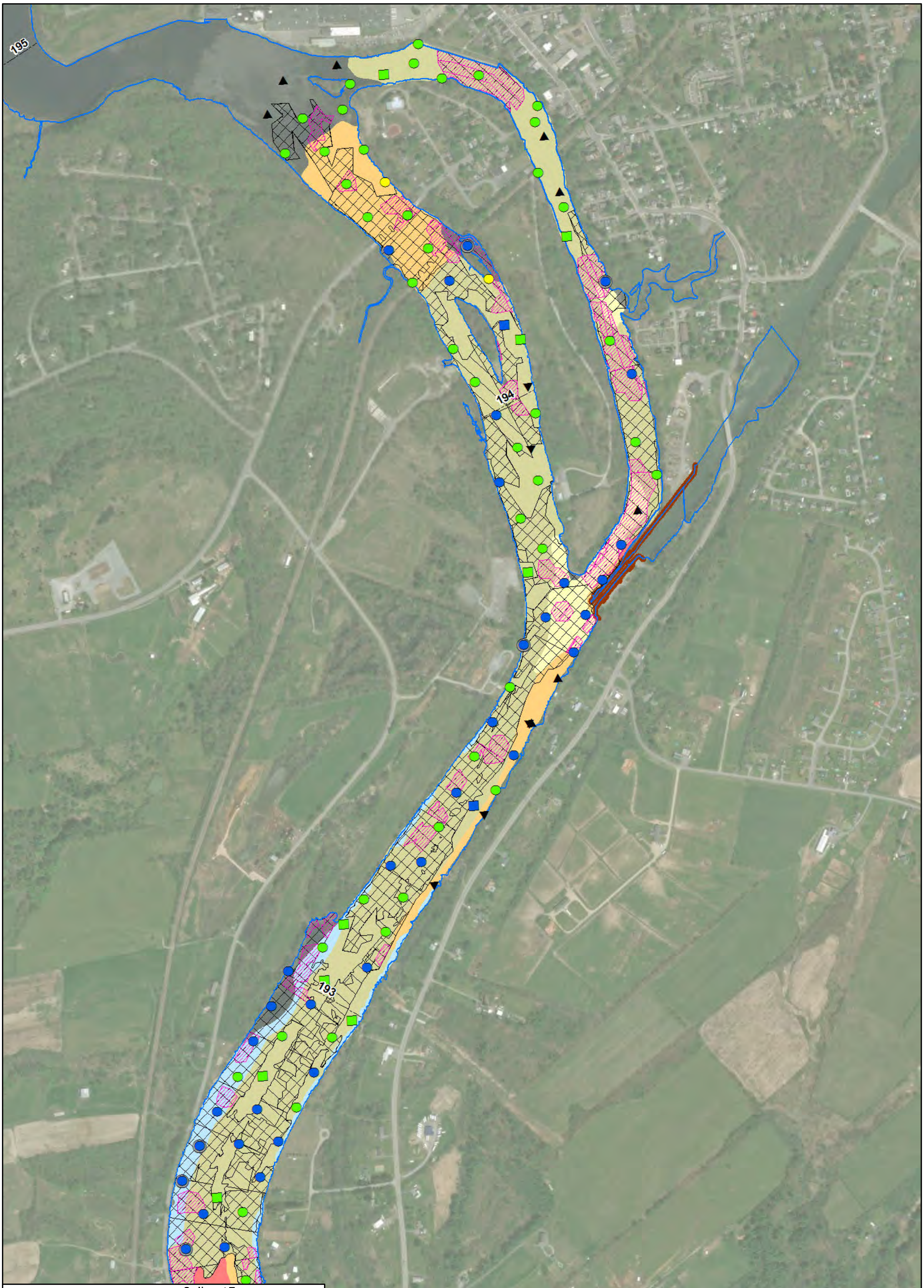


Legend

Tri+ PCB (mg/kg)

🟦 ●	0-0.25 (Less than MNA Expectation)
🟩 ●	0.25-10.0 (Less than RS1 Surface Criteria)
🟨 ●	10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
🟧 ●	>30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

🟦	Silt
🟨	Silt and Sand
🟧	Gravel
🟫	Transitional
🟥	Bed Rock

●	NYSDEC Sampling Location 2017
■	GE OM&M Sampling Location 2016
◉ ▣	NonDetect Values
▲	NYSDEC Abandoned Location 2017
▼	GE OM&M Abandoned Location 2016
▧	Dredge Area
▨	Backfilled Area
▨	Capped Area
▬	Dam and Lock Locations
☐	Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

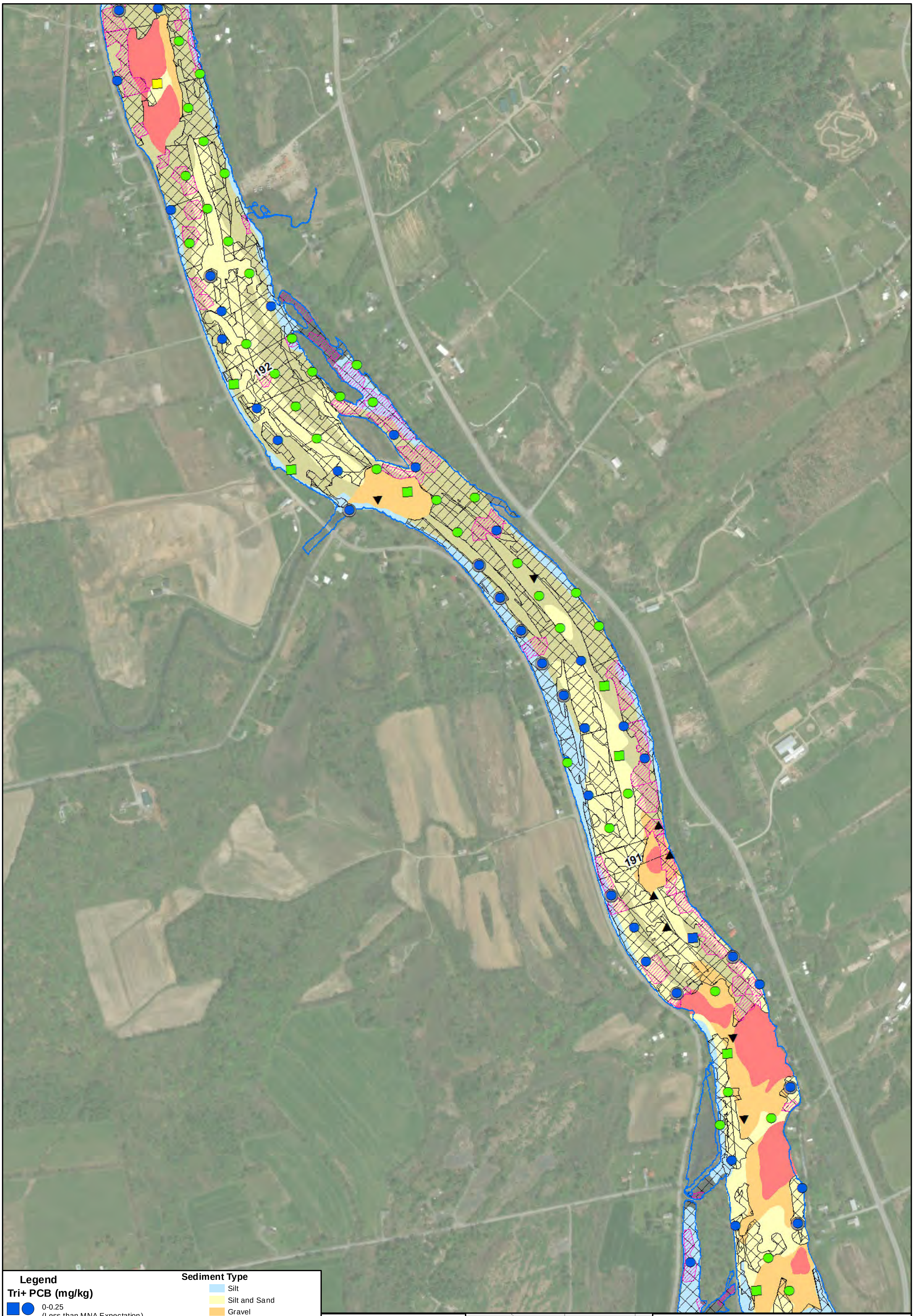
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3a

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd

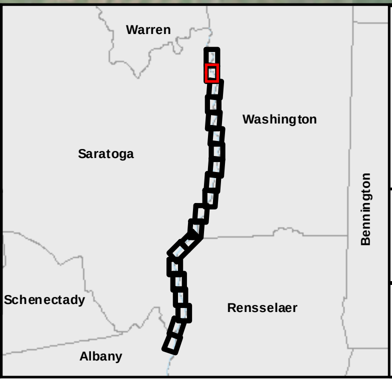


*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019



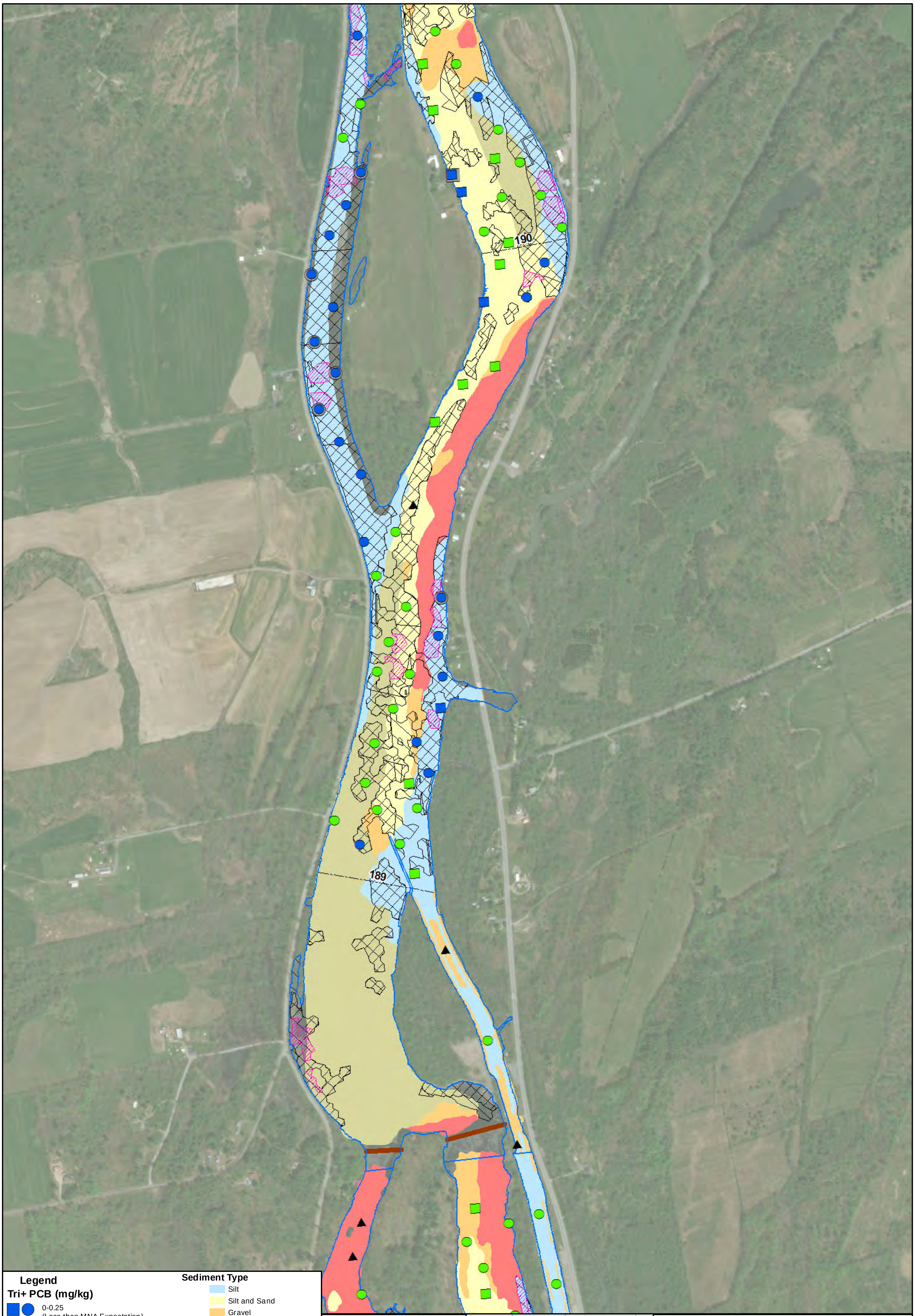
Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3b

N
0 15 30 Miles

Document Path: M:\02859919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

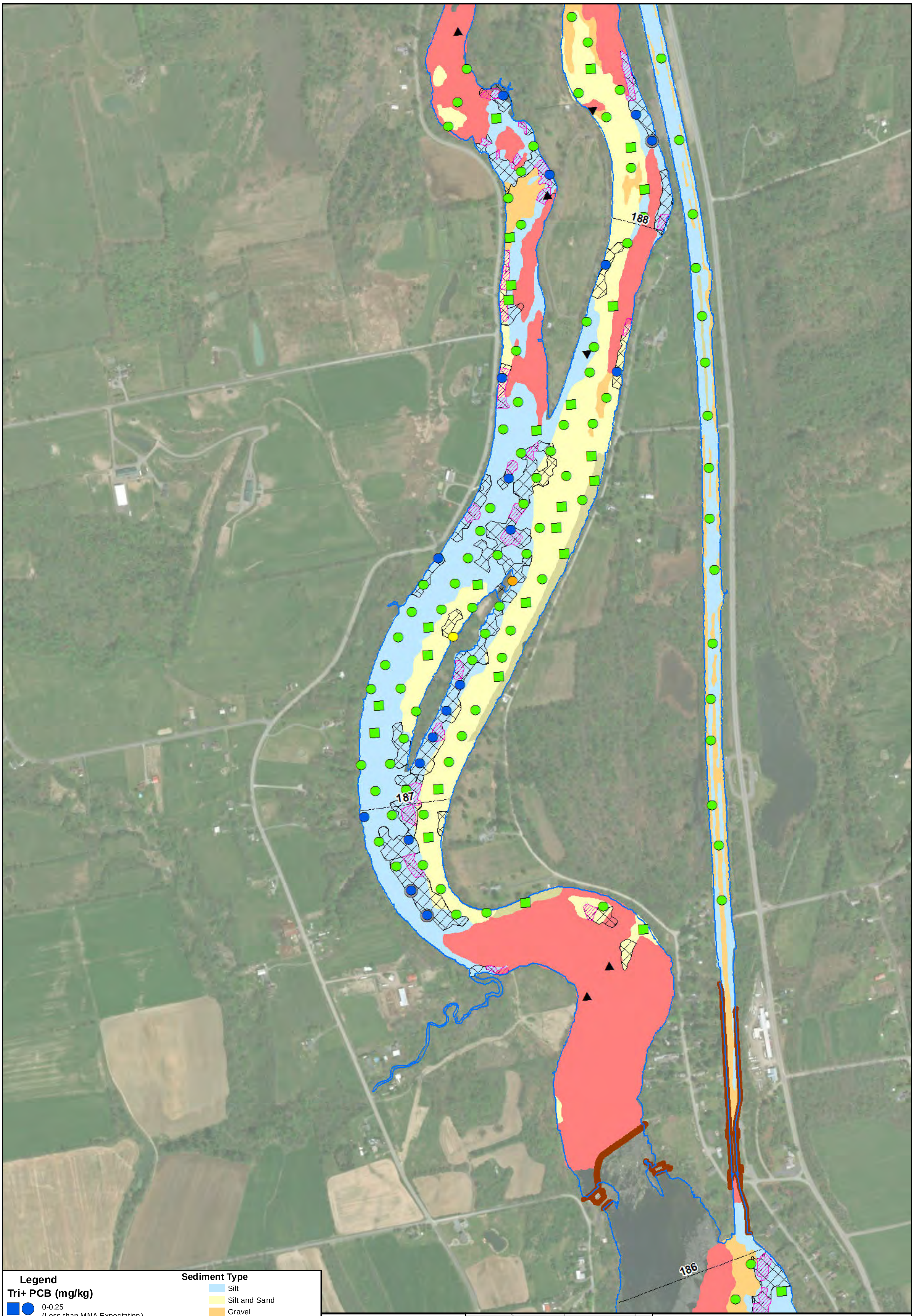
April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3c

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

🟦 ● 0-0.25 (Less than MNA Expectation)

🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)

🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)

🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

● NYSDEC Sampling Location 2017

■ GE OM&M Sampling Location 2016

● ■ NonDetect Values

▲ NYSDEC Abandoned Location 2017

▼ GE OM&M Abandoned Location 2016

▧ Dredge Area

▨ Backfilled Area

▨ Capped Area

Dam and Lock Locations

☐ Shoreline

*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

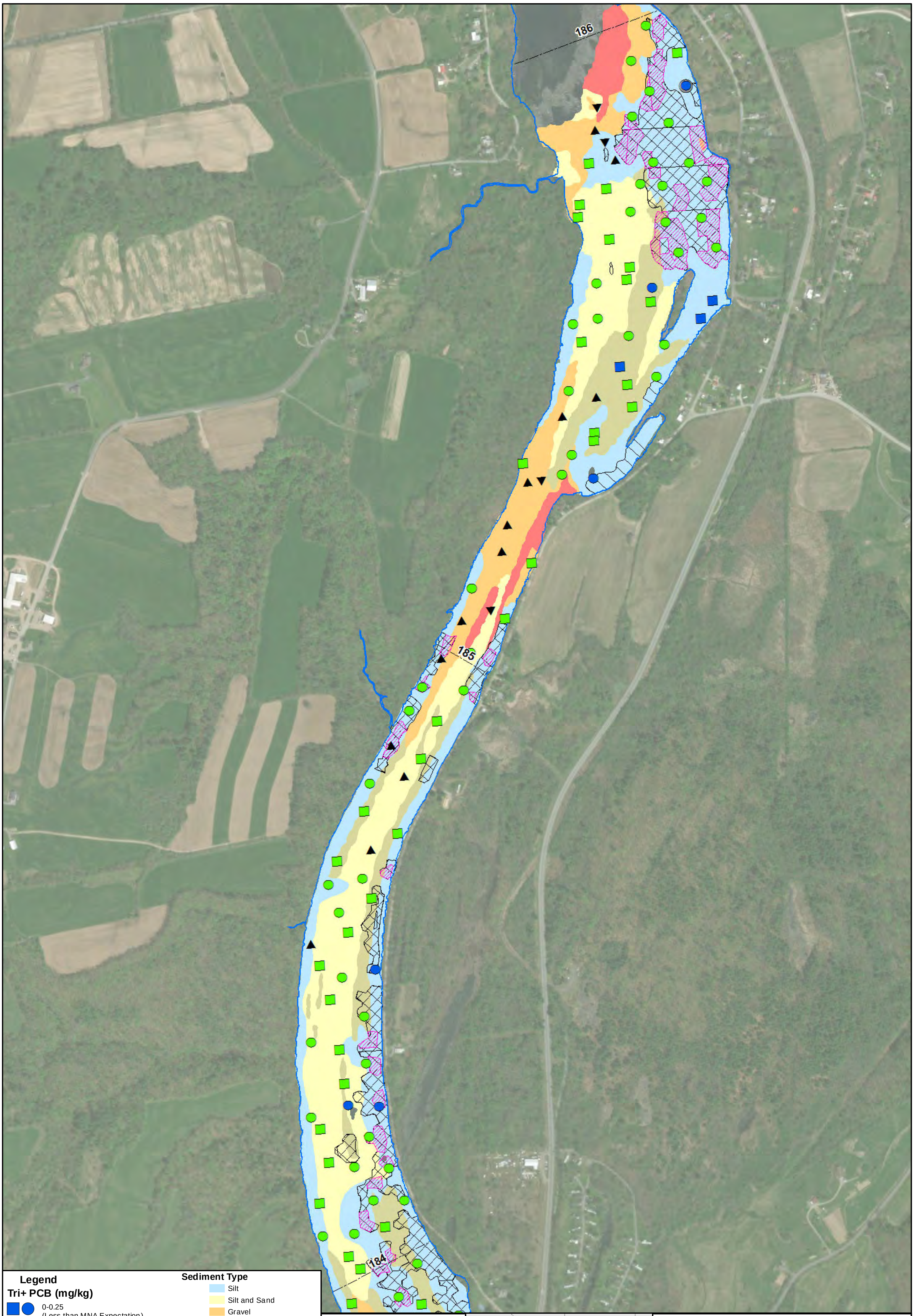
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3d

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- ▨ Transitional
- 🟥 Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▨ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ☐ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3e

N

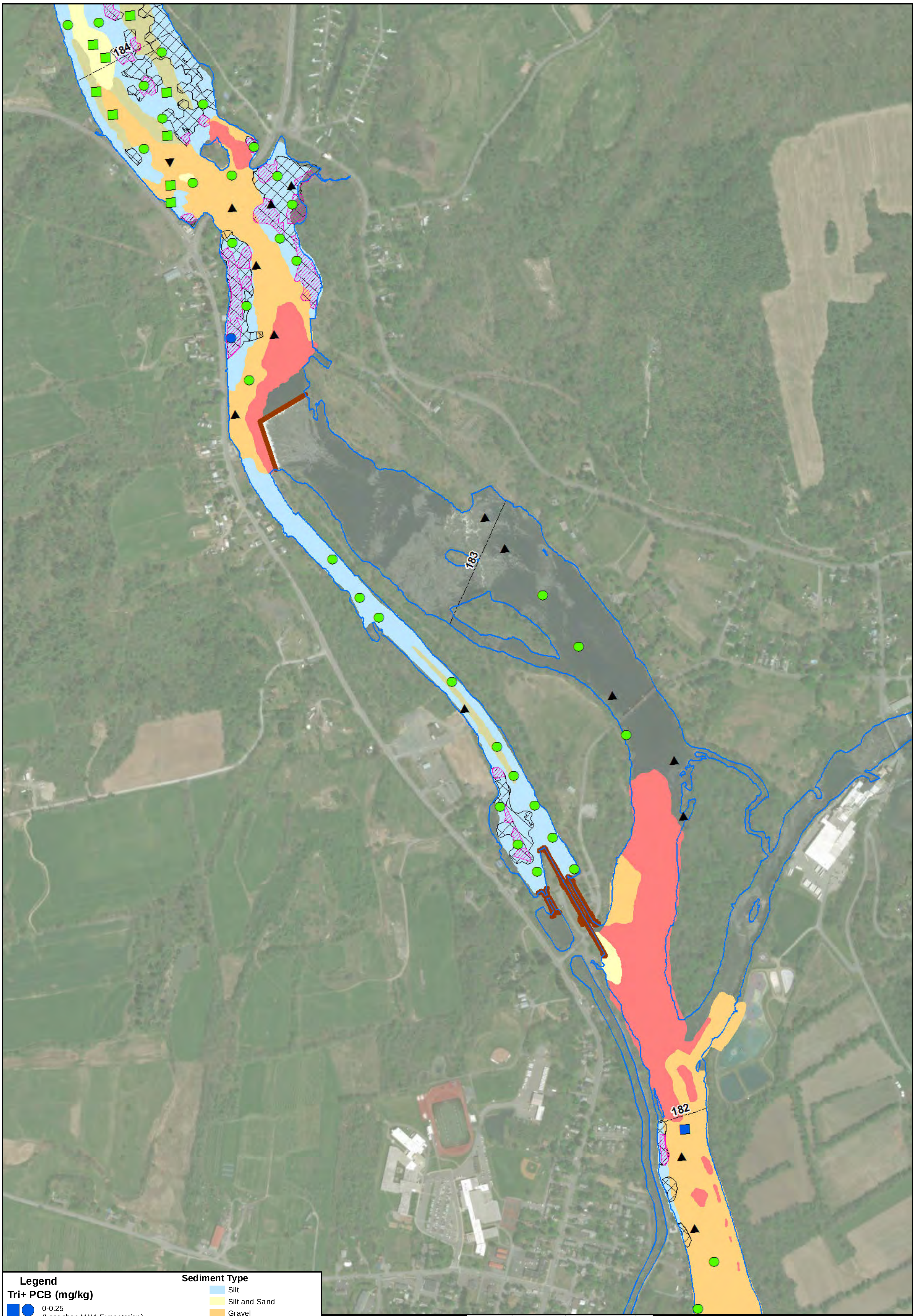
0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3f



Legend

Tri+ PCB (mg/kg)

🟦 ●	0-0.25 (Less than MNA Expectation)
🟩 ●	0.25-10.0 (Less than RS1 Surface Criteria)
🟨 ●	10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
🟧 ●	>30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

▭	Silt
▭	Silt and Sand
▭	Gravel
▭	Transitional
🟥	Bed Rock

●	NYSDEC Sampling Location 2017
■	GE OM&M Sampling Location 2016
◉ ▣	NonDetect Values
▲	NYSDEC Abandoned Location 2017
▼	GE OM&M Abandoned Location 2016
▧	Dredge Area
▨	Backfilled Area
▨	Capped Area
▬	Dam and Lock Locations
▭	Shoreline

*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

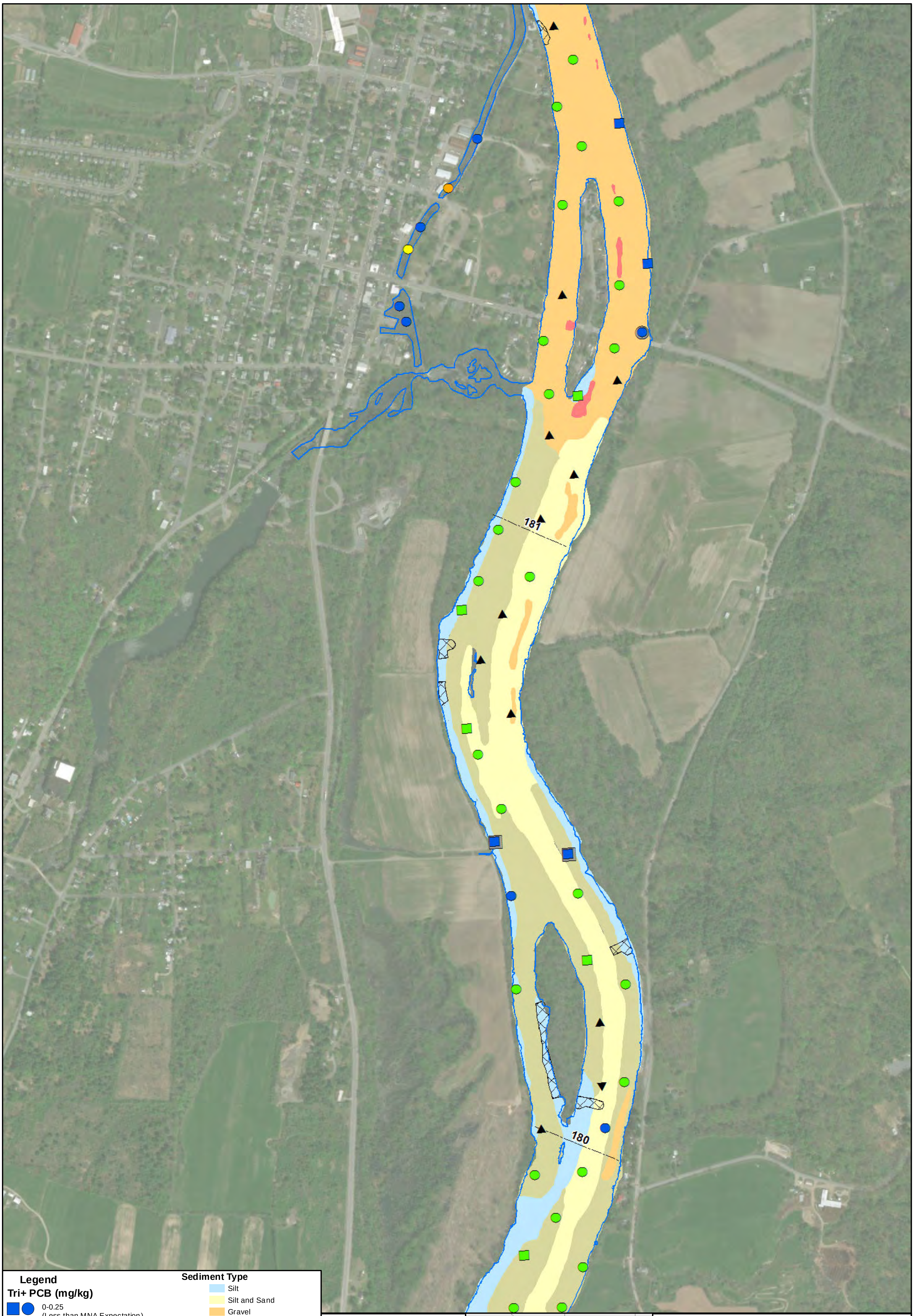
Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- ▨ Transitional
- 🟥 Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ● ■ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ☐ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

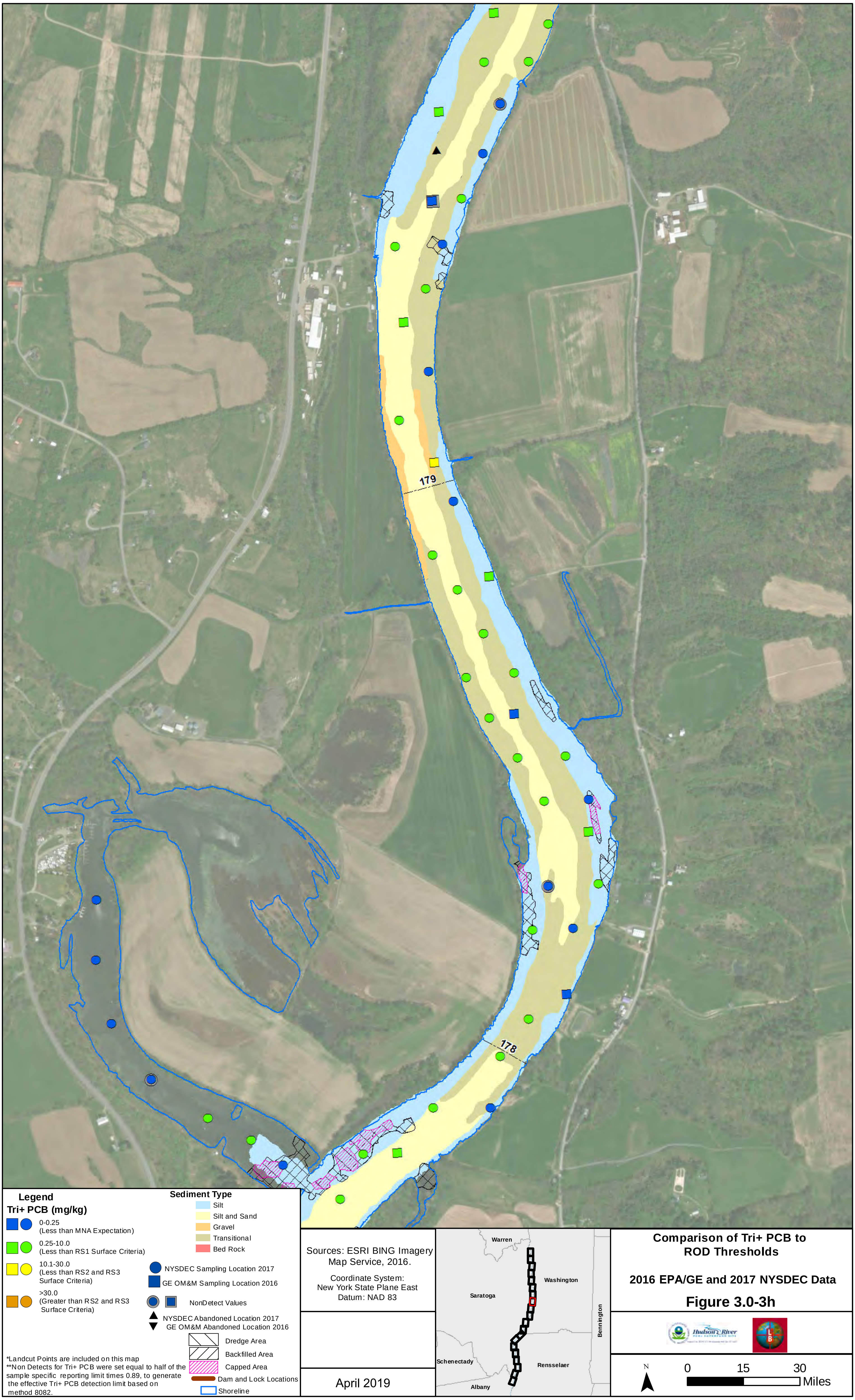
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3g

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

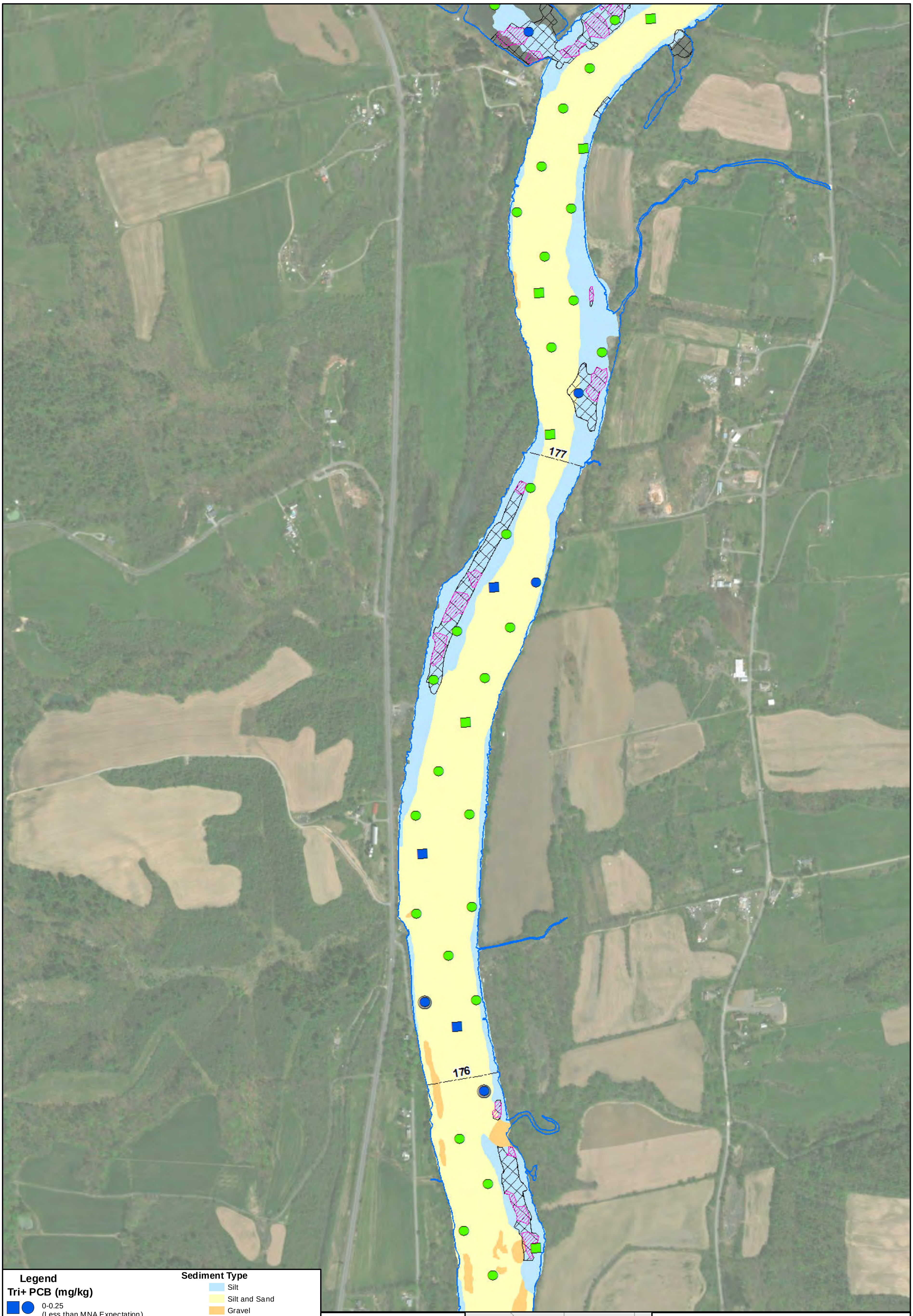
April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3h

Document Path: M:\02859919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- ■ Silt
- ■ Silt and Sand
- ■ Gravel
- ■ Transitional
- ■ Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ☐ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

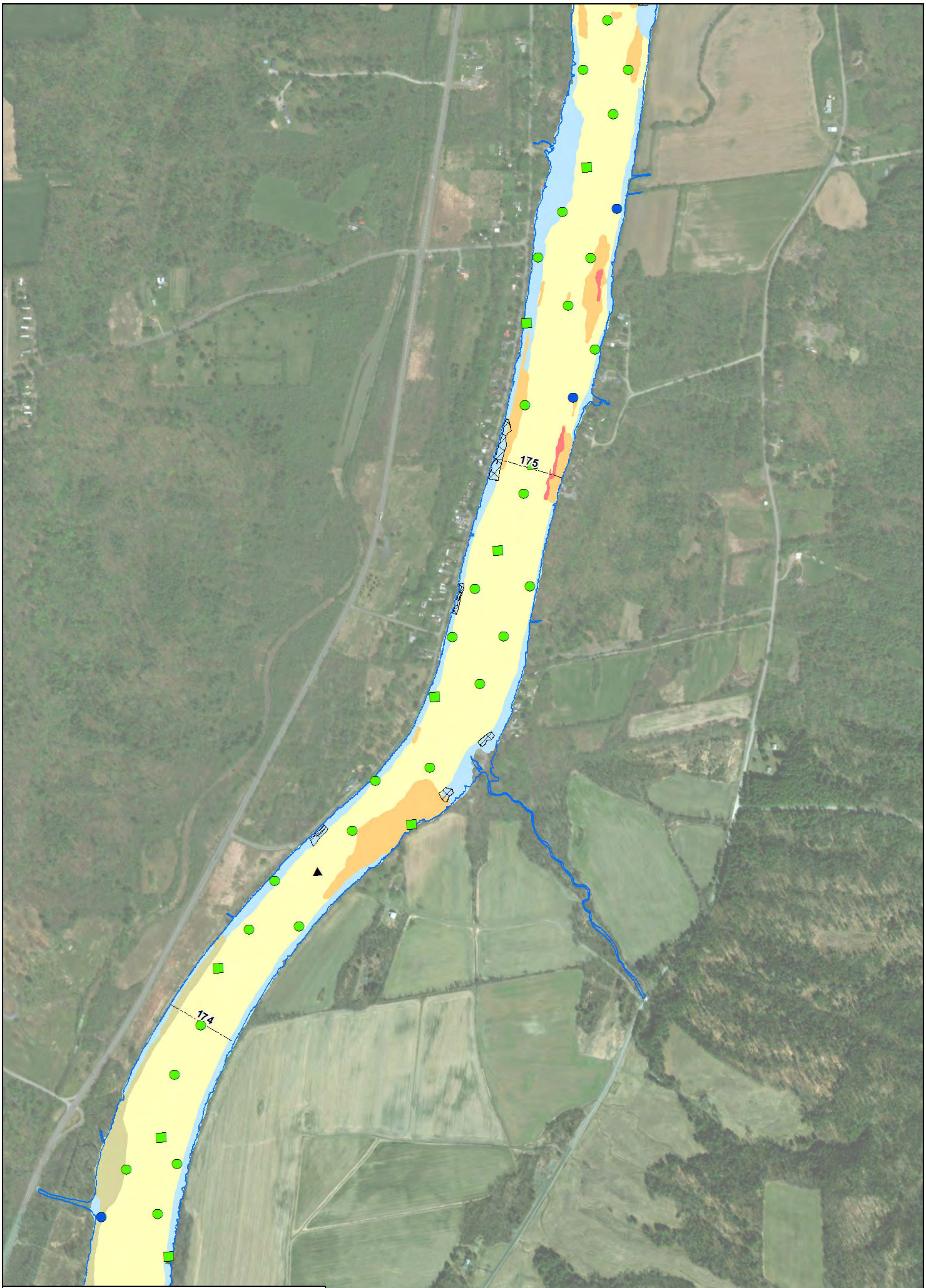
April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3i

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ☐ Shoreline

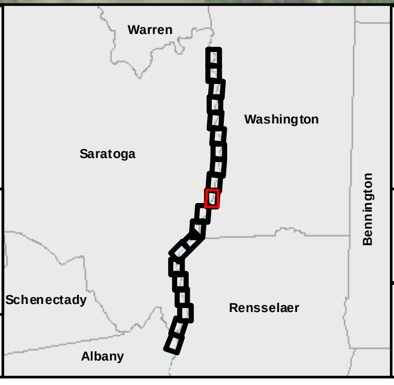
*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019



Comparison of Tri+ PCB to ROD Thresholds

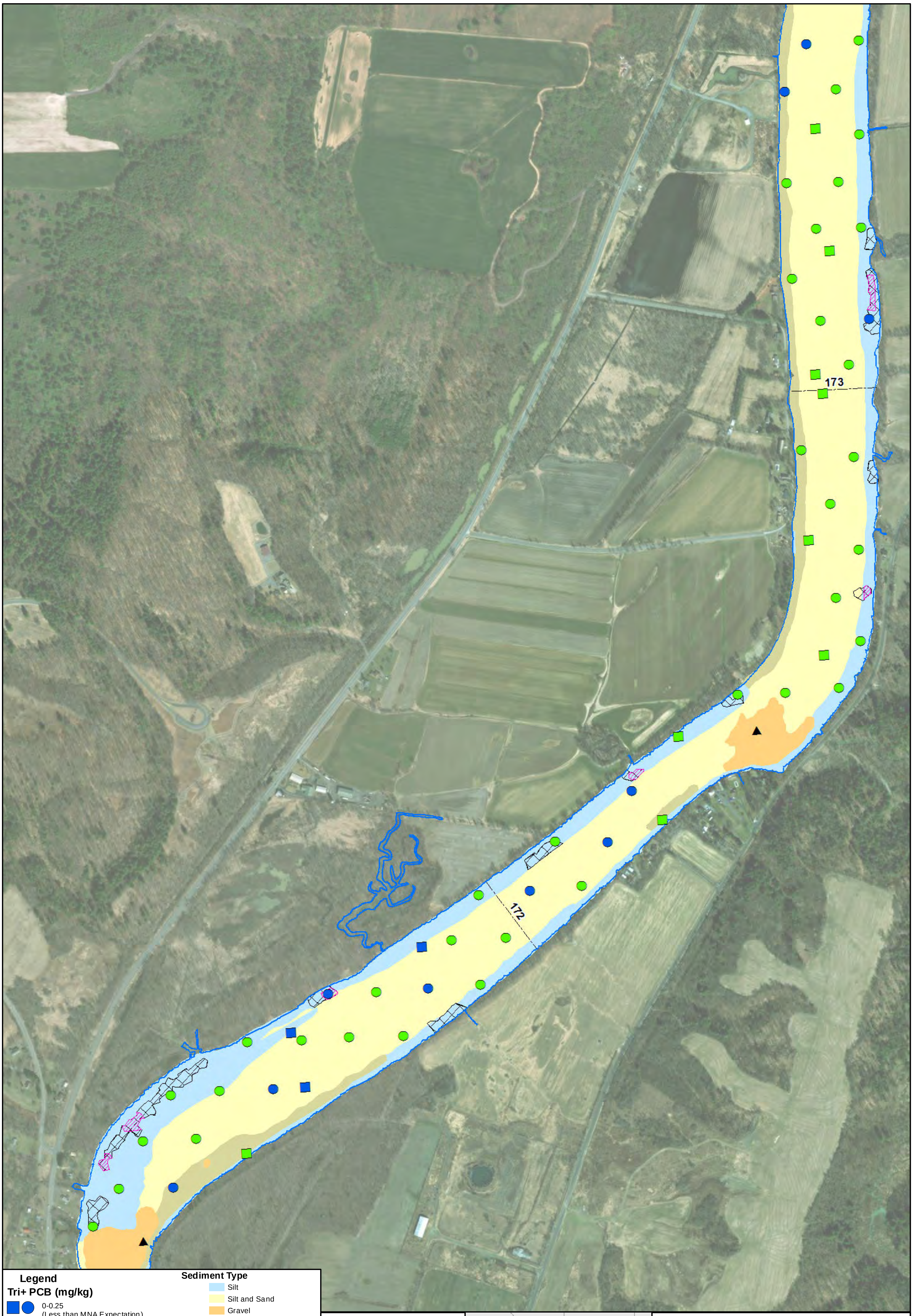
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3j

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 🔵 0-0.25 (Less than MNA Expectation)
- 🟩 🟢 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 🟡 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 🟠 >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ▭ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

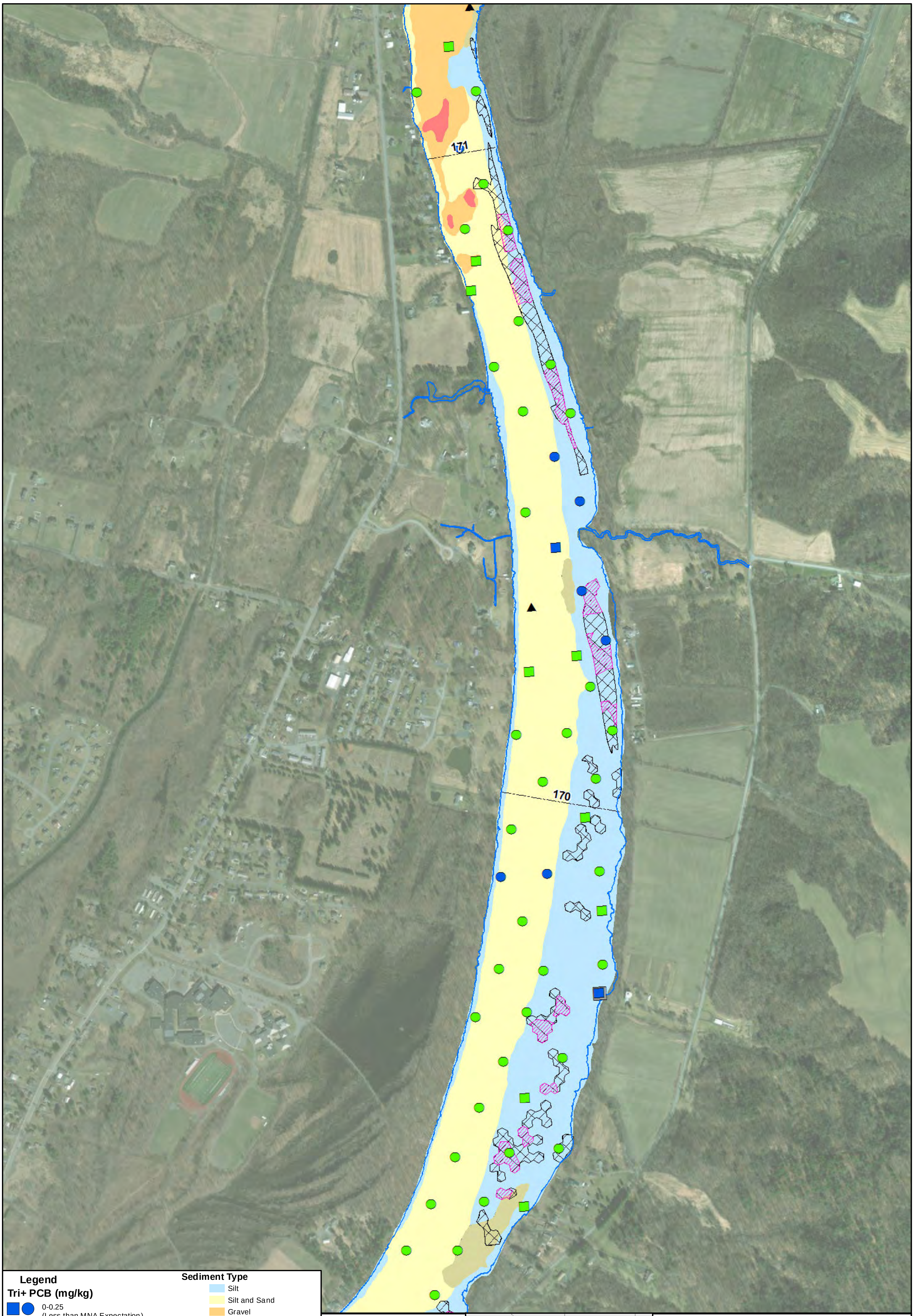
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3k

N

0 15 30 Miles

Document Path: M:\02859919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ● ■ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ☐ Shoreline

*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

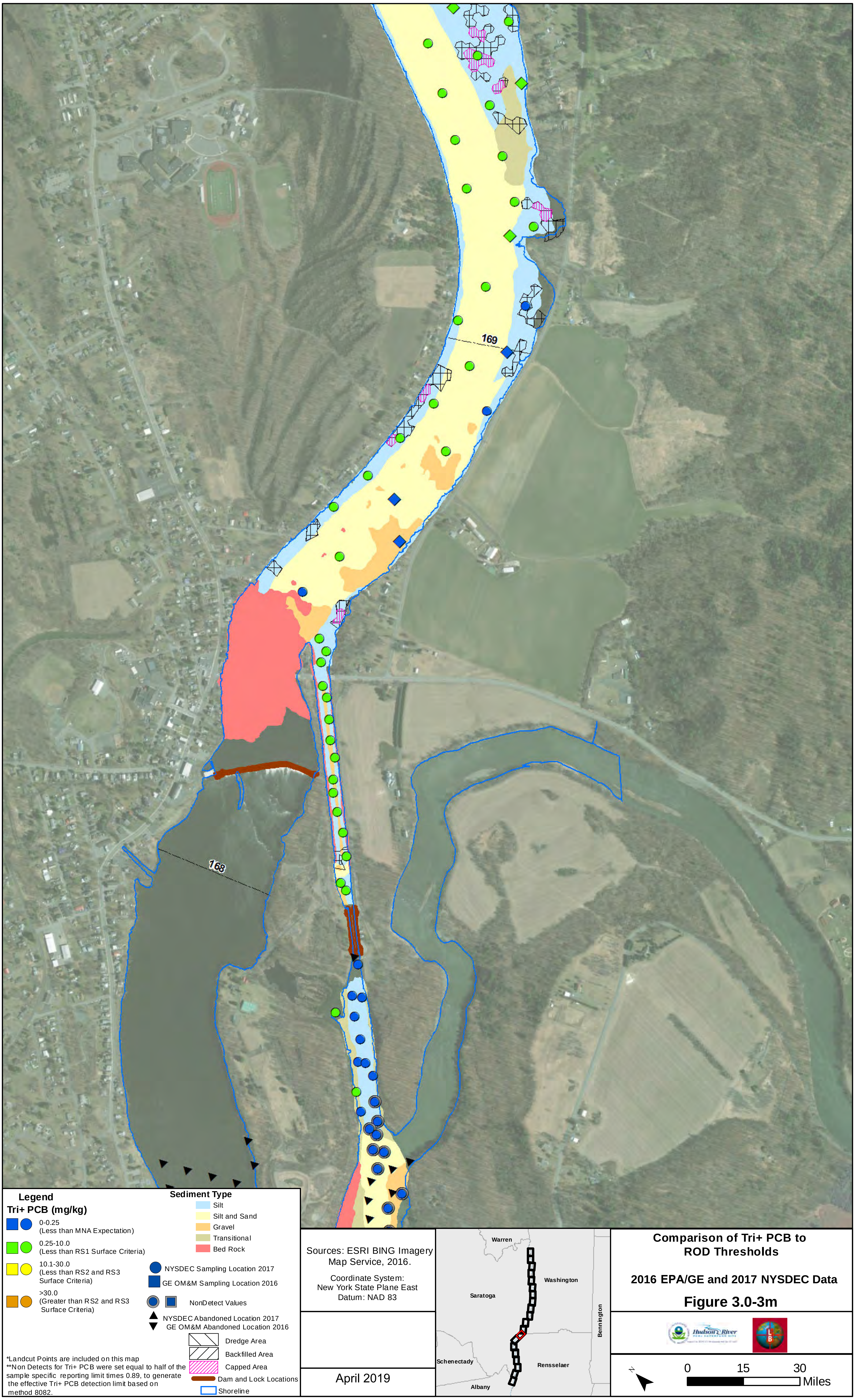
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3l

N

0 15 30
Miles

Document Path: M:\02859919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

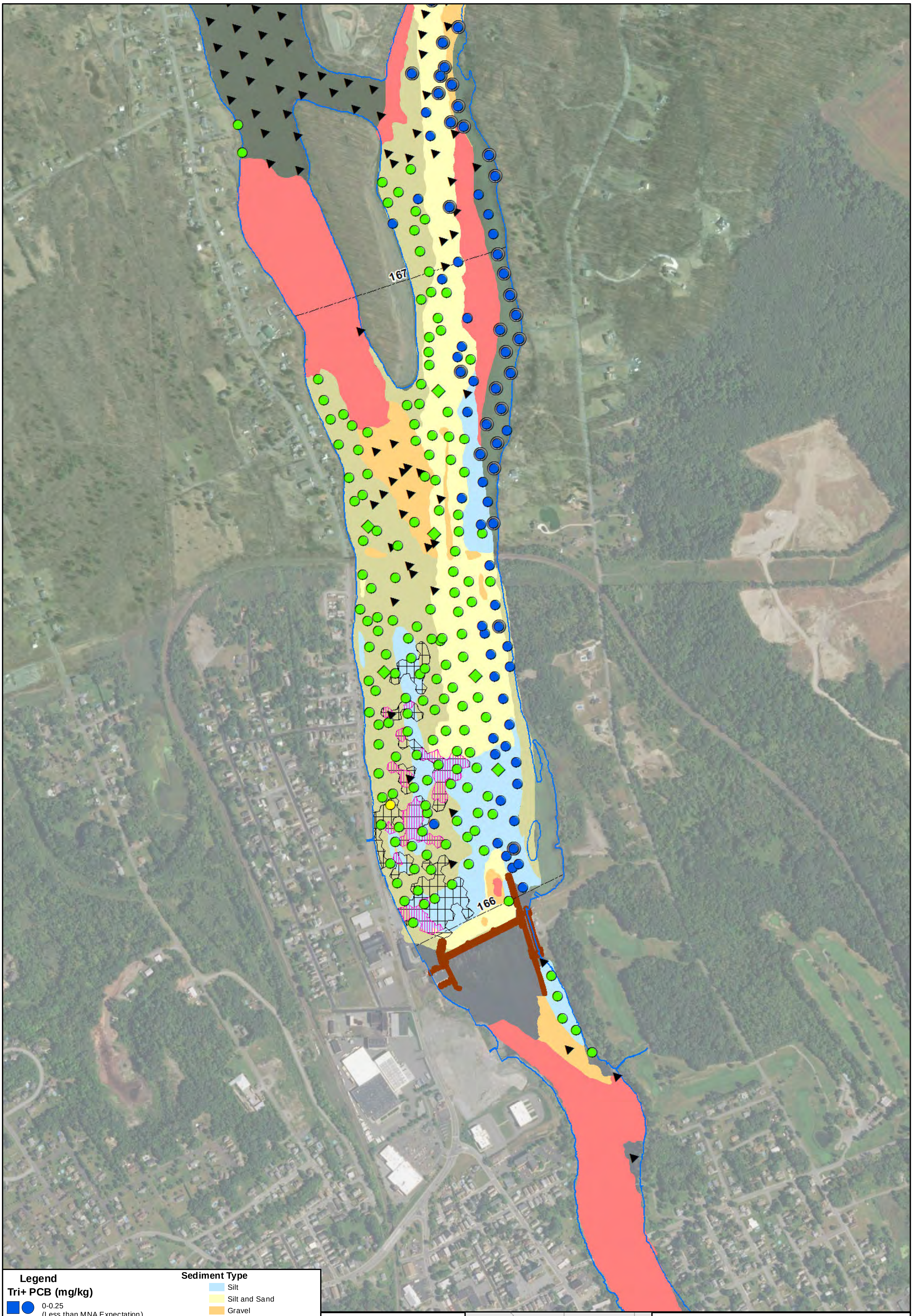
April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3m

Document Path: M:\0285919\GIS\OM_M3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 🔵 0-0.25 (Less than MNA Expectation)
- 🟩 🟢 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 🟡 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 🟠 >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ▭ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

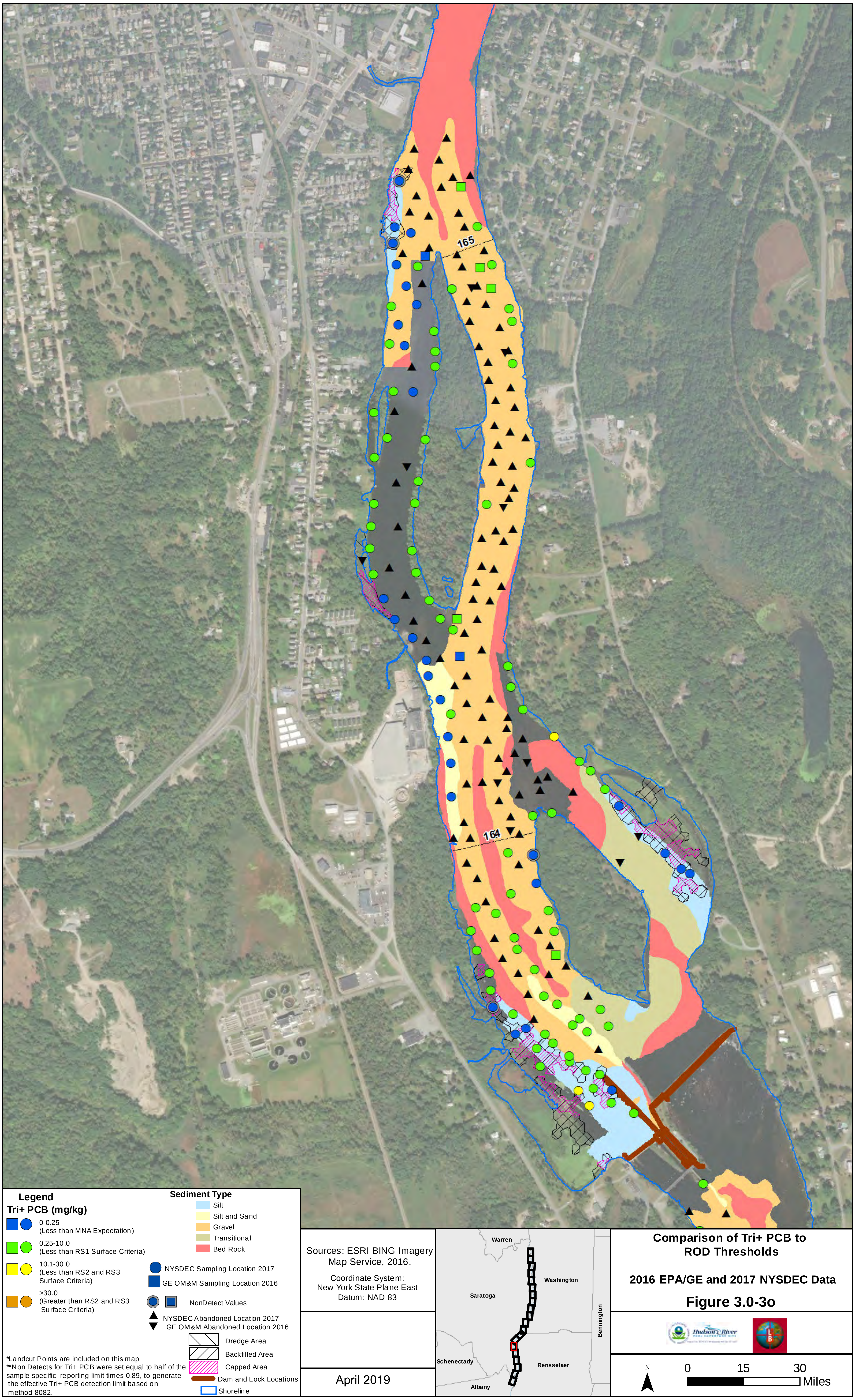
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3n

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

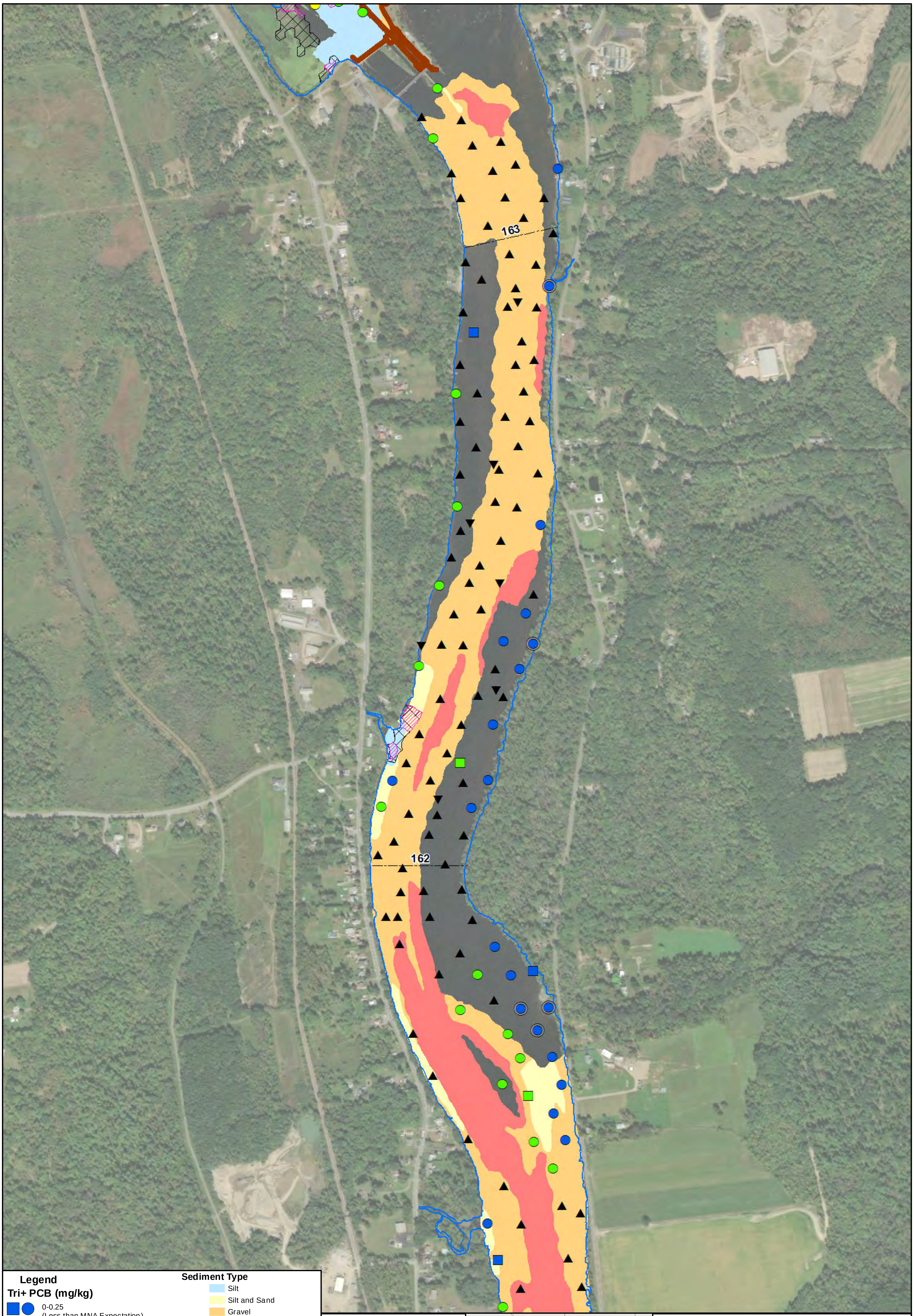
April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3o

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

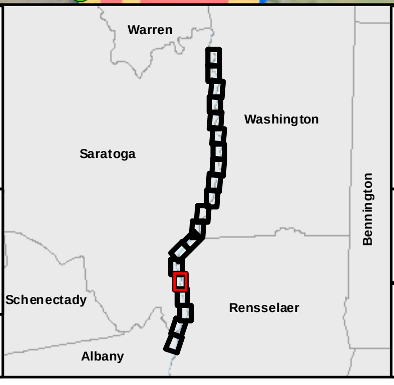
- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ☐ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019



Comparison of Tri+ PCB to ROD Thresholds

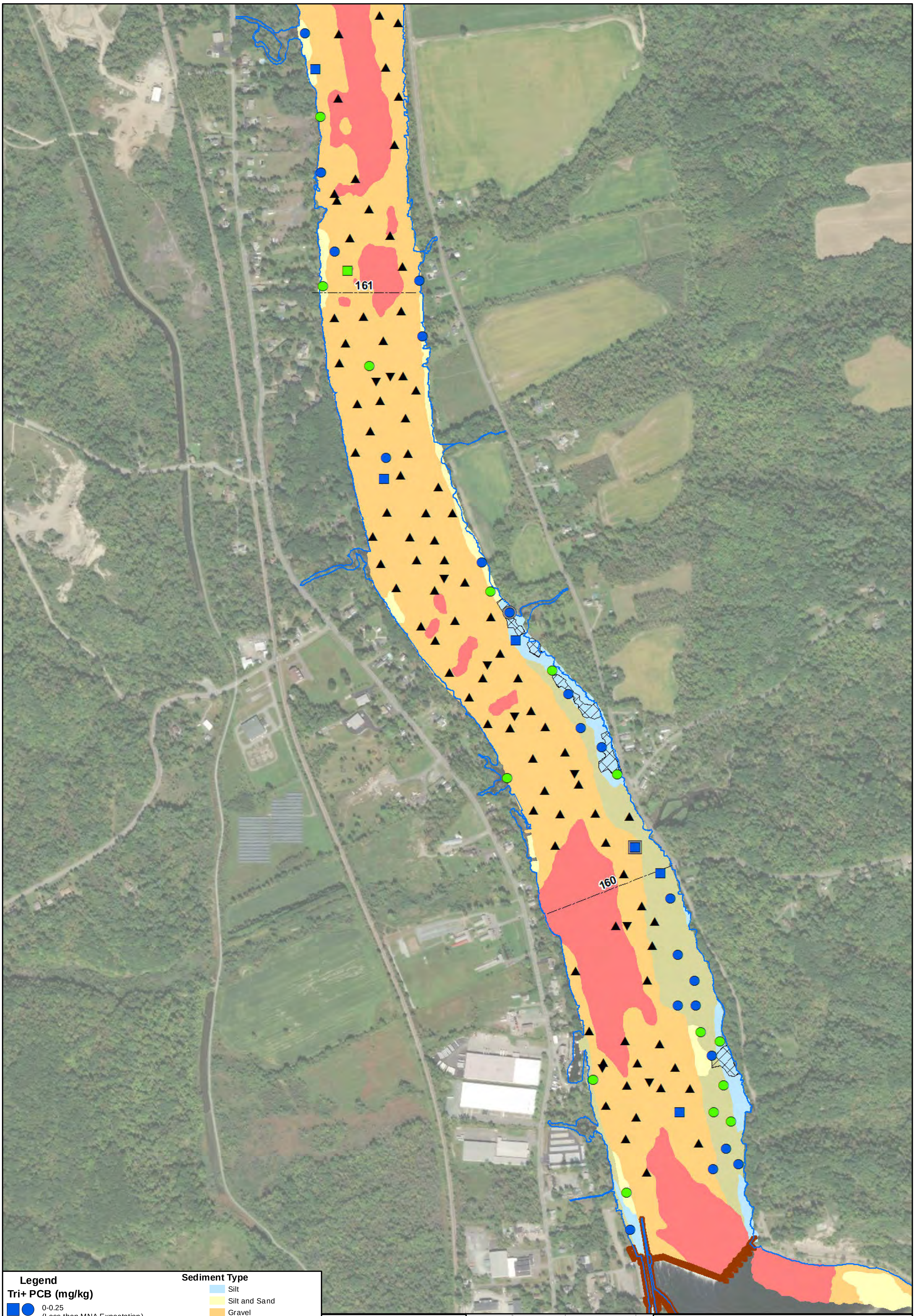
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3p

N

0 15 30 Miles

Document Path: M:\02859191\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

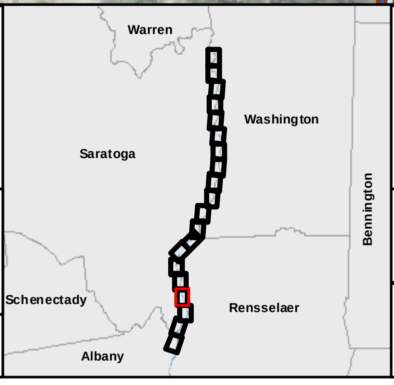
- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam and Lock Locations
- ▭ Shoreline

*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019



Comparison of Tri+ PCB to ROD Thresholds

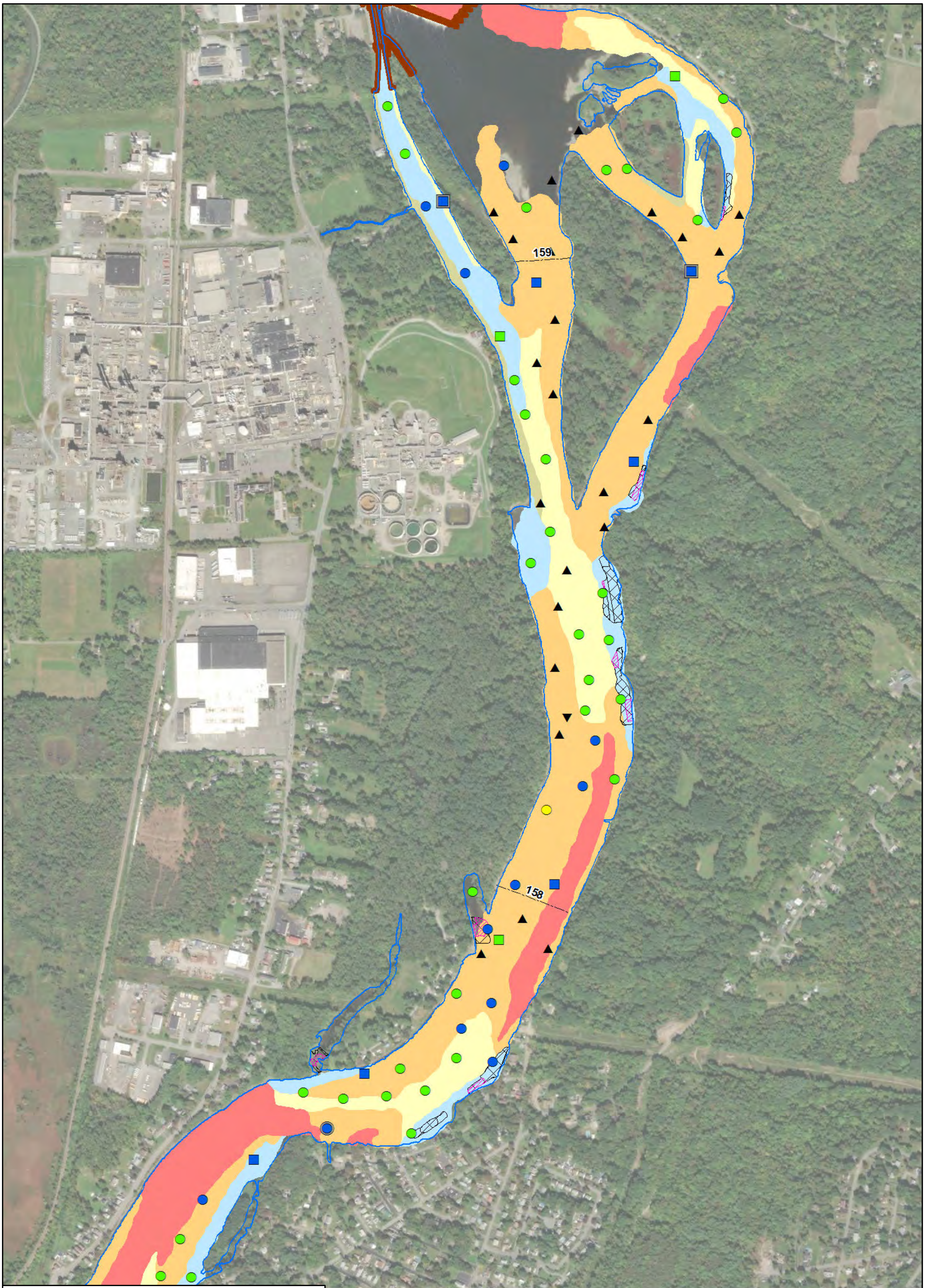
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3q

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Legend

Tri+ PCB (mg/kg)

🟦 ●	0-0.25 (Less than MNA Expectation)
🟩 ●	0.25-10.0 (Less than RS1 Surface Criteria)
🟨 ●	10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
🟧 ●	>30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

🟦	Silt
🟨	Silt and Sand
🟧	Gravel
🟫	Transitional
🟥	Bed Rock

●	NYSDEC Sampling Location 2017
■	GE OM&M Sampling Location 2016
◉ ▣	NonDetect Values
▲	NYSDEC Abandoned Location 2017
▼	GE OM&M Abandoned Location 2016
▧	Dredge Area
▨	Backfilled Area
▨	Capped Area
▬	Dam and Lock Locations
☐	Shoreline

*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

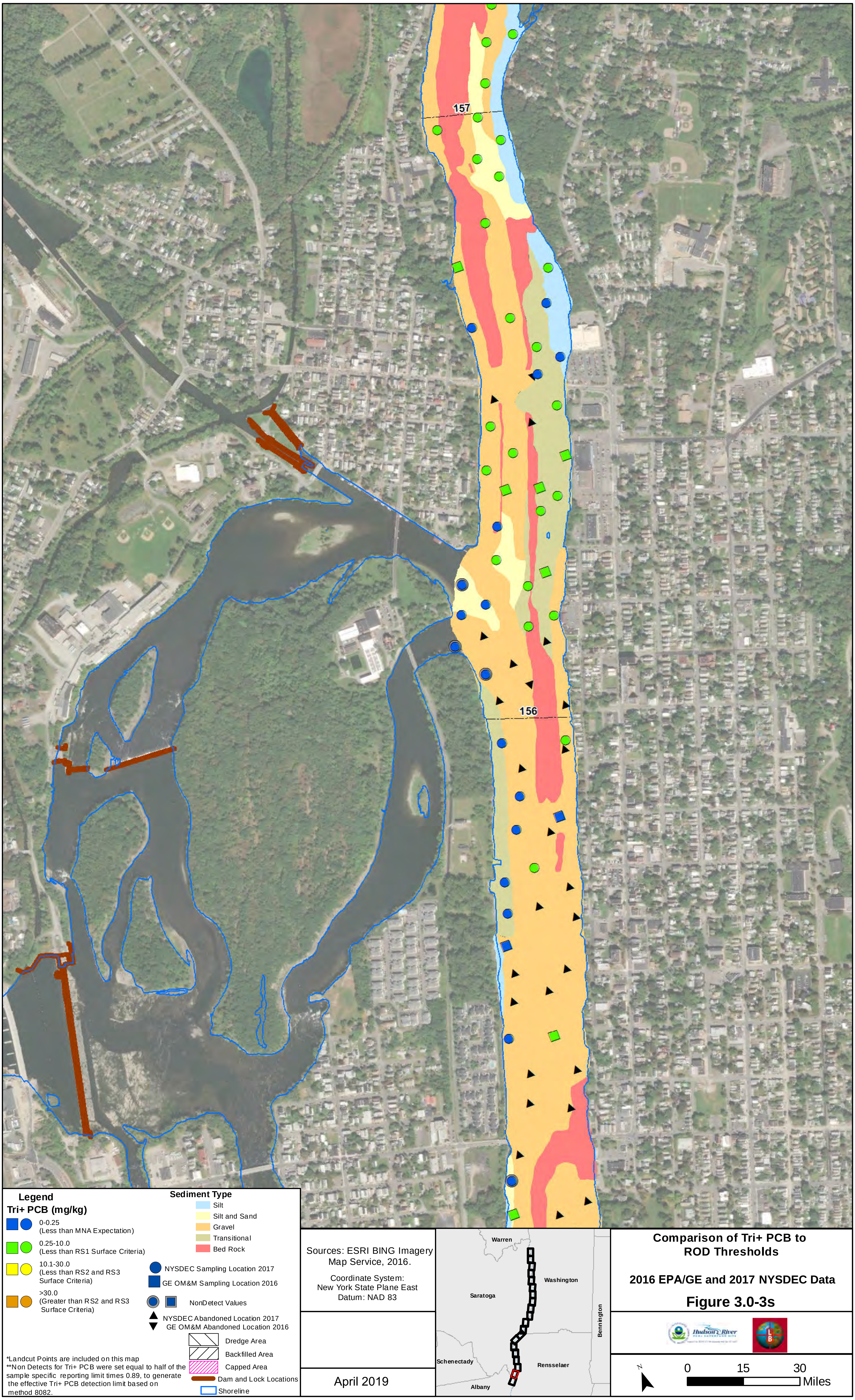
2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3r

N

0 15 30 Miles

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



*Landcut Points are included on this map
**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

April 2019

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3s

Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd

Comparison of Tri+ PCB to ROD Thresholds

2016 EPA/GE and 2017 NYSDEC Data

Figure 3.0-3t

Legend

Tri+ PCB (mg/kg)

- 🟦 ● 0-0.25 (Less than MNA Expectation)
- 🟩 ● 0.25-10.0 (Less than RS1 Surface Criteria)
- 🟨 ● 10.1-30.0 (Less than RS2 and RS3 Surface Criteria)
- 🟧 ● >30.0 (Greater than RS2 and RS3 Surface Criteria)

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ◉ ▣ NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- Dam and Lock Locations
- ☐ Shoreline

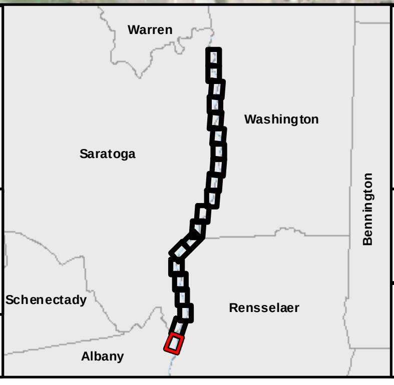
*Landcut Points are included on this map

**Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

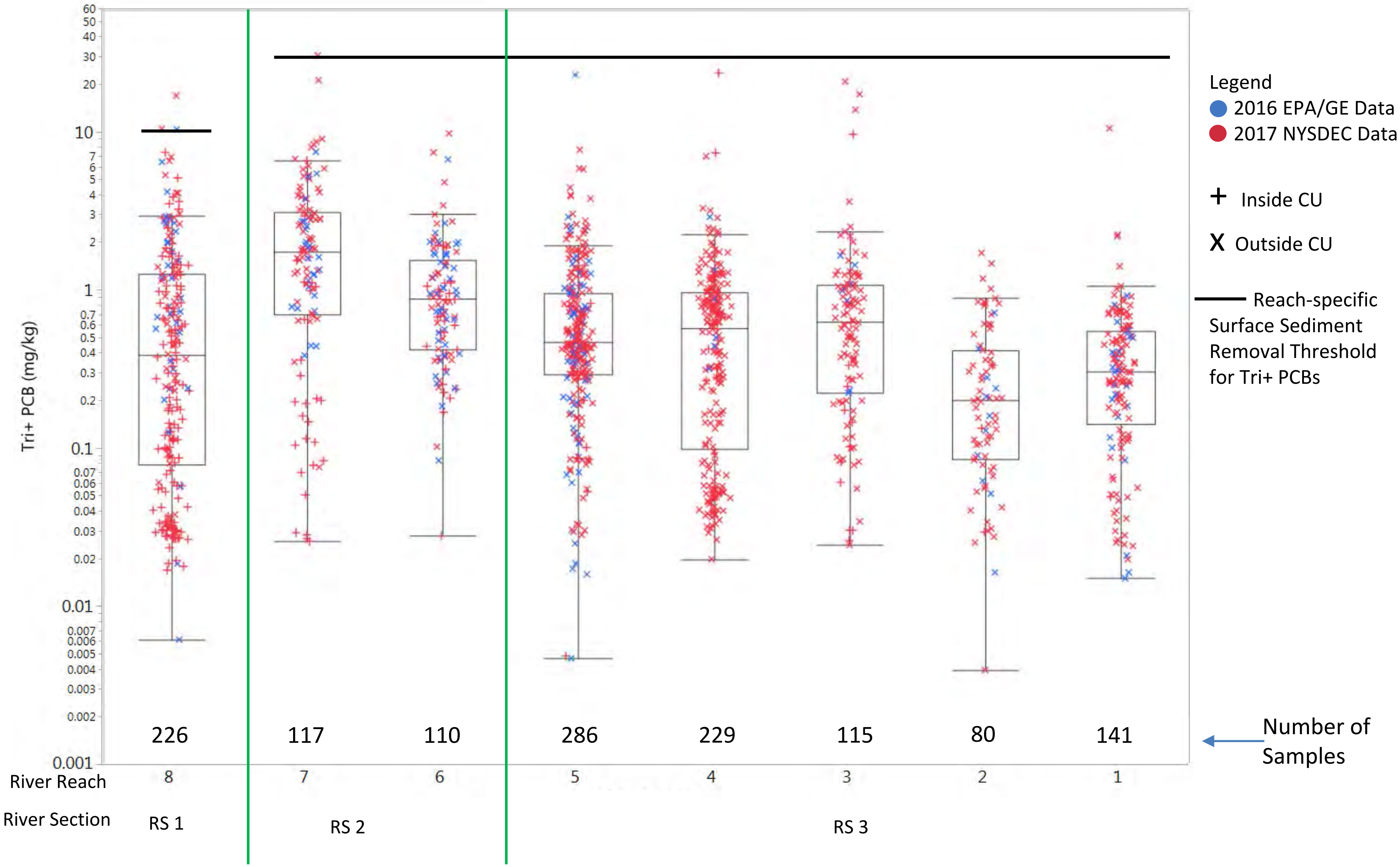
April 2019



N

0 15 30 Miles

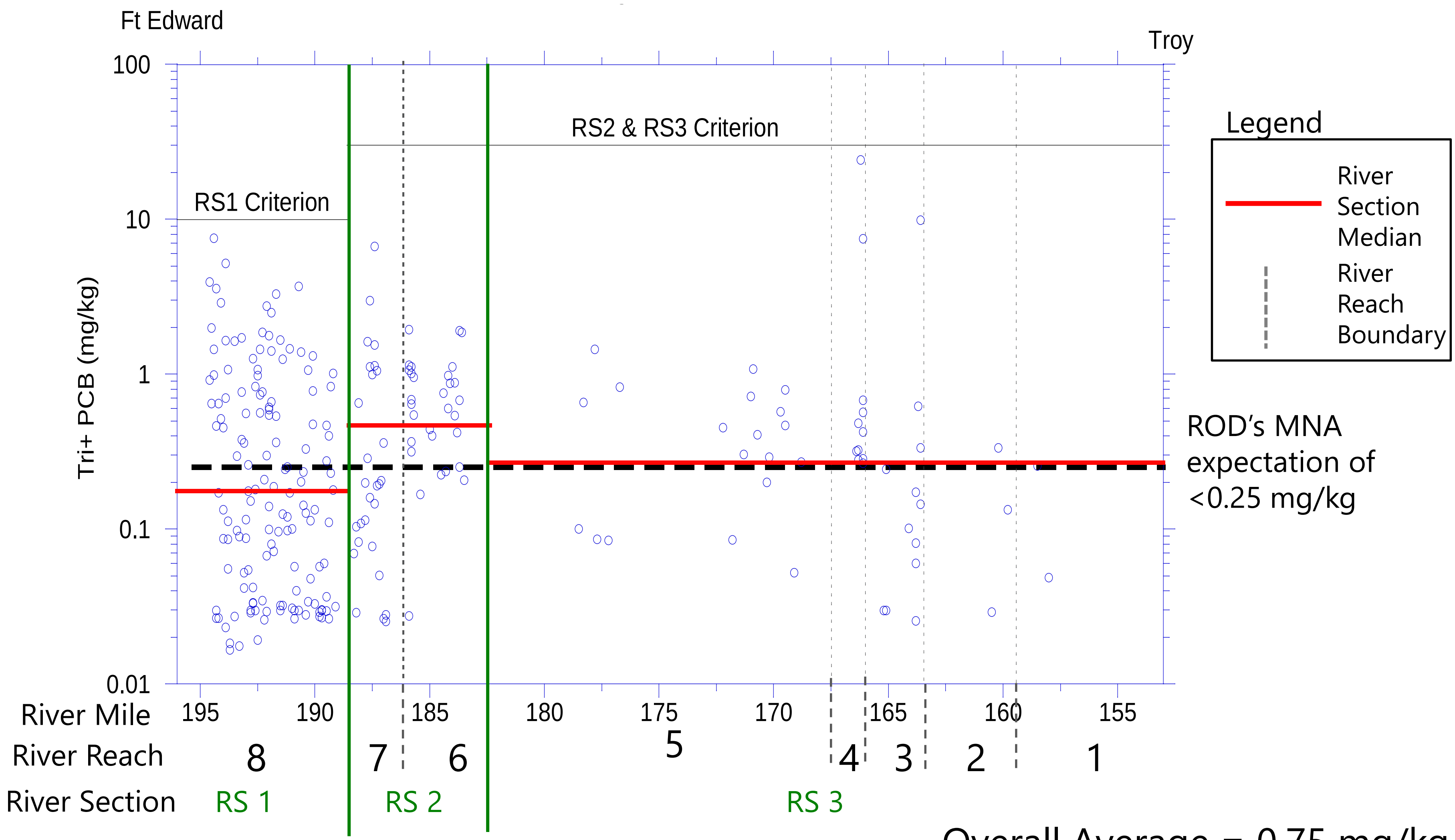
Document Path: M:\0285919\GIS\OM_M\3.0-3 Tri+PCB -No Red.mxd



Tri+ PCBs in Recoverable Sediments by River Reach

Figure 3.0-4

April 2019

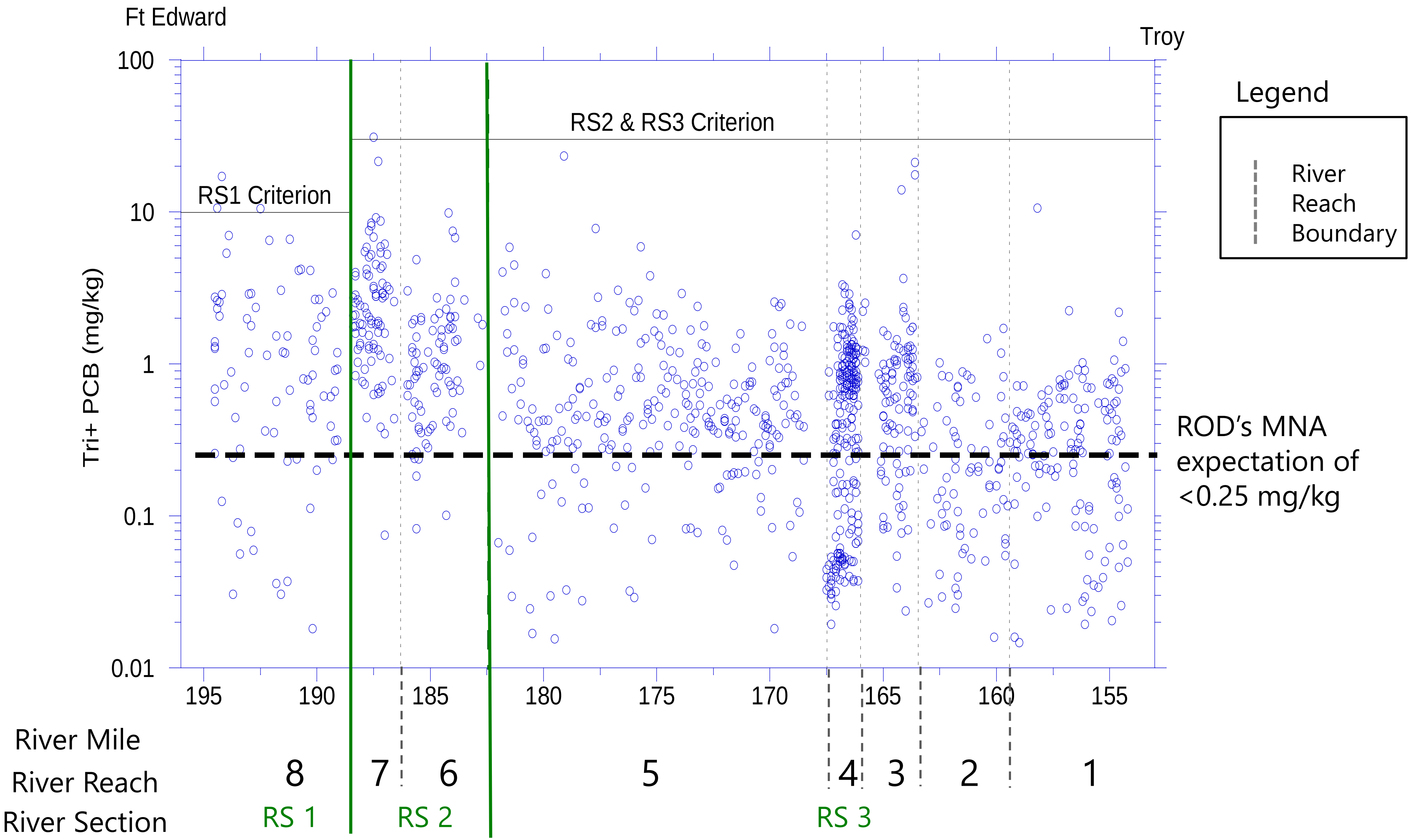


Overall Average = 0.75 mg/kg
Overall Median = 0.26 mg/kg

2017 Dredged Area Samples by River Mile

Figure 3.0-5

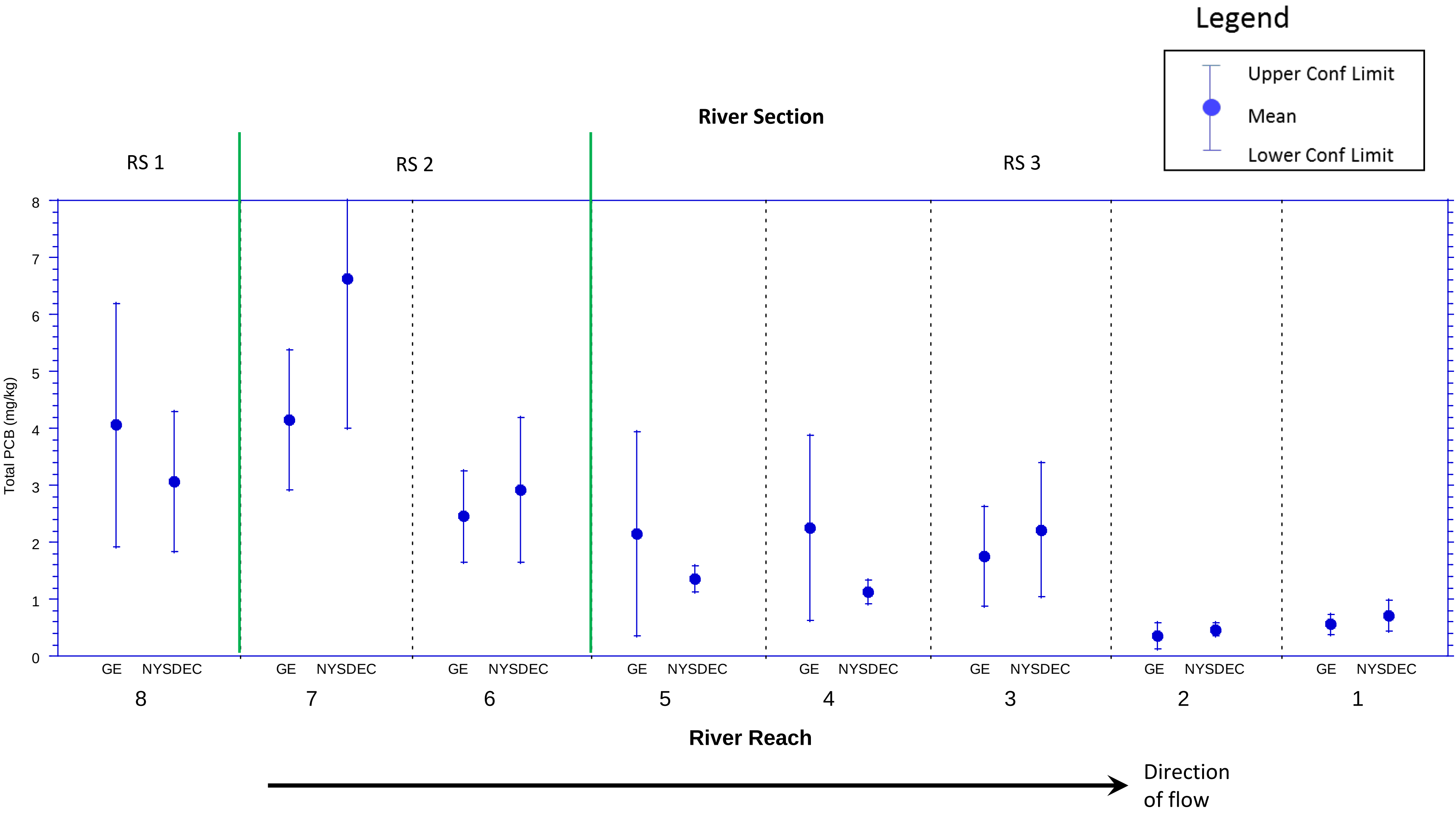
April 2019



2016 & 2017 Non-Dredged Area Samples by River Mile

Figure 3.0-6

April 2019

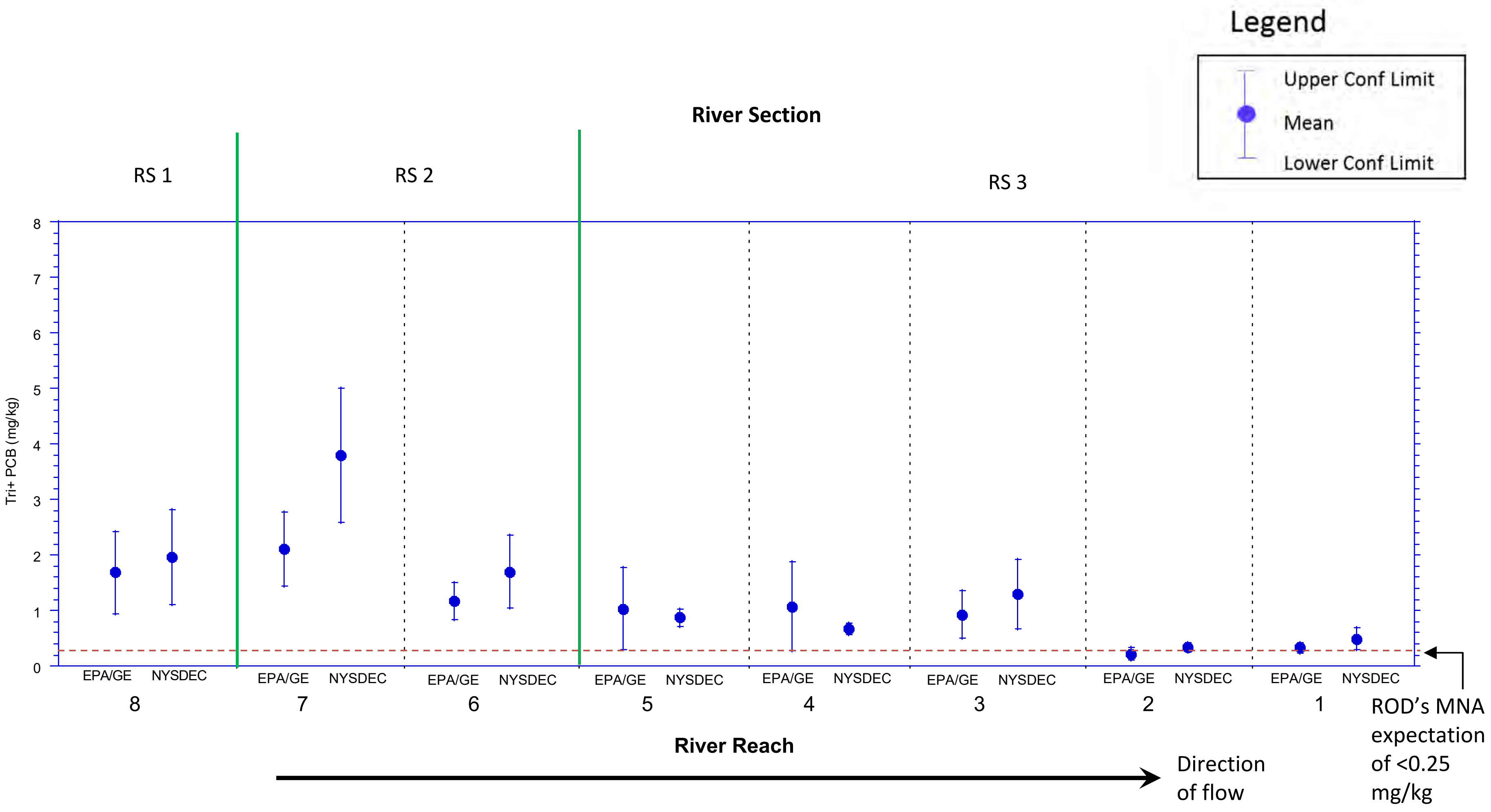


- Error bars represent plus or minus 2 times the standard error on the mean
- 2017 NYSDEC and 2016 EPA/GE Data

Recoverable Sediment (2016 vs. 2017 data) - Method 8082 Results Only
Total PCB, Non-Dredged Areas

Figure 3.1-1

April 2019

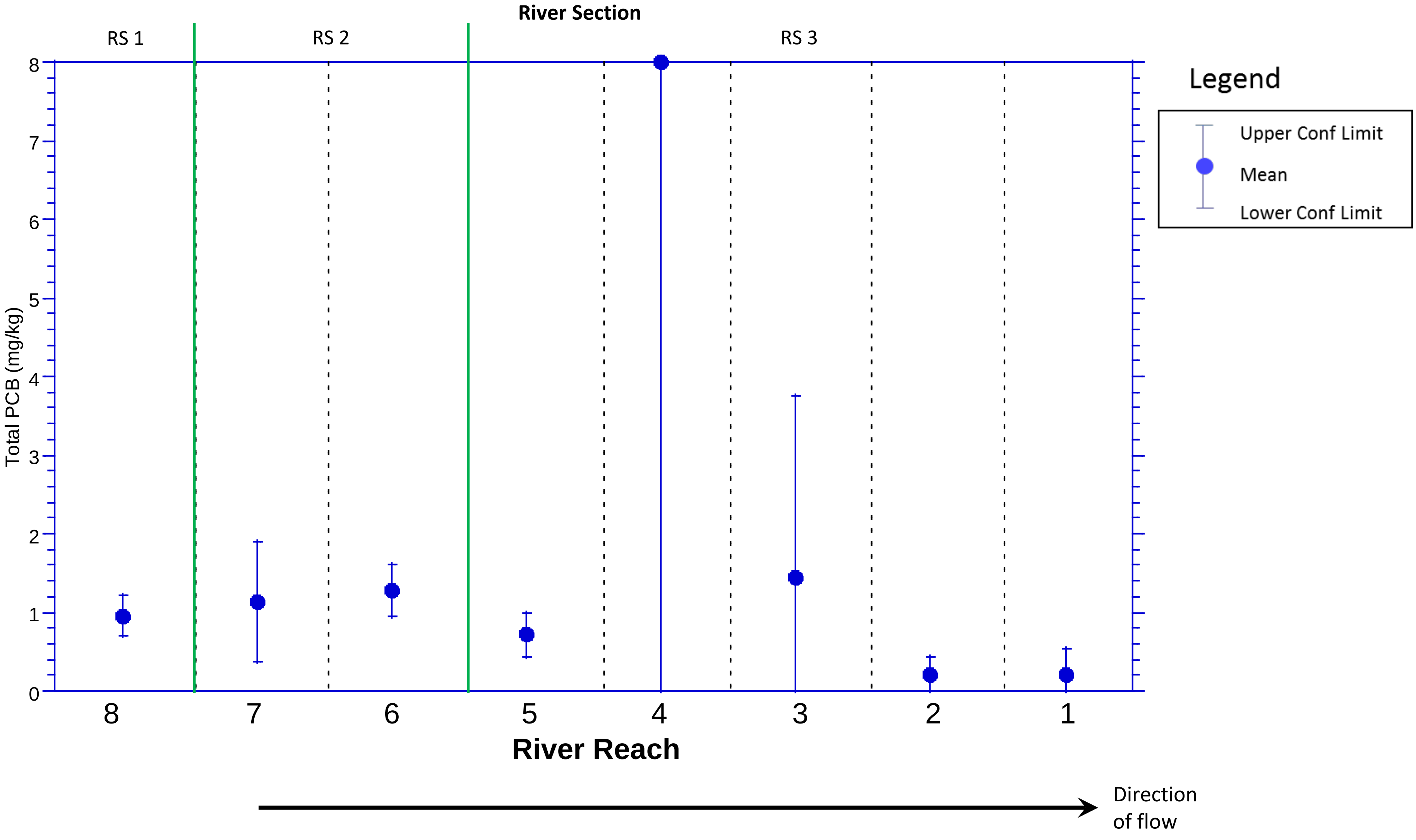


- Error bars represent plus or minus 2 times the standard error on the mean
- 2017 NYSDEC and 2016 EPA/GE Data

Recoverable Sediment (2016 vs. 2017 data) - Method 8082 Results Only
Tri+ PCB, Non-Dredged Areas

Figure 3.1-2

April 2019

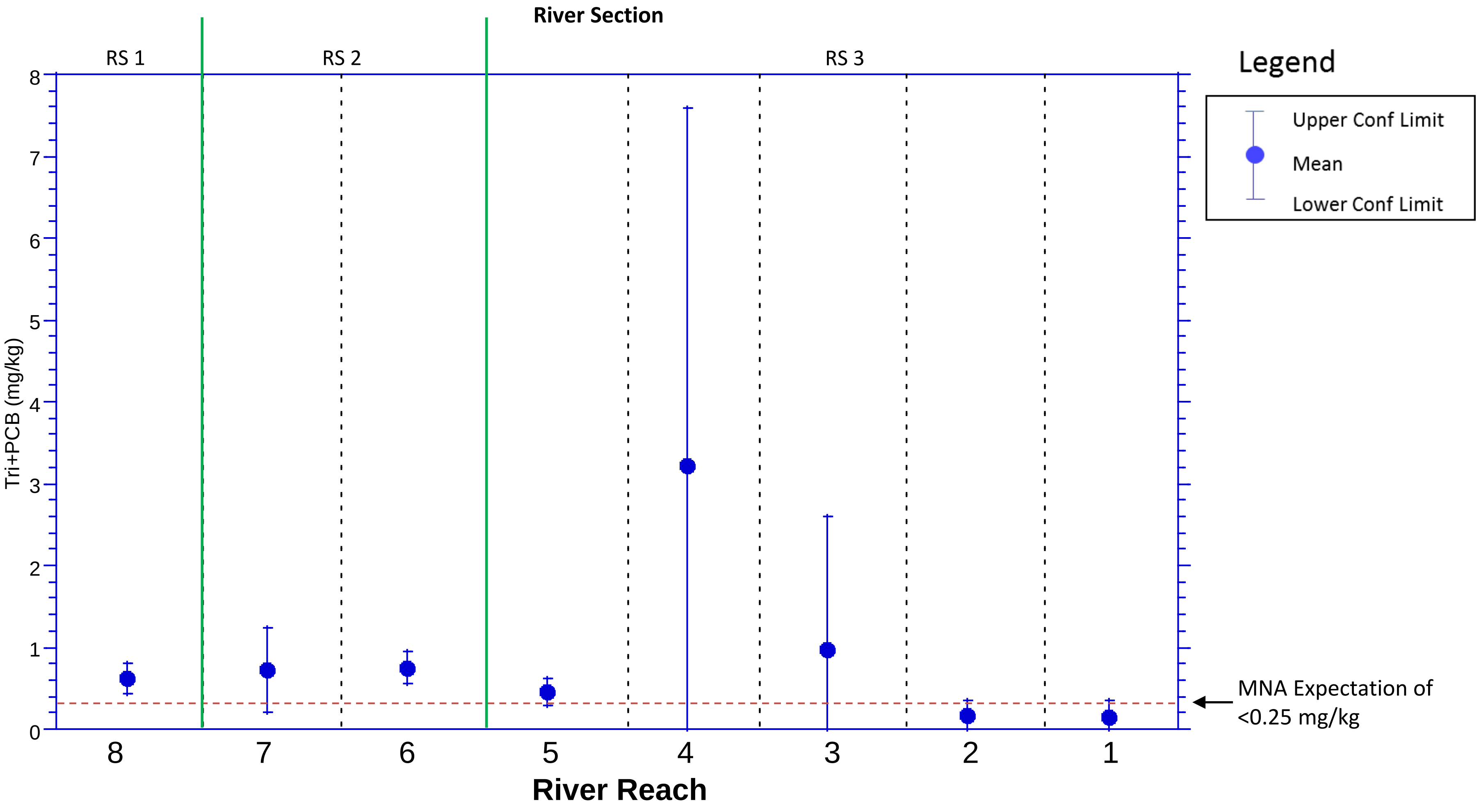


- Error bars represent plus or minus 2 times the standard error on the mean
- 2017 NYSDEC Data

Recoverable Sediment (2017 data) – Dredged Areas - Method 8082 Results Only
Total PCBs

Figure 3.1-3

April 2019



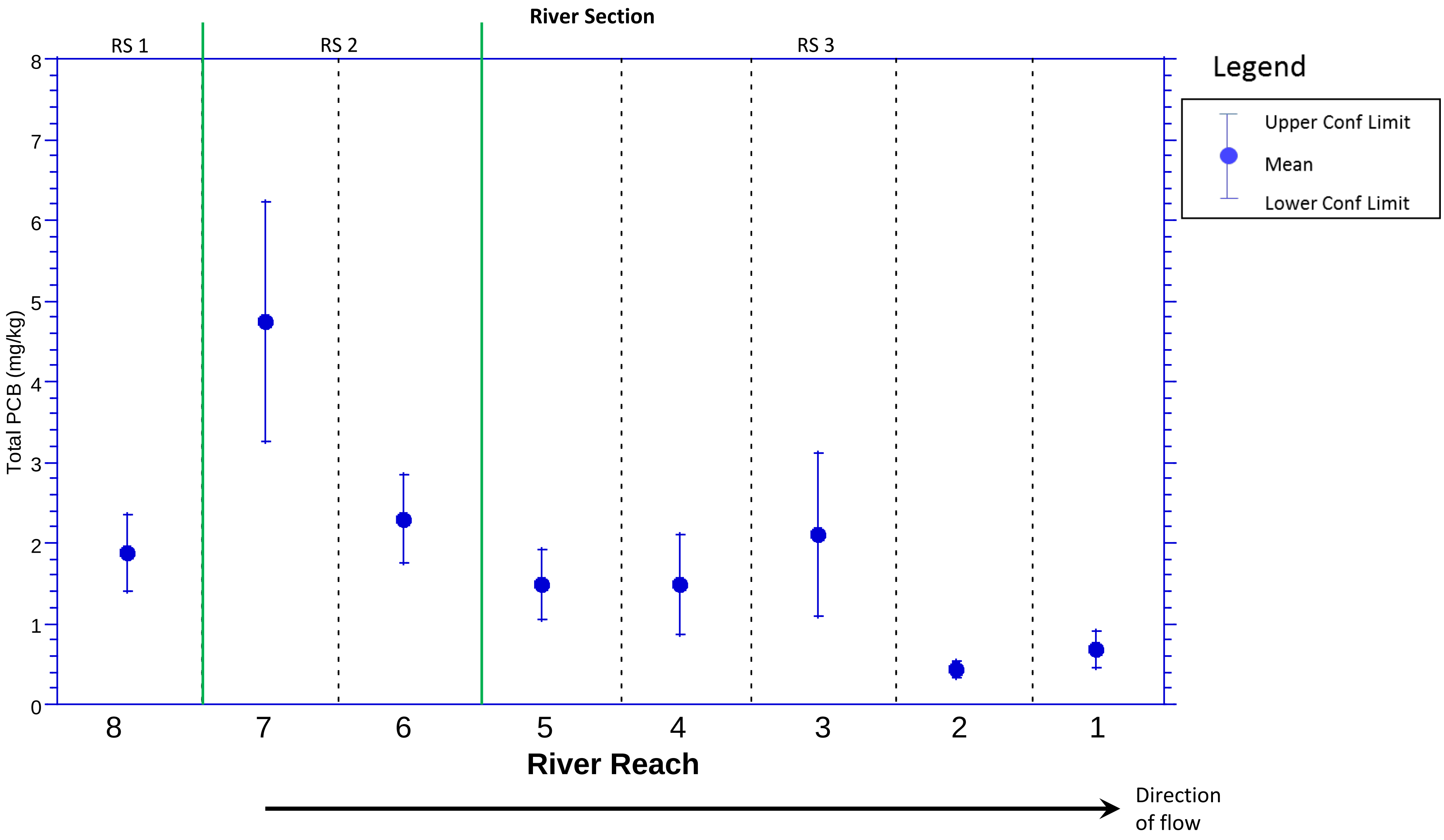
Direction
of flow

- Error bars represent plus or minus 2 times the standard error on the mean
- 2017 NYSDEC Data

Recoverable Sediment (2017 data) – Dredged Areas - Method 8082 Results Only
Tri+ PCBs

Figure 3.1-4

April 2019

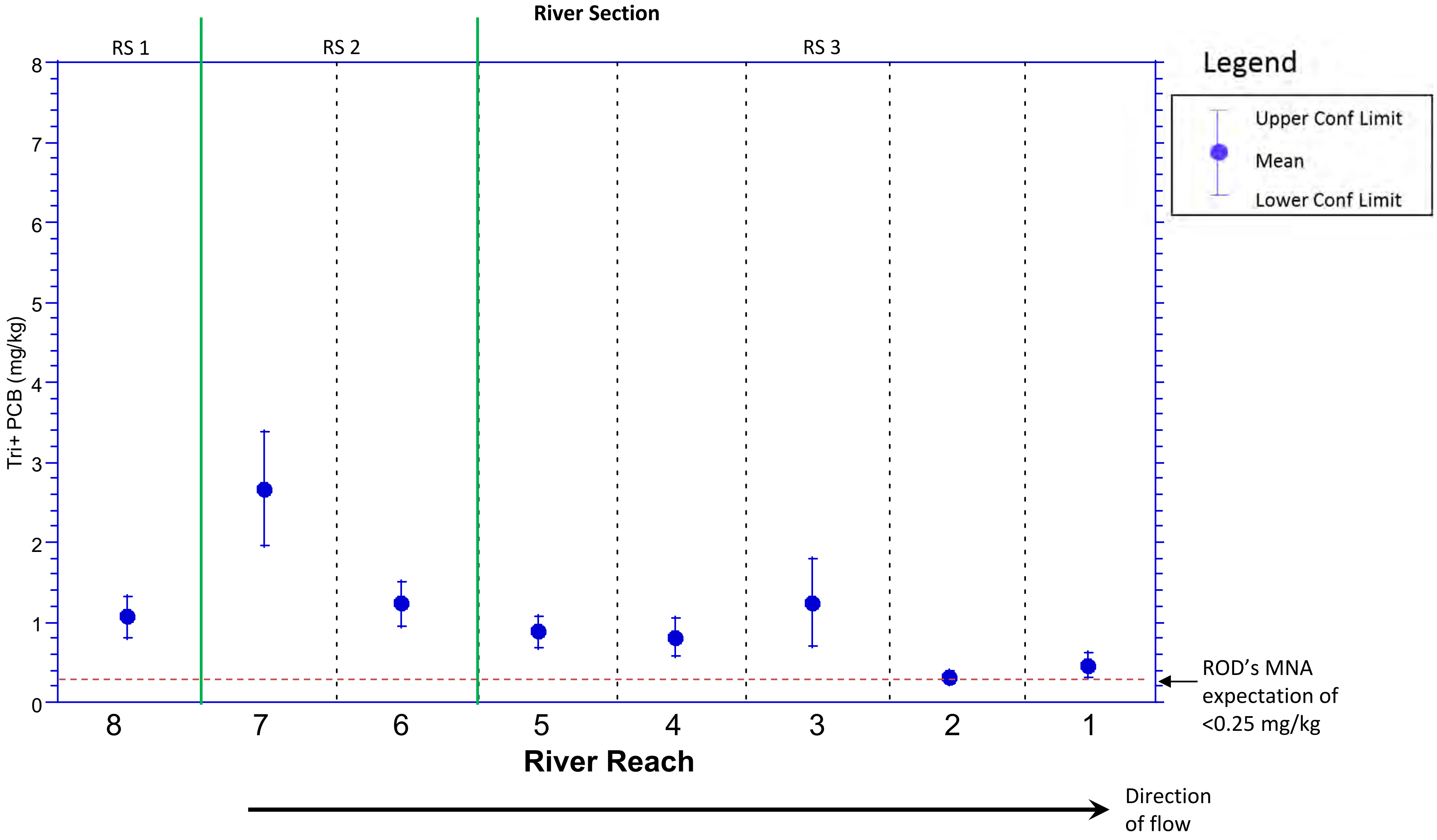


- Error bars represent plus or minus 2 times the standard error on the mean
- 2017 NYSDEC and 2016 EPA/GE Data

Recoverable Sediment (2016 & 2017 data) for Dredged and Non-dredged Areas Combined: Method 8082 Results Only, Total PCB

Figure 3.1-5

April 2019

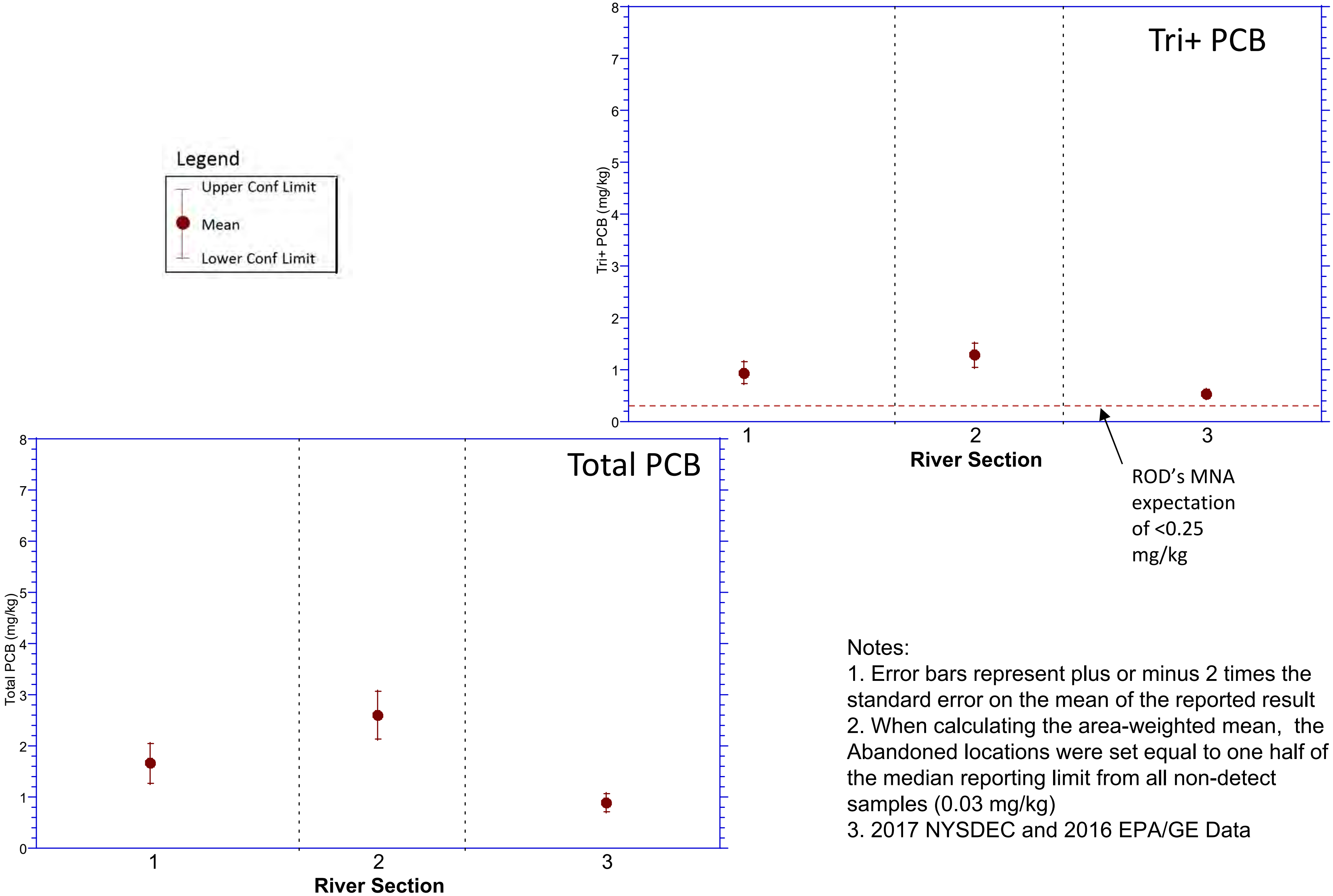


- Error bars represent plus or minus 2 times the standard error on the mean
- 2017 NYSDEC and 2016 EPA/GE Data

Recoverable Sediment (2016 & 2017 data) for Dredged and Non-dredged Areas Combined: Method 8082 Results Only, Tri+ PCB

Figure 3.1-6

April 2019

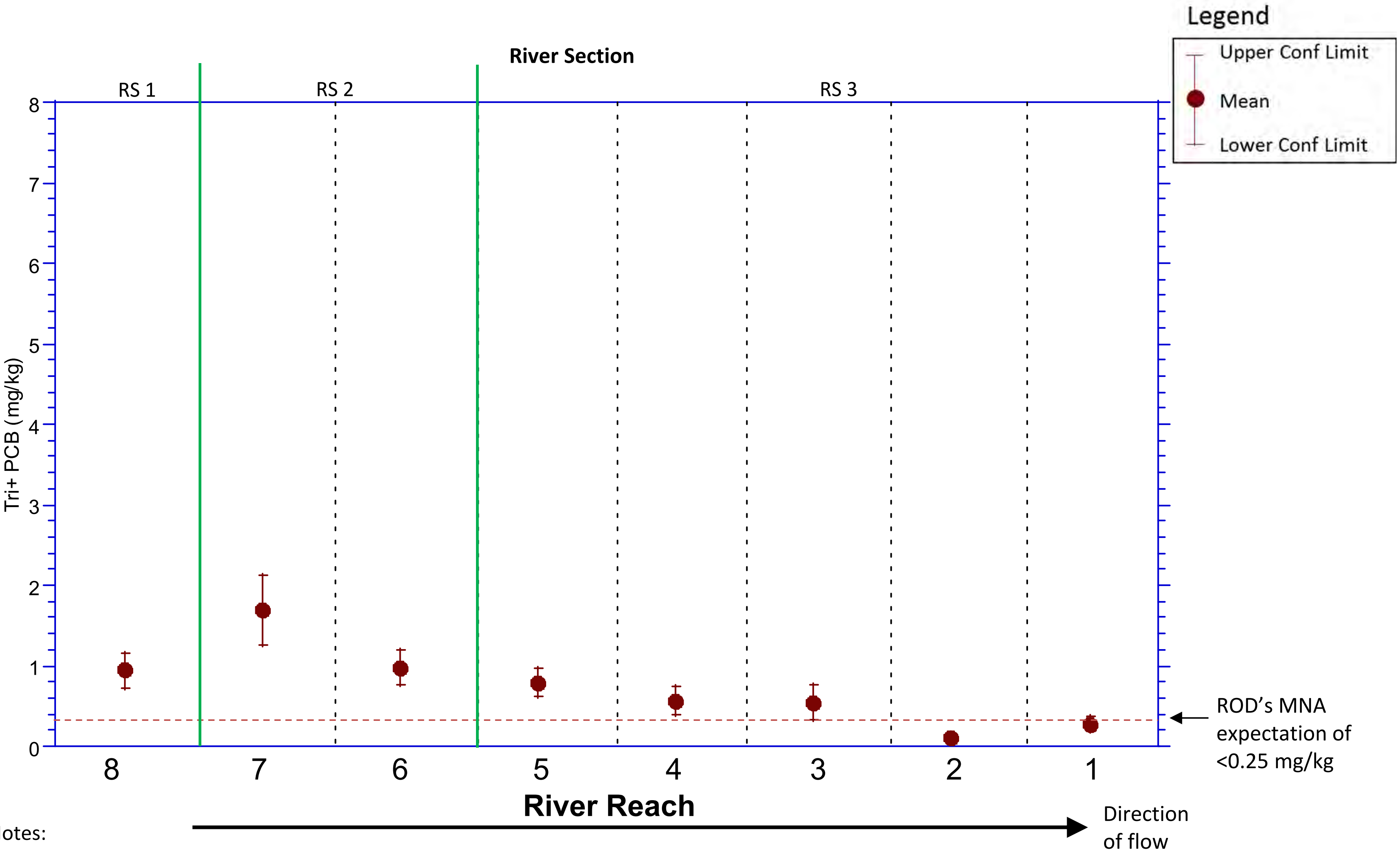


Notes:
1. Error bars represent plus or minus 2 times the standard error on the mean of the reported result
2. When calculating the area-weighted mean, the Abandoned locations were set equal to one half of the median reporting limit from all non-detect samples (0.03 mg/kg)
3. 2017 NYSDEC and 2016 EPA/GE Data

Area-Weighted Mean Sediment Concentrations – by River Section
(2016 & 2017 data) - Method 8082 Results Only

Figure 3.2-1

April 2019



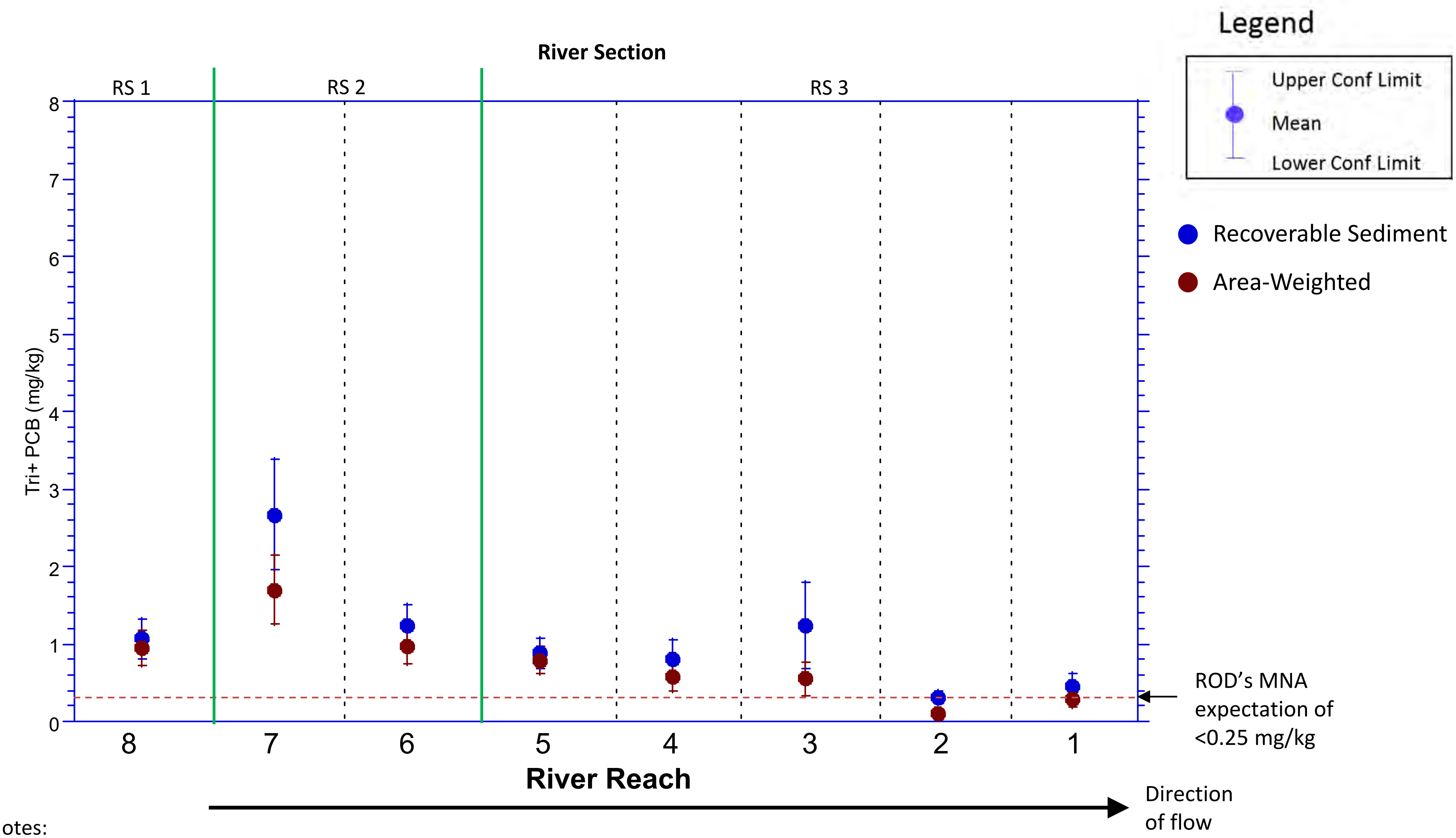
Notes:

1. Error bars represent plus or minus 2 times the standard error on the mean of the reported result
2. When calculating the area-weighted mean, the Abandoned locations were set equal to one half of the median reporting limit from all non-detect samples (0.03 mg/kg)
3. 2017 NYSDEC and 2016 EPA/GE Data

Area-Weighted Mean Sediment Concentrations – by River Reach
Tri+ PCB

Figure 3.2-2

April 2019



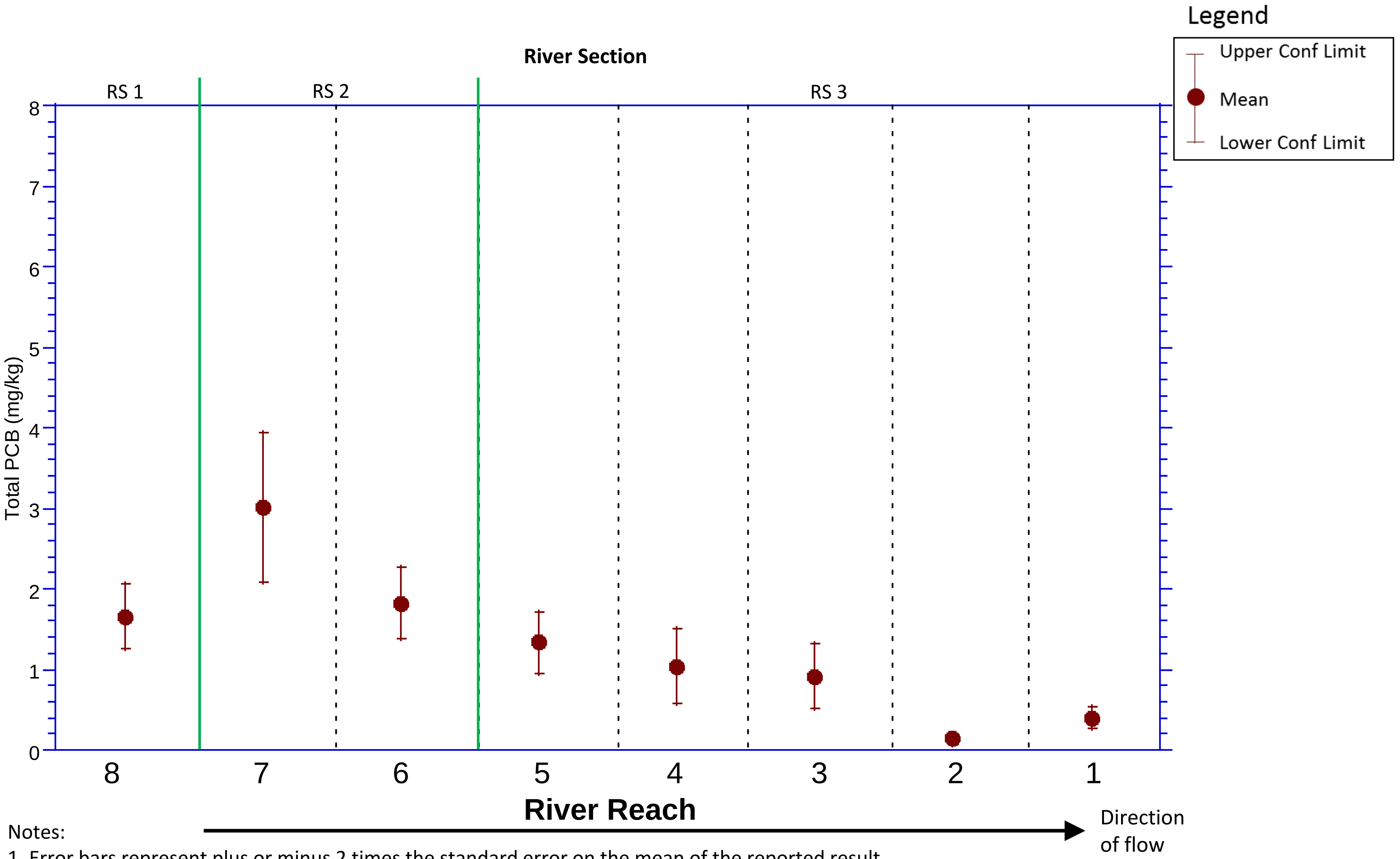
Notes:

1. Error bars represent plus or minus 2 times the standard error on the mean of the reported result
2. When calculating the area-weighted mean, the Abandoned locations were set equal to one half of the median reporting limit from all non-detect samples (0.03 mg/kg)
3. 2017 NYSDEC and 2016 EPA/GE Data

Recoverable vs. Area-Weighted Mean Sediment Concentrations – by River Reach
Tri+ PCB

Figure 3.2-3

April 2019



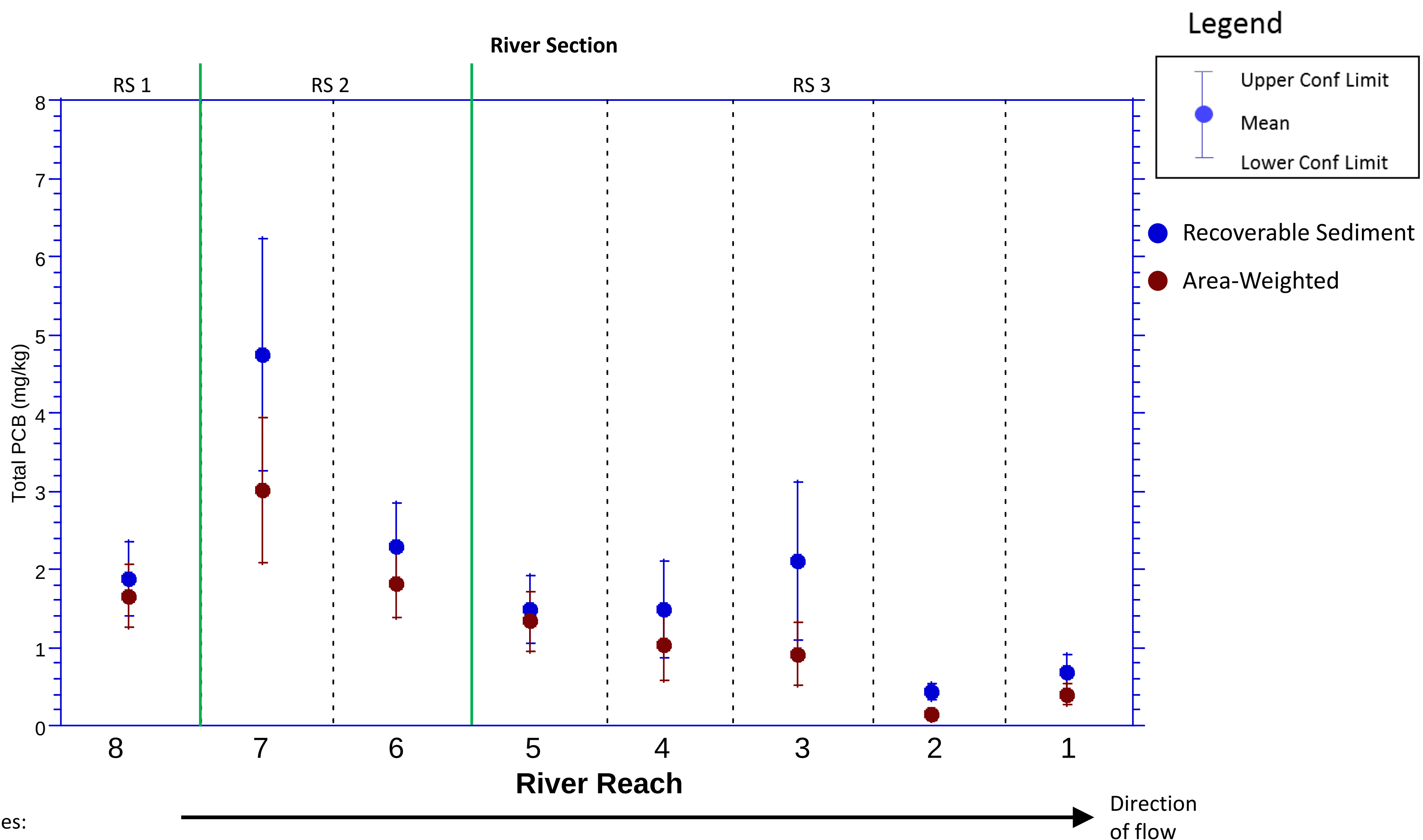
Notes:

1. Error bars represent plus or minus 2 times the standard error on the mean of the reported result
2. When calculating the area-weighted mean, the Abandoned locations were set equal to one half of the median reporting limit from all non-detect samples (0.03 mg/kg)
3. 2017 NYSDEC and 2016 EPA/GE Data

Area-Weighted Mean Sediment Concentrations – by River Reach
Total PCB

Figure 3.2-4

April 2019



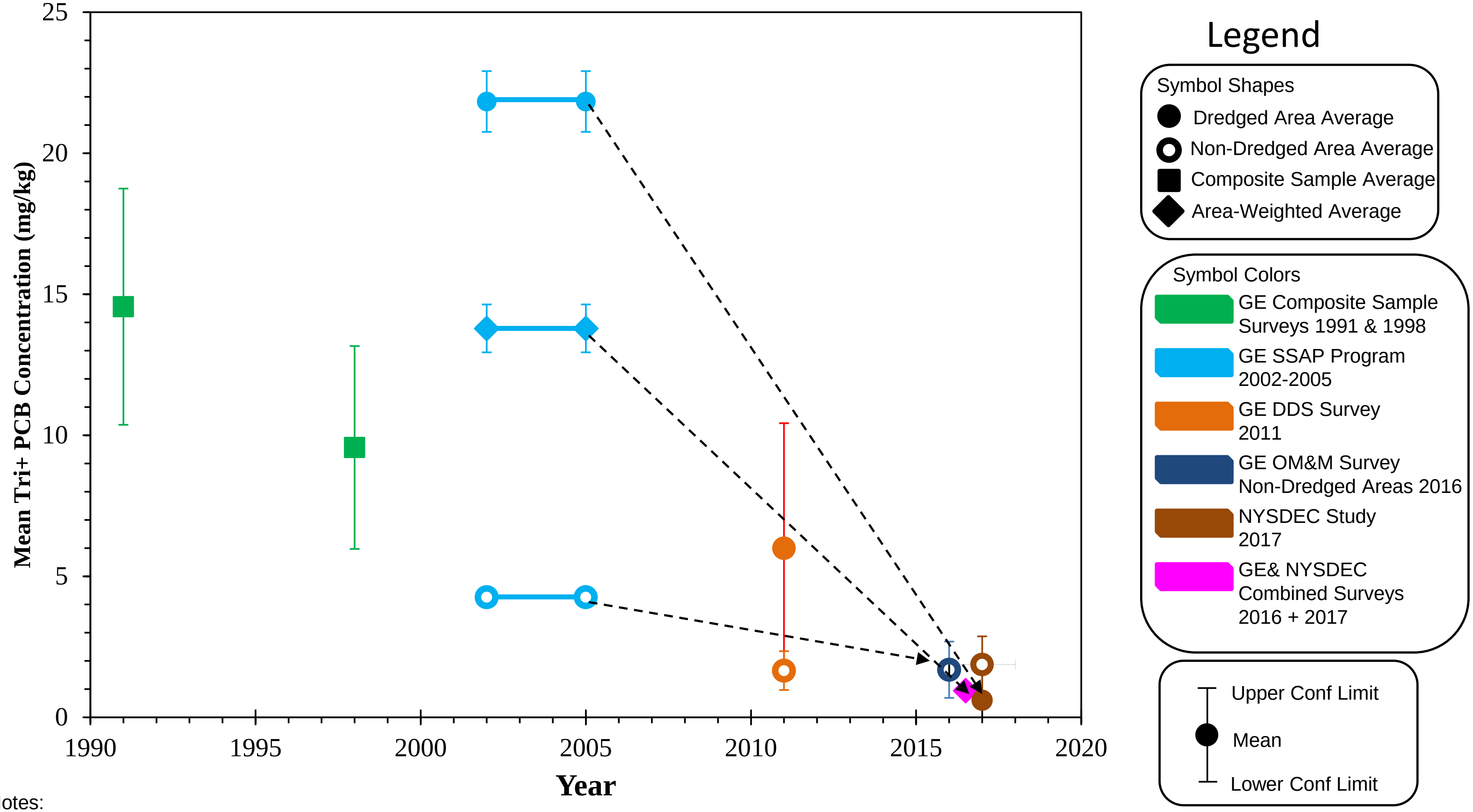
Notes:

1. Error bars represent plus or minus 2 times the standard error on the mean of the reported result
2. When calculating the area-weighted mean, the Abandoned locations were set equal to one half of the median reporting limit from all non-detect samples (0.03 mg/kg)
3. 2017 NYSDEC and 2016 EPA/GE Data

Recoverable vs. Area-Weighted Mean Sediment Concentrations – by River Reach
Total PCB

Figure 3.2-5

April 2019



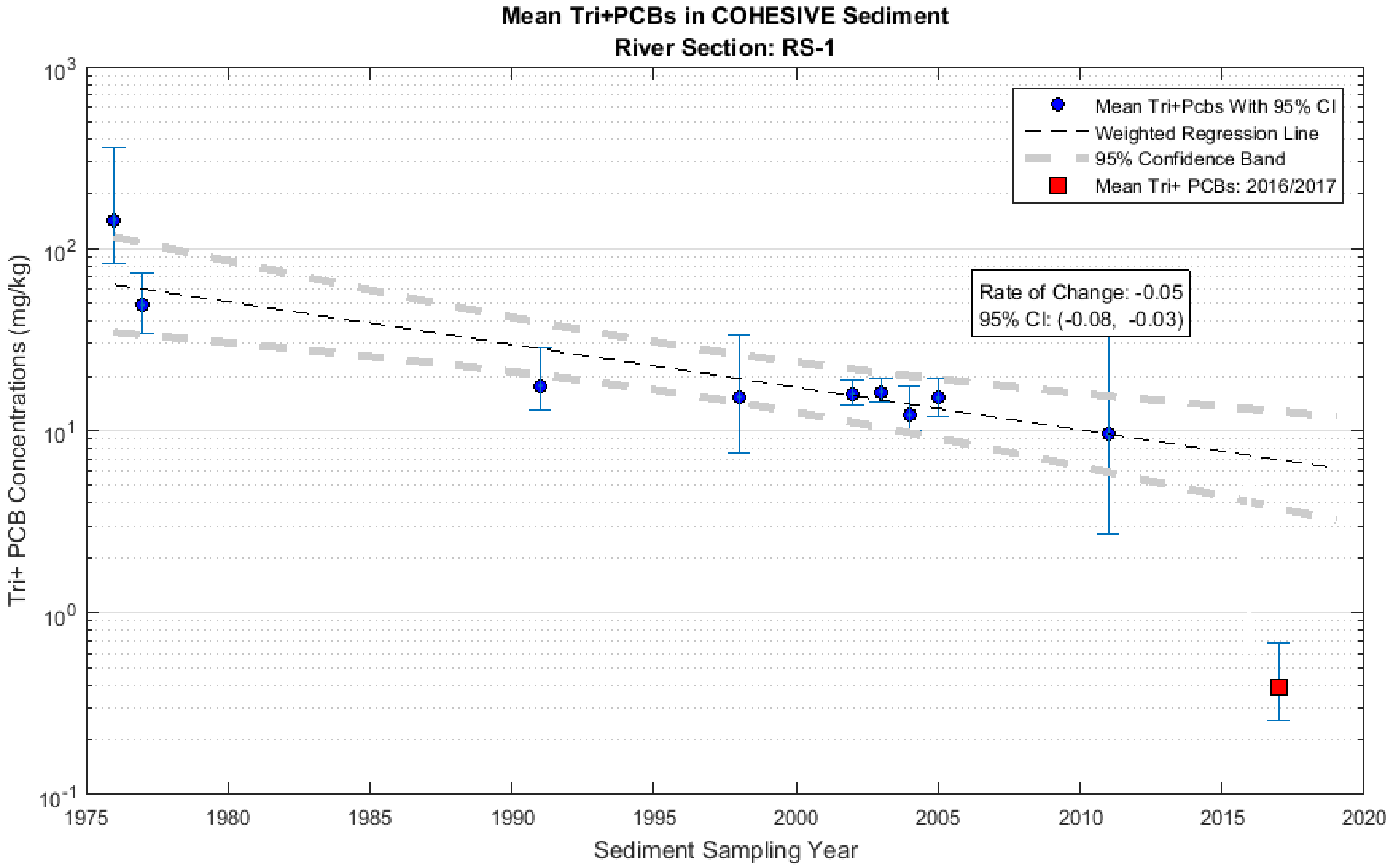
Notes:

- Error bars represent plus or minus 2 times the standard error on the mean
- Data points above represent 0-2 in sediments
- 2002-2005 Area-weighted average includes bedrock areas with an assigned values of 0.03 mg/kg Tri+ PCB. Error bars are approximate.
- 2016-2017 Area-weighted average includes bedrock areas with an assigned value of 0.03 mg/kg Tri+ PCB. Error bars are within the size of the marker

Estimated Mean Tri+ PCB Concentration in Surface Sediment from Six Different Surveys: RS 1

Figure 4.1-1

April 2019

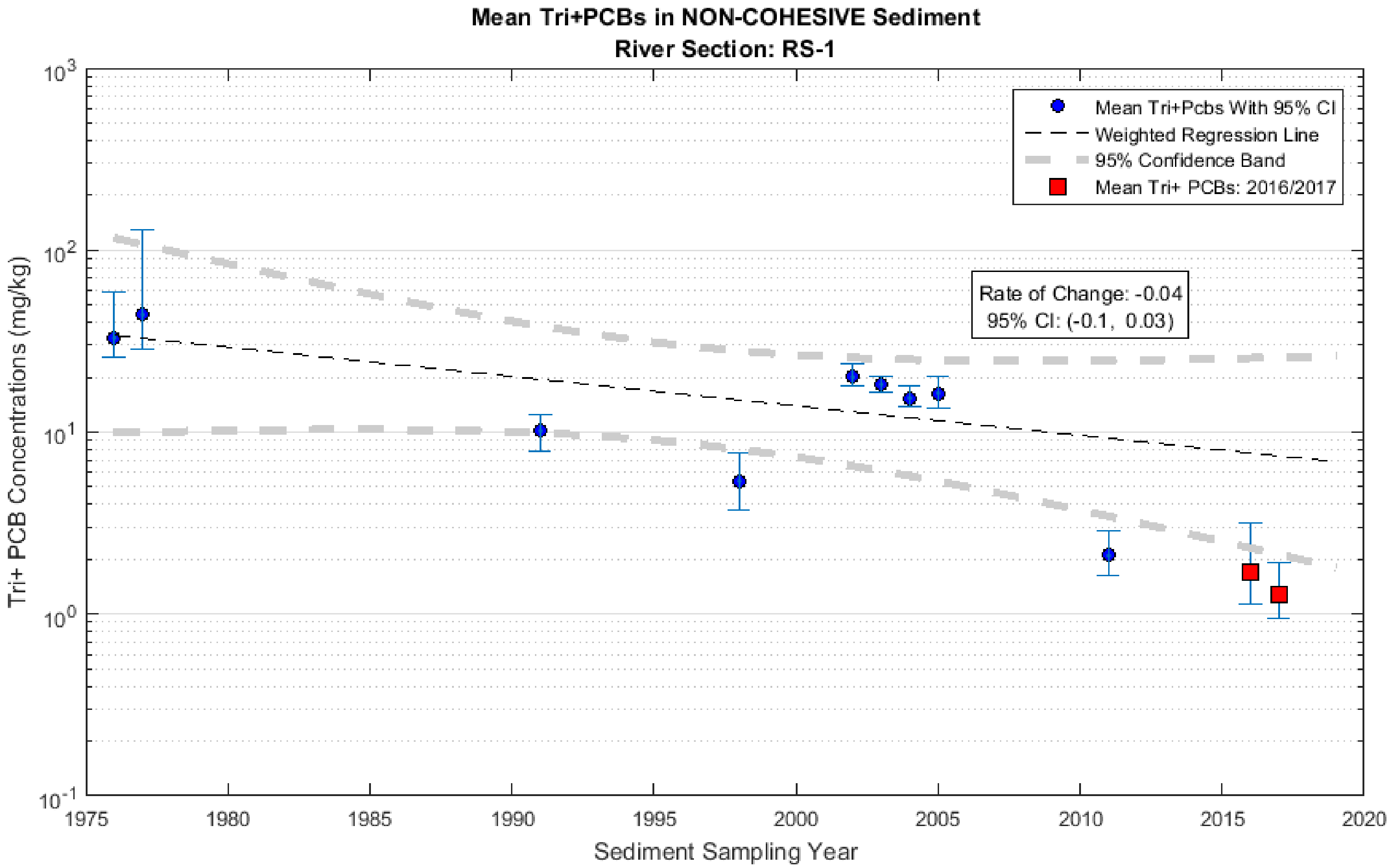


- Data points above represent 0-2 in sediments
- 2016 data were not used to generate the regression curve and its uncertainty.

Temporal Trend of Tri+ PCB Mean Concentration in Cohesive Sediments : RS 1

Figure 4.2-1a

April 2019

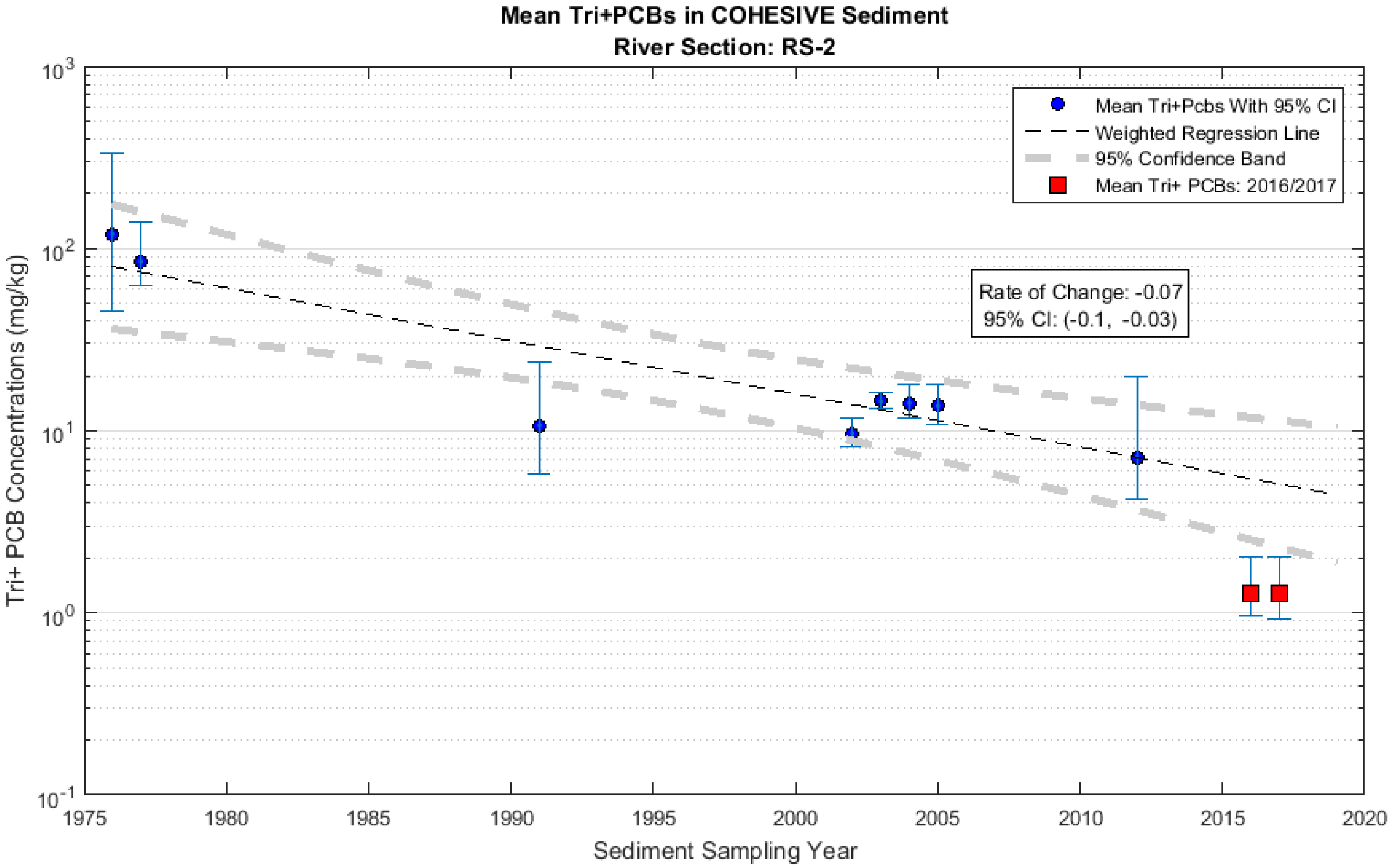


- Data points above represent 0-2 in sediments
- 2016 and 2017 data were not used to generate the regression curve and its uncertainty.

Temporal Trend of Tri+ PCB Mean Concentration in Non-Cohesive Sediments : RS 1

Figure 4.2-1b

April 2019

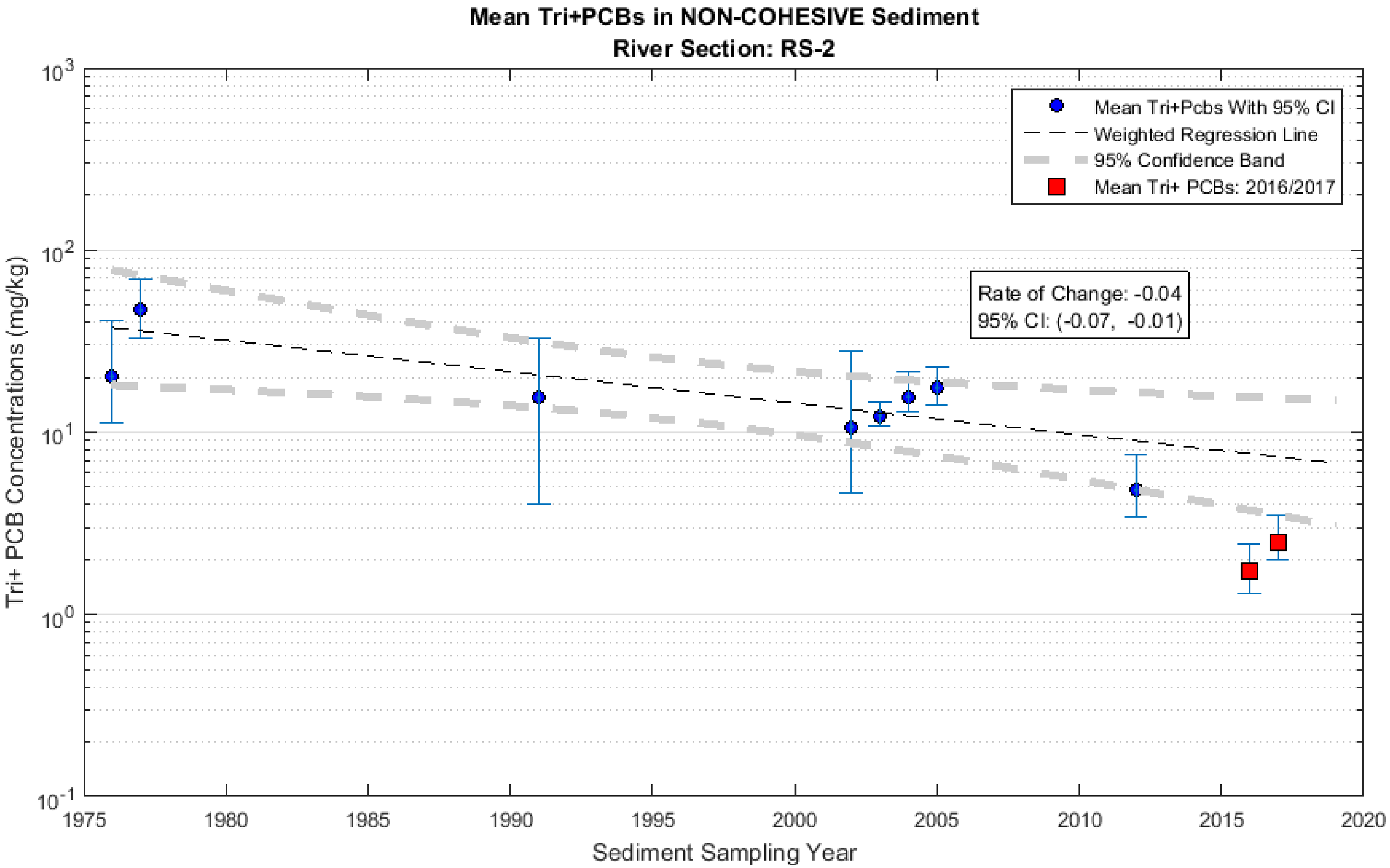


- Data points above represent 0-2 in sediments
- 2016 and 2017 data were not used to generate the regression curve and its uncertainty.

Temporal Trend of Tri+ PCB Mean Concentration in Cohesive Sediments : RS 2

Figure 4.2-1c

April 2019

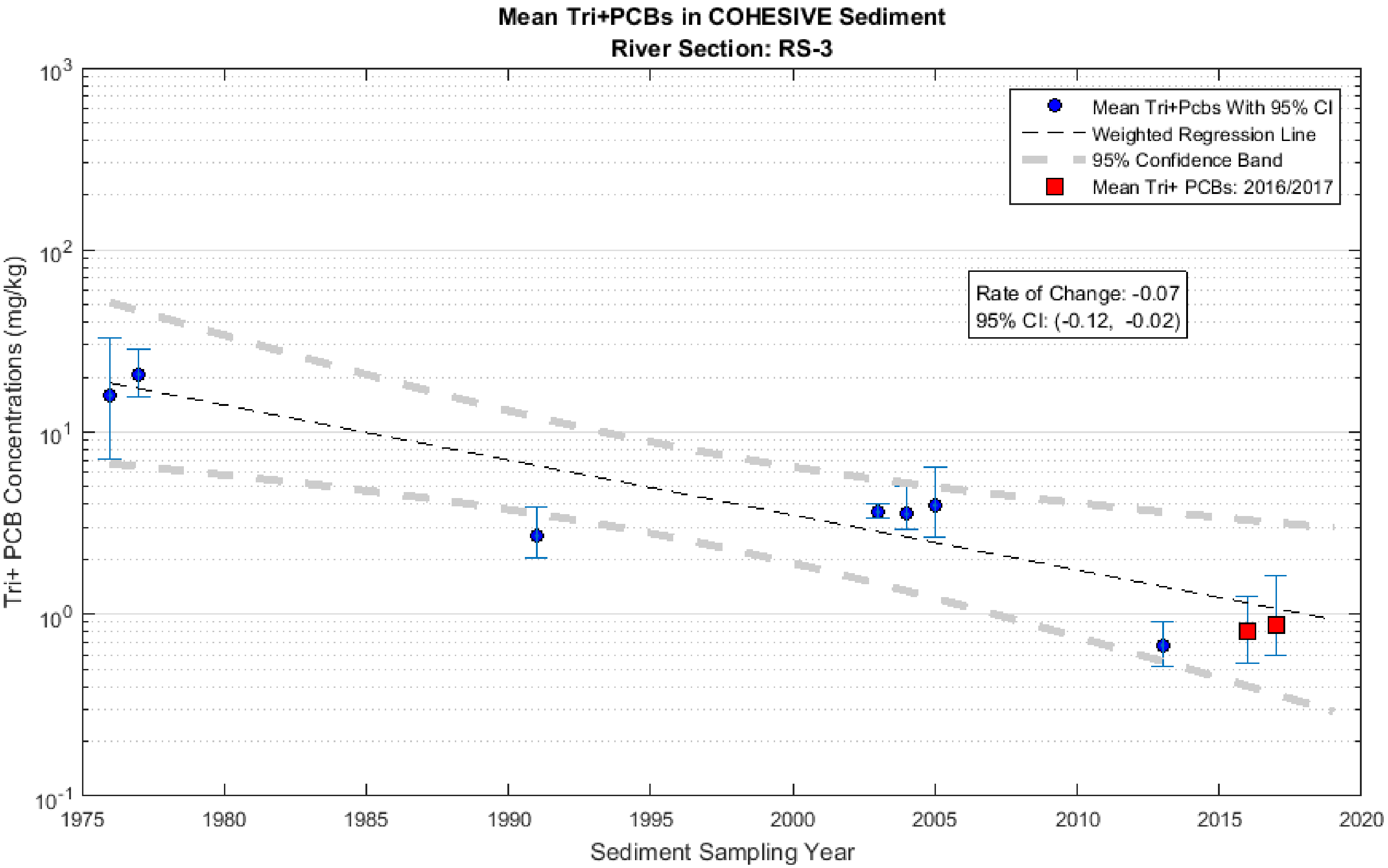


- Data points above represent 0-2 in sediments
- 2016 and 2017 data were not used to generate the regression curve and its uncertainty.

Temporal Trend of Tri+ PCB Mean Concentration in Non-Cohesive Sediments : RS 2

Figure 4.2-1d

April 2019

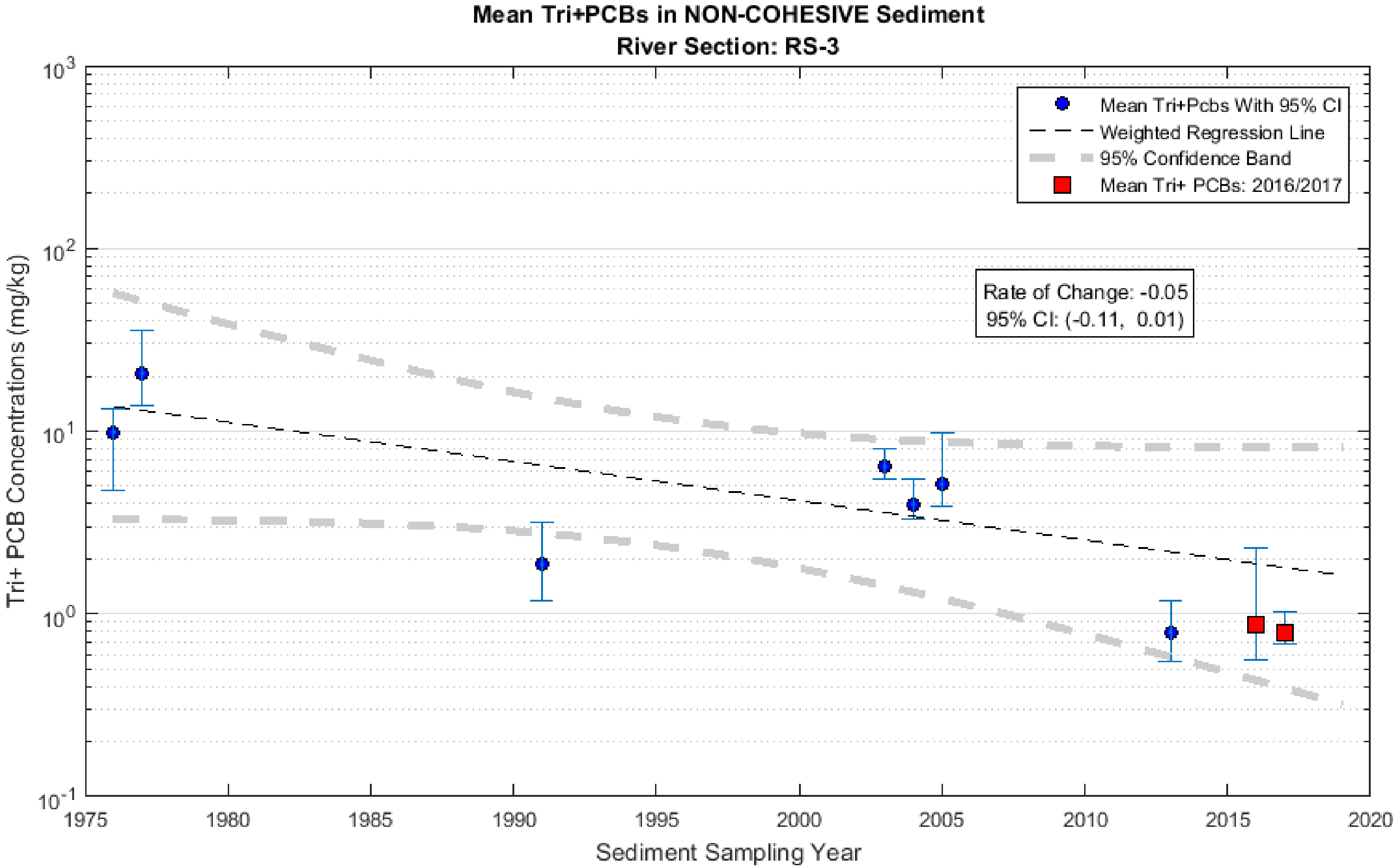


- Data points above represent 0-2 in sediments
- 2016 and 2017 data were not used to generate the regression curve and its uncertainty.

Temporal Trend of Tri+ PCB Mean Concentration in Cohesive Sediments : RS 3

Figure 4.2-1e

April 2019

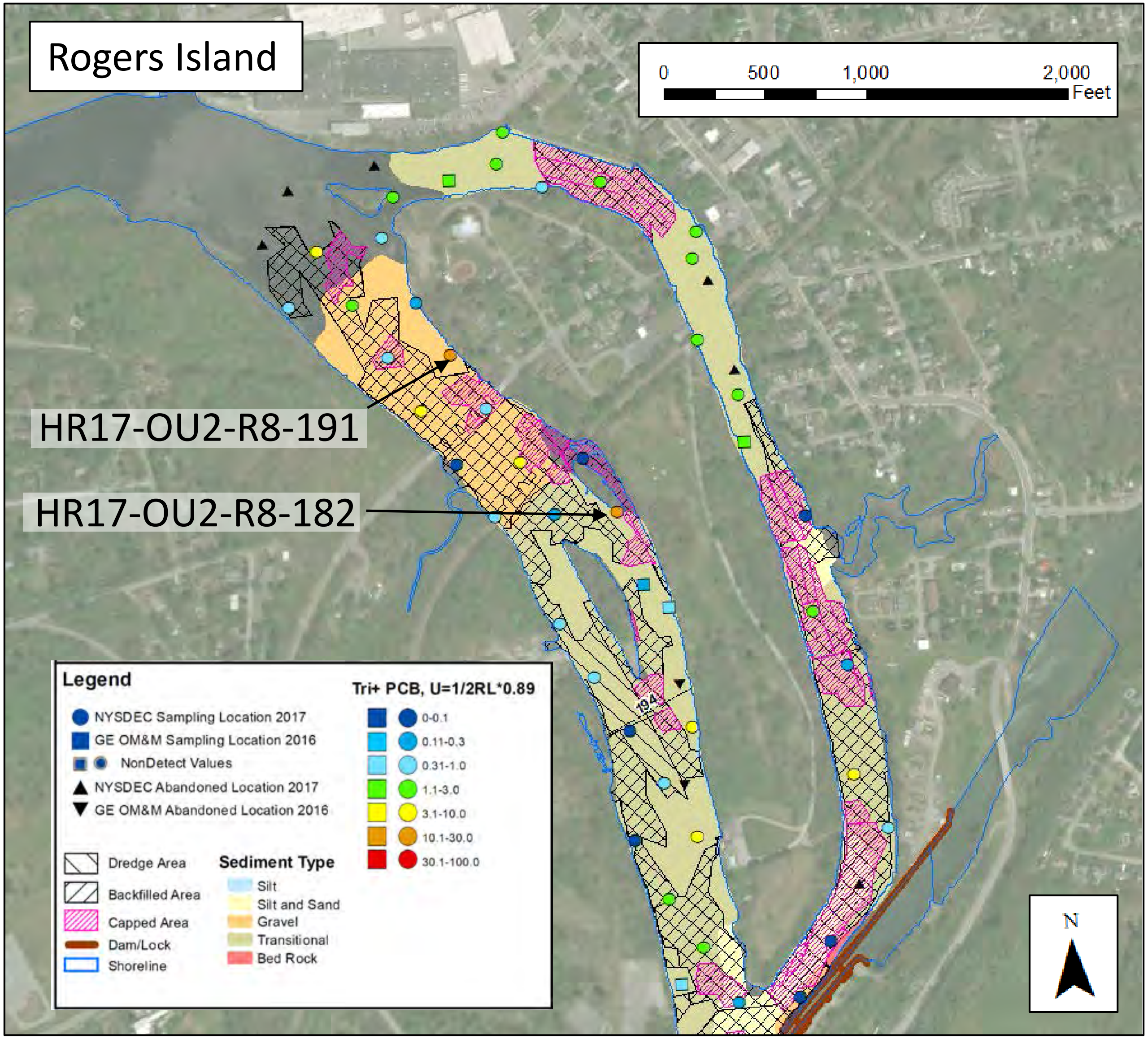


- Data points above represent 0-2 in sediments
- 2016 and 2017 data were not used to generate the regression curve and its uncertainty.

Temporal Trend of Tri+ PCB Mean Concentration in Non-Cohesive Sediments : RS 3

Figure 4.2-1f

April 2019

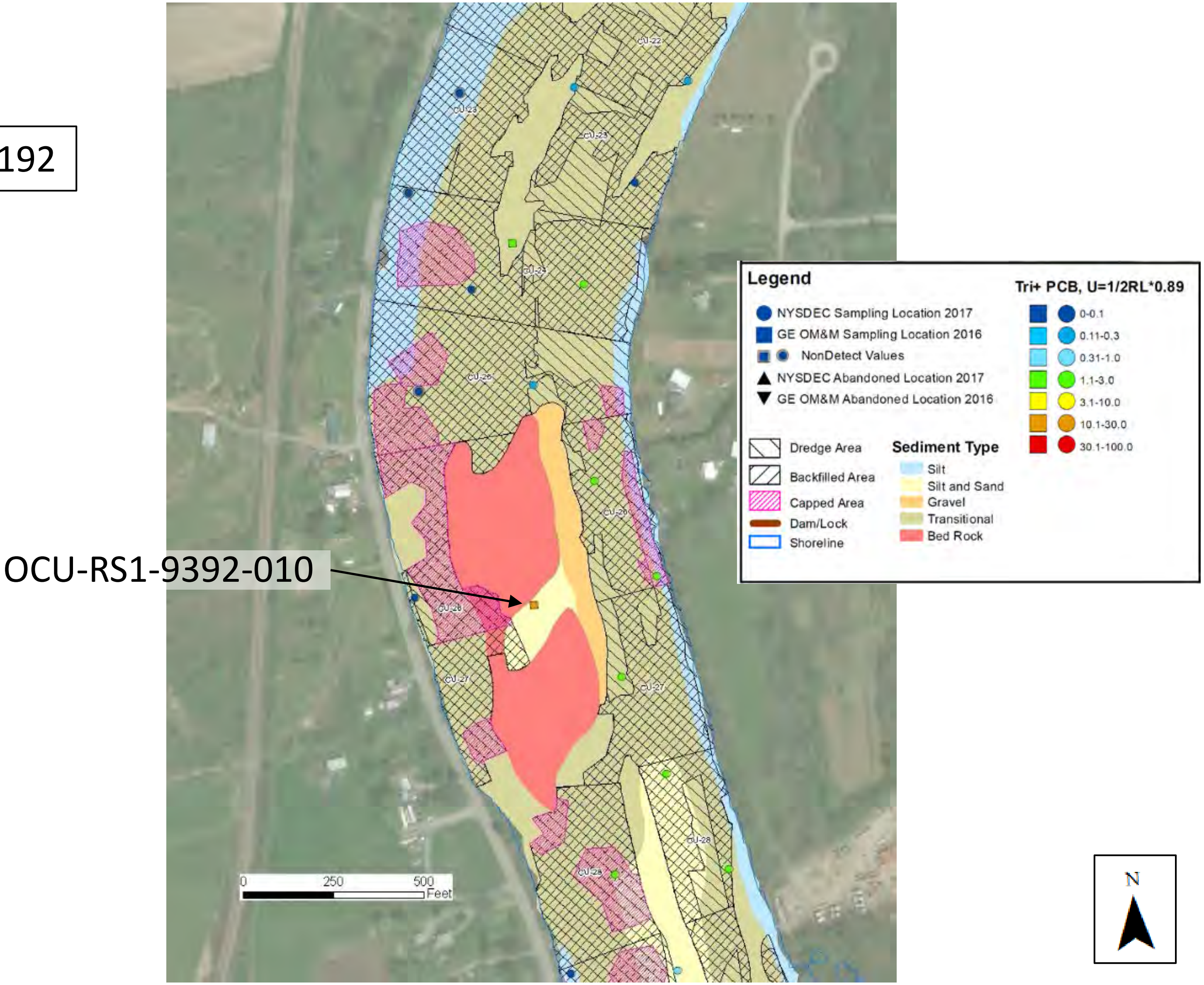


Sampling Locations with Tri+ PCB Exceeding RS 1 Dredging Criteria (10 mg/kg): Rogers Island Area

Figure 5.1-1

April 2019

RM 193 - 192



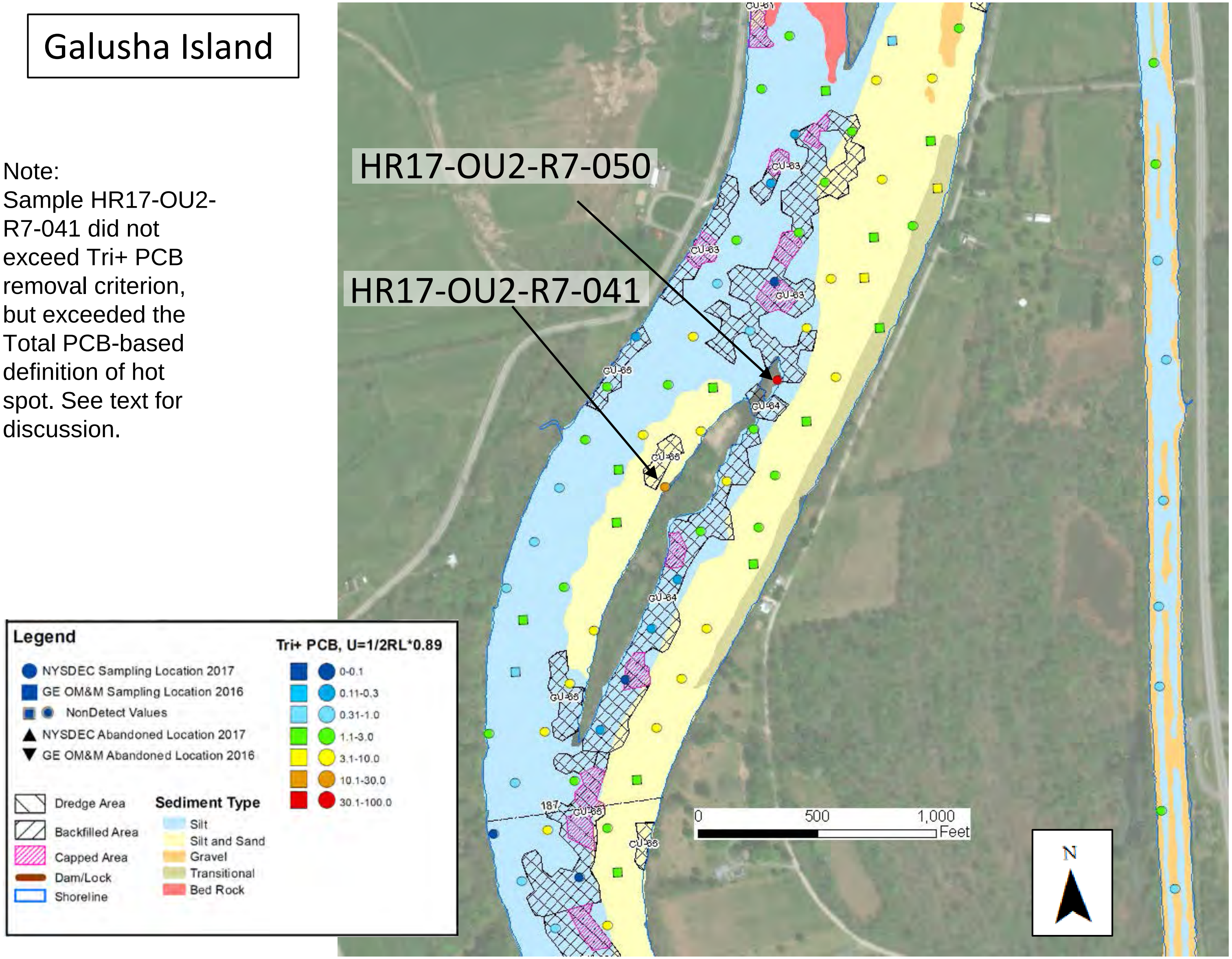
Sampling Location with Tri+ PCB Exceeding RS 1 Dredging Criteria (10 mg/kg):
RM 193 - RM 192

Figure 5.1-2

April 2019

Galusha Island

Note:
Sample HR17-OU2-R7-041 did not exceed Tri+ PCB removal criterion, but exceeded the Total PCB-based definition of hot spot. See text for discussion.

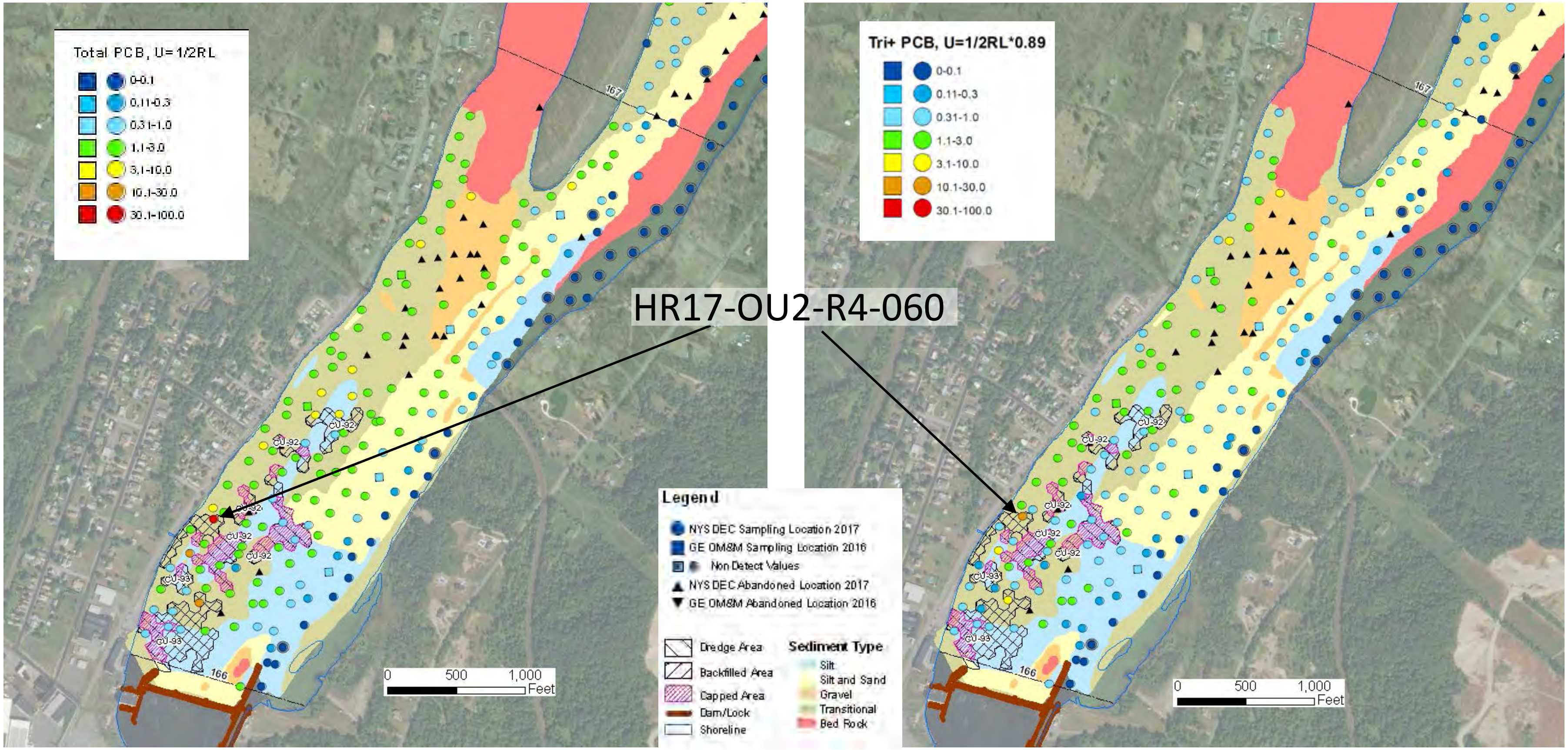


Sampling Location with Tri+ PCB Exceeding RS 2 Dredging Criteria (30 mg/kg): Galusha Island Area

Figure 5.1-3

April 2019

Upper Mechanicville Dam



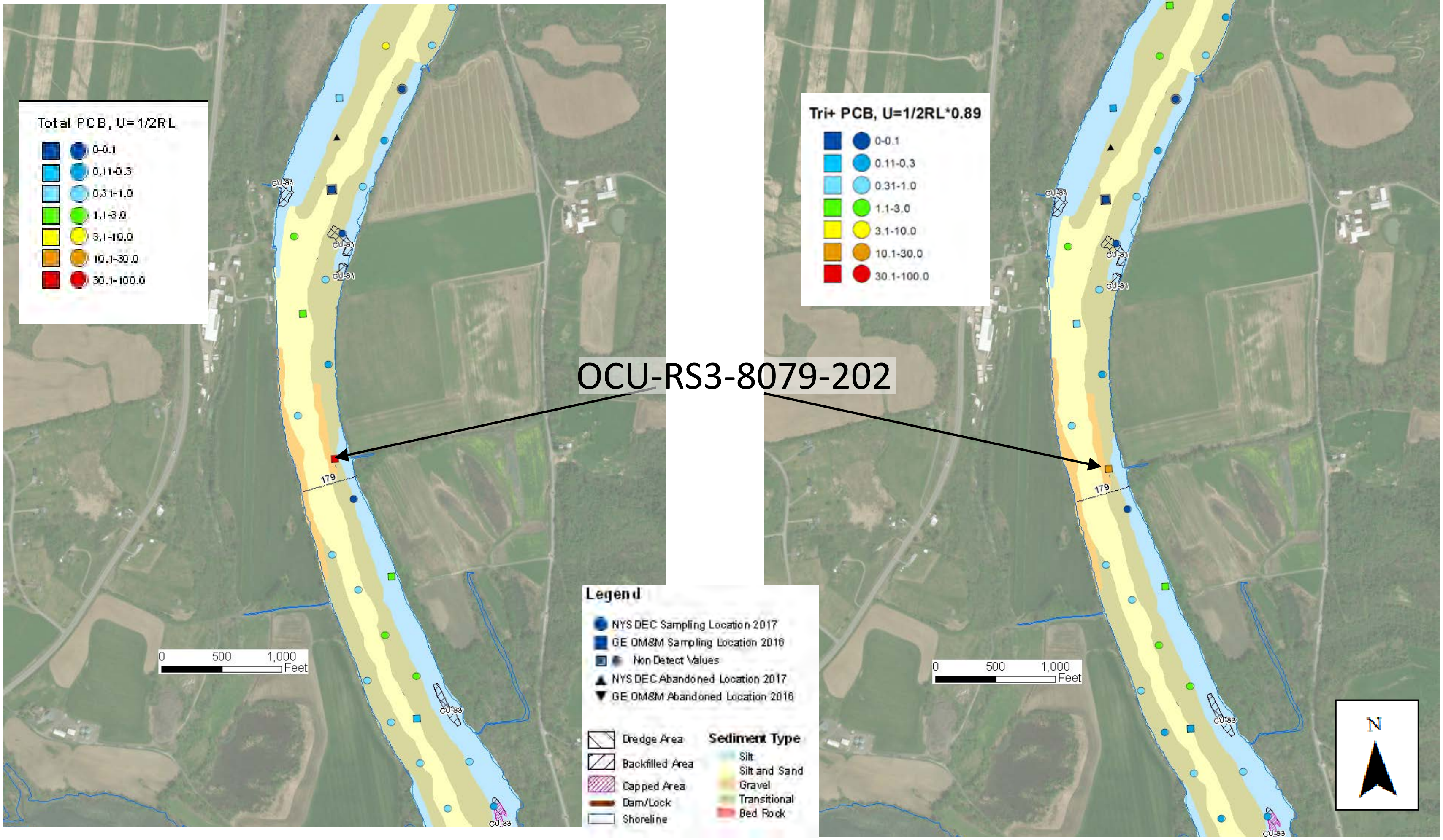
- 50 mg/kg Total PCB was originally defined by NYSDEC (Tofflemire and Quinn, 1979) as a "hot spot" threshold.
- Although this location exceeds 50 mg/kg Total PCB, it does not exceed the Tri+ PCB removal criterion of 30 mg/kg.

Sampling Location with Total PCB Concentration in Excess of 50 mg/kg:
Upper Mechanicville Dam Area

Figure 5.1-4

April 2019

RM 179

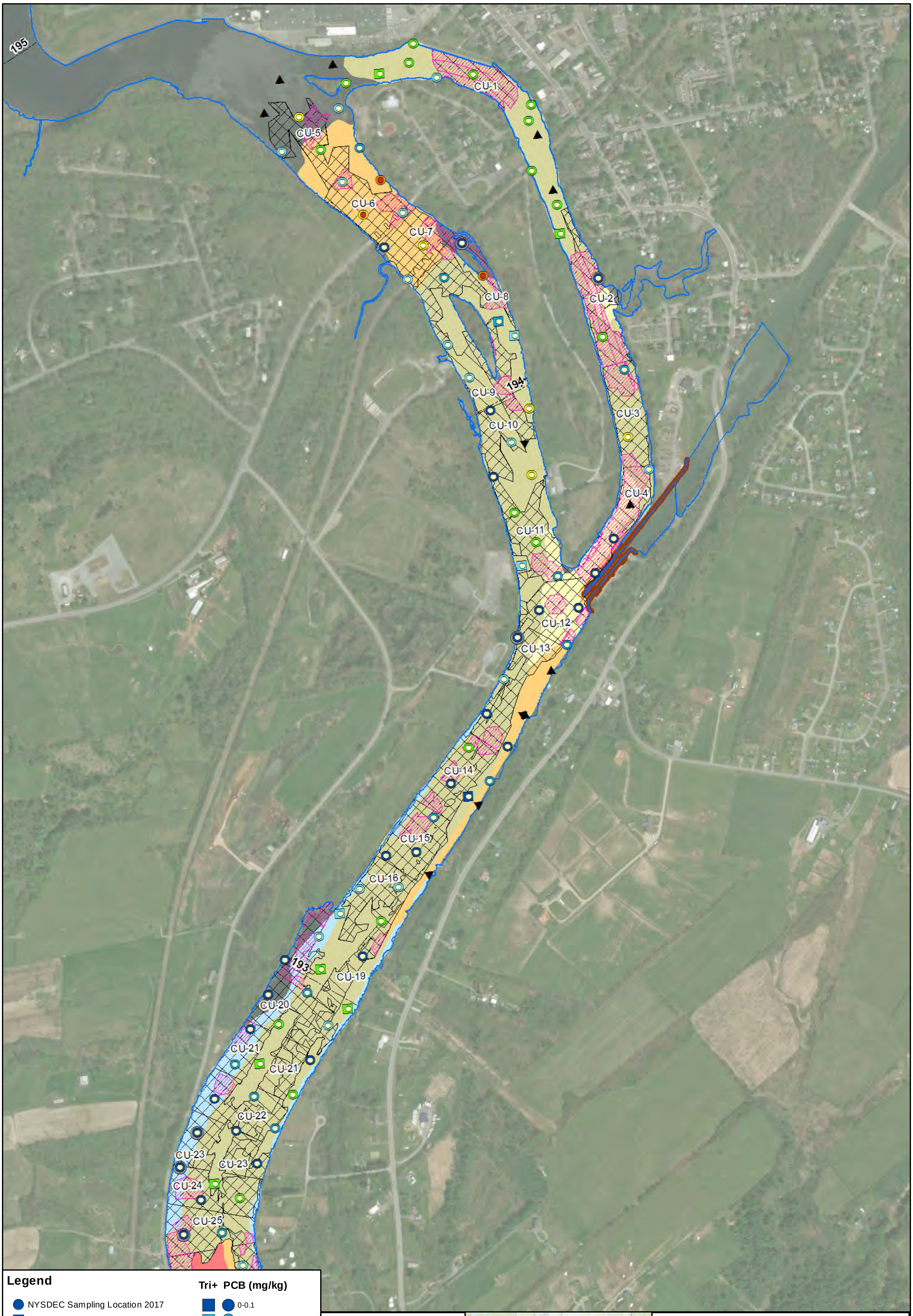


- 50 mg/kg Total PCB was originally defined by NYSDEC (Tofflemire and Quinn, 1979) as a "hot spot" threshold.
- Although this location exceeds 50 mg/kg Total PCB, it does not exceed the Tri+ PCB removal criterion of 30 mg/kg.

Sampling Location with Total PCB Concentration in Excess of 50 mg/kg:
RM 179 Area

Figure 5.1-5

April 2019



* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

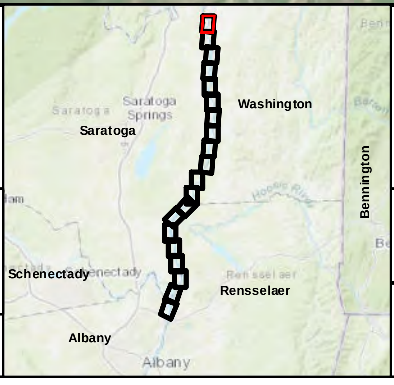
***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

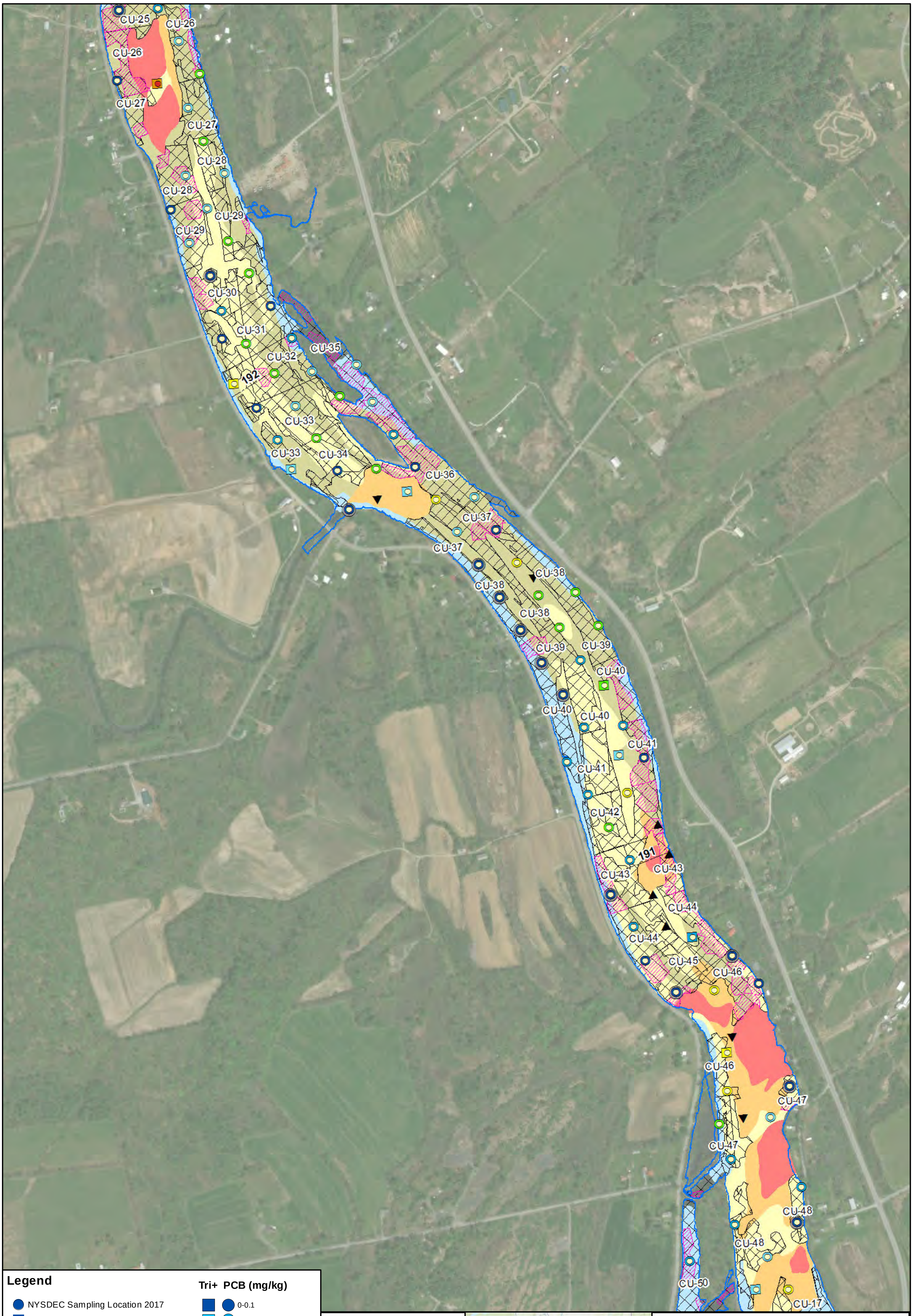


Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 1 of 20

Document Path: M:\02859191\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

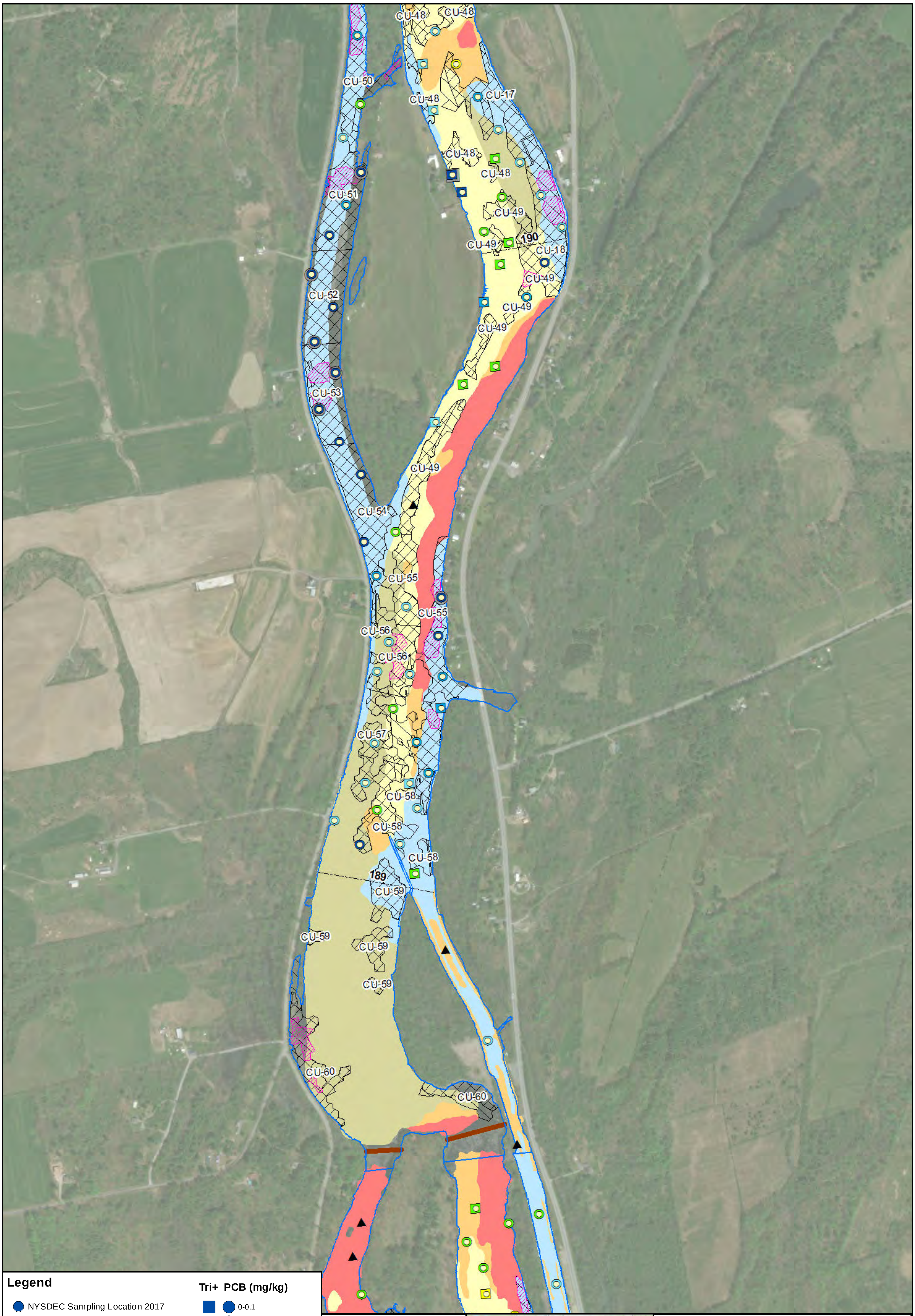
April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 2 of 20

Document Path: M:\02859191\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ● Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

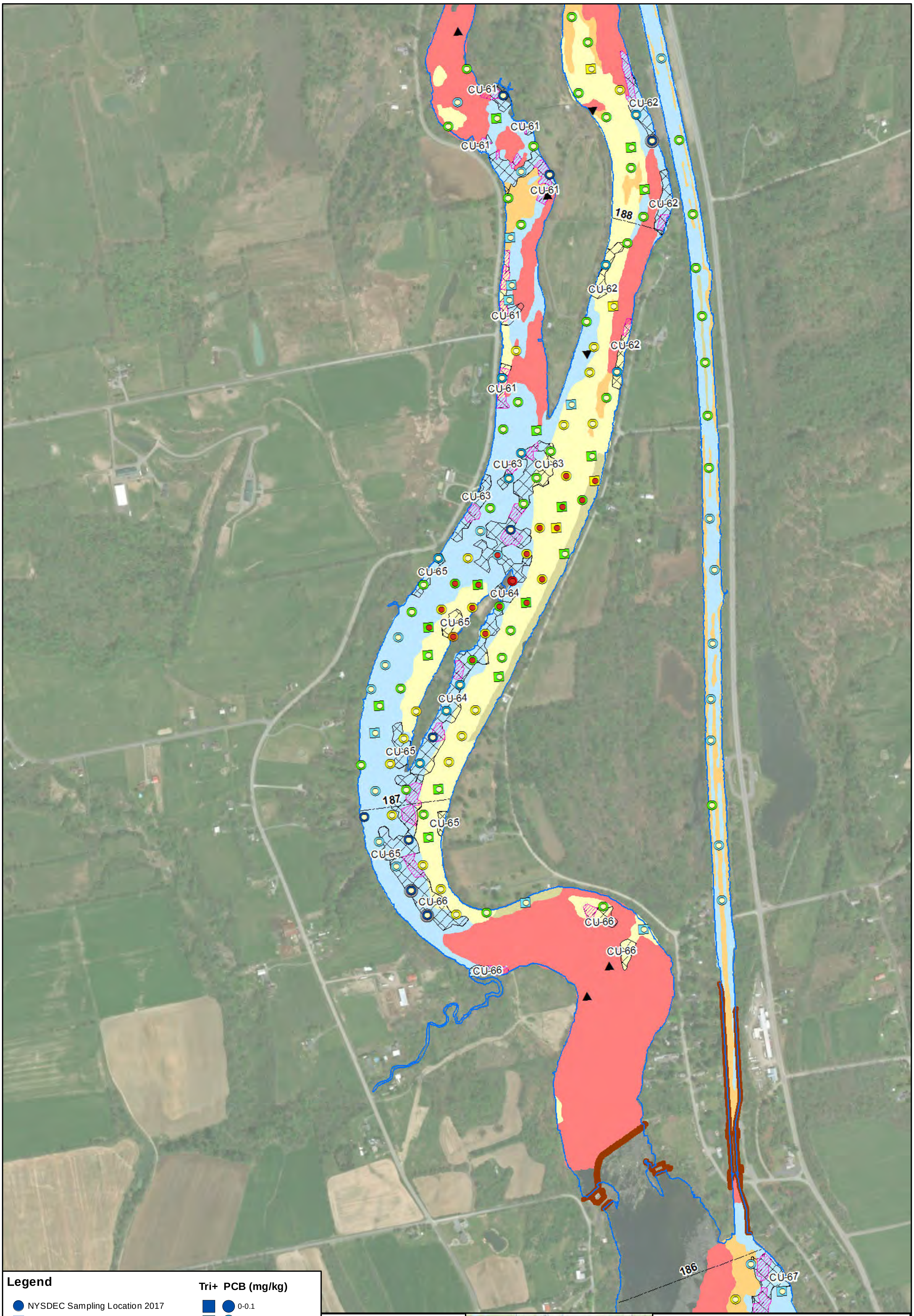
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 3 of 20

N
0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

■	●	0-0.1
■	●	0.11-0.3
■	●	0.31-1.0
🟩	●	1.1-3.0
🟨	●	3.1-10.0
🟧	●	10.1-30.0
🟥	●	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

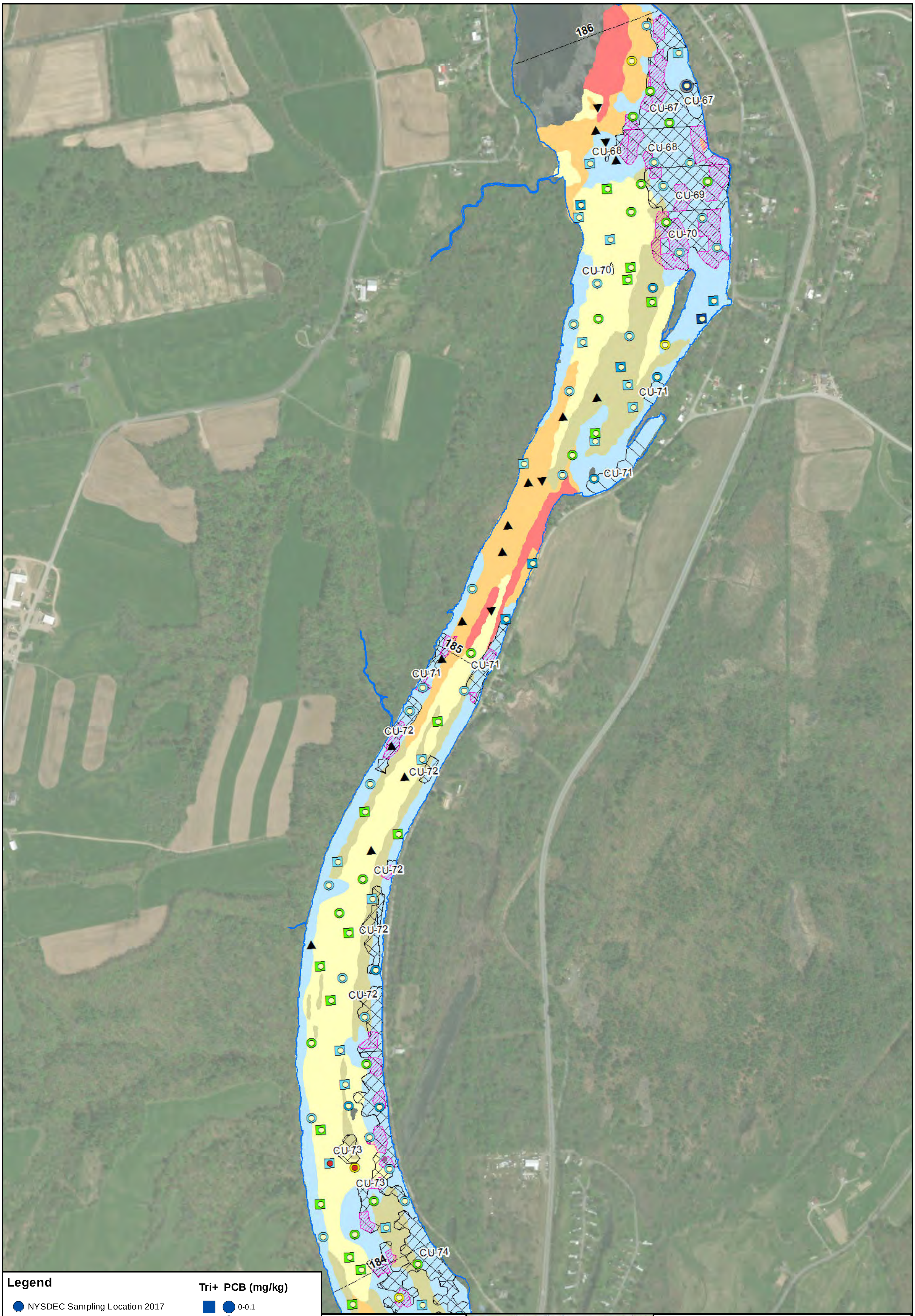
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1

Sheet 4 of 20

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ⧅ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement.
Not for Public Release.
FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

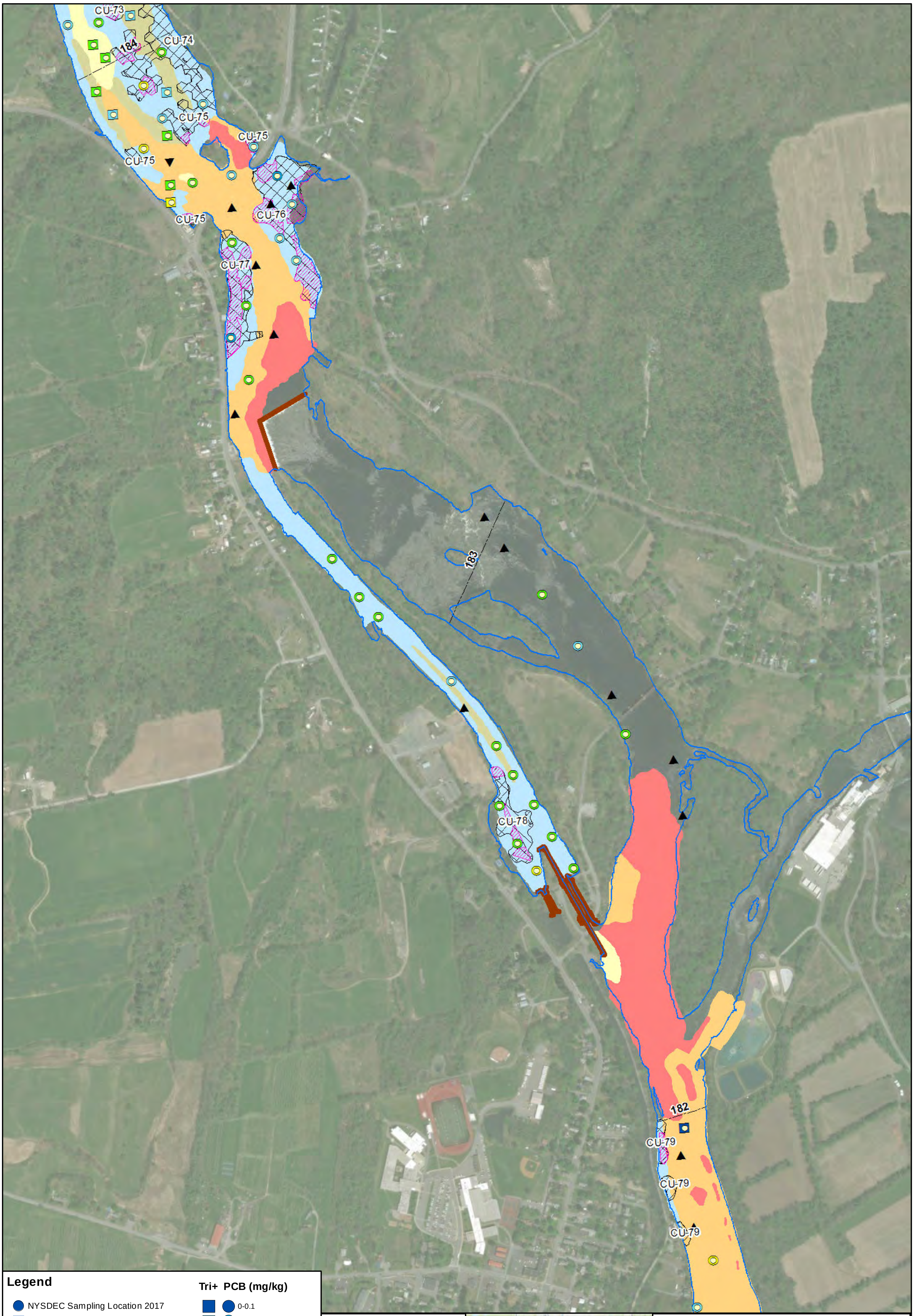
Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 5 of 20

N

0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

■	●	0-0.1
■	●	0.11-0.3
■	●	0.31-1.0
■	●	1.1-3.0
■	●	3.1-10.0
■	●	10.1-30.0
■	●	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

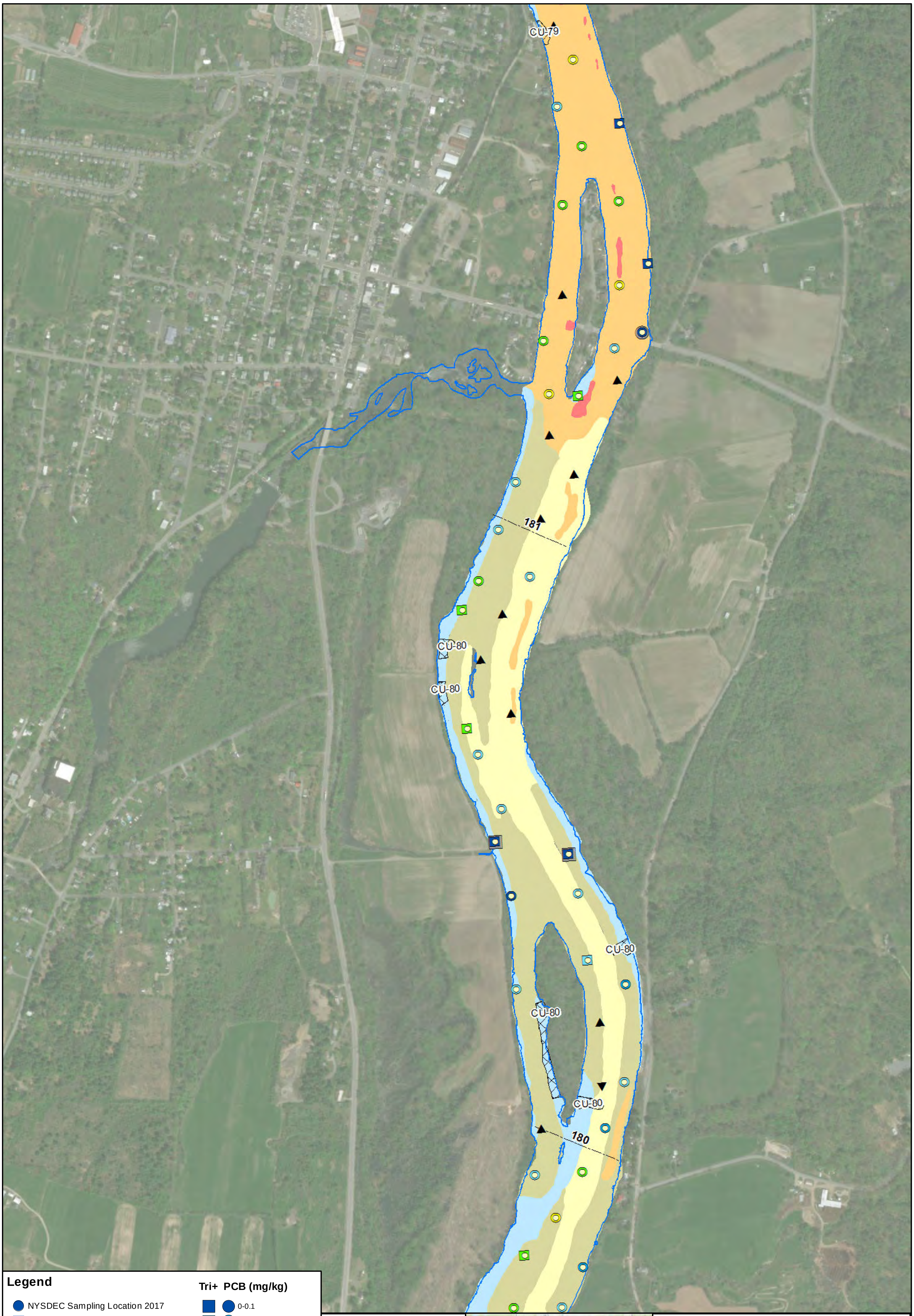
April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 6 of 20

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- ■ Silt
- ■ Silt and Sand
- ■ Gravel
- ■ Transitional
- ■ Bed Rock

Tri+ PCB (mg/kg)

■	●	0-0.1
■	●	0.11-0.3
■	●	0.31-1.0
🟩	●	1.1-3.0
🟨	●	3.1-10.0
🟧	●	10.1-30.0
🟥	●	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

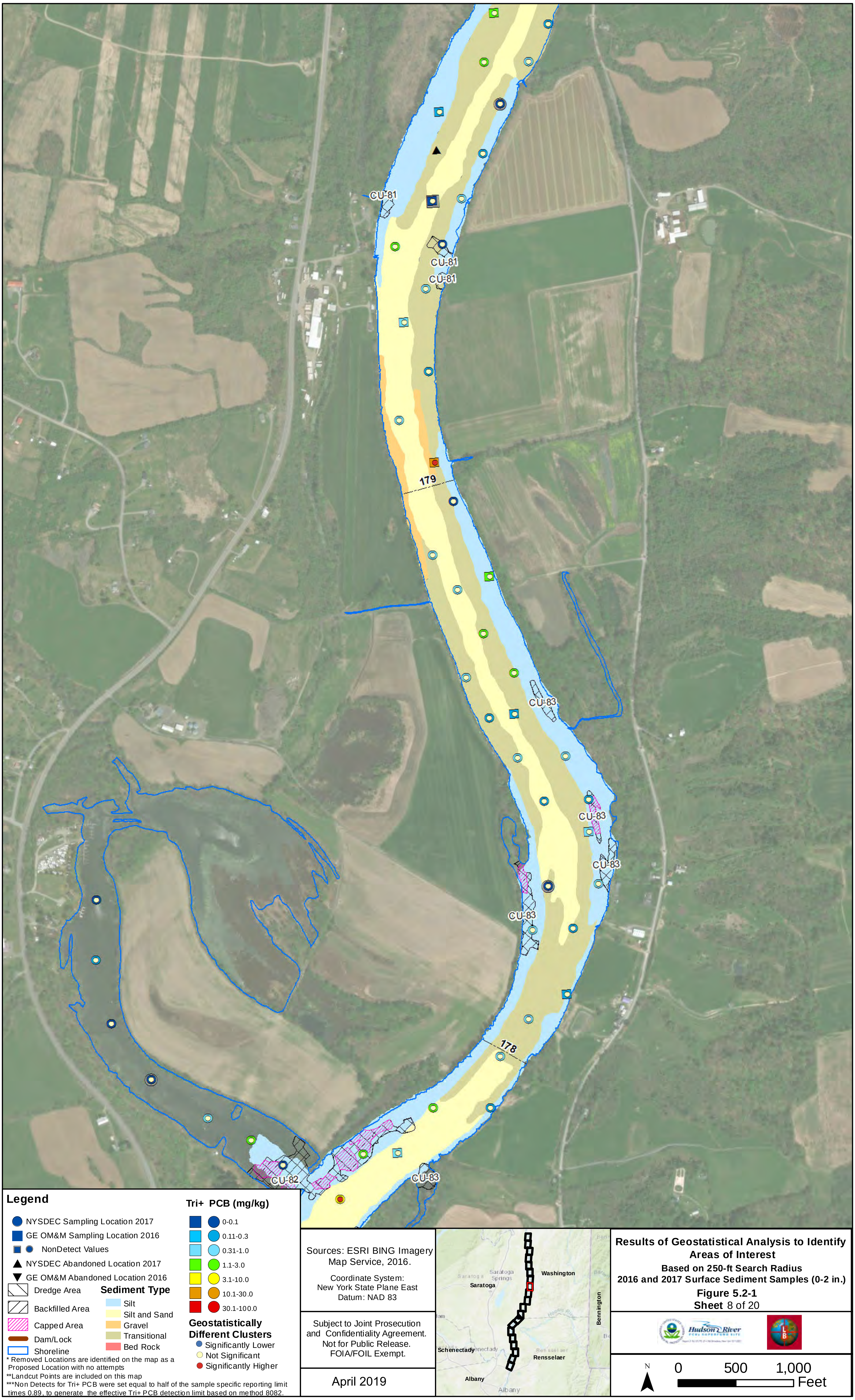
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 7 of 20

N
0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▨ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ● Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

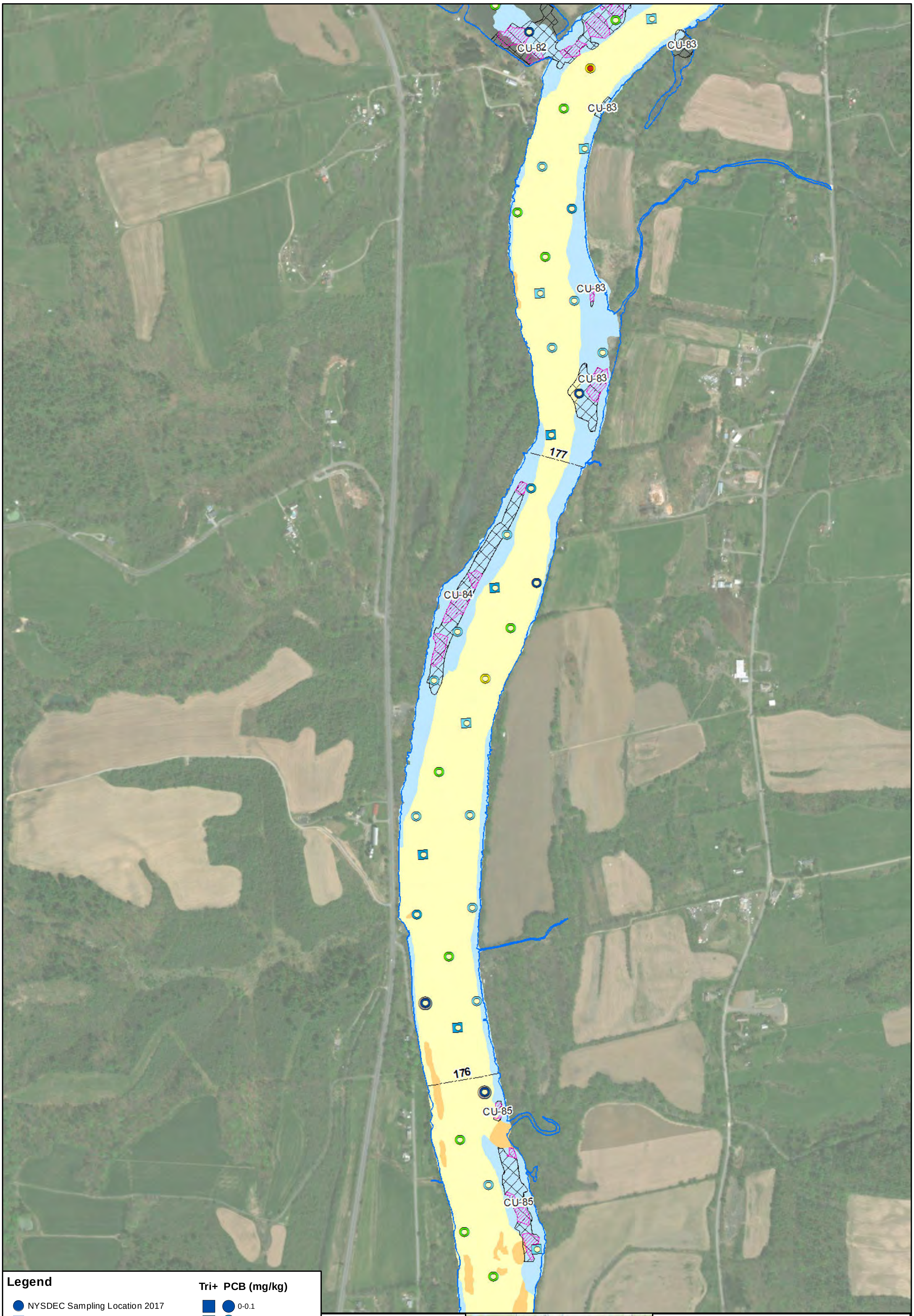
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1

Sheet 8 of 20

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

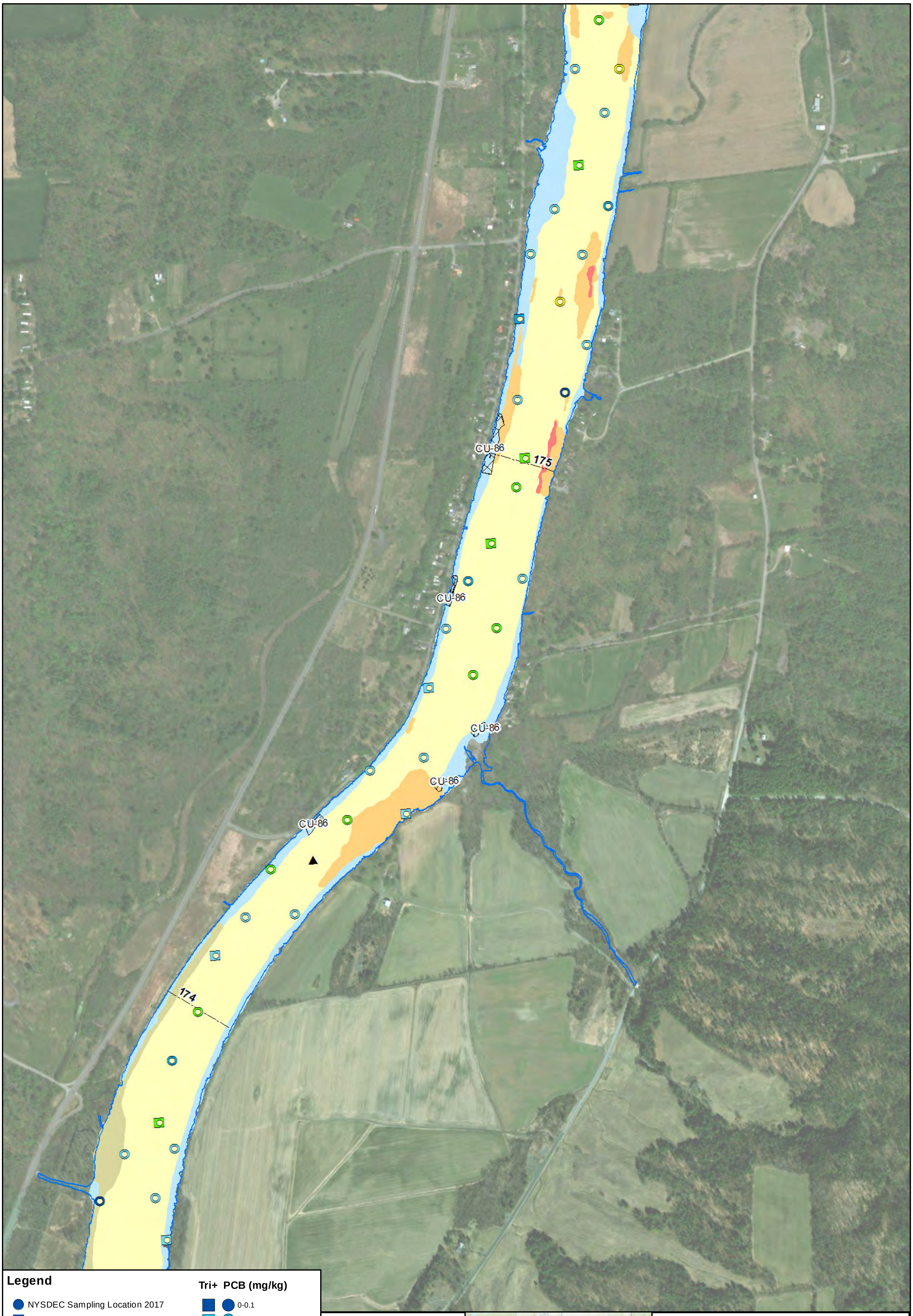
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 9 of 20

N
0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- ▨ Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

■	●	0-0.1
■	●	0.11-0.3
■	●	0.31-1.0
🟩	●	1.1-3.0
🟨	●	3.1-10.0
🟧	●	10.1-30.0
🟥	●	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 10 of 20

N

0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

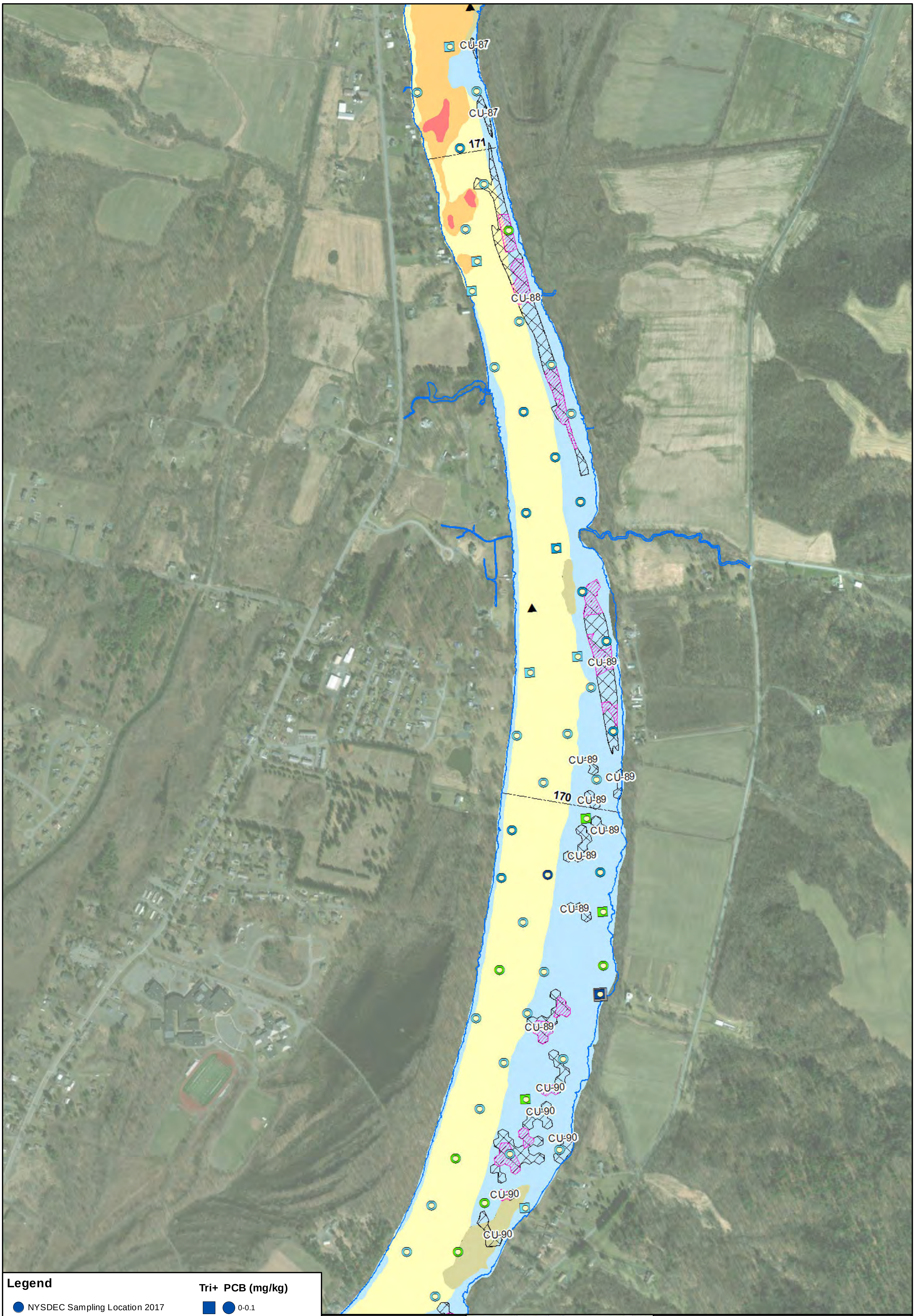
April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 11 of 20

Document Path: M:\02859191\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ⧄ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

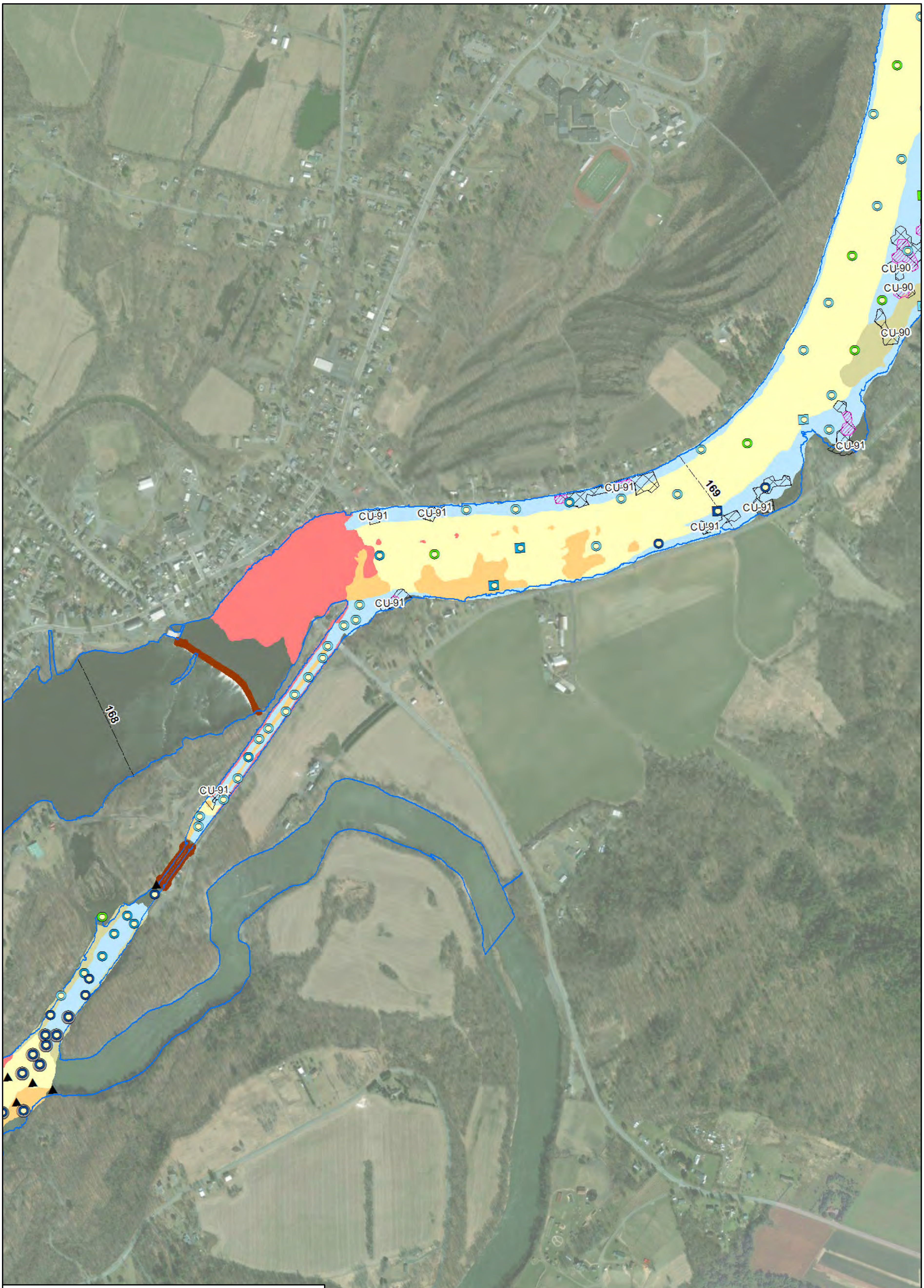
Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 12 of 20

N

0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- 🟩 🟢 1.1-3.0
- 🟨 🟡 3.1-10.0
- 🟧 🟠 10.1-30.0
- 🟥 🔴 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

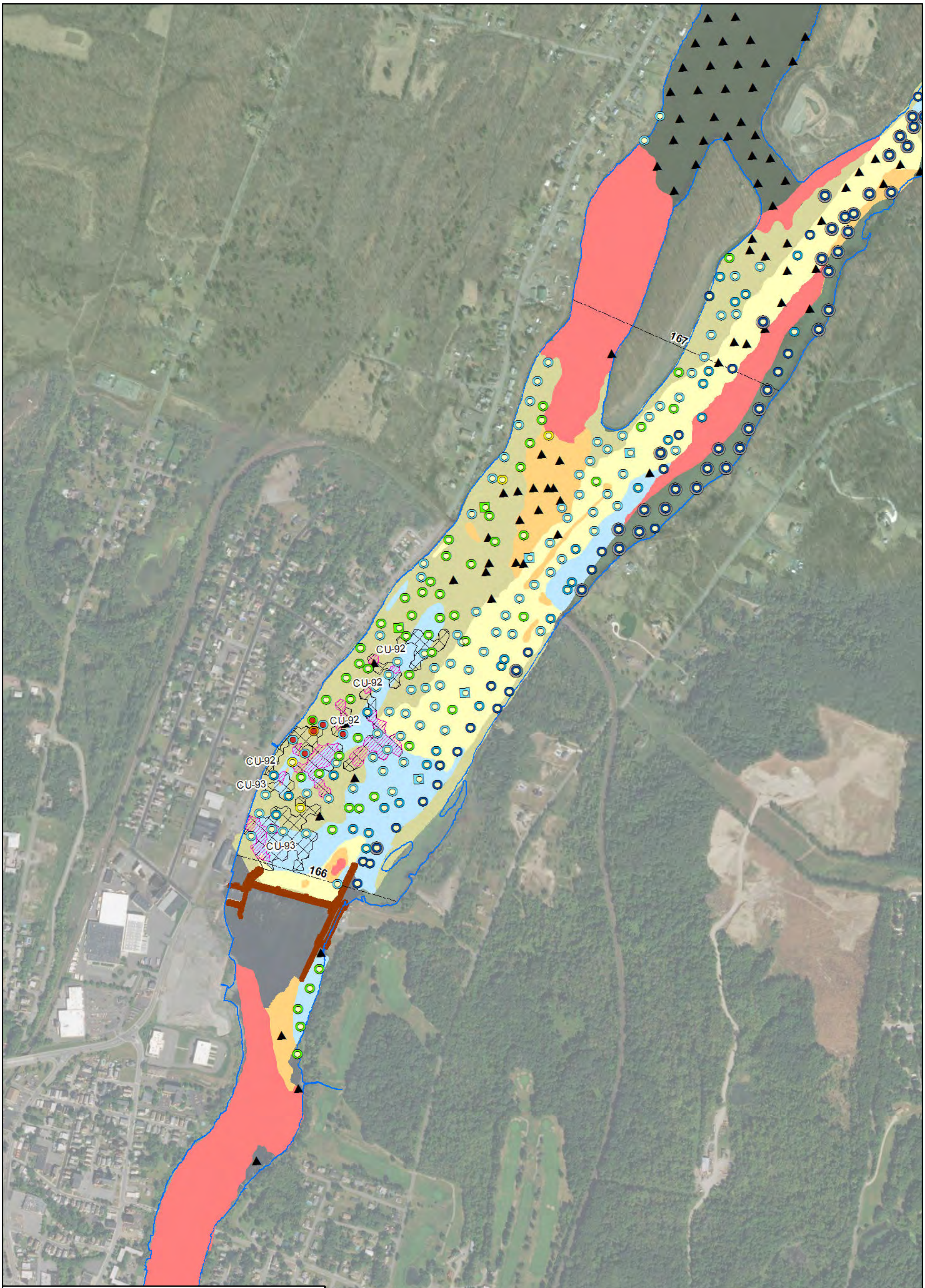
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 13 of 20

N
0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

■	●	0-0.1
■	●	0.11-0.3
■	●	0.31-1.0
■	●	1.1-3.0
■	●	3.1-10.0
■	●	10.1-30.0
■	●	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

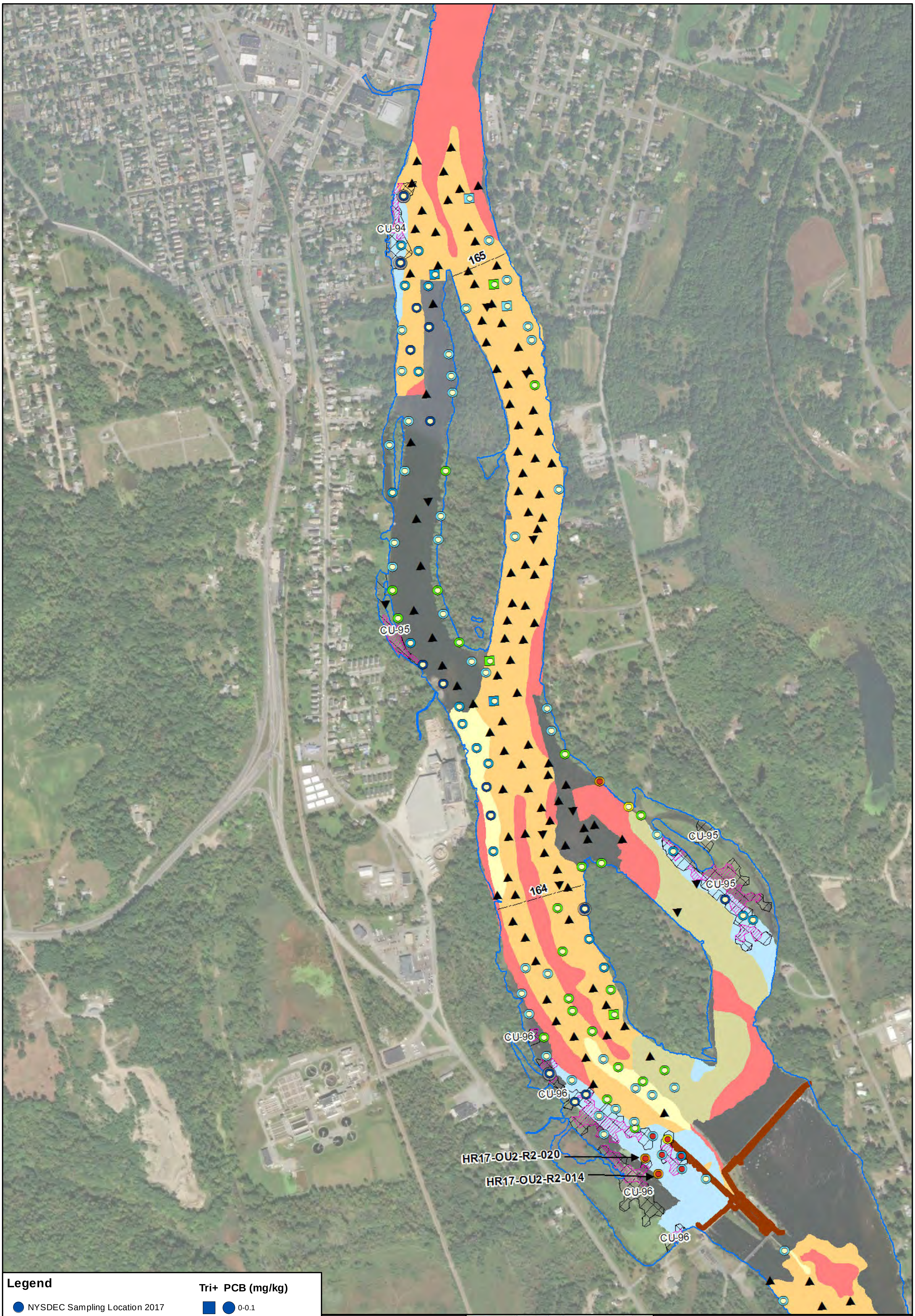
Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 14 of 20

N

0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- 🟩 ● 1.1-3.0
- 🟨 ● 3.1-10.0
- 🟧 ● 10.1-30.0
- 🟥 ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

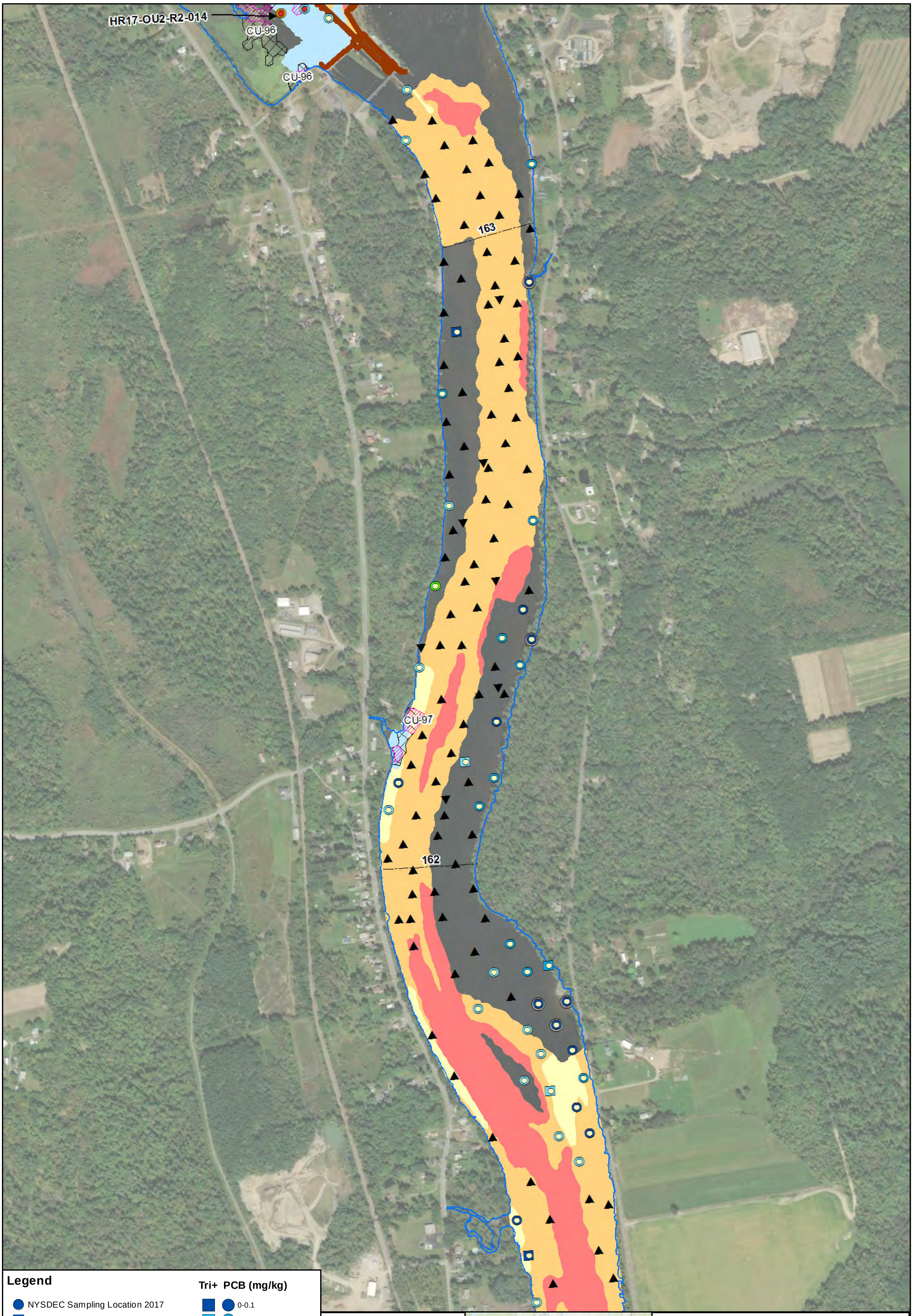
Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 15 of 20

N

0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟫 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

■	●	
🟦	🔵	0-0.1
🟦	🔵	0.11-0.3
🟦	🔵	0.31-1.0
🟩	🟢	1.1-3.0
🟨	🟡	3.1-10.0
🟧	🟠	10.1-30.0
🟥	🔴	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

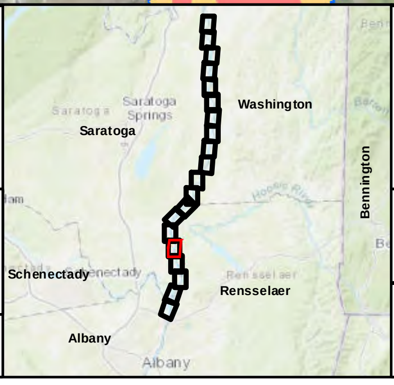
***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019



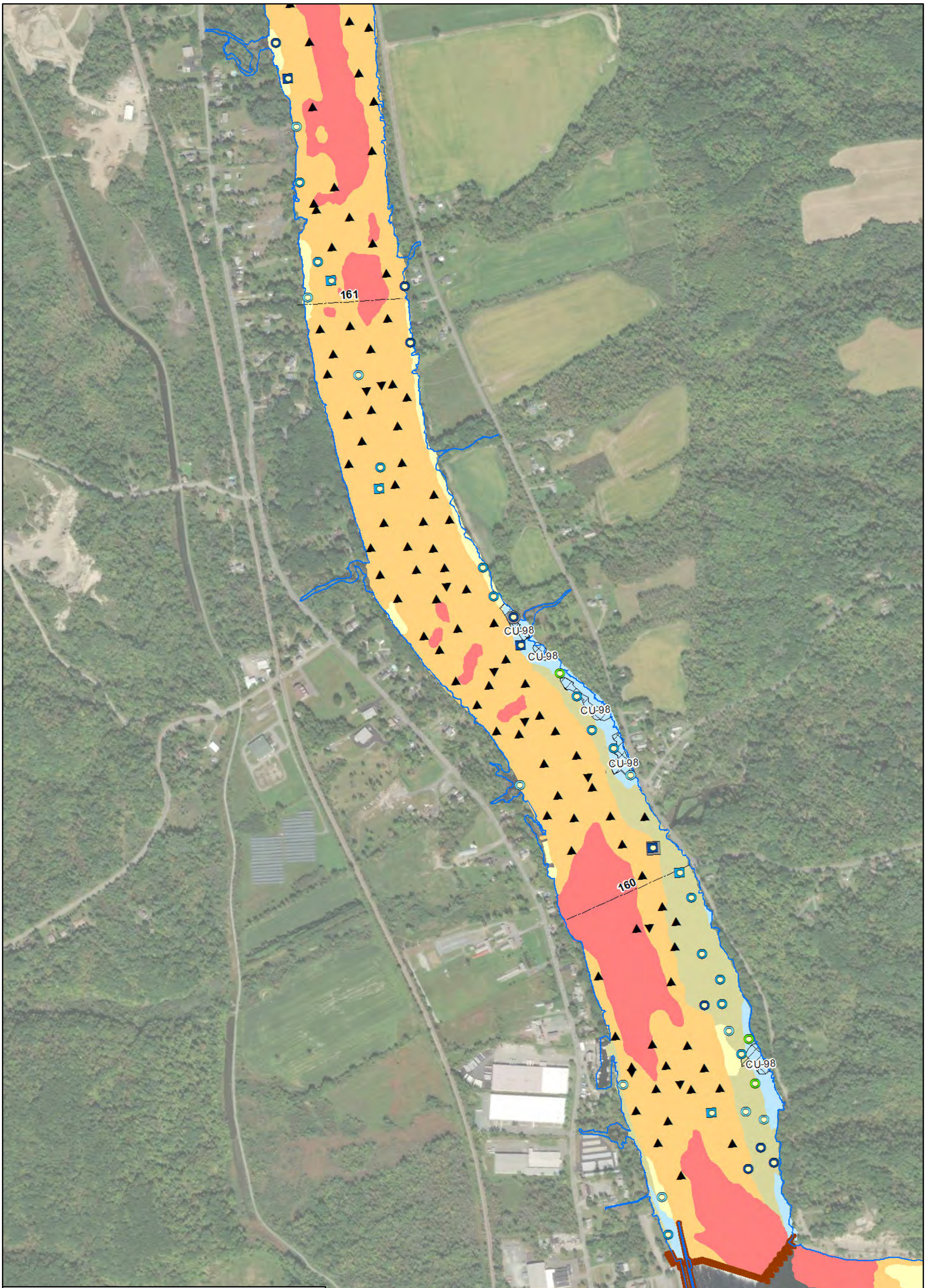
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 16 of 20

N
0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ⧄ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟩 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

■	●	
■	●	0-0.1
■	●	0.11-0.3
■	●	0.31-1.0
■	●	1.1-3.0
■	●	3.1-10.0
■	●	10.1-30.0
■	●	30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1

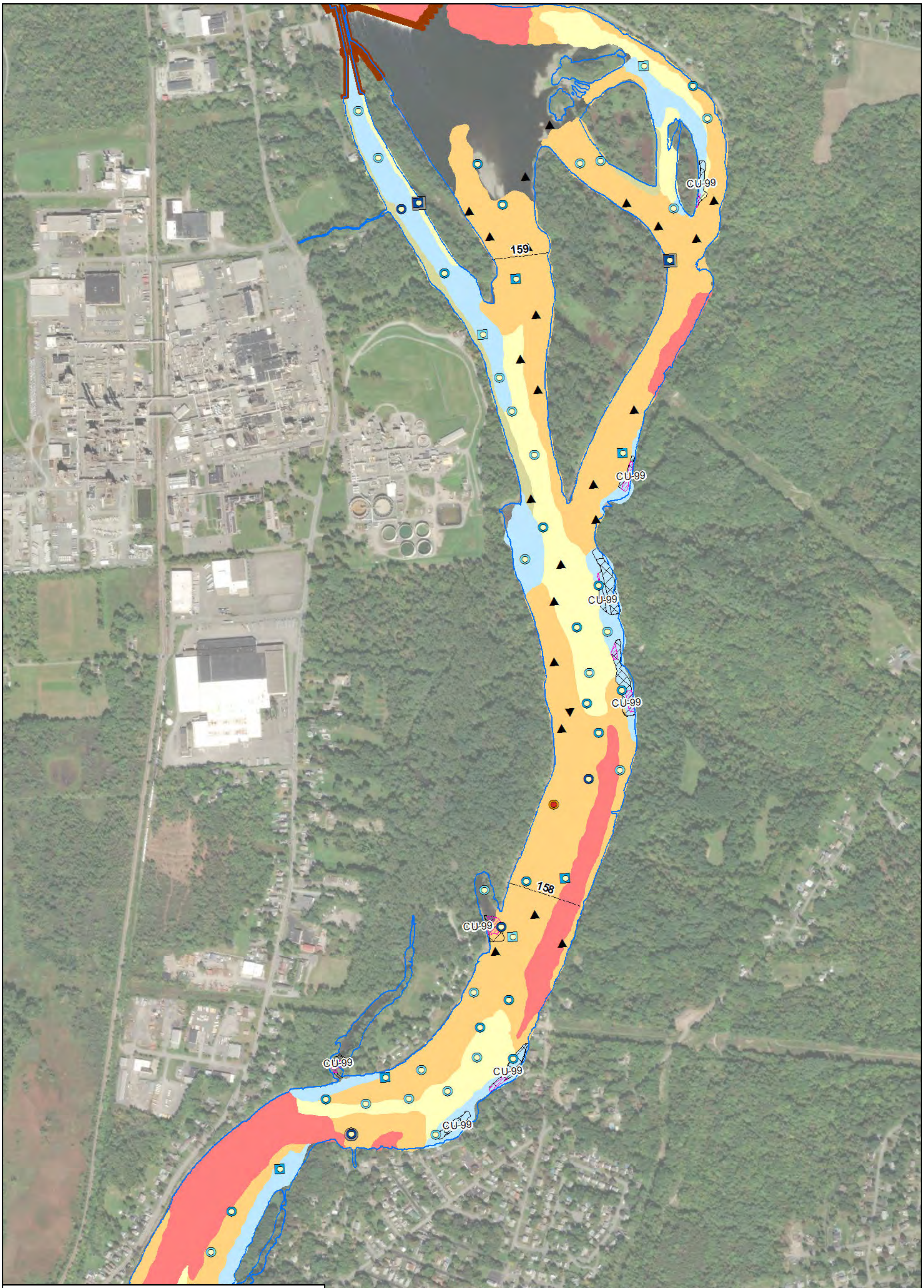
Sheet 17 of 20

Hudson River PCBs Superfund Site

N

0 500 1,000 Feet

Document Path: M:\0285919\GIS\OM_MNYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- 🟩 ● 1.1-3.0
- 🟨 ● 3.1-10.0
- 🟧 ● 10.1-30.0
- 🟥 ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts
**Landcut Points are included on this map
***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

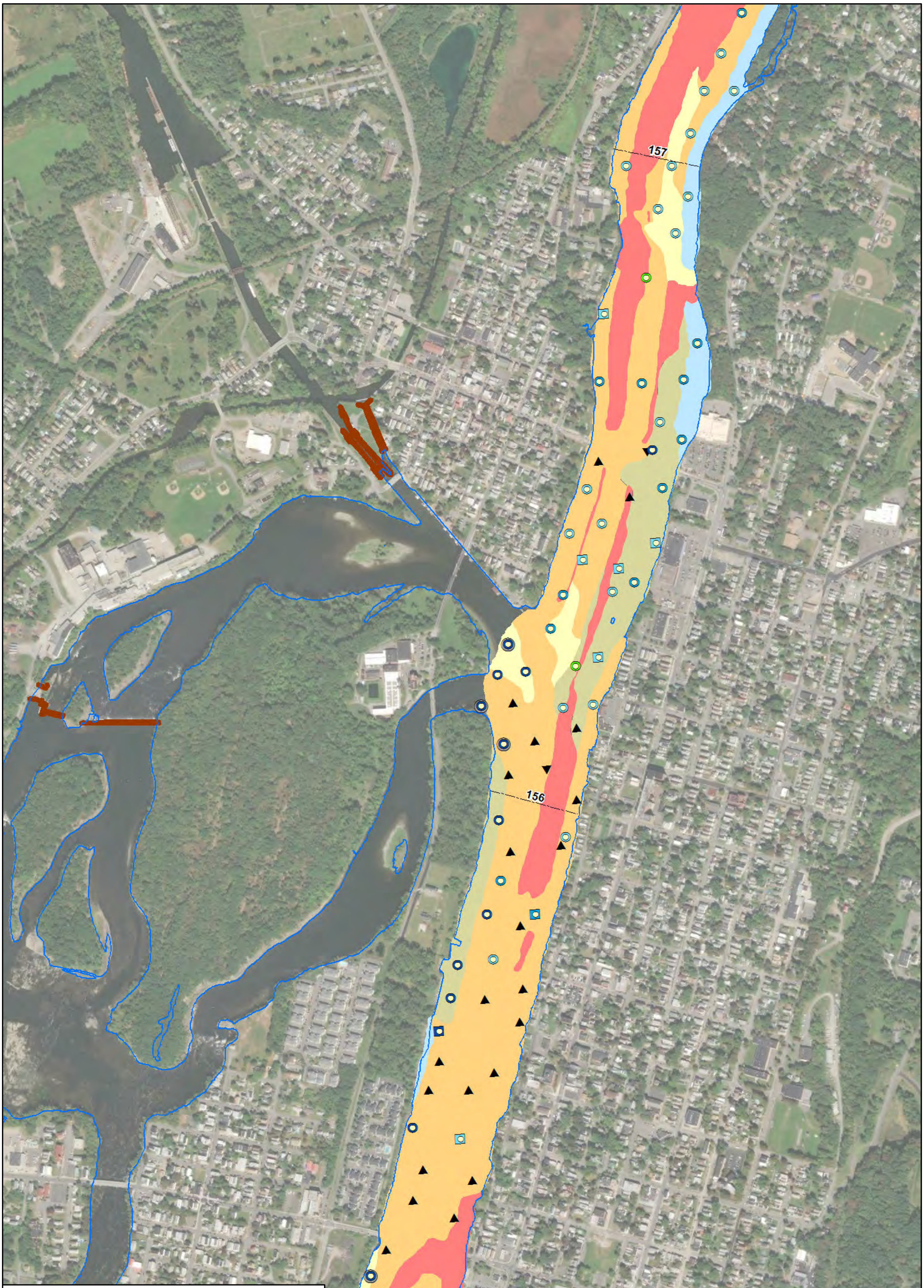
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 18 of 20

N
0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ☐ Shoreline

Sediment Type

- 🟦 Silt
- 🟨 Silt and Sand
- 🟧 Gravel
- 🟩 Transitional
- 🟥 Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- 🟩 🟢 1.1-3.0
- 🟨 🟡 3.1-10.0
- 🟧 🟠 10.1-30.0
- 🟥 🔴 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

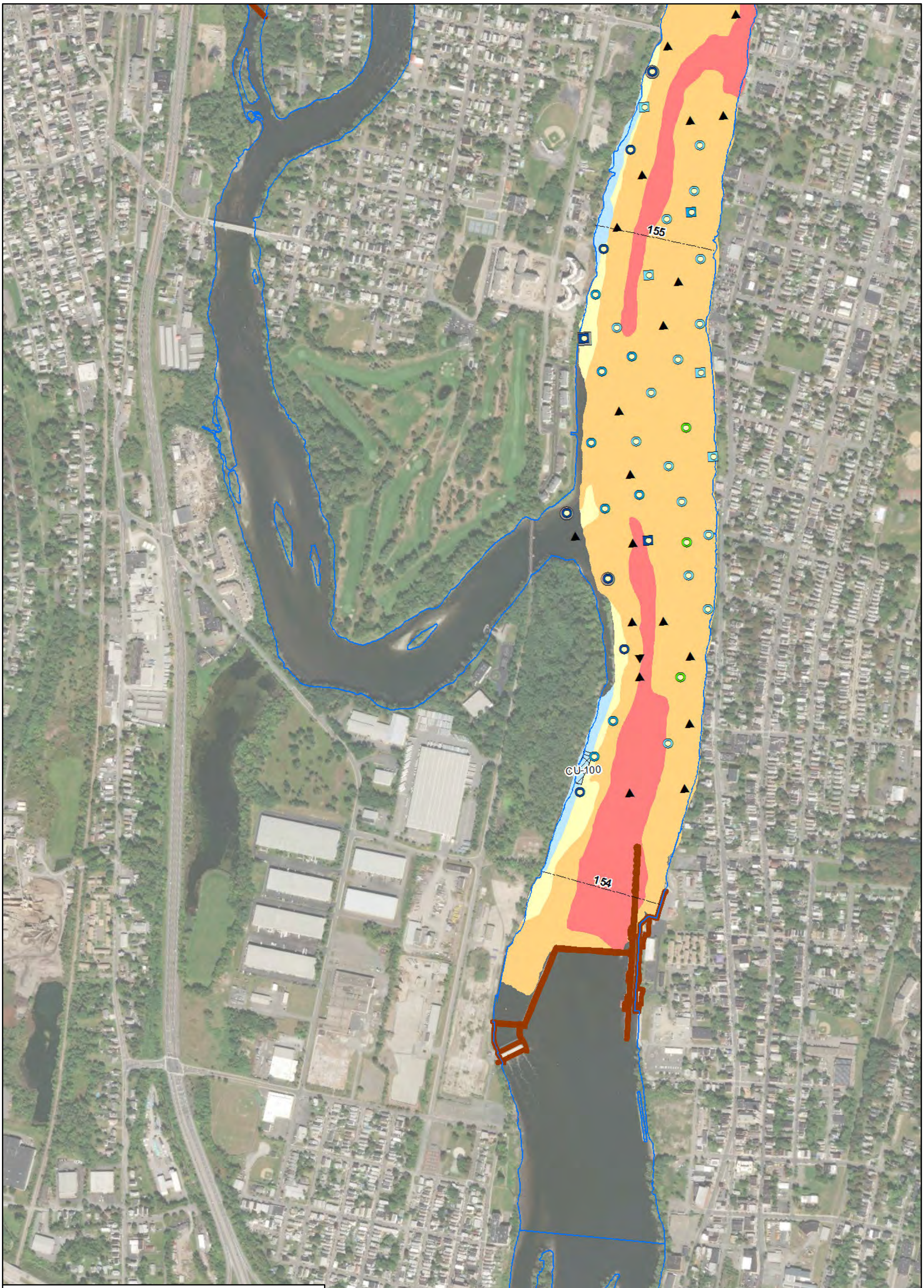
Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius
2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 19 of 20

N
0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_M\NYSDEC Hotspots Fig521.mxd



Legend

- ● NYSDEC Sampling Location 2017
- ■ GE OM&M Sampling Location 2016
- ■ ● NonDetect Values
- ▲ NYSDEC Abandoned Location 2017
- ▼ GE OM&M Abandoned Location 2016
- ▧ Dredge Area
- ▨ Backfilled Area
- ▨ Capped Area
- ▬ Dam/Lock
- ▭ Shoreline

Sediment Type

- Silt
- Silt and Sand
- Gravel
- Transitional
- Bed Rock

Tri+ PCB (mg/kg)

- ■ ● 0-0.1
- ■ ● 0.11-0.3
- ■ ● 0.31-1.0
- ■ ● 1.1-3.0
- ■ ● 3.1-10.0
- ■ ● 10.1-30.0
- ■ ● 30.1-100.0

Geostatistically Different Clusters

- ● Significantly Lower
- ○ Not Significant
- ● Significantly Higher

* Removed Locations are identified on the map as a Proposed Location with no attempts

**Landcut Points are included on this map

***Non Detects for Tri+ PCB were set equal to half of the sample specific reporting limit times 0.89, to generate the effective Tri+ PCB detection limit based on method 8082.

Sources: ESRI BING Imagery Map Service, 2016.

Coordinate System:
New York State Plane East
Datum: NAD 83

Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.

April 2019

Results of Geostatistical Analysis to Identify Areas of Interest

Based on 250-ft Search Radius 2016 and 2017 Surface Sediment Samples (0-2 in.)

Figure 5.2-1
Sheet 20 of 20

N
0 500 1,000
Feet

Document Path: M:\0285919\GIS\OM_MNYSDEC Hotspots Fig521.mxd

Hudson River PCBs Superfund Site

TECHNICAL MEMORANDUM

EVALUATION OF 2016 EPA/GE AND 2017 NYSDEC SURFACE SEDIMENT DATA

ATTACHMENT A: SUPPORTING ANALYSES

Prepared by:

Louis Berger US, Inc.

&

Kern Statistical Services, Inc.

April 2019

Attachment A: Supporting Analyses
Technical Memorandum
Evaluation of 2016 EPA/GE and 2017 NYSDEC Surface Sediment Data
Hudson River PCBs Superfund Site

Table of Contents

List of Tables

List of Figures

Attachment A: Supporting Analyses
Technical Memorandum
Evaluation of 2016 EPA/GE and 2017 NYSDEC Surface Sediment Data
Hudson River PCBs Superfund Site

This attachment provides a series of detailed data analyses conducted to support the main portion of the memorandum entitled Evaluation of 2017 NYSDEC Surface Sediment Data. The analyses primarily make use of the 2017 NYSDEC surface sediment data, although the 2016 surface sediment data obtained by GE are also included when appropriate. Each discussion is intended to serve as a stand-alone analysis.

A.1 Sample Locations and Collection Success

Section A.1 provides supporting information for Section 2 of the main memorandum. In the original NYSDEC sampling program (EA, 2017), the State designed a sampling plan to examine PCB contamination on a reach-by-reach basis, as opposed to the EPA's river section-based sampling program. NYSDEC proposed a total of 1,673 surface sediment locations[1] to supplement OM&M activities for the Operable Unit (OU)-2 of the Hudson River PCBs Superfund Site. These target sample locations and the number of samples were selected to provide sufficient data points to achieve NYSDEC's statistically-based data quality objectives, which were: (1) the ability to detect an 8 percent annual decline in mean sediment total PCB concentrations within a given reach between two consecutive 5-year monitoring periods with a statistical power of 80 percent at the 95 percent confidence level, and (2) the ability to determine the arithmetic mean PCB concentration for each reach with a relative error no greater than 20 percent (EA, 2018). During the 2017 sampling event, 14 additional locations were added based on field considerations. In total, NYSDEC obtained sediment from a total of 1,162 locations (1,089 in the mainstem of the river, 59 in land cut areas, 9 in the Old Champlain Canal and 5 in the Coveville inlet); 472 locations were considered abandoned (*i.e.,* the location was occupied but no sediment was recovered), and 53 locations were considered removed (*i.e.,* these locations were not attempted due to access issues). See Section 2 of the main memorandum for further definition of these terms. Table A.1-1 summarizes these location tallies.

Section A1.1 describes how Louis Berger integrated the sample location information, including the State's success rate in collecting the samples and how the samples were categorized for area-weighted mean concentration calculation purposes. In addition to examining the collection success rate, an examination of the possible effect of abandoned or removed grid points on the unbiased nature of the sampling plan is summarized in Section A.1.2. Finally, an examination of the abandoned and high-concentration locations inside certification units (CUs) and their coincidence with capped areas, areas with erosion stabilization fabrics, non-backfilled areas or any other conditions is discussed in Section A.1.3.

A.1.1 Integration of Proposed, Attempted, Abandoned, Removed, and Recovered Locations

NYSDEC and EA Engineering, P.C. and its affiliate EA Science and Technology (EA) analyzed both the 2002-2005 SSAP data and the 2016 EPA/GE OM&M data in the non-dredged areas to

---

[1] This total included 1589 planned locations plus an additional 84 contingency locations to be used in the event that some of the original 1589 could not be occupied or were unsuccessful.

develop a supplemental OM&M sampling plan. The NYSDEC sampling plan was designed to complement the GE OM&M sampling such that the combination of the two data sets would provide a rigorous basis to assess post-dredging contamination levels in the river on a reach-by-reach basis. Based on NYSDEC's specific goal of PCB trend analysis over eight river reaches in 5-year increments, it determined that 1,589 samples would be a sufficient sample size to provide the statistical power required. Sample locations in the main stem of the river were laid out in a systematic triangular grid pattern with a random start point, yielding a randomized, unbiased sampling design, covering both dredged and non-dredged areas, including backfilled and capped areas. The proposed locations incorporated the locations previously sampled by GE in 2016 such that when the GE locations were close to NYSDEC grid locations the GE location was used and no additional sample was collected. Bedrock locations, or those close to the locks and dams which could be unsafe for the sampling crews, were excluded from the sampling program. A contingency of 84 sample locations was added in the event safety or accessibility issues arose in connection with the original sample locations. During the sampling event, which commenced in June 2017, an additional 14 sample locations were added to Reach 5 in the Coveville area and the Old Champlain Canal, for a total of 1,687 proposed, contingency and field-added sample locations, as shown in Figure 2.1-1 of the main text of this memorandum.[2] However, it should be noted that, unlike the EPA/GE OM&M sediment sampling effort, [3] no alternate locations were selected for originally proposed locations that did not yield recoverable sediment.

In the NYSDEC sampling design, the State placed the proposed locations in a gridded pattern so that the arithmetic mean of the samples across a river reach would yield an accurate, unbiased estimate of the PCB concentration. A gridded pattern is generally followed through areas with cohesive sediment types like silt and sand, as well as non-cohesive areas, as characterized by transitional and gravel areas. Areas with a side-scan sonar (SSS) classification of bedrock were generally avoided, with the notable exception of some areas of Reach 7.

Three sampling vessels were used concurrently to conduct the sediment sampling effort. Navigation to within a tolerance of 10 feet (ft) of each proposed sample location was performed with the aid of a global navigation satellite system (GNSS). Each location was classified by NYSDEC into one of three groups, recovered, abandoned, or removed. If there was sufficient sediment in a location, a sample was taken, sent to the lab, and analyzed. Such successfully sampled locations are referred to as having "recoverable sediments." In general, each proposed location was attempted up to six times by NYSDEC, typically by moving the sampling boat slightly to make each attempt. Generally, after six sampling attempts, if sufficient sediment could not be obtained from a single location or bedrock

---

[2] The locations in Coveville and the Old Champlain Canal are not part of the mainstem of the Upper Hudson River as so were excluded from any area-based calculations. Duplicate pair samples from these areas were considered in assessing sampling and analytical precision,

[3] EPA/GE utilized a randomized, unbiased sampling design and proposed the collection of 226 surface sediment samples in non-dredged areas, with 226 secondary locations selected in the event any of the primary locations were inaccessible or could not otherwise be sampled. The secondary locations were not adjacent to the primary proposed locations.

was encountered, the location was considered abandoned. Any locations that were not attempted, (*i.e.,* where access was limited and prevented sampling) were grouped together as removed. This usually included areas with shallow water conditions or the presence of submerged aquatic vegetation (SAV) or debris.

To facilitate the calculation of area-weighted mean surface sediment concentrations, NYSDEC's location classification was modified by Louis Berger as needed to reflect one of three categories: successful (also referred to as having "recoverable sediments"), abandoned, or removed. In addition, based on the notes from the sampling effort and EPA/Louis Berger discussions with NYSDEC/EA, some NYSDEC-classified locations were changed from abandoned to removed or vice versa to consistently represent the various location types in the Berger area-weighted mean concentration calculation. Any unsuccessful location with field notes referencing SAV was grouped with the removed category, since the SAV effectively prevented any sampling attempt. Unsuccessful locations that referenced bedrock or no available substrate for sampling were characterized as abandoned, since these locations were attempted but did not yield recoverable sediment. Additionally, there were some locations with notes that indicated the sampling radius was probed and bedrock was encountered but no sample collection was attempted. These locations were also included with the abandoned locations because they were occupied and probed but lacked sufficient sediment to permit sampling.

There were 78 land cut locations, 5 of which were classified as abandoned. Land cut areas are outside of the mainstem of the river and connect the navigable pools via locks. Since these locations represent hydrodynamic conditions that are unlike those of the river, they are unlikely to recover at the same rate as the rest of the river channel. To obtain an accurate representation of the contamination in the mainstem of the river, land cut samples were excluded from the area-weighted average concentration calculations.

After the review of NYSDEC sampling notes, 53 locations were considered removed, 467 locations were considered abandoned, and 1,089 locations yielded recoverable surface sediment samples, spanning the eight river reaches, for a total of 1,609 locations in the main stem of the river. The total number of NYSDEC sample locations in each reach ranges from 86 (Reach 6) to 307 (Reach 4), and the number of recoverable sediment samples ranges from 67 (Reach 6) to 223 (Reaches 4 and 5). Table A.1.1-1 presents a summary of the sediment samples that were collected on behalf of NYSDEC. Figure 2.1-1 of the main memorandum shows the proposed, attempted, abandoned, and recoverable sediment sample locations, as well as the measured Tri+ PCB concentrations across the eight reaches for both the NYSDEC and GE programs. Proposed NYSDEC locations are indicated by the 100-ft radius circles (the actual proposed location is at the center of each circle). NYSDEC-attempted locations are shown by a black "X". Abandoned locations are shown by black triangles for both the NYSDEC and GE programs. Removed locations can be identified by proposed sampling locations (indicated by the 100-ft radius circles) with no interior markers indicating attempted, abandoned or recovered sediment locations. Finally, locations with recoverable sediments by either NYSDEC or GE are shown by program-specific symbols color-coded to the Tri+ PCB concentration.

Figures A.1.1-1 through A.1.1-3 summarize the distribution of recoverable sediment points, abandoned locations and removed locations for the 2016 EPA/GE non-dredged area data, 2017 NYSDEC non-dredged area data and 2017 NYSDEC dredged area data, respectively. In reviewing Figure A.1.1-2 relative to the other figures, the 2017 NYSDEC non-dredged area data show a much higher proportion of abandoned and removed locations in River Reaches 1 to 4, all part of River Section (RS) 3. River Reaches 2 and 3 have the highest proportion of abandoned locations to successful locations, largely the result of the large areas of gravel and bedrock in these reaches. Data counts for each river section are included in Table A.1.1-1. These counts exclude land cut areas, Coveville and the Old Champlain Canal locations along the three river sections.

A.1.2 Assessment of the Sampling Grid by River Reach

The NYSDEC sampling design created a unique gridded pattern for each river reach. The number of samples per river reach varied to reflect the anticipated variance of the data in each reach, based on data obtained by GE during the SSAP program (2002-2005) and the 2016 EPA/GE OM&M sampling, to meet the NYSDEC statistically-based data quality objectives listed previously. Grid density and spacing changed with each river reach based on the number of planned locations, the size of the reach, the extent of bedrock area as mapped by GE in 2002/2003 by SSS and the accessibility of the area (*e.g.,* areas immediately upstream and downstream of dams were generally avoided). The number of proposed locations for each river reach is based on a calculation completed by the State which combines the 2002-2005 SSAP and the 2016 EPA/GE OM&M data. This approach uses the initial mean and the pooled standard deviation of the combined data sets to estimate the number of samples needed to achieve the statistical goals. Reaches 6 and 7 have significantly fewer samples than the rest of the reaches, based on the lower variance calculated for these reaches by NYSDEC.

As summarized in Figures A.1.1-1 to A.1.1-2 and mapped in Figure 2.1-1 of the main text, Reaches 2 and 3, particularly near river mile (RM) 165 and 163, contain a large percentage of abandoned locations. A high number of abandoned locations can affect the estimates of area-based mean PCB concentration if they are not considered in the calculations. Effectively, areas with many abandoned locations are under-represented while the areas with many successful locations are over-represented. A simple arithmetic mean of the recovered sediment location data does not account for the abandoned or removed locations and the areas represented by these locations. To address these concerns and assess the impact of areas with no recoverable sediments (as represented by the abandoned locations), average PCB concentrations were constructed as simple arithmetic averages using only recoverable sediment samples, as well as area-weighted averages which assigned values to abandoned locations and included them in the calculation.

A.1.3 Examination of Abandoned Locations and High-Concentration Locations Inside Dredged Areas

The remedy implemented by GE under EPA's direction covered most areas with backfill; a limited number of areas were capped and had no backfill over the top. A still smaller area was dredged but not backfilled or capped, due to navigational or engineering considerations. Thus, it was anticipated that locations placed in dredged areas would yield recoverable sediments at low PCB concentration, and in most instances, this was true, based on the NYSDEC data. However, in a limited number of instances, locations in dredged areas yielded higher concentrations or were abandoned with little or no sediment recovery. While the reasons for these observations are unknown, there are some possible explanations.

A total of 11 out of 265 dredged area locations were abandoned. Most of the abandoned locations occurred in capped areas, suggesting that the capping material was too coarse to be recovered. Table A.1.3-1 presents a breakdown of the sample locations located within the dredged areas. As shown in this table, capped areas had a much higher rate of abandonment (12 percent) as compared to backfilled areas (2 percent), supporting this hypothesis.

The number of dredged area locations with elevated PCB concentrations and the range of these higher concentrations is quite small. The top 5 percent of higher-concentration locations (13 in all) fall in the range of 2.8 to 24 mg/kg Tri+ PCB. Ninety five percent of all dredged area locations yielded concentrations less than 2.75 mg/kg Tri+ PCB. The reason for the higher concentrations is unknown, but there are several possible explanations. For example, the backfill may have eroded away, exposing an underlying layer of PCB-bearing sediment or the backfill sediment mixed with a higher PCB concentration from the newly deposited sediment. However, there are no recent geophysical surveys to confirm this hypothesis. Alternatively, the elevated locations may be located near the edge of a backfilled area or in a dredged but not backfilled area (such as in the Champlain Canal channel), where backfill was eroded or never placed. To test this hypothesis, Figure A.1.3-1 presents the thirteen highest locations (top 5 percent) vs. their distance to the perimeter of the backfilled area. It can be seen in the figure that there is no correlation with this distance. Note that the one sample obtained outside the backfilled area has among the lowest concentrations in the group. In fact, there are 25 other locations from areas that were dredged but not backfilled that were successfully sampled but yielded values below 2.75 mg/kg Tri+ PCB. Thus, proximity to the backfill perimeter, or lack of backfill or cap, is not a reason for these higher concentrations, and the reason for them remains unknown.

In general, high surface concentrations in the dredged areas occur infrequently (the mean and median dredged area concentrations are 0.75 and 0.26 mg/kg Tri+ PCB) and do not occur in clusters. Individual sampling locations with higher Tri+ PCB and Total PCB levels are scattered throughout the river, with the majority located in non-dredged areas, as can be seen by comparing Figure 3.0-4 with Figure 3.0-5 in the main document.

A.1.4 Variation of PCB Levels near the Dredging Boundaries

This section evaluates whether the sediments in non-dredged areas located adjacent to the dredging boundaries are more contaminated than those located far away from the dredging boundaries. In this analysis, EPA examined both the recent surface sediment measurements (2016 and 2017) as well as the PCB data from samples collected as part of the remedial design (the SSAP and SEDC samples collected from 2002-2005, and from 2007, respectively). Figures A.1.4-1a, A.1.4-1b and A.1.4-1c show the variation of 2016-2017 surface sediment Tri+ PCB concentrations (0-2 inch) with distance from the closest dredging area boundary, including points inside the boundary and outside the boundary. For RS 1, data outside the dredged area are limited to 150 ft due to the paucity of data beyond this distance. In RS 2 and RS 3, results are limited to 300 ft for the same reason. The figures also display the ROD threshold for removal for each river section (*i.e.,* 10 mg/kg for RS 1, 30 mg/kg for RS 2 and RS 3).

These figures include a weighted average line, which tracks the midpoint of the data as a function of distance from the dredging boundary. Separate curves are generated on each plot for data inside and outside dredged areas. The weighted curves for the areas outside dredging boundaries show no significant positive increase in surface sediment Tri+ PCB concentrations near the dredging boundary and are essentially flat out to the maximum distance values on the plot. These figures demonstrate that the areas outside the dredged area do not exhibit a “doughnut” effect, *i.e.,* that for 0- 2 inch samples, areas close to the dredging boundaries are not substantively more contaminated than those farther away. In general, areas outside the dredging areas have a similar level of contamination regardless of proximity to the dredge boundaries.

Inside the dredging boundaries, the post-dredging data show very low concentrations overall, and a dramatic reduction in concentration relative to the pre-dredging conditions. This can be directly observed by comparing Figures A.1.4-2a, A.1.4-2b and A.1.4-2c, which represent the pre-dredging data (SSAP program) with Figures A.1.4-1a, A.1.4-1b and A.1.4-1c, respectively, which represent the post-dredging data (2016 GE/EPA and 2017 NYSDEC). Figures A.1.4-2a, A.1.4-2b and A.1.4-2c also demonstrate the absence of generally higher concentrations outside the dredging boundaries, with little trend with distance from the boundary edge. Note that the local mean concentration approximately 40 ft from the dredging boundary are not substantively different from the mean concentrations more than 200 ft from the boundary.

EPA repeated this analysis of contamination with distance based on the main parameters used for the dredged area delineation, *i.e.,* the Tri+ PCB mass per unit area (MPA) and the maximum observed Tri+ PCB concentration in the top 12 inches of sediment. These analyses are presented in

Figures A.1.4-3a to c and Figures A.1.4-4a to c for the MPA and the 0-12 inch maximum value, respectively. Similar to the previous presentations, the plots of MPA and 0-12 inch maximum value do not show substantively higher levels of contamination close to the dredging boundaries relative to those farther away.

Based on EPA's review of both the recent data as well as the remedial design data, the analysis does not support the existence of large areas of contaminated sediment close to the dredging boundaries. Both the recent data and the remedial design data demonstrate that Tri+ PCB contamination is similar at distances near and far from the dredging boundaries. Additionally, the 2016-2017 also show the near complete absence of exceedances of the dredging criteria (4 exceedances out of 1,055 main stem samples) in the 0-2 inch samples from non-dredged areas across the entire Upper Hudson. This is further evidence to support EPA's assertion that the remedy successfully targeted and removed PCB contamination as specified in the 2002 ROD.

A.2 PCB Analytical Methods and Laboratory Precision

This section discusses the PCB analytical methods used by NYSDEC to analyze the surface sediment samples and the assessment of the laboratory precision by evaluating the parent and field-duplicate samples. It supports the discussion on PCB methods included in Section 2 of the main portion of the memorandum.

A.2.1 PCB Analytical Methods

Surface sediment samples were analyzed for PCB Aroclors via Method 8082A (M8082). Samples were also analyzed for total organic carbon (TOC) via Lloyd Khan method, grain size via ASTM D422 method, and percent moisture via USDA 26 and ASTM D2216 methods (EA, 2017). Ten percent of the samples were analyzed for PCB Congeners via M1668c. NYSDEC contracted Pace Analytical Services, LLC (Pace) with samples shipped to their laboratories in Minneapolis, Minnesota; Green Bay, Wisconsin; and Billings, Montana to analyze the surface sediment samples (EA, 2017). It was NYSDEC's intention to use the same analytical version of M8082 and the same analytical firm (Pace Analytical) as used by GE to maximize comparability between the GE and the NYSDEC data.

NYSDEC's surface sediment program also included the collection of additional laboratory quality control samples (e.g., field duplicates, matrix spike, and matrix spike duplicates). In addition, NYSDEC submitted five Performance Evaluation (PE) samples to Pace for analysis randomly throughout the program as a measure of accuracy. PE samples will be used to establish accuracy limits (upper and lower control limits) for future analytical testing (EA, 2017) and are not evaluated here. The next several subsections describe the level of precision achieved by Pace Analytical for the NYSDEC program.

A.2.2 Assessment of Laboratory Precision

PCB Aroclors via Method 8082A

NYSDEC analyzed samples for PCB Aroclors via M8082 from 1,162 unique locations. In addition, NYSDEC analyzed field duplicate samples collected at a rate of about 10 percent (1 per 10 samples), for a total of 117 samples. As part of the quality control program, precision in each analytical batch was monitored by field duplicates and matrix spike duplicates. Imprecision was documented by the laboratory and associated field samples were qualified accordingly during validation. To examine overall precision in the program, Louis Berger completed an independent assessment of the field duplicate data. Field duplicates were selected because they incorporate variance originating from field sample handling as well as from analytical imprecision, thus they are a rigorous test of the data quality.

Total PCB concentrations for M8082 results were calculated as the sum of Aroclors 1221, 1242, and 1254. Non-detect results for other Aroclors were set to zero in creating the Total PCB value. The Total PCB concentrations between the parent and field duplicate pairs were compared using relative percent difference (RPD) for each parent/field duplicate pair based on the final (reportable) concentration. The RPD was only calculated when the PCB concentration was detected in both parent and duplicate samples. Inclusion of non-detect results in the RPD calculations effectively requires a guess for each non-detect result, introducing significant uncertainty. This resulted in 107 quantitated pairs. In accordance with the OM&M Letter Work Plan (EA, 2017), the acceptable range for field duplicate precision was less than 40 percent RPD. The average RPD for the 107 sample pairs was found to be 33 percent (median = 22 percent). A total of 79 of the 107 pairs (74 percent) had a precision of less than 40 RPD. RPDs were also calculated from Tri+ PCB concentration estimates after applying GE's 2011 regression model (discussed in Section A.3) to the M8082 data; similar RPDs and distributions were observed. The average RPD was 32 percent (median = 21 percent), with 80 pairs having a precision of less than 40 RPD. Figure A.2.2-1 displays the distribution of RPDs for Total PCB and the calculated Tri+ PCB by River Sections and dredged/non-dredged areas. As can be seen in the figure, these distributions have similar ranges and medians across river section and dredged *vs.* non-dredged areas, indicating that sample precision was not dependent on these variables. As a result, the entire set of sample pairs were combined for further precision analyses. Figure A.2.2-2 summarizes the overall RPD distribution for Total PCB and Tri+ PCB. Overall, the distribution is centered on lower RPD values (less than 30 percent) for both parameters, with about 70 percent of the sample pairs meeting the acceptance criteria. The mean and median RPD values easily meet the acceptance criteria, indicating that sampling and analytical precision was well controlled by NYSDEC.

The previous discussion considered all pairs where both samples were detected. However, a plot of parent vs. duplicate suggests the existence of at least one outlier (see Figure A.2.2-3A). Mahalanobis distance was used to identify outliers based on their distances from the overall distribution of a data set. Figure A.2.2-3B presents the analyses to identify these outliers using the upper confidence limit

(UCL) on the Mahalanobis distance for Total PCB. Seven parent/duplicate pairs were identified as outliers at 95th confidence level (α=0.05)) (denoted as orange points in Figures A.2.2-3B). Most outliers were identified based on their concentrations but were consistent with the general relationship between parent and duplicate and so were not excluded. When the 99th confidence level (α=0.01) was used, only one pair was identified as outlier (denoted as cross orange point in Figures A.2.2-3). This sample pair is clearly different from the rest of the data set. Based on the overall distribution of the data points shown in Figure A.2.2-3A, the one outlier identified at α=0.01 was removed from subsequent analyses. Although not shown, the Mahalanobis distances identified the same outlier for Tri+ PCB. Excluding the one outlier reduced the mean RPD for Total PCB from 33 to 31 percent and for Tri+ PCB from 32 to 30 percent.

An alternative to analyzing RPD is to plot the Total PCB concentration reported for the field duplicate against its respective parent concentration as shown in Figure A.2.2-4. Note the one outlier identified above is omitted in this analysis. Ideally, a 1:1 relationship would be observed for each sample pair but, as seen with the RPDs, some sample concentrations differed by more than the target 40 RPD. A regression through the duplicate pairs yields a relatively high R^2 (0.84), again indicating a relatively good agreement within sample pairs overall. The plot itself shows that the scatter increases at lower concentrations and that duplicate precision is better at higher concentrations, when contaminant mass in the sample is greater.

In summary, the majority of sample pairs meet the RPD for M8082 analysis, yielding mean and median RPDs that are well below the targeted criterion of 40 RPD. Additionally, sample precision increases at higher concentrations, with concentrations at 1 mg/kg and above exhibiting reduced sample pair variability. Based on these observations concerning the NYSDEC data, it is EPA's conclusion that the data are sufficiently precise to support the subsequent analyses conducted in the memorandum.

PCB Congeners via Method 1668c (M1668c)

Sixteen samples were measured in duplicate using the PCB congener-based M1668c. Like the M8082 data, RPD was only calculated when PCB concentration was detected in both parent and duplicate samples. This resulted in 14 quantitated pairs. RPD values for Total PCB concentrations for M1668c ranged from 3 to 181 with an average of 50. Of the 14 sample pairs, 9 pairs (i.e., 64 percent) had a precision of less than 40 RPD. High RPD values were obtained for two sample pairs, HR17-OU2-R7-087/HR17-OU2-R7-FD03 and HR17-OU2-R3-032/HR17-OU2-R3-FD02, where the Total PCB concentrations differed by more than an order of magnitude (*i.e.*, approximately 180 percent RPD in each case). Although the RPDs indicate a substantial difference in concentration for some sample pairs, the M1668c results can also be examined for consistency in congener pattern. To this end, a mass fraction was determined for each PCB congener to effectively normalize the data to the total. If the congener patterns in two replicate samples behave similarly, the same mass fraction profiles should result when mass fractions are plotted against PCB congener number (BZ#). Figures A.2.2-5a to A.2.2-5g illustrate very similar congener profiles not only for most pairs but also among most locations despite their origin in different river sections and dredged areas.

Another examination of these mass fractions is presented in Figures A.2.2-6a to A.2.2-6g, where the mass fractions of the congeners for each duplicate pair are plotted against each other. Assuming the parent and duplicate samples have a similar congener pattern, the congener mass fraction pairs should plot close to the one-to-one line. A linear regression line forced through the origin was plotted in the figures to aid in the comparison. Duplicate pairs that are highly correlated will have a regression slope close to unity and a low Chi-squared (χ^2). This statistic is often used to determine differences between sample patterns since it is based on the sum the squared errors for each pair. The closer χ^2 values are to zero, the greater the similarity in the sample pair pattern. The χ^2 is provided for each pair on each plot in Figures A.2.2-6a to A.2.2-6g. The χ2 values range from 0.0027 to 0.25, with an average of 0.06.

Notably, samples that exhibit higher RPDs also exhibit higher χ^2 values. The three sample pairs with the highest RPDs (ranging from 85 to 181 RPD) had the highest χ^2 values, between 0.12 and 0.25. This correlation between RPD and χ^2 is consistent with expectations since sample pairs that do not agree well in absolute concentrations (high RPD) might also be expected to have poor agreement in congener pattern.

The 14 sample pairs analyzed with the PCB congener-based M1668c were also analyzed using Aroclor-based M8082, thus a second metric is available for comparison. For M8082 results, only 13 sample pairs have detectable results both in parent and duplicate samples. RPD values calculated using the M8082 results for Total PCB for these 13 pairs ranged from 5 to 86 percent, with an average of 24 percent RPD; RPD values for 11 of the 13 pairs were less than the 40 percent RPD target set by the State. Figures A.2.2-7 and A.2.2-8 offer visual comparisons of RPDs determined from Total PCBs calculated from results derived from both M8082 and M1668c. As shown in Figure A.2.2-7, the sample pair R3-032/ R3-FD02 exhibited the highest RPD (181) for M1668c, but at low RPD (20) observed for M8082. For R1-035/R1-FD11sample pair, the M1668c RPD of 12 was similarly not consistent with the M8082 RPD of 68 for the pair. The lack of correspondence in RPD values for the two methods for duplicate pairs would indicate that the lack of precision may be related to laboratory procedural variations, rather than a sampling error or sample heterogeneity. In Figure A.2.2-8, it can be seen the RPD by one method is not correlated with RPD for the other method across the entire set of duplicate pairs. This further suggests that the main source of imprecision is due to laboratory procedure variations and not due to sample heterogeneity. If sample heterogeneity were the source, then the RPD values would be expected to correlate. Based on the 13 matched pairs of duplicate analyses by the two methods, it appears that for Pace Analytical, the M8082 results for Total PCB are generally more precise than the M1668c results, although the median RPD values meet the target RPD set by the State for both methods. The potential for reduced precision by M1668c, at least in this instance, is offset by the greater accuracy for Total PCB and Tri+ PCB obtained by the method.

A.2.3 Evaluation of the Impact of the Misidentified TCMX Peak in Method 8082 Chromatography on Total PCB and Tri+ PCB Concentrations

Determination of Samples Affected

In the 2017 NYSDEC surface sediment program, a total of 1,162 field samples and 117 field duplicates were analyzed for PCB Aroclors via M8082. This method used two surrogates as indicators of accuracy: 2,4,5,6-Tetrachloro-Meta-Xylene (TCMX) and decachlorobiphenyl. In the NYSDEC data set, 21 field samples and 2 duplicates had TCMX surrogate recoveries that were outside of method control limits of 30 to 125 percent (refer to Table A.2.3-1 for this list of samples). Consequently, the data validator qualified the associated PCB Aroclor results in 23 samples as estimated (*i.e.,* assigned the qualifier "J") due to the surrogate recovery nonconformance. Recoveries outside these limits are usually indicative of laboratory analytical problems. Values much greater than 125 percent may be indicative of an interfering compound.

Per the SW846 Method 8000 guidelines, surrogate recovery data are used to evaluate and qualify the PCB Aroclor data but are not used directly to quantify PCB Aroclor concentrations. PCB Aroclor quantification is accomplished by comparing the sample chromatogram to the most similar Aroclor standard to determine the pattern of peaks. However, in the 2017 NYSDEC data set, there was an observed relationship between TCMX recoveries and Aroclor 1221 concentrations when the TCMX recoveries were outside the control limits. This relationship was not present when the TCMX recoveries are within the control limits (see Figure A.2.3-1).

TCMX is identified in the chromatogram with a retention time of 2.05, which is located among the five characteristic peaks used to quantify Aroclor 1221 (having retention times at 1.634, 1.895, 2.238, 2.328, and 2.380). The difference in retention time is wide enough to distinguish the TCMX surrogate peak from the Aroclor 1221 characteristic peaks. It was concluded that the TCMX recoveries have no effect on the quantification of Aroclor 1221. The observed relationship of TCMX recoveries and Aroclor 1221 concentration presented in Figure A.2.3-1 may be associated with matrix interference that was related to low molecular weight congeners present when the degree of dechlorination was high in a sample, yielding apparently high concentrations of Aroclor 1221. The laboratory reports also showed that some samples were diluted to meet calibration range; Aroclor 1221 concentrations were reported on the dilution run but TCMX recoveries were reported on initial analyses, which may also be contributing to the observed trends. Samples with high TCMX recoveries tend to be associated with high Aroclor 1221 concentrations, supporting this premise. Because of the relationship between Aroclor 1221 and the TCMX results, the occurrence of outside-of-target TCMX recoveries likely did not impact data usability for Aroclor 1221 results and all 23 samples were considered and used in subsequent analyses for this memorandum.

A.3 Determination of Total and Tri+ PCB Concentration from Aroclor Measurements

Several analytical methods were used by both EPA/GE and NYSDEC in their recent sediment investigations in 2016 and 2017, respectively. In both cases, the clear majority of analyses were conducted using M8082, an Aroclor-based method. As stated in Appendix 5 of the Five-Year Review Report, measuring PCB concentrations as Aroclors relies on a relatively fixed composition of congeners in the mixture. M8082 uses a pattern recognition technique to qualitatively determine whether a given Aroclor mixture is present, after which that portion of the spectrum is quantified using a standard that includes the particular Aroclor. Therefore, the quantitation of PCBs via M8082 is subject to the analyst's interpretation and is not inherently comparable to the sum of the concentrations of PCB congeners. Additionally, M8082 does not provide a direct basis to determine the Tri+ PCB concentration.

Historically, GE has relied on another method (the modified Green Bay Method, or mGBM) to measure Tri+ PCBs directly and develop a conversion basis for the M8082 results. The mGBM analytical procedure was discontinued at the end of 2016 by the one lab that still had this capability, and so the method is no longer available to the Hudson River studies. In its place, NYSDEC implemented a more accurate and rigorous method (*i.e.,* M1668c) for the determination of Tri+ and Total PCBs. EPA also analyzed a subset of the 2016 EPA/GE samples by this method. Unlike the Aroclor-based M8082, M1668c determines the concentrations of individual congeners by a sophisticated analytical methodology using high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) combined with isotope dilution techniques. This method requires no presumptions regarding the PCB source material; M1668c identifies the presence and concentration of each of the 209 PCB congeners in a sample. Both EPA and NYSDEC analyzed about ten percent of the 2016 and 2017samples, respectively, using M1668c. This section compares the Total PCB concentrations measured via M8082 and M1668c for the matched pairs by both agencies. In addition, conversion factors for Tri+ PCB from Aroclor-based measurement to congener-based quantitation by GE's mGBM approach and using NYSDEC data are also examined in this section.

The remainder of this section is separated into two parts: first an assessment of the Total PCB to Tri+ PCB conversion formula historically used by GE, evaluating the degree of variation in the relationship over time. Since NYSDEC purposely chose to replicate the GE M8082 procedure to analyze all of it samples, this conversion is directly applicable to the NYSDEC data, and can be used to yield estimates of Tri+ PCB concentration that can be directly compared with earlier GE work. The second portion of this section examines the NYSDEC and GE data for samples analyzed by both M8082 and M1668. As noted above, the latter method provides a more robust measure of Total PCB and Tri+ PCB concentration. The Tri+ PCB concentration can be determined directly from the M1668 results and does not require a conversion formula, unlike M8082. The discussion will describe the relationships between M8082 and M1668c for Total PCB and Tri+ PCB. Additionally, the discussion will also present the relationship between the M1668c Tri+ PCB concentration and the Tri+ PCB estimate yielded by the M8082 to Tri+ PCB conversion relationship developed by GE.

A.3.1 Examination of GE's Conversion Factor of Tri+ PCB from Method 8082 to Modified Green Bay Method (mGBM) Equivalent

As part of their data collection efforts for the remedial design, GE was required to collect and analyze a subset of the remedial design samples by M8082 as well as by mGBM. The purpose of these matched pairs was to develop a reliable relationship between the two methods so that the more economical M8082-based measurements of PCBs could be converted to an estimate of the Tri+ PCB concentration. In processing the data, GE utilized a linear multiple regression methodology, which consisted of applying a weighted least squares (*i.e.,* "damped-leverage") regression to convert the Aroclor-based M8082 measurement to Tri+ PCB concentrations (GE, 2009). In 2011, GE analyzed their last M8082/mGBM pairs and indicated that there was no further need for the congener-based method analysis because the regression coefficients had stabilized, as documented in Corrective Action Memorandum (CAM) No. 3 (GE, 2011). The final regression cited in this memorandum is as follows:

$$\mathrm{Tri+\ PCB}_{est} = (0.13 \times \mathrm{A1221}) + 0.89 \times (\mathrm{A1242} + \mathrm{A1254}) \qquad \text{(Eq. A-1)}$$

where A1221, A1242 and A1254 refer to the concentrations of Aroclor 1221, Aroclor 1242 and Aroclor 1254, respectively and Tri+ PCB_{est} is the estimated Tri+ PCB concentration present in the sample.

In assessing the stability of the regression coefficients, GE reviewed their regression analysis periodically from 2002 through 2011, using the accumulated matched-pair data at each point in time. Although the overall average regression appeared consistent through time when adding small annual increments of matched pair analyses to the existing large data base of matched pairs, EPA was concerned that the regression relationship might vary year by year, when the annual data were considered independently of prior measurements. To address this concern, Louis Berger assessed the regression equation coefficients through time by grouping the data into three different sampling periods and calculating linear regression curves for each period. The first period contained the original 278 samples collected from 2002 to 2006, the second period consisted of 125 samples collected in 2009, and the third period consisted of 42 samples collected in 2011. The cumulative number of matched pair M8082 and mGBM samples was 445. Figure A.3.1-1 provides a visual comparison among the regression coefficients, along with their uncertainty, for the three different periods for Aroclor 1221 (top panel) and for the sum of Aroclors 1242 and 1254 (bottom panel). The uncertainty bars plotted in the figure represent two times standard error on each regression coefficient. Based on a simple linear regression approach, it appears that the regression coefficients vary through time, shown by non-overlapping error bars among the sampling periods.

However, the data are approximately log-normally distributed, as shown in Figure A.3.1-2. Given the data distributions, a regression based on logs may more accurately capture any true changes in the relationships over time. For this reason, the regression analysis by sampling period is repeated on the log-transformed data. Figure A.3.1-3 shows the regression coefficients for M8082 to mGBM Tri+ PCB concentration for the three sampling periods along with their associated uncertainty bars. It can be seen from this figure that the regression coefficients for the PCB terms are not statistically different among the different sampling periods. The uncertainty bars for the coefficients overlapped across all three sampling periods, indicating that the coefficients agreed within error. This result indicated that the coefficients did not vary statistically over time. The intercept of the line suggests some minor variation between 2002-2006 and 2009, but the difference is unimportant, equivalent to less than 5 percent for Tri+ PCBs. Based on the apparent lack of temporal trend when evaluated on a log basis, EPA determined that the entire data set could be combined to generate a single regression relationship between M8082 and mGBM, similar to the data handling by GE. The results of the log-transformed regression model can be found in Figure A.3.1-4. In the figure, the Tri+ PCB values predicted by the log-based regression are plotted against the actual Tri+ PCB concentrations obtained by the mGBM. The results are indicated by blue 'X' symbols.

The predicted Tri+ PCB concentrations using the log-transformed regression were then compared to the Tri+ PCB concentrations produced with GE's final equation, equation A-1. These results are shown by the red '+' symbols in Figure A.3.1-4. The two regressions yield comparable R^2 and Root Mean Square Error (RMSE) results. Both parameters provide a measure of how well the model performed. The RMSE specifically describes the absolute average difference between values predicted by a model and the actual values. A small RMSE value indicates a better fit. Although it appears that the regression coefficients vary through time in linear space (original untransformed data), the weighted least squares regression equation developed by GE for the combined data gives a similar result to that of the log-transformed regression equation. Therefore, the conversion factors developed by GE during the Remedial Action Monitoring Program (RAMP) give a good approximation of Tri+ PCB concentrations from the Aroclor measurements. Since the GE formula has been used extensively to estimate Tri+ PCB concentrations from M8082 results, and since the quality of the fit provided by each regression is nearly identical, it is recommended that GE's conversion factors continue to be used when comparing Tri+ PCB estimates from future M8082 PCB data to the historical data sets.

A.3.2 Examination of Total and Tri+ PCB based on 2017 NYSDEC M8082 and M1668c Paired Samples

As described above, the historical means to estimate Tri+ PCB and Total PCB concentrations was based on the relationship between the Aroclor-based M8082 and the mGBM. While the mGBM resolved congener-specific peaks, it was still calibrated to Aroclor- (and not congener-) based standards. Thus, while mGBM was superior to M8082, it still did not provide a straightforward quantitation of the congeners present in a sample. M1668c (used by EPA/GE in 2016 and by NYSDEC in 2017) supersedes these methods in several important ways. First M1668c is calibrated to congener-specific standards, so that the reported results can be directly tied to known congener reference values. Second, by use of the high-resolution GC/MS detector, the identity of each congener is confirmed based on its unique mass spectrometer signature. Third, by incorporation of isotope surrogates in the sample processing and analysis, the method can correct for analytical extraction effects and achieve detection limits far lower than the other two methods. Thus, M1668c provides a more robust basis to determine both Total PCB and Tri+ PCB concentrations.

Considering its superior analytical capabilities and with the loss of the mGBM capacity, NYSDEC chose to incorporate M1668c into their 2017 analytical program. It was the State's intention to provide a more robust basis for the conversion of the M8082 data to Total PCB and Tri+ PCB estimates. To accomplish this, a large number of matched pair samples run by M8082 and M1668c were required. Additionally, the matched pair data would also require a thorough regression analysis to establish a basis for conversion of M8082 results to M1668c equivalents. The EPA also ran matched pairs of M1668c analyses with 2016 EPA/GE samples analyzed by M8082. This yielded a much smaller data set and is discussed after the NYSDEC data discussion, which follows.

In 2017, NYSDEC analyzed both M8082 and M1668c for ten percent of the samples obtained, yielding 117 matched pair samples). Out of the 117 samples, eight were non-detect based on M8082. This left 109 matched pair samples to determine a numerically-based relationship between the M8082 and M1668c measurements for Total PCB and Tri+ PCB. The derivation of these relationships is described in the subsequent subsections. Additionally, the M1668c Tri+ PCB concentrations and the Tri+ PCB estimates obtained from M8082 using the GE equation (equation A-1 above) were compared to assess the difference between the historical Tri+ PCB estimates and those based on M1668c.

In these analyses, several different regressions are developed, specifically: (1) a major axis regression, a statistical procedure that attempts to minimize errors in both x and y while optimizing a best fit line, (2) a regression curve based solely on the average ratio between the M1668c and M8082 results for each sample pair, and (3) a regression based on the median ratio between M1668c and M8082 results for each sample pair. The three approaches provide different ways to incorporate the uncertainties in the regression process. The major axis regression addresses the uncertainty in both variables in the regression but is influenced to some degree by the absolute concentrations in the samples. The mean and median ratio approaches also incorporate the uncertainties in both variables, since each individual ratio estimate is simply the quotient of the two variables. The additional advantage of the ratio-based regression is its simplicity, since the ratio is more easily understood.

In the regression process, it is important that the regression go through the origin. That is, when one method reports a zero, so should the other. A log-based major axis regression was selected since this regression goes through the origin y default. Similarly, the ratio-based regressions go through the origin since their intercept values are set equal to zero. A RMSE is calculated for each regression to provide a simple basis for comparison among the regressions. Additionally, the 95 percent confidence intervals on the coefficients are calculated for the ratio-based regressions. As will be shown, since the ratio-based regressions and the major axis regressions were so similar, the uncertainty was not estimated for the major axis regression coefficients.

Total PCB by M8082 *vs.* M1668c: Figure A.3.2-1 shows a scatter plot of Total PCB based on the matched pairs of M8082 (x-axis) and M1668c (y-axis). Three different regression lines described above are plotted on Figure A.3.2-1, along with the RMSE of each model fit. The major axis regression uses the following formula:

$$log[TPCB_{M1668c}] = a \times log[TPCB_{M8082}] + b \qquad \text{(Eq. A-2)}$$

where *a* and *b* are determined by the regression through the data, and $TPCB_i$ is the Total PCB concentration given by method i. Because this is a log-based regression, the curve goes through the origin by default.

The mean-based regression line is based on the following formula:

$$TPCB_{M1668c} = a \times TPCB_{M8082} + b \qquad \text{(Eq. A-3)}$$

where *a* is the mean value of the ratio of the two methods, given by

$$a = \frac{\sum_{i=1}^{n} \frac{TPCB_{M1668c_i}}{TPCB_{M8082_i}}}{n} \qquad \text{(Eq. A-4)}$$

and *n* is the number of sample pairs (109). *b* is set equal to 0, which forces the regression line through the origin.

The median-based regression line uses the same form as equation A-3, with the coefficient *a* given as the median ratio of $\frac{TPCB_{M1668c}}{TPCB_{M8082}}$. *b* is also set equal to 0

In the mean-based regression calculation, all sample values contribute equally to the mean ratio; there is no weighting for those samples with higher PCB concentrations. In a similar manner, the median regression line also does not weight sample concentration, simply selecting the ratio at the midpoint of the ratio distribution.

It can be seen from Figure A.3.2-1 that the major axis regression resulted in the smallest RMSE. However, the median regression line gives a similar RMSE to that of the major axis. Both the median and the major axis regressions fit the data comparably well between 0.1 and 10 mg/kg TPCB. All three curves yield poorer agreement with the data below 0.1 mg/kg. Given the acceptable agreement between 0.1 and 10 mg/kg, and the similar level of error for the major axis and the median regressions, it is recommended that the simpler median-ratio based curve be used to estimate M1668c Total PCB concentrations from M8082. Besides its similarity to the major axis regression, the median ratio regression also has the advantage of being insensitive to outlier values, as compared to the mean-ratio regression. Based on the median ratio of congener-based to Aroclor-based Total PCB (*i.e.,* 1.65), Total PCB concentrations derived from M1668c measurements are approximately 55 percent higher than those derived from M8082. The formula is given as follows:

$$Total\ PCB_{M1668c} = 1.55 \times \sum Aroclors\ 1221, 1242, 1254_{M8082} \qquad \text{(Eq. A-5)}$$

The 95 percent confidence limits on the coefficient are 1.34 to 1.79, based on a 10,000-replicate bootstrap analysis of the matched pair data. These represent a ±14 percent variation of the median ratio regression coefficient.

Estimation of Tri+ PCB by M1668c from M8082 Data: A similar analysis was also performed for Tri+ PCB concentrations. The sum of congeners with three or more chlorine atoms (*i.e.,* tri-chlorinated) yields the Tri+ PCB for M1668c. Several approaches to convert M8082 Aroclor concentrations to M1668c Tri+ PCB concentrations have been examined. The first method attempted is a multiple linear regression for the raw data (linear space). The multiple linear regression yielded a negative intercept term, which produces a negative value for Tri+ PCBs at low PCB concentrations, an unacceptable result. The analysis indicated the intercept was not statistically significant, and therefore could be assigned a value of zero. However, when the analysis was repeated with the intercept set to zero, the A1221 coefficient became negative, which means there was no contribution from A1221 to the Tri+ PCB concentrations. Based on the study by Rushneck *et al.* (2004), Aroclor 1221 contains slightly less than 5 percent Tri+ PCB by mass. Thus, its contribution (and coefficient) should be positive. Additionally, there is the potential for negative Tri+ PCB concentrations at high Aroclor 1221 concentrations. Based on these considerations, Aroclor 1221 was removed from the regression and only Aroclors 1242 and 1254 were used to predict the Tri+ PCB concentration.

The regression analyses conducted for Tri+ PCBs parallel those used for Total PCBs described in the previous section. The major axis regression uses the following formula:

$$log[Tri + PCB_{M1668c}] = a \times log[A1242 + A1254_{M8082}] + b \qquad \text{(Eq. A-6)}$$

where *a* and *b* are determined by the regression through the data. Like the TPCB regression, this is a log-based regression and the curve goes through the origin by default.

The mean-based regression line is based on the following formula:

$$Tri + PCB_{M1668c} = a \times (A1242 + A1254)_{M8082} + b \qquad \text{(Eq. A-7)}$$

where *a* is the mean value of the ratio of the two methods, given by

$$a = \frac{\sum_{i=1}^{n} \frac{Tri+PCB_{M1668c_i}}{(A1242+A1254)_{M8082_i}}}{n} \qquad \text{(Eq. A-8)}$$

and *n* is the number of sample pairs (109). *b* is set equal to 0, which forces the regression line through the origin.

The median-based regression line uses the same form as equation A-7, with the coefficient *a* given as the median ratio of $\frac{Tri{+}PCB_{M1668c}}{(A1242{+}A1254)_{M8082}}$. *b* is also set equal to 0

Figure A.3.2-2 presents the matched pairs of M8082 and M1668c results used in the formulas above. M8082 results are plotted as the sum of Aroclors 1242+1254, whereas the M1668c results are shown as the sum of the Tri+ PCB congeners (*i.e.,* Tri+ PCB concentration). The three regression curves closely match each other, particularly over the concentration range of greatest interest for the site, 0.1 to 10 mg/kg Tri+ PCB. The least squares results show that there is little difference in uncertainty among all three regressions. Given that the simpler median-based regression approach yields nearly the same Tri+ PCB values and degree of uncertainty over the main concentration range of interest as does the major axis regression, and its diminished sensitivity to outlier values, it is recommended that the median-based regression be used to estimate Tri+ PCB concentrations from the M8082 data. The equation is as follows:

$$Tri + PCB_{M1668c} = 1.35 \times \sum Aroclors\ 1242 + 1254_{M8082} \qquad \text{(Eq. A-9)}$$

The 95 percent confidence limits on the coefficient are 1.19 to 1.43, based on a 10,000-replicate bootstrap analysis of the matched pair data. These represent a -12 to + 6 percent variation of the median ratio regression coefficient.

Estimation of Tri+ PCB by M1668c from Tri+ PCB Estimates Generated by the GE Formula: Section A.3.1 confirms the relationship used by GE to convert the M8082 results for the historical SSAP data as well as the more recent 2016 survey data to estimates of the Tri+ PCB concentration based on the mGBM. The 2017 NYSDEC data provide the opportunity to develop a formula to relate the historical Tri+ PCB estimates based on the GE formula to those obtained by the more rigorous M1668c. Effectively, such a formula would permit the conversion of the historical data to a basis comparable to the M1668c Tri+ PCB concentrations. Such a calculation is possible because NYSDEC replicated the M8082 technique used by GE by hiring the same laboratory and specifying the same analytical procedures. In addition, NYSDEC had a large subset of the data analyzed by both M8082 and M1668c, permitting the comparison described in the previous subsections as well as the calculations to be presented below. While it is possible to calculate such a relationship based on the NYSDEC data, application of the relationship to the historical data requires several assumptions regarding the data. These are discussed after the regression analysis presented below.

The relationship between the GE formula-based estimates of Tri+ PCB and the M1668 measurements of Tri+ PCB was derived from the following steps:

1. Using the 109 matched pairs of M8082 and M1668c data, the M8082 Aroclor values were used to generate Tri+ PCB estimates based on equation A-1, given above.

2. EPA applied the same regression techniques as those used above, on the matched pairs of M1668c Tri+ PCB and the GE Tri+ PCB estimates. That is, EPA performed a major axis regression, a median-based regression and a mean-based regression.

The major axis regression uses the following formula:

$$log[Tri + PCB_{M1668c}] = a \times log[Tri + PCB_{est,M8082}] + b \qquad \text{(Eq. A-10)}$$

where *a* and *b* are determined by the regression through the data and Tri+ $PCB_{est,\ M8082}$ is the estimate obtained from equation A-1. Like the previous major axis regressions, this log-based regression goes through the origin by default.

The mean-based regression line is based on the following formula:

$$Tri + PCB_{M1668c} = a \times Tri + PCB_{est,M8082} + b \qquad \text{(Eq. A-11)}$$

where *a* is the mean value of the ratio of the two methods, given by

$$a = \frac{\sum_{i=1}^{n} \frac{Tri+PCB_{M1668c_i}}{Tri+PCB_{est,M8082_i}}}{n} \qquad \text{(Eq. A-12)}$$

and *n* is the number of sample pairs (109). *b* is set equal to 0, which forces the regression line through the origin.

The median-based regression line uses the same form as equation A-12, with the coefficient *a* given as the median ratio of $\frac{Tri+PCB_{M1668c}}{Tri+PCB_{est,M8082}}$. *b* is again set equal to 0

Figure A.3.2-3 presents the matched pairs of Tri+ $PCB_{est,\ M8082}$ and M1668c Tri+ PCB results used in the formulas above. The three regression curves closely match each other, particularly over the concentration range of greatest interest for the site, 0.1 to 10 mg/kg Tri+ PCB. The least squares results show that there is little difference in uncertainty among the three regressions. Again, given that the simpler median-based regression approach yields nearly the same Tri+ PCB values and degree of uncertainty over the main area of interest as the other regressions but with less sensitivity to outliers, it is recommended that the median-based regression be used to estimate M1668c Tri+ PCB concentrations from the GE Tri+ PCB estimates data. The equation is as follows:

$$Tri + PCB_{M1668c} = 1.44 \times Tri + PCB_{est,M8082} \qquad \text{(Eq. A-13)}$$

The 95 percent confidence limits on the coefficient are 1.23 to 1.53, based on a 10,000-replicate bootstrap analysis of the matched pair data. These represent a -15 to + 6 percent variation of the median ratio regression coefficient.

This analysis yields a very similar slope (1.44) for conversion of Tri+ $PCB_{est,\ M8082}$ to the M1668c Tri+ PCB basis as was obtained for the conversion of the M8082 sum of Aroclors 1242 and 1254

(1.35). Over the range of 0.1 to 10 mg/kg Tri+ PCB, the two curves are nearly equivalent, indicating a negligible contribution from Aroclor 1221 in this range. However, at higher PCB concentrations (in the range of 30 to 1,000 mg/kg), the behavior of equation A-13 is untested.

Any applicability of equation A-13 for the conversion of historical Tri+ PCB concentrations needs to consider the following:

1. Historical M8082 procedures and current M8082 procedures need to have been sufficiently similar to maintain internal precision through time. This concern is untested because long term performance evaluation standards (such as NIST standards) were not analyzed as part of the various analytical programs and long-term data comparability was not a goal of the earlier studies.
2. The tested range for the conversion is at most 0.1 to 30 mg/kg Tri+ PCB.
3. The conversion of GE data outside the range examined in Figure A.3.2-3 is untested since data to assess this range do not exist.

For these reasons, it is not recommended that equation A-13 be used in a quantitative manner to convert historical data to the M1668c basis. Rather, this formula has been prepared to provide a qualitative estimate of historical conditions. Note that this conversion does not invalidate the historical analyses of PCB exposure and risk, since essentially the entire set of sediment, water and fish measurements as well as the basis for risk estimates (*e.g.,* risk slope factors) employed M8082 or mGBM results.

A.4 Sediment Texture and Grain Size Analysis

Section A.4 supports Section 2 of the main memorandum and was prepared in response to NYSDEC's observations of sediment texture and the apparent disagreement between discrete sample results and the SSS maps created by GE in 2002/2003. In addition to chemical analysis, grain size (particle size) distribution was determined for both GE and NYSDEC surface sediment samples. Grain size distribution is one of the important characteristics of sediment. In general, grain size is a dominant controlling factor in sediment geochemistry. PCB concentration levels of sediment are known to be linked to sediment grain size. PCBs tend to bind to fine-grained sediments, such as clay and silt, which have a higher surface area to volume ratio than larger particle size classes. In addition to samples analyzed for grain size distribution, geophysical investigations utilizing SSS, subbottom profiling and river bathymetry have been undertaken in the Upper Hudson River to characterize river bed morphology and sediment distribution patterns within the river. There were two SSS surveys performed for the Upper Hudson River. The first, which covered RS 1 and RS 2, was performed by the EPA in 1991-1992 for the remedial investigation. The second, which covered the entire 40-mile stretch of the river (RS 1, RS 2 and RS 3) was performed by GE in 2002/ 2003 for the remedial design. The following analyses focus on the 2002/ 2003 survey since it is more recent. The sediment distribution pattern of the river bottom information is needed to better understand the distribution of PCBs on the river bottom and to characterize the potential for resuspension.

A.4.1 Relationships between sediment texture categories and NYSDEC and GE sample grain size distribution results.

This section examines the sediment grain size distribution based on sieve size analysis and sediment texture based on GE's 2002/2003 SSS survey. Comparison between the sample grain size distributions and the SSS results was performed for the following samples:

- 262 surface (0-2 inch) sediment samples collected by GE in 2016 from the non-dredged areas. Note that these 262 samples include the 47 samples from GE's "abandoned" locations which yielded material too coarse for PCB analysis. EPA analyzed the grain size distribution for the 2016 EPA/GE samples via analytical method ASTM D422 which employs a graded series of sieves to separate standard particle size ranges.
- 908 surface[4] (0-2 inch) sediment samples collected by NYSDEC in 2017 from non-dredged areas. NYSDEC also used method ASTM D422 to determine the grain size distribution.

GE mapped the river bottom surficial sediment texture based on 2002/2003 SSS survey results and categorized bottom areas as follows (GE, 2005):

- **Type I** (clay, silt, fine sands): Smooth, generally featureless bottom; principally composed of soft aqueous silty sediments. Type I is referred to as **"Silt"** sediment texture.
- **Type II** (sands): Smooth to mottled bottom; principally composed of semi-compact to compact sand deposits. Type II is referred to as **"Silt and Sand"** sediment texture.
- **Type III** (coarse gravel and sand mixtures): Irregular bottom; principally composed of compact gravel and cobble deposits intermixed with sand. Type III is referred to as **"Gravel"** sediment texture.
- **Type IV** (mixed sediments): Smooth and irregular bottom; a varying assemblage of sediments typically associated with Types I, II, and III. Type IV is referred to as **"Transitional"** sediment texture.
- **Type V** (rocky): Extremely irregular bottom; principally composed of bedrock, cobbles, and/or boulders that are often overlain by a variable thickness of unconsolidated sediments. Type V is referred to as **"Bedrock"** sediment texture.

For each sample, the mode of the grain size distribution (*i.e.,* the most common particle size in the sample) was used in assigning sediment texture for grain size classifications. The resulting sediment texture descriptions by the sieve size analysis were compared to the SSS survey results for surface sediments along the Upper Hudson River. Figure A.4.1-1 shows grain size classification *vs.* the SSS classification for the 2016 EPA/GE surface sediment data. These data are limited to the non-dredged areas. On the horizontal axis are the sediment area Types I through IV listed above. The fifth type, bedrock, is not represented since GE did not sample any bedrock areas, by design. Each bar represents the distribution of samples obtained by GE from locations in the specific area

---

[4] Three samples from Old Champlain Canal labeled as PC were excluded.

category. The colors represent the proportion of the sediment samples by sediment sample properties. For example, for the Type III SSS category Transitional, approximately 20 percent of the samples collected by GE in 2016 from SSS-defined transitional areas were characterized as silt based on grain size distribution analysis. Approximately 44 percent (from 20 to 64 percent on the bar) of the samples were characterized as fine sand. 24 percent of the samples (64 to 88 percent of the bar) were characterized as medium sand. Only 12 percent of the samples were classified as coarse sand or gravel.

In general, the grain size distributions for the samples collected from each SSS area category agreed with the SSS classification. For example, the samples collected in the river bottom with SSS classification of "Silt" have grain size data classified as either "Silt" or "Fine Sand" by the ASTM D422 method in approximately 90 percent of the samples. Similarly, the samples collected in the "Silt and Sand" areas are primarily fine and medium sand (84 percent of all samples in this category) with a much small proportion of silt samples (7 percent). Coarser SSS area categories are characterized by samples that are generally coarser as well.

Figure A.4.1-2 is constructed similarly to Figure A.4.1-1 and shows the distribution of individual sample grain size classifications *vs.* the GE SSS classification for the 2017 NYSDEC surface sediment data in the non-dredged areas. The biggest apparent discrepancy between the SSS category and the individual samples is for the samples collected in the "Bedrock" area in which approximately 43 percent of the samples were classified as "Silt" by the ASTM D422 method. However, these results are for recoverable sediments in bedrock areas, a total of 7 samples. In reality, 74 percent of the locations in bedrock areas were abandoned, indicating no recoverable sediment after 6 attempts. In the locations where recoverable sediments were found, often multiple attempts often yielded no recoverable sediment at the target location before sediments were discovered (see Figure 2.1-1 of the main text).

The other SSS classifications generally become coarser from left to right, paralleling the trend in the SSS axis, but the samples are consistently coarser than those obtained by GE. The NYSDEC samples in each SSS category contain a much higher frequency of coarse sand and a lower frequency of fine sand relative to the GE data. This can be seen by comparing the length of the light and dark green bars in Figure A.4.1-1 and Figure A.4.1-2 Similarly, NYSDEC also obtains higher frequencies of silt samples than GE. The reason for these disagreements is not known. Given the good agreement between PCB results obtained by GE and NYSDEC (see Figures 3.1-2 and 3.1-3 in the main memorandum), it does not appear likely that the differences are due to differences in sample collection techniques. It may be the result of differences in the measurement procedures used to determine sediment grain size distribution.

A.4.2 Relationships between sediment texture classifications and rates of abandoned sites

The relationship between sediment texture classifications and the associated rates of abandoned sites was examined. Tables A.4.2-1 and A.4.2-2 show the rates of abandoned, sampled and removed locations for the 2016 and 2017 surface sediment locations, respectively. Both EPA and NYSDEC selected the sampling locations using an unbiased sampling design. EPA targeted 226 random locations and provided a full set of 226 backup locations in case the primary locations were inaccessible or did not have sufficient sediment for sampling. Although NYSDEC was also using an unbiased sampling design based on a sampling grid, they did not have backup locations. Due to this difference in the aspect of the sampling design, the relative frequency of abandoned locations in the 2016 sample group (approximately 18 percent) is less than that for the 2017 sample group (approximately 28 percent). In general, RS 3 has the most abandoned locations, especially in the "Gravel" and "Bedrock" areas. The "Silt" and "Silt and Sand" areas were sampled most successfully, with abandoned rates less than 10 percent for both 2016 and 2017 sampling events. In comparison, the gravel and bedrock areas had the highest abandoned rates. Abandoned rates varied from 40 to 74 percent. The high rate of abandonment in these areas is consistent with their coarse sediment texture, which makes sampling difficult.

A.4.3 Relationship between PCB concentrations with sediment texture by sample and side-scan sonar class.

This section examines the correlation between the measured sediment grain size distribution for each sample and the sample's level of PCB contamination. Although historically there is a correlation between PCB levels and sample grain size, the 2016 and 2017 results do not exhibit such a correlation. Figure A.4.3-1 characterizes the distribution, median and geometric mean of Total PCB concentrations for different primary grain size categories by river reach in the dredged and non-dredged areas. Because of the skewed nature of PCB concentrations, EPA tested the geometric mean of each population for statistically significant differences. Two separate sediment domains (dredged *vs.* non-dredged) are examined for each river reach. The Tukey-Kramer honestly significant difference (HSD) test (a component of the analysis of variance [ANOVA]) was applied to identify mean PCB concentrations in the various sediment classifications that were significantly different from each other. The result of the means comparison among the different primary grain size category groups by river reach and by the dredged and non-dredged areas are shown in Figure A.4.3-1. Samples across the primary grain size categories have similar Total PCB concentration ranges and the geometric mean concentrations are not statistically different for all river reaches, except for river reach 4 in the non-dredged area (Figure A.4.3-1c). This is illustrated by the Tukey-Kramer circles shown at the right in the diagram of the figure. Circles represent the geometric mean (center of the circle) and its uncertainty (circle radius) for each of the sample groups examined. Tukey-Kramer circles that do not touch or intersect only slightly are indicative of sample groups that are statistically different from each other.[5] Only silt in the non-dredged area of river reach 4 yields a Tukey-Kramer circle that is separate from the other sediment classes of the reach (Figure A.4.3-1c).

---

[5] The size of the circle reflects the uncertainty in the mean value, with larger circles reflecting larger uncertainty. Thus, small sample sizes or highly variable data sets have larger circles than those of large data sets or low variability data sets. Circles for means that are significantly different either do not intersect, or intersect slightly, so that the outside angle of intersection is less than 90 degrees. If the circles intersect by an angle of more than 90 degrees, or if they are nested, the means are not considered significantly different at an alpha level of 0.05 (95 percent confidence level).

To further examine the correlation between grain size distribution and PCB concentration, Figure A.4.3-2 shows the Total PCB and Tri+ PCB concentrations vs. the percent silt in the sample for the dredged and non-dredged areas. A similar observation can be seen from this figure. There is no significant correlation between the PCB concentrations and the amount of silt in the sample for the current data sets. It is EPA's hypothesis that the removal of the highly contaminated fine-grained areas of the river bottom removed much of the correlation between these variables. However, the historical correlation between PCB levels and sample grain size, along with the current low surface sediment concentrations, continues support the assertion that PCB levels in coarse-grained areas are generally low.

A.5 Total and Tri+ PCB Area-Weighted Mean Concentrations Calculations

This discussion was prepared to support Section 3 of the main memorandum. Although both GE and NYSDEC sampling plans were designed to yield representative sampling locations and sample results, the integration of that information requires consideration of both the recovered samples themselves, as well as the recognition of the large number of locations that failed to yield recoverable sediment. The locations without recoverable sediment, *i.e.,* the abandoned locations, still provide information, documenting the absence of sediment and the probable absence of associated PCB contamination. Additionally, the areas represented by removed locations must be considered when calculating an area-weighted mean concentration. While it is possible to calculate the mean of the recovered sediment samples, such a calculation ignores the contribution of areas with abandoned locations, areas represented by the removed locations, and areas not targeted for sampling due to access concerns. Such a calculation is thus potentially misleading with respect to the full range of conditions to which fish are exposed, since much of the un-sampled areas, especially expanses of bedrock and cobble, do not tend to have very high levels of PCBs. Although the PCB concentrations of the un-sampled areas are not known, these areas need to be accounted for in the overall average surface concentration and therefore some inferences and assumptions are required. Calculations of the area-weighted mean concentrations for the sampled and un-sampled areas are presented in this section. Like the calculations described in Section 3.1 of the main memorandum for recoverable sediments alone, analyses in this section exclude data from the land cut areas and the Old Champlain Canal.

As defined in Section 2 of the main memorandum and in Section A.1 above, abandoned locations were those that yielded insufficient sediment to sample, based on direct sampling or on probing. Removed locations were those that were inaccessible due to occurrence of conditions such as dense beds of submerged aquatic vegetation, low water levels or swift currents.

A.5.1 Variables and assumptions of the area-weighted mean calculation

To estimate the area-weighted means of Tri+ PCB and Total PCB concentrations for each reach or river section, the river bottom was broken down into five separate sediment categories as follows:

1. Bedrock (areas determined using the information from GE's 2002/2003 SSS classifications).
2. Recoverable and removed locations in dredged sediment areas. Concentrations for removed locations were assumed to be equivalent to those found in successfully sampled sediment, and the areas represented by two location types were grouped together using the same estimated mean concentration.
3. Non-recoverable dredged sediment areas (abandoned locations).
4. Recoverable and removed locations in non-dredged sediment areas (again, concentrations for removed locations were assumed to be equivalent to those found in successfully sampled sediment, and the areas represented by two location types were grouped together).
5. Non-recoverable non-dredged sediment areas (abandoned locations)

Before discussing the area-weighted mean concentration calculations, it is important to understand the various terms used in approaching the exercise. As stated above, the extent of some areas and PCB concentrations are unknown, and inferences and assumptions are required to estimate the areas and assign PCB concentrations. Table A.5.1-1 lists the various sediment categories, the terms used in the area-weighted mean concentration calculation, whether the area is known or unknown, and how they are treated in the calculations.

Areas of bedrock were determined using the information from GE's 2002/2003 SSS classification. Similarly, the dredged areas were also known, based on GE's reports for the remediation. All other areas were determined by apportioning the remaining area in each reach based on the number of recoverable sediment locations, and the number of abandoned samples. Table A.5.1-1 describes the definition of different areas and how they were determined from the available information.

To state the obvious, PCB concentrations for recoverable sediment locations are known, whereas PCB concentrations for all other areas are unknown. For these areas, inferences and assumptions need to be made to assign PCB concentrations. Table A.5.1-2 lists the status of knowledge of PCB concentrations by sediment category and what inferences or assumptions were made to estimate the unknown terms.

To further clarify, a term is considered known if it can be generated independently of additional calculations. For example, the area of bedrock is known because it is generated from the SSS and was measured directly. In comparison, the PCB concentrations in dredged areas are considered estimable and therefore known, since the average can be estimated from the direct measurements of PCB concentration in the dredged areas. Lastly, by definition, the PCB concentrations in abandoned areas are considered unknown since there are no data to characterize these sites.

Concentrations in areas represented by removed locations were assumed to be the same as those for recoverable sediments in the remainder of the river reach or river section. That is, the average PCB concentration for areas assigned to removed locations was the average PCB concentration for recoverable sediment locations for the specific domain (dredged or non-dredged) in that river reach or river section.

For abandoned locations, one-half of the median reporting limit from all non-detect samples (0.03 mg/kg) was assigned as the concentration for all bedrock areas and for areas represented by non-recoverable sediment locations. The assigned value of 0.03 mg/kg was selected because bedrock and areas where no sediment could be recovered generally contain little silt or sand and thus would not be expected to have high levels of PCBs. The assigned variance value of 0.003 also reflects the anticipated low concentration and variability in these areas.

A.5.2 Equations and calculations for mean area-weighted concentrations

Area-weighted concentrations were determined for each of the spatial domain/data set pairs listed below for each river section and each river reach. Each spatial domain/data set pair is comprised of two or more of the sediment categories listed in Tables A.5.1-1 and A.5.1-2.

1. Inside dredged areas from 2017 NYSDEC data (sediment categories 2 and 3)
2. Outside dredged areas from 2016 EPA/GE data (sediment categories 1, 4, and 5)
3. Outside dredged areas from 2017 NYSDEC data (sediment categories 1, 4, and 5)
4. Outside dredged areas from the combined 2016 EPA/GE and 2017 NYSDEC data sets (sediment categories 1, 4, and 5)
5. Combined average surface sediment concentration for entire river bottom combining inside and outside dredged areas (sediment categories 1, 2, 3, 4 and 5)

The areas (A_i) and concentrations (C_i) in the formulas below refer to the five sediment categories in the tables. The constants and variables listed in Tables A.5.1-1 and A.5.1-2 were used in several different equations below to calculate the area-weighted mean concentrations presented in the main memorandum. The equations described below specifically pertain to the spatial domain/data set pair described in no. 5 above; however, they can be applied to the other four spatial domain/data set pairs by simply removing the additional variables.

The first step in this process is to estimate "p" for each river reach, where p is the ratio of abandoned locations to total locations (the proportion of surface area with recoverable sediment). Then, each value of "p" is multiplied by the total area excluding bedrock (A) to generate the areas of A2-A5 for each reach. (A1 is the area of bedrock and is considered known based on the SSS classifications and has no variance associated with it). Since the areas for A2-A5 are estimated based on the number of abandoned and recovered + removed points, the variance (var) for each area is calculated using Equation A-14 below.

$$var(A_i) = A^2 \times \frac{p_i \times (1-p_i)}{n}\text{; i=2, 3, 4, 5} \qquad \text{(Eq. A-14)}$$

where A is the total of areas 2 through 5.[6] Once the area and concentrations have been estimated for sediment categories 1-5 for a given data set (*e.g.,* the combined EPA/GE and NYSDEC data sets for

---

[6] The term "A" excludes bedrock area because the bedrock area is known and not part of the area where samples were attempted.

spatial domain/data set pair no. 5), they can be combined into Equation A-15 to generate the area-weighted mean. Using the areas, and the calculated and assumed concentrations, the mean area-weighted concentration is calculated for each river reach and further combined into corresponding values for each river section.

$$\bar{C}_{Total} = \frac{A_1\bar{C}_1 + A_2\bar{C}_2 + A_3\bar{C}_3 + A_4\bar{C}_4 + A_5\bar{C}_5}{A_1 + A_2 + A_3 + A_4 + A_5} \quad \text{(Eq. A-15)}$$

The next step is to determine the variance on the concentration $\bar{C}_{Total}$. To estimate this variance, the variance of all of the A_iC_i pairs must first be determined. When the area of a sediment category is known (*i.e.,* A1 for category 1 only), Equation A-16 is used. When the area is unknown (*i.e.,* A2 through A5) and must be estimated based on the number of abandoned points, Equation A-17 is used. Both formulas include the variance of the PCB concentrations in each area category, “var($\bar{C}_i$)” to estimate the variance of the A_iC_i product, “$var(A_i\bar{C}_i)$”.

Area-known Case

$$var(A_1C_1) = {A_1}^2 var(C_1) \quad \text{(Eq. A-16)}$$

Area-unknown Case

$$var(A_iC_i) = {A_i}^2 var(C_i) + {C_i}^2 var(A_i) - var(A_i)var(C_i) \quad \text{(Eq. A-17)}$$

These variances can then be incorporated into Equation A-18, to generate the variance for the mean area-weighted concentrations.

$$var\{\bar{C}_{Total}\} = \frac{var(A_1\bar{C}_1)+var(A_2\bar{C}_2)+var(A_3\bar{C}_3)+var(A_4\bar{C}_4)+var(A_5\bar{C}_5)}{(Total\ Area)^2} \quad \text{(Eq. A-18)}$$

A.5.3 Variance Contribution by the Tri+ PCB Conversion from Aroclor-based Results

The estimating equation for the mean Tri+ PCB concentration representative of areas where sampling was attempted (Groups 2 and 3 in the non-dredged areas and groups 4 and 5 in the dredged areas) is composed of sums and products of terms representing three components which must be estimated from sample data; 1) the Aroclor 1221 concentration and the sum of Aroclor 1242 and Aroclor 1254 concentrations, 2) the proportion of surface area where sediments were recoverable, and 3) the regression coefficients converting Aroclors results to Tri+ PCB concentrations. The formula we used is given below:

$$\overline{Tri + PCB} = \hat{P} \times avg\left[\hat{\beta}_1 \times (A1221) + \hat{\beta}_2 \times (A1242 + A1254)\right] + \left(1 - \hat{P}\right) \times (Tri + PCB_{No\ Sediment}) \quad \text{(Eq. A-19)}$$

where $\hat{P}$ is the proportion of surface area with recoverable sediment, $\hat{\beta}_1$ and $\hat{\beta}_2$are the regression coefficients converting from Aroclors to Tri+ PCB (from Eq. A-1), "avg[ ]" indicates the average of the term in brackets and $A1221$ and $A1242 + A1254$ represent the Aroclor concentrations as reported by M8082. The value $\overline{Tri + \ PCB}$ represents the estimated average for the areas where sampling was attempted, including both areas where sediment was recovered and areas where no sediment was recovered. In general, the variance estimate for this average should include components representing all terms in Eq. A-19 that are unknown and must be estimated from sample data.

To investigate the relative importance of the three variance components (concentration, recoverable sediment area and regression coefficients), a statistical method based on Taylor expansion (Casella and Berger, 1990, page 328) was used to construct the variance estimator. From this analysis, it was found that the variance is composed of a sum of three independent terms, the first involving covariance of the regression coefficients; the second involving covariance of the Aroclor concentrations and the third involving the variance of $\hat{P}$. This analysis process is briefly outlined below.

Define $\underline{\theta}$ to be the vector of parameters used to determine $Tri + PCB$ for area where sampling was attempted (recoverable and no-sediment areas):

$$\underline{\theta} = \langle \hat{\beta}_1, \hat{\beta}_2, \overline{A1221}, \overline{A1242 + A1254}, \hat{P} \rangle \qquad \text{(Eq. A-20)}$$

and let $Tri + PCB_{No\ Sediment}$ be represented as an assumed value representing the average Tri+ PCB concentration in areas where sampling was attempted, but no sediment was recovered (*i.e.,* abandoned locations). For this evaluation assume this value will be treated as a known constant, although the results developed here would hold if this term is treated as a random quantity with a measure of uncertainty associated with it as described above. Now also consider the estimating equation to be a function "g" such that:

$$\overline{Tri + \ PCB} = g(\underline{\theta}) \ . \qquad \text{(Eq. A-21)}$$

The Delta method[7] uses a first order Taylor expansion as an approximation to the complex function of random variables. This method approximates the variance of the more complex equation by pre- and post-multiplying the variance-covariance matrix of the parameter vector $\underline{\theta}$ (*i.e.,* the statistics) with the vector of partial derivatives of the estimating equation.

$$var(\overline{Tri + \ PCB}) \cong \left(\frac{\partial g}{\partial \underline{\theta}}\right) cov(\underline{\theta}) \left(\frac{\partial g}{\partial \underline{\theta}}\right)^T \qquad \text{(Eq. A-22)}$$

---

[7] Casella, G., and R.L. Berger. 1990. Statistical Inference. Duxbury Press, Belmont, CA.

Here, T, represents matrix transpose which is required so that matrices and vectors in Eq A-22 are dimensionally compatible. Applying this process to the estimating equation for Tri+ PCB, it can be shown that the variance can be expressed as a sum of three independent terms:

$$\begin{aligned} var(\overline{Tri+\ PCB}) \\ &= var(Regression\ Parameters) \\ &+ var(Aroclor\ Concentrations) \\ &+ var(Proportion\ Recoverable\ Sed) \end{aligned}$$

(Eq. A-23)

To understand the importance of each component, one might consider that the regression coefficients are less than 1.0 and have variances that are also less than 1.[8] Similarly, the proportions of area with recoverable and non-recoverable sediments can only vary between 0 and 1, and so their variances should be close to 1 as well. Variance and covariance terms associated with Aroclors are in squared concentrations, so one could anticipate that the variances associated with Aroclor concentrations would be the most important. To test this expectation, the regression parameters and necessary variance and covariance terms were estimated from the 440 paired Aroclor and Tri+ PCB values,[9] and it was assumed that 60% of the surface area was composed of recoverable sediments. These terms were applied using Eq. A-23. The estimated variance components were, 0.04, 12.5 and 1.5 for the regression, concentration and proportion recoverable respectively with a total variance of 14. On a percentage basis, uncertainty in the regression coefficients added just 0.3% to the total variance while the concentration and proportion recoverable terms contributed 88.8% and 10.9% respectively. Because the regression coefficients in Eq. A-1 were estimated from a large number of pairs and because the fit was very strong (R^2=0.98) there was very little variance associated with the regression parameters. With this finding, the uncertainty estimates associated with the area-weighted Tri+ PCB concentrations reported in the memo were developed as if the regression coefficients in Eq. A-1 are known constants. This simplifies the calculations with negligible effect on the estimated variances.

With this simplifying assumption and noting that the Aroclors can be converted to Tri+ PCB at the sample level or after averaging them, the estimating equation A-19 can be expressed in simplified form:

$$\overline{Tri+\ PCB} = \hat{P} \times \overline{Tri+PCB}_{Recoverable\ Sediment} + \left(1-\hat{P}\right) \times (\overline{Tri+PCB}_{No\ Sediment})$$

(Eq. A-24)

---

[8] This can be inferred from Figure A.3.1-1, which shows the estimates for the regression coefficients and the associated error bars. The error bars represent plus-or-minus 2 times the standard error on the mean coefficient and indicate errors on the coefficients are much less than 1. The regression coefficient variance is the standard error squared.

[9] These are the matched pair data for M8082 and mGBM obtained by GE that were used in the derivation of Eq. A-1.

and known formulas for variances of sums and products of random variables (Goodman, 1960) are used to calculate the variance and subsequently confidence limits as described above in Section A.5.2.

References

Casella, G., and R.L. Berger. 1990. *Statistical Inference.* Duxbury Press, Belmont, CA.

EA Engineering, P.C. and Its Affiliate (EA), 2017. Operation, Maintenance, and Monitoring Letter Work Plan, Contract/Work Assignment No. D007624-36, Site/Spill No./Pin: Hudson River PCB Sediments OU-2 (546031). June 23, 2017.

EA, 2018. Data Summary Report, Hudson River PCB Sediments OU-2 (546031), Upper Hudson River, New York, Work Assignment No. D007624-36. DRAFT. March 2018

GE, 2011. Corrective Action Memorandum (CAM) No. 3 – Modification of Sediment Residual Monitoring Program – Discontinuing mGBM Analysis of Sediment Samples and Updates of the Regression Coefficients. Memorandum from Emily Chen, Anchor QEA to Bob Gibson, GE. August 15, 2011.

GE, 2005. Phase 1 Dredge Area Delineation Report. Prepared for: General Electric Company, Albany, NY. Prepared by: Quantitative Environmental Analysis, LLC, Montvale, NJ. February 28, 2005.

GE, 2009. Hudson River PCB Site Phase 1 Remedial Action Monitoring Program Quality Assurance Project Plan. Appendix 51: Tri+ PCB Regression – Technical Memo. Prepared by Anchor QEA, LLC in conjunction with Environmental Standards and Arcadis. May 2009.

Goodman, L.A., 1960. On the exact variance of products. *Journal of the American Statistical Association,* Vol. 55, No. 292 pp 708-713.

TABLES

Table A.1-1
Location Tally for 2017 NYSDEC Data

River Area	**Proposed Locations**		**Resulting Catategories**			
	Planned Locations	**Field Added Locations**	**Recoverable Sediment**	**Removed Locations**	**Abandoned Locations**	**Total**
Main Stem	1609	-	1089	53	467	1609
Landcut	64	-	59	-	5	64
Old Champlain Canal	-	9	9	-	-	9
Coville	-	5	5	-	-	5
Total	**1673**	**14**	**1162**	**53**	**472**	**1687**

Table A.1.1-1

Location Tally for 2017 NYSDEC Data: Main Stem Locations Only

Area	River Section	Total	Recoverable Sediment	Removed Locations	Abandoned Locations	River Reach	Total	Recoverable Sediment	Removed Locations	Abandoned Locations
Inside CU	1	148	143 (97%)	(0%)	5 (3%)	8	148	143 (97%)	(0%)	5 (3%)
	2	62	58 (94%)	(0%)	4 (6%)	7	29	28 (97%)	(0%)	1 (3%)
						6	33	30 (91%)	(0%)	3 (9%)
	3	55	48 (87%)	5 (9%)	2 (4%)	5	20	20 (100%)	(0%)	(0%)
						4	12	11 (92%)	(0%)	1 (8%)
						3	18	12 (67%)	5 (28%)	1 (6%)
						2	3	3 (100%)	(0%)	(0%)
						1	2	2 (100%)	(0%)	(0%)
	Total	265	249 (94%)	5 (2%)	11 (4%)	Total	265	249 (94%)	5 (2%)	11 (4%)
Outside CU	1	62	50 (81%)	4 (6%)	8 (13%)	8	62	50 (81%)	4 (6%)	8 (13%)
	2	119	99 (83%)	0%	20 (17%)	7	66	62 (94%)	(0%)	4 (6%)
						6	53	37 (70%)	(0%)	16 (30%)
	3	1163	691 (59%)	44 (37%)	428 (37%)	5	232	203 (88%)	7 (3%)	22 (9%)
						4	295	212 (72%)	11 (4%)	72 (24%)
						3	222	96 (43%)	20 (9%)	106 (48%)
						2	236	66 (28%)	4 (2%)	166 (70%)
						1	178	114 (64%)	2 (1%)	62 (35%)
	Total	1344	840 (63%)	48 (4%)	456 (34%)	Total	1344	840 (63%)	48 (4%)	456 (34%)
Grand Total		**1609**	**1089 (68%)**	**53 (3%)**	**467 (29%)**	**Grand Total**	**1609**	**1089 (68%)**	**53 (3%)**	**467 (29%)**

Table A.1.3-1
Location Tally for 2017 NYSDEC Dredged Areas

	Total	**Recoverable**	**Abandoned**	**Removed Locations**
Backfilled	179	172 (96%)	4 (2%)	3 (2%)
Capped	60	51 (85%)	7 (12%)	2 (3%)
Not backfilled or capped	26	26 (100%)	0 (0%)	0 (0%)
Inside CU Total	**265**	**249 (94%)**	**11 (4%)**	**5 (2%)**

Table A.2.3-1

Results for Samples with TCMX Surrogate Recoveries Outside the Method Control Limits: M8082

Sample ID	Parent Sample ID	Surrogate	Recovery (%)	Exceed Surrogate Criteria?	Analyze for E1668A?	PCB-1016 (Aroclor 1016) (ug/kg)	PCB-1221 (Aroclor 1221) (ug/kg)	PCB-1232 (Aroclor 1232) (ug/kg)	PCB-1242 (Aroclor 1242) (ug/kg)	PCB-1248 (Aroclor 1248) (ug/kg)	PCB-1254 (Aroclor 1254) (ug/kg)	PCB-1260 (Aroclor 1260) (ug/kg)	TPCB (ug/kg)
HR17-OU2-R7-041_20170726		2,4,5,6-Tetrachloro-Meta-Xylene	9710	Yes	No		42900		13100		4900		60,900
HR17-OU2-R7-050_20170727		2,4,5,6-Tetrachloro-Meta-Xylene	5770	Yes	No		27900		26300		4550		58,750
HR17-OU2-R4-060_20170731		2,4,5,6-Tetrachloro-Meta-Xylene	5680	Yes	No		46800		18400		1920		67,120
HR17-OU2-R6-040_20170729		2,4,5,6-Tetrachloro-Meta-Xylene	1390	Yes	No		8170		9480		1440		19,090
HR17-OU2-R6-FD02_20170729	HR17-OU2-R6-040_20170729	2,4,5,6-Tetrachloro-Meta-Xylene	1150	Yes	No		6770		8080		1100		15,950
HR17-OU2-R4-050_20170809		2,4,5,6-Tetrachloro-Meta-Xylene	879	Yes	No		8970		6030		638		15,638
HR17-OU2-R6-034_20170728		2,4,5,6-Tetrachloro-Meta-Xylene	819	Yes	No		10300		6320		609		17,229
HR17-OU2-R4-026_20170807		2,4,5,6-Tetrachloro-Meta-Xylene	639	Yes	No		7740		6590		704		15,034
HR17-OU2-R8-174_20170707		2,4,5,6-Tetrachloro-Meta-Xylene	572	Yes	No		5920		4720		469		11,109
HR17-OU2-R7-080_20170728		2,4,5,6-Tetrachloro-Meta-Xylene	496	Yes	No		3890		3820		321		8,031
HR17-OU2-R7-029_20170726		2,4,5,6-Tetrachloro-Meta-Xylene	431	Yes	No		3160		4920		694		8,774
HR17-OU2-R5-137_20170707		2,4,5,6-Tetrachloro-Meta-Xylene	351	Yes	No		5830		5250		566		11,646
HR17-OU2-R3-113_20170828		2,4,5,6-Tetrachloro-Meta-Xylene	331	Yes	No		13000		12900		925		26,825
HR17-OU2-R8-182_20170707		2,4,5,6-Tetrachloro-Meta-Xylene	324	Yes	Yes		4610		14500		4020		23,130
HR17-OU2-R8-FD02_20170707	HR17-OU2-R8-182_20170707	2,4,5,6-Tetrachloro-Meta-Xylene	328	Yes	Yes		5760		14800		3890		24,450
HR17-OU2-R8-022_20170722		2,4,5,6-Tetrachloro-Meta-Xylene	270	Yes	No		2300		1830		315		4,445
HR17-OU2-R7-011_20170724		2,4,5,6-Tetrachloro-Meta-Xylene	254	Yes	No		2430		2820		474		5,724
HR17-OU2-R7-042_20170726		2,4,5,6-Tetrachloro-Meta-Xylene	214	Yes	Yes		2570		6380		773		9,723
HR17-OU2-R8-085_20170717		2,4,5,6-Tetrachloro-Meta-Xylene	214	Yes	No		3000		2540		456		5,996
HR17-OU2-R7-056_20170727		2,4,5,6-Tetrachloro-Meta-Xylene	159	Yes	No		5380		6560		334		12,274
HR17-OU2-R4-202_20170816		2,4,5,6-Tetrachloro-Meta-Xylene	134	Yes	No		1850		1600		94.6		3,545
HR17-OU2-R8-089_20170717		2,4,5,6-Tetrachloro-Meta-Xylene	124	No	No		1880		3190		233		5,303
HR17-OU2-R3-014_20170724		2,4,5,6-Tetrachloro-Meta-Xylene	123	No	No		15700		16800		684		33,184
HR17-OU2-R8-083_20170717		2,4,5,6-Tetrachloro-Meta-Xylene	123	No	No		1590		1350		279		3,219
HR17-OU2-R7-020_20170725		2,4,5,6-Tetrachloro-Meta-Xylene	120	No	No		1610		2790		270		4,670
HR17-OU2-R8-007_20170719		2,4,5,6-Tetrachloro-Meta-Xylene	120	No	No		863		756		143		1,762
HR17-OU2-R4-FD06_20170804	HR17-OU2-R4-107_20170804	2,4,5,6-Tetrachloro-Meta-Xylene	117	No	No		1520		1830		175		3,525
HR17-OU2-R7-005_20170724		2,4,5,6-Tetrachloro-Meta-Xylene	117	No	No		534		1050		96		1,680
HR17-OU2-R7-098_20170731		2,4,5,6-Tetrachloro-Meta-Xylene	117	No	No		1250		1960		420		3,630
HR17-OU2-R8-099_20170715		2,4,5,6-Tetrachloro-Meta-Xylene	117	No	No		520		2090		645		3,255
HR17-OU2-R7-021_20170725		2,4,5,6-Tetrachloro-Meta-Xylene	116	No	No		1600		2380		665		4,645
HR17-OU2-R8-137_20170712		2,4,5,6-Tetrachloro-Meta-Xylene	115	No	No		3030		2680		123		5,833
HR17-OU2-R1-135_20170627		2,4,5,6-Tetrachloro-Meta-Xylene	32	No	No		3960		11400				15,360
HR17-OU2-R6-012_20170727		2,4,5,6-Tetrachloro-Meta-Xylene	19	Yes	No		382		1270		237		1,889
HR17-OU2-R6-005_20170727		2,4,5,6-Tetrachloro-Meta-Xylene	2	Yes	No		185		1310		315		1,810

Table A.4.2-1

Relationships between Sediment Texture (GE SSS) and Rates of Abandoned Locations for 2016 EPA/GE Surface Sediment Samples

2016 EPA/GE Data

				Side Scan Sonar Categories Location Tally[1]							Side Scan Sonar Percent of Locations in each Category[2]						Percent of Abandoned and Recovered locations By River Reach[2]
Area Type	**River Section**	**Reach**	**Abandoned/ Removed**	**Silt**	**Silt and Sand**	**Gravel**	**Bedrock**	**Transitional**	**No SSS Coverage**	**Total**	**%Silt**	**%Silt and Sand**	**%Gravel**	**%Bedrock**	**%Transitional**	**% No SSS Coverage**	
Outside CU	**1**	8	Abandoned			6		3		**9**			60.0%		15.8%		21.4%
			Sampled	2	11	4		16		**33**	100.0%	100.0%	40.0%		84.2%		78.6%
	2	7	Abandoned	1		1				**2**	11.1%		33.3%				6.9%
			Sampled	8	14	2		3		**27**	88.9%	100.0%	66.7%		100.0%		93.1%
		6	Abandoned	1	1	3				**5**	9.1%	5.6%	42.9%				10.4%
			Sampled	10	17	4		12		**43**	90.9%	94.4%	57.1%		100.0%		89.6%
	3	5	Abandoned		1					**1**		5.6%					1.6%
			Sampled	17	31	7		8		**63**	100.0%	96.9%	100.0%		100.0%		98.4%
		4	Sampled	1	3			2		**6**	100.0%	100.0%			100.0%		100.0%
		3	Abandoned	1		5		1	3	**10**	100.0%		41.7%		100.0%	100.0%	58.8%
			Sampled			7				**7**			41.2%				41.2%
		2	Abandoned			12			4	**16**			66.7%			57.1%	59.3%
			Sampled	1		6		1	3	**11**	100.0%		33.3%		100.0%	42.9%	40.7%
		1	Abandoned			4				**4**			19.0%				13.8%
			Sampled	2	3	17		3		**25**	100.0%	100.0%	81.0%		100.0%		86.2%
Grand Total			Abandoned	3	2	31	0	4	7	**47**	6.8%	2.5%	39.7%	0.0%	8.2%	70.0%	17.9%
			Sampled	41	79	47	0	45	3	**215**	93.2%	97.5%	60.3%	0.0%	91.8%	30.0%	82.1%
			All	**44**	**81**	**78**	**0**	**49**	**10**	**262**							

Notes:

1.Data set includes Land cut samples

2. Percentages sum to 100% by river reach within each column, Percentage based on total number of samples in each category in that reach

Table A.4.2-2

Relationships between Sediment Texture (GE SSS) and Rates of Abandoned Locations for 2017 NYSDEC Surface Sediment Samples

2017 NYSDEC Data

				Side Scan Sonar Categories Location Tally[1]							Side Scan Sonar Percent of Locations in each Category[2]						Percent of Abandoned and Recovered locations By River Reach[2]
Area Type	**River Section**	**Reach**	**Abandoned/ sampled/ removed**	**Silt**	**Silt and Sand**	**Gravel**	**Bedrock**	**Transitional**	**No SSS Coverage**	**Total**	**%Silt**	**%Silt and Sand**	**%Gravel**	**%Bedrock**	**%Transitional**	**% No SSS Coverage**	
Inside CU	**1**	8	Abandoned		3	1		1		**5**		9.1%	9.1%		1.7%		3.4%
			Sampled	32	30	10		59	12	**143**	100.0%	90.9%	90.9%		98.3%	100.0%	96.6%
	2	7	Abandoned	1						**1**	4.2%						3.4%
			Sampled	23	5					**28**	95.8%	100.0%					96.6%
		6	Abandoned	3						**3**	9.7%						8.8%
			Sampled	28	1			2		**31**	90.3%	100.0%			100.0%		91.2%
	3	5	Sampled	18	1			1		**20**	100.0%	100.0%			100.0%		100.0%
		4	Abandoned					1		**1**					20.0%		7.7%
			Sampled	8				4		**12**	100.0%				80.0%		92.3%
		3	Abandoned			1				**1**			50.0%				7.7%
			Removed	1					4	**5**							
			Sampled	10		1			1	**12**	100.0%		50.0%			100.0%	92.3%
		2	Sampled	2				1		**3**	100.0%				100.0%		100.0%
		1	Sampled	1		1				**2**	100.0%		100.0%				100.0%
Outside CU	**1**	8	Abandoned		1	3		2	3	**9**		11.1%	27.3%		7.1%	50.0%	15.0%
			Removed						4	**4**							
			Sampled	6	8	8		26	3	**51**	100.0%	88.9%	72.7%		92.9%	50.0%	85.0%
	2	7	Abandoned	1			4			**5**	2.6%			50.0%			6.0%
			Sampled	38	25	7	4	4	1	**79**	97.4%	100.0%	100.0%	50.0%	100.0%	100.0%	94.0%
		6	Abandoned	4	3	8	1	1		**17**	14.3%	21.4%	53.3%	100.0%	14.3%		26.2%
			Sampled	24	11	7		6		**48**	85.7%	78.6%	46.7%		85.7%		73.8%
	3	5	Abandoned		4	8		5	5	**22**		3.4%	34.8%		15.2%	25.0%	9.3%
			Removed						7	**7**							
			Sampled	41	115	15		28	15	**214**	100.0%	96.6%	65.2%		84.8%	75.0%	90.7%
		4	Abandoned	1	14	11	1	13	34	**74**	1.6%	16.9%	50.0%	50.0%	15.3%	55.7%	23.6%
			Removed					3	8	**11**							
			Sampled	60	69	11	1	72	27	**240**	98.4%	83.1%	50.0%	50.0%	84.7%	44.3%	76.4%
		3	Abandoned		3	81	4	1	17	**106**		21.4%	73.0%	80.0%	33.3%	30.9%	52.5%
			Removed	4					16	**20**							
			Sampled	14	11	30	1	2	38	**96**	100.0%	78.6%	27.0%	20.0%	66.7%	69.1%	47.5%
		2	Abandoned		1	128	5	3	29	**166**		9.1%	87.7%	100.0%	21.4%	56.9%	71.6%
			Removed						4	**4**							
			Sampled	5	10	18		11	22	**66**	100.0%	90.9%	12.3%		78.6%	43.1%	28.4%
		1	Abandoned		3	49	5	2	3	**62**		11.5%	44.1%	83.3%	16.7%	42.9%	35.2%
			Removed			2				**2**							
			Sampled	14	23	62	1	10	4	**114**	100.0%	88.5%	55.9%	16.7%	83.3%	57.1%	64.8%
Grand Total			Abandoned	10	32	290	20	29	91	**472**	3.0%	9.4%	63.0%	74.1%	11.4%	42.5%	28.9%
			Sampled	324	309	170	7	226	123	**1159**	97.0%	90.6%	37.0%	25.9%	88.6%	57.5%	71.1%
			Removed	5	0	2	0	3	43	**53**							
			All	**339**	**341**	**462**	**27**	**258**	**257**	**1684**							

Notes:

1.Data set includes Land cut samples

2. Percentages sum to 100% by river reach within each column, Percentage based on total number of samples in each category in that reach

* Three samples from the Old Champlain labeled PC were excluded

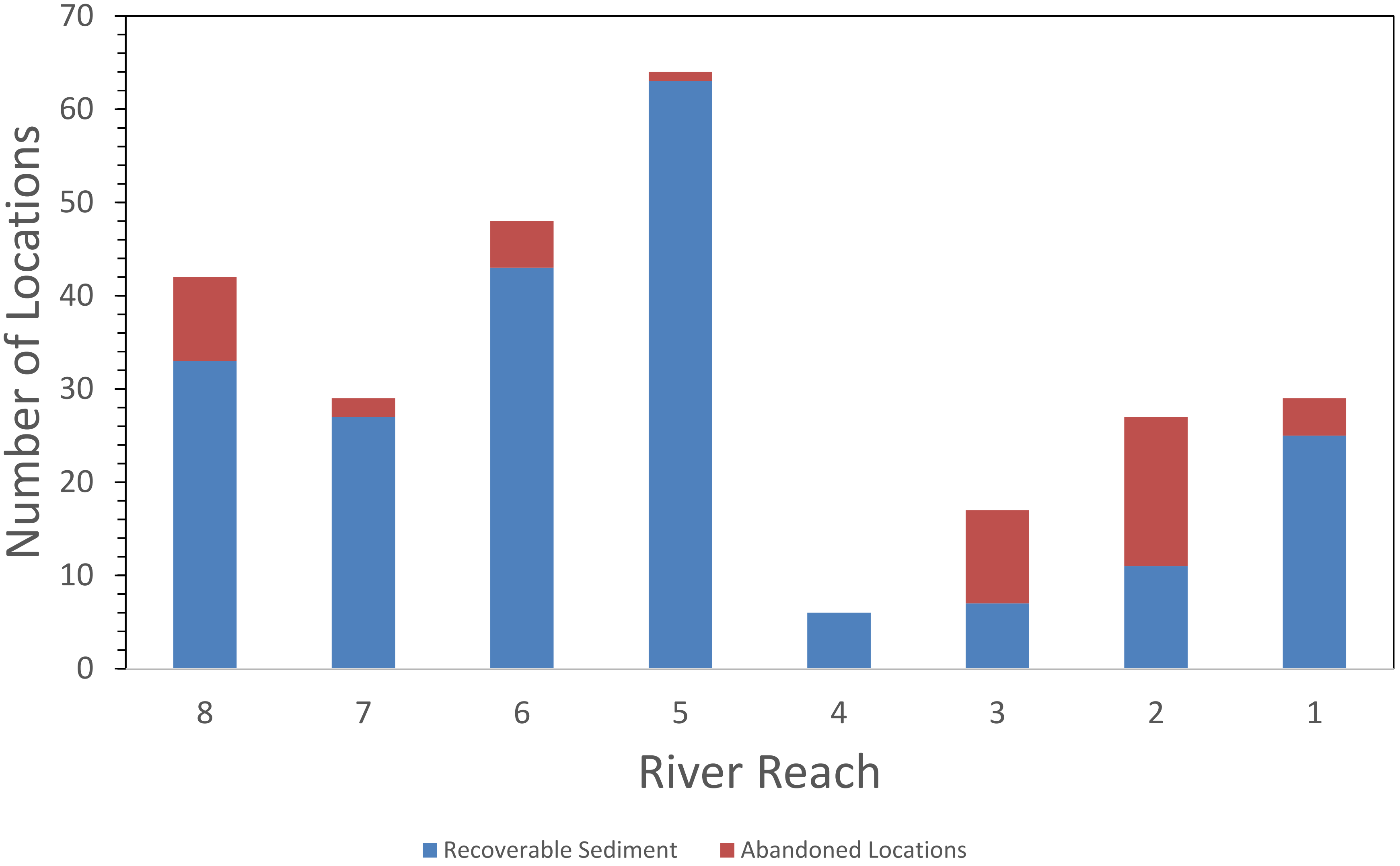
Table A.5.1-1
Sediment Category and Area Information

Sediment Category No.	**Sediment Category *i.e.*, Area represented by:**	**Area Term used in Equations A-14 to A-18**	**Status of the Area in the Sediment Category**		**Source of Information**
1	Bedrock	A1	Known		GE 2003 Side Scan Sonar
2	Recoverable Dredged Sediment	A2	Unknown	Sum of A2+A3 is Known	Dredged areas are known from GE reports. Proportion of A2 to A3 area is estimated from sample data based on proportion of abandoned locations. Area represented by removed locations in dredged areas is included in A2
3	Abandoned Dredged	A3	Unknown		
4	Recoverable Non-Dredged Sediment	A4	Unknown	Sum of A4+A5 is Known	These represent the remaining river area after bedrock and dredged area are accounted for. Proportion of A4 to A5 estimated from sample data based on proportion of abandoned locations. Area represented by removed locations in non-dredged areas is included in A2
5	Abandoned Non-Dredged Sediment	A5	Unknown		

Table A.5.1-2
Sediment Category and Concentration Information

Sediment Category No.	Sediment Category *i.e.,* Area represented by:	Area Term used in Equations A-14 to A-18	Status of the Concentration in the Sediment Category	Source of Information
1	Bedrock	C1	Unknown	Assigned 0.03 mg/kg, one-half the median reporting limit for nondetect samples
2	Recoverable Dredged Sediment	C2	Known	Estimated from recoverable sediment data
3	Abandoned Dredged Sediment	C3	Unknown	Assigned 0.03 mg/kg, one-half the median reporting limit for nondetect samples
4	Recoverable Non-Dredged Sediment	C4	Known	Estimated from recoverable sediment data
5	Abandoned Non-Dredged Sediment	C5	Unknown	Assigned 0.03 mg/kg, one-half the median reporting limit for nondetect samples

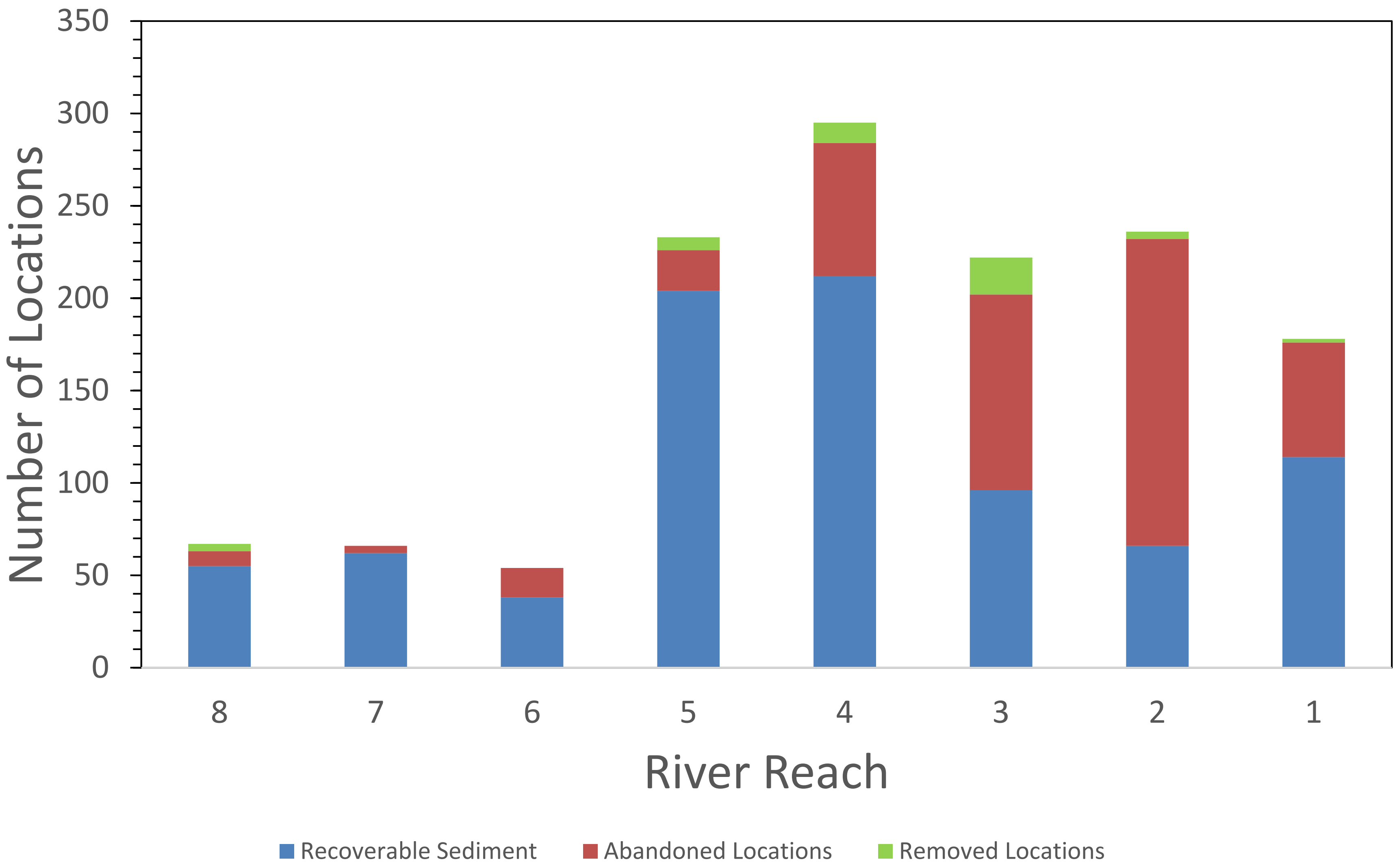
FIGURES



2016 EPA/GE Non-Dredged
Area Data Sample Count

Figure A.1.1-1

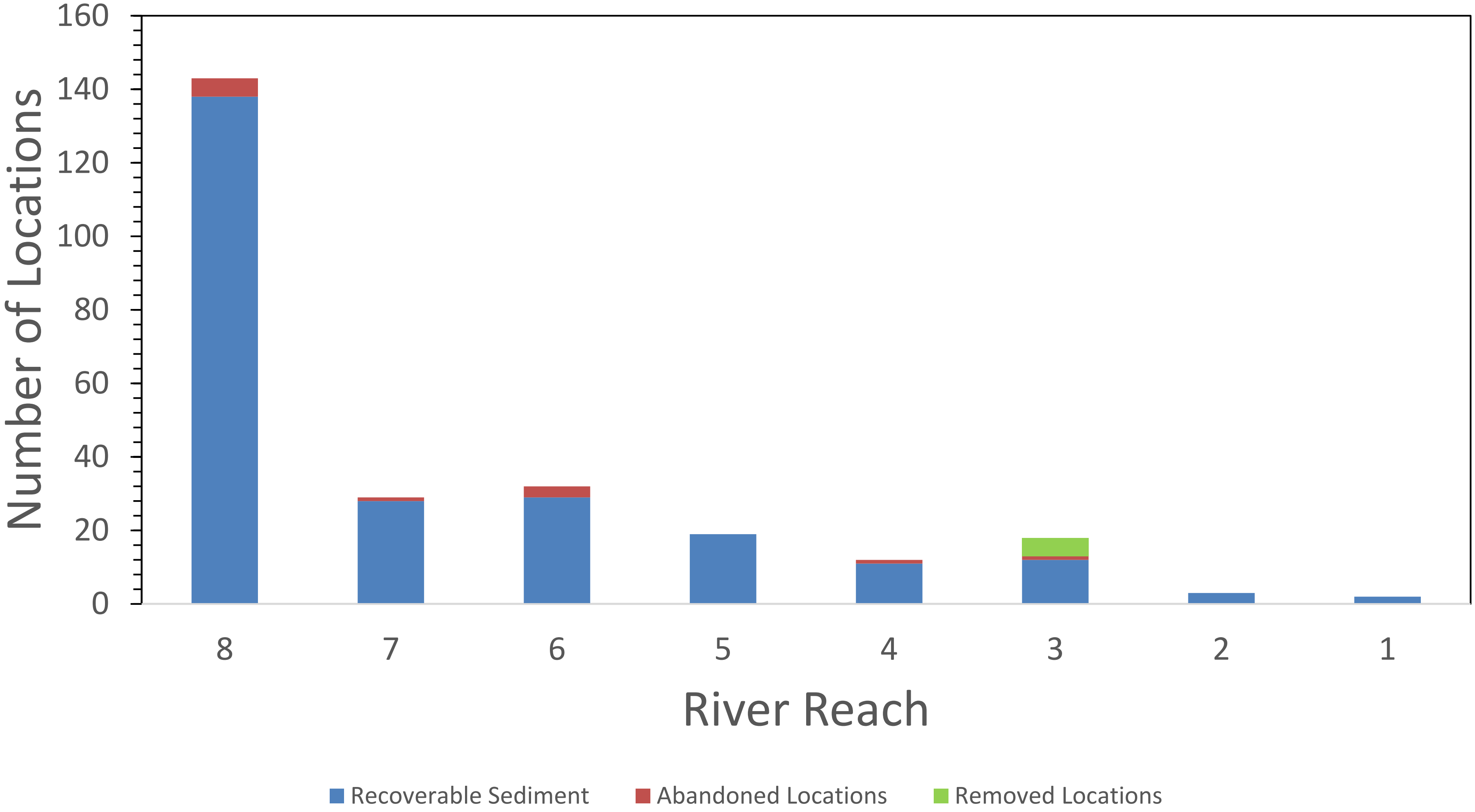
April 2019



2017 NYSDEC Non-Dredged Area Data
Sample Count

Figure A.1.1-2

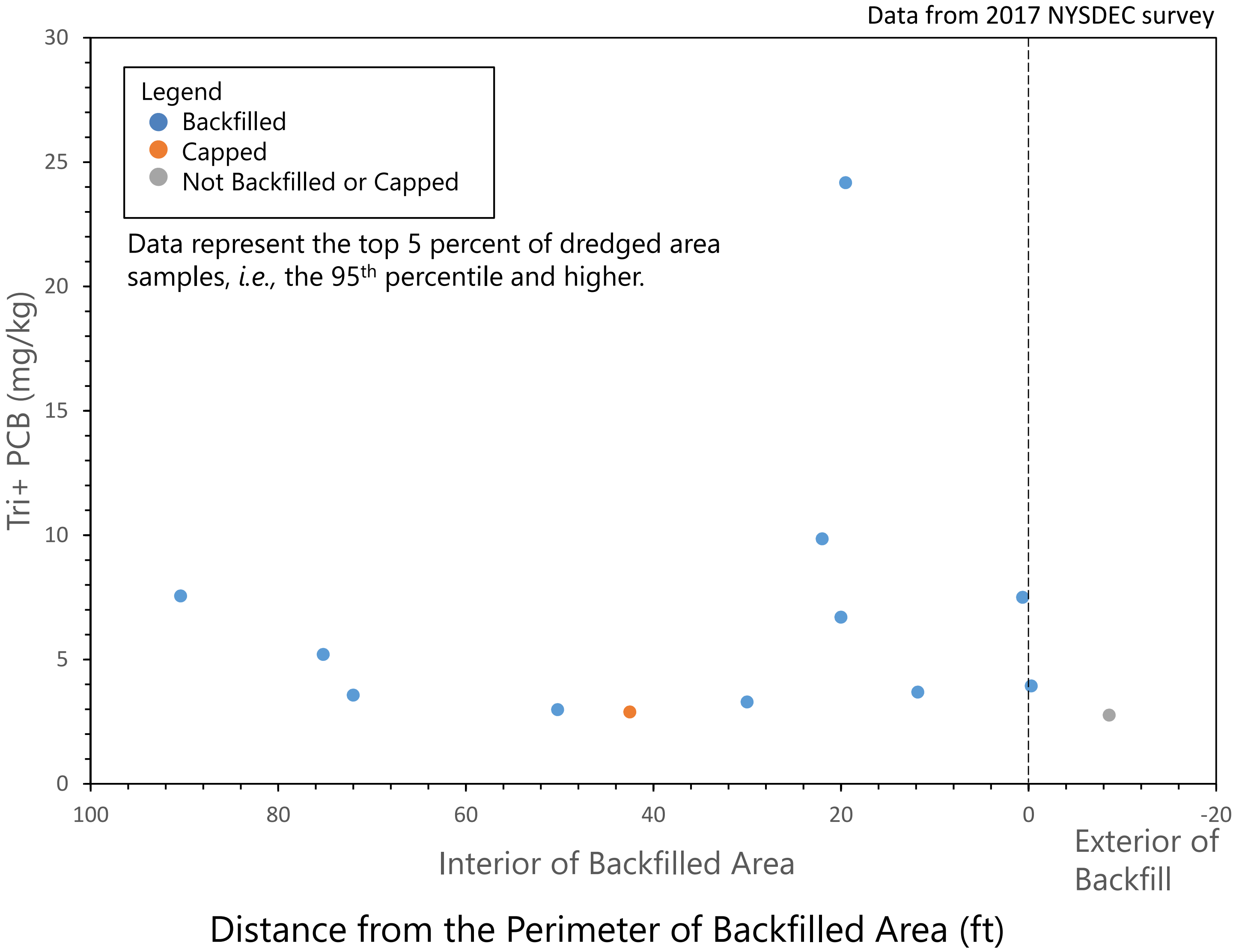
April 2019



2017 NYSDEC Dredged Area Data
Sample Count

Figure A.1.1-3

April 2019

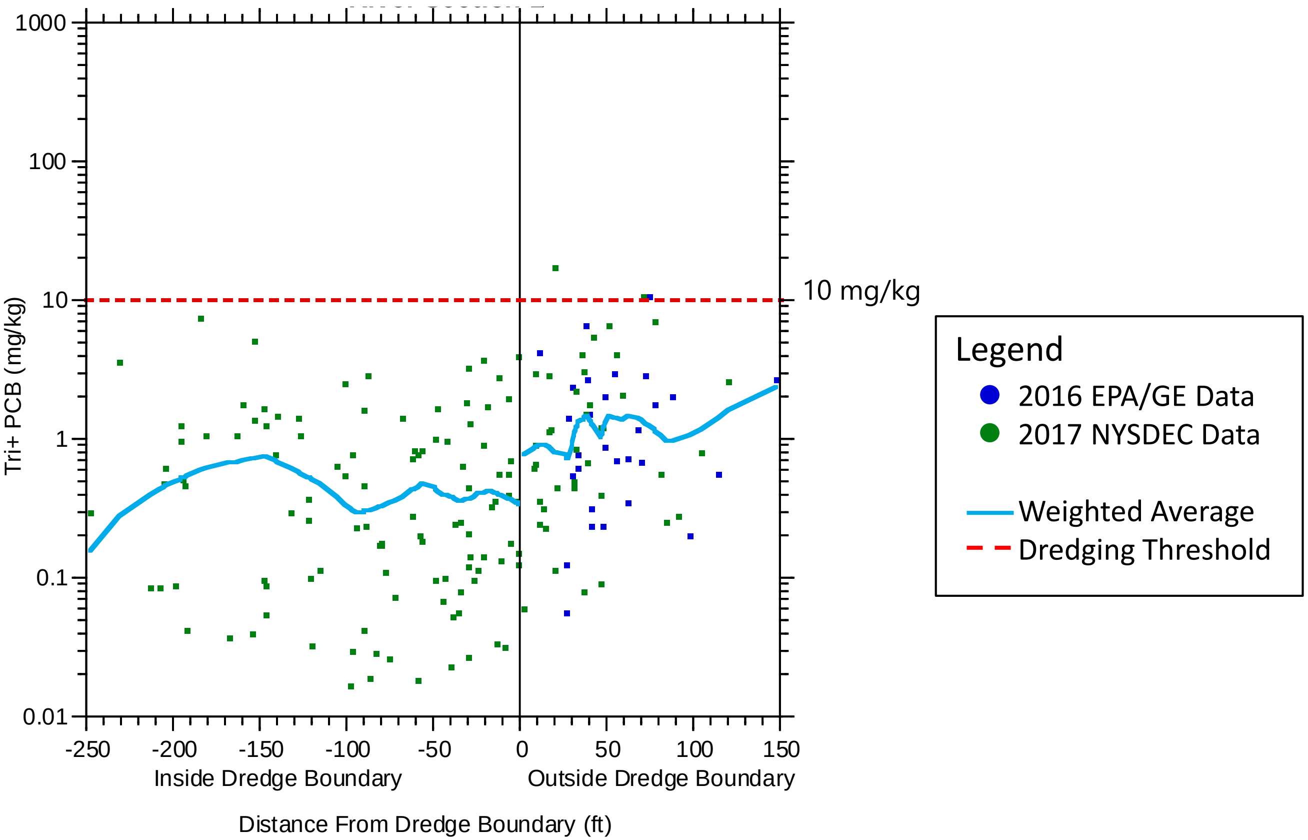

Data from 2017 NYSDEC survey

Data represent the top 5 percent of dredged area samples, *i.e.*, the 95th percentile and higher.

Variation of Tri+ PCB Concentration with Distance from Backfill Perimeter

Figure A.1.3-1

April 2019

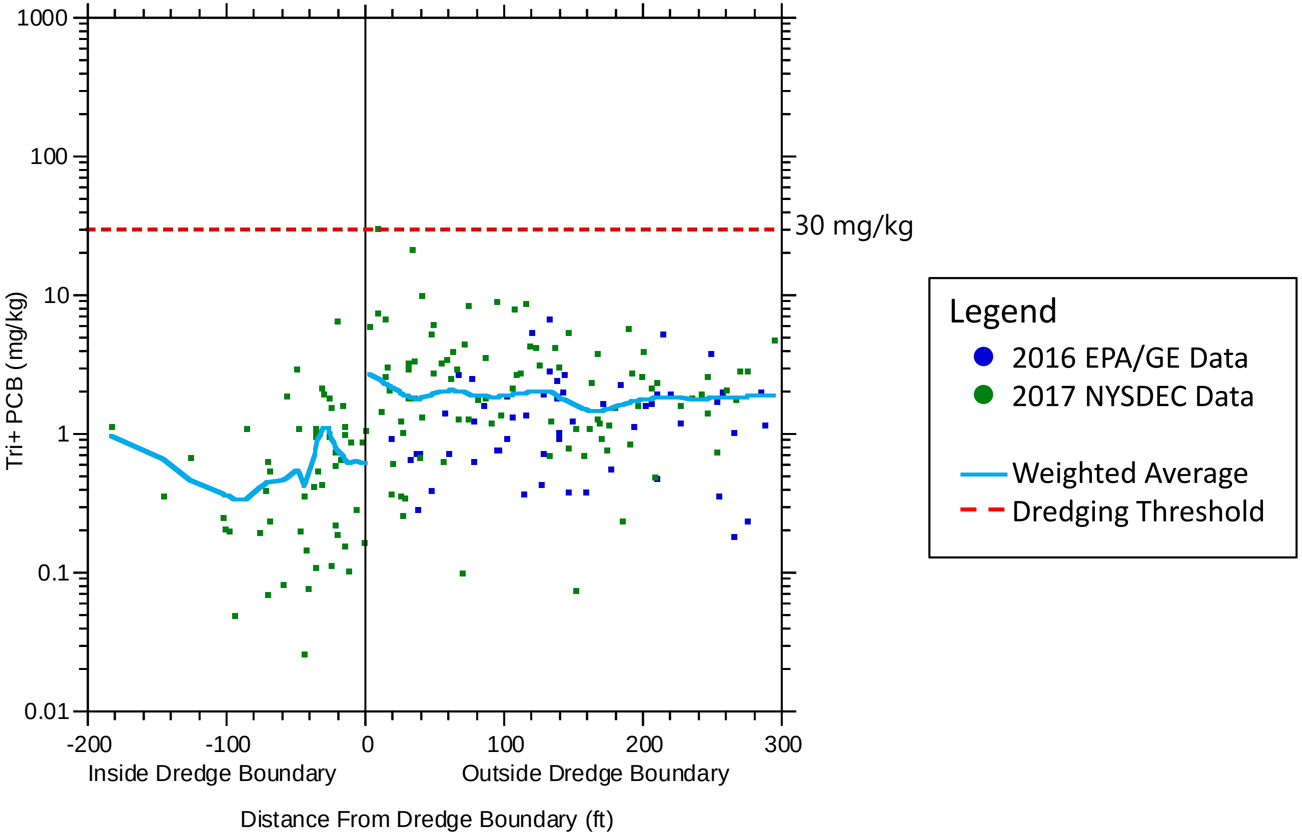


Tri+ PCB Concentration vs. Distance from the Closest Dredging Boundary
River Section 1
2016 EPA/GE and 2017 NYSDEC Data

Figure A.1.4-1a

April 2019

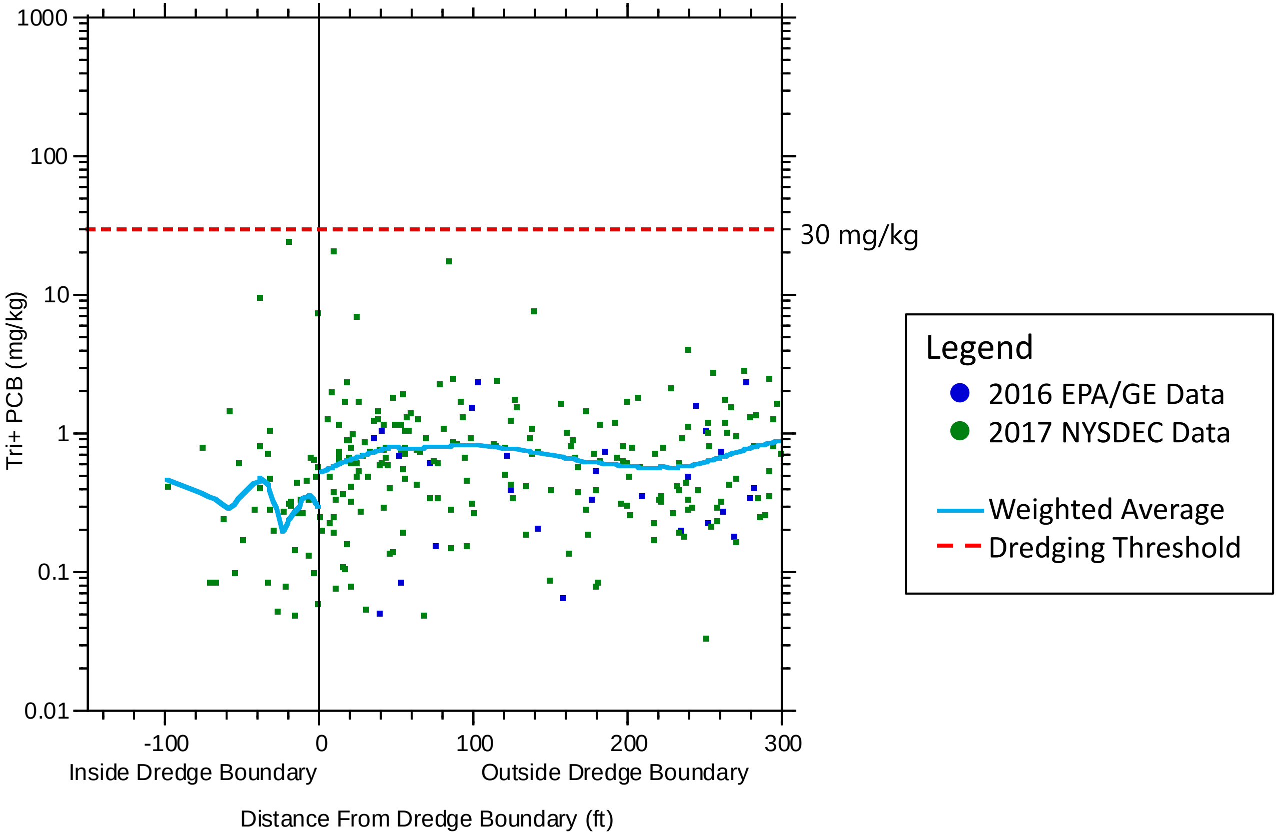
Subject to Joint Prosecution and Confidentiality Agreement. Not for Public Release. FOIA/FOIL Exempt.



VTri+ PCB Concentration vs. Distance from the Closest Dredging Boundary
River Section 2
2016 EPA/GE and 2017 NYSDEC Data

Figure A.1.4-1b

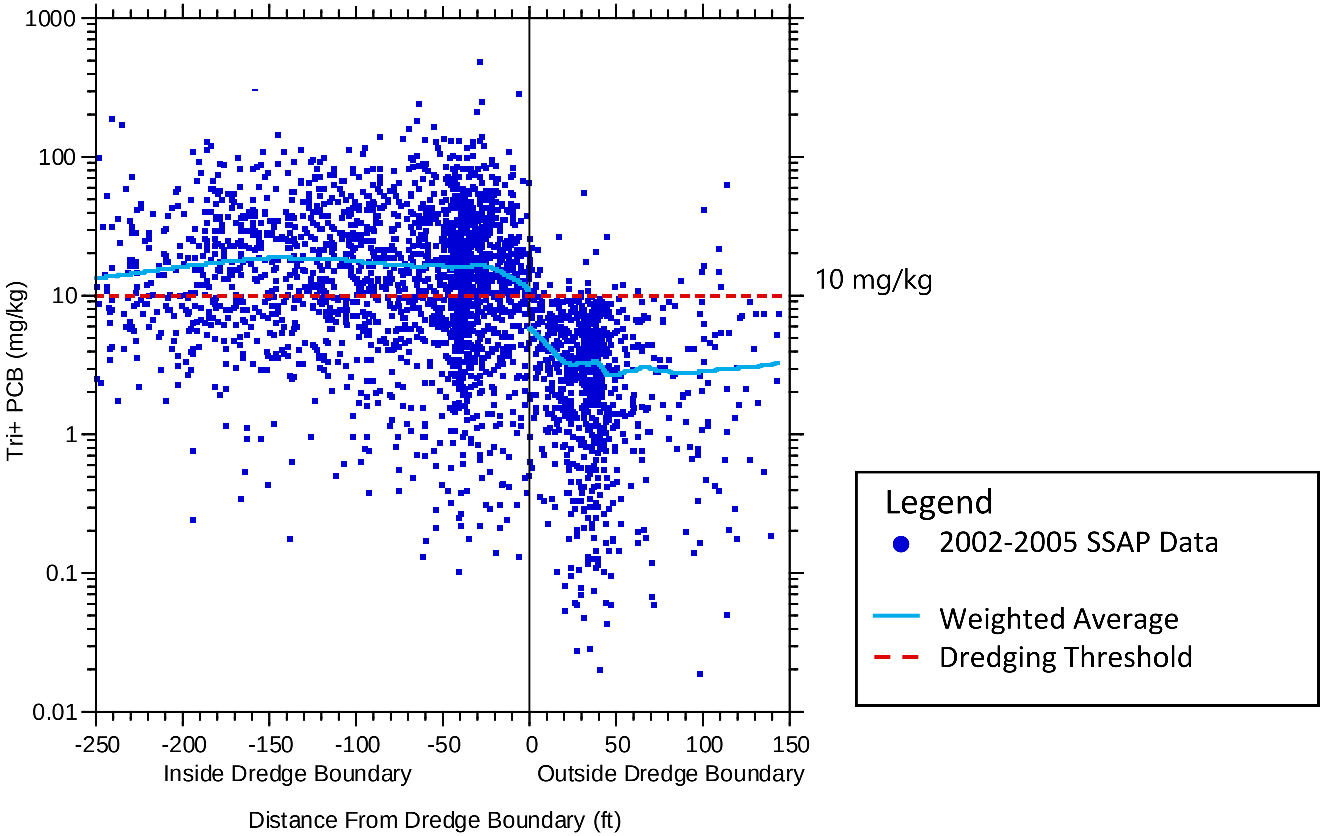
April 2019



VTri+ PCB Concentration vs. Distance from the Closest Dredging Boundary
River Section 3
2016 EPA/GE and 2017 NYSDEC Data

Figure A.1.4-1c

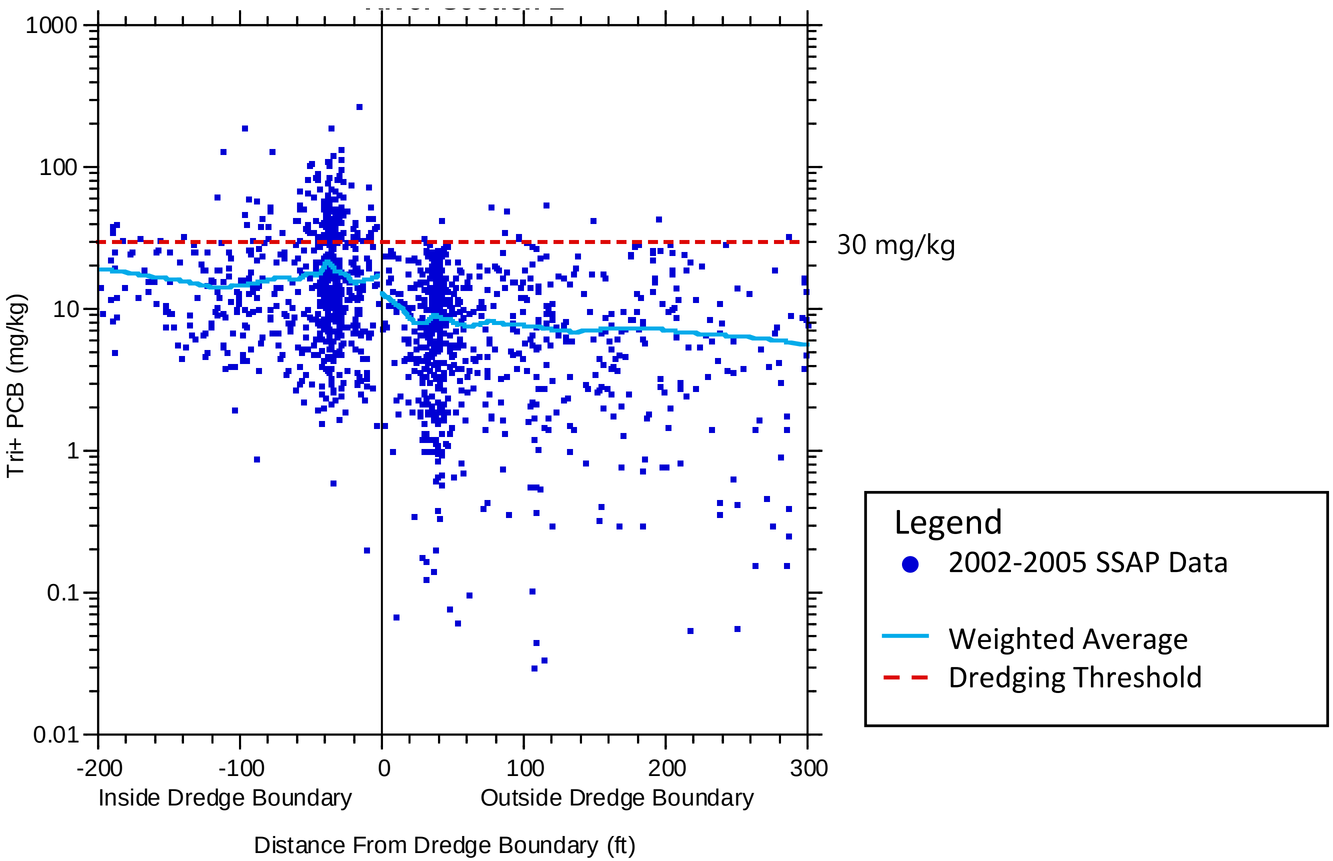
April 2019



Tri+ PCB Concentrations *vs.* Distance from the Closest Dredging Boundary
River Section 1
2002-2005 SSAP (0-2 in. Samples)

Figure A.1.4-2a

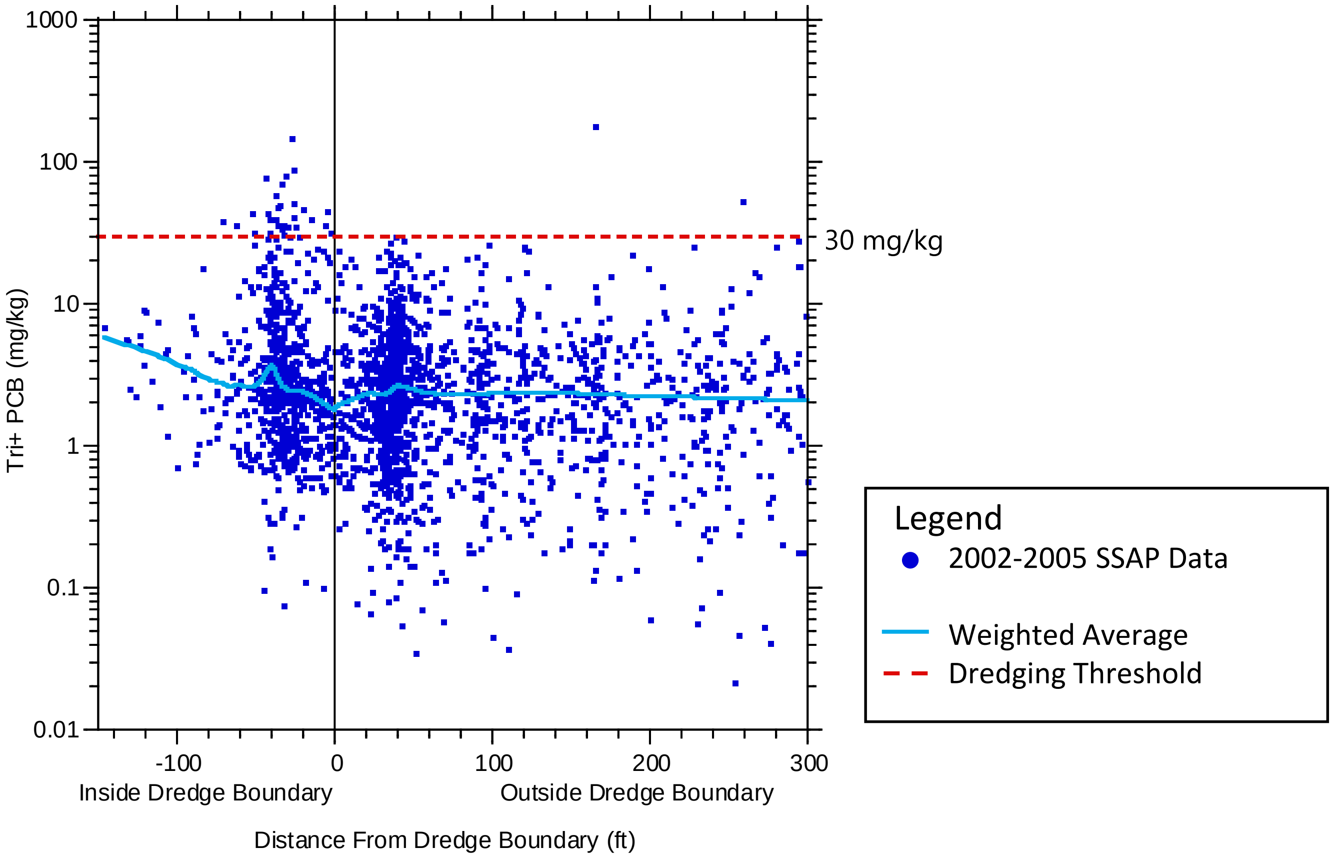
April 2019



Tri+ PCB Concentrations vs. Distance from the Closest Dredging Boundary
River Section 2
2002-2005 SSAP (0-2 in. Samples)

Figure A.1.4-2b

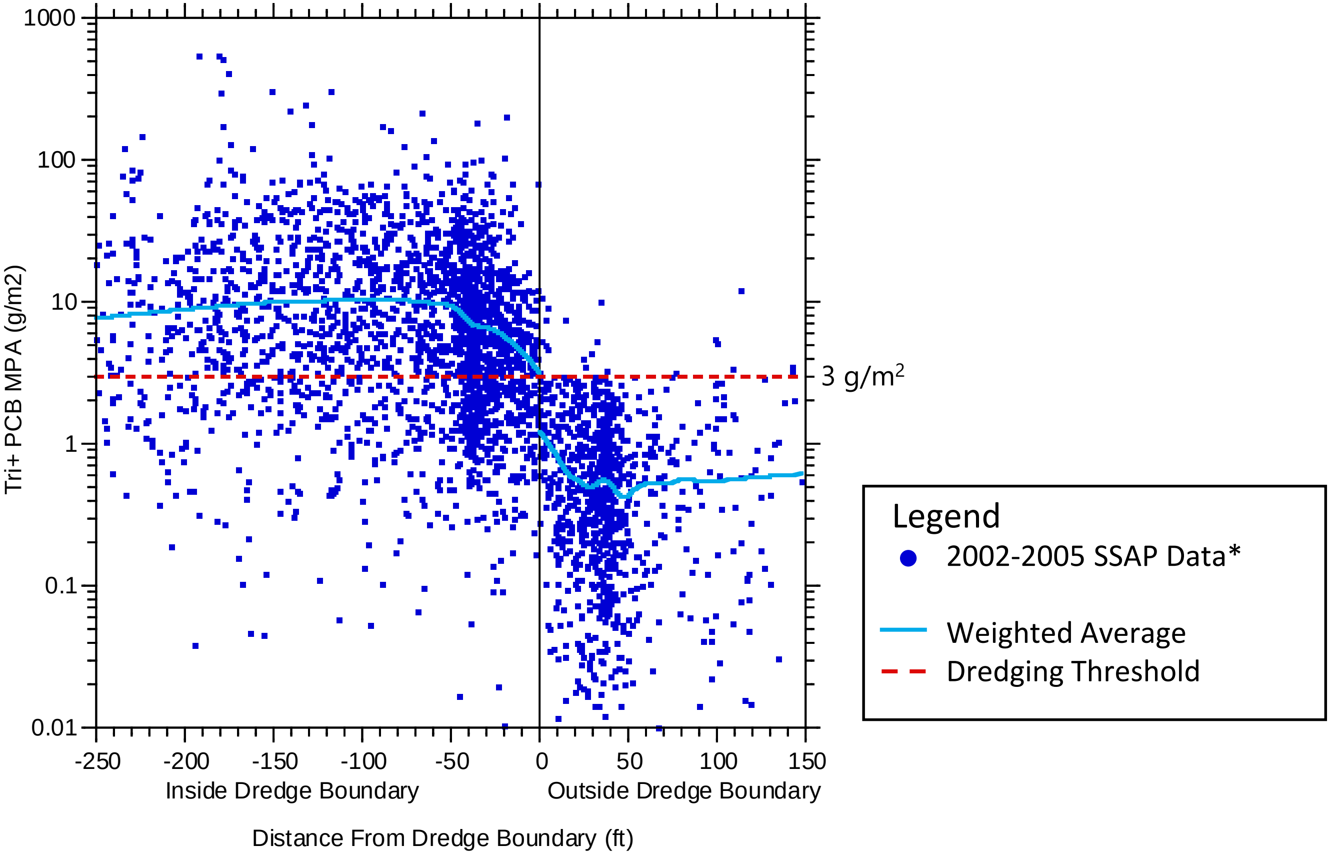
April 2019



Tri+ PCB Concentrations vs. Distance from the Closest Dredging Boundary
River Section 3
2002-2005 SSAP (0-2 in. Samples)

Figure A.1.4-2c

April 2019

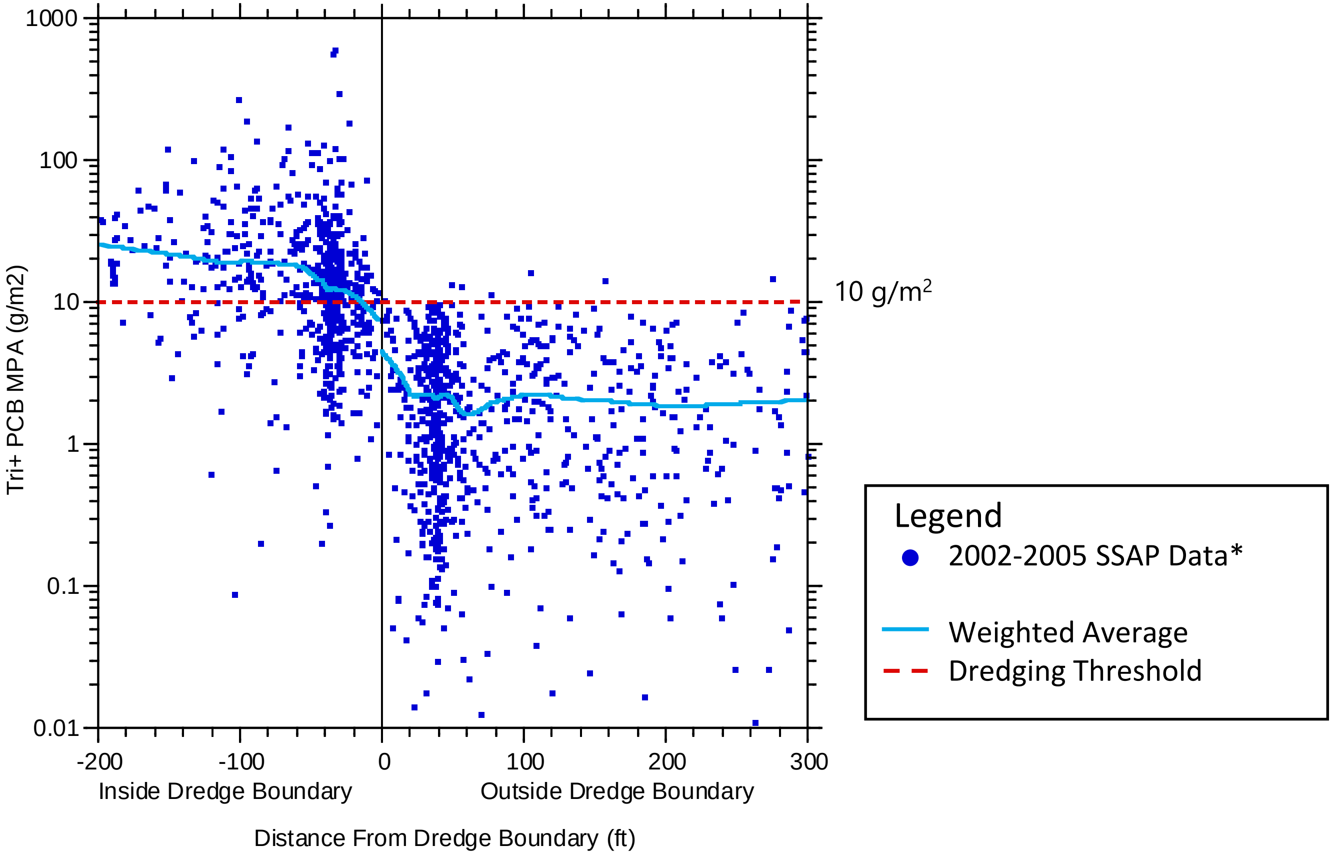


*Majority of points from the SSAP data set were from 2002 to 2005, a small portion of the points were obtained in 2007 as a part of the SEDC sampling program.

Tri+ PCB Mass per Unit Area (MPA) vs. Distance from the Closest Dredging Boundary
River Section 1
2002-2005 SSAP Samples

Figure A.1.4-3a

April 2019

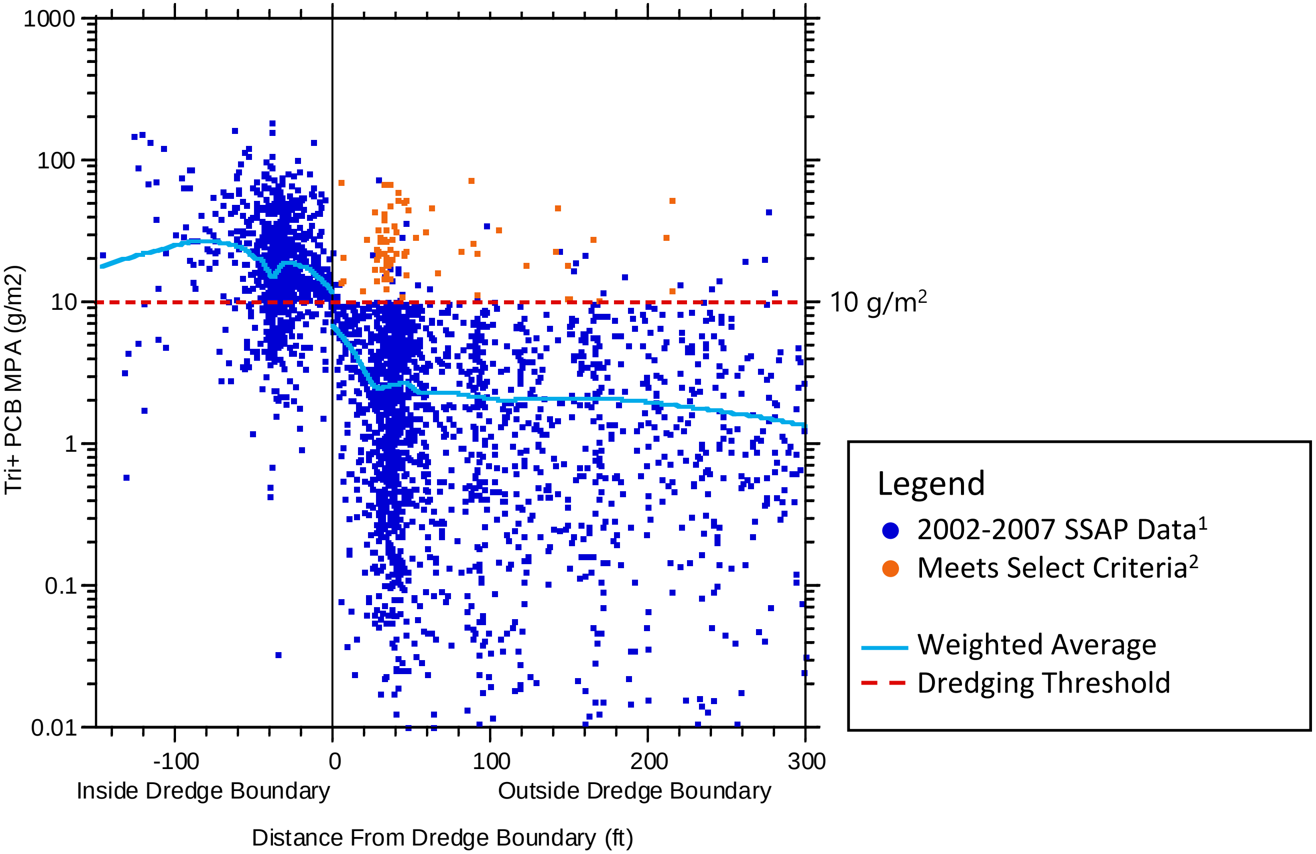


*Majority of points from the SSAP data set were from 2002 to 2005, a small portion of the points were obtained in 2007 as a part of the SEDC sampling program.

Tri+ PCB Mass per Unit Area (MPA) *vs.* Distance from the Closest Dredging Boundary
River Section 2
2002-2005 SSAP Samples

Figure A.1.4-3b

April 2019

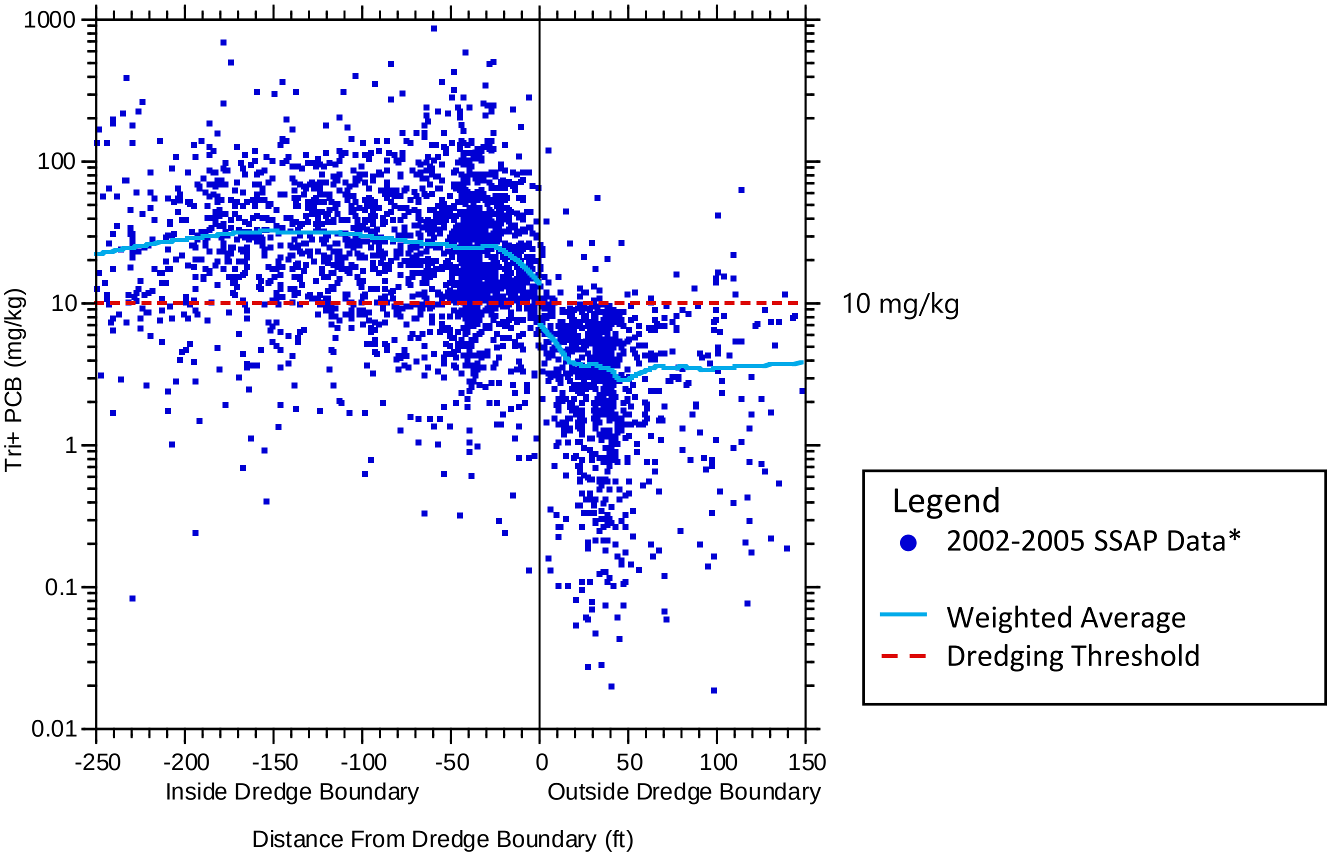


1. Majority of points from the SSAP data set were from 2002 to 2005, a small portion of the points were obtained in 2007 as a part of the SEDC sampling program.
2. The orange dots shown present spatially isolated locations that met the "Select" criterion of an inventory greater than 10 g/m^2 underlying a minimum of 12 inches of surface sediment less than 1 mg/kg Total PCB, which were permitted to remain according to the ROD criteria.

Tri+ PCB Mass per Unit Area (MPA) vs. Distance from the Closest Dredging Boundary
River Section 3
2002-2005 SSAP Samples

Figure A.1.4-3c

April 2019

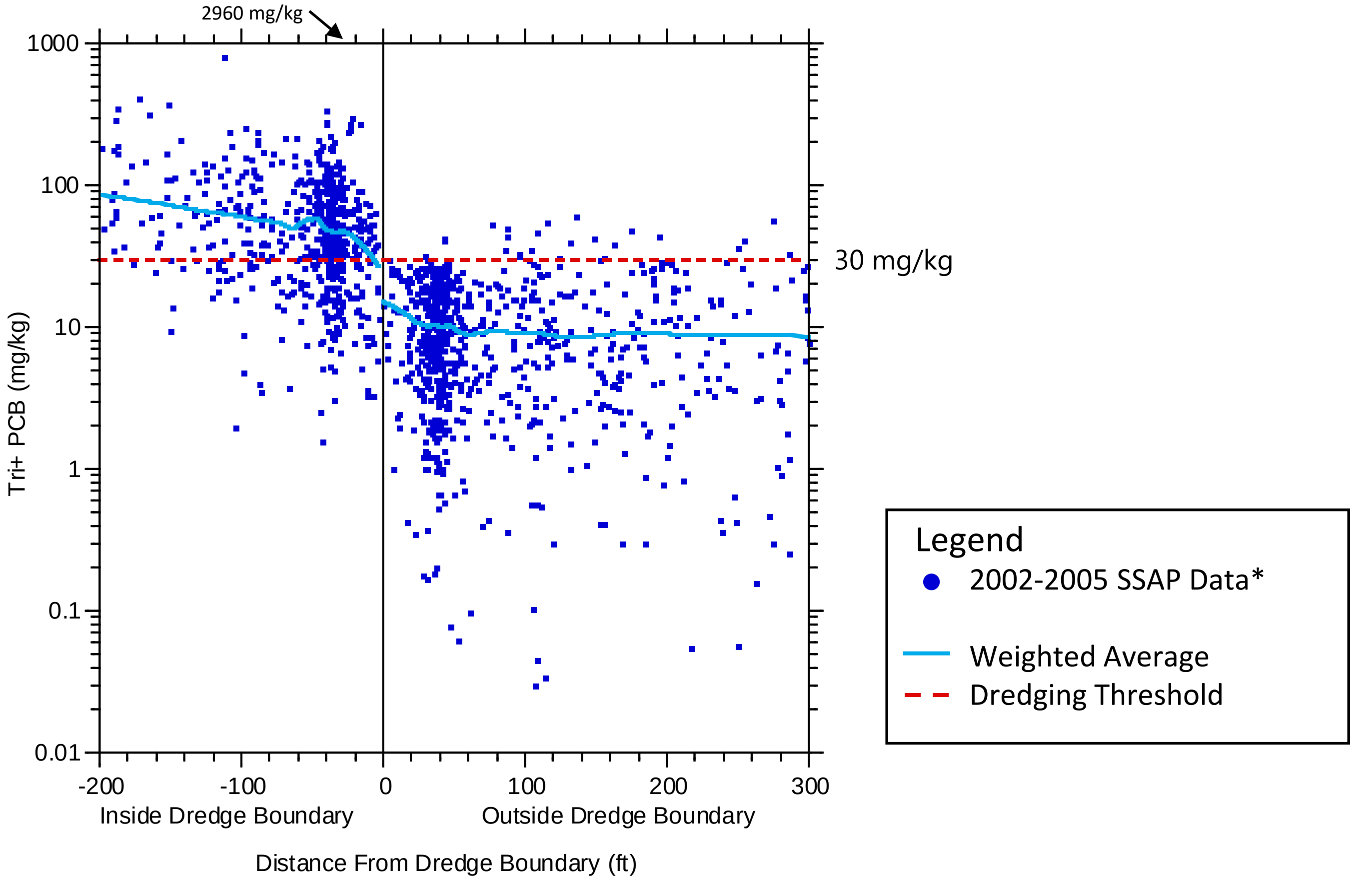


*Majority of points from the SSAP data set were from 2002 to 2005, a small portion of the points were obtained in 2007 as a part of the SEDC sampling program.

Maximum Sediment Tri+ PCB Concentration *vs.* Distance from the Closest Dredging Boundary
River Section 1
2002-2005 SSAP Samples (maximum value in 0-12 in. interval)

Figure A.1.4-4a

April 2019

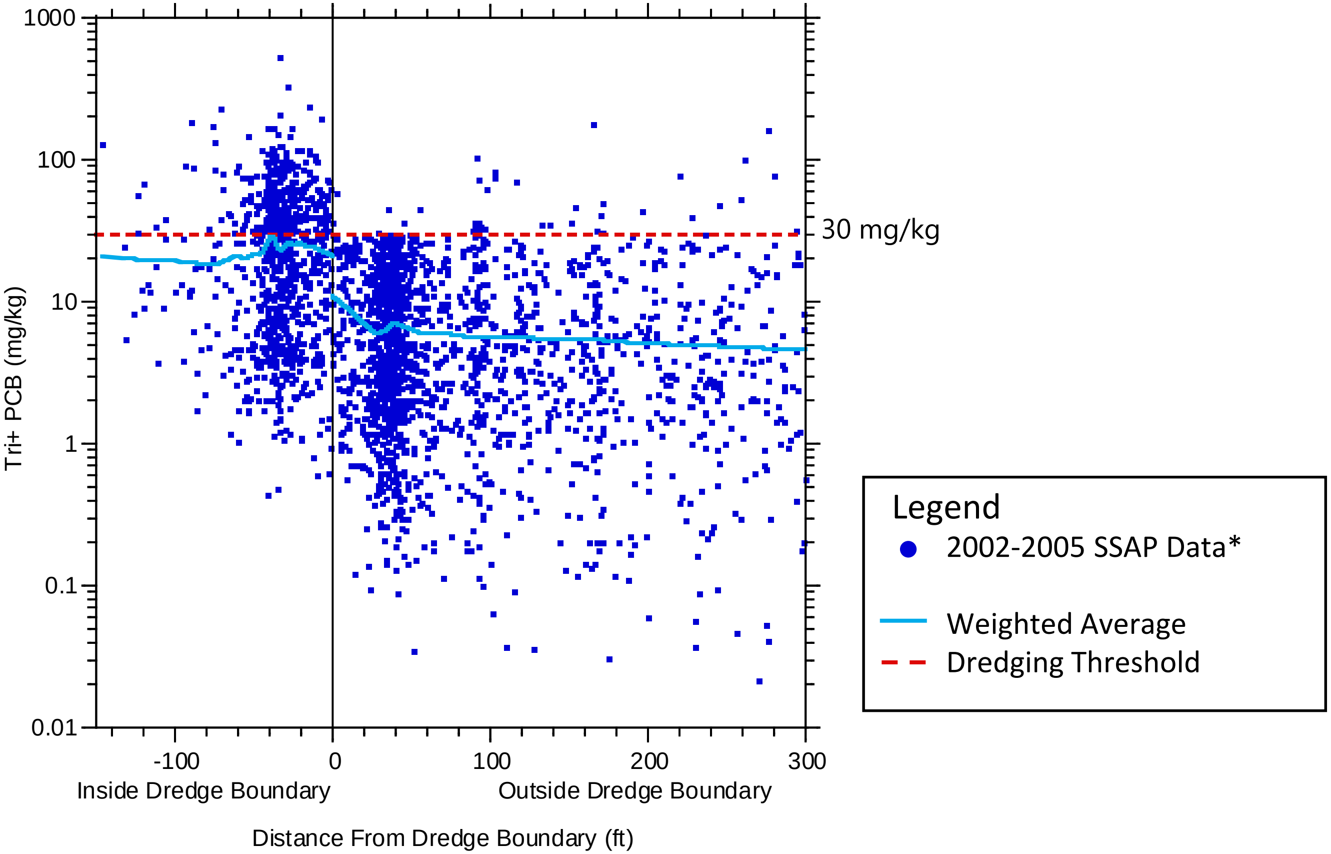


*Majority of points from the SSAP data set were from 2002 to 2005, a small portion of the points were obtained in 2007 as a part of the SEDC sampling program.

Maximum Sediment Tri+ PCB Concentration vs. Distance from the Closest Dredging Boundary
River Section 2
2002-2005 SSAP Samples (maximum value in 0-12 in. interval)

Figure A.1.4-4b

April 2019

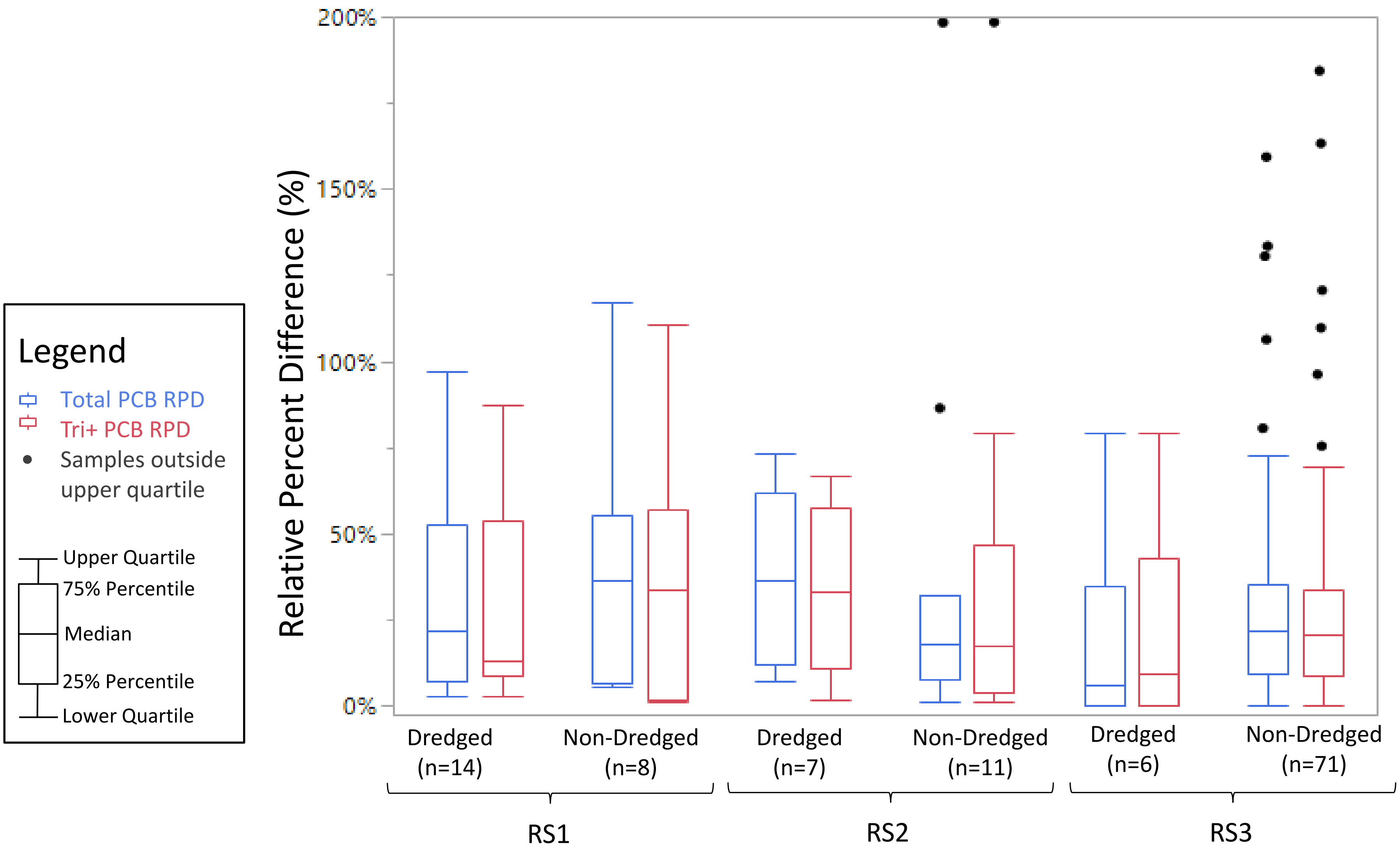


*Majority of points from the SSAP data set were from 2002 to 2005, a small portion of the points were obtained in 2007 as a part of the SEDC sampling program.

Maximum Sediment Tri+ PCB Concentration vs. Distance from the Closest Dredging Boundary
River Section 3
2002-2005 SSAP Samples (maximum value in 0-12 in. interval)

Figure A.1.4-4c

April 2019

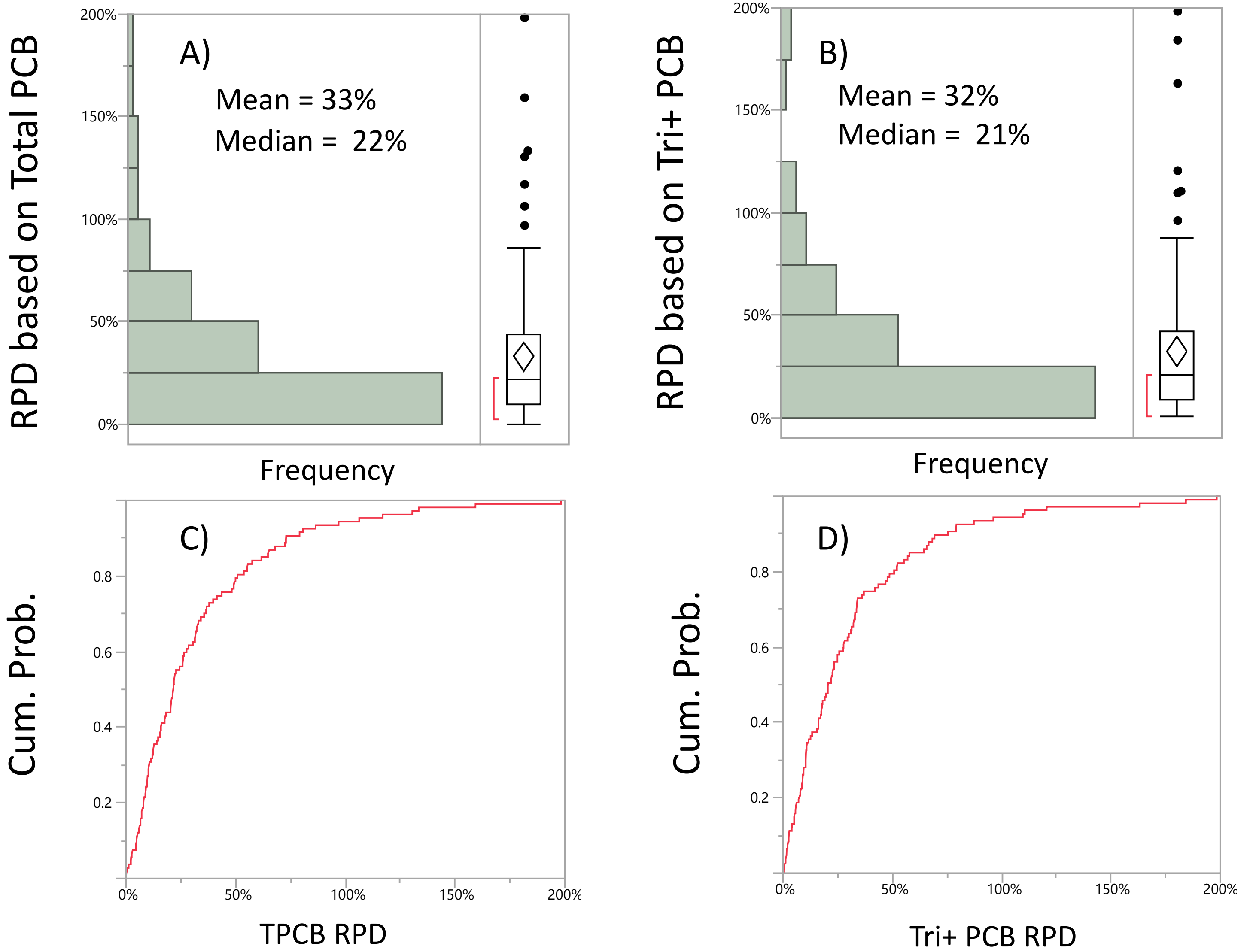


Total PCB is the sum of Aroclors 1221, 1242 and 1254. Tri+ PCB is from GE's 2011 conversion, discussed in section A.3.
Non-detect results were excluded in the RPD evaluation.

RPD Distribution by River Section and Remedial Treatment for M8082 Data.

Figure A.2.2-1

April 2019

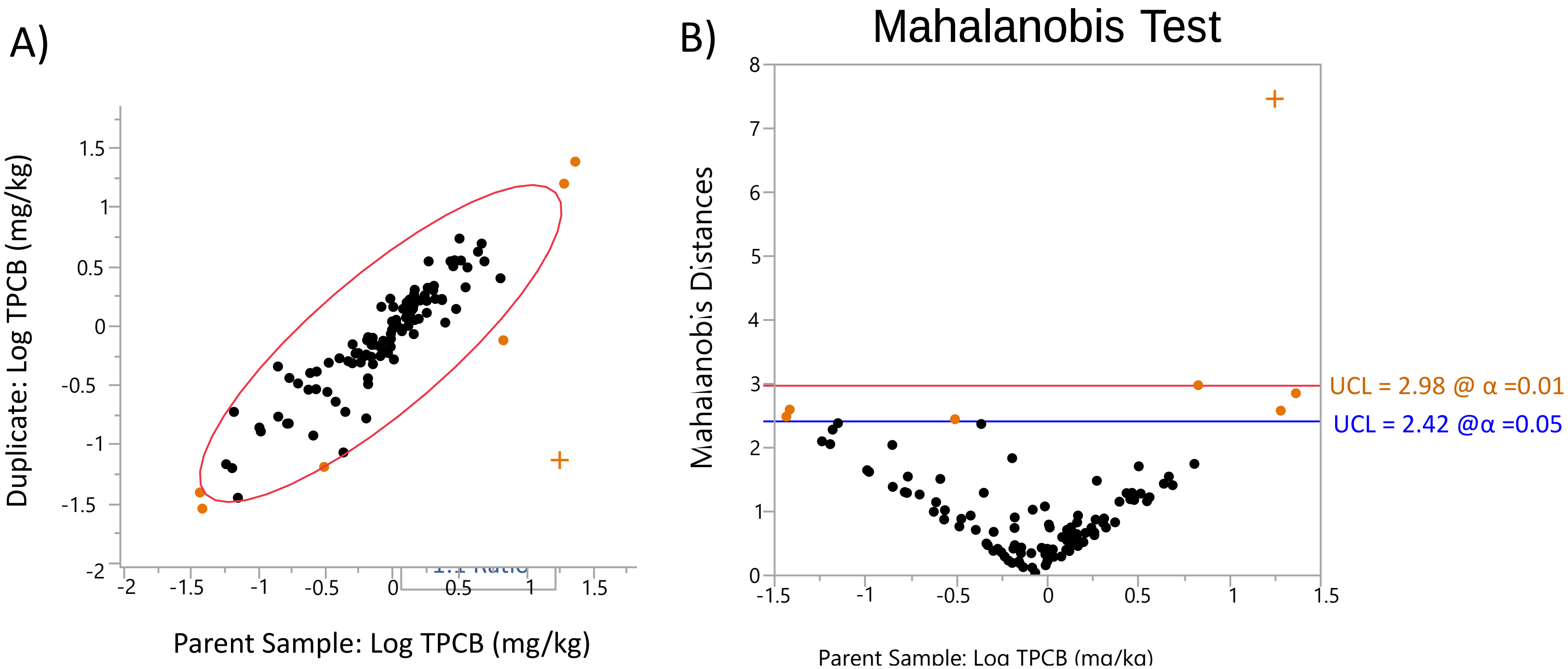


Total PCB is the sum of Aroclors 1221, 1242 and 1254. Tri+ PCB is from GE’s 2011 conversion, discussed in section A.3.
Non-detect results were excluded in the RPD evaluation.

Overall Distribution of RPD for Total PCB and Tri+ PCB Duplicate Pairs for M8082 Results

Figure A.2.2-2

April 2019



Legend
● Non Outliers
● Outliers at α =0.05
+ Outlier at α =0.01 and excluded in regression

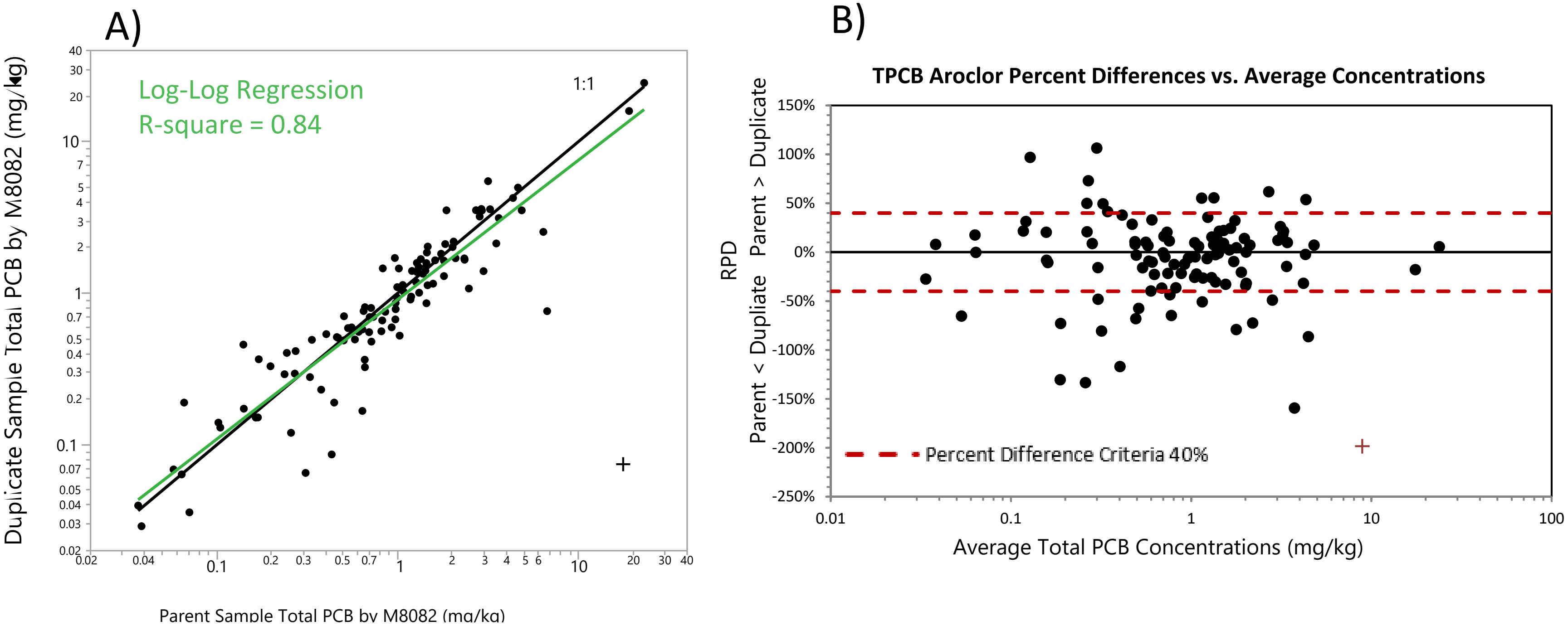
Notes:

- Non-detect results were excluded in the RPD evaluation.
- Total PCB is the sum of the detected Aroclor
- Upper control limit (UCL) from Mahalanobis Test

Duplicate Sample Pair Results and Identification of Outlier Pairs:
2017 NYSDEC M8082 Data

Figure A.2.2-3

April 2019



Notes:

- Regression result excludes 1 outlier identified in Figure A.2.2-3 (+)
- Non-detect results were excluded in the RPD evaluation

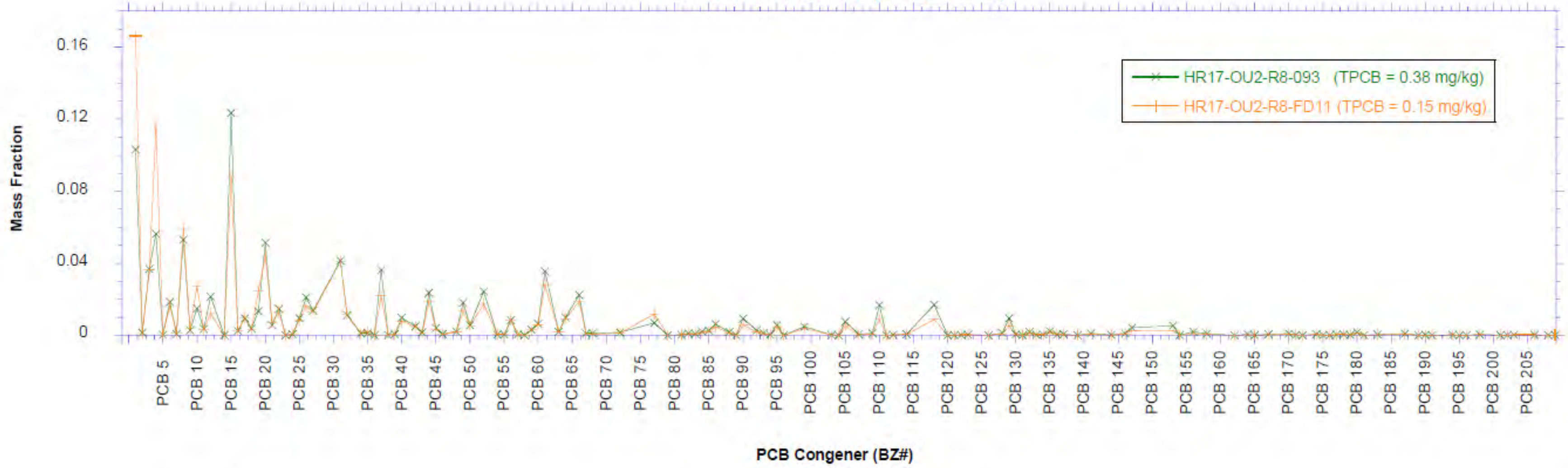
Hudson River PCBs Superfund Site

Assessment of Duplicate Pair Precision for M8082 Results

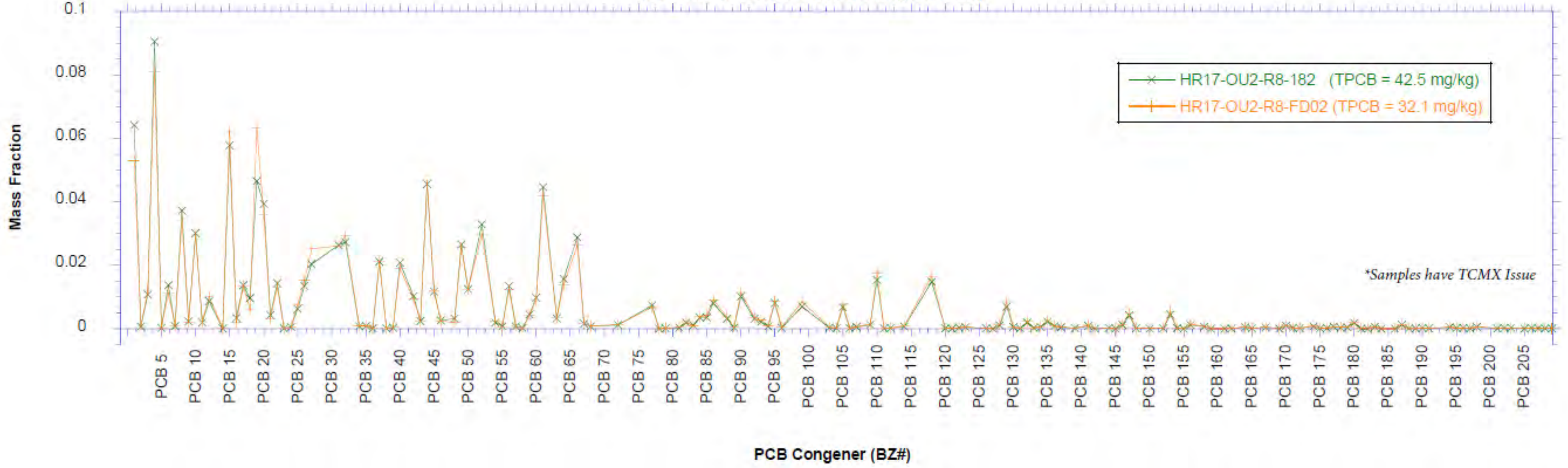
Figure A.2.2-4

April 2019

RS1 HR17-OU2-R8-093 (Dredged Area)



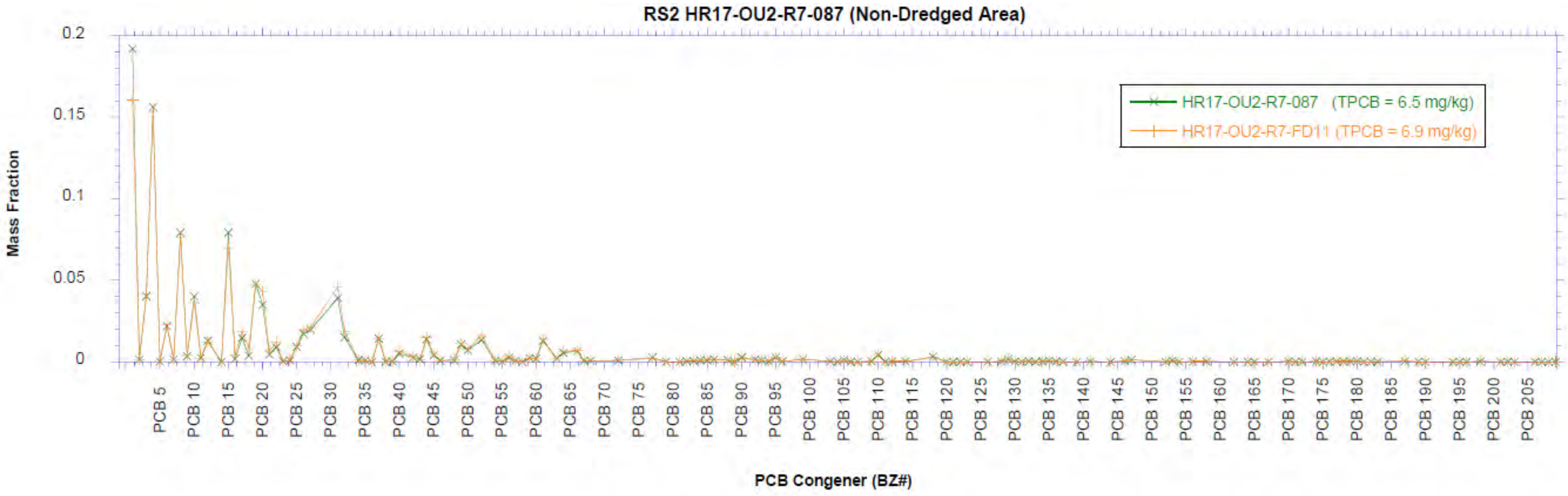
RS1 HR17-OU2-R8-182 (Dredged Area)

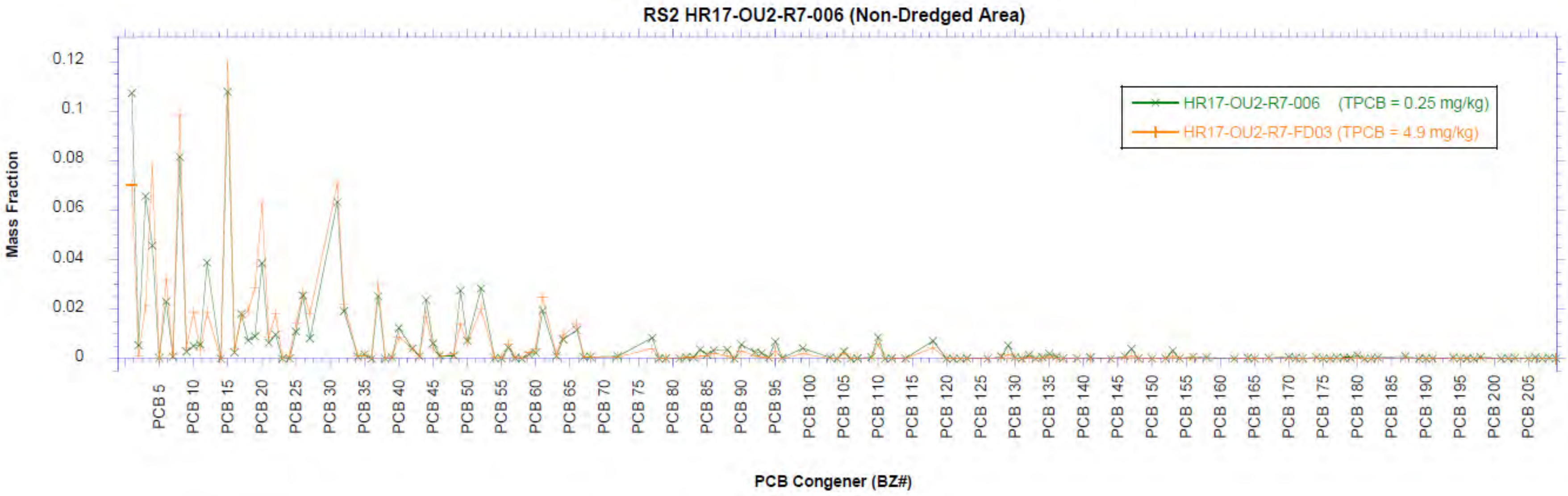


Examination of Congener Pattern Precision in Sample Duplicates:
Method 1668c Results

Figure A.2.2-5a

April 2019



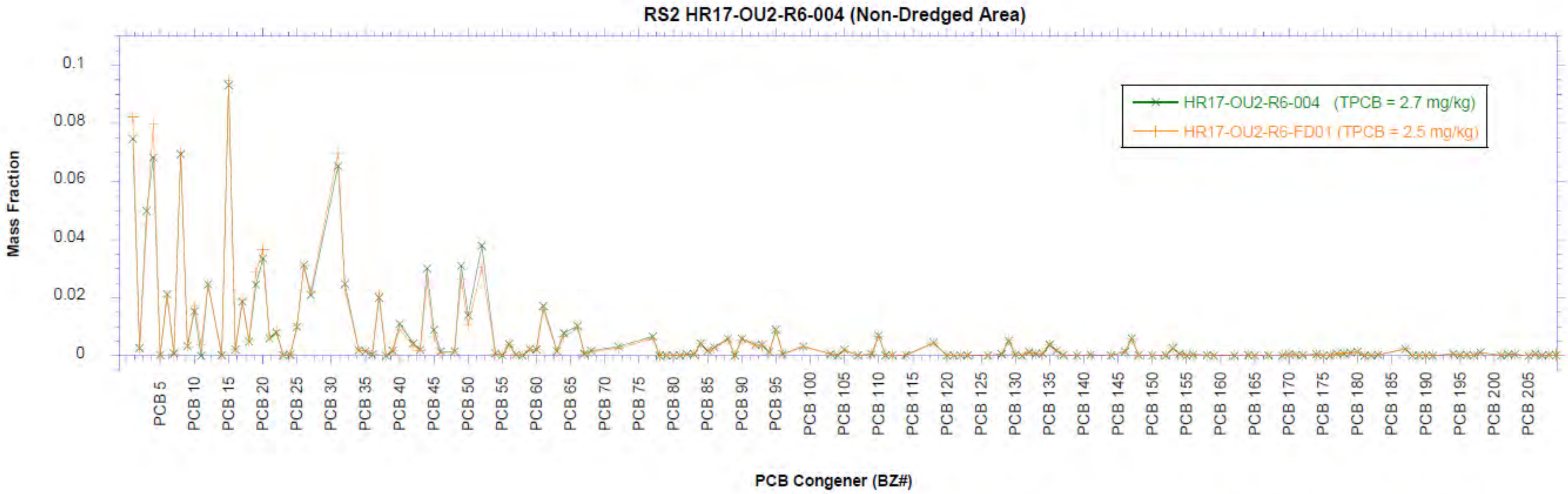


Hudson River PCBs SUPERFUND SITE

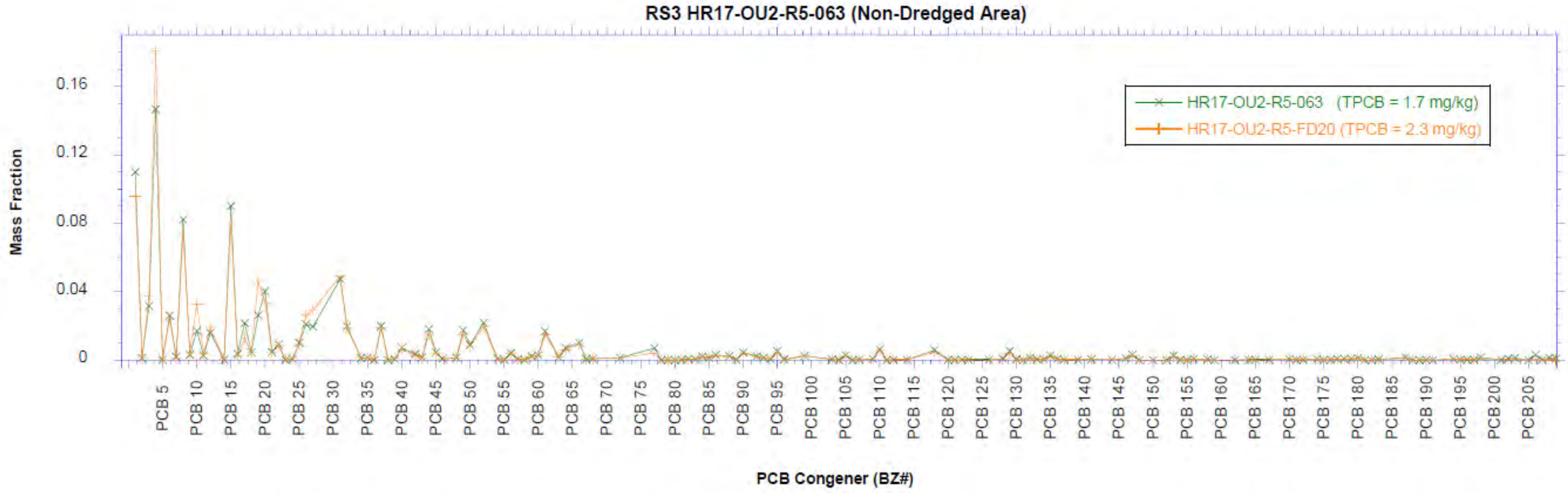
Examination of Congener Pattern Precision in Sample Duplicates: Method 1668c Results

Figure A.2.2-5b

April 2019



RS2 HR17-OU2-R6-004 (Non-Dredged Area)

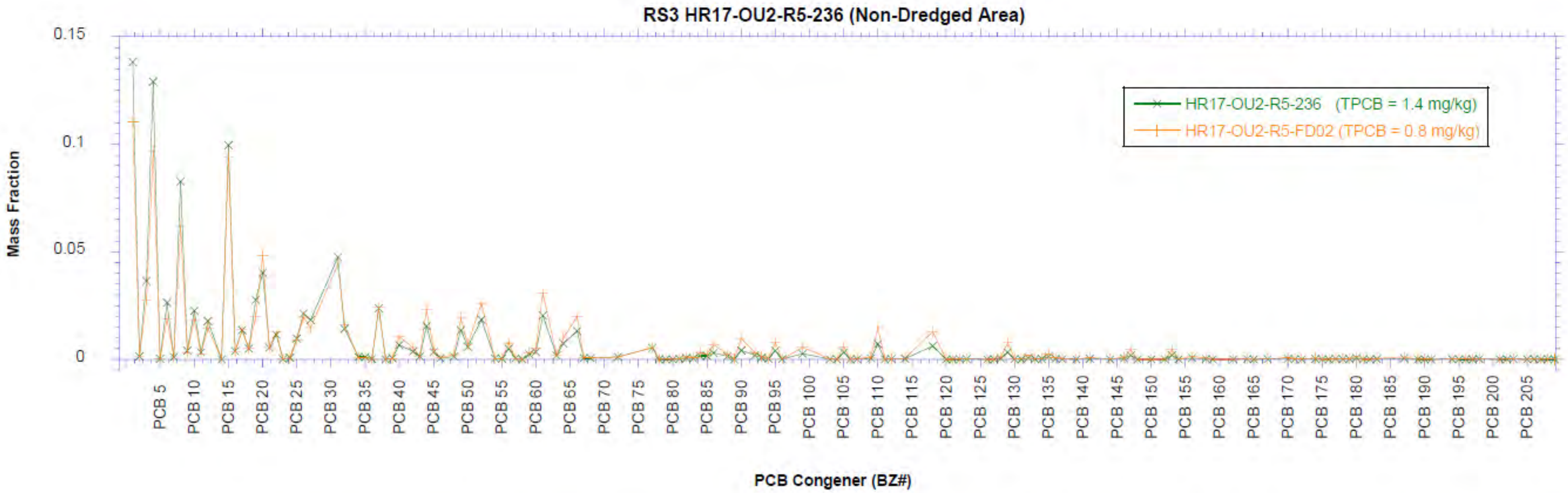


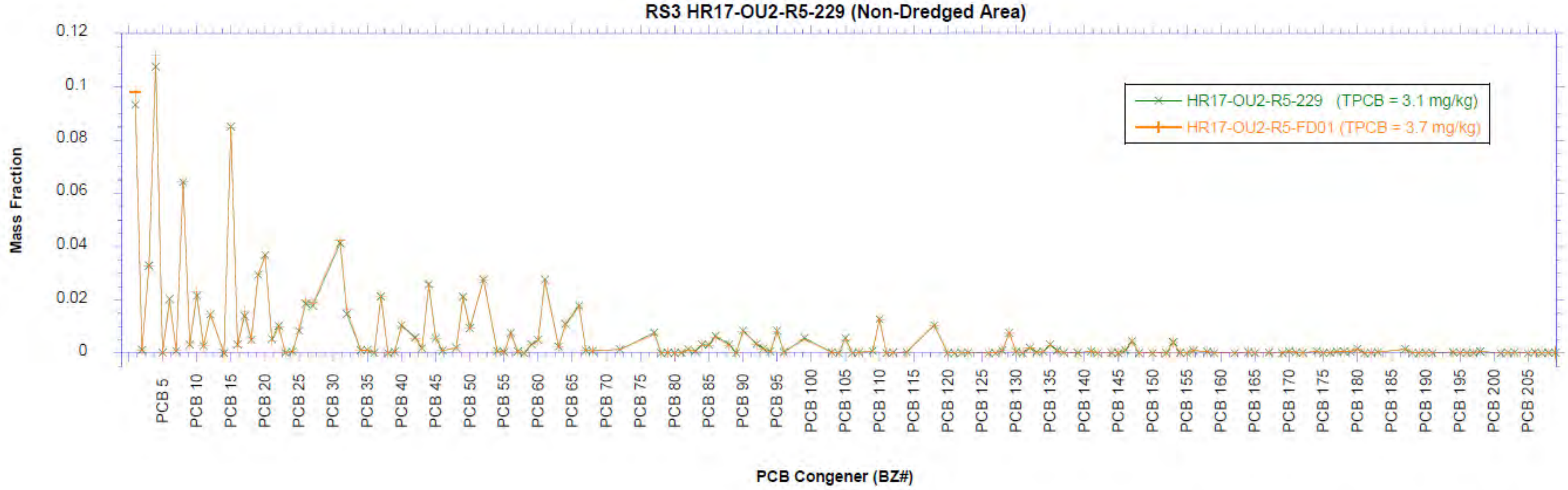
RS3 HR17-OU2-R5-063 (Non-Dredged Area)

Examination of Congener Pattern Precision in Sample Duplicates:
Method 1668c Results

Figure A.2.2-5c

April 2019

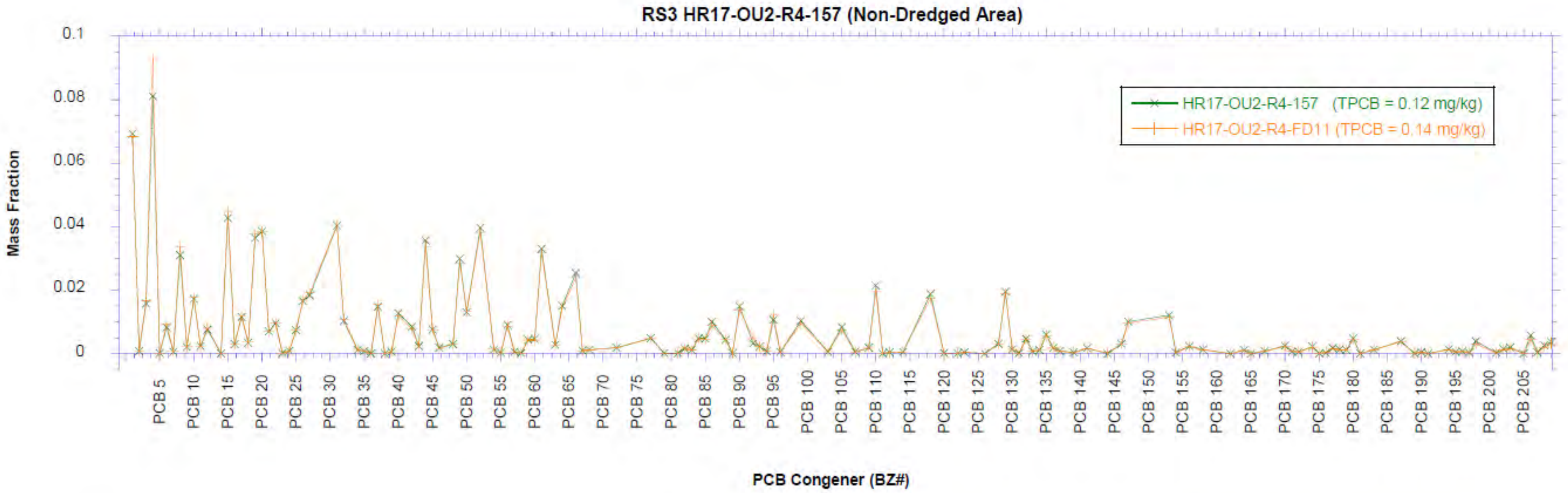

RS3 HR17-OU2-R5-236 (Non-Dredged Area)


RS3 HR17-OU2-R5-229 (Non-Dredged Area)

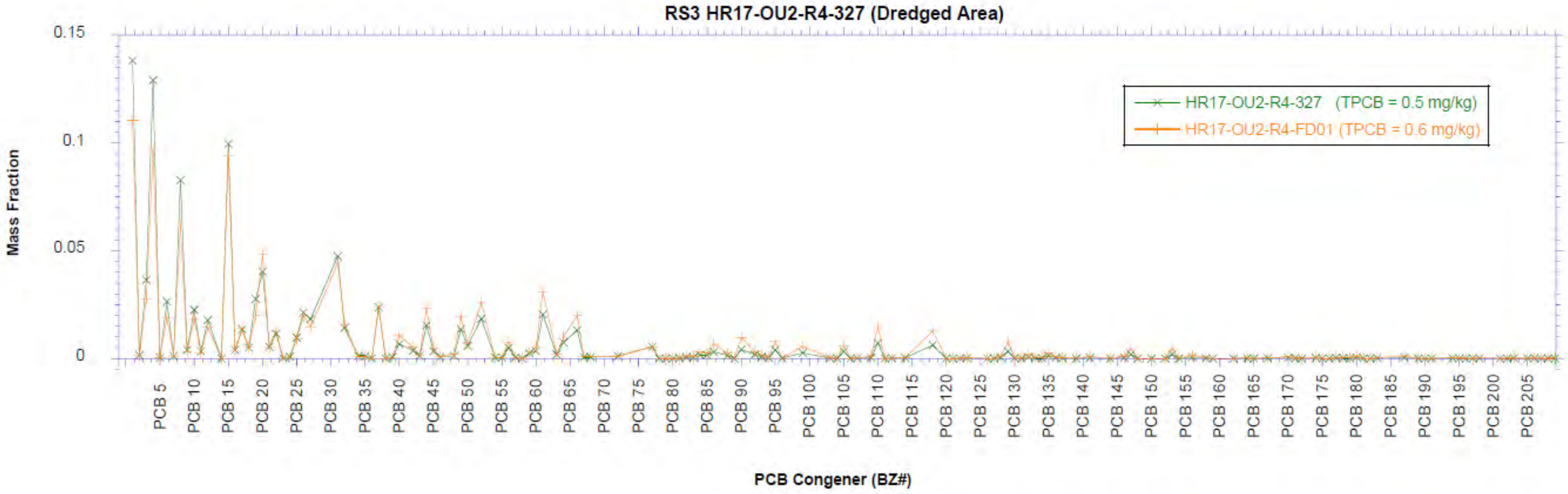
Examination of Congener Pattern Precision in Sample Duplicates:
Method 1668c Results

Figure A.2.2-5d

April 2019



RS3 HR17-OU2-R4-157 (Non-Dredged Area)

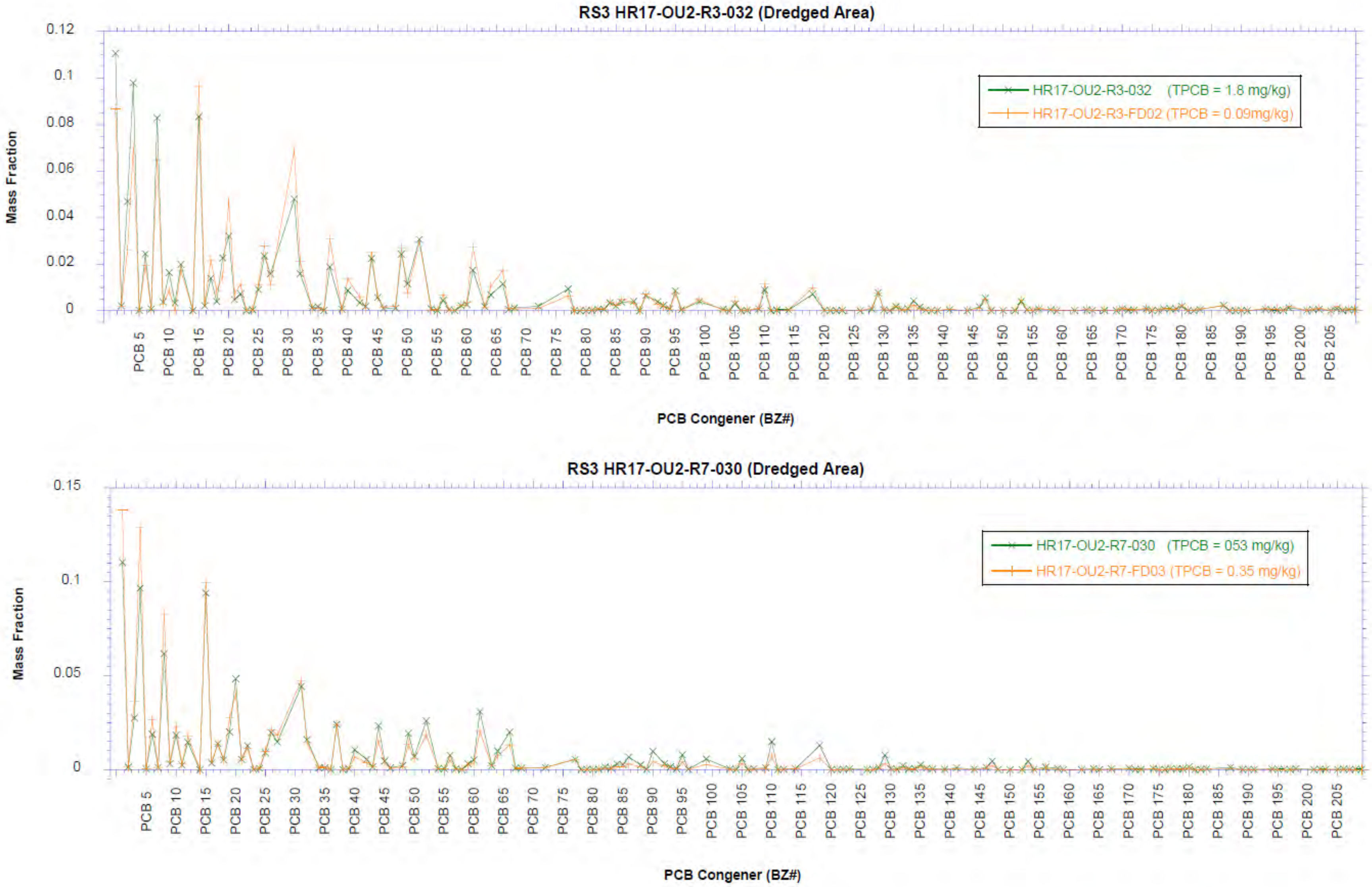


RS3 HR17-OU2-R4-327 (Dredged Area)

Examination of Congener Pattern Precision in Sample Duplicates:
Method 1668c Results

Figure A.2.2-5e

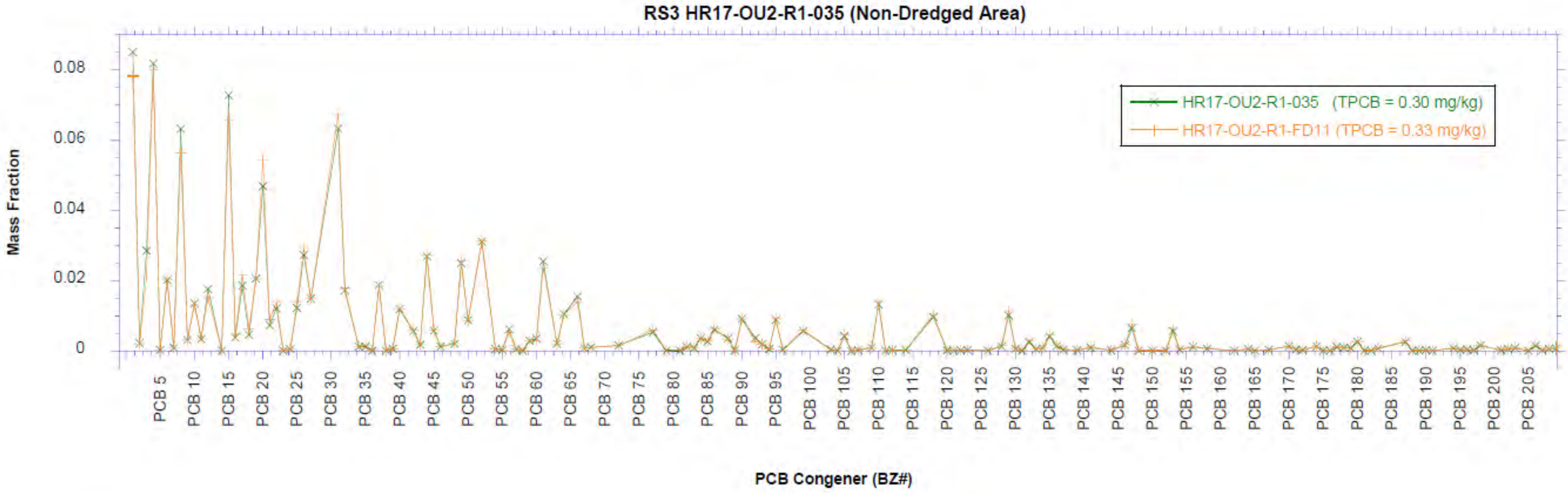
April 2019

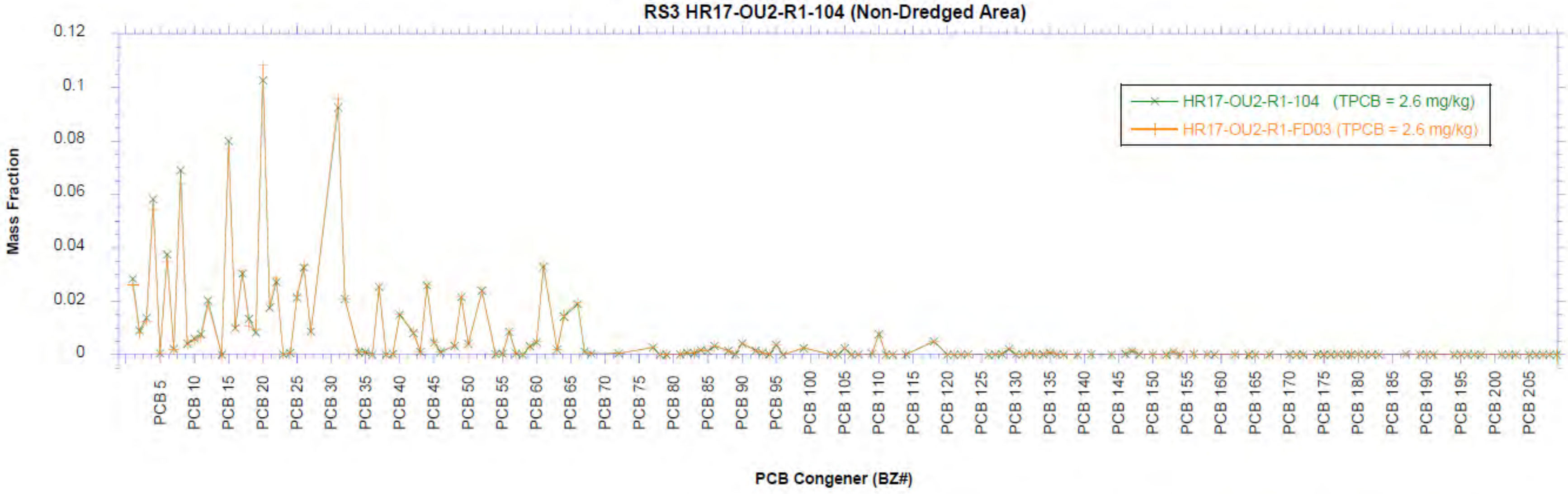


Examination of Congener Pattern Precision in Sample Duplicates:
Method 1668c Results

Figure A.2.2-5f

April 2019

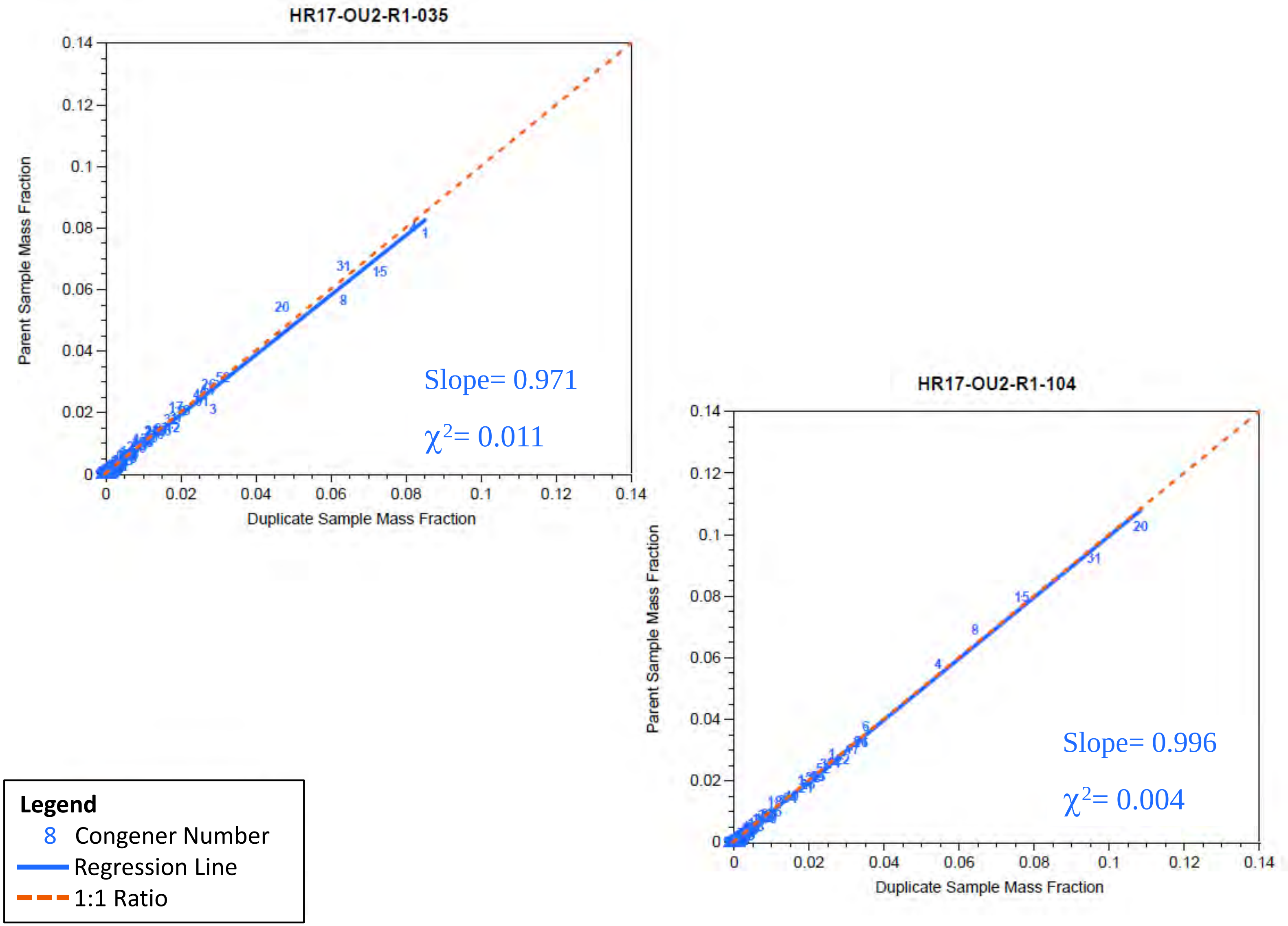

RS3 HR17-OU2-R1-035 (Non-Dredged Area)


RS3 HR17-OU2-R1-104 (Non-Dredged Area)

Examination of Congener Pattern Precision in Sample Duplicates:
Method 1668c Results

Figure A.2.2-5g

April 2019

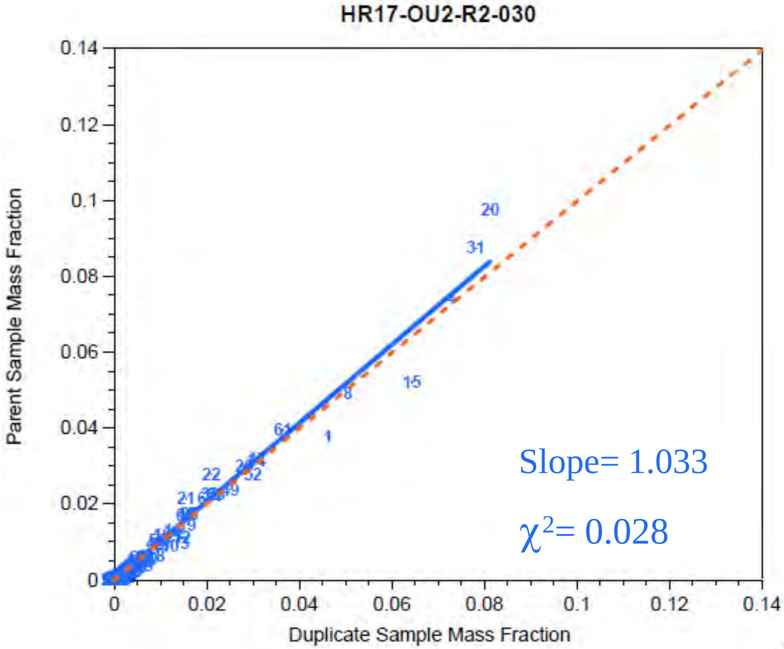


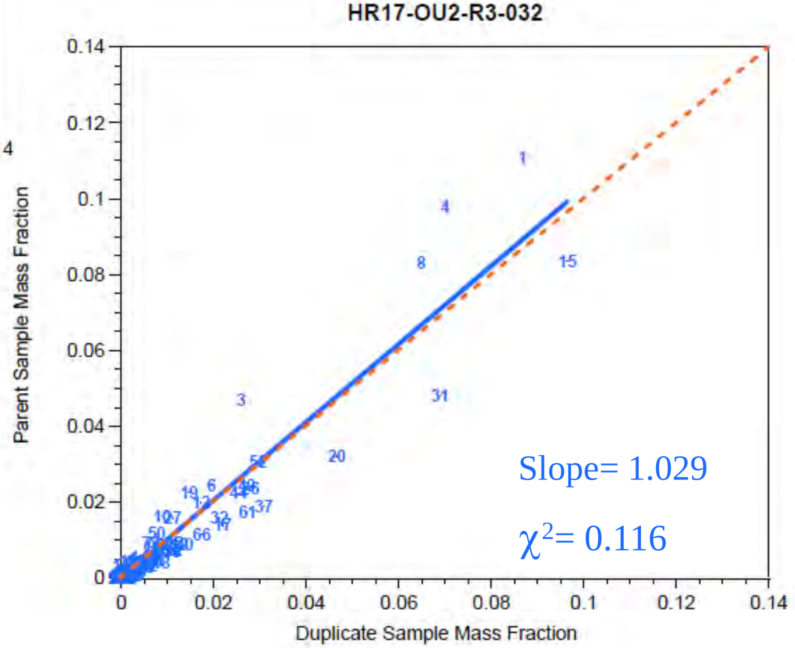
Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6a

April 2019





Legend

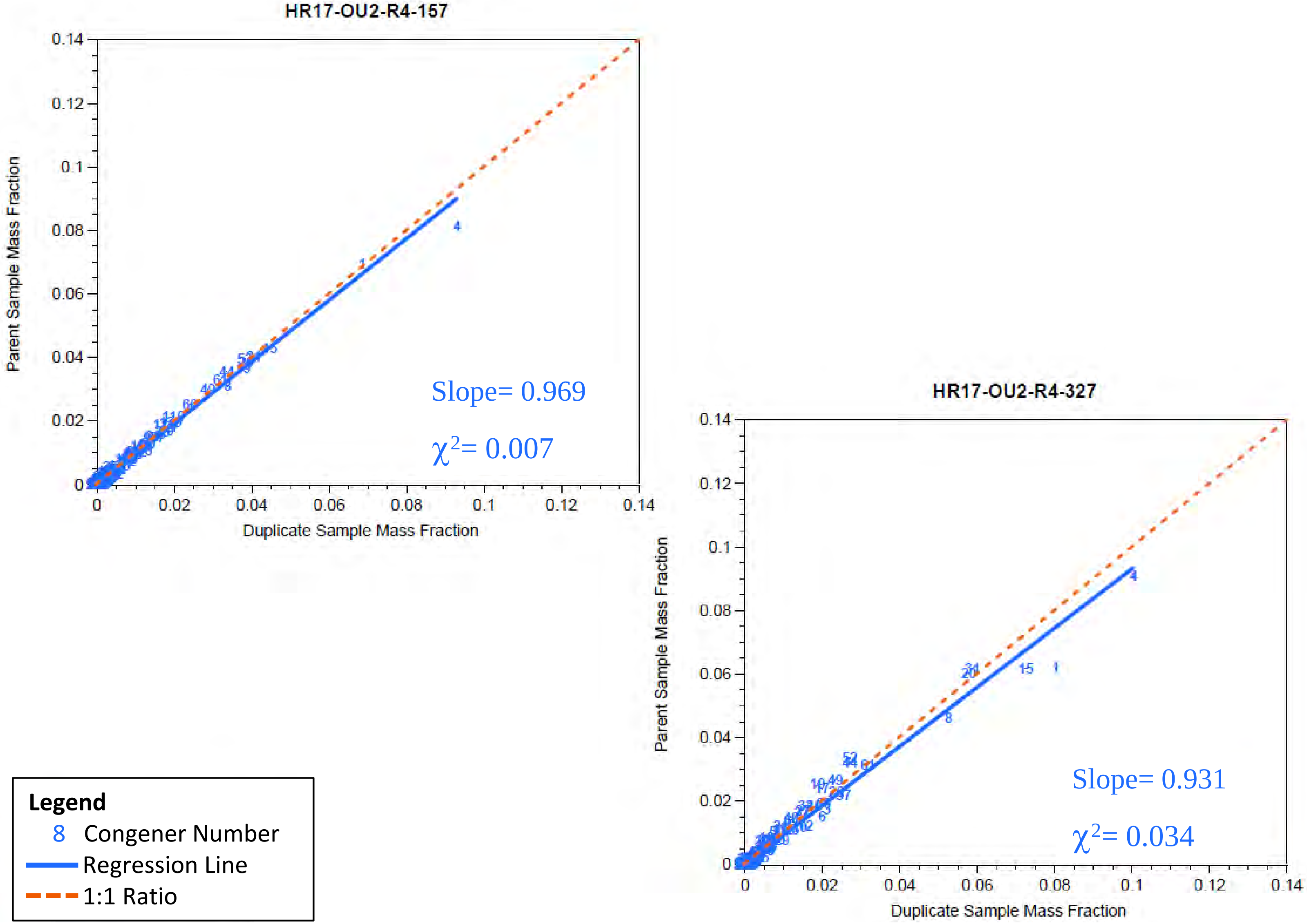
8	Congener Number
▬	Regression Line
- - -	1:1 Ratio

Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6b

April 2019

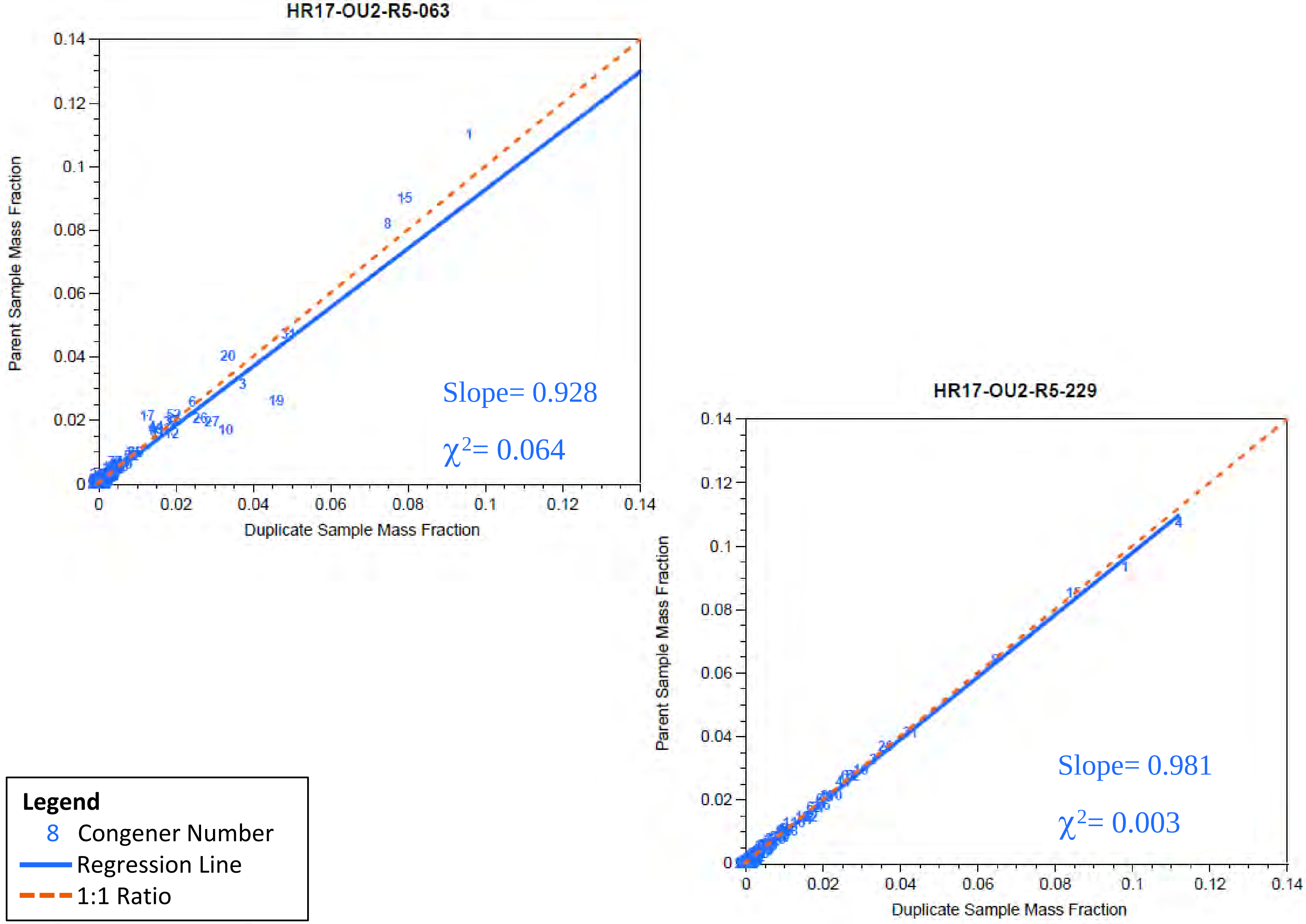


Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6c

April 2019

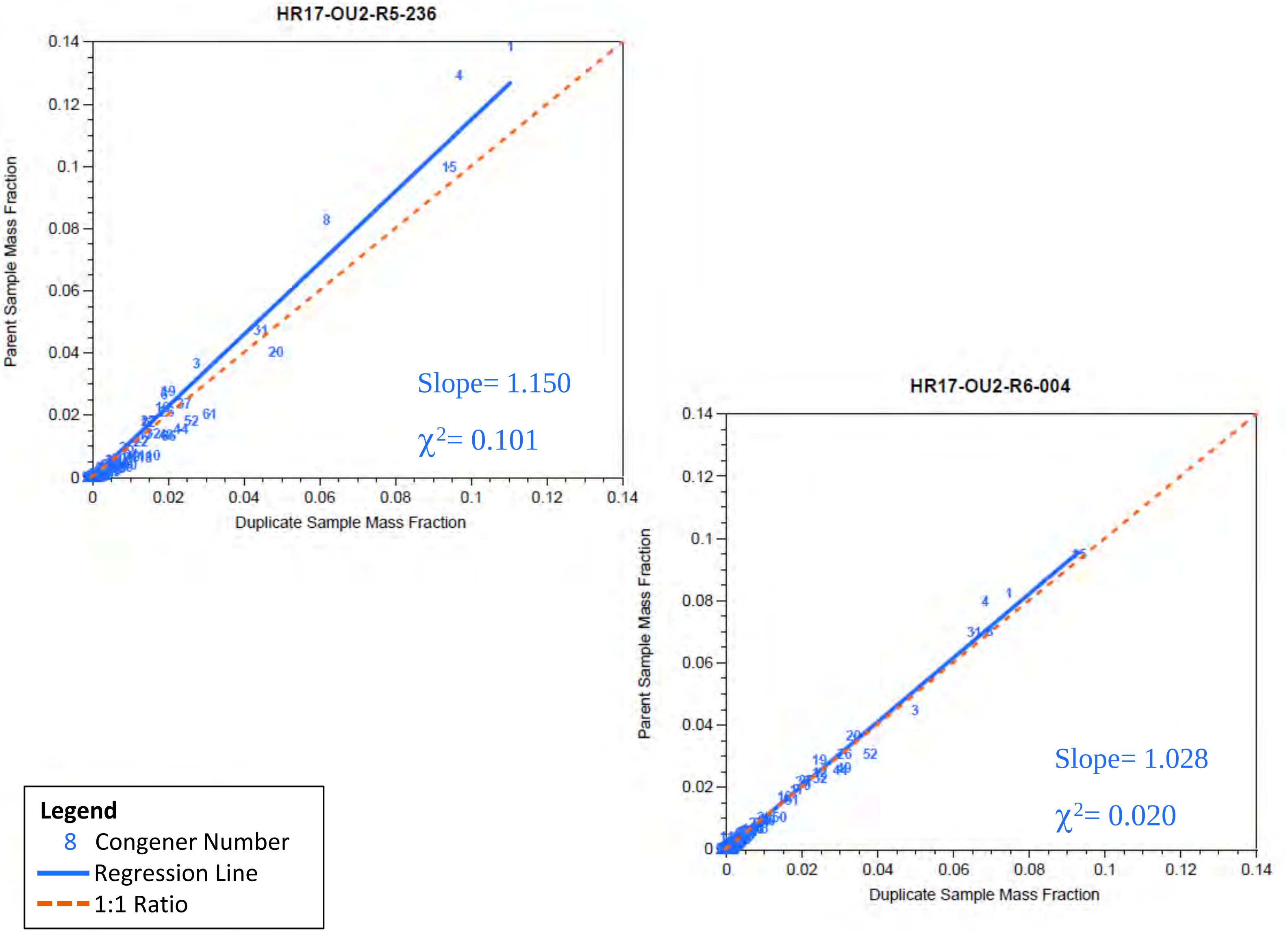


Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6d

April 2019

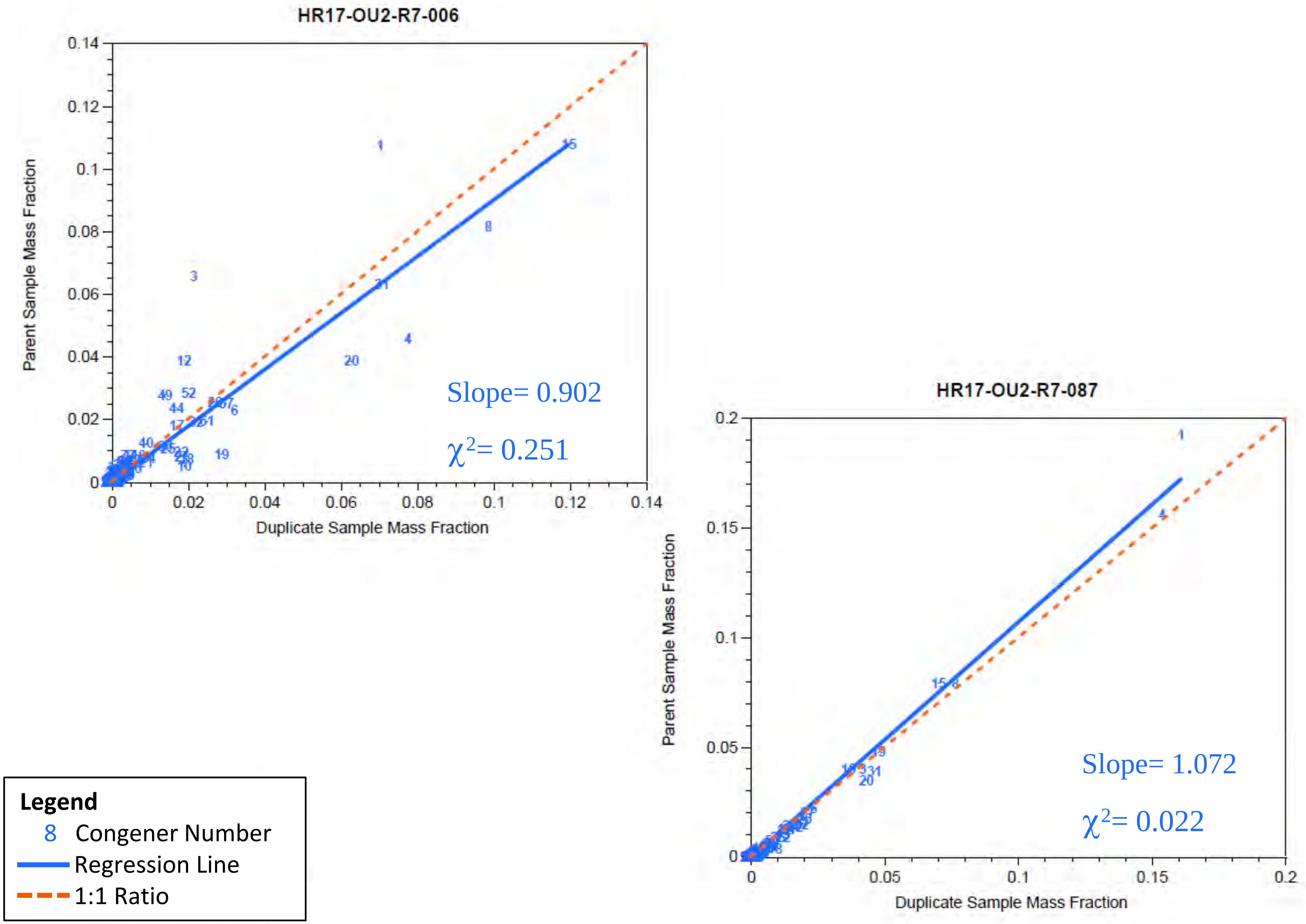


Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6e

April 2019

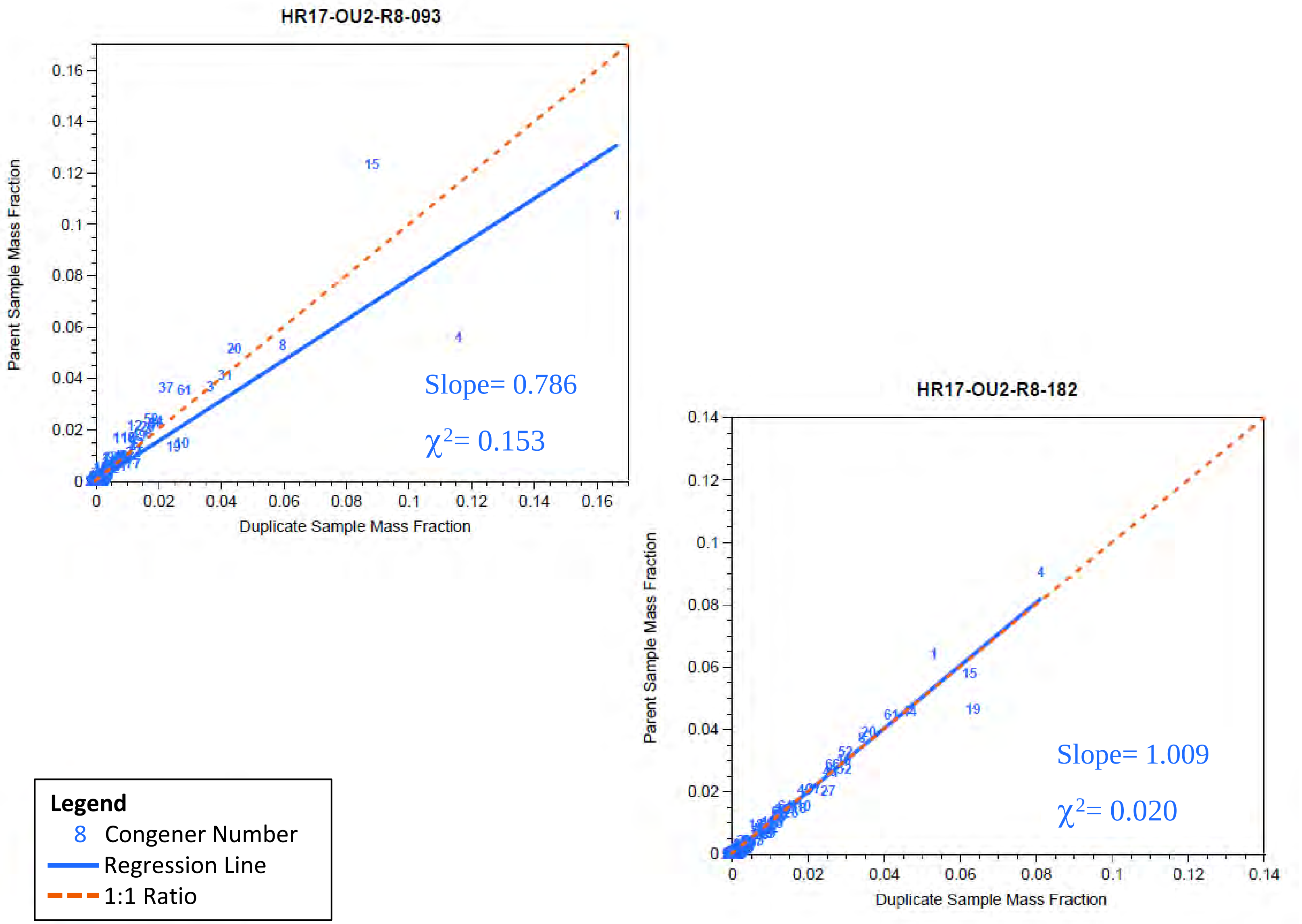


Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6f

April 2019

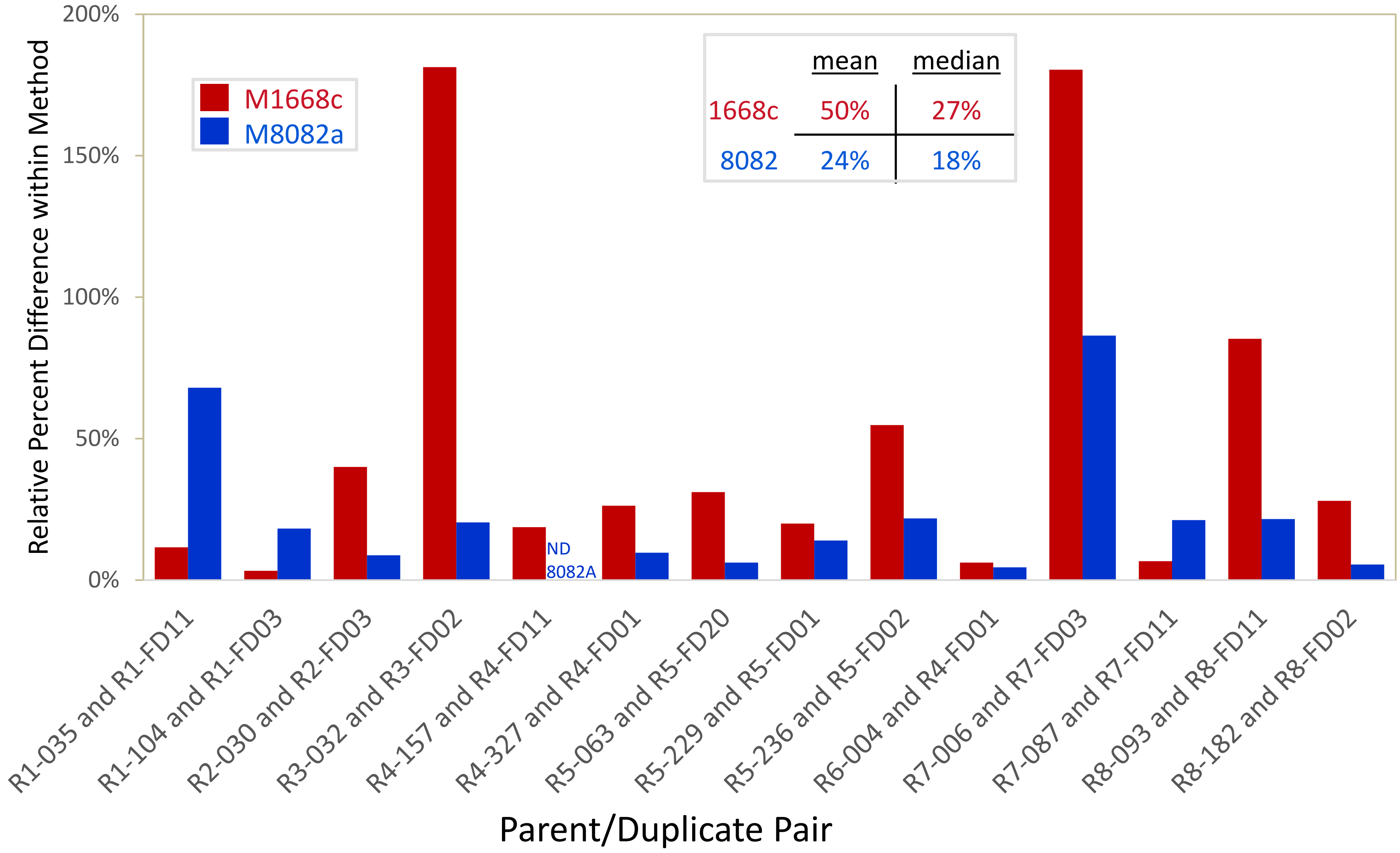


Note: Regression line is forced through zero.

Comparison of Duplicate Sample Pair Congener Patterns
Based on Mass Fraction: M1668c

Figure A.2.2-6g

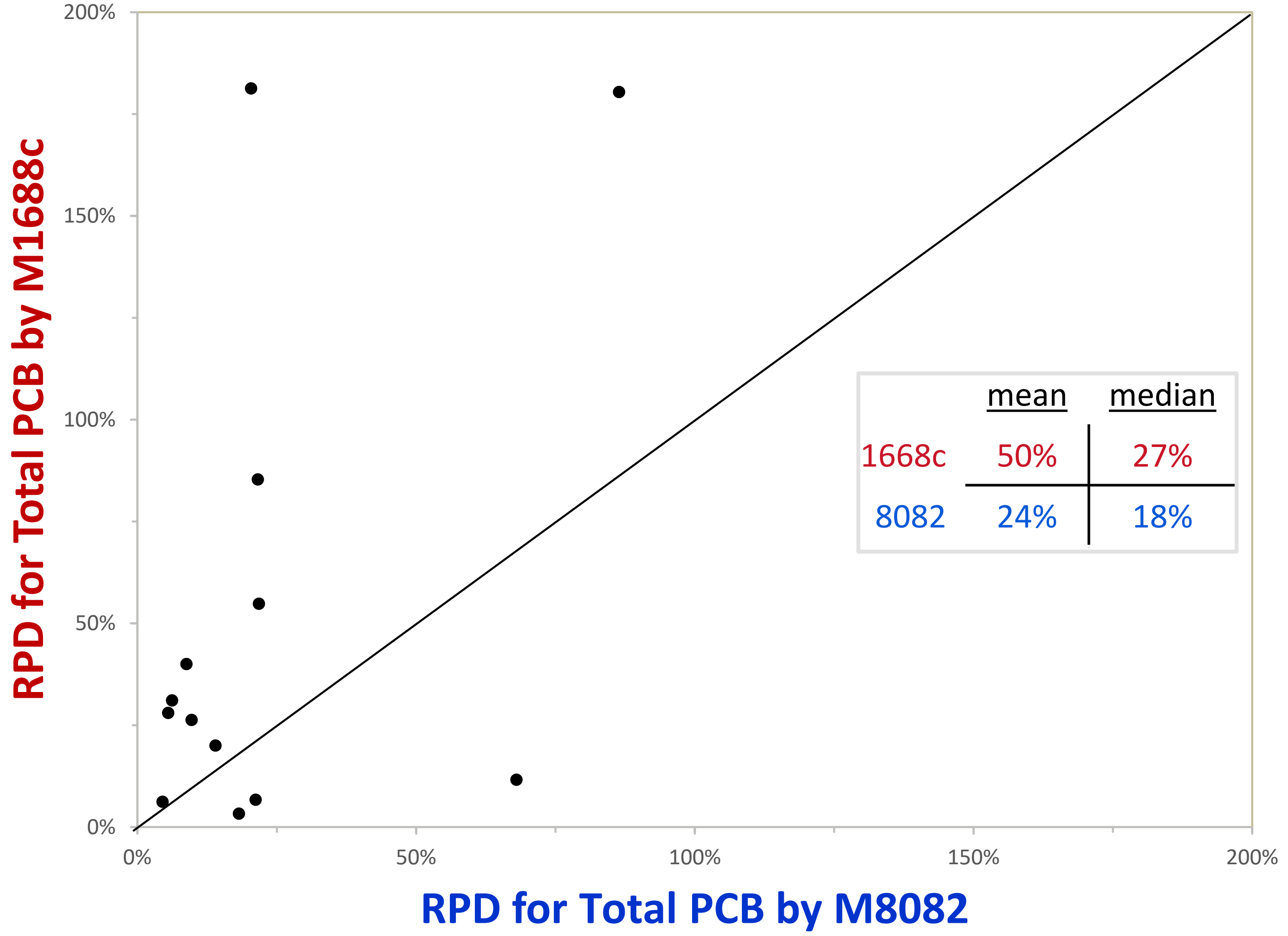
April 2019



Comparison of RPDs for M8082 and M1668c for NYSDEC Duplicate Sample Pairs

Figure A.2.2-7

April 2019



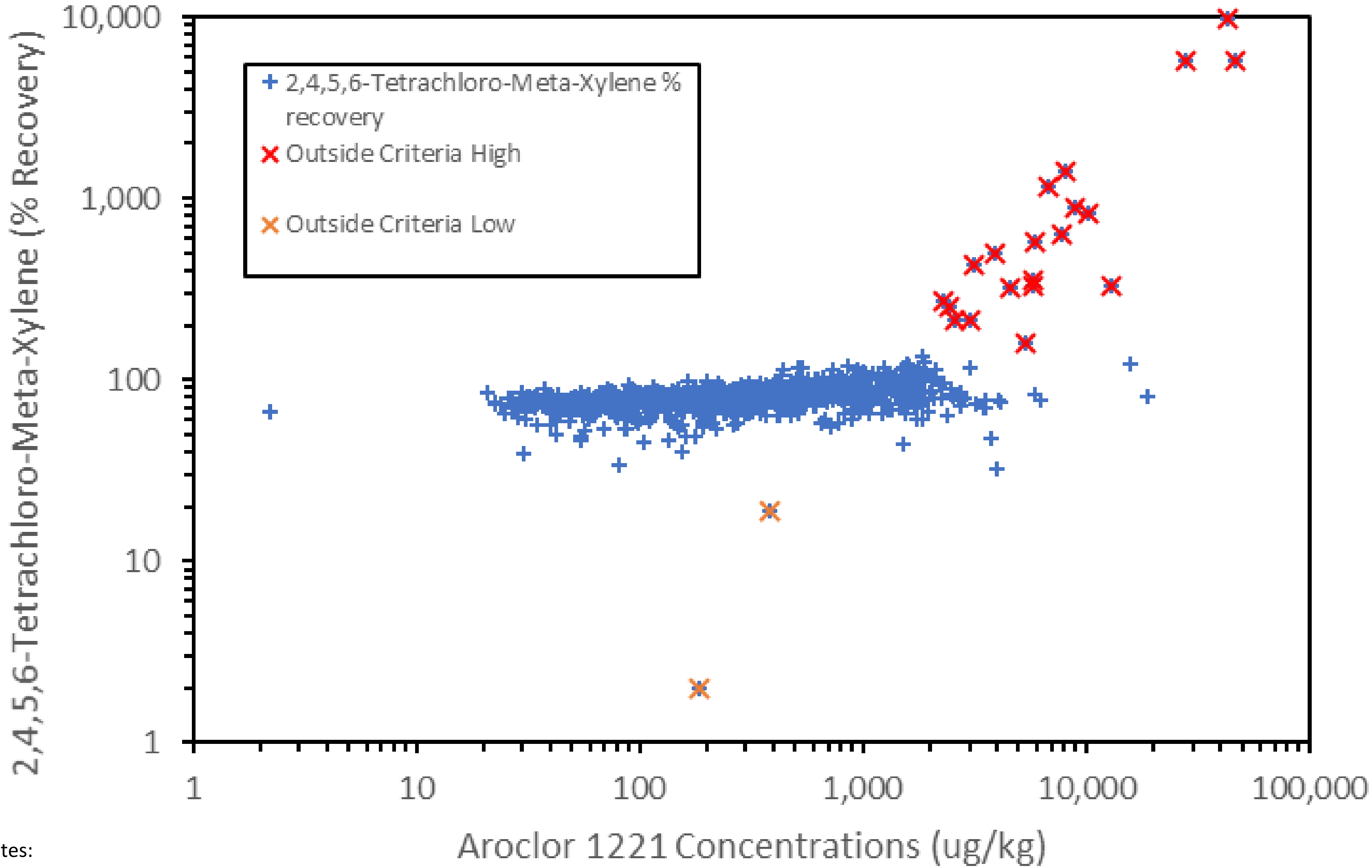
	mean	median
1668c	50%	27%
8082	24%	18%

Notes:
- 2017 NYSDEC Data shown above
- 1:1 line is shown for reference only

Lack of Correlation of RPDs for Total PCB by M8082 and M1668c for NYSDEC Duplicate Sample Pairs

Figure A.2.2-8

April 2019



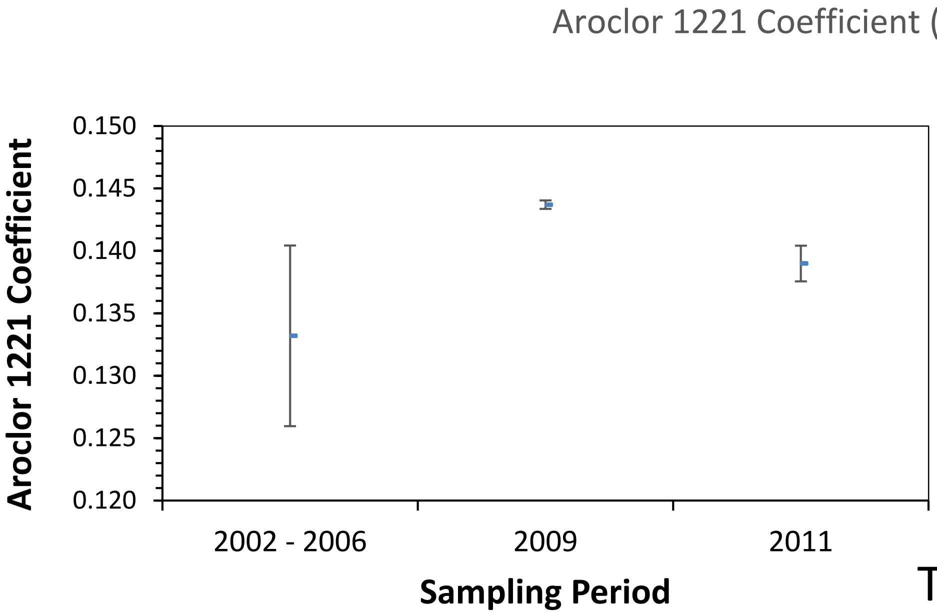
Notes:

- Data shown above is from 2017 NYSDEC Data set
- See text for explanation of percent recovery

TCMX Recovery vs. Aroclor 1221 Concentration for M8082 Results

Figure A.2.3-1

April 2019



Aroclor 1221 Coefficient (a)

Legend:

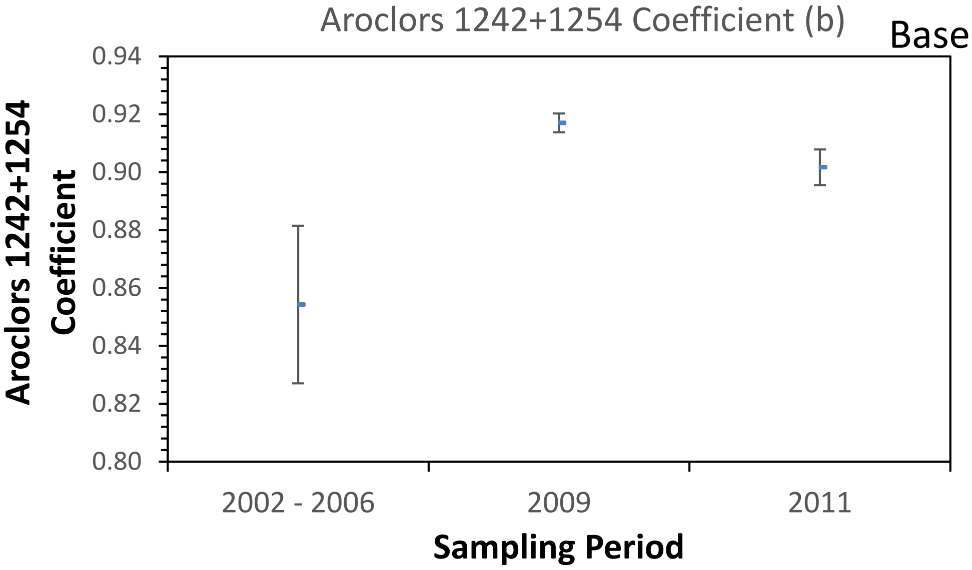
Coefficient

2 standard Error

Charts are based on GE data from 2002-2011,

$$Tri^{+}\ PCB = a[A1221] + b[A1242 + A1254]$$

Based on linear regression with untransformed data

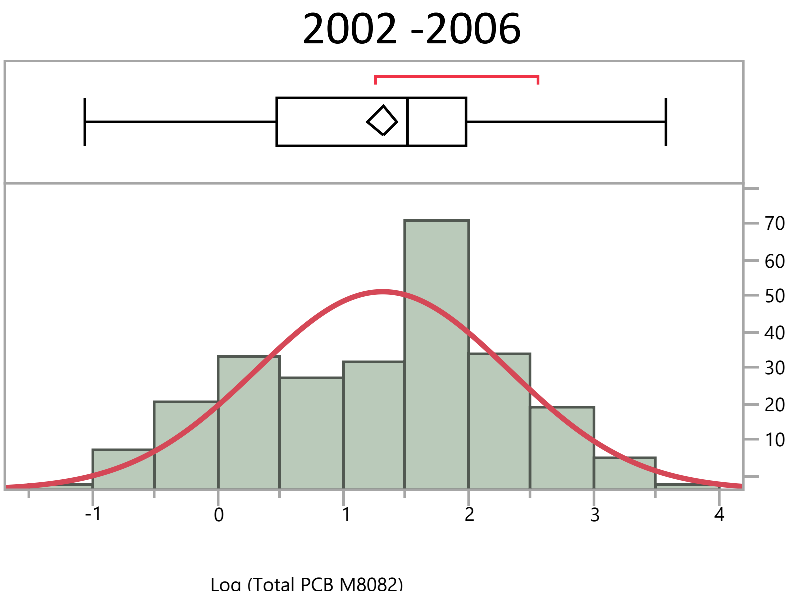


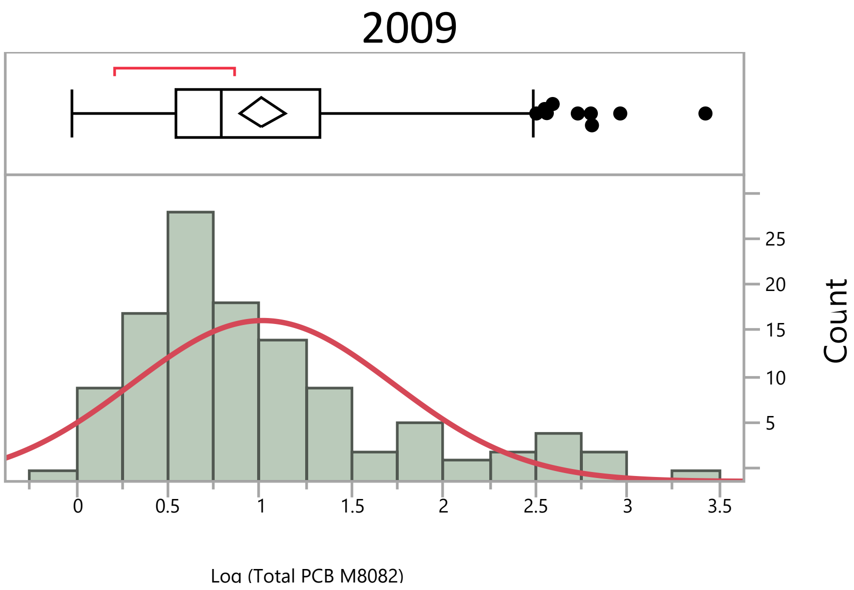
Aroclors 1242+1254 Coefficient (b)

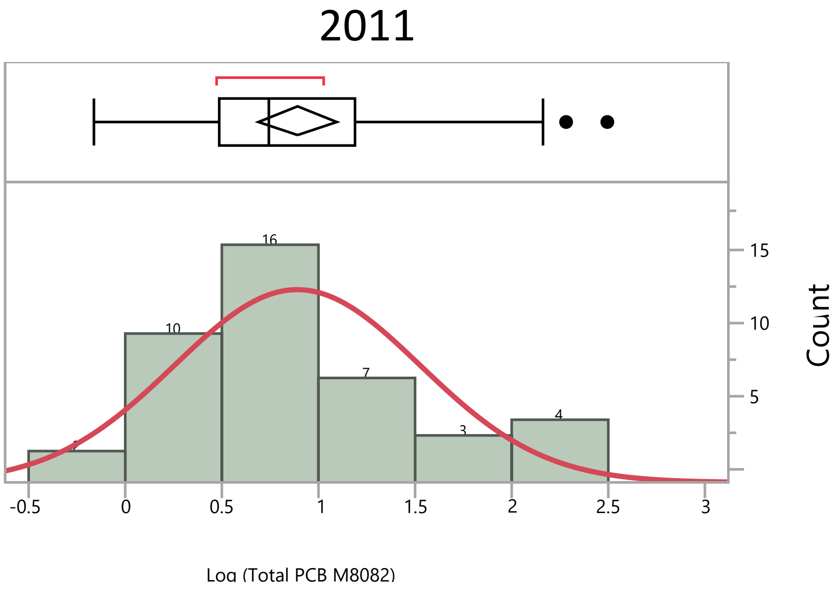
Coefficients for GE's M8082 to mGBM Conversion Factors through Time

Figure A.3.1-1

April 2019







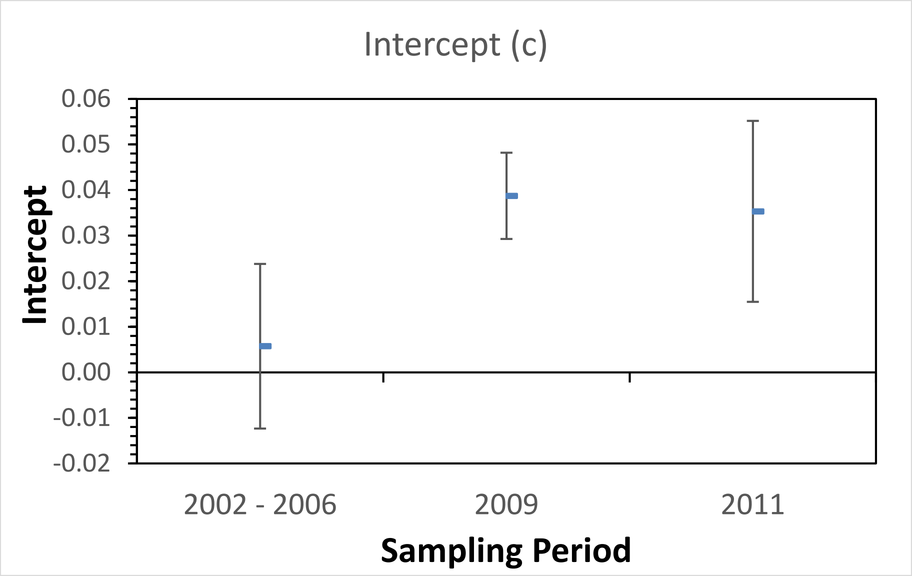
Notes:

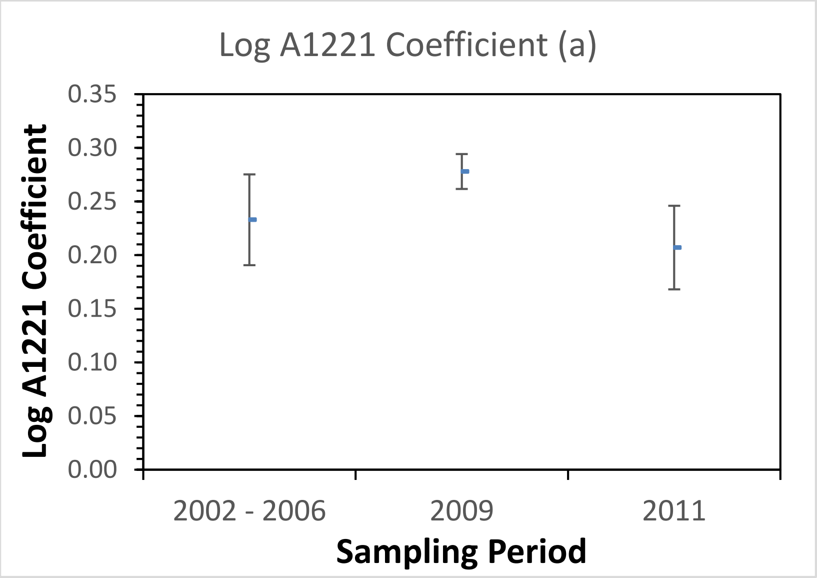
- Charts above are based on GE data from 2002-2011

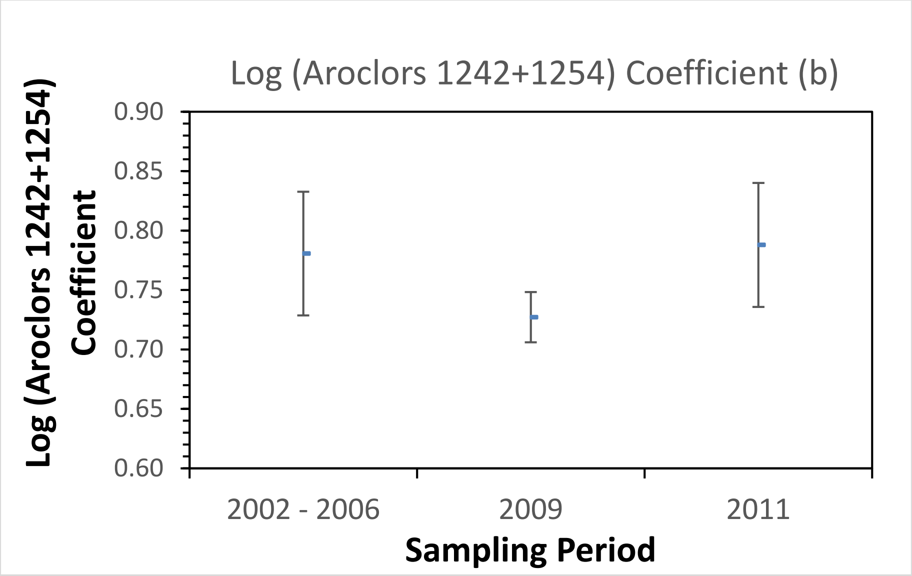
Distribution of Total PCB Concentrations for GE Data 2002 to 2011: M8082

Figure A.3.1-2

April 2019







Charts are based on GE data from 2002-2011

$$\text{Tri+ PCB} = 10^{(a*\text{Log}[A1221]+b*\log[A1242 + A1254] + c)}$$

Legend:

2 standard Error

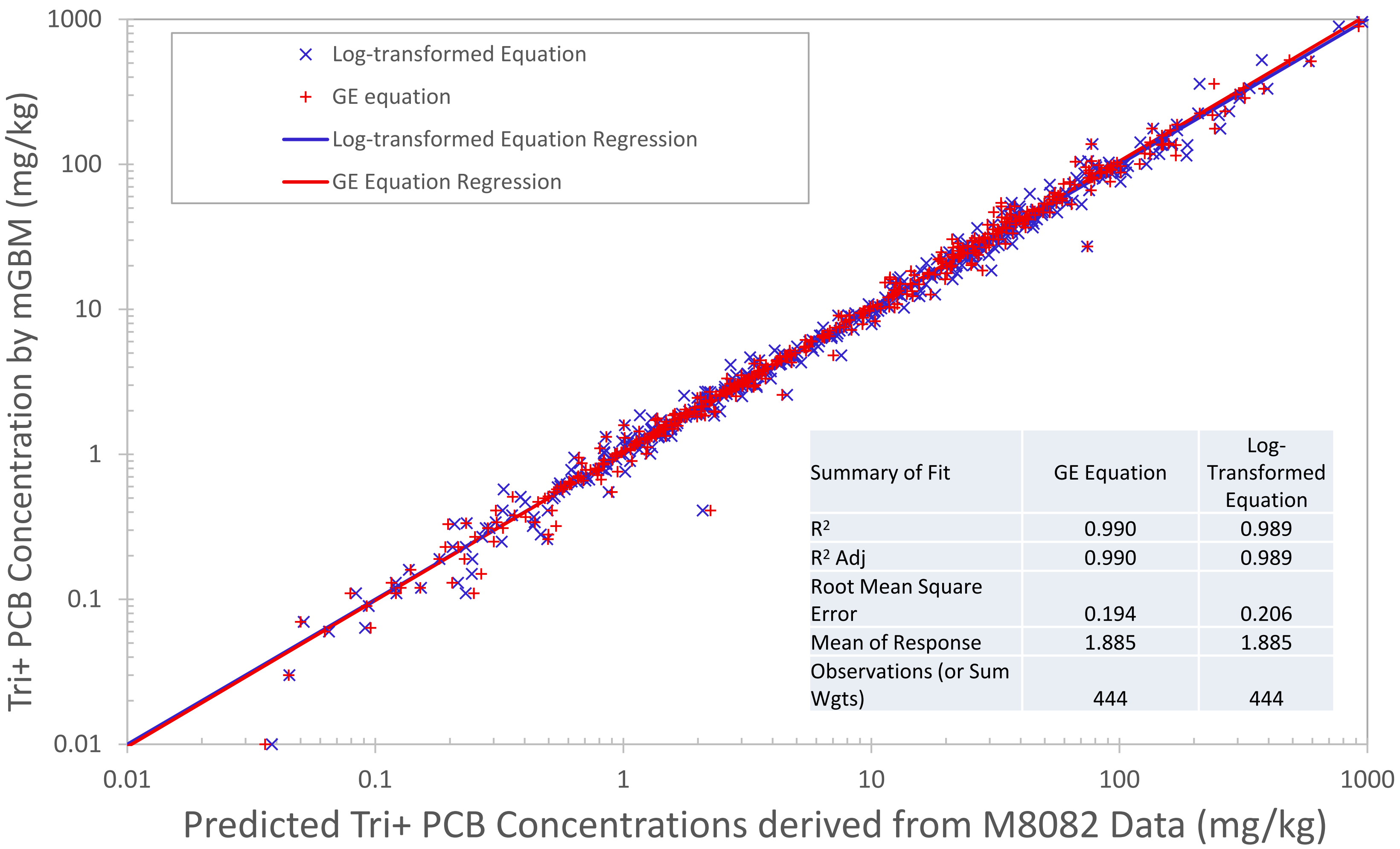
Coefficient

2 standard Error

Coefficients for Conversion of Log-transformed M8082 Results to Estimates of mGBM Tri+ PCB Concentrations over Time

Figure A.3.1-3

April 2019



Summary of Fit	GE Equation	Log-Transformed Equation
R^2	0.990	0.989
R^2 Adj	0.990	0.989
Root Mean Square Error	0.194	0.206
Mean of Response	1.885	1.885
Observations (or Sum Wgts)	444	444

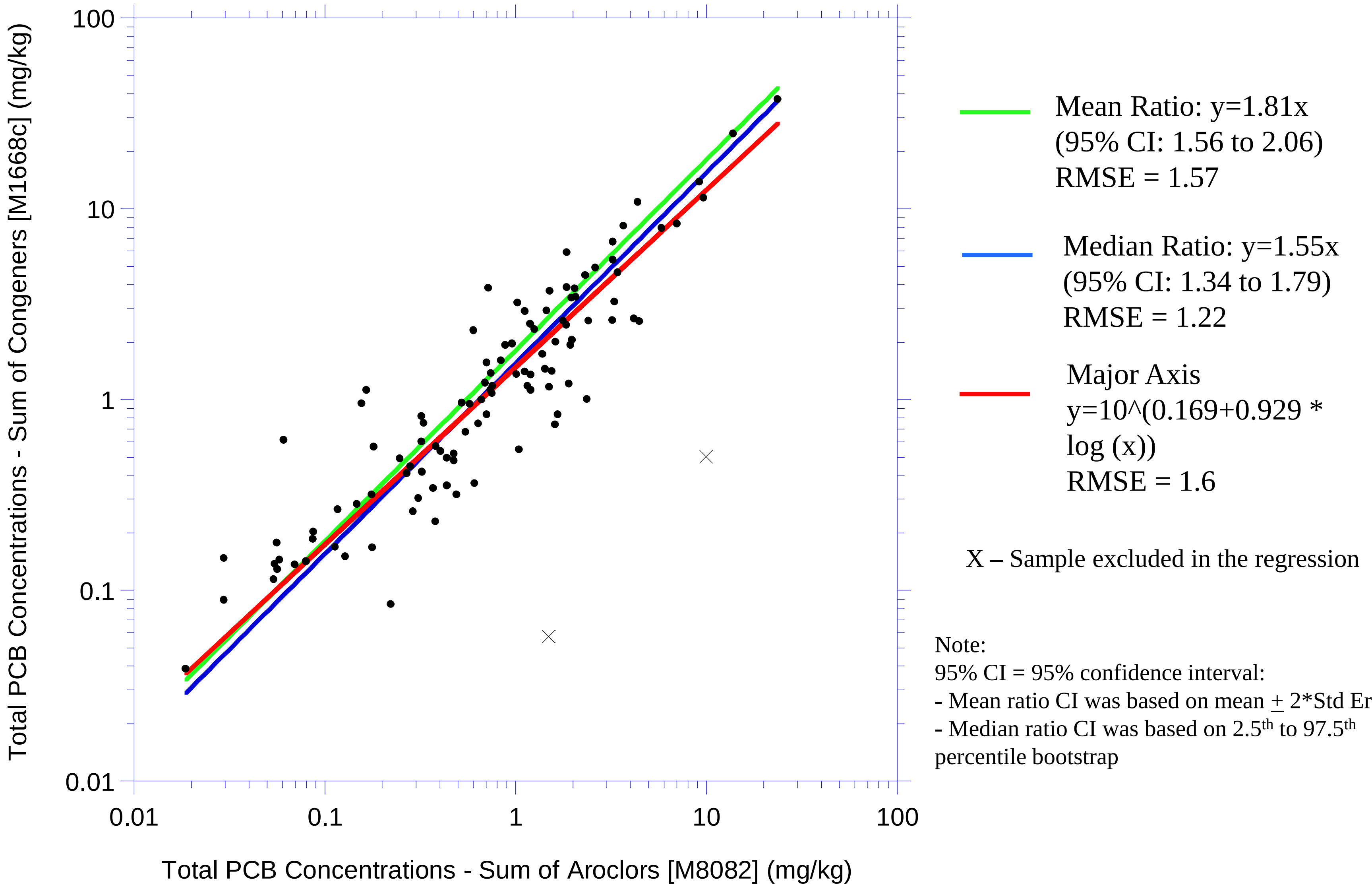
Notes:

- GE Equation: Tri$^+$ PCB = (0.13 x A1221) + 0.89 x (A1242 + A1254)
- Log-transformed Equation: Tri$^+$ PCB = 10^(0.02 + 0.25 x Log(A1221) + 0.75 x Log(A1242 + A1254))
- Chart above based on GE data from 2002-2011

Predicted Tri+ PCB Concentrations based on GE’s Original Equation and a Log-Transformed RegressionEquations vs. mGBM Tri+ PCB Concentrations

Figure A.3.1-4

April 2019

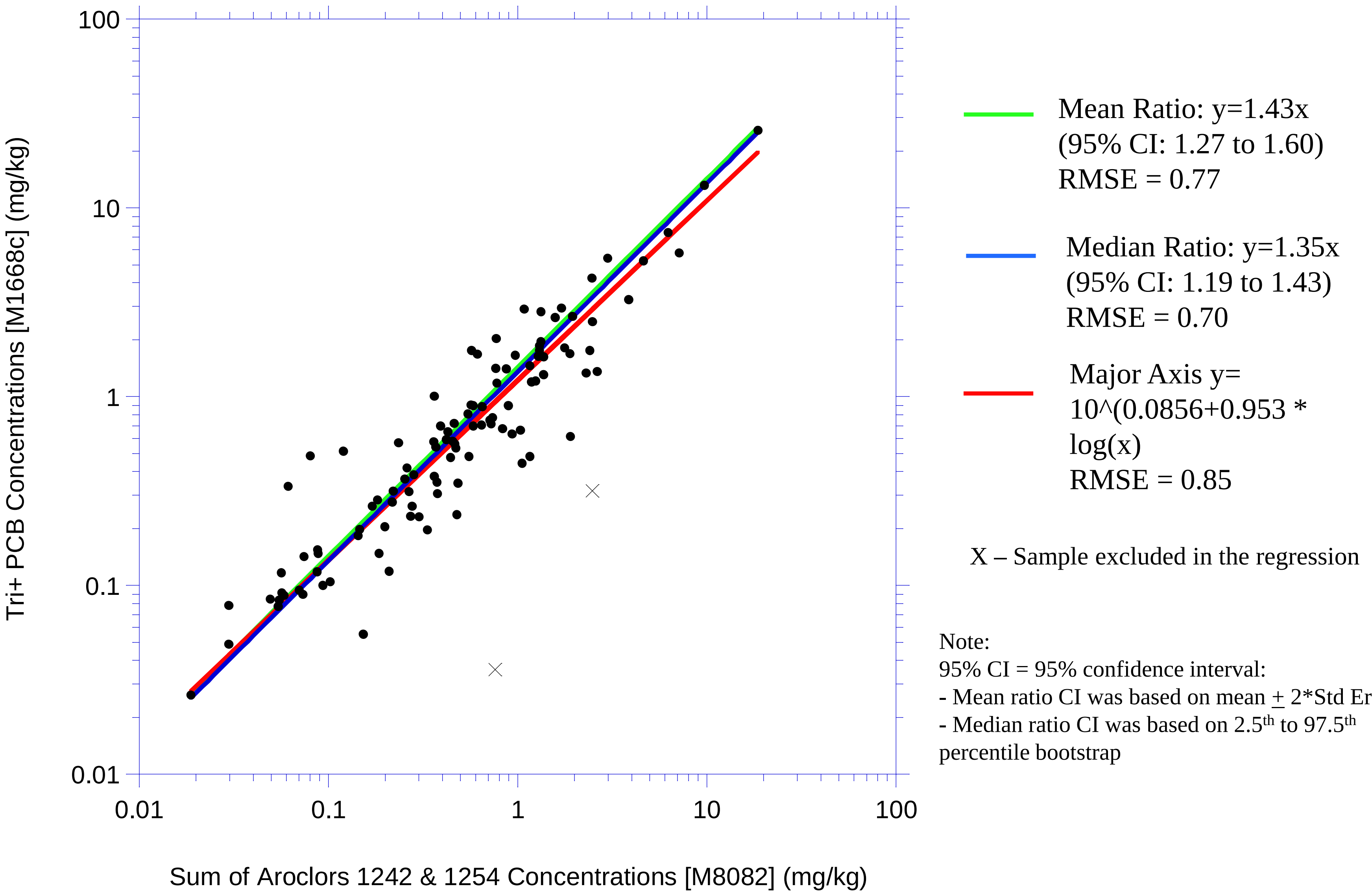


Note:
95% CI = 95% confidence interval:
- Mean ratio CI was based on mean ± 2*Std Error
- Median ratio CI was based on 2.5th to 97.5th percentile bootstrap

Figure A.3.2-1

Regression results for Total PCB concentrations determined by M8082 and M1668c

April 2019



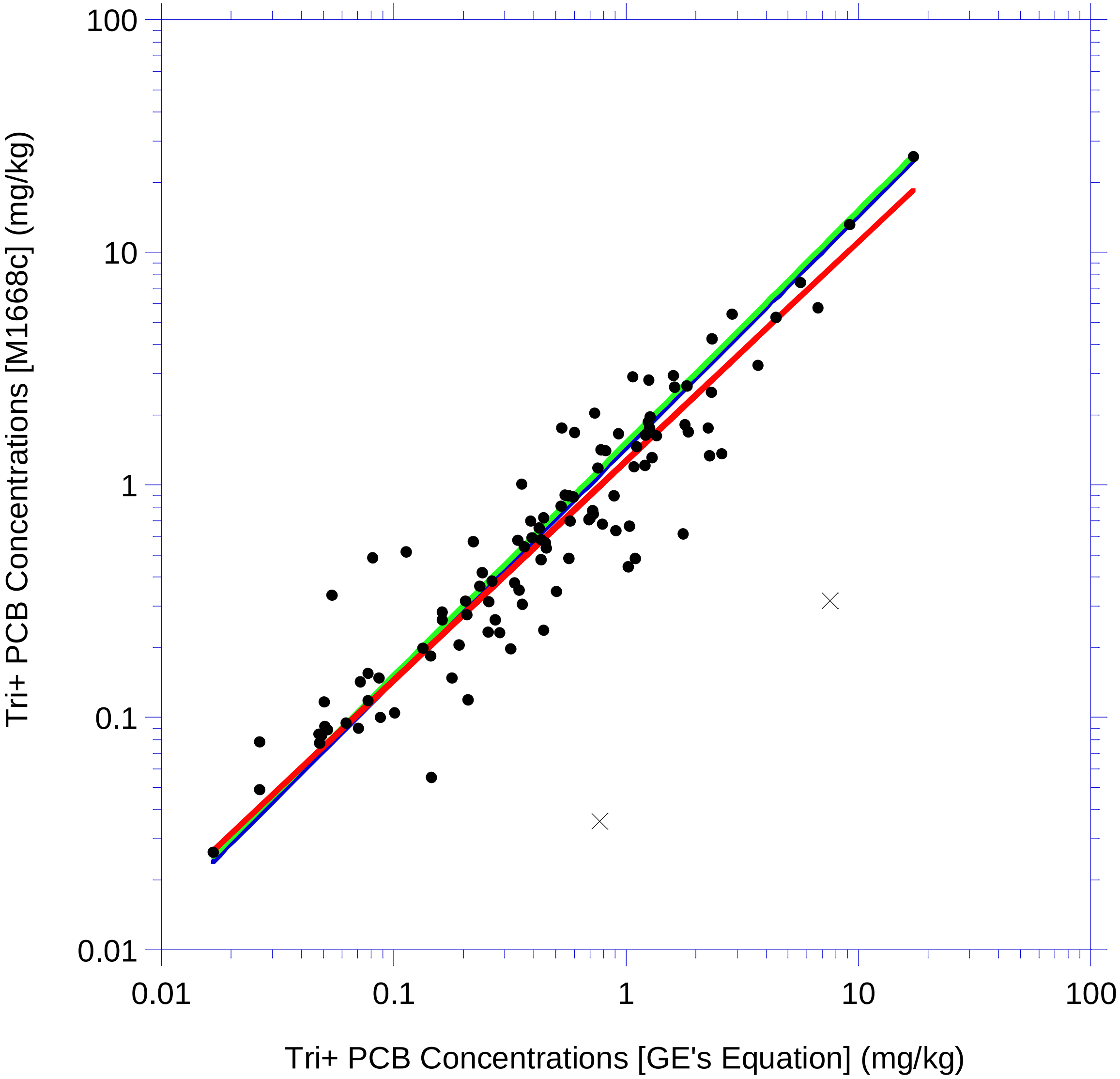
X – Sample excluded in the regression

Note:
95% CI = 95% confidence interval:
- Mean ratio CI was based on mean ± 2*Std Error
- Median ratio CI was based on 2.5th to 97.5th percentile bootstrap

Regression results for Tri+ PCB concentrations determined by M8082 and M1668c

Figure A.3.2-2

April 2019



🟩 Mean Ratio: $y=1.51x$
(95% CI: 1.34 to 1.68)
RMSE = 0.69

🟦 Median Ratio: $y=1.44x$
(95% CI: 1.23 to 1.53)
RMSE = 0.71

🟥 Major Axis $y=10^{(0.102+0.943 * \log(x))}$
RMSE = 0.94

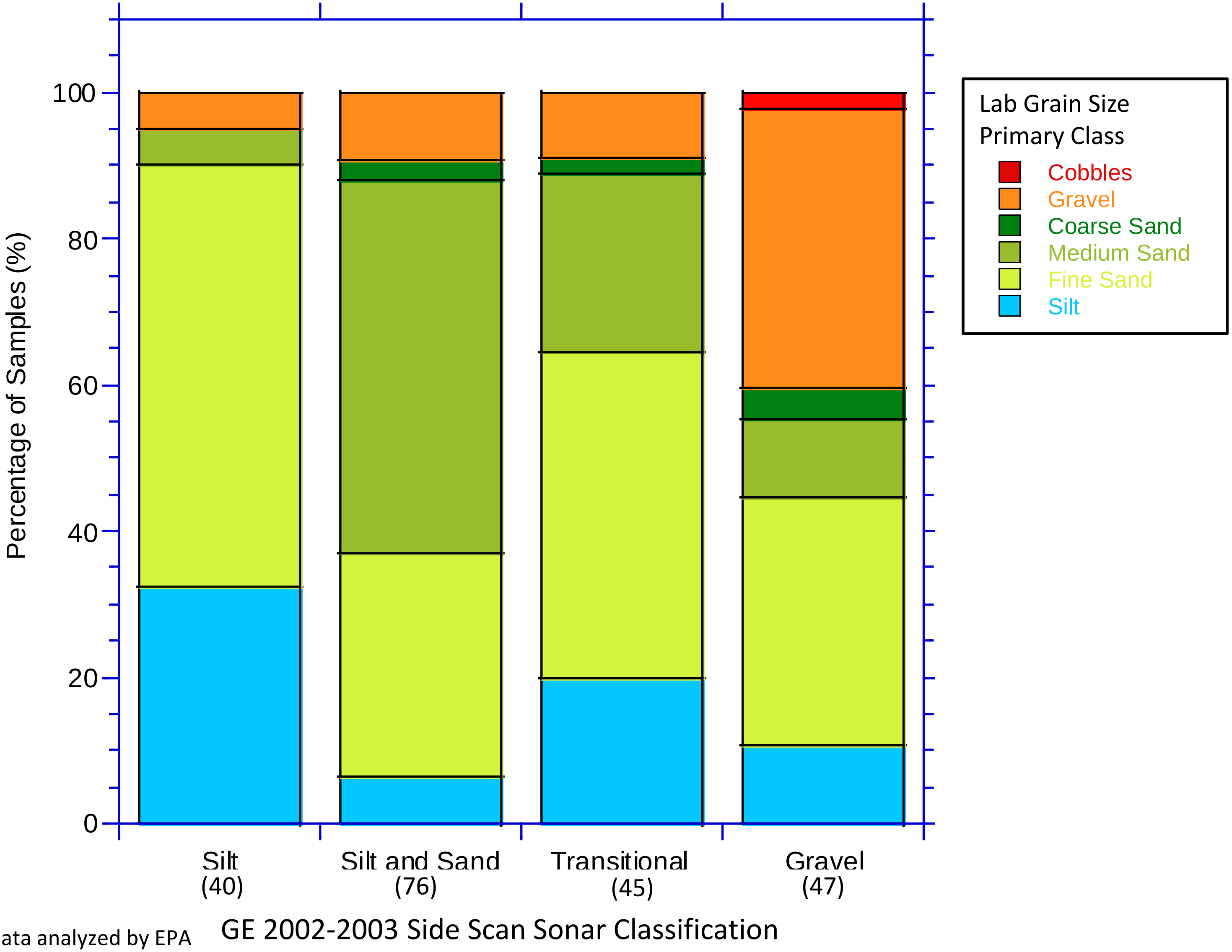
X – Sample excluded in the regression

Notes:
1. GE's Equation (CAM 3, 2011)
   Tri+ = 0.13*A1221 = 0.89*(A1242+A1254)
2. 95% CI = 95% confidence interval:
   - Mean ratio CI was based on mean ± 2*Std Error
   - Median ratio CI was based on 2.5th to 97.5th percentile bootstrap

Regression results for Tri+ PCB concentrations determined by GE's Equation and M1668c

Figure A.3.2-3

April 2019



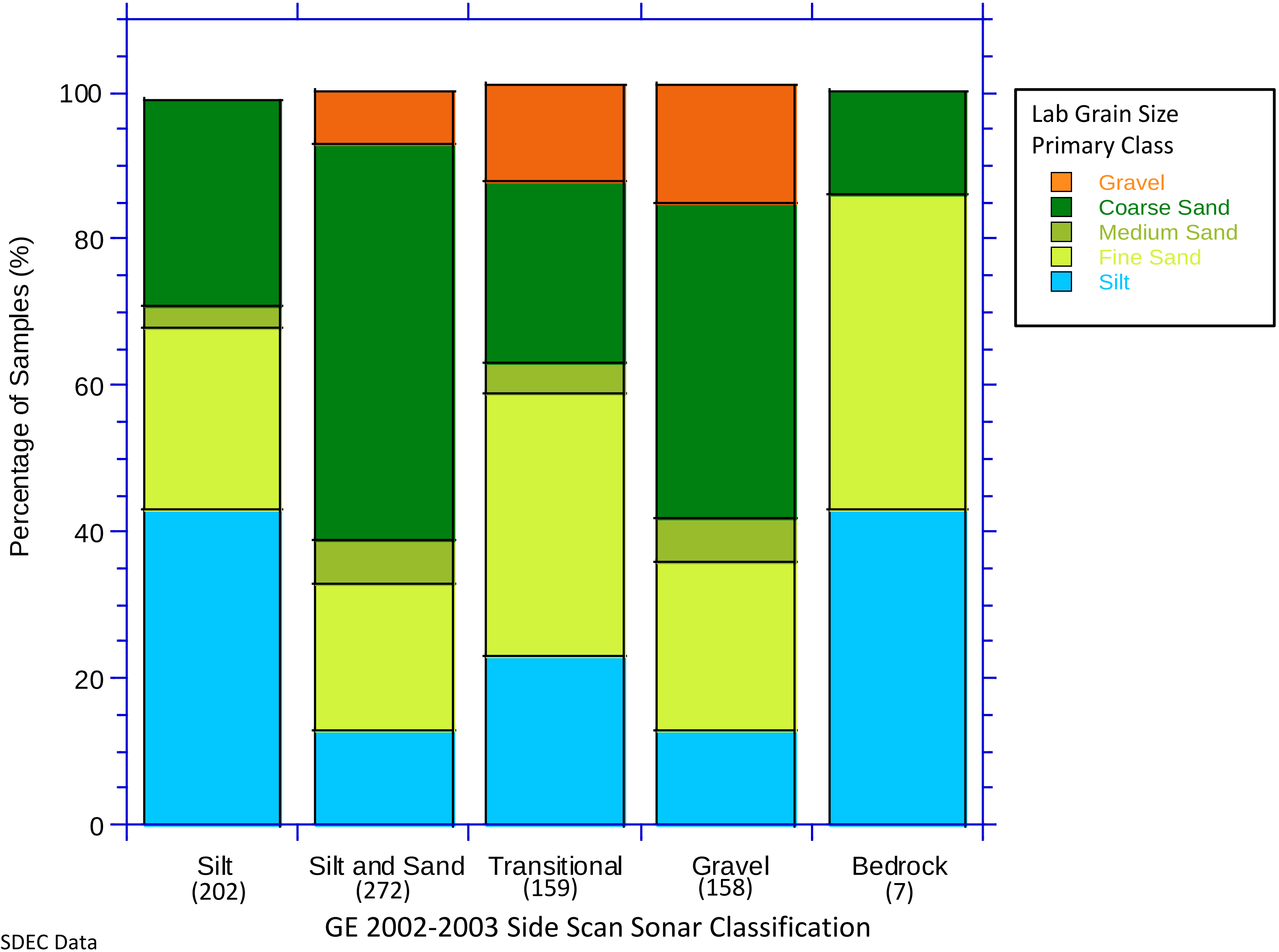
Notes:

- 2016 EPA/GE Data analyzed by EPA
- The number below each Side Scan Sonar classification is the total number of located in that classification area
- Samples located outside the SSS area or that lacked a sample analysis for grain size distribution were not included

GE SSS Classification vs. Laboratory Grain Size Classification (ASTM D422)
2016 EPA/GE Surface Sediment Data in Non-Dredged Areas

Figure A.4.1-1

April 2019



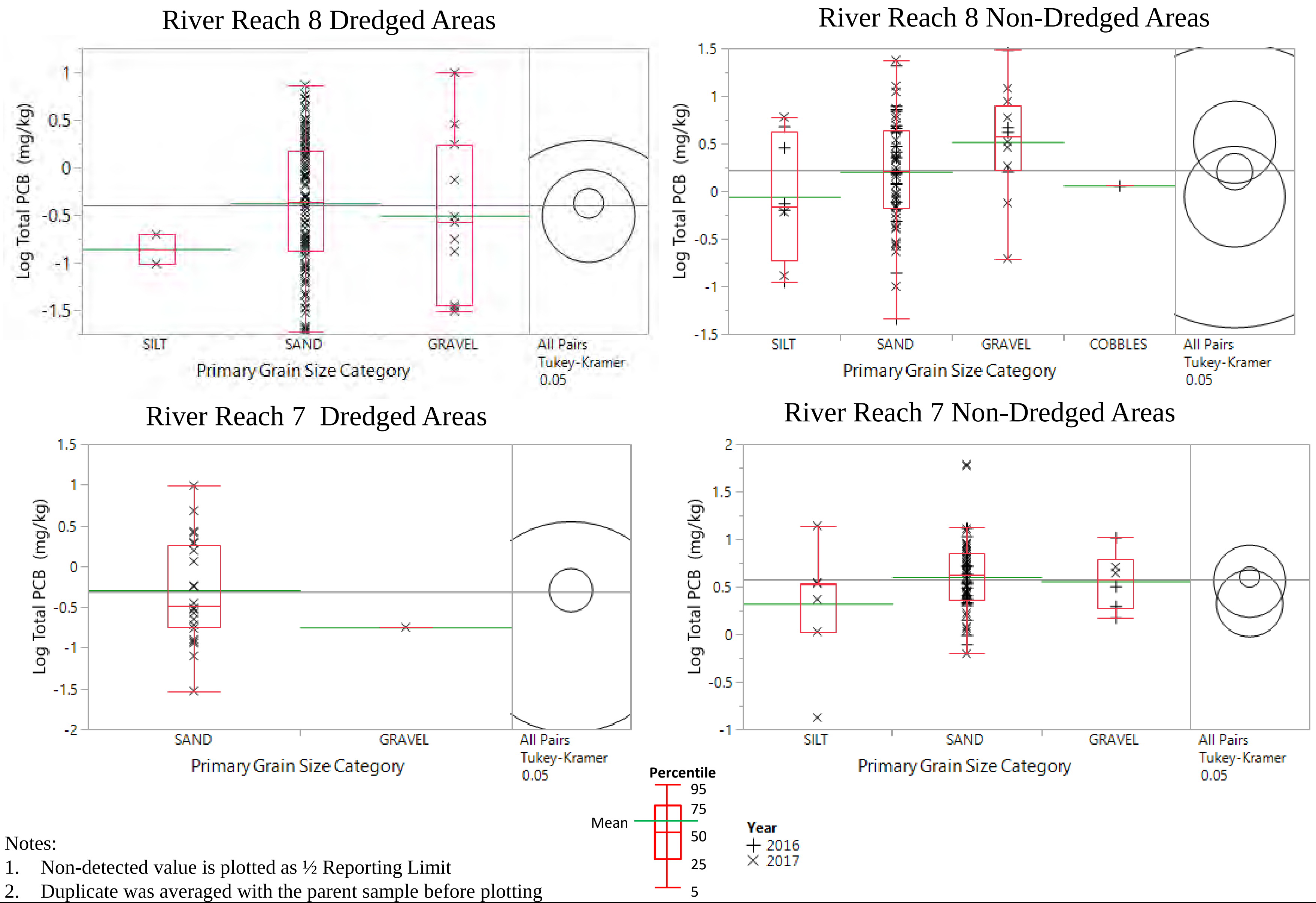
Notes:

- 2017 NYSDEC Data
- The number below each Side Scan Sonar classification is the total number of located in that classification area
- Samples located outside the SSS area or that lacked a sample analysis for grain size distribution were not included

GE SSS Classification vs. Laboratory Grain Size Classification (ASTM D422)
2017 NYSDEC Surface Sediment Data in Non-Dredged Areas

Figure A.4.1-2

April 2019



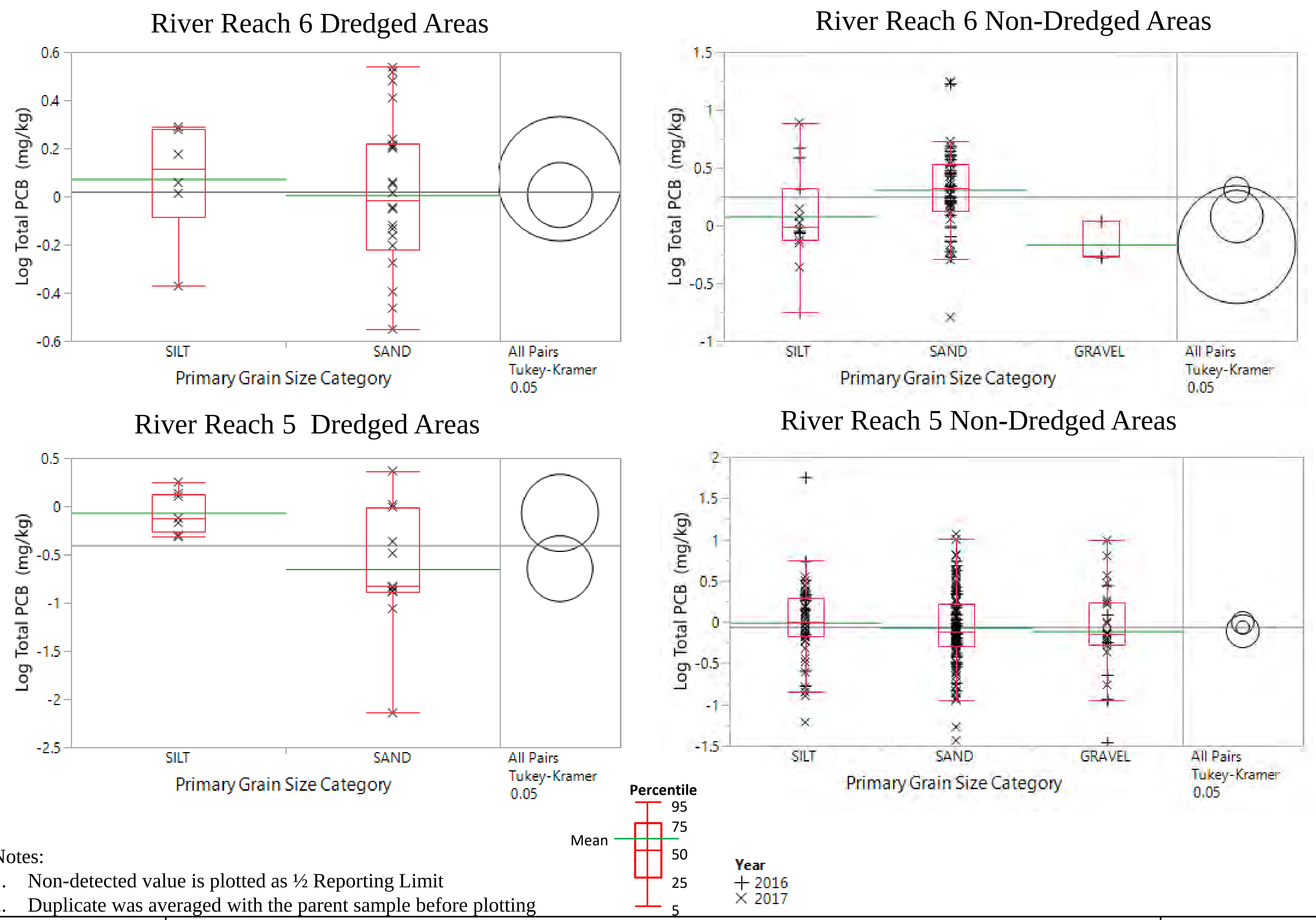
Notes:

1. Non-detected value is plotted as ½ Reporting Limit
2. Duplicate was averaged with the parent sample before plotting

Total PCB Concentrations vs. Primary Grain Size Category by River Reach

Figure A.4.3-1a

April 2019



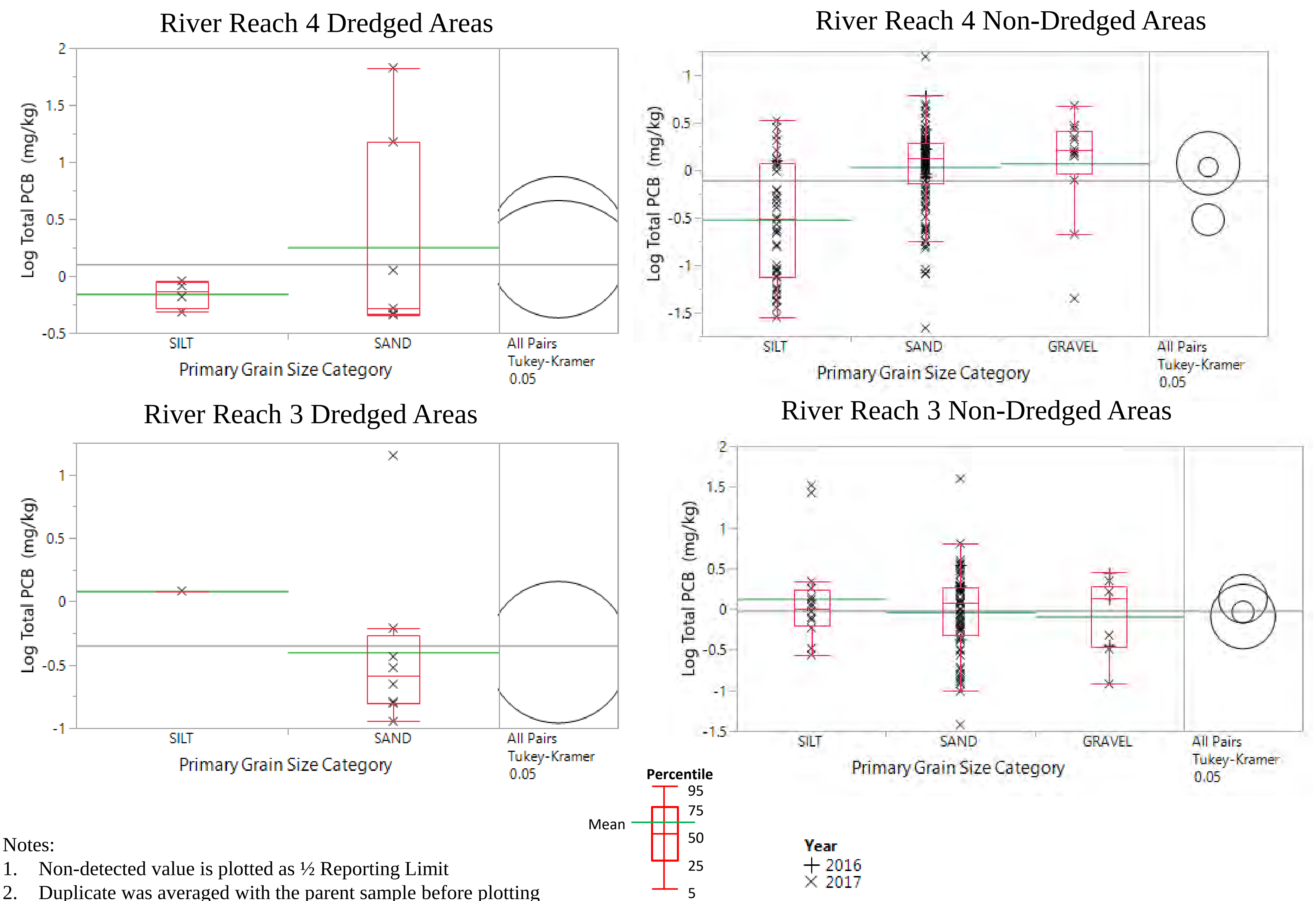
Notes:

1. Non-detected value is plotted as ½ Reporting Limit
2. Duplicate was averaged with the parent sample before plotting

Total PCB Concentrations vs. Primary Grain Size Category by River Reach

Figure A.4.3-1b

April 2019



River Reach 4 Dredged Areas

River Reach 4 Non-Dredged Areas

River Reach 3 Dredged Areas

River Reach 3 Non-Dredged Areas

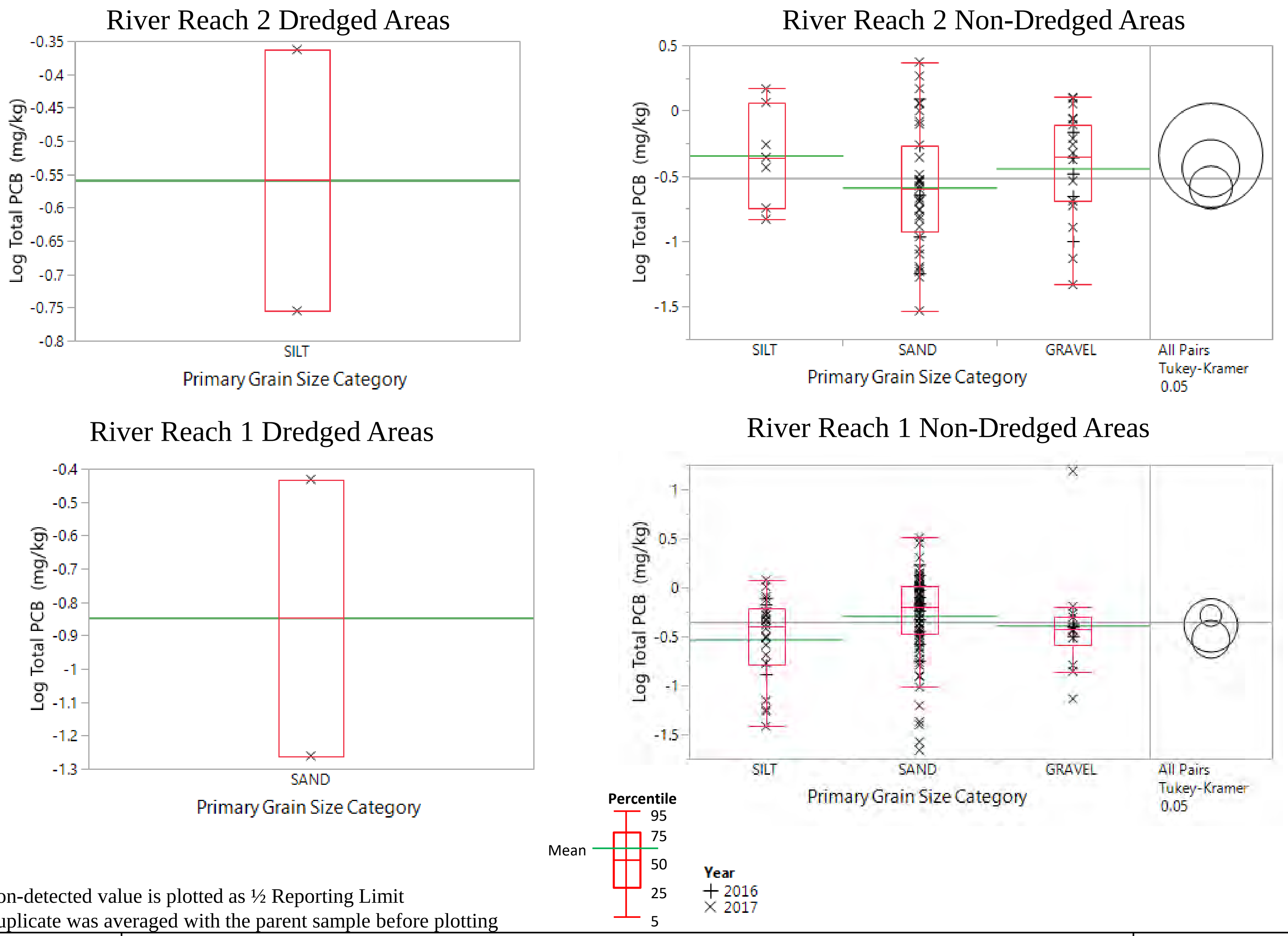
Notes:

1. Non-detected value is plotted as ½ Reporting Limit
2. Duplicate was averaged with the parent sample before plotting

Total PCB Concentrations vs. Primary Grain Size Category by River Reach

Figure A.4.3-1c

April 2019



River Reach 2 Dredged Areas

River Reach 2 Non-Dredged Areas

River Reach 1 Dredged Areas

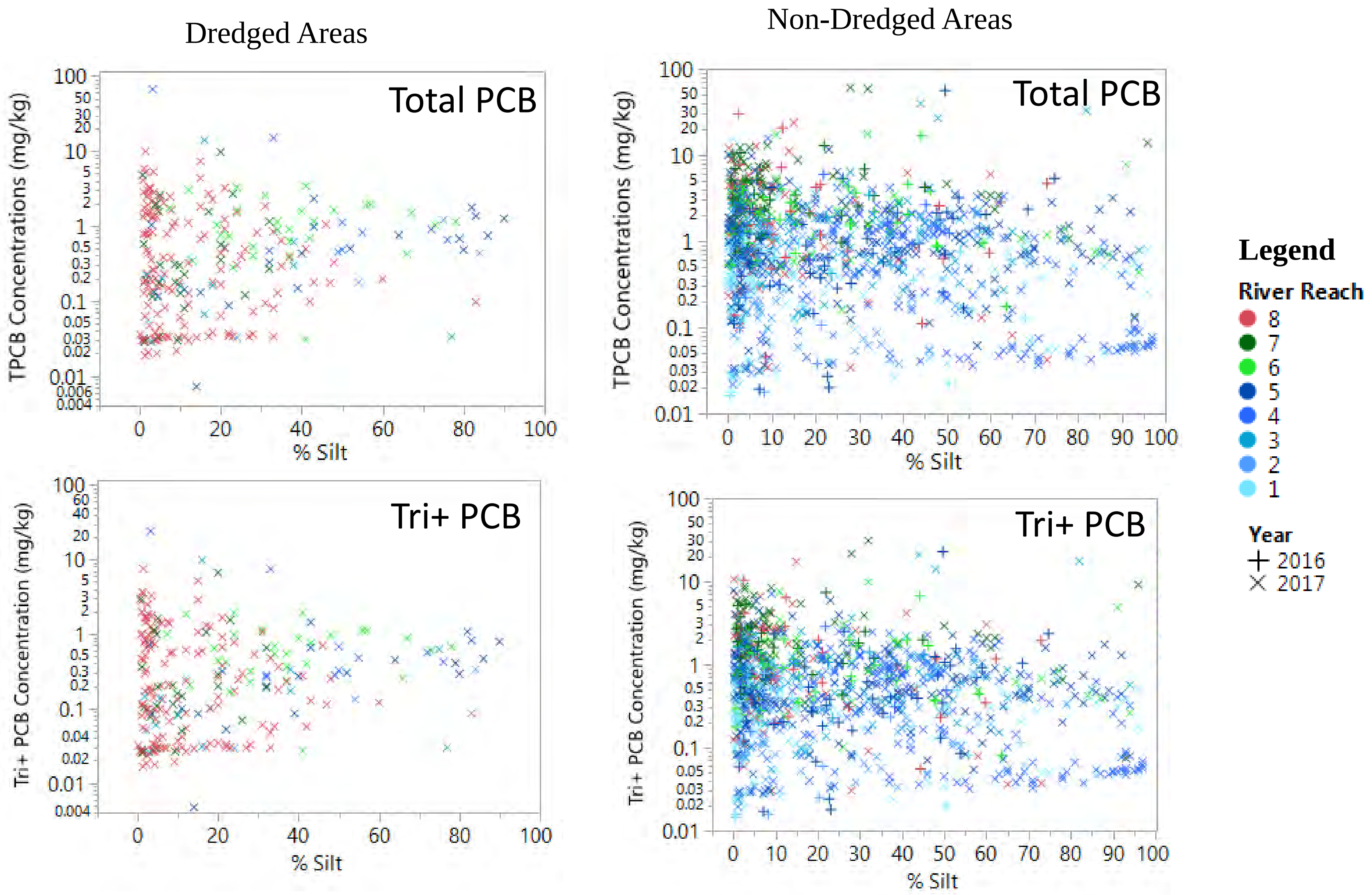
River Reach 1 Non-Dredged Areas

Notes:
1. Non-detected value is plotted as ½ Reporting Limit
2. Duplicate was averaged with the parent sample before plotting

Total PCB Concentrations vs. Primary Grain Size Category by River Reach

Figure A.4.3-1d

April 2019



Notes:

1. Non-detected values are plotted as ½ Reporting Limit
2. Duplicate was averaged with the parent sample before plotting

Total PCB and Tri+ PCB Concentrations vs. Percent Silt

Figure A.4.3-2

April 2019