrates of 0.026 mg/kg (0.026 mg/kg ÷ 0.02 = 1.3 mg/kg).

g = Post-remedy SWAC based on highest tissue residue HQ of 9.2 for total PCB congeners in mummichog.

h = Post-remedy SWAC for PCBs based on bird dietary intake using a Study Area BSAF of 0.02 for polychaete-based TDI and a SWAC BSAF of 0.82 for mummichog-based TDI for a target HQ = 1.

i = Approximate post-remedy Study Area-wide SWAC for total D/F congeners needed to reach a target HQ of 1 based on total D/F congener TEQ (Mammal) in blue crab (see BHHRA table 6-29); this HQ is also protective of human health exposure to D/Fs from the consumption of striped bass and white perch.

j = Post-remedy SWAC based on highest tissue residue HQ of 2.8 for total D/F congener (TEQ) (Fish) for striped bass.

k = There is no statistical relationship between copper in mummichog or blue crab tissue and sediment; therefore, a sediment copper PRG based on tissue residue cannot be validated as a risk threshold.

l = Post-remedy not-to-exceed for copper based on dietary intake for mummichog and target HQ = 1 (modeled mummichog diet is based on 100% polychaetes and incidental ingestion of sediment at 1%) (see BERA Table 10-7).

m = Post-remedy SWAC for copper (intertidal areas only) based on dietary intake for spotted sandpiper and target HQ = 1 (modeled spotted sandpiper diet based on 100% polychaetes and incidental ingestion of sediment at 16%) (see BERA Table 11-10b).

n = Post-remedy SWAC for lead (intertidal areas only) based on dietary intake for spotted sandpiper and target HQ = 1 (modeled spotted sandpiper diet based on 100% polychaetes and incidental ingestion of sediment at 16%) (see BERA Table 11-10b).

o = A 20-fold reduction in post-remedy cancer risk for total PCB congeners TEQ (Mammal) in blue crab following a post-remedy reduction of the noncancer HQ from 20 to 1 (see BHHRA Table 6-30 for blue crab cancer risk levels).

p = A 10-fold reduction in post-remedy cancer risk for total nondioxin-like PCB congeners and total PCB congeners TEQ (Mammal) in white perch following a post-remedy reduction of the noncancer HQ from 10 to 1 (see BHHRA Table 6-22 for white perch cancer risk levels).

q = A 20-fold reduction in post-remedy cancer risk for total nondioxin-like PCB congeners in striped bass following a post-remedy reduction of the noncancer HQ from 20 to 1 (see BHHRA Table 6-14 for striped bass cancer risk levels).

r = An 8-fold reduction in post-remedy cancer risk for total D/F congener TEQ (Mammal) in blue crab following a post-remedy reduction of the noncancer HQ from 8 to 1 (see BHHRA Table 6-30 for blue crab cancer risk levels); this post-remedy cancer risk is also protective of cancer risk due to D/Fs from the consumption of striped bass and white perch.

Abbreviations:
2,3,7,8-TCDD: 2,3,7,8-tetrachlorodibenzo-p-dioxin
BERA: *Baseline Ecological Risk Assessment*
BHHRA: *Baseline Human Health Risk Assessment*
BSAF: biota-sediment accumulation factor
CBR: critical body residue
D/F: dioxin/furan
FS: Feasibility Study
HQ: hazard quotient
LOEC: lowest observed effect concentration
mg/kg: milligrams per kilogram
N/A: not applicable
ng/kg: nanograms per kilogram
PCB: polychlorinated biphenyl
PRG: preliminary remediation goal
SWAC: surface-weighted average concentration
TDI: total daily intake
TEQ: toxic equivalence quotient
USEPA: U.S. Environmental Protection Agency

Table 2-1
Total PCBs Preliminary Remediation Goals: Avian Dietary Pathway

Analysis	Exposure Area	Chemical	Sediment Concentration	Units	Sediment Metric	Sediment TDI	Polychaete TDI	Adjusted Polychaete 95% UCL TDI (0.1 Diet Fraction; mg/kg per day)	Adjusted Mummichog 95% UCL TDI (0.9 Diet Fraction; mg/kg per day)	Adjusted Atlantic Menhaden 95% UCL TDI (0.5 Diet Fraction; mg/kg per day)	Adjusted Mummichog 95% UCL TDI (0.5 Diet Fraction; mg/kg per day)	Water TDI[a]	Sum TDI	LOAEL Value	HQ	Notes
Spotted Sandpiper																
BERA Baseline Risk Analyses[b]	All, Intertidal	Total PCBs	54	mg/kg, dry	95% Chebyshev (Mean, Sd) UCL	5.1E-01	5.0E-01	N/A	N/A	N/A	N/A	9.8E-07	1.00E+00	0.58	1.7E+00	95% UCL used to calculate tissue TDI in the BERA.
Estimated Sediment PRG for target HQ = 1[c]	All, Intertidal	Total PCBs	31	mg/kg, dry	Spotted Sandpiper SWAC	2.9E-01	2.8E-01	N/A	N/A	N/A	N/A	9.8E-07	5.7E-01	0.58	9.9E-01[d]	Based on BSAF for polychaete of 0.02.
Black-Crowned Night Heron																
BERA Baseline Risk Analyses[b]	All, Intertidal	Total PCBs	54	mg/kg, dry	95% Chebyshev (Mean, Sd) UCL	7.9E-02	N/A	4.1E-02	8.8E-01	N/A	N/A	4.7E-07	1.0E+00	0.58	1.7E+00	95% UCL used to calculate tissue TDI in the BERA.
Estimated Sediment PRG for target HQ = 1[c]	All, Intertidal	Total PCBs	2.0	mg/kg, dry	Black-Crowned Night Heron SWAC	3.0E-03	N/A	1.5E-03	5.7E-01	N/A	N/A	4.7E-07	5.8E-01	0.58	9.9E-01[d]	Based on BSAF for polychaetes of 0.02 and BSAF for mummichog of 0.82.
Green Heron																
BERA Baseline Risk Analyses[b]	All, Intertidal	Total PCBs	54	mg/kg, dry	95% Chebyshev (Mean, Sd) UCL	1.0E-01	N/A	5.5E-02	1.2E+00	N/A	N/A	6.2E-07	1.3E+00	0.58	2.3E+00	95% UCL used to calculate tissue TDI in the BERA.
Estimated Sediment PRG for target HQ = 1[c]	All, Intertidal	Total PCBs	1.5	mg/kg, dry	Green Heron SWAC	3.0E-03	N/A	1.5E-03	5.7E-01	N/A	N/A	6.2E-07	5.8E-01	0.58	9.9E-01[d]	Based on BSAF for polychaetes of 0.02 and BSAF for mummichog of 0.82.
Belted Kingfisher																
BERA Baseline Risk Analyses[b]	All	Total PCBs	12	mg/kg, dry	95% Chebyshev (Mean, Sd) UCL	1.0E-02	N/A	N/A	N/A	1.5E-01	8.9E-01	7.9E-07	1.1E+00	0.58	1.8E+00	95% UCL used to calculate tissue TDI in the BERA.
Estimated Sediment PRG for target HQ = 1[c]	All	Total PCBs	1.5	mg/kg, dry	Belted Kingfisher SWAC	1.3E-03	N/A	N/A	N/A	1.5E-01	4.2E-01	7.9E-07	5.7E-01	0.58	9.9E-01[d]	Based BSAF for mummichog of 0.82. Atlantic menhaden TDI same as that used in the BERA because it is a pelagic fish.

Notes:
95% UCL: 95% upper confidence limit of the mean
Avian dietary evaluation uses the dietary intake models and exposure parameters for avian receptors presented in the BERA (Anchor QEA 2018).
a: Total daily intake for water.
b: Copy of the BERA Baseline Risk Analyses. See BERA Table 11-10b for details on the dietary model and the exposure parameters for each receptor and Table 11-11a for the LOAELs.
c: Back-calculation of a sediment concentration (estimated PRG) for a target HQ = 1 (set just under 1 for the calculation). Dietary doses calculated based on a BSAF of 0.02 for polychaete (see BERA Figure 11-3) and a BSAF for mummichog of 0.82 calculated from a Study Area-wide PCB SWAC and Study Area-wide 95% UCL PCB mummichog tissue concentration (see notes column).
d: The target HQ is set just under 1 for the PRG back-calculation.

Abbreviations:
BERA: *Baseline Ecological Risk Assessment*
BSAF: biota-sediment accumulation factor
HQ: hazard quotient
LOAEL: lowest observed adverse effect level
mg/kg: milligram per kilogram
N/A: not applicable
PCB: polychlorinated biphenyl
Sd: standard deviation
SWAC: surface weighted average concentration
TDI: total daily intake
UCL: upper confidence limit of the mean

Source:
Anchor QEA (Anchor QEA), 2018. *Baseline Ecological Risk Assessment* . Remedial Investigation/Feasibility Study, Newtown Creek. October 2018.

Table 4-1
Copper Preliminary Remediation Goals: Mummichog Dietary Pathway

Analysis	Exposure Area	Chemical	Sediment Concentration (mg/kg)	Sediment Units	Sediment Metric	Sediment TDI	Polychaete TDI	Sum TDI	LOAEL Value	HQ	Notes
Estimated Sediment PRG for target HQ = 1[a]	Study Area	Copper	490	mg/kg, dry	Back-calculated sediment concentration for a target HQ = 1	9.60E-02	0.41	5.02E-01	0.48	1.0E+00	Maximum used to calculate the TDI for the PRG

Notes:
Mummichog dietary evaluation uses the dietary intake model and exposure parameters for mummichog presented in the SLERA (Anchor QEA 2018).
a: Back-calculation of a sediment concentration (estimated PRG) for a target HQ = 1. Given the lack of spatial variability in tissue copper concentrations for polychaetes (see BERA Appendix A12a for tissue data), tissue concentrations held constant at the maximum for calculation of the tissue TDIs. See BERA Appendix A13b for polychaete input files used in calculation of the BERA TDIs.

Abbreviations:
BERA: *Baseline Ecological Risk Assessment*
HQ: hazard quotient
LOAEL: lowest observed adverse effect level
mg/kg: milligram per kilogram
PRG: preliminary remediation goal
SLERA: screening level ecological risk assessment
TDI: total daily intake

Source:
Anchor QEA (Anchor QEA), 2018. *Baseline Ecological Risk Assessment* . Remedial Investigation/Feasibility Study, Newtown Creek. October 2018.

Table 4-2
Copper and Lead Preliminary Remediation Goals: Spotted Sandpiper Dietary Pathway

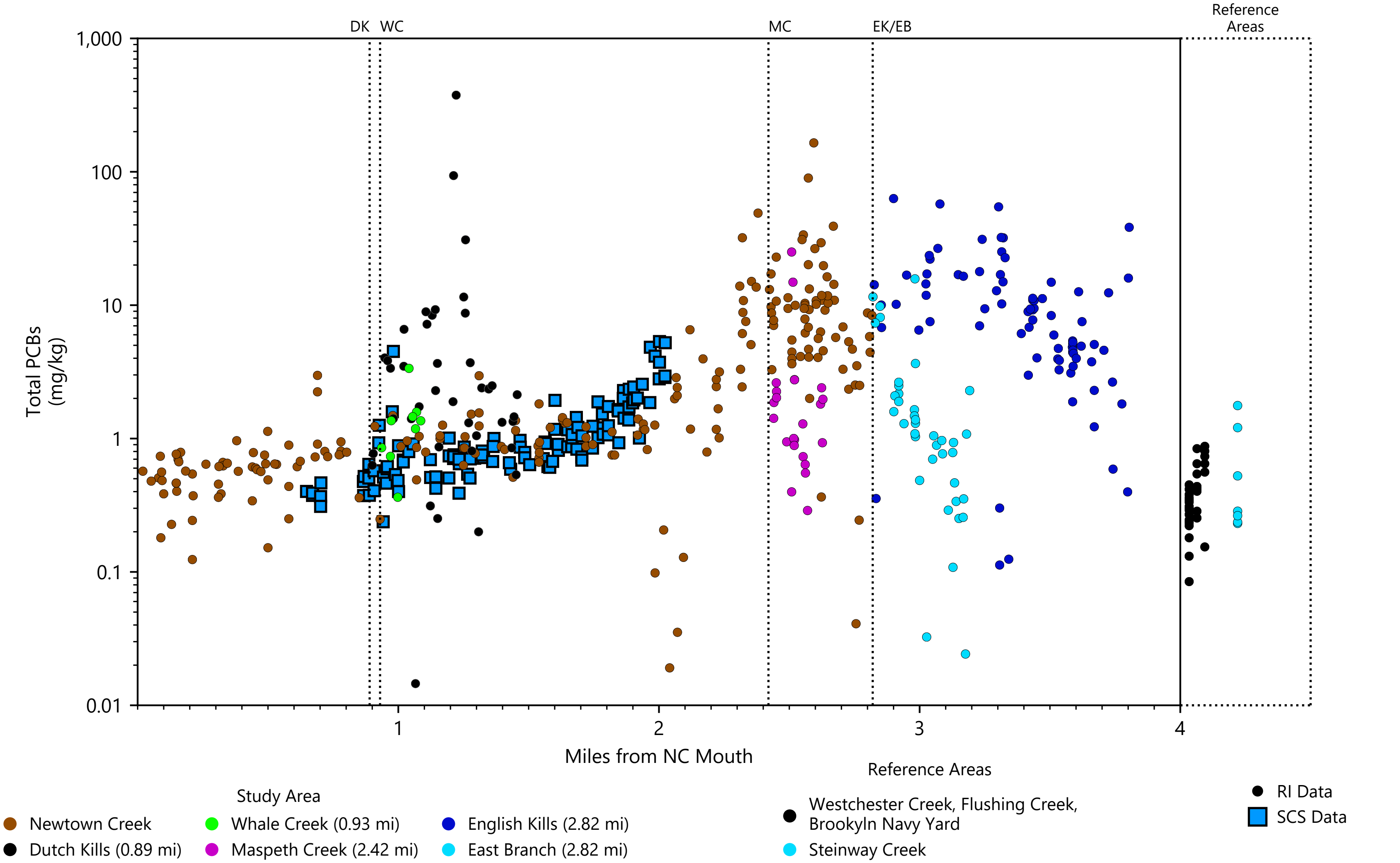
Analysis	Exposure Area	Chemical	Sediment Concentration (mg/kg)	Sediment Units	Sediment Metric	Sediment TDI	Polychaete TDI	Water TDI	Sum, TDI	LOAEL Value	HQ	Notes
BERA Baseline Risk Analyses[a]	All	Copper	1,250	mg/kg, dry	95% Chebyshev (Mean, Sd) UCL	1.18E+01	8.00E-01	4.60E-04	1.26E+01	12.1	1.0E+00	95% UCL used to calculate tissue and water TDI in the BERA.
Estimated Sediment PRG for target HQ = 1[b]	All	Copper	1,150	mg/kg, dry	Sediment to have HQ <1	1.08E+01	1.22E+00	4.60E-04	1.20E+01	12.1	9.9E-01[c]	Maximum used to calculate the tissue TDI and 95% UCL used to calculate the water TDI.
BERA Baseline Risk Analyses[a]	All	Lead	530	mg/kg, dry	95% Chebyshev (Mean, Sd) UCL	4.98E+00	7.50E-02	1.80E-04	5.06E+00	3.26	1.6E+00	95% UCL used to calculate tissue and water TDI in the BERA.
Estimated Sediment PRG for target HQ = 1[b]	All	Lead	340	mg/kg, dry	Sediment to have HQ <1	3.15E+00	1.03E-01	1.80E-04	3.25E+00	3.26	9.9E-01[c]	Maximum used to calculate the tissue TDI and 95% UCL used to calculate the water TDI.

Notes:
95% UCL: 95% upper confidence limit of the mean
Spotted sandpiper dietary evaluation uses the dietary intake model and exposure parameters for spotted sandpipers presented in the BERA (Anchor QEA 2018).
a: Copy of the BERA Baseline Risk Analyses. Polychaetes represent 100% of the TDI with incidental sediment ingestion set at 16% of dietary intake (see BERA Table 11-10b for details on the dietary model and the exposure parameters, and Table 11-11a for the LOAELs)
b: Back-calculation of a sediment concentration (estimated PRG) for a target HQ = 1 (set just under 1 for the calculation). Given the lack of spatial variability in tissue copper and lead concentrations for polychaetes (see BERA Appendix A12a for tissue data), tissue concentrations held constant at the maximum for calculation of the tissue TDIs.
c: The target HQ is set just under 1 for the PRG back-calculation.

Abbreviations:
BERA: *Baseline Ecological Risk Assessment*
HQ: hazard quotient
LOAEL: lowest observed adverse effect level
mg/kg: milligram per kilogram
PRG: preliminary remediation goal
Sd: standard deviation
TDI: total daily intake
UCL: upper confidence limit of the mean

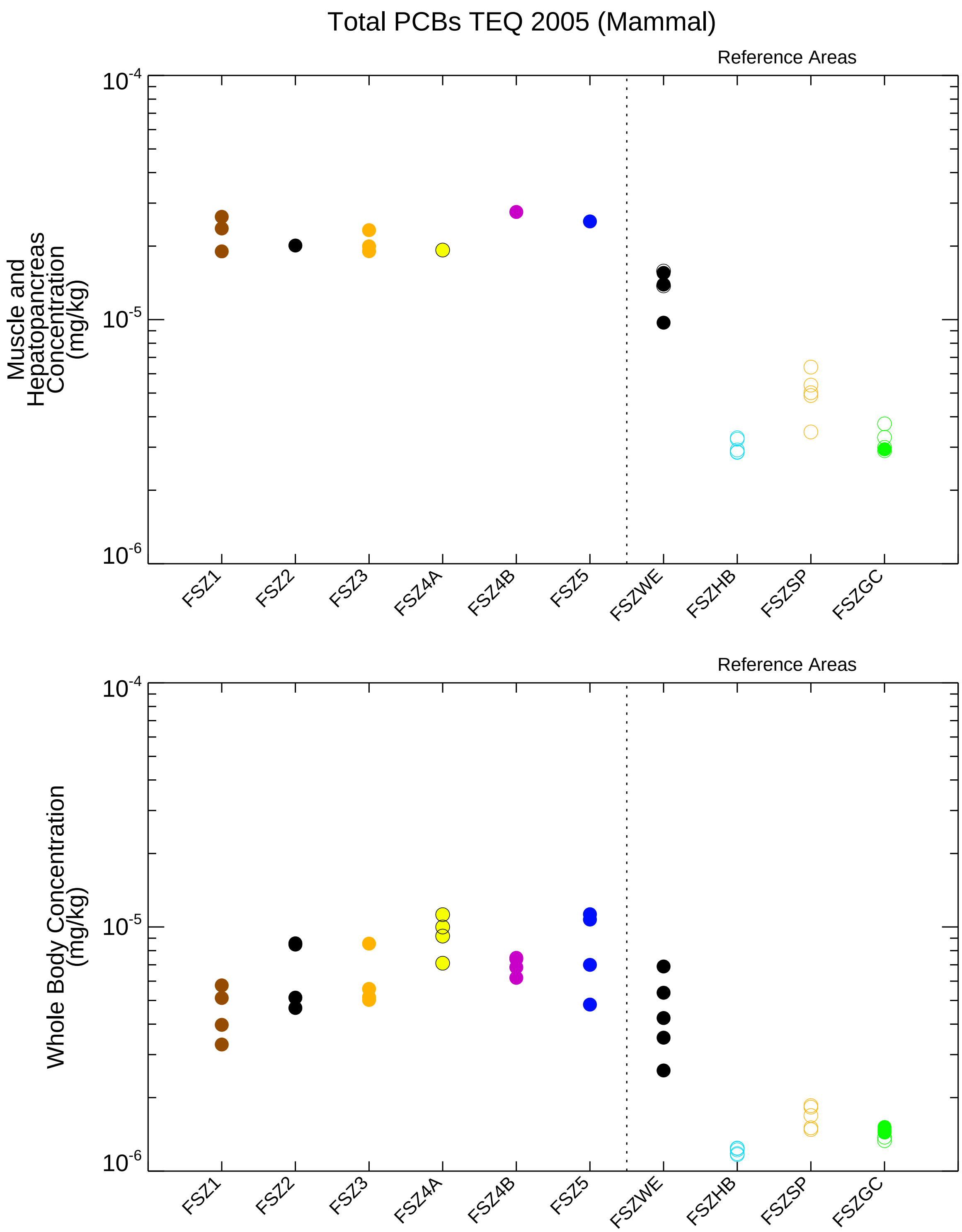
Source:
Anchor QEA (Anchor QEA), 2018. *Baseline Ecological Risk Assessment* . Remedial Investigation/Feasibility Study, Newtown Creek. October 2018.

Figures



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Depth range for surface sediment is 0 to 15 cm.
Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek.
Caret symbols and numbers above or below panel indicate the number of values outside y-axis range.
Only a subset of reference areas are shown: Westchester Creek, Brooklyn Navy Yard, Flushing Creek, and Steinway Creek.

Figure 2-1
Total PCBs in Surface Sediment



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).

- Fish Zone 1
- Fish Zone 2
- Fish Zone 3
- Fish Zone 4a
- Fish Zone 4b
- Fish Zone 5
- Westchester Creek (Ind/CSO)
- Head of Bay (Ind/Non-CSO)
- Spring Creek (Non-Ind/CSO)
- Gerritsen Creek (Non-Ind/Non-CSO)

Publish Date: 11/27/2019 14:41 | User: mk/lhb
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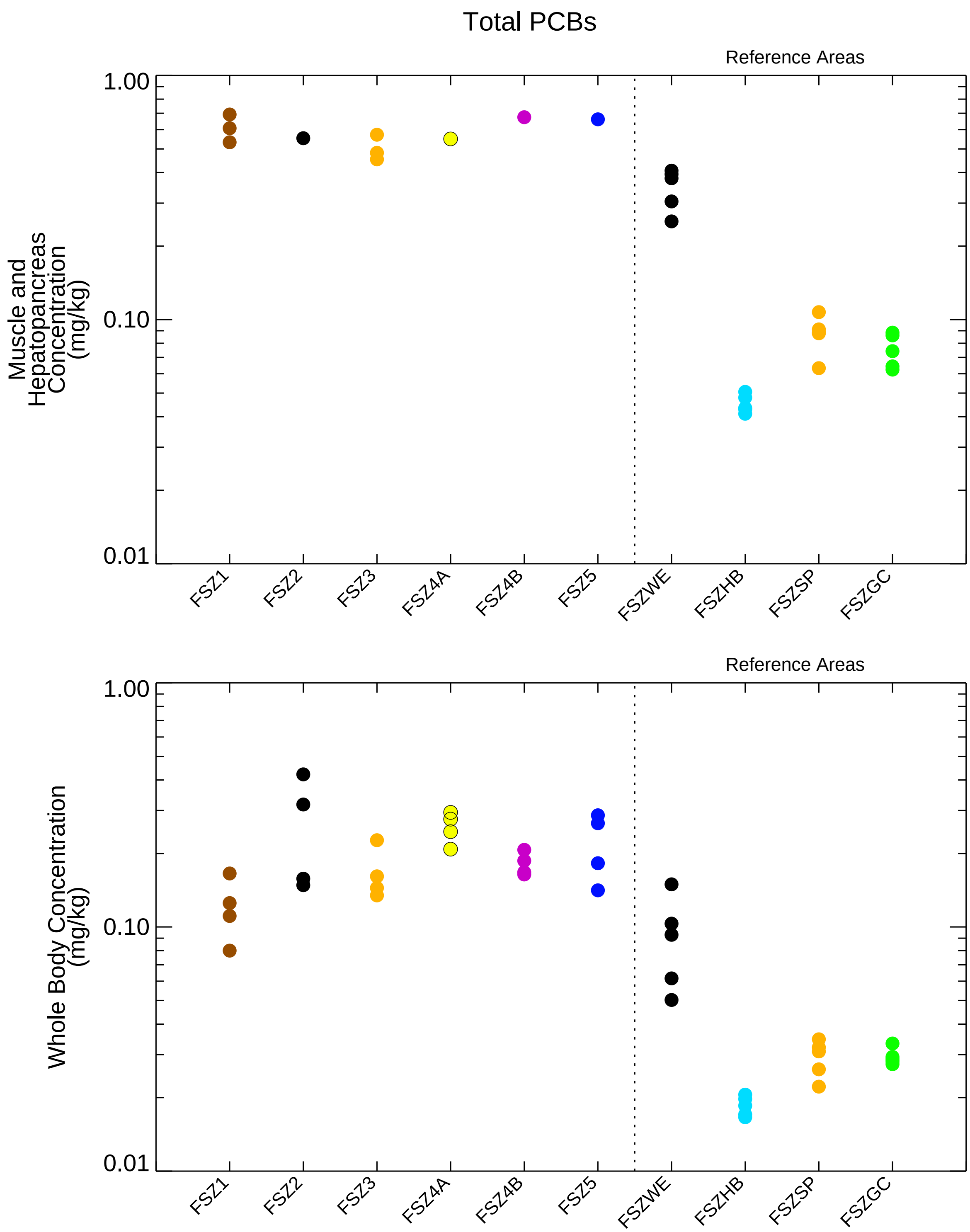
ANCHOR QEA

Figure 2-2

Total PCBs TEQ 2005 (Mammal) in Blue Crab Muscle + Hepatopancreas and Whole Body Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2 FishCrab wKM 20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).

- Fish Zone 1
- Fish Zone 2
- Fish Zone 3
- Fish Zone 4a
- Fish Zone 4b
- Fish Zone 5
- Westchester Creek (Ind/CSO)
- Head of Bay (Ind/Non-CSO)
- Spring Creek (Non-Ind/CSO)
- Gerritsen Creek (Non-Ind/Non-CSO)

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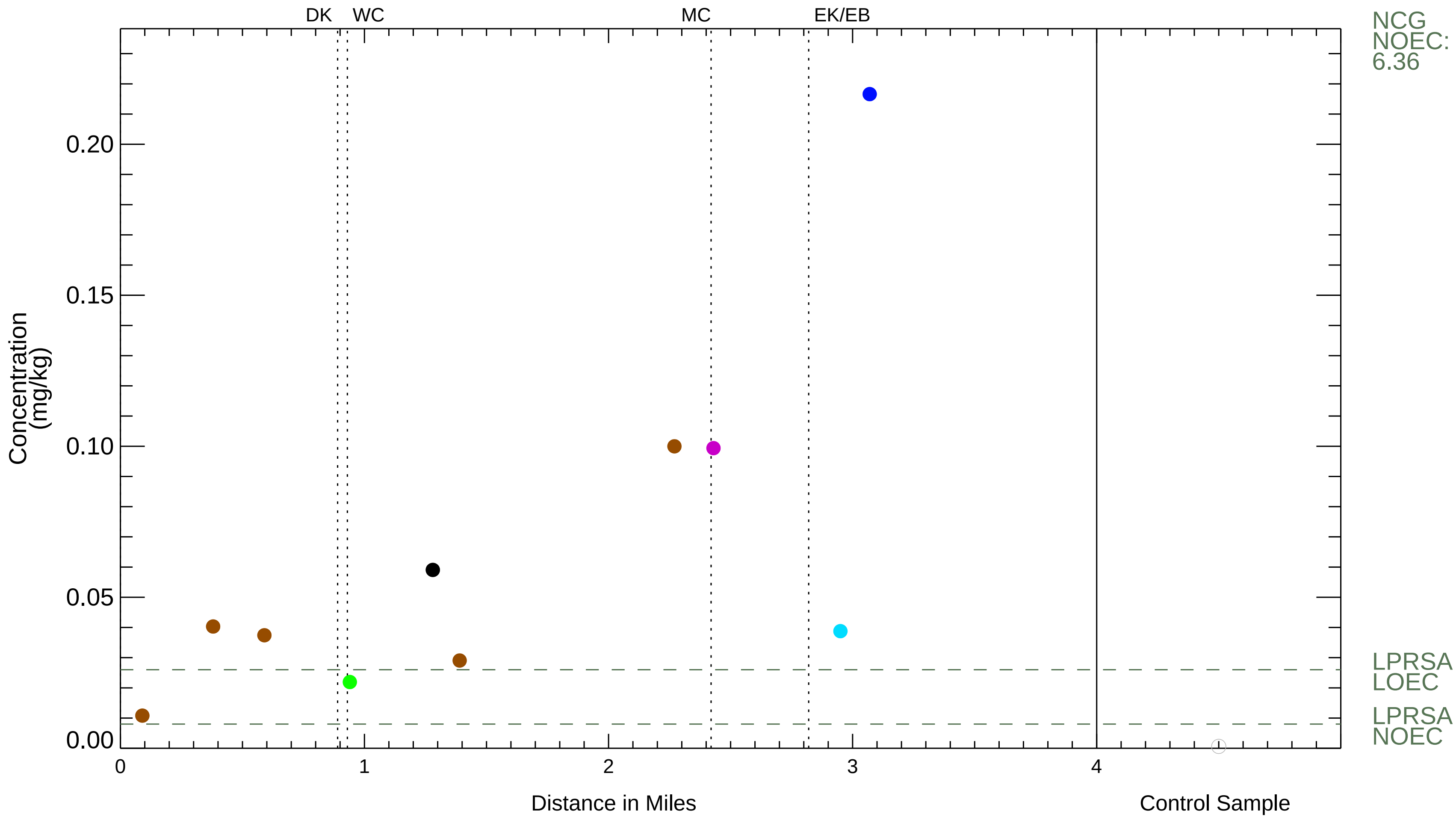
Figure 2-3
Total PCBs in Blue Crab Muscle + Hepatopancreas and Whole Body Tissue
Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek. LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration. NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

- Newtown Creek
- Dutch Kills
- Whale Creek
- Maspeth Creek
- English Kills
- East Branch
- Control Sample

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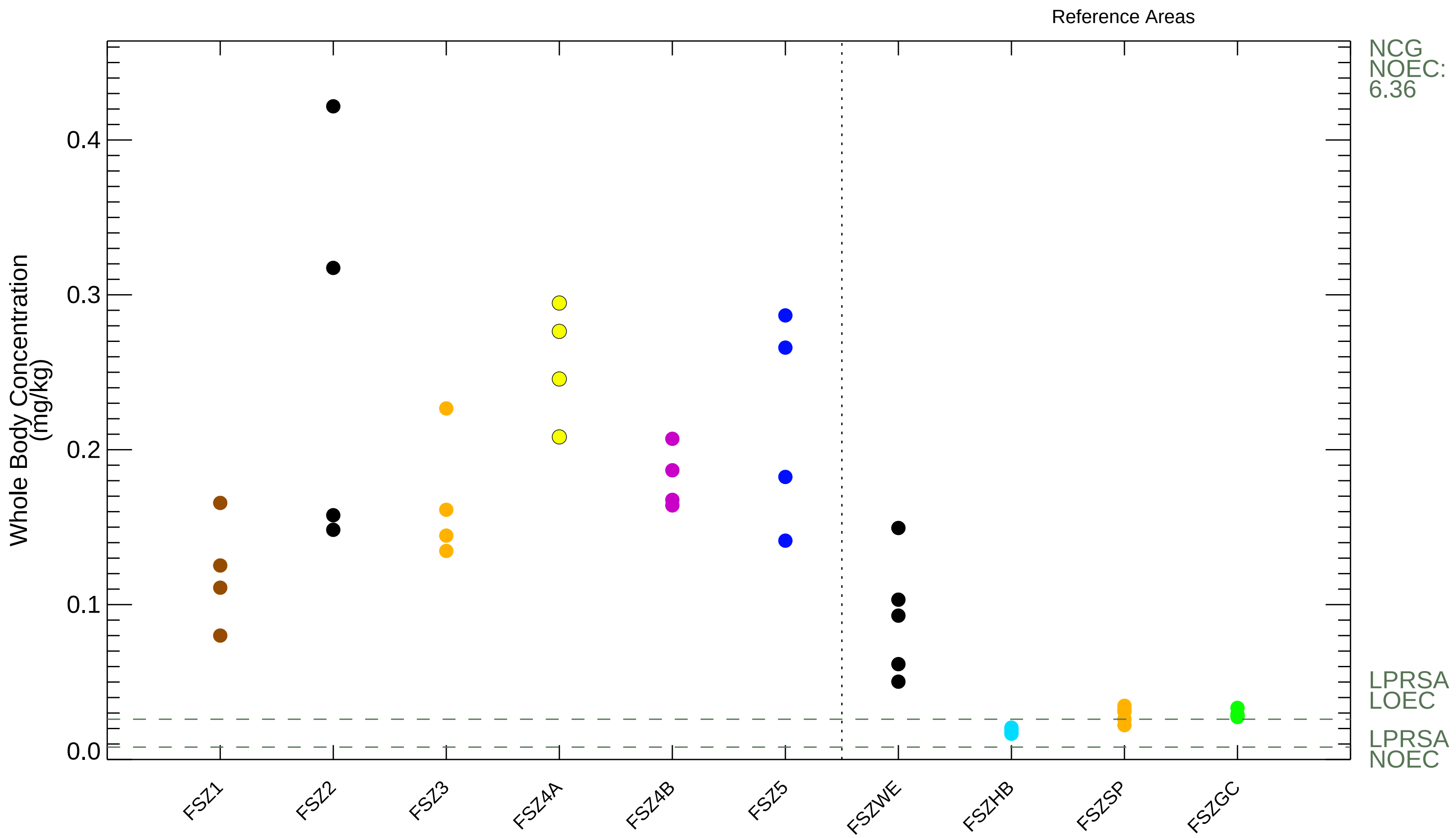
Figure 2-4

Total PCBs in Caged Bivalve Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_Bivalves_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).
LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration.
NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

● Fish Zone 1
● Fish Zone 2
● Fish Zone 3
● Fish Zone 4a
● Fish Zone 4b
● Fish Zone 5
● Westchester Creek (Ind/CSO)
● Head of Bay (Ind/Non-CSO)
● Spring Creek (Non-Ind/CSO)
● Gerritsen Creek (Non-Ind/Non-CSO)

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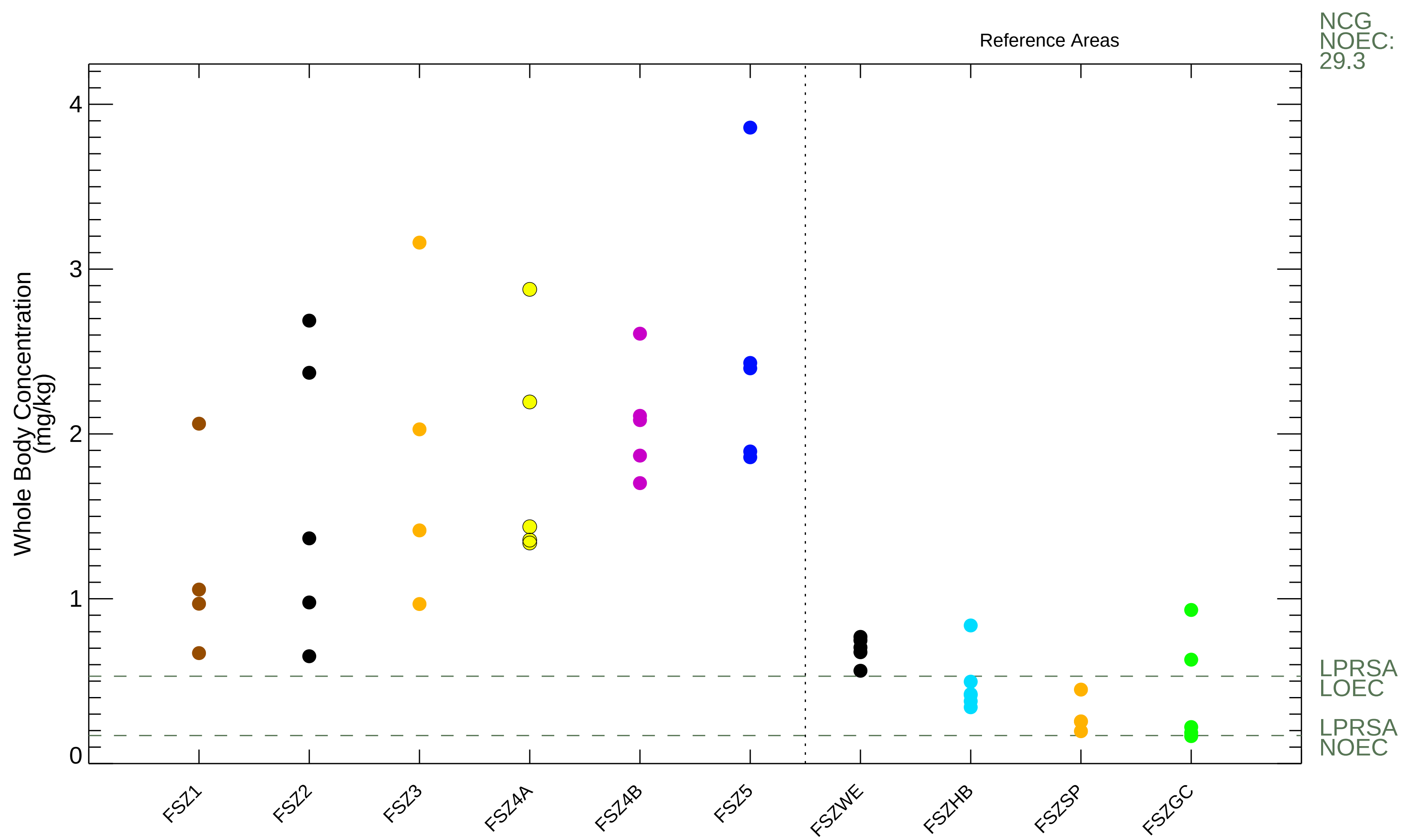
Figure 2-5

Total PCBs in Blue Crab Whole Body Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).
LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration.
NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

Fish Zone 1
Fish Zone 2
Fish Zone 3
Fish Zone 4a
Fish Zone 4b
Fish Zone 5
Westchester Creek (Ind/CSO)
Head of Bay (Ind/Non-CSO)
Spring Creek (Non-Ind/CSO)
Gerritsen Creek (Non-Ind/Non-CSO)

Publish Date: 12/02/2019 12:20 | User: mk
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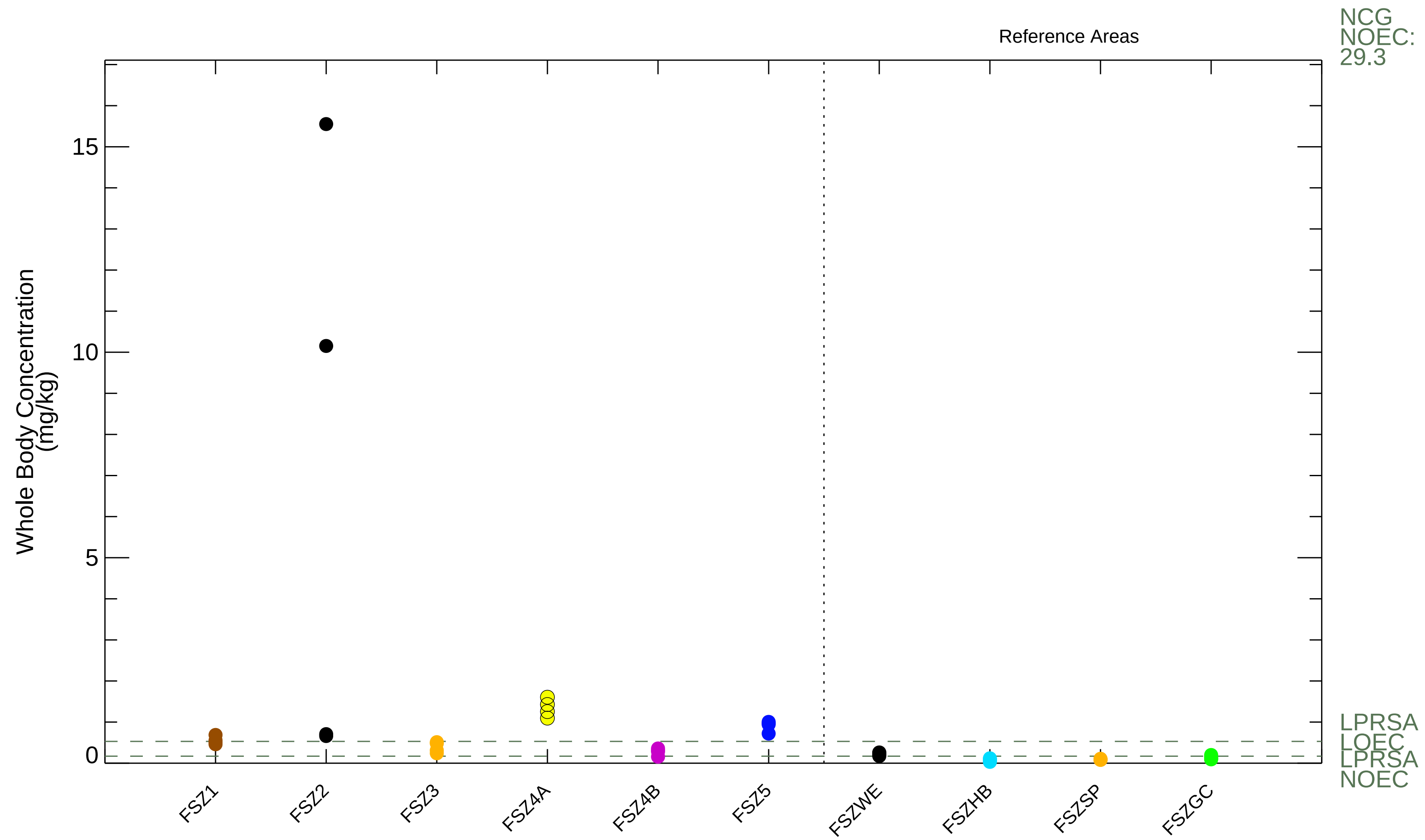
Figure 2-6
Total PCBs in Striped Bass Whole Body Tissue
Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).
LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration.
NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

Fish Zone 1
Fish Zone 2
Fish Zone 3
Fish Zone 4a
Fish Zone 4b
Fish Zone 5
Westchester Creek (Ind/CSO)
Head of Bay (Ind/Non-CSO)
Spring Creek (Non-Ind/CSO)
Gerritsen Creek (Non-Ind/Non-CSO)

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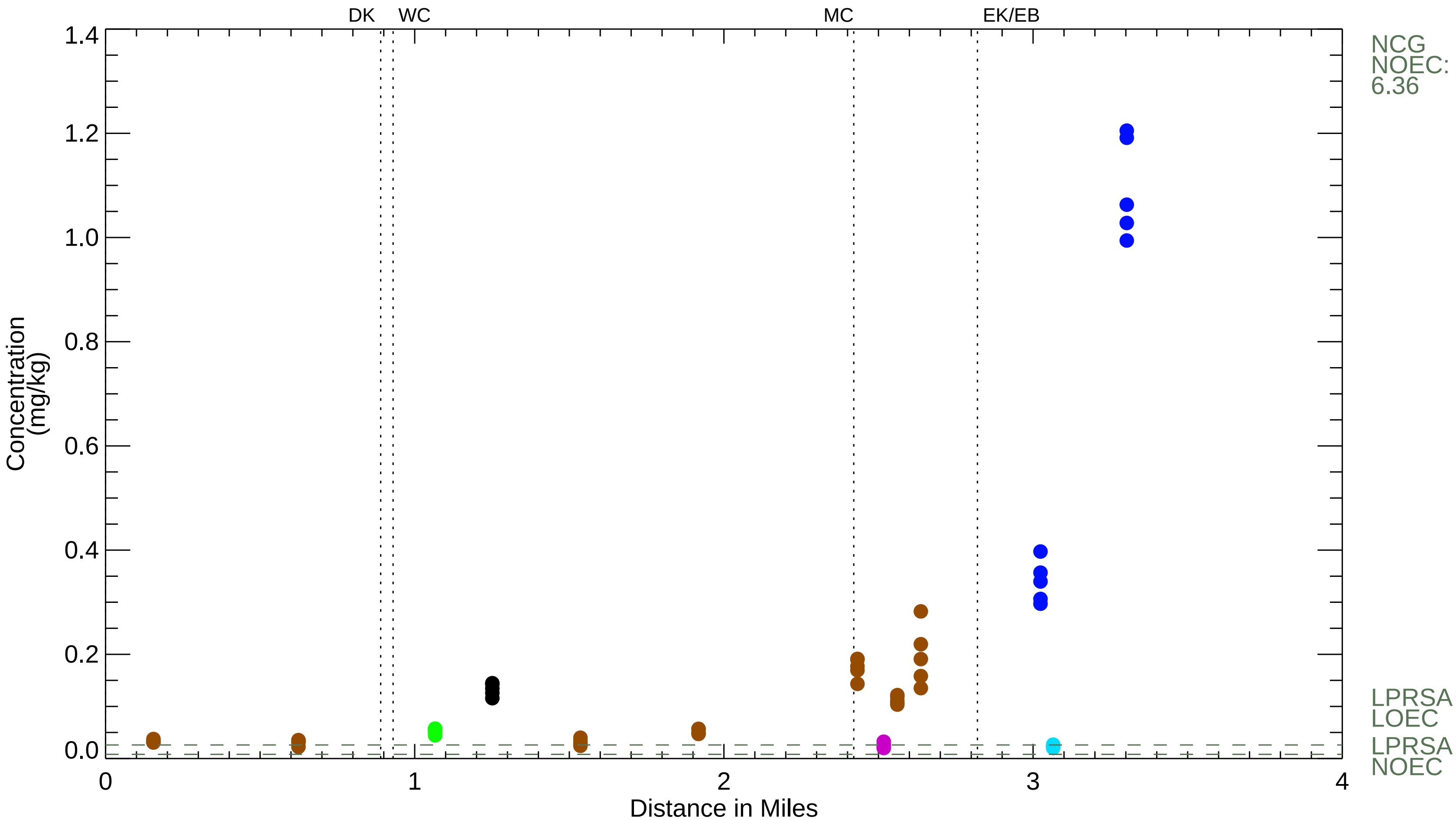
Figure 2-7
Total PCBs in Mummichog Tissue
Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek. LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration. NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

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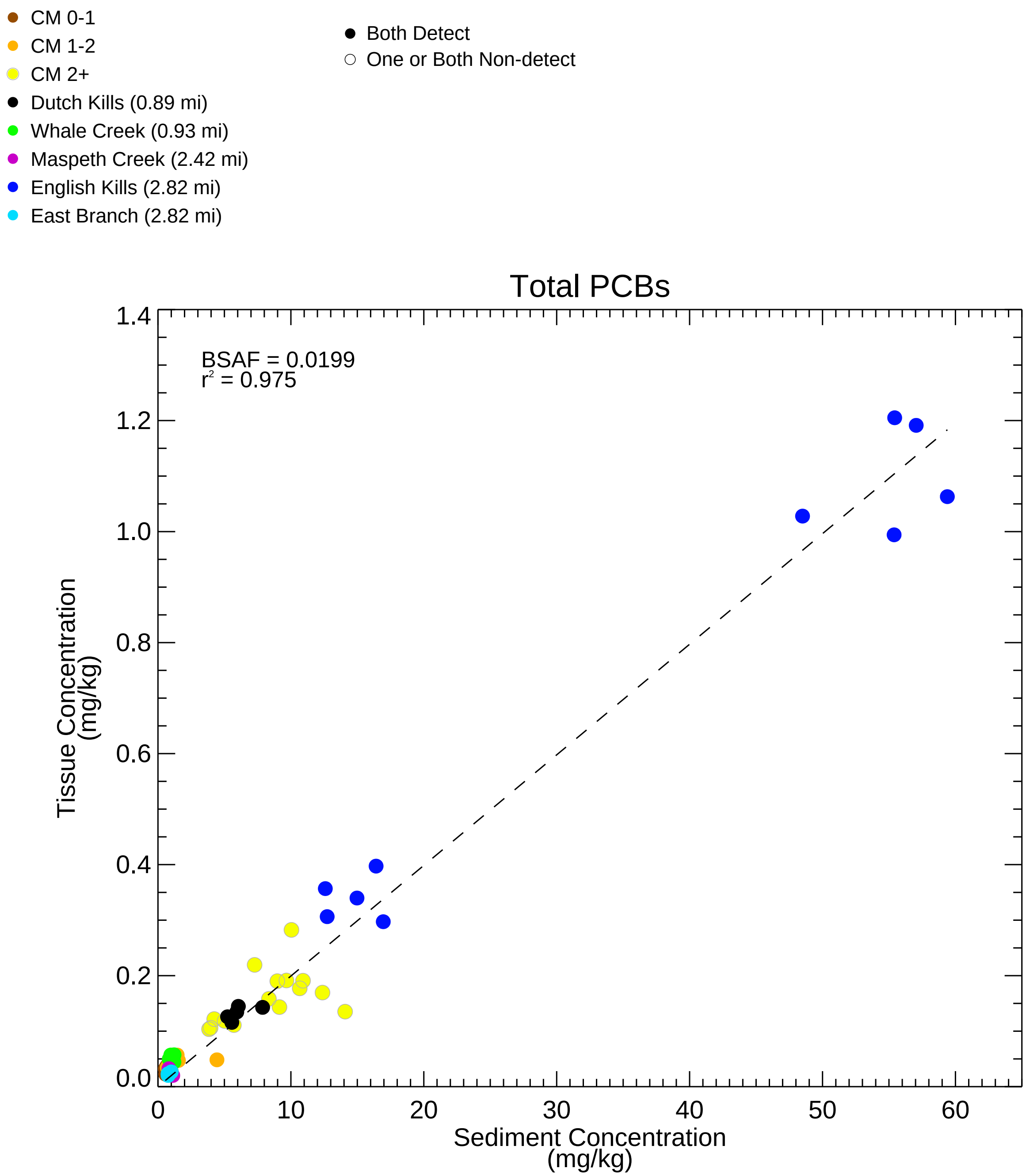
Figure 2-8

Total PCBs in Polychaete Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_Bioaccumulation_wKM_20161222.bin



Notes: Non-detects included at method detection limit and plotted with an open symbol.
Sediment plotted on a dry-weight basis, tissue plotted on a wet-weight basis. BSAF calculated as regression with intercept forced through zero.

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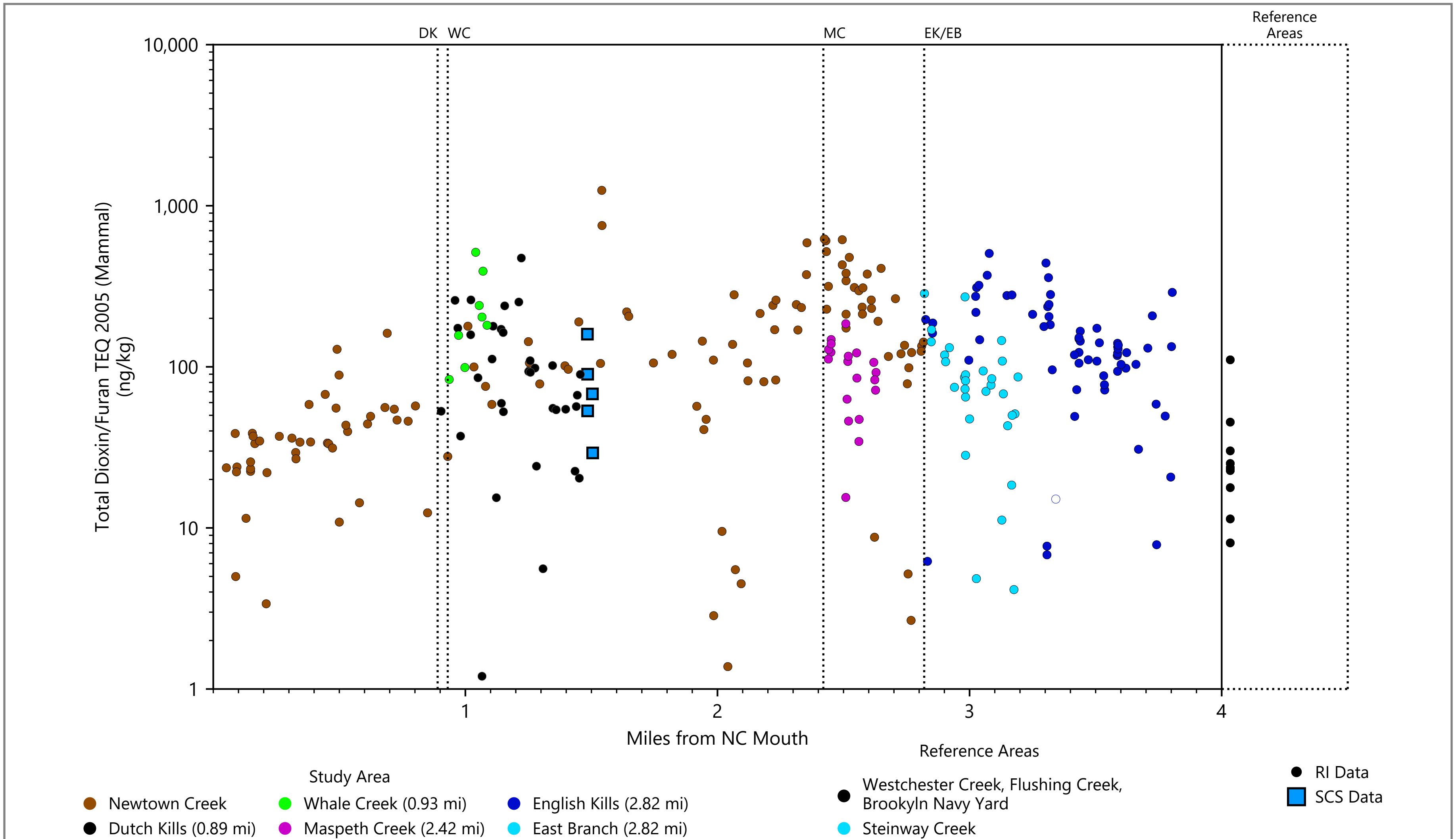
Figure 2-9

Relationship Between Study Area Sediment and Polychaete Tissue Data - Total PCBs

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Depth range for surface sediment is 0 to 15 cm.
Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek.
Caret symbols and numbers above or below panel indicate the number of values outside y-axis range.
Only a subset of reference areas are shown: Westchester Creek, Brooklyn Navy Yard, Flushing Creek, and Steinway Creek.

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Figure 3-1
Total Dioxin/Furan TEQ 2005 (Mammal) in Surface Sediment
Development of Risk-Based Preliminary Remediation Goals
Newtown Creek RI/FS

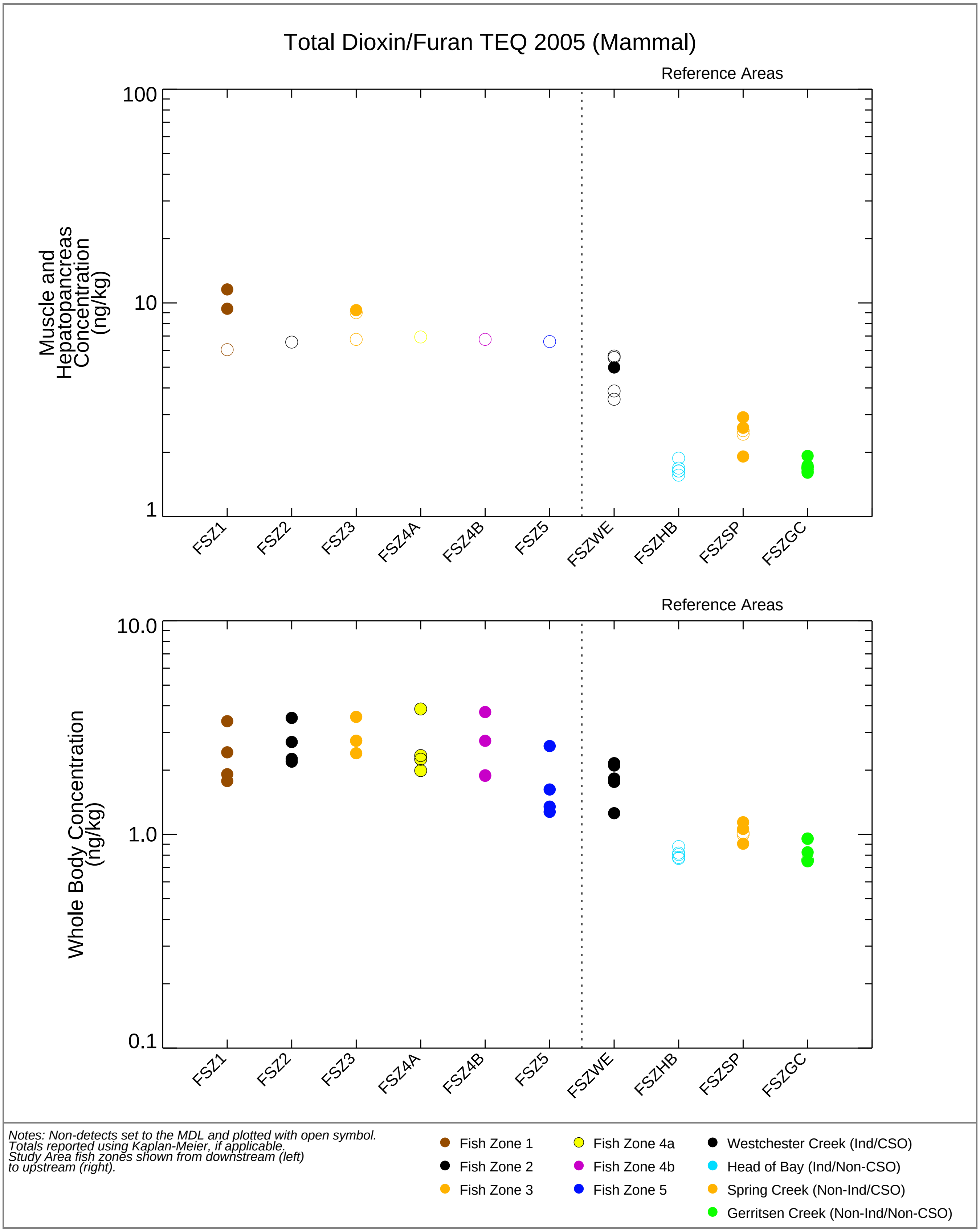

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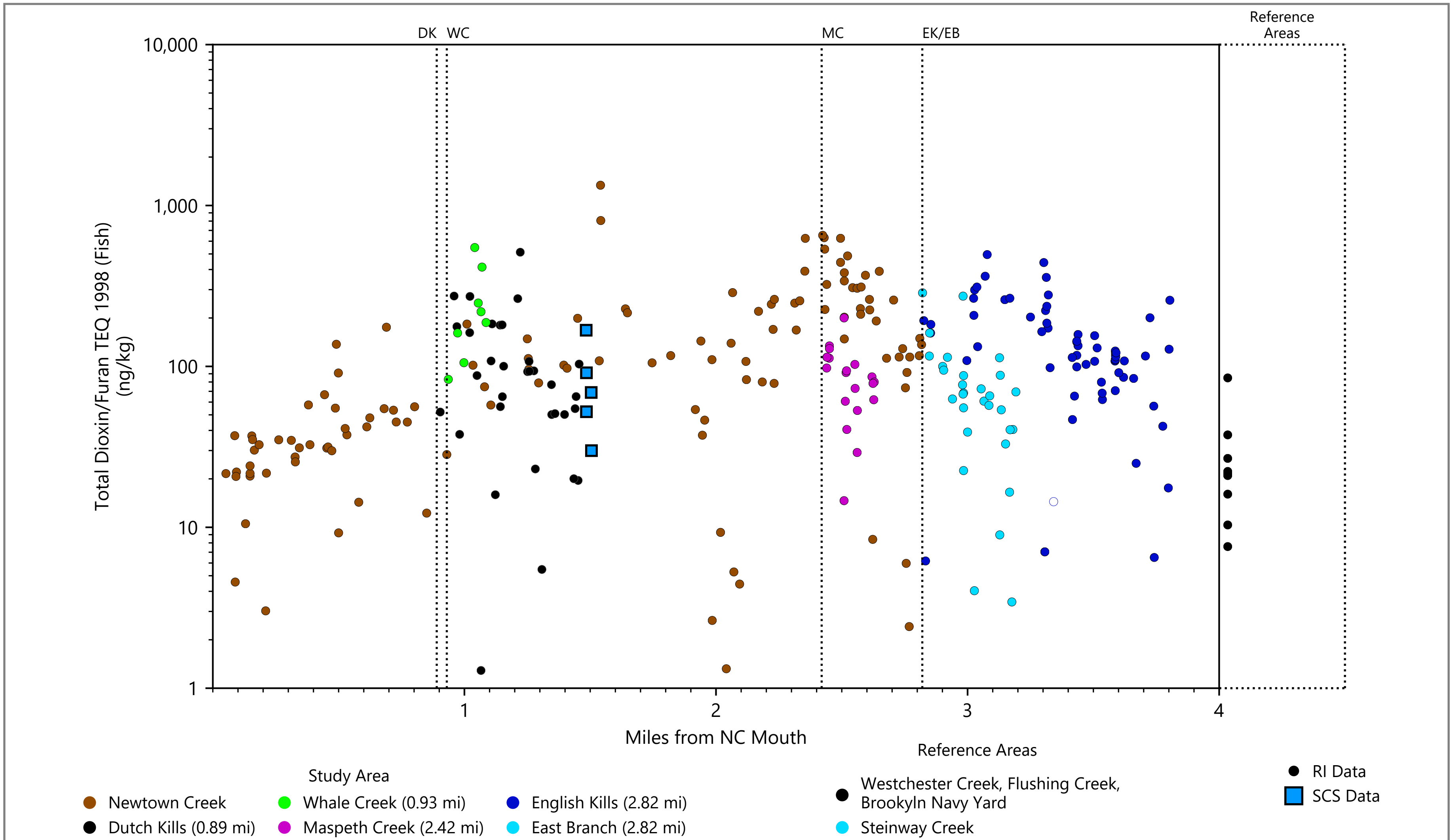
Figure 3-2

Total Dioxin/Furan TEQ 2005 (Mammal) in Blue Crab Muscle + Hepatopancreas and Whole Body Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Depth range for surface sediment is 0 to 15 cm.
Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek.
Caret symbols and numbers above or below panel indicate the number of values outside y-axis range.
Only a subset of reference areas are shown: Westchester Creek, Brooklyn Navy Yard, Flushing Creek, and Steinway Creek.

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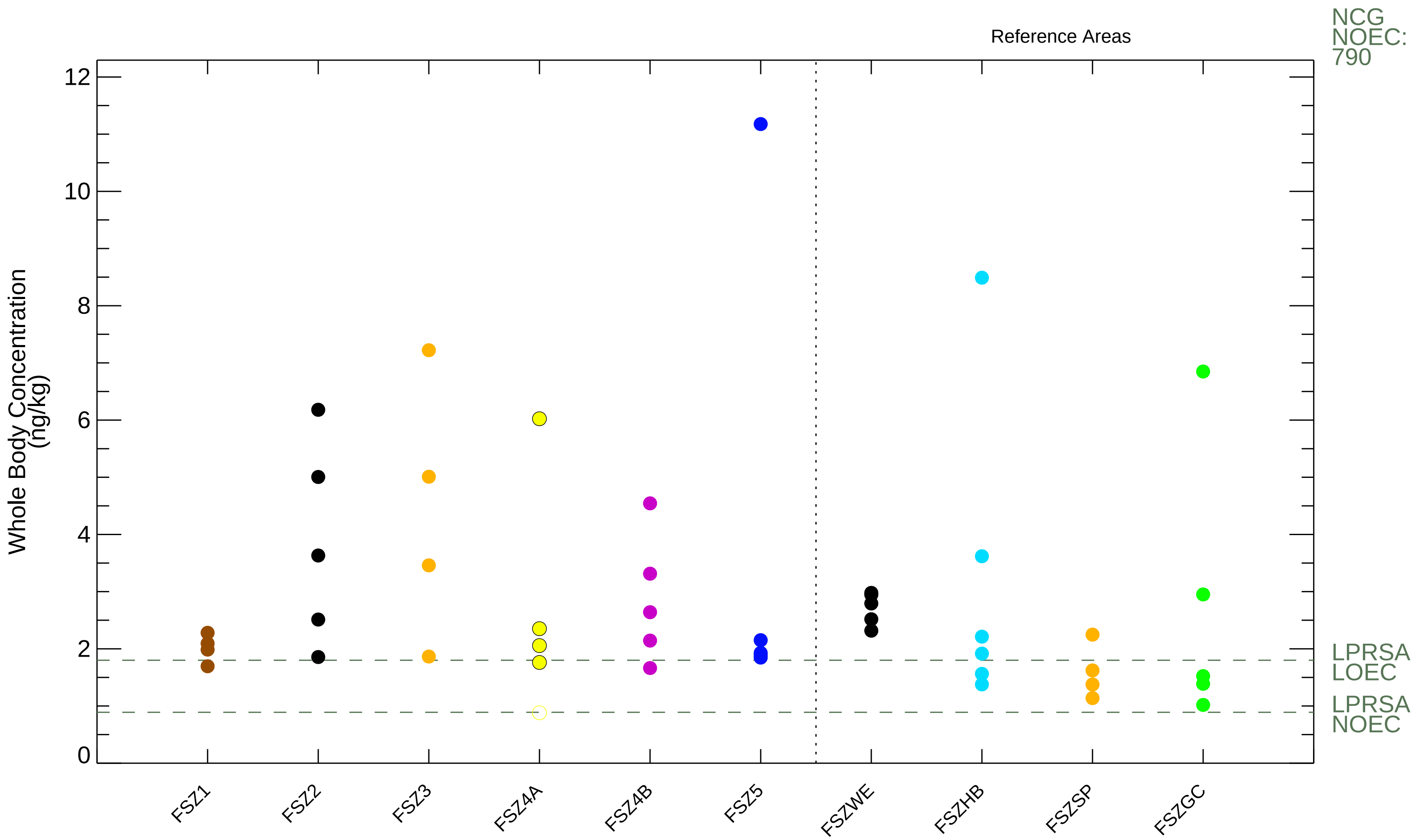
ANCHOR QEA

Figure 3-3
Total Dioxin/Furan TEQ 1998 (Fish) in Surface Sediment
Development of Risk-Based Preliminary Remediation Goals
Newtown Creek RI/FS



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).
LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration.
NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

- Fish Zone 1
- Fish Zone 2
- Fish Zone 3
- Fish Zone 4a
- Fish Zone 4b
- Fish Zone 5
- Westchester Creek (Ind/CSO)
- Head of Bay (Ind/Non-CSO)
- Spring Creek (Non-Ind/CSO)
- Gerritsen Creek (Non-Ind/Non-CSO)

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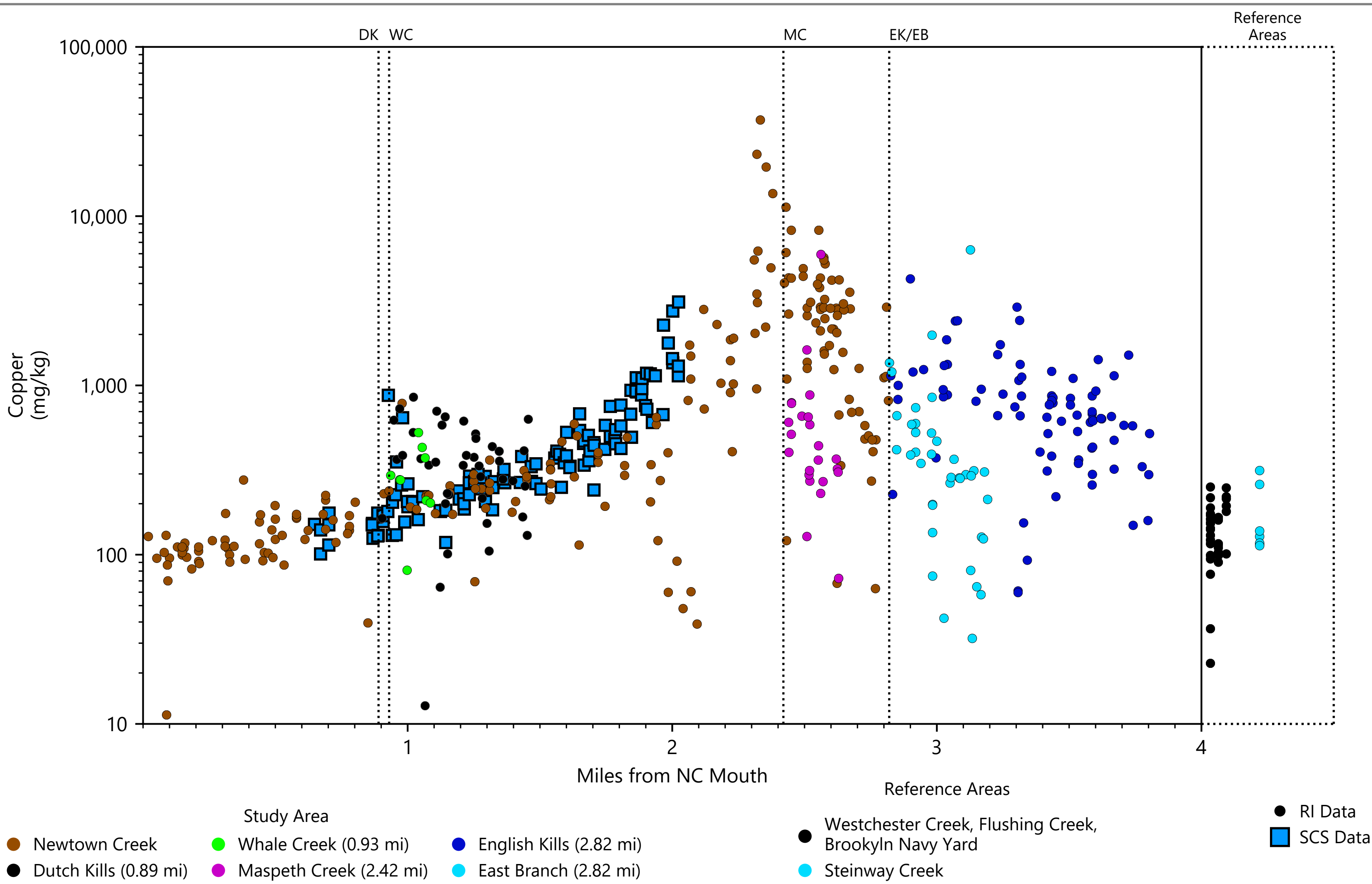
ANCHOR QEA

Figure 3-4

Total Dioxin/Furan TEQ 1998 (Fish) in Striped Bass Whole Body Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin

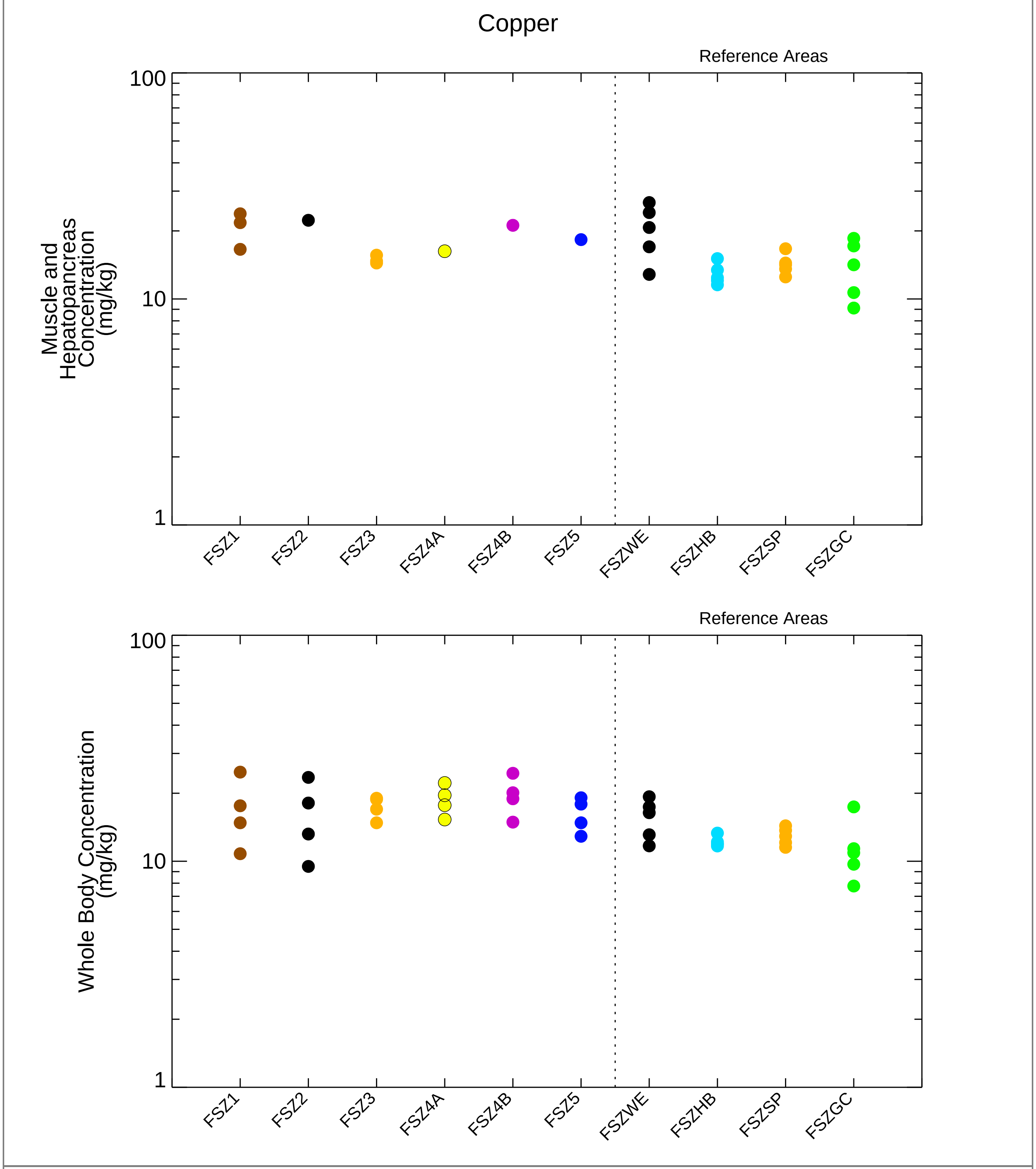


Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Depth range for surface sediment is 0 to 15 cm.
Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek.
Caret symbols and numbers above or below panel indicate the number of values outside y-axis range.
Only a subset of reference areas are shown: Westchester Creek, Brooklyn Navy Yard, Flushing Creek, and Steinway Creek.

Publish Date: 10/19/2021 14:52 PM | User: WCL-LBAT2
File Path: \\iris\woodcliff\Newtown_Creek_Early_Action\Deliverables\Focused_Feasibility_Study\Figures\python\NTC_surfsed_spatial_wEASurfSed_appendixB.py

ANCHOR QEA

Figure 4-1
Copper in Surface Sediment
Development of Risk-Based Preliminary Remediation Goals
Newtown Creek RI/FS



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).

Publish Date: 11/27/2019 14:41 | User: mk/lhb
File Path: \\iris\woodcliff\Projects\Newtown_Creek_Early_Action\Deliverables\Focused_Feasibility_Study\Figures\IDL\Spatial_BCrabT_by_prep_RI_AA.pro

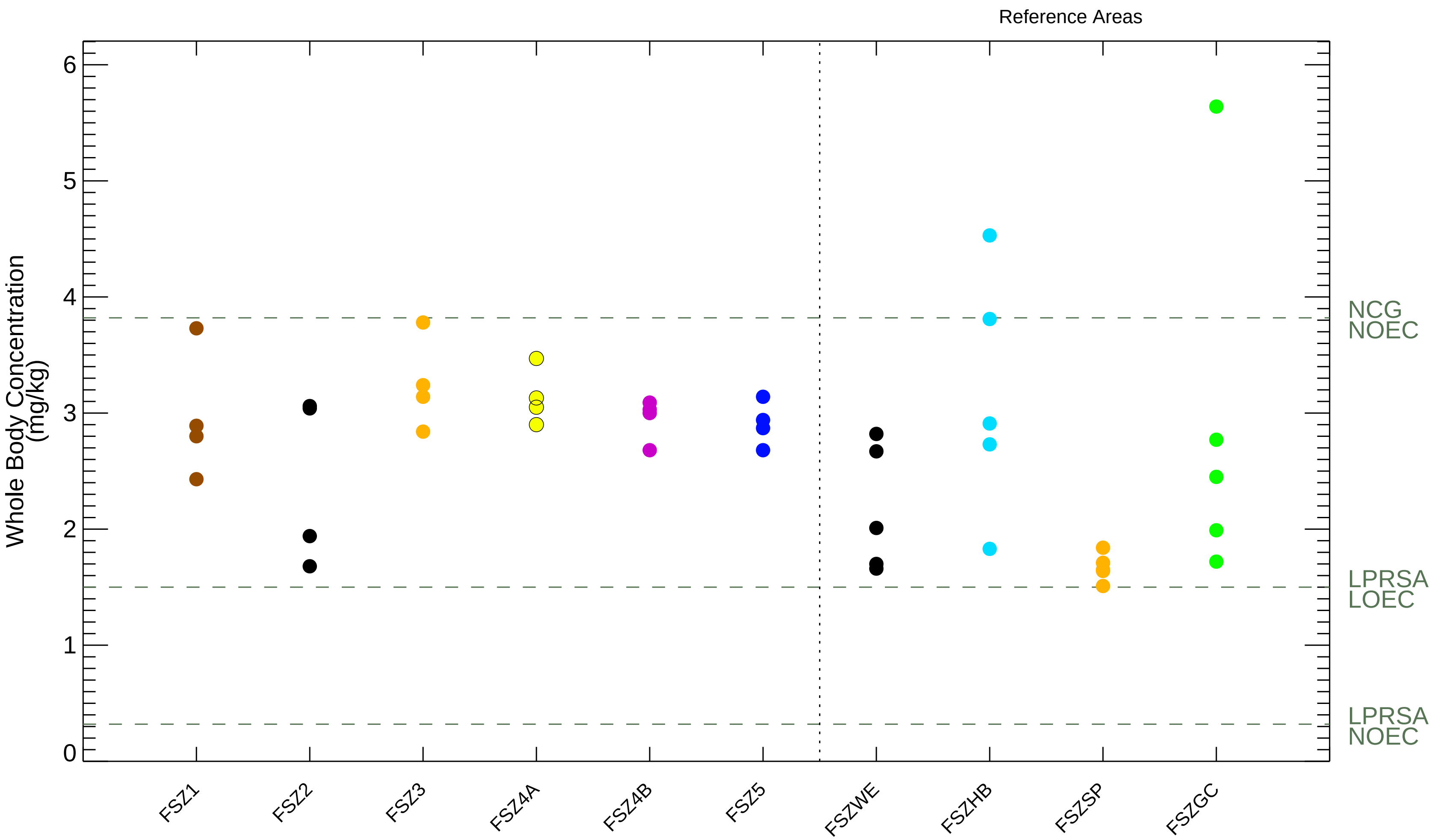
ANCHOR QEA

Figure 4-2

Copper in Blue Crab Muscle + Hepatopancreas and Whole Body Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol.
Totals reported using Kaplan-Meier, if applicable.
Study Area fish zones shown from downstream (left) to upstream (right).
LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration.
NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

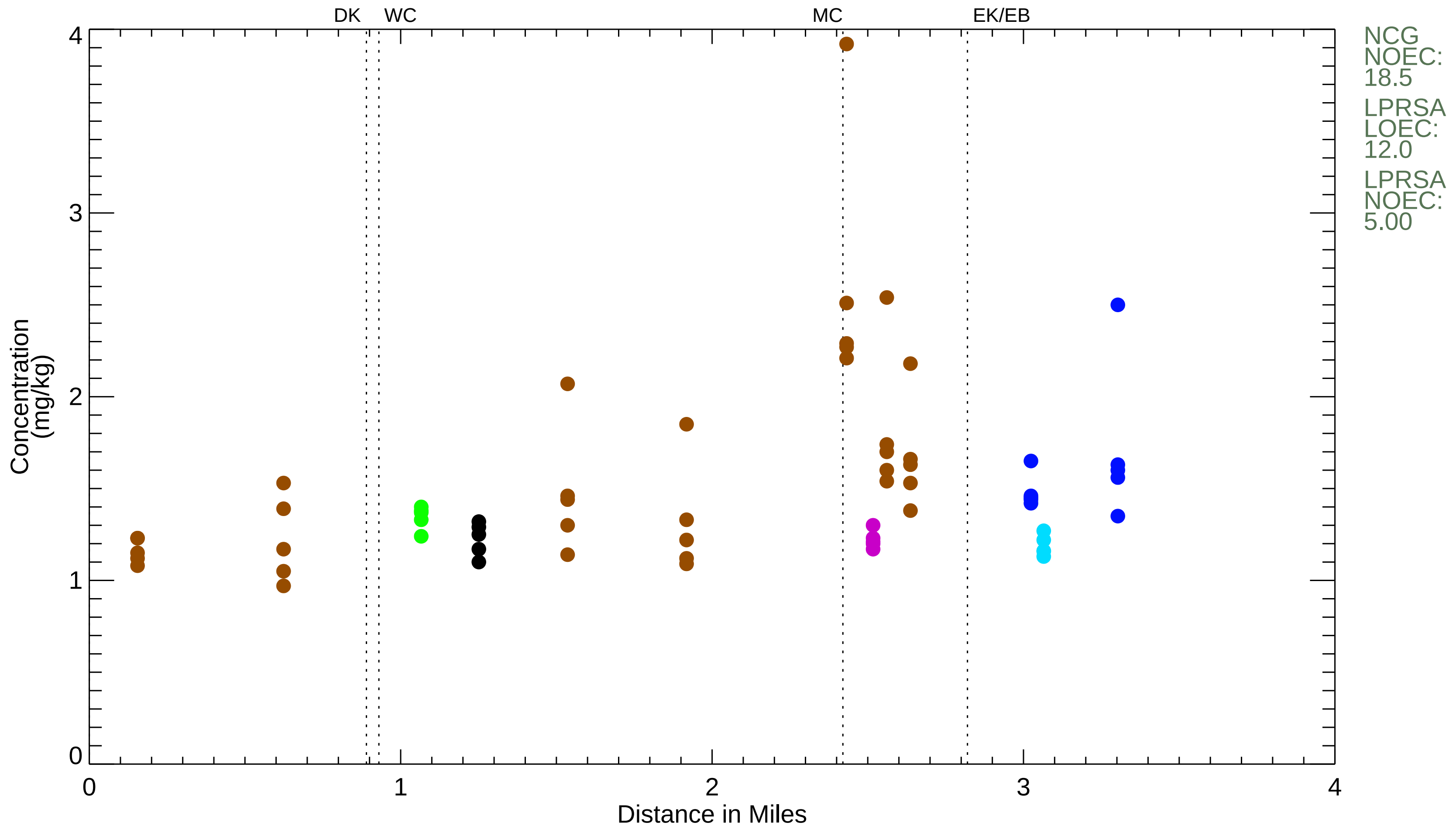
- Fish Zone 1
- Fish Zone 2
- Fish Zone 3
- Fish Zone 4a
- Fish Zone 4b
- Fish Zone 5
- Westchester Creek (Ind/CSO)
- Head of Bay (Ind/Non-CSO)
- Spring Creek (Non-Ind/CSO)
- Gerritsen Creek (Non-Ind/Non-CSO)

Publish Date: 12/02/2019 12:18 | User: mk
File Path: \\iris\woodcliff\Projects\Newtown_Creek_Early_Action\Deliverables\Focused_Feasibility_Study\Figures\IDL\Spatial_FishT_by_prep_RI_AA.pro

ANCHOR QEA

Figure 4-3
Copper in Mummichog Tissue
Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_FishCrab_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek. LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration. NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

Publish Date: 10/18/2019 21:32 | User: mk
File Path: \\iris\woodcliff\Projects\Newtown_Creek_Early_Action\Deliverables\Focused_Feasibility_Study\Figures\IDL\p_surfsed_worm_spatials_1panel.pro

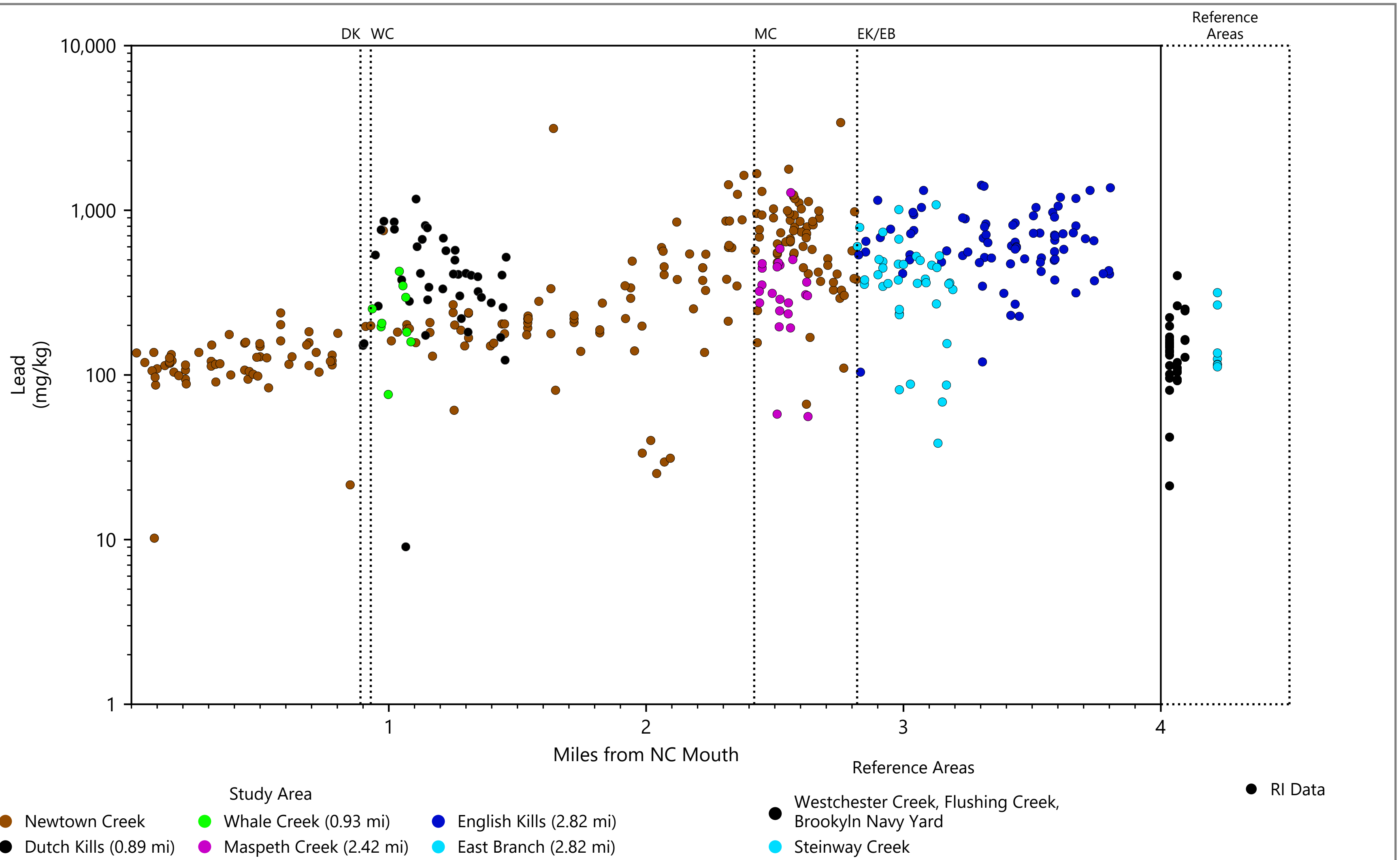
ANCHOR QEA

Figure 4-4

Copper in Polychaete Tissue

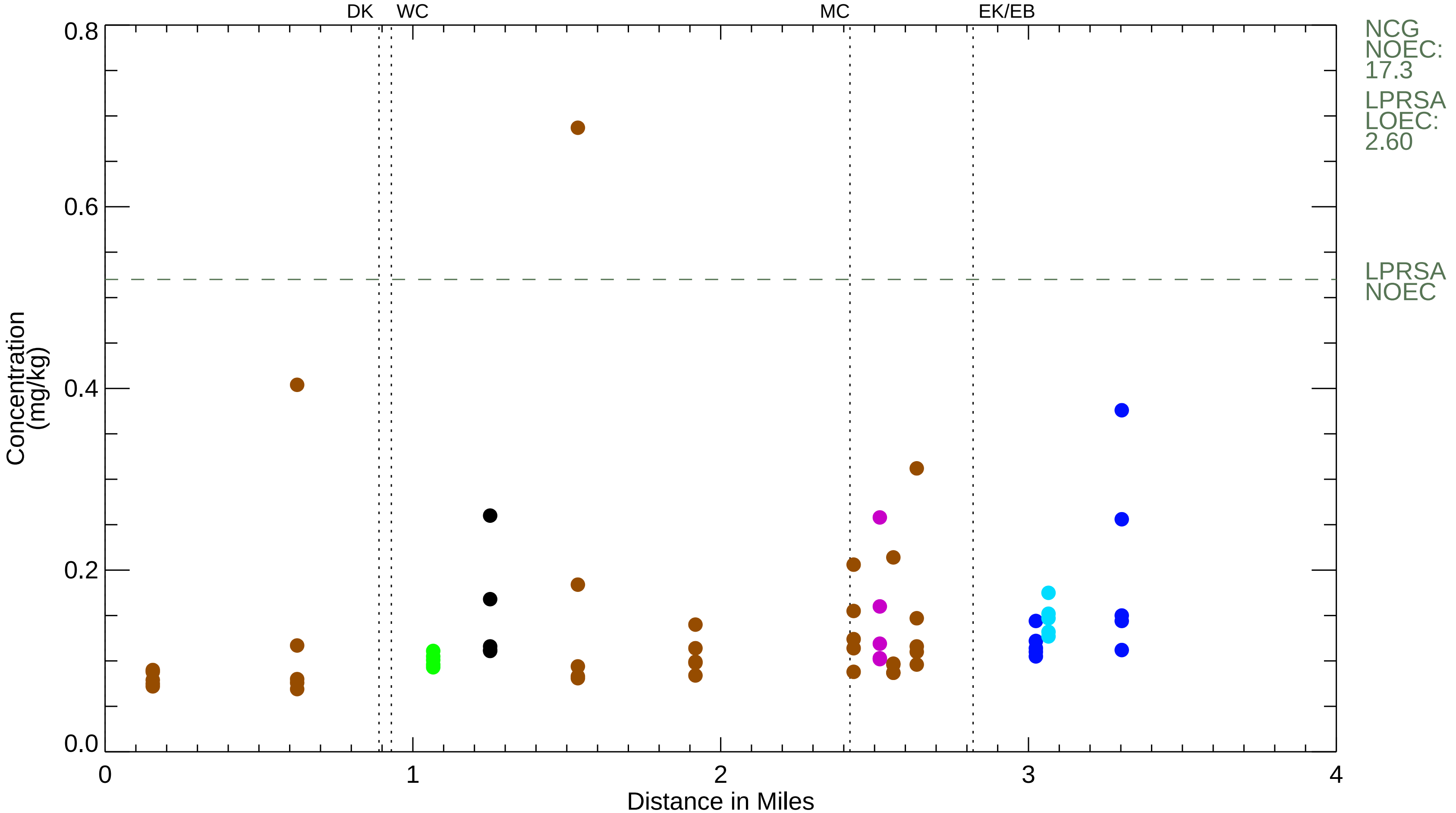
Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_Bioaccumulation_wKM_20161222.bin



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Depth range for surface sediment is 0 to 15 cm.
Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek.
Caret symbols and numbers above or below panel indicate the number of values outside y-axis range.
Only a subset of reference areas are shown: Westchester Creek, Brooklyn Navy Yard, Flushing Creek, and Steinway Creek.

Publish Date: 10/19/2021 14:52 PM | User: WCL-LBAT2
File Path: \\iris\woodcliff\Newtown_Creek_Early_Action\Deliverables\Focused_Feasibility_Study\Figures\python\NTC_surfsed_spatial_wEASurfSed_appendixB.py



Notes: Non-detects set to the MDL and plotted with open symbol. Totals reported using Kaplan-Meier, if applicable. Dashed vertical lines represent the confluence of the indicated tributaries with Newtown Creek. LOEC = Lowest Observed Effect Concentration. NOEC = No Observed Effect Concentration. NCG = Newtown Creek Group. LPRSA = Lower Passaic River Study Area.

Publish Date: 10/18/2019 21:32 | User: mk
File Path: \\iris\woodcliff\Projects\Newtown_Creek_Early_Action\Deliverables\Focused_Feasibility_Study\Figures\IDL\p_surfsed_worm_spatials_1panel.pro

ANCHOR QEA

Figure 5-2
Lead in Polychaete Tissue

Development of Risk-Based Preliminary Remediation Goal
Newtown Creek RI/FS

Data source: NCP2_Bioaccumulation_wKM_20161222.bin

Attachment A
SWAC Figures

Attachment B
Risk-Based PRG Calculations

Attachment C

USEPA Hydrocarbon PRG Derivation

Newtown Creek Hydrocarbon Interim Risk-Based PRG Derivation

June 18, 2020

Newtown Creek Interim Risk-Based PRG Development

- NCG submitted on 12/12/19, *Draft Development of Risk-Based Preliminary Remediation Goals* for PCBs, D/F, PAHs, Cu, and Pb.
- EPA reviewed and found the interim risk-based PRGs for PCBs, D/Fs, and Pb to be acceptable for preliminary planning purposes.
- EPA has technical concerns regarding the NCG's interim risk-based PRG for copper and will provide additional feedback in the near future.
- The PAH interim risk-based PRG was not derived in accordance with EPA's guidance and was not acceptable. PAHs are discussed in this presentation.

NCG Porewater PAH RG Method

- NCG used sediment data from 35 Study Area locations and 24 Reference Area locations – those that were included in the 2014 sediment quality triad (SQT) sampling for benthic community, sediment toxicity, and chemical analyses.

- NCG cited EPA's 2017 guidance, *Developing Sediment Remediation Goals at Superfund Sites Based on Pore Water for the Protection of Benthic Organisms from Direct Toxicity to Non-ionic Organic Contaminants*, but did not follow the guidance to derive RGs.

- NCG's novel method was not acceptable to EPA.

EPA Porewater PAH RG Method

- NCG used 28-D survival as toxicity endpoint to determine PAH PRGs
- EPA guidance states that sublethal endpoints are more sensitive, and more appropriate for determining toxic responses.
- However, because the survival in the 10-D toxicity test was so poor (only one location had survival >75%), and because the 28-D growth and reproduction were significantly reduced in all but a few locations, correlations were not possible. So, EPA also used 28-D survival endpoint.
- Therefore, the following PRGs are based on survival, not the more conservative sublethal endpoints, and are likely to underestimate risk.

EPA Porewater PAH RG Method

- EPA Region 2 followed EPA's 2017 PW RG guidance, and after consultation with the authors of the guidance (EPA ORD), the results indicated that PW data from the 35 SQT locations did not lend itself to the PW RG method.

  - The majority of the measured PW concentrations were below the detection limits, regardless of sediment concentrations. Using ½ the reporting limit for most of the PW C_{free} concentrations yielded PW values not related to sediment concentrations.

  - Possibly due in part to elevated anthropogenic OC, because a significant portion of the sediment OC is actually the hydrocarbon contamination.

  - Possibly due to interference during sampling, the PW PAH(34) concentrations yielded extremely low sediment:PWPRG concentrations (e.g., <4 mg/kg)

EPA Porewater PAH RG Method

- EPA's 2017 guidance explains that in natural systems, sediment OC comes from the diagenesis of plants. In and around Newtown Creek, the OC is primarily anthropogenic (oils/greases, NAPL, tars, coal, soot, and/or microplastic particulates).

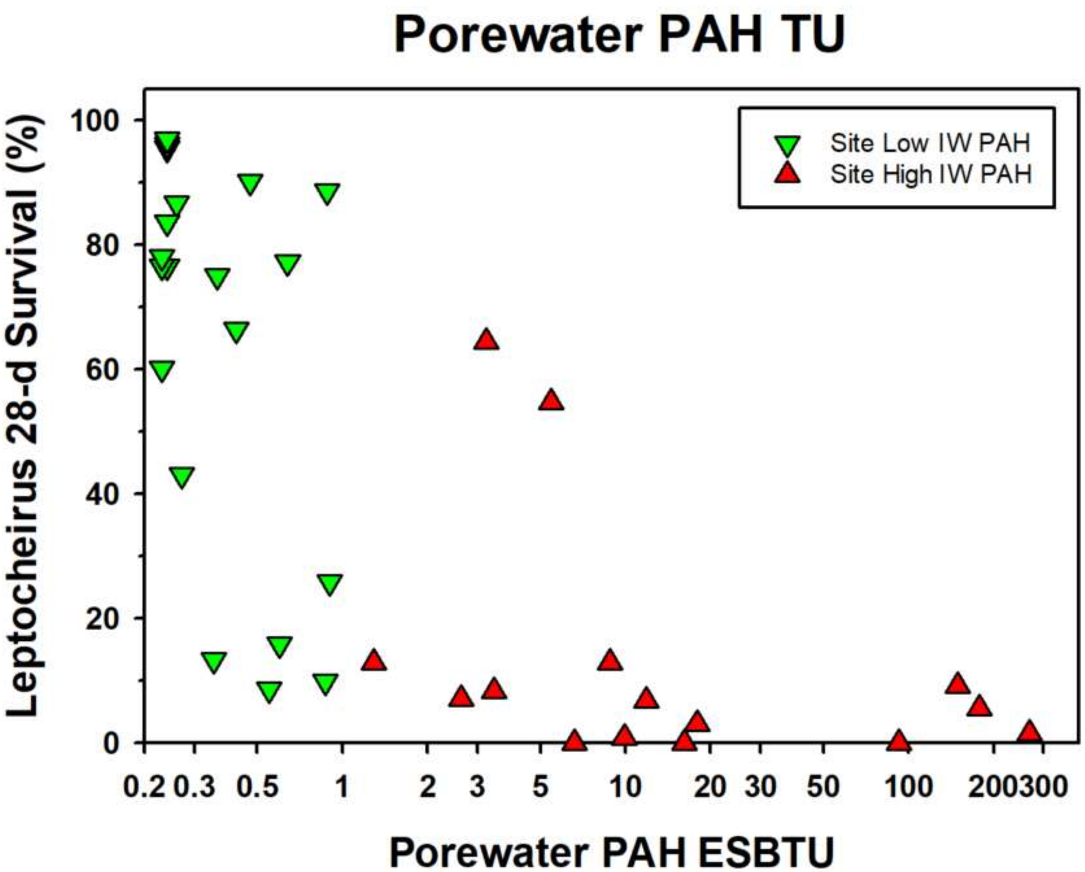
- Anthropogenic OC has larger sorption capability (K_{OC}) than natural OC, so the concentrations of chemicals in PW are potentially lower than in uncontaminated sediments having the same concentrations of chemicals on a bulk dw basis with the same OC.

EPA Method PAH RG Calculation

Station ID	CM	28-Day Leptocheirus Survival (%)	Measured Bulk Sediment PAH (34) (ug/g dw)	Measured Porewater PAH (34) C_{free} (ug/L)	Total Porewater Toxic Units	Bulk Sediment PAH (34) $C_{s:PWRG}$ (ug/g dw)
DK001	0.014	88.6	92.37	3.89	0.88	105.29
DK037	0.361	12.9	193.42	7.25	1.29	149.88
DK040	0.508	13.3	196.04	3.20	0.35	554.54
EB006	0.245	9.9	364.02	6.09	0.87	417.91
EB036	0.307	8.6	305	3.99	0.55	555.98
EK006	0.25	3	1929.3	125.21	17.91	107.74
EK057	0.204	9.1	874.75	258.62	148.95	5.87
EK059	0.483	1.5	1809.35	616.47	268.96	6.73
EK065	0.685	6.8	391.12	33.00	11.83	33.05
EK072	0.8	8.3	707.9	23.27	3.44	205.68
EK076	0.981	0	680.91	37.55	6.61	102.96
MC005	0.097	25.8	220.73	6.30	0.90	244.01
MC017	0.021	15.9	251.59	4.43	0.60	421.75
MC023	0.204	7	393.98	20.39	2.62	150.12
NC037	1.254	77.3	99.3	2.92	0.64	156.22
NC046	1.536	86.7	73.22	1.35	0.26	280.21
NC065	2.231	43	164.11	1.43	0.27	610.38
NC071	2.432	0	1289.23	229.00	92.36	13.96
NC153	0.052	76.6	95.12	0.72	0.23	408.73
NC154	0.155	95.5	70.46	0.77	0.24	295.94
NC156	0.262	83.6	80.56	1.13	0.24	340.86
NC158	0.344	78.1	51.26	0.71	0.23	222.69
NC161	0.624	90.2	72.41	5.01	0.47	153.59
NC162	0.773	75	71.82	3.08	0.36	199.93
NC164	1.105	96.2	58.14	0.76	0.24	245.73
NC165	1.395	97	70.87	0.75	0.24	300.79
NC167	1.746	60.2	76.71	1.05	0.23	329.15
NC168	1.918	66.4	180.63	2.16	0.42	434.79
NC169	1.984	76.6	105.28	0.75	0.24	446.29
NC174	2.353	0	802.61	51.07	16.12	49.78
NC180	2.637	5.5	677.83	240.32	178.09	3.81
NC181	2.817	12.9	550.61	23.34	8.82	62.46
NC293	2.561	0.8	1230.4	40.21	9.91	124.10
WC010	0.006	54.7	149.18	16.63	5.46	27.33
WC012	0.136	64.4	236.74	12.59	3.22	73.48

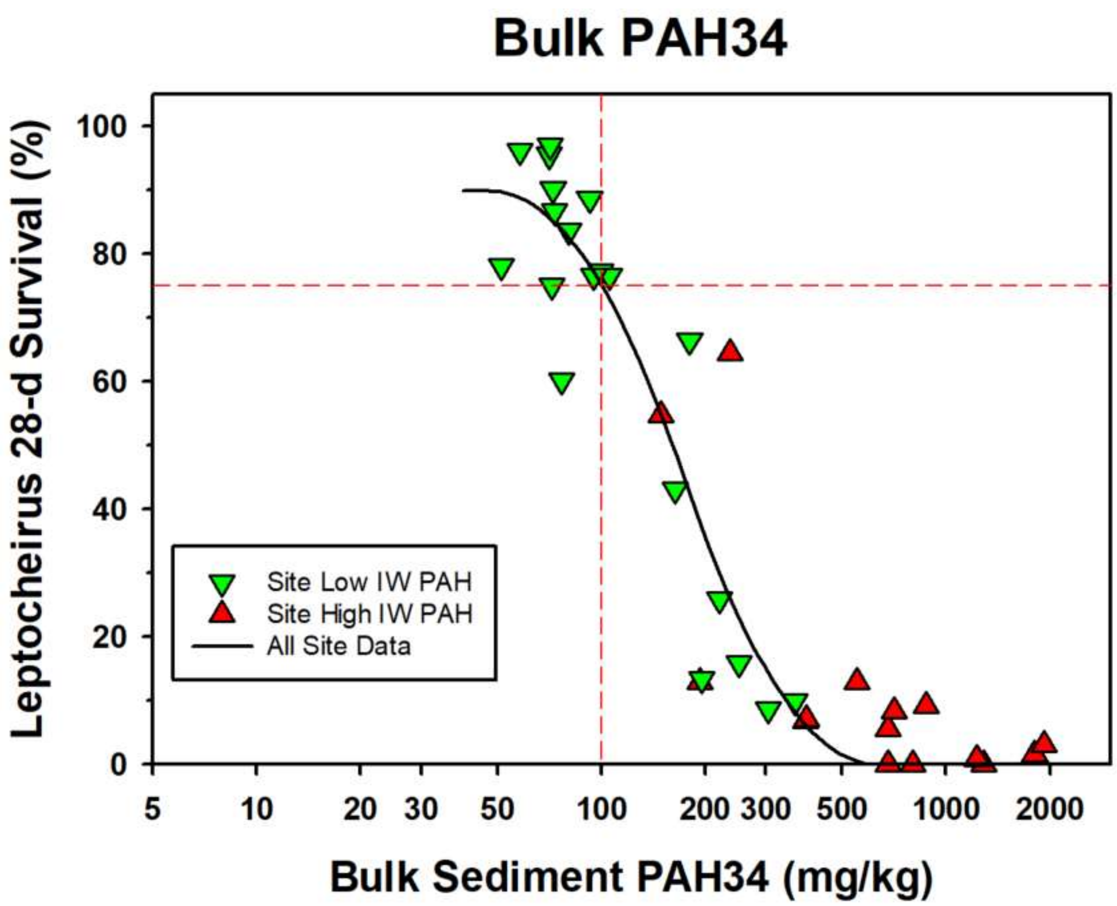
- EPA's PW-based bulk sediment PRG calculations did not yield reasonable remedial goals, because most PW samples were ND.
- Newtown calculated bulk sediment PAH(34) $C_{s:PWRG}$ values ranged 3.91 mg/kg to 610 mg/kg
- Collaboration with the EPA ORD guidance authors led to re-assessment of bulk sediment concentrations of hydrocarbon compounds.

Porewater PAH(34) C_{free} vs Survival



- Green triangles had PW TU<1, and red triangles had PW TU>1
- The PW PAH(34) C_{free} did not correlate with 28-D survival
- Most samples with PW TU <0.5 were mostly ND, and could actually have lower PW TU
- All samples with PW TU >1 were toxic, as expected
- Many samples without bioavailable PAHs yielded low survival, indicating PAHs are not the only cause of toxicity
- **PW TU is not an adequate marker for toxicity**

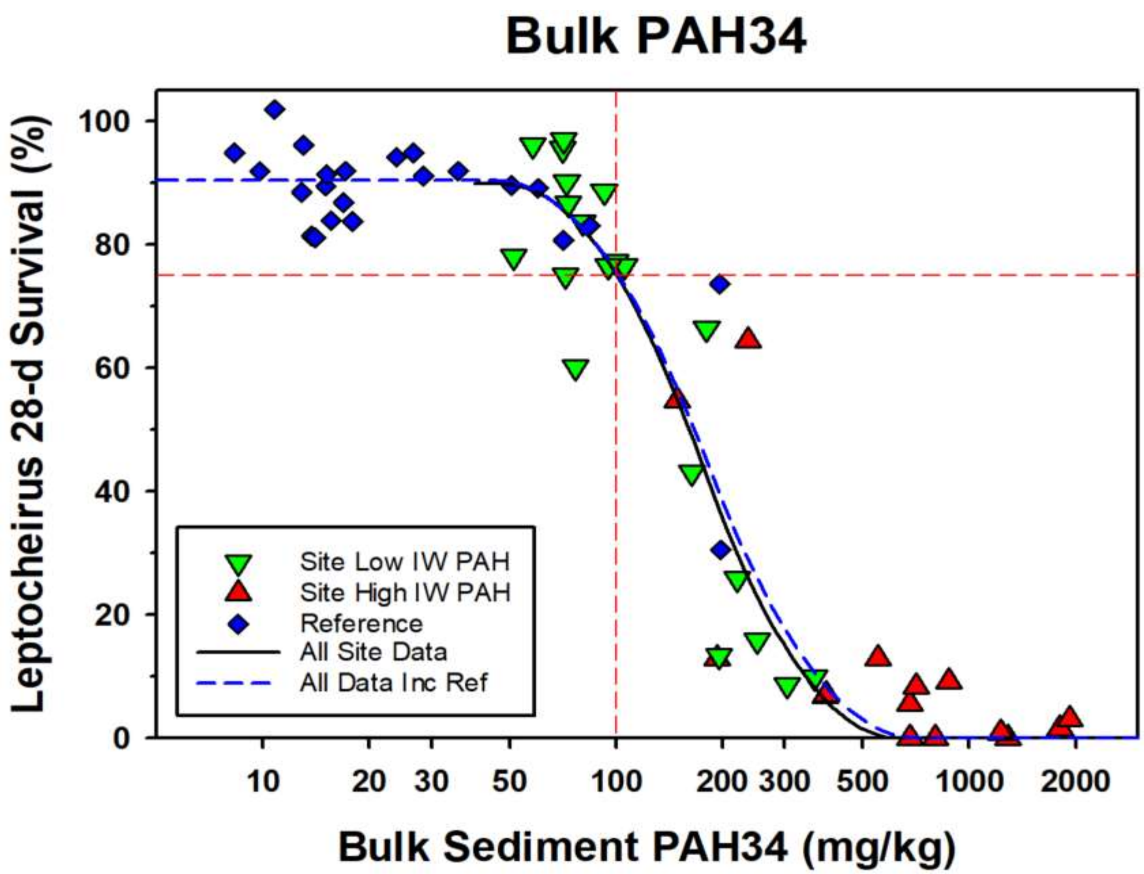
Bulk Sediment PAH(34) vs Survival



- Bulk sediment PAH(34) correlates well with toxicity but shows many samples that did not have bioavailable PAHs, suggesting that PAH(34) may be correlated with other sources of toxicity.
- Below 75% survival samples are toxic
- Sediment was toxic to *Leptocheirus* at approximately:

100 mg/kg dw PAH(34)

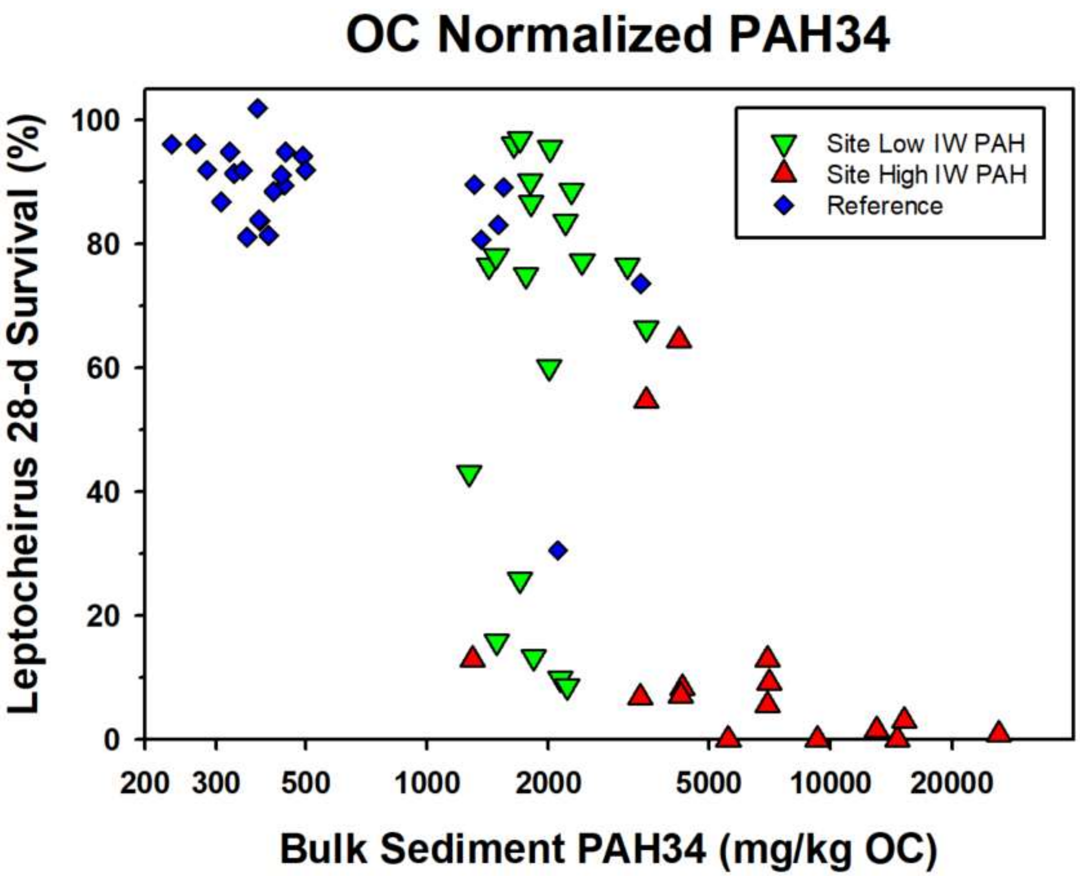
Bulk Sediment PAH(34) vs Survival



- Inclusion of the Reference Area data had no impact on the overall response curve.
- Sediment was toxic to *Leptocheirus* at approximately:

100 mg/kg dw PAH(34)

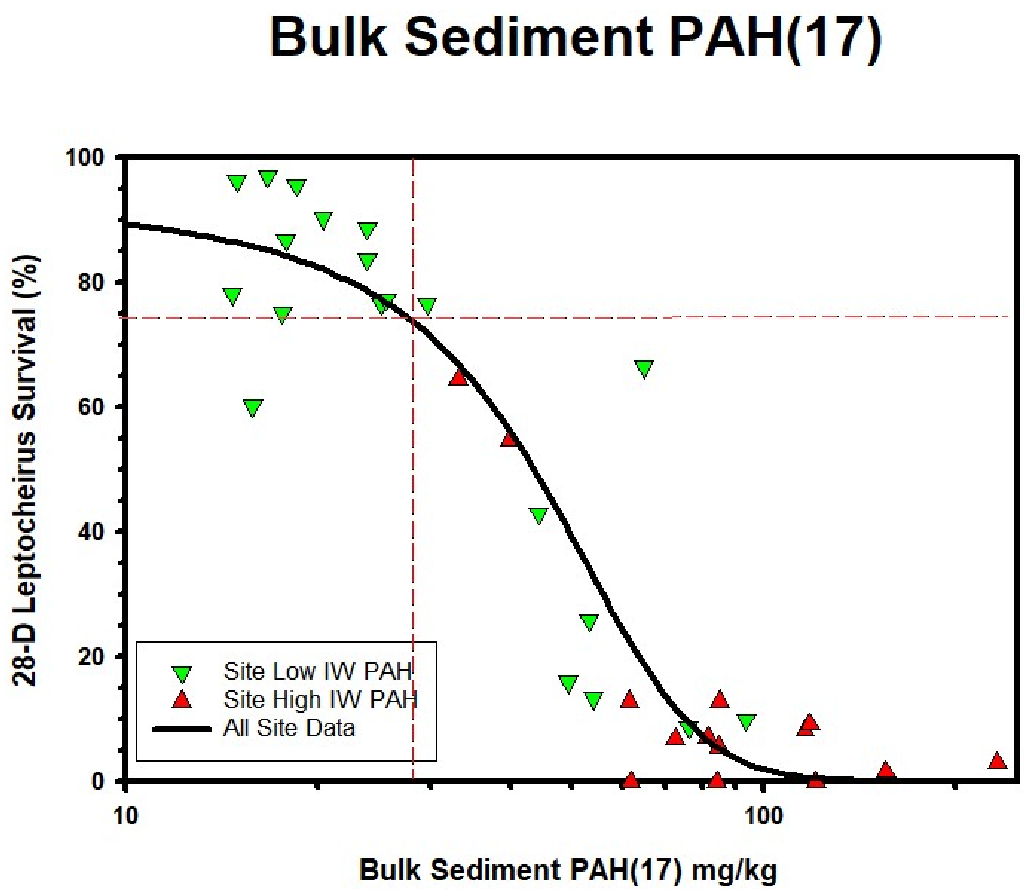
OC-Normalized Bulk Sediment PAH(34) vs Survival



- OC-Normalized Bulk Sediment PAH(34) did not correlate with survival
- While OC normalization is usually expected to improve correlation with toxicity, in this case a lot of the OC is actually the aliphatic hydrocarbons which are contributing to toxicity
- The samples with high OC often have high aliphatics, but the high hydrocarbon contribution decreases the OC-normalized PAH concentrations, potentially increasing the scatter rather than decreasing it.

- **OC-Normalized Bulk Sediment is not an adequate marker for toxicity**

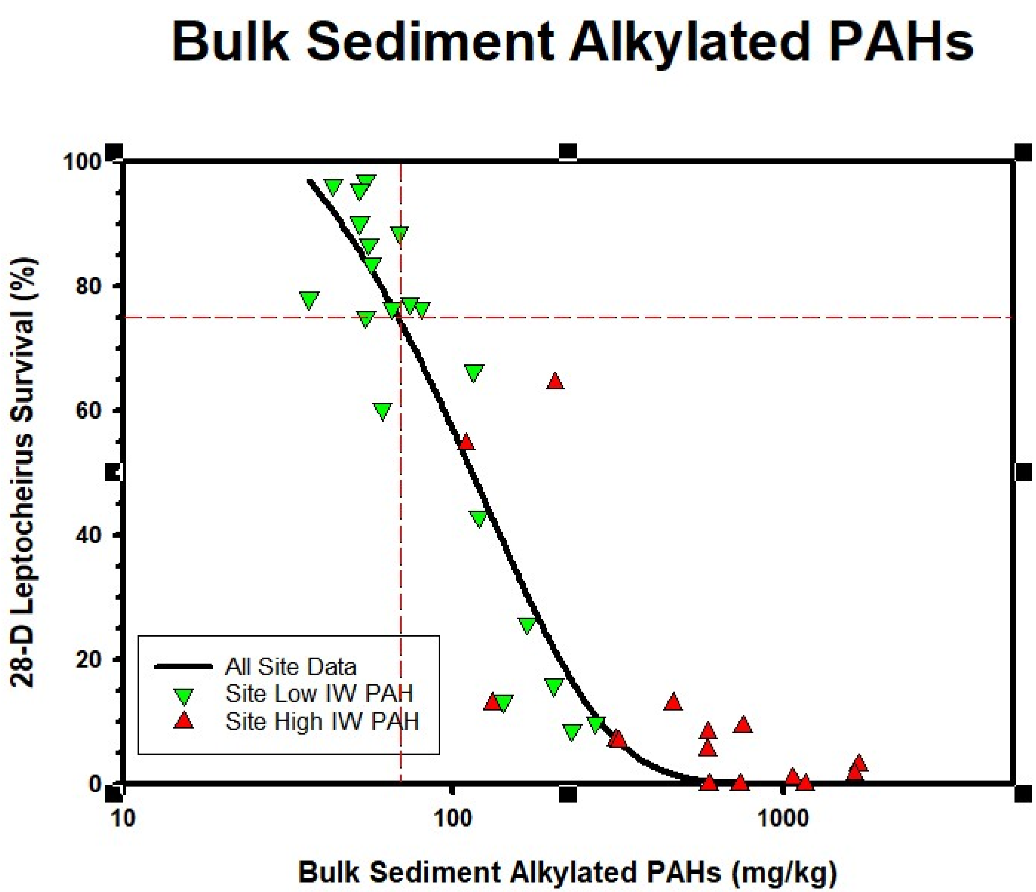
Bulk Sediment PAH(17) vs Survival



- Bulk sediment PAH(17) correlates well with toxicity but shows many samples that did not have bioavailable PAHs, suggesting that PAH(17) may be correlated with other sources of toxicity.
- Sediment was toxic to *Leptocheirus* at approximately:

30 mg/kg dw PAH(17)

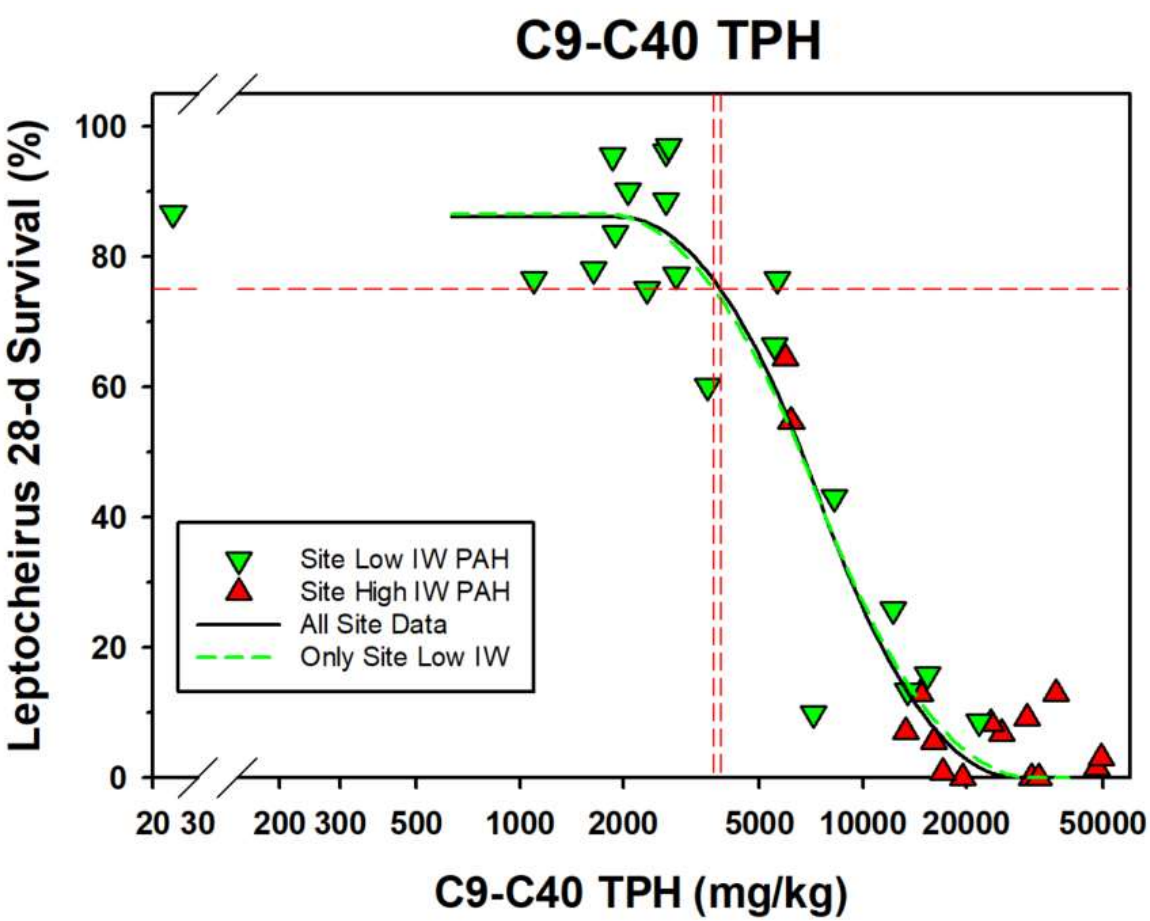
Bulk Sediment Alkylated PAHs vs Survival



- Bulk sediment Alkylated PAHs – subtracting the PAH(17) list from the PAH(34) list, yielding the more toxicologically potent hydrocarbons – correlate well with toxicity but shows some samples that did not have bioavailable PAHs, suggesting that PAHs may be correlated with other sources of toxicity.
- Sediment was toxic to *Leptocheirus* at approximately:

70 mg/kg dw Alkylated PAHs

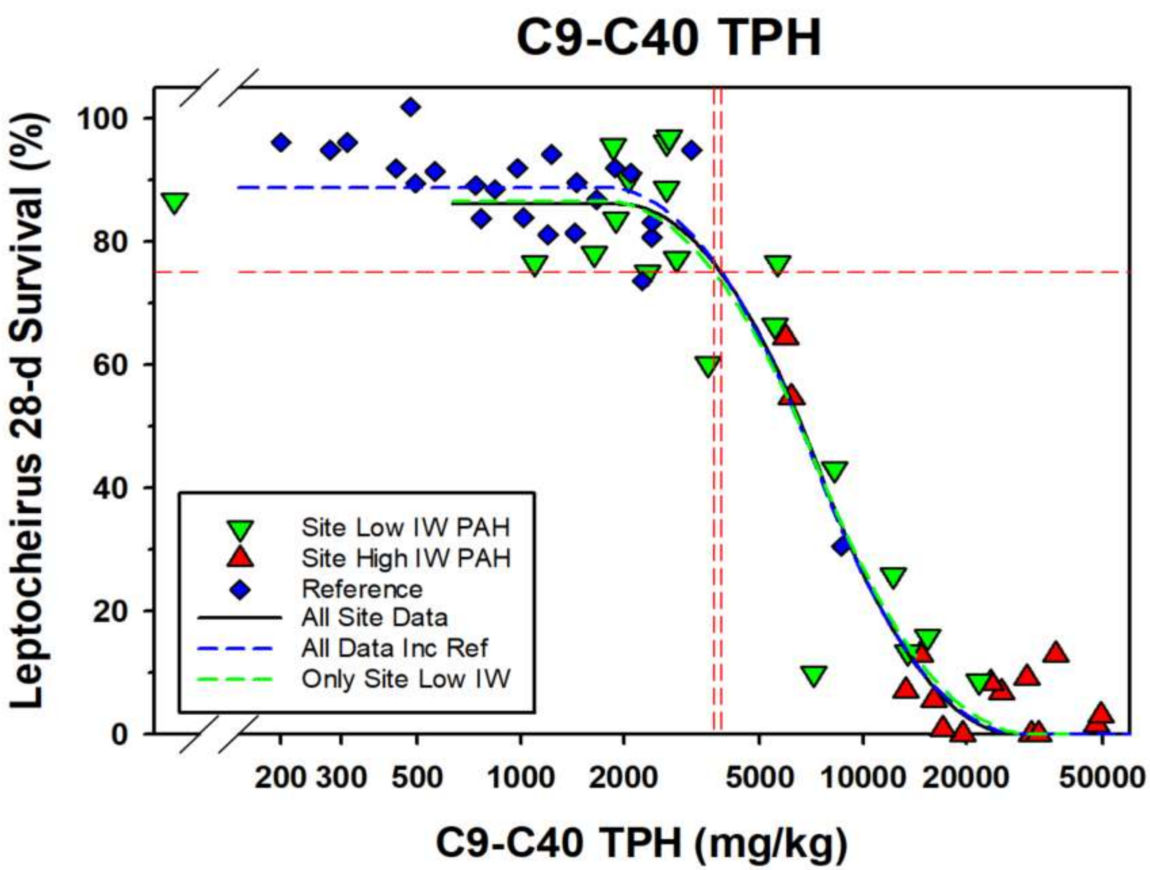
Bulk Sediment C9-C40 TPH vs Survival



- Bulk sediment TPH correlates well with toxicity
- Sediment was toxic to *Leptocheirus* at approximately:

3,820 mg/kg dw TPH

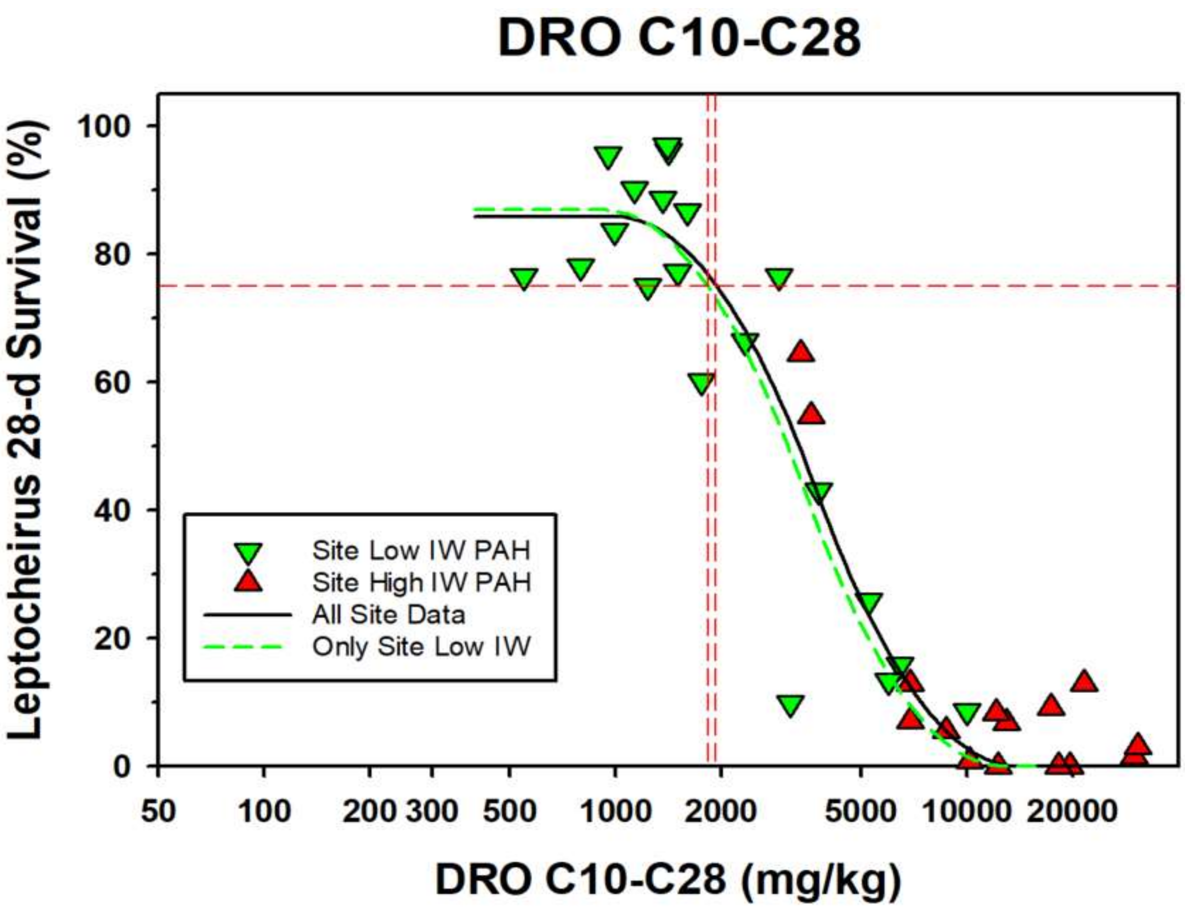
Bulk Sediment C9-C40 TPH vs Survival



- Inclusion of the Reference Area data had no impact on the overall response curve.
- Sediment was toxic to *Leptocheirus* at approximately:

3,820 mg/kg dw TPH

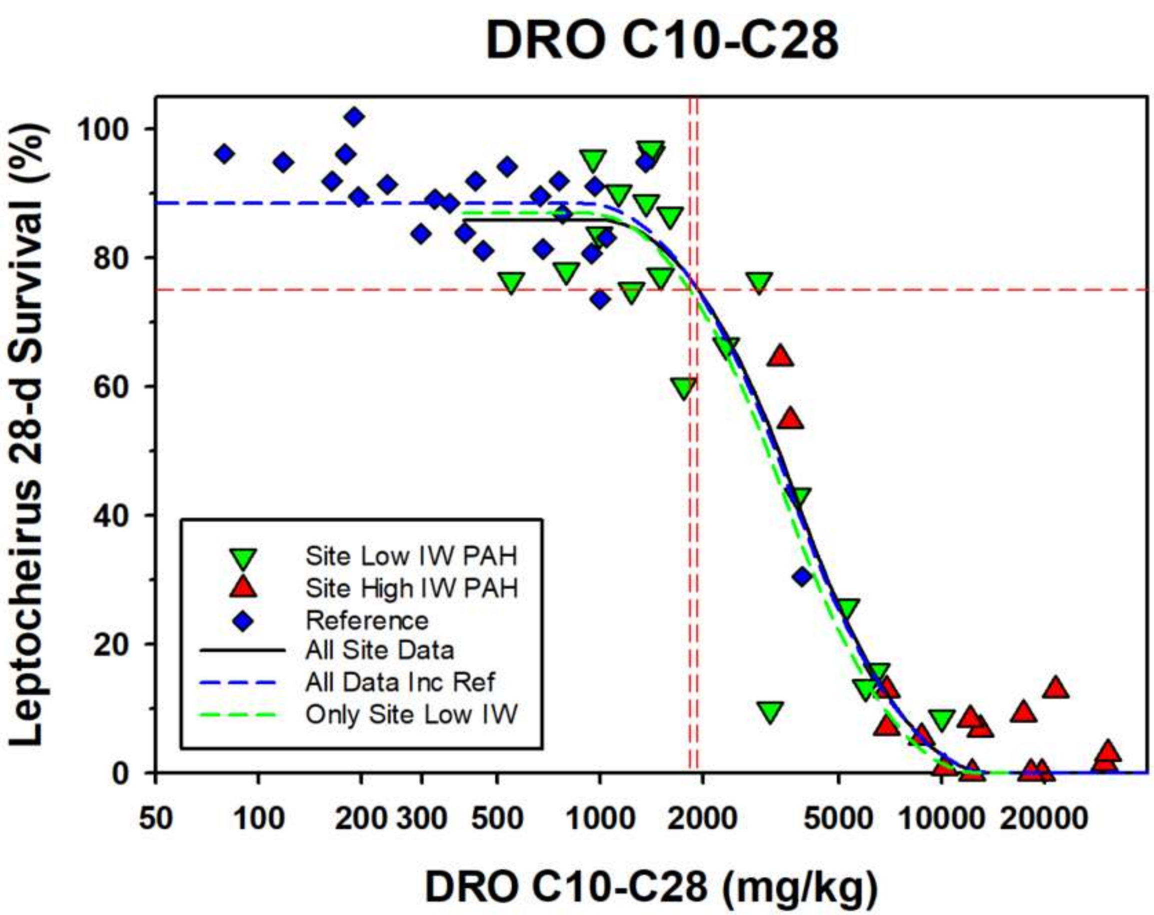
Bulk Sediment DRO vs Survival



- Bulk sediment DRO correlates well with toxicity
- Sediment was toxic to *Leptocheirus* at approximately:

  1,920 mg/kg dw DRO

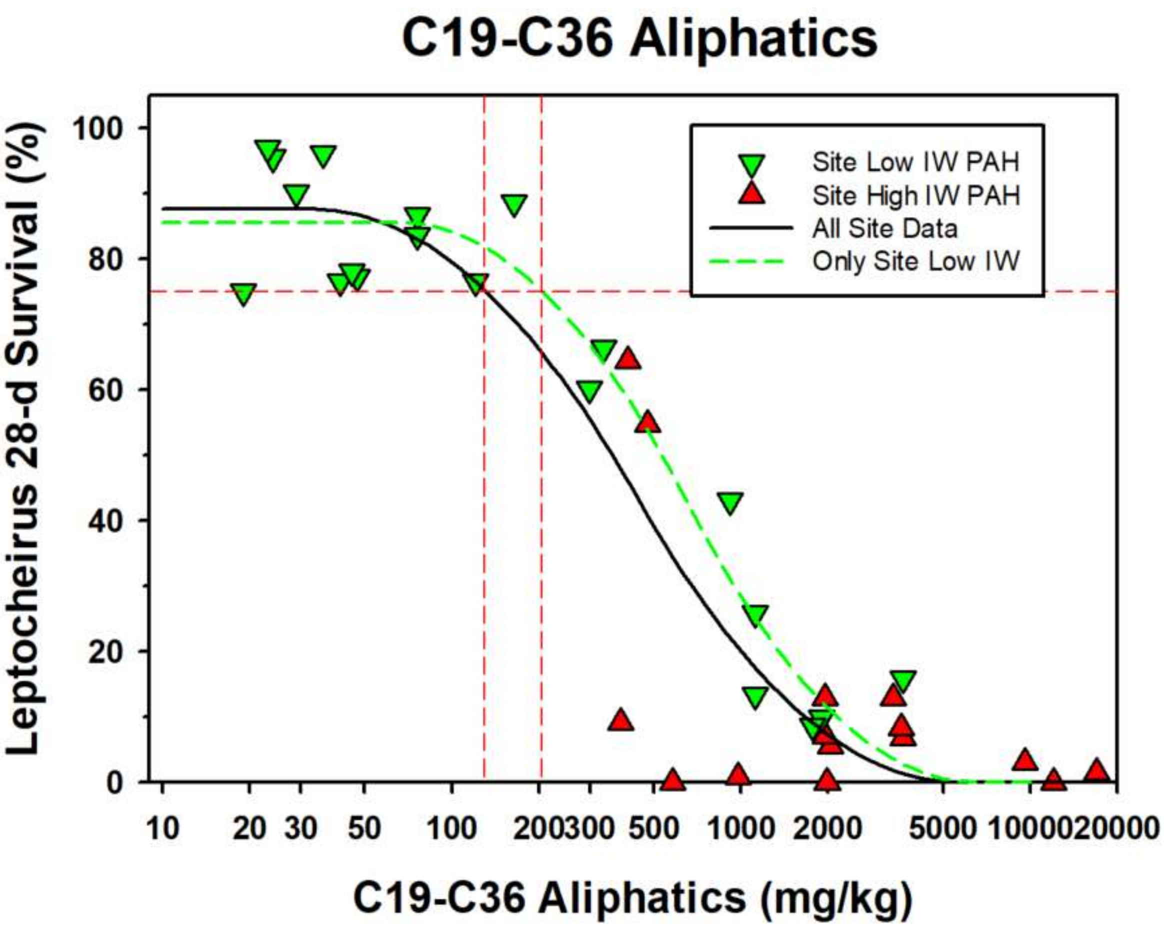
Bulk Sediment DRO vs Survival



- Inclusion of the Reference Area data had no impact on the overall response curve.
- Sediment was toxic to *Leptocheirus* at approximately:

  1,920 mg/kg dw DRO

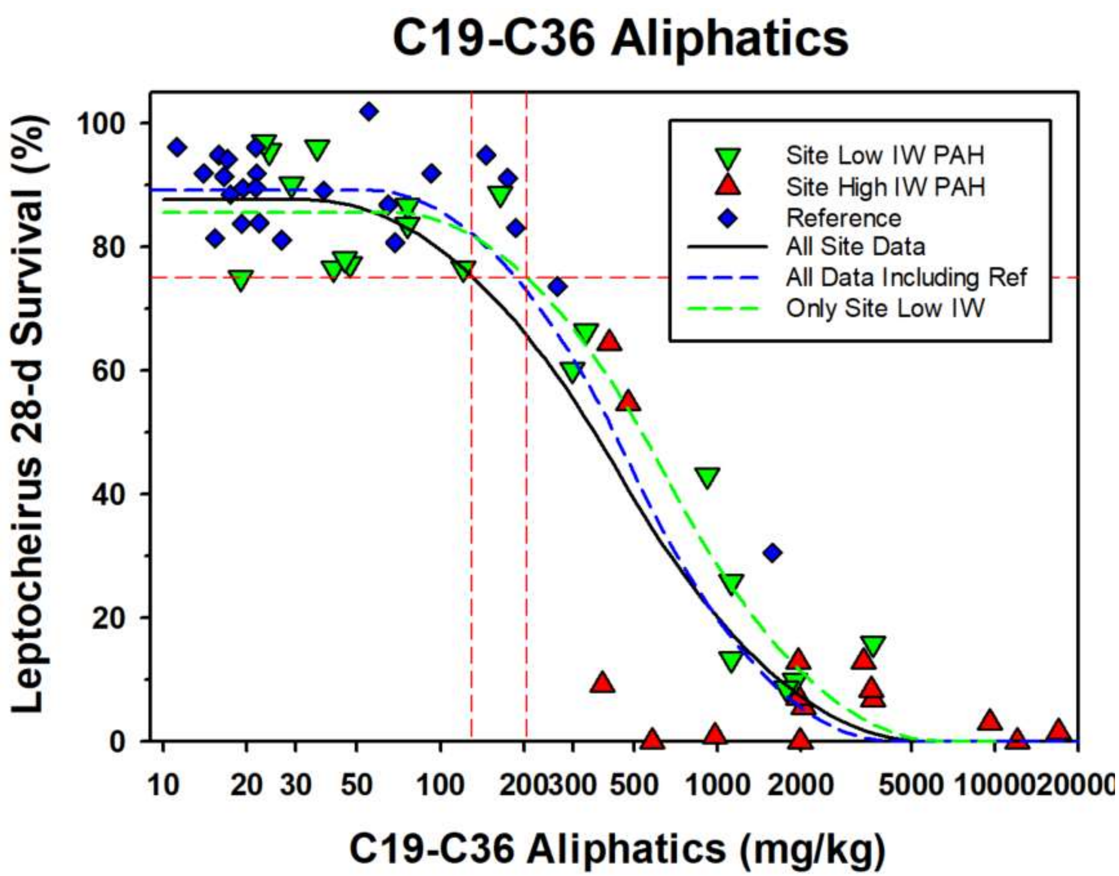
Bulk Sediment C19-C36 vs Survival



- Bulk sediment C19-C36 correlates well with toxicity
- Several samples with PAH(34) TU >1 and low survival are at the center bottom, these pull the response curve down, indicating that the toxicity in those samples is related to PAHs rather than C19-C36 aliphatics.
- If the site samples with the high PW PAH TUs are removed (fitting the line to only the green samples), the model moves to the right and has a better fit in the area of the 75% survival
- The 75% survival line perfectly segregates toxic samples from nontoxic samples
- Sediment was toxic to *Leptocheirus* at approximately:

200 mg/kg dw C19-C36

Bulk Sediment C19-C36 vs Survival



- Inclusion of the Reference Area data had no impact on the overall response curve.
- Sediment was toxic to *Leptocheirus* at approximately:

  200 mg/kg dw C19-C36

Summary Hydrocarbon Interim Risk-Based PRGs

Bulk sediment hydrocarbon concentrations correlated better with toxicity than did OC-normalized bulk sediment or porewater concentrations:

Interim Risk-Based PRGs

C9-C40 TPH = 3,820 mg/kg

C10-C28 DRO = 1,920 mg/kg

C19-C36 = 200 mg/kg

PAH(34) = 100 mg/kg

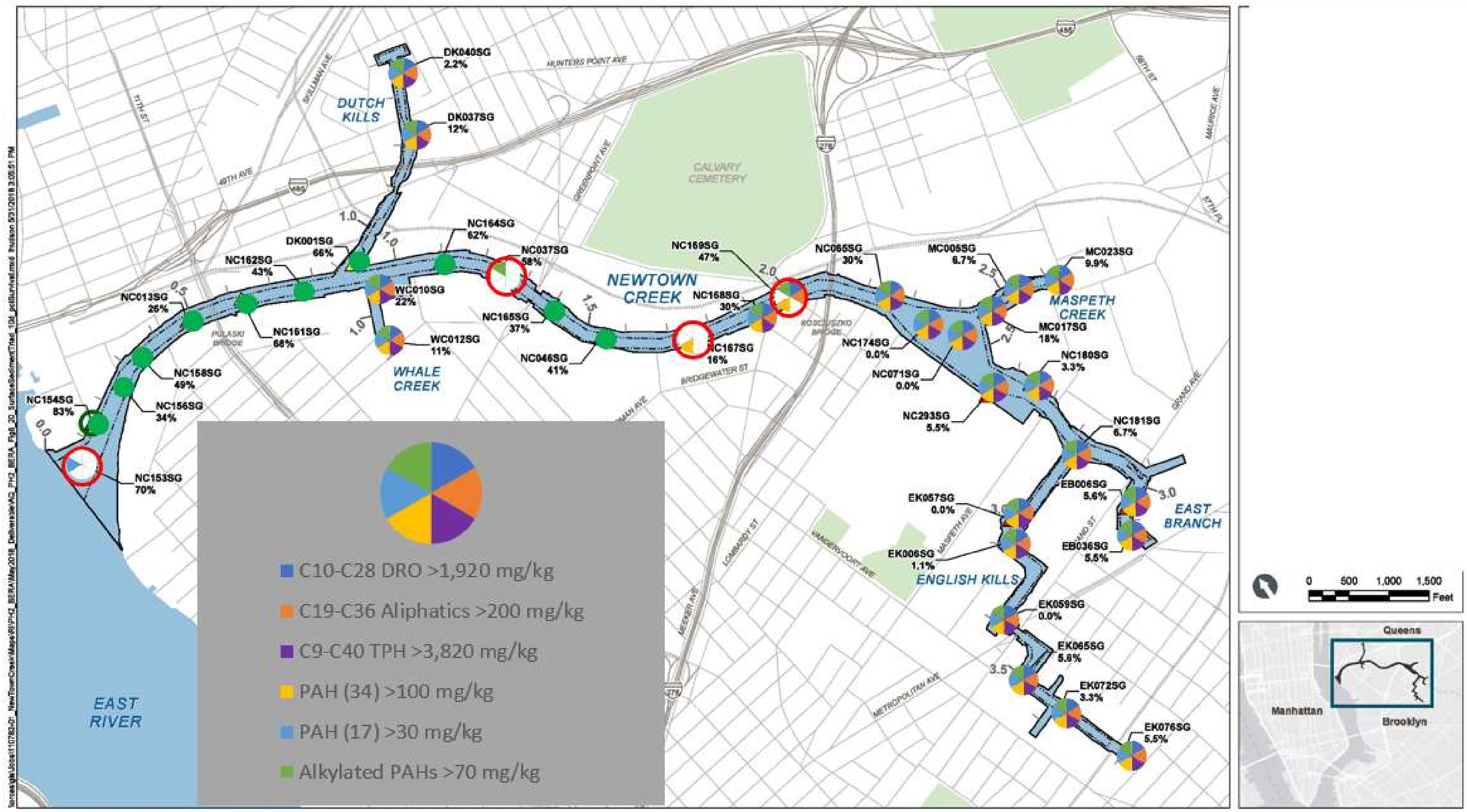
PAH(17) = 30 mg/kg

Alkylated PAHs = 70 mg/kg

EPA's Interim Risk-Based PRG Spatial Distribution

EPA's calculated spatial distribution of hydrocarbon interim risk-based PRG exceedances

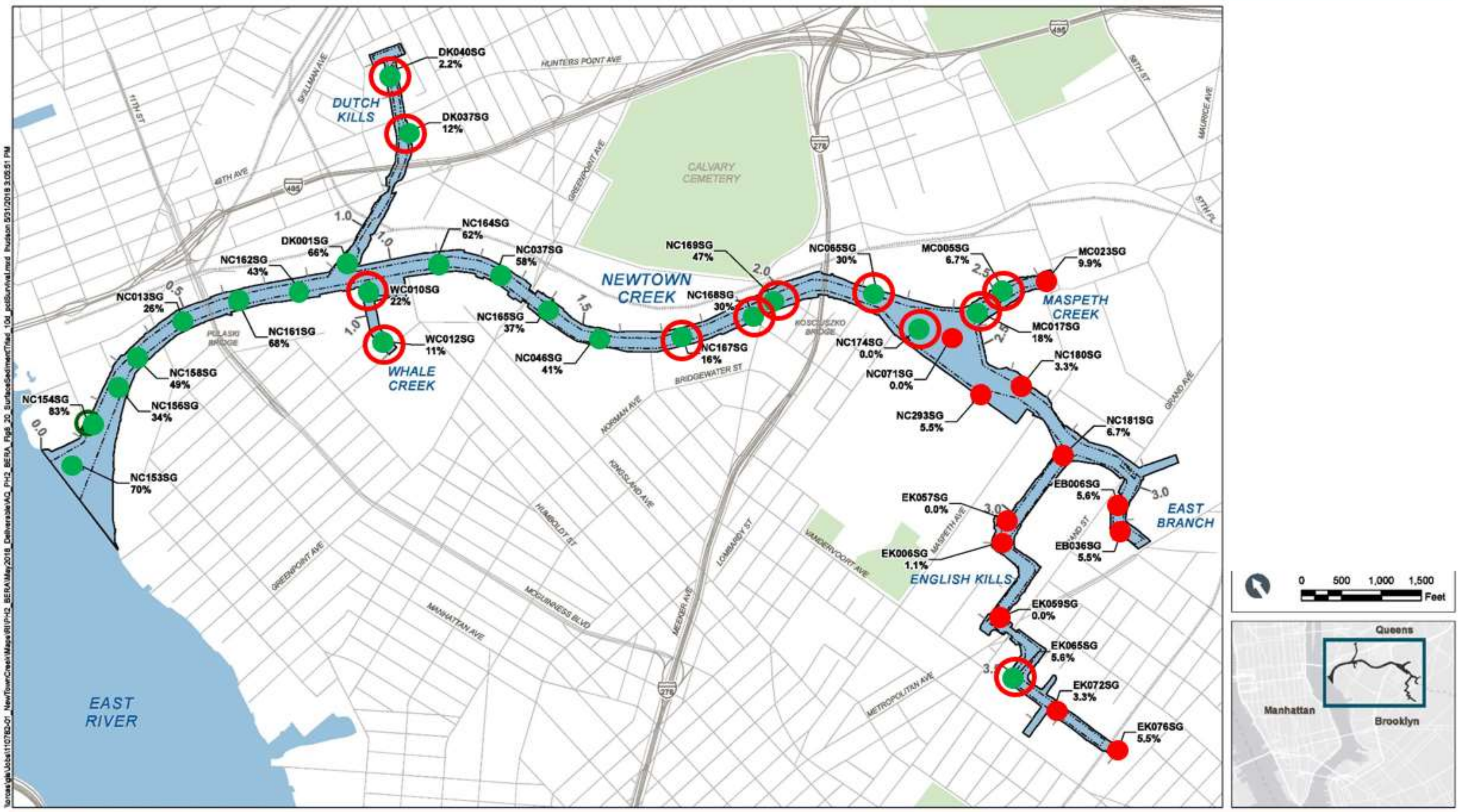
Initial interpretation shows that all six PRGs have similar footprints, with the exception of four locations – NC037, NC153, NC167, and NC169 (open red circles)



NCG's Interim Risk-Based PAH(17) PRG Spatial Distribution

NCG's calculated spatial distribution of hydrocarbon interim risk-based PRG exceedances

Initial interpretation shows that compared to EPA's values, NCG's values would yield approximately half as many locations that exceed PRGs – primarily in Dutch Kills, Whale Creek, Maspeth Creek, and the boundary of CM1.8-2.2



Evaluation of Interim Hydrocarbon Risk-Based PRG Options

Station ID	28-Day Leptocheirus Survival (%)	C10-C28 Diesel-Range Organics (mg/kg dw) PRG=1,920	C19-C36 Aliphatics - unadjusted (mg/kg dw) PRG=200	C9-C40 Total Petroleum Hydrocarbons (mg/kg dw) PRG=3,820	Measured Bulk Sediment PAH (34) (ug/g dw) PRG=100	Measured Bulk Sediment PAH(17) (ug/g dw) PRG=30	Measured Bulk Sediment Alkylated PAHs (ug/g dw) PRG=70
DK001	88.6	0.71	0.82	0.70	0.92	0.80	0.98
DK037	12.9	3.59	9.80	3.85	1.93	2.05	1.88
DK040	13.3	3.11	5.60	3.53	1.96	1.80	2.03
EB006	9.9	1.64	9.50	1.87	3.64	3.13	3.86
EB036	8.6	5.21	8.85	5.71	3.05	2.54	3.27
EK006	3	15.94	47.95	12.91	19.29	7.74	24.24
EK057	9.1	9.01	1.93	7.85	8.75	3.94	10.81
EK059	1.5	15.57	85.00	12.54	18.09	5.18	23.63
EK065	6.8	6.77	18.15	6.62	3.91	2.42	4.55
EK072	8.3	6.30	17.90	6.15	7.08	3.87	8.45
EK076	0	9.48	60.50	8.51	6.81	2.81	8.52
MC005	25.8	2.74	5.60	3.19	2.21	1.77	2.39
MC017	15.9	3.36	18.20	4.03	2.52	1.65	2.89
MC023	7	3.60	9.80	3.48	3.94	2.73	4.46
NC037	77.3	0.78	0.23	0.75	0.99	0.85	1.05
NC046	86.7	0.83	0.38	0.01	0.73	0.59	0.79
NC065	43	1.97	4.58	2.16	1.64	1.48	1.71
NC071	0	10.21	9.95	8.12	12.89	4.02	16.69
NC153	76.6	0.29	0.21	0.29	0.95	0.99	0.94
NC154	95.5	0.50	0.12	0.49	0.70	0.62	0.74
NC156	83.6	0.52	0.38	0.50	0.81	0.80	0.81
NC158	78.1	0.41	0.23	0.43	0.51	0.49	0.52
NC161	90.2	0.59	0.14	0.54	0.72	0.68	0.74
NC162	75	0.64	0.10	0.62	0.72	0.59	0.78
NC164	96.2	0.73	0.18	0.70	0.58	0.50	0.62
NC165	97	0.73	0.12	0.71	0.71	0.56	0.77
NC167	60.2	0.92	1.50	0.92	0.77	0.53	0.87
NC168	66.4	1.22	1.67	1.45	1.81	2.16	1.65
NC169	76.6	1.52	0.61	1.48	1.05	0.84	1.15
NC174	0	6.41	2.90	5.10	8.03	2.06	10.58
NC180	5.5	4.54	10.20	4.21	6.78	2.84	8.47
NC181	12.9	11.20	16.85	9.58	5.51	2.85	6.65
NC293	0.8	5.31	4.89	4.48	12.30	5.21	15.35
WC010	54.7	1.88	2.39	1.62	1.49	1.33	1.56
WC012	64.4	1.76	2.04	1.56	2.37	1.10	2.91

- Dividing the current concentrations of each of the four hydrocarbon classes by their proposed interim risk-based PRG yields a ratio:
  - Green = <1
  - Light Yellow = 1-3
  - Darker Yellow = 3-6
  - Orange = 6-10
  - Red = >10

Evaluation of Interim Hydrocarbon Risk-Based PRG Options

Station ID	28-Day Leptocheirus Survival (%)	C10-C28 Diesel-Range Organics (mg/kg dw) PRG=1,920	C19-C36 Aliphatics - unadjusted (mg/kg dw) PRG=200	C9-C40 Total Petroleum Hydrocarbons (mg/kg dw) PRG=3,820	Measured Bulk Sediment PAH (34) (ug/g dw) PRG=100	Measured Bulk Sediment PAH(17) (ug/g dw) PRG=30	Measured Bulk Sediment Alkylated PAHs (ug/g dw) PRG=70
DK001	88.6	NA	NA	NA	NA	NA	NA
DK037	12.9	0.37	1.00	0.39	0.20	0.21	0.03
DK040	13.3	0.56	1.00	0.63	0.35	0.32	0.11
EB006	9.9	0.17	1.00	0.20	0.38	0.33	0.39
EB036	8.6	0.59	1.00	0.64	0.34	0.29	0.18
EK006	3	0.33	1.00	0.27	0.40	0.16	0.29
EK057	9.1	4.67	1.00	4.07	4.53	2.04	1.93
EK059	1.5	0.18	1.00	0.15	0.21	0.06	2.67
EK065	6.8	0.37	1.00	0.36	0.22	0.13	0.99
EK072	8.3	0.35	1.00	0.34	0.40	0.22	0.50
EK076	0	0.16	1.00	0.14	0.11	0.05	0.90
MC005	25.8	0.49	1.00	0.57	0.39	0.32	0.43
MC017	15.9	0.18	1.00	0.22	0.14	0.09	0.29
MC023	7	0.37	1.00	0.36	0.40	0.28	0.25
NC037	77.3	NA	NA	NA	NA	NA	0.02
NC046	86.7	NA	NA	NA	NA	NA	0.53
NC065	43	0.43	1.00	0.47	0.36	0.32	0.72
NC071	0	1.03	1.00	0.82	1.30	0.40	1.64
NC153	76.6	NA	NA	NA	NA	NA	0.56
NC154	95.5	NA	NA	NA	NA	NA	0.36
NC156	83.6	NA	NA	NA	NA	NA	0.08
NC158	78.1	NA	NA	NA	NA	NA	0.11
NC161	90.2	NA	NA	NA	NA	NA	0.26
NC162	75	NA	NA	NA	NA	NA	0.40
NC164	96.2	NA	NA	NA	NA	NA	NA
NC165	97	NA	NA	NA	NA	NA	NA
NC167	60.2	0.61	1.00	0.62	0.51	0.35	NA
NC168	66.4	0.73	1.00	0.87	1.08	1.30	NA
NC169	76.6	NA	NA	NA	NA	NA	NA
NC174	0	2.21	1.00	1.76	2.77	0.71	NA
NC180	5.5	0.44	1.00	0.41	0.66	0.28	NA
NC181	12.9	0.66	1.00	0.57	0.33	0.17	NA
NC293	0.8	1.09	1.00	0.92	2.52	1.06	NA
WC010	54.7	0.78	1.00	0.68	0.62	0.56	NA
WC012	64.4	0.86	1.00	0.76	1.16	0.54	NA

- Assuming sediment concentrations at all locations were below the C19-C36 PRG (200 mg/kg), and assuming all hydrocarbon concentrations were reduced by the same percentage
  - Shows most, but not all locations would yield a ratio <1
  - PAH(34) would have the most locations with a ratio >1
- Assuming sediment concentrations at all locations were below the interim risk-based PRGs for both C19-C36 and PAH(34) would bring all locations to a ratio <1

Conclusion

- The correlations between 28-D survival and bulk sediment concentrations of C9-C40 TPH, C10-C28 DRO, C19-C36, PAH(34), PAH(17), and Alkylated PAHs are all good, and all are similar.
- EPA concludes that the following hydrocarbon concentrations should be used on an interim basis until final risk-based PRGs can be developed:

Bulk Sediment PAH(34) at 100 mg/kg dw

Bulk Sediment C19-C36 at 200 mg/kg dw