Naval Information
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PACIFIC

TECHNICAL REPORT 3319
SEPTEMBER 2023

Long Term Monitoring of Activated Carbon Amendment to Reduce Bioavailability of Polychlorinated Biphenyls (PCBs) in Sediments at an Active Shipyard

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Administrative Notes:
This report was approved through the Release of Scientific and Technical Information (RSTI) process in August 2023 and formally published in the Defense Technical Information Center (DTIC) in September 2023.

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ADMINISTRATIVE INFORMATION

The work described in this report was performed by the Energy and Environmental Sustainability Branch of the Advanced Systems and Applied Sciences Division, Naval Information Warfare Center Pacific (NIWC Pacific), San Diego, CA. The Department of Defense's Environmental Security Technology Certification Program (ESTCP), provided funding for this technology demonstration under Project #ER18-5079..

Released by
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ACKNOWLEDGMENTS

This project was supported by the Department of Defense's Environmental Security Technology Certification Program (ESTCP), under project #ER18-5079. We gratefully acknowledge logistical and technical support from multiple organizations and individuals including, but not limited to, Dr. John Frew (NIWC) Pacific, Phil Nenninger and Joy Gryzenia (NAVFAC Northwest), Dr. Robert K. Johnston (Retired Navy; Applied Ecological Solutions), Dr. Anthony Bednar and Jenifer Netchaev (U.S. Army Corps Engineer Research and Development Center, Vicksburg, MS), John Collins and Dr. Moses Ajemigbitse (AquaBlok, Ltd.), Daniel Gray (Koppers, Inc.), Trevor Richardson (PSNS Code 106.3) and the Puget Sound Naval Shipyard Dive Team at PSNS&IMF, Anne Christopher (EPA Region X), and Leonard Machut (Washington Dept. of Ecology).

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Editor: MRM

EXECUTIVE SUMMARY

ES-1 Introduction

Activated carbon (AC)-based amendments have been demonstrated widely in recent years as an effective, and relatively non-disruptive means of sequestering sediment associated with hydrophobic organic contaminants (HOC), such as polychlorinated biphenyls (PCBs). In 2012, under an earlier project (ESTCP #ER-201131), an AC amendment (AquaGate+PAC™) was placed at a half-acre plot adjacent to and underneath Pier 7 at the Puget Sound Naval Shipyard & Intermediated Maintenance Facility (PSNS & IMF) to reduce PCB availability. This study site was unique to other AC amendment demonstrations by being at a high-energy hydrodynamic environment at an active military harbor. Post-placement monitoring conducted over a 3-year period showed a persistent 80-90% reduction in available PCBs when compared with those made prior to placement. Benthic invertebrate census and sediment profile imagery (SPI) did not indicate significant differences in benthic community ecological metrics among the pre-amendment and 3 post-amendment monitoring events, supporting existing scientific literature that the approximate activated carbon dosage level (4%, by weight addition of AC (particle diameter ≤74 mm) in the uppermost 10 cm of surface sediment) does not significantly impair native benthic invertebrate communities. The results reported herein are from a follow-on monitoring effort, conducted in 2019 (~7 years post placement), to help answer ongoing questions about the longevity of AC remedies. This report should be considered an addendum to the larger project ER-201131 report (Kirtay et al. 2017), where more detail can be found on various components including amendment placement, earlier monitoring results, and costs and implementation of the technology.

ES-2 Objectives of the Demonstration

The primary objective of this project was to evaluate the long-term stability and effectiveness of the AC-based amendment as *in situ* treatment for persistent HOC impacted sediments. The demonstration focused specifically on PCBs, but should be applicable to other HOC sediment sites. The demonstration also evaluated the secondary consideration of ensuring the amendment would not adversely affect benthic ecological resources. While many studies have addressed the short-term performance of AC amendments, there is a general data gap with respect to long-term performance. This data gap leaves uncertainty based on the multitude of potential long-term outcomes associated with AC performance at DoD contaminated sediment sites.

To meet the overall goals of the project, the specific task objectives included long-term evaluation of:

Task 1: Effectiveness of AC amendment to reduce bioavailable concentrations of PCBs in biota and available concentrations of PCBs in porewater;

Task 2: Stability of the AC amendment with observations of the lateral and vertical extent, uniformity, and persistence in surface sediments;

Task 3: Potential for adverse impacts to the benthic community due to the remedy; and,

Task 4: Potential for technology transfer through commercial availability and acceptance of the technology.

ES-3 Technology Description

The primary technology demonstrated in this project was a commercially available product, AquaGate+PAC™, which is a sediment amendment consisting of powdered activated carbon (PAC), that serves as a competitive, potentially less disruptive, alternative to sediment removal (i.e. dredging) or capping of contaminated sediment sites. The material was specifically formulated for sequestration of hydrophobic organic contaminants (HOC) and for successful application in relatively deep water environments such as those associated with an active Navy Shipyard. The amendment is coated onto a small (~2 cm) aggregate core using a bentonite clay binder, and once delivered to the sediment surface within a water body, becomes incorporated into the top layers by natural processes. This technology was coupled with multiple other technologies that provided a comprehensive monitoring program to evaluate the amendment performance. The monitoring approach largely followed that used for the pre-installation, and 3 years of post-installation monitoring, of the remedy in a preceding ESTCP demonstration project (#ER-201131; Kirtay et al. 2017) by the same project team. Physical, chemical, and biological parameters were measured using a suite of primarily *in situ* technologies to evaluate the persistence and effectiveness of the amendment (i.e. towards reduced contaminant exposure to aquatic life), as well as identifying any adverse impacts to the benthic community at the site.

ES-4 Performance Evaluation

The performance evaluation is summarized in Table 1, which is followed by a short summary of results associated with each objective.

ES-4 Performance Evaluation

Table 1. Summary of performance objectives, success criteria, and results.

Qualitative Performance Objectives				Results
#	**Objective**	**Data Requirements**	**Success Criteria**	
1	Demonstrate reduction in PCB bioavailability is sustained over time.	Polychaete and bivalve bioaccumulation *in situ*. Passive sampler uptake *in situ*.	Rigorous characterization of PCB bioavailability at 10 multi-metric stations 82-months post amendment placement.	Met. Polychaete, bivalve, and passive sampler uptake of PCBs were 85 to 93% lower relative to baseline uptake prior to amendment placement, comparable to that observed at 33-months post placement.
2	Demonstrate the continued presence of activated carbon within the target amendment area and physical stability over time.	Lloyd Khan for Total Organic Carbon (TOC) content, petrographic analysis for carbon speciation, and chemical oxidation method* for analysis of black carbon within the footprint.	High resolution evaluation of TOC and AC presence using multiple methods at four profiles within the top 20 cm at 20 sampling locations for TOC and BC (chemical oxidation) and 7 select sampling locations for AC by petrographic analysis	Met. TOC (2.8%) and BC by chemical oxidation (1.0%) comparable on average over depth and comparable with 33-month post placement concentrations. Petrographic analysis verified presence of AC (0.9% on average) at comparable concentrations to BC analysis.
3	Evaluate benthic community changes in response to amendment.	Benthic community census data.	Successful sampling and analysis of benthic community metrics for comparison with short-term monitoring data and concurrent comparison of both reference and amended sediment stations.	Met. No statistically-significant differences among the groups for total abundance, diversity, evenness, Swartz dominance index, and percent abundance of the top 5 abundant taxa were observed, with P values of 0.11, 0.14, 0.81, 0.34, and 0.20, respectively.
4	Promote technology transfer and acceptance	Results from Tasks 1-3, collaboration with site managers and regulators, broad dissemination within the community of practice.	Identifying commercial vendors, cooperation with site managers and regulators, publicizing long-term performance through inter-agency and commercial workgroups.	Met based on completion of multiple proposed technology transfer mechanisms.

Performance Objective #1: Demonstrate reduction in PCB bioavailability is sustained over time

Performance Objective 1 was developed to determine if the AC amendment continued to show sustained reduction of PCB availability over time, specifically at 82 months post-placement at Pier 7. This was evaluated using *in situ* exposures of two benthic invertebrates, *Macoma nasuta* (bent-nosed clam) and *Nephtys caecoides* (a polychaete), and passive samplers (solid-phase microextraction (SPME). Both organisms and SPME were successfully deployed, recovered, and analyzed for all 10 sampling locations, indicating that this objective was met. These results are summarized and compared with results from monitoring events from the first 3 years post-placement in Figure 1. The results showed that concentrations for both species continued to show a >90% reduction in PCB concentrations compared with concentrations prior to placement of the amendment. Similarly, the porewater PCB concentrations showed a >85% reduction. For both bioaccumulation and porewater, concentrations were not statistically different from the significant reductions observed in earlier events.

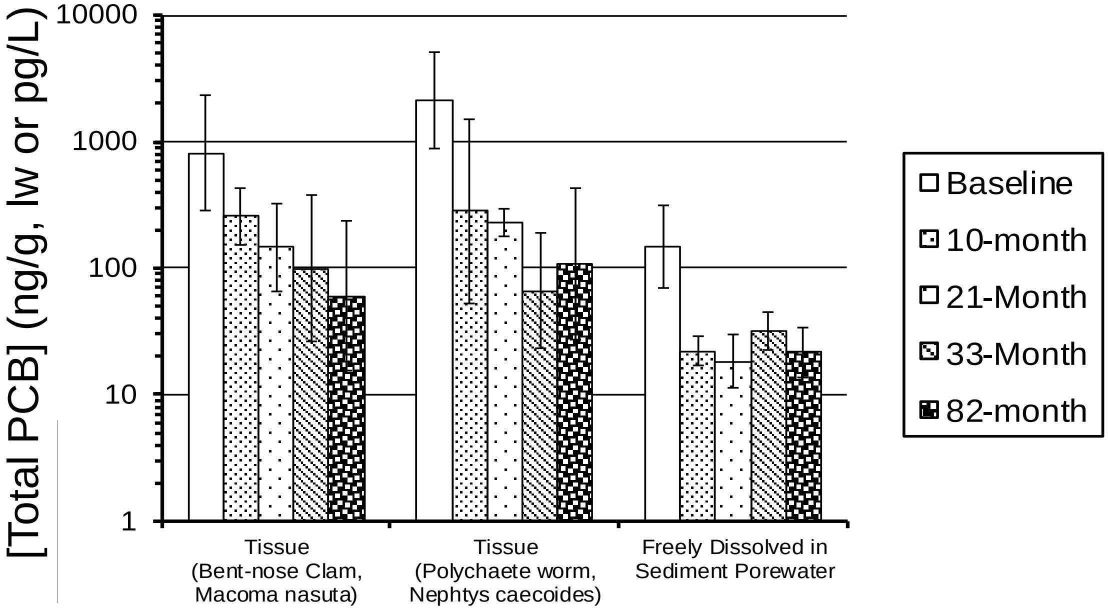

Figure 1. Summary of mean (± 95% confidence level) reduction in concentrations of total PCBs in tissue (lipid weight (lw) normalized) and sediment porewater (pg/L) including at 82-month (long-term) monitoring event. Note concentrations are on a logarithmic scale.

Performance Objective #2: Demonstrate long-term presence of activated carbon

Performance objective 2 was developed to demonstrate how much of the activated carbon placed at the site remained in the surface sediments after 82 months. This was evaluated from the measurement of total organic carbon (TOC) and Black Carbon (BC) as had been done in earlier monitoring events, but also the incorporation of carbon petrography to quantify AC specifically. All targeted samples were successfully collected, analyzed, and provided meaningful data, indicating that this objective was met. The TOC concentration at 82 months ranged from 2.5-3.3%, on average, and were generally consistent among the 4 depths measured. Black carbon concentration ranged from 0.7-1.3%, on average, while the AC content was 0.9%, suggesting that most of the BC was made up by AC. Both BC and AC averaged 4.3 fold higher in samples that contained the aggregate used to deploy the amendment than those without aggregate.

Performance Objective #3: Evaluate long-term benthic community changes in presence of sediment

Performance objective 3 was incorporated into the demonstration to assess any secondary effects on the benthic invertebrate community. The 82-month data were compared with the pre-placement benthic community data to assess whether or not the presence of the amendment had impacted the biota. Overall, there is no evidence from the 82-month data indicating an effect on benthic invertebrate communities at the amended area, as found for previous monitoring events (Kirtay et al., 2018). No statistically-significant differences among the groups for total abundance, diversity, evenness, Swartz dominance index, and percent abundance of the top 5 abundant taxa were observed, with P values of 0.11, 0.14, 0.81, 0.34, and 0.20, respectively. Differences among the groups for taxa richness were noted (P = 0.04). Species richness was statistically different (lower) in the baseline for the unamended area compared to the 82-month amended area, suggesting improved ecological health in the amended area compared to the reference stations. The observations from this sampling event further confirm the findings of most scientific studies proposing that adverse effects on benthic invertebrates are not expected as a result of activated carbon amendments (Janssen and Beckingham, 2013), especially when activated carbon dosage rates remain below approximately 5% by weight in sediment (Rakowska et al., 2012; Janssen and Beckingham, 2013; Kupryianchyk, et al. 2015; Patmont et al., 2015).

Performance Objective #4: Promote technology transfer and acceptance

Performance objective 4 was to promote technology transfer and acceptance which involved collaboration with site managers and regulators and broad dissemination within the community of practice, with a particular focus on the long-term performance and persistence of the remedial technology. This objective focused on (1) transitioning the methods and knowledge to our commercial partners in the project and other qualified commercial entities to provide the expertise and capabilities for long-term monitoring of the remedy; (2) providing publicly accessible documentation of the long-term performance of the technology at an operational site under operational conditions; and (3) disseminating information about the technology performance as widely as possible to the community of practice via conference presentations, webinars, publications and social media. Partnering with Geosyntec, CMA, Ecoanalysts, and AquaBlok, Inc. ensured continuity of methods and continued momentum towards transition of the amendment and associated tools that have all been commercialized. The project team published a peer-reviewed journal article in *Environmental Toxicology and Chemistry* (Wang et al. 2022), and a list of multiple venues for tech transfer are listed in subsequent sections of this report.

ES-5 Cost-Benefit & Implementation

In situ reactive amendment with AquaGate+PAC^{TM} is well suited to be implemented in a variety of environmental conditions from shallow, quiescent, flat-bottom settings to deep water, variable, or sloping water depths, and tidal environments with active vessel traffic and infrastructure. This technology could be of great interest as a remedy to HOC-impacted (e.g., PCBs, polycyclic aromatic hydrocarbon [PAHs], and pesticides) surface sediments in association with Superfund sites and sites implementing remediation in response to equivalent state and local regulations associated with contaminated surface sediments. *In situ* treatment technology may be limited to sites with contamination to depths within the site-specific bioturbation mixing zone (generally 10–20 centimeters [cm] below sediment-water interface) unless it is determined that there is little or no advective transport of contaminant from depths below the bioturbation mixing zone. AquaGate+ has an advantage in the ability to place amendments around infrastructure (e.g., piers and bulkheads) where dredging may be found to be more expensive or infeasible. Another advantage of AquaGate+ is the ability to place the amendment in navigational channels and berthing areas where capping may be infeasible due to water depth requirements. Costs of implementing AquaGate+ are competitive with alternative remedial methods; however, as with selection of any remedy, cost is dependent on site-specific conditions and complexity.

ES-6 Conclusion

This study successfully continued the evaluation of the performance of an AC amendment in an active harbor area throughout a multiyear monitoring period. The results showed a sustained reduction in PCB availability 82 months post application of the AC amendment in the uppermost 10 cm of the surface sediment. As noted in previous events, reductions in PCB availability of 85 to >90% (relative to baseline) were found using the SPME porewater and *in situ* bioaccumulation measurement approaches. These reduced PCB availability levels would meet typical risk-based screening or management criteria for surface sediments and many contaminated sites. This achievement is especially significant given that traditional sediment remedies (e.g., dredging and capping) would be challenging or infeasible for this location, which includes an area adjacent to/beneath a pier and within a vessel berth with specific water-depth requirements.

Measurements of amendment placement using TOC, BC, and aggregate presence indicated results similar to previous monitoring events: the amended area is stable and AC levels in the surficial layers continue to approximate 1% AC. A novel approach (carbon petrography) was employed to evaluate the accuracy of the BC results, and data support the use of BC measurements to confirm AC presence and dosing rates. Carbon petrography may be useful to validate BC measurements at other sites, particularly those with levels of BC that may interfere with post-amendment monitoring.

Benthic invertebrate census results from the 82-month study did not indicate differences in benthic community ecological metrics among the pre-amendment and 4 post-amendment monitoring events that would indicate a negative impact of the AC amendment. The recent data confirm previous observations noted by Kirtay et al. (2018) that the AC amendment applied at the site did not affect the benthic community.

Overall, the performance of the amendment shown in the present study, now demonstrated over a 7-year period following the AC amendment placement in 2012, will ideally encourage the consideration of activated carbon amendments for similar logistically challenging settings in contaminated sediment sites and as an alternative to traditional sediment remedies.

ACRONYMS

AC	Activated Carbon
ANOVA	Analysis of Variance
ASTM	American Society for Testing and Materials
ATS	Titanosilicate adsorbant by Surfatas
AWA	Area Weighted Average
BC	Black Carbon
BNC	Bremerton Naval Complex
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
CMA	Coastal Monitoring Associates
CoC	Contaminants of Concern
CO_2	carbon dioxide
DoD	Department of Defense
EDD	Electronic Data Deliverables
ENR	Enhanced Natural Recovery
EPA	Environmental Protection Agency
ERDC	Engineer Research and Development Center
ESTCP	Environmental Security Technology Certification Program
GPS	Global Positioning System
HASP	Health and Safety Plan
HOC	Hydrophobic Organic Contaminant
ICs	Institutional Controls
IDW	Investigation-derived Waste
LPTL	Lowest Practical Taxonomic Level
lw	lipid weight
MLLW	Mean Lower Low Water
MeHg	Methylmercury
MCUL	Minimum Cleanup Level
MD	Maryland
MDL	Method Detection Limit

MNR	Monitored Natural Recovery
MM	Multi-Metric
mg/kg	milligram per kilogram
mm	millimeter
NCP	National Oil and Hazardous Substance Contingency Plan
NAVFAC	Naval Facilities Engineering Command
NIWC	Naval Information Warfare Center
NSB	Naval Station Bremerton
OU	Operable Unit
OC	Organic Carbon
OM	Organic Matter
PAC	Powder Activated Carbon
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated biphenyl
pg/L	picogram per liter
PSNS&IMF	Puget Sound Naval Shipyard and Intermediate Maintenance Facility
QC	Quality Control
RA	Remedial Action
RAO	Remedial Action Objectives
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SCUBA	Self Contained Underwater Breathing Apparatus
SEA Ring	Sediment Ecotoxicity Assessment Ring
SERDP	Strategic Environmental Research and Development Program
SPME	Solid-phase Microextraction
SPI	Sediment Profile Imagery
SAMMS	Self Assembled Monolayers on Mesoporous Supports
SARA	Superfund Amendments and Reauthorization Act
TOC	Total Organic Carbon
USACE	Unites States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

CONTENTS

APPENDICES

FIGURES

TABLES

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1. INTRODUCTION

The primary and unique objective of this work was to demonstrate and validate long-term performance of a reactive amendment that was placed for treatment of contaminated sediments at an active Department of Defense (DoD) harbor. This project extended current pilot-scale testing of the application of activated carbon (AC) to decrease the bioavailability of polychlorinated biphenyls (PCBs) in contaminated sediment to near full-scale demonstration under realistic conditions at an active DoD harbor site. The evaluation was conducted under field conditions at Pier 7 at the Puget Sound Naval Shipyard (PSNS), Bremerton, WA.

Demonstration and validation on the preceding project (ESTCP ER-201131; Kirtay et al. 2017) focused on: 1) placement of the amendment in deeper water areas that support vessel traffic; 2) physical stability and longevity of the amendment in the sediment following placement; 3) effectiveness of the amendment in controlling contaminant bioavailability over time; and 4) response of the benthic community to the amendment application, and largely consisted of the same project team members (Appendix A). This follow-on project aimed to address these same goals, 7-years post placement of the remedy. Performance objectives for this project were specifically designed to assess physical endpoints (including distribution, mixing and stability), chemical endpoints (including changes in PCB partitioning/sorption in the presence of the amendment), and biological endpoints (including tissue concentrations of contaminants and assessment of benthic community effects following placement). This range of monitoring endpoints allowed the team to examine multiple facets of the amendment's long-term performance under an active harbor setting, including the feasibility of deep water stability of material placement, the extent to which material placement reduces tissue residue concentrations of PCBs (and mercury), together with the observable impact or enhancement of the structure, diversity, and density of the benthic community.

1.1 BACKGROUND

Active, deep-water DoD harbor areas pose a number of significant challenges to the effective use of traditional sediment remedies such as dredging, capping and monitored natural recovery (MNR). Successful demonstration of long-term stability and effectiveness of in-situ treatment materials that can address these challenges has the potential to reduce costs and recovery timeframes for a wide range of active DoD sites and provide a more effective alternative to traditional methods of remediation. Cleanup costs for contaminated sediments at DoD sites are estimated to exceed $2B. Cost effective remedies for sediment remediation at contaminated DoD sites are limited, particularly for active harbor areas. Currently, the primary remedial options for DoD sites include dredging, isolation capping, and MNR (USEPA, 2005). Although in-situ treatment is described in EPA Guidance for Contaminated Sediment Remediation (2005), large-scale demonstrations, implementation and acceptance are generally lacking, and there had been no demonstrations in active DoD harbors until the parent project (ER-201131; Kirtay et al. 2017, 2018) that led to this one.

Dredging is expensive, energy intensive, can have adverse short-term effects, severely impacts the benthic community, can negatively impact surface water, cannot be applied near structural bulkheads and beneath piers, and its effectiveness is often hampered by the inability to remove contaminated sediments in and around the pier and structural areas that are common to active DoD harbors. Conventional sand-based isolation capping also impacts the benthic community, may be limited by vessel draft requirements, can be unstable in the face of ship and tug movements, and has minimal capacity to control sources. MNR is generally targeted to quiescent, depositional environments and is generally thought to be poorly suited to high-energy environments subject to significant vessel traffic. To date, the majority of the *in situ* reactive amendment applications have been small, pilot-scale efforts generally targeted to areas with minimal vessel traffic, obstructions or harbor activities. In addition, most of these efforts have focused on the use of granulated AC, which may not be suitable for delivery and stability in deep water active harbors due to its low density. Extending these efforts to an active DoD harbor area where propeller wash, piers, bulkheads, deep water and a range of other common challenges associated with coastal installations was necessary (and conducted under ER-201131) to demonstrate the broader, more critical application for solving DoD's contaminated sediment challenge.

1.2 OBJECTIVE OF THE DEMONSTRATION

The primary objective of this project was to evaluate the long-term stability and effectiveness of AC-based amendment as *in situ* treatment for persistent hydrophobic organic contaminant (HOC) impacted sediments. The demonstration focused specifically on PCBs, but should be applicable to other HOC sediment sites. The demonstration also evaluated the secondary consideration of ensuring the amendment would not adversely affect benthic ecological resources. While many studies have addressed the short-term performance of AC amendments, there is a general data gap with respect to long-term performance. This data gap leaves uncertainty based on the multitude of potential long-term outcomes associated with AC performance at DoD contaminated sediment sites, as depicted in the conceptual diagrams presented in Figure 2.

To meet the overall goals of the project, the specific project objectives included evaluation of:

1. Long-term effectiveness of AC amendment to reduce bioavailable concentrations of PCBs in biota and available concentrations of PCBs in porewater;
2. Long-term stability of the AC amendment with observations of the lateral and vertical extent, uniformity, and persistence in surface sediments;
3. Long-term potential for adverse impacts to the benthic community due to the remedy, and;
4. The potential for technology transfer through commercial availability and acceptance of the technology.

These project objectives were evaluated with respect to quantitative and qualitative performance objectives. Data collected in support of the performance objectives provided multiple lines of evidence for assessing the long-term persistence of the amendment as an in situ strategy for limiting chemical bioavailability at contaminated sediment sites.

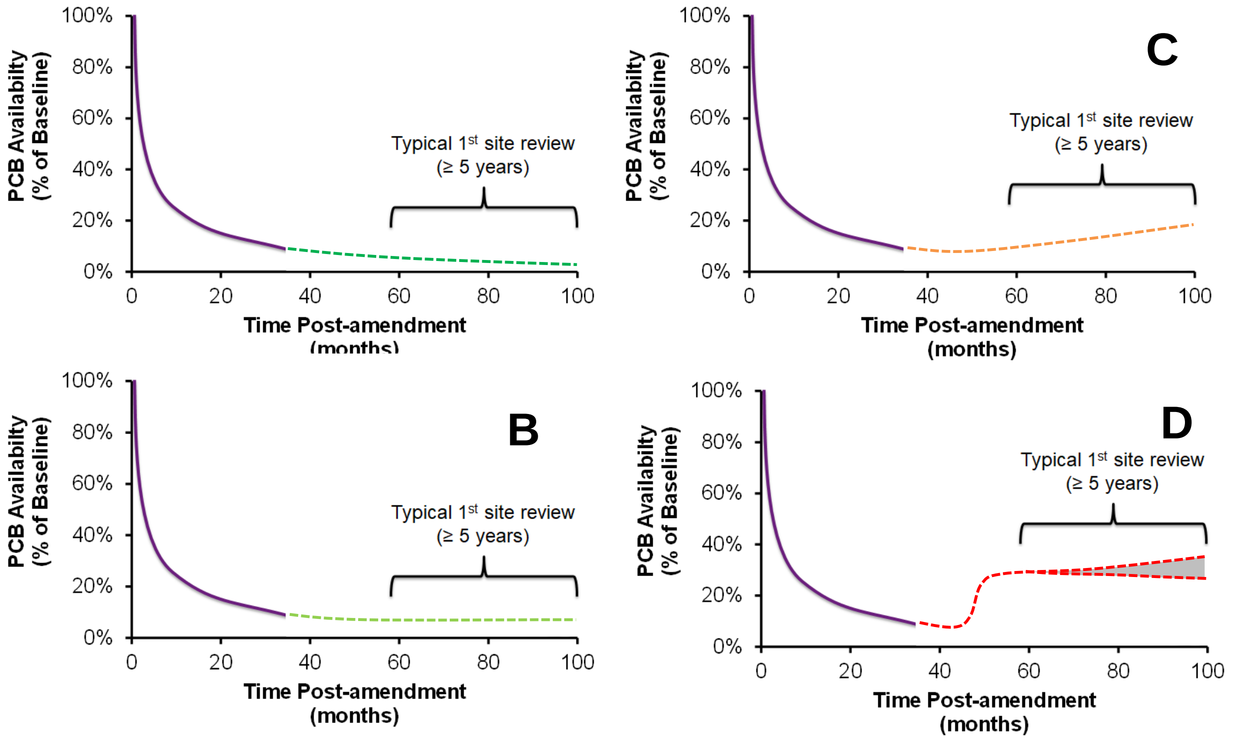

Figure 2. Conceptual models for long-term AC performance including: (A) continued reduction in bioavailability associated with ongoing mixing and contact of the AC with the PCBs; (B) stabilization of bioavailability associated with a rough equilibrium between the AC and the PCBs; (C) a gradual increase in bioavailability associated with potential winnowing of the AC during resuspension events, burial beneath the bioactive zone, bacterial fouling of the AC, edge effects of the pilot plot, and/or moderate levels of recontamination; and (D) an abrupt increase in the bioavailability associated with an extreme event such as a large release of contaminated material or a very large resuspension and redistribution event.

1.3 REGULATORY DRIVERS

The remedy at the Bremerton Naval Complex (Pier 7) under ER-201131 was placed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). Implementation of the CERCLA remediation process is outlined in Title 40 of the Code of Federal Regulations (40 CFR) Part 300, National Oil and Hazardous Substance Contingency Plan (NCP).

2. TECHNOLOGY

This section describes the reactive amendment technology and a suite of *in situ* monitoring tools to provide a better understanding of the amendment's functionality, operation, and performance. Also presented are past applications and the advantages and limitations of this remedial alternative, and its application at the Puget Sound Naval Shipyard site.

2.1 TECHNOLOGY DESCRIPTION

This project focused on long-term performance associated with a recently-completed ESTCP demonstration project (ER-201131; PI Dr. Bart Chadwick; Kirtay et al. 2017, 2018) which involved the placement and three years of post-remedy monitoring of an AC-based amendment (AquaGate+PACTM) for the sequestration of PCBs at Pier 7 at the Puget Sound Naval Shipyard & Intermediated Maintenance Facility (PSNS & IMF; Figure 3). The technologies included are the AC-based amendment itself (Appendix B), which was specifically formulated for successful application in deep water environments, coupled with a comprehensive monitoring program to evaluate the performance of the amendment. The approach generally followed the design used for the pre- and post-installation monitoring in the previous demonstration project (Kirtay et al. 2017, Kirtay et al. 2018), which included physical, chemical, and biological lines of evidence using a suite of largely in situ based technologies to evaluate the persistence, effectiveness, and potential for adverse impacts to the benthic community.

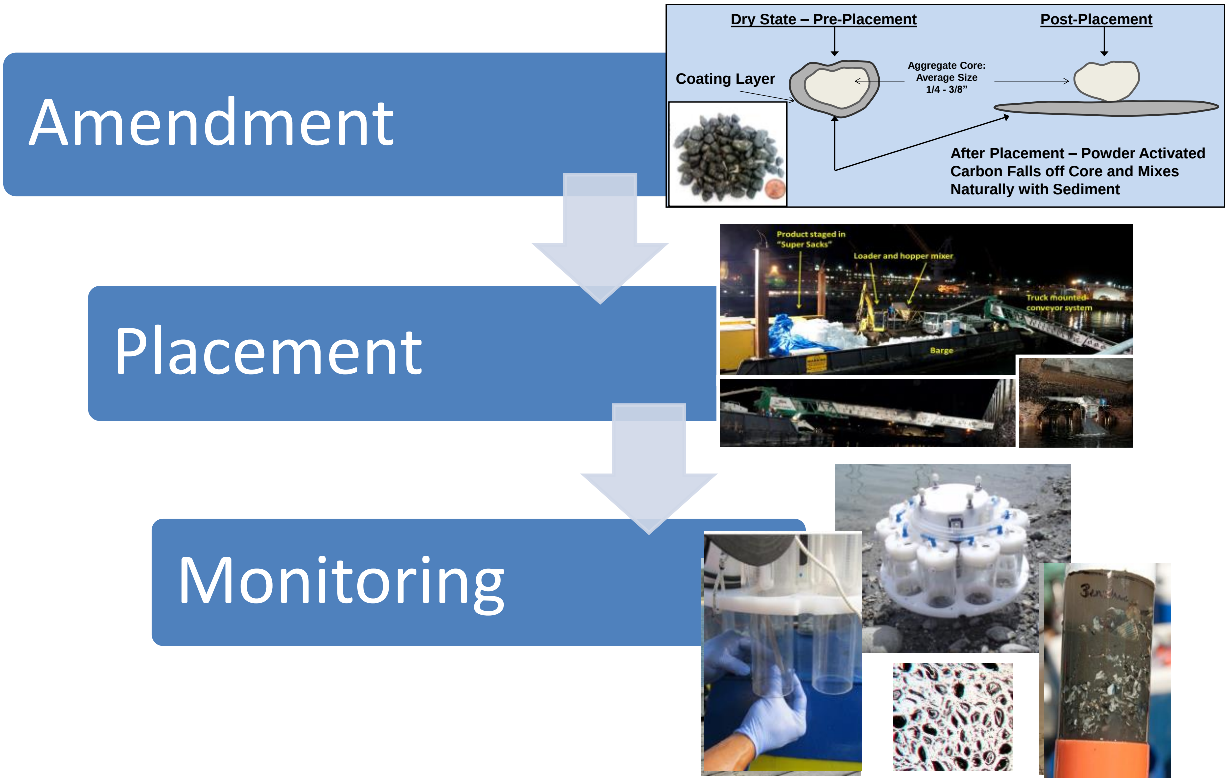

Figure 3. Technology Demonstration – Reactive Amendment, Conventional Delivery System for Placement, and a Suite of Monitoring and Characterization Tools.

Physical parameters assessed in this project characterized the lateral and vertical extent, stability, and content of the AC amendment in surface sediments, to evaluate changes in these parameters over time resulting from natural sedimentation, benthic mixing, ship and tug activity; and/or increased sediment cohesiveness. Chemical parameters included monitoring concentrations of PCB congeners in surface sediment to evaluate changes in bulk concentrations, as well as monitoring the reduction in contaminant availability via *in situ* bioaccumulation of PCBs in clam and polychaetes, as well as porewater concentrations from passive sampling (i.e. magnitude and sustainability of reduced bioavailability). Biological parameters included assessment of any changes in benthic community richness, abundance, evenness, and diversity ~7 years post placement of the remedy. As discussed below, the earlier results of the first monitoring events, as reported in ER-201131 (Kirtay et al. 2017, 2018), indicated immediate and sustained performance of the AC in reducing PCB availability by approximately 70-90%, without any significant adverse impacts on the native benthic invertebrate community.

2.1.1 Contaminated Sediment Remediation

HOCs, such as PCBs and PAHs, when released into the aqueous environment eventually become associated with sediment where they may reside for long periods of time due to a combination of strong sorption and slow degradation (Millward 2005). PCBs have been identified as among the most common chemicals of concern in contaminated sediments in the United States (NRC 2001). These contaminants pose long-term risks to ecosystems and human health.

The most widely used approach for remediating contaminated sediments is dredging and disposal. This approach can be expensive and disruptive to existing ecosystems. Numerous dredging projects have failed to achieve their cleanup goals because they were carried out when site conditions were unfavorable or because of dredging residual contamination, an inevitable side effect of dredging (NRC 2001). Also, dredging is not always feasible (e.g., beneath existing piers and directly adjacent to engineered bulkheads). Capping with clean sediments, another widely used remedial option, is not always practical in sensitive environments, such as wetlands or in areas where changes to the sediment bathymetry are of concern (e.g., shipyards). Finally, monitored natural recovery (MNR) of sediments, a risk management alternative that relies upon natural environmental processes to permanently reduce risk to the environment (Magar et al. 2009), is generally targeted to quiescent, depositional environments and is generally thought to be poorly suited to high-energy environments subject to significant vessel traffic.

While existing remedial options continue to be important and effective strategies under suitable conditions, numerous DoD and non-DoD sites face increasing demands to address contaminated sediment issues, particularly in active harbor areas where traditional remedial options such as dredging, capping and monitored natural recovery (MNR) may be limited in effectiveness. Due to the complexity and heterogeneity of many sites, a combination of approaches and new technologies are needed to develop economic and effective ways to treat sediment contamination. More recently, research in contaminated sediment management has been moving towards the use of *in situ* sorbent (reactive) amendments as a means of altering sediment geochemistry and increasing contaminant binding to reduce contaminant exposure (Ghosh et al. 2011, Patmont et al. 2015, Kirtay et al. 2018, Wang et al. 2022).

2.1.2 Contaminant Sorption in Sediments

It has long been understood that the organic matter (OM) in soils and sediments is the principal factor controlling sorption of organic compounds (Lambert, 1968). Sorption to sediment is a key process in determining the actual fate and risk of HOCs in aquatic environments. It lowers aqueous concentrations and therefore reduces mobility, bioavailability, and chemical and biological degradation processes (Jonker and Koelmans, 2002). Because of their hydrophobic nature, HOCs predominantly sorb to the hydrophobic regions of sediments. The volumetrically most important sedimentary hydrophobic domain is natural organic carbon, the degradation product of dead biomass. Therefore, sorption is commonly described as being a function of the organic carbon content in sediments (Jonker and Koelmans, 2002). Historically, researchers have estimated the sorption of hydrophobic organic compounds to solids (K_d, L/kg_{solid}) using the organic carbon (OC) content (f_{oc}, k_{goc}/kg_{solid}) and the OC-normalized distribution coefficient (K_{oc}, L/k_{goc}). This model assumes that all hydrophobic chemicals partition into organic matter. However, some reported sorption data do not conform to this partitioning model, and researchers have observed K_d values that are greater than predicted by f_{oc} K_{oc}. To explain this discrepancy, it has been proposed that sediments and soils contain more than one carbon fraction, each sorbing chemicals with a different affinity (Accardi-Dey and Gschwend 2002).

For regulatory purposes, the organic carbon fraction is typically taken as a measure of the sorption capacity which enables normalization of the aqueous equilibrium relationship for sediments containing different amounts of organic carbon. However, as mentioned above, it is now understood that this approach is too simplistic because organic carbon in sediment comes in different forms that may have very different sorption capacities for HOCs (Ghosh et al 2003). As shown by numerous research studies (Grossman and Ghosh 2009; Lohmann 2005; Cornelissen 2005; Cornelissen 2004; Ghosh et al 2003; Jonker and Koelmans 2002; Kraaij et al 2002), in addition to natural materials such as vegetative debris, decayed remains of plants and animals, and humic matter, sediment organic carbon also comprises particles such as coal, coke, charcoal, and soot (often referred to as black carbon (BC[1]) that are known to have extremely high sorption capacities. For example, the log K_{oc} values for the PAH phenanthrene spans several orders of magnitude: non-BC lignin=5 and humic acid=5; BC-derived particulate charcoal=5.5, soot carbon=6.5 and activated carbon=7 (Ghosh et al, 2003). The possible importance of black carbon in sorption processes in sediment has led to an increasing body of research into the use of carbon sorbents to reduce HOC bioavailability in sediments (Cornelissen 2011; Ghosh et al 2011; Oen 2011; Werner et al 2010; Cho et al 2009).

2.1.3 *In Situ* Sorbent (Reactive) Sediment Amendments

Reactive amendments are chemical or mineral-based materials designed to react *in situ* with sediments and porewater through direct contact or emplacement in caps or barriers. They do not decrease the total sediment concentrations of contaminants but rather decrease contaminant bioavailability and transport to surface- and groundwater. As more emphasis is being placed on the development of alternative *in situ* sediment remedial technologies (USEPA 2005; SERDP 2004; SERDP 2016) and research has demonstrated strong binding of HOCs in anthropogenic and naturally occurring particulate, black carbonaceous matter in sediments (Zimmerman 2004), there is a growing movement towards the development and application of *in situ* sorbent amendments for contaminated sediment management.

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[1] Black Carbon is generally defined as a carbonaceous material formed during the incomplete combustion of plant or other organic materials (Grossman and Ghosh 2009).

There are numerous reactive amendments – both natural mineral sorbents (e.g. apatite, barite, bentonite) as well as engineered materials (e.g. ATS, Thiol-SAMMS) – that have been bench-scale tested for their organic and metal sorption capacity (Kwon et al. 2010; Ghosh 2011; Ghosh 2008). For HOCs such as PCBs, activated carbon (AC)[2] has been demonstrated to be the most effective type of sorbent. Other carbon types such as coke, charcoal, and organoclays have been suggested, but the sorption capacity for PCBs and PAHs in activated carbon[2] is at least an order of magnitude higher than in the other sorbents (Ghosh 2003).

Laboratory studies have demonstrated that contaminated field sediment amended with activated carbon amendments in the range of 1-5% reduced the equilibrium pore water concentrations of HOCs in the range of 70-99%, thereby reducing the diffusive flux of the HOCs into the water column and transfer into organisms (Hale 2010). Most studies (e.g. Ghosh et al. 2011, Kirtay et al. 2018, and references therein) using benthic organisms show a reduction of biouptake of HOCs in the range of 70-90% compared to untreated control sediment. Similar results have recently been observed in laboratory studies investigating biological uptake reduction with AquaGate+PAC™ in PCB contaminated sediments from PSNS. The results from the laboratory treatability study conducted prior to the ER-201131 demonstration that preceded this long-term assessment showed that amending the contaminated sediment collected from the Bremerton Naval Complex (BNC) Pier 7 site with AC (delivered as AquaGate+PAC™) in laboratory scale studies effectively reduced the bioavailability of PCBs to the marine polychaete, *Neanthes arenaceodentata*, with increasing AquaGate contact time with the Pier 7 sediment resulting in progressively lower uptake with up to 94% total PCB reduction after a one month mixing period. The three-years of post AquaGate placement monitoring at the Pier 7 site showed similar scales of reductions in PCB availability for PCBs in sediment porewater, field-deployed marine polychaetes, *Nephtys caecoides*, and marine clams, *Macoma nasuta* (Kirtay et al. 2017, 2018).

2.1.4 AquaGate+PAC™ Composite Aggregate Technology

The goal of reactive amendment technology, specifically *in-situ* remediation approaches, for contaminated sediments is to reduce bioavailability and contaminant transport by introducing a small amount of a chemical sorbent to the contaminated surface sediment. The chemical composition of the sorbent is selected based on the nature of sediment contamination and the extent to which amendments are required to achieve specific remedial strategies.

Among the large number of amendments tested, AC has shown promising results at pilot-scale for reducing the bioavailability of HOCs such as PCBs in sediment. However, AC has a very low bulk density and readily floats in fresh and saline waters. This property limits the ability for AC to be applied to sediments that are underwater continuously (i.e., sediments in areas below the low-water tide line) because AC added directly to underwater sediment tends to float upwards into the water column rather than remain within the sediment. Previously-successful applications of AC to aquatic sediment have been primarily limited to sediment in shallow areas that were exposed to the air at low tide, allowing manual mixing of the AC into the sediment using land-based equipment before the tide covered the area with water.

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[2] Activated Carbon is produced from coal or biomass feedstock and treated with high temperature to produce a highly porous structure with greater sorption capacity (Ghosh et al. 2011).

A range of approaches for applying AC to underwater sediments have recently been demonstrated at a pilot scale. One of these technologies considered to have significant potential for flexible, low cost application of powder activated carbon (PAC) was developed by AquaBlok, Ltd (hereafter referred to as AquaBlok).

AquaBlok initially applied its composite particle technology to the delivery of a bentonite-based material to form a low-permeability cap over contaminated sediments. This technology is now well proven, having been successfully evaluated under the USEPA SITE (Superfund Innovative Technology Evaluation) program and installed at over one hundred sites to contain the migration of contamination in sediments or soils. In 2007, AquaBlok began working both in Norway and the U.S. to adapt its technology for the delivery of PAC through the water. This product is called AquaGate+PAC. Below is a schematic representation (Figure 4) of the composite particle approach employed by AquaBlok for PAC.

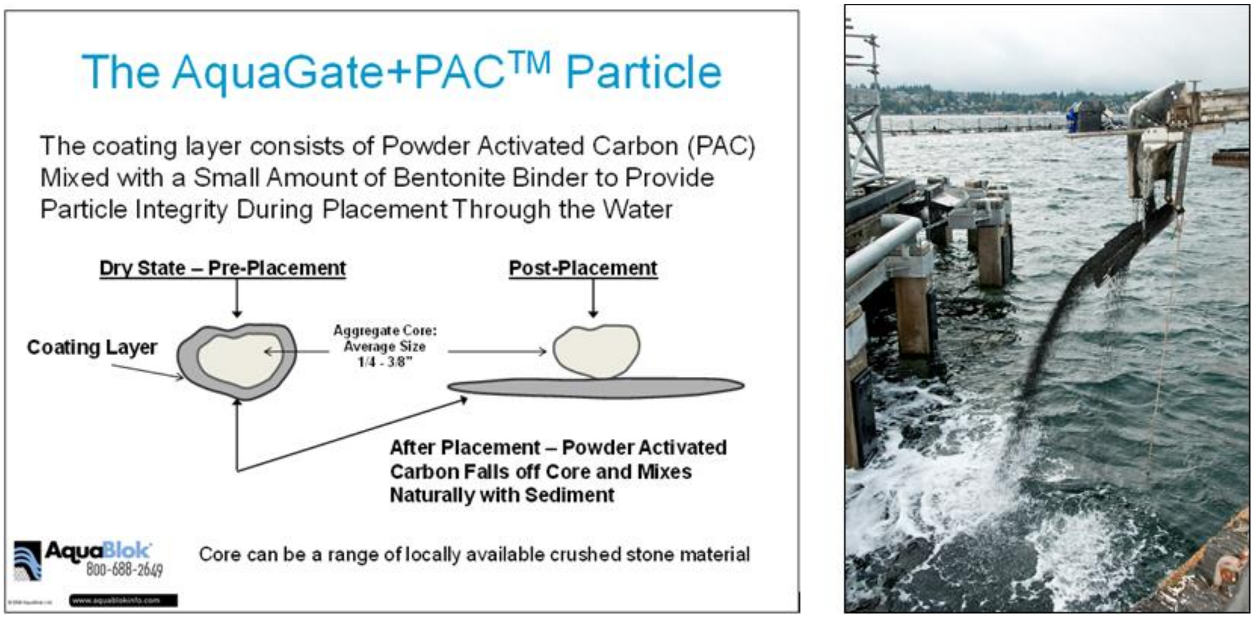

Figure 4. AquaGate composite particle technology (left), and 2012 placement of the amendment at Pier 7 (right).

The AquaGate composite particle is manufactured using a crushed stone core coated with a combination of bentonite-based clay and powder activated carbon materials. Because bentonite-based clay minerals are known to have a high cation exchange and binding capacity for metals, this single composite particle will also be evaluated for its mercury sorption capability. Because the lighter powder materials are bound to an aggregate substrate to form the composite particle, the particle has a very high specific gravity (compared to the coating materials) and it will fall rapidly through the water, either alone or in combination with other granular materials.

As shown in Figure 4, after placement, the coating materials will disaggregate from the stone core and become mixed with the underlying sediment. It is expected that natural mixing (bioturbation) will take place over time and incorporate the PAC material into the surface sediment layer allowing it to adsorb target contaminants, providing reduction in bioavailability over time. Specifications of AquaGate+PAC are provided in Appendix B.

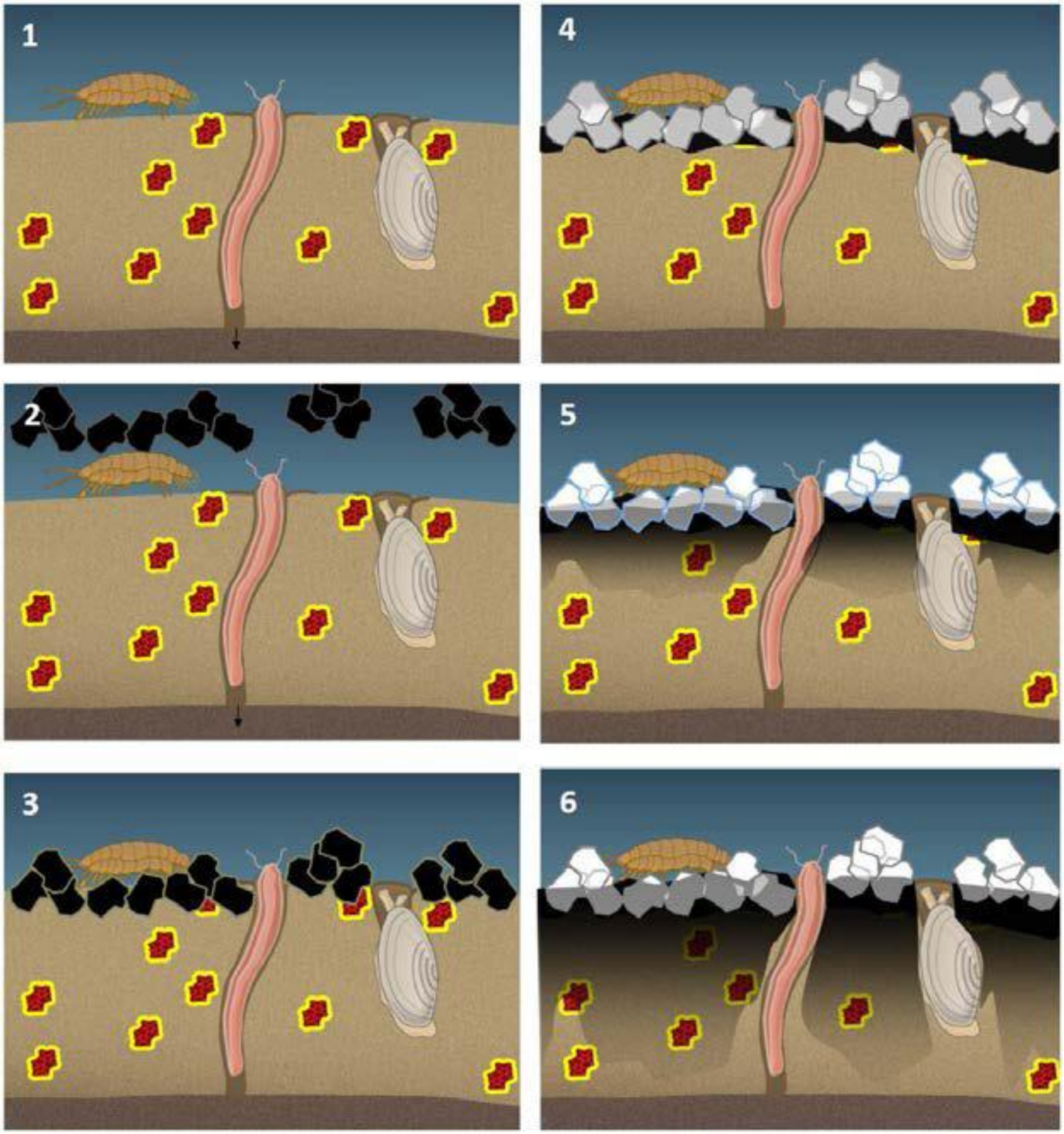

Figure 5. AquaGate+PAC delivery (frames 1-3), AC release (4), and mixing in surface sediment (5-6).

Validation of the AquaGate and other AC amendment technologies have progressed since the initiation of ER-201131 in 2011. In addition to the 3-year demonstration and validation at Pier 7 under ER-201131 (Kirtay et al. 2017, 2018), pilot scale studies at DoD sites have included those at the Lower Duwamish River Waterway (Amec Foster Wheeler et al., 2018), Pearl Harbor Naval Shipyard (NAVFAC 2018), Hunters Point Naval Shipyard (NAVFAC 2015). Based on the growing number of research and demonstration projects supported by SERDP/ESTCP, DoD sites, and industry, reactive sediment amendments, and specifically AC, has emerged as a well understood and heavily researched remediation alternative. Significant bench scale testing of AC has demonstrated its applicability for binding contaminants into matrices that reduce aqueous phase concentrations and bioavailability (Ghosh et al 2000; Ghosh et al 2003; Millward et al 2005; USEPA 2005; Zimmerman 2005; Ghosh et al 2009; Merritt et al 2009; Patmont et al. 2015). For hydrophobic organic contaminants such as PCBs, AC has shown consistently positive results for (Luthy et al 2004; Magar et al 2003). Although a form of AquaGate was applied in a deep water setting during a pilot project in Bergen, Norway in early 2010, this delivery technology had not been used in the U.S. to place PAC in a deep water active shipyard setting until ER-201131 (Kirtay et al. 2017, 2018).

2.2 TECHNOLOGY DEVELOPMENT

Extensive technology development, through laboratory and field demonstrations, has occurred over the past 20-plus years. The most relevant development related to the site, however, includes being laboratory treatability studies conducted by NIWC Pacific, the 2012 amendment placement, and 3-year post-placement monitoring program at Pier 7 as reported by Kirtay et al. (2017) and Kirtay et al. (2018). Key monitoring tools (i.e *in situ* bioaccumulation and passive sampling) used in that project were reemployed here based on the previous successes of those tools, and for comparability between earlier and long-term monitoring events. Additional technologies to characterize the presence of the activated carbon 7 years post-placement were reincluded and expanded upon using tools such as black carbon characterization by chemical oxidation (Grossman and Ghosh 2009) and activated carbon presence by carbon petrography (Wang et al. 2022).

2.3 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY

The principal strategies used for managing contaminated sediment include monitored natural recovery (MNR), *in situ* capping, and dredging. *In situ* treatment (e.g., reactive amendments) is often categorized as a type of *in situ* cap. However, for the purpose of this document and in accordance with EPA guidance, *in situ* treatment is considered here as a fourth remedial strategy although it's application at full-scale has yet to be demonstrated and is still under development as exemplified by this and other research projects (e.g. Ghosh et al. 2011). Each remedial strategy has its advantages and limitations. The selection of the most appropriate strategy, or combination of strategies, requires balancing several criteria for remedial selection which includes long-term effectiveness, permanence and cost; and reduction of toxicity, mobility, or volume through treatment (USEPA 2005). While a comprehensive review of the advantages and limitations of these remedial strategies is beyond the scope of this report, a summary, as described in the USEPA 2005 *Sediment Remediation Guidance for Hazardous Waste Sites* was included in Kirtay et al. (2017), and focused on comparisons of tools including monitored natural recovery, *in situ* capping, dredging, and reactive amendments.

3. PERFORMANCE OBJECTIVES

The objective of this work was to demonstrate long-term persistence and performance of reactive amendments for in-situ treatment of contaminated sediments in active DoD harbor settings. The technology deployed incorporated a combination of a reactive amendment, a conventional delivery system, and a suite of robust monitoring techniques for assessing persistence and effectiveness in reducing bioavailability, and potential adverse effects to the benthic community.

This follow-on project to ER-201131 (Kirtay et al. 2017, 2018) was designed to assess the long-term (~7-year) performance and effectiveness of the application of a reactive amendment (AquaGate+PAC) to an active DoD, deep-water harbor site at the Puget Sound Naval Shipyard Pier 7 (Bremerton, Washington). At this site, elevated surface sediment concentrations of PCBs were of concern, and physical disturbance is dominated by ship and tug activity. The preceding demonstration provided baseline (pre-amendment placement) monitoring and post-placement short-term monitoring at 10, 21, and 33 months after placement of the reactive amendment using both quantitative and qualitative measurements to achieve the objectives of the project. Long-term (i.e. 82 months) performance was evaluated using many of the same measurements, but was also assessed qualitatively based on the uncertainty of site-specific factors that could have altered the presence and performance of the amendment, such as winnowing, low to moderate resuspension events, or presence of significant newly deposited sediment. The performance objectives for the long-term monitoring are provided in Table 1. Additional details regarding the design of this study, data requirements, and statistical analyses are provided in Section 5 (Test Design). Results of the study are detailed in this report with additional detail provided in Appendix C, D E, and F.

Demonstration and validation focused on:

(1) Long-term effectiveness of AC amendment to reduce bioavailable concentrations of PCBs in biota and available concentrations of PCBs in porewater;

(2) Long-term stability of the AC amendment with observations of the lateral and vertical extent, uniformity, and persistence in surface sediments;

(3) Long-term potential for adverse impacts to the benthic community due to the remedy, and;

(4) Promotion of technology availability and regulatory acceptance, which formed the basis of the performance objectives for this project.

Data collected in support of these performance objectives were used to provide multiple lines of evidence for assessing the effectiveness of long-term performance of the amendment as an *in situ* strategy for reducing chemical bioavailability at contaminated sediment sites.

Table 2. Performance Objectives.

Qualitative Performance Objectives			
#	**Objective**	**Data Requirements**	**Success Criteria**
1	Demonstrate reduction in PCB bioavailability is sustained over time.	Polychaete and bivalve bioaccumulation *in situ*. Passive sampler uptake *in situ*.	Rigorous characterization of PCB bioavailability at 10 multi-metric stations 82 months post amendment placement.
2	Demonstrate the continued presence of activated carbon within the target amendment area and physical stability over time.	Lloyd Khan for Total Organic Carbon (TOC) content, petrographic analysis for carbon speciation, and chemical oxidation method* for analysis of black carbon within the footprint.	High resolution evaluation of TOC and AC presence using multiple methods at four profiles within the top 20 cm at 20 sampling locations for TOC and BC (chemical oxidation) and 7 select sampling locations for AC by petrographic analysis.
3	Evaluate benthic community changes in response to amendment.	Benthic community census data.	Successful sampling and analysis of benthic community metrics for comparison with short-term monitoring data and concurrent comparison of both reference and amended sediment stations.
4	Promote technology transfer and acceptance.	Results from Tasks 1-3, collaboration with site managers and regulators, broad dissemination within the community of practice.	Identifying commercial vendors, cooperation with site managers and regulators, publicizing long-term performance through inter-agency and commercial workgroups.

*Grossman and Ghosh (2009)

3.1 PERFORMANCE OBJECTIVE #1: DEMONSTRATE SUSTAINED REDUCTION OF PCB AVAILABILITY OVER TIME

Description

The effectiveness of the technology for contaminated sediment remediation is a function of the degree to which the target contaminants are sequestered by the reactive amendment and contaminant bioavailability to benthic organisms is decreased. The success in remediating the test area depended on the demonstration of the reduction in bioaccumulation and porewater concentrations of the target contaminants of concern (PCBs) in the field. This task evaluated the extent to which the amendment contributed to the reduction in availability of PCBs to the benthic invertebrate community 7 years post placement of the amendment.

3.1.1 Data Requirements

The effectiveness of the amendment was evaluated on the basis of reduction in bioaccumulation of PCBs in benthic organisms and concentration in sediment porewater (passive sampler PCB concentrations) relative to baseline conditions. The tools to evaluate changes in availability included measurement of PCB concentrations in benthic invertebrates *in situ* using the Sediment Ecotoxicity Assessment Ring (SEA Ring) technology (Burton et al. 2012, Rosen et al. 2012, Rosen et al. 2017) and measurement in sediment porewater concentrations using solid-phase microextraction (SPME) methods (porewater concentrations represent the bioavailable chemical fraction in sediments). Data for this assessment included 7-year post-placement contaminant concentrations in *Nephtys caecoides* (polychaete) and *Macoma nasuta* (bent-nosed clam) and sediment porewater concentration using SPME.

3.1.2 Success Criteria

The objective was considered to be met if characterization of PCB bioavailability at the 10 surface (uppermost 10-15 cm) sediment multi-metric stations used in the previous project (ER-201131; Kirtay et al. 2017) resulted in useful data for both benthic species and passive samplers with which to compare with similar measurements obtained during the first three years of monitoring. ANOVA and non-parametric tests comparing baseline, post-amendment placement, and long-term monitoring results were applied as appropriate to test the significance of the data.

Extent to Which Success Criteria Were Met

Concentrations of total PCBs in *M. nasuta* tissue were 93% lower relative to pre-amendment (baseline) monitoring levels. Eight of the 10 stations were non-detect for PCBs, so half the method detection limit (MDL) was used to represent tissue PCBs at stations with non-detect results.

Concentrations of total PCBs in *N. caecoides* tissue were 95% lower relative to pre-amendment (baseline) monitoring levels. Seven of the 10 stations were non-detect for PCBs, so half the MDL was used to represent tissue PCBs at stations with non-detect results.

Concentrations of total PCBs freely dissolved in sediment porewater were 85% lower relative to pre-amendment (baseline) monitoring levels. Eight of the 10 stations were non-detect for PCBs, so half the MDL was used to represent C_{free} data at stations with non-detects.

3.2 PERFORMANCE OBJECTIVE #2: DEMONSTRATE LONG-TERM PRESENCE OF ACTIVATED CARBON

Sediment samples were collected from 20 stations, including the 10 multi-metric stations previously used for ER-201131 and 10 additional stations within the amendment footprint, and analyzed to investigate the trends in the presence and mixing of AC added to the Site in October 2012. There are no standardized methods of quantifying the AC content of sediment. AC is carbon produced from natural source materials (nutshells, coconut husk, peat, wood, lignite, coal, and/or petroleum pitch). Traditional Total Organic Carbon (TOC) content measurement methods (e.g., Lloyd Khan) can under-represent levels of AC in sediment, as some of the natural source material-derived AC is lost prior to quantification of TOC (Grossman and Ghosh, 2009). This loss of AC may have resulted in biased-low measurements of AC in the original Pier 7 sampling events (Kirtay et al., 2018).

3.2.1 Data Requirements

For the monitoring of AC at the Site, three approaches were used to evaluate AC in Site sediment: 1) an analysis of TOC content (consistent with previous measurements using the Lloyd Khan method); 2) an analysis of Black Carbon (BC) content using the Grossman and Ghosh (2009) chemical oxidation method; and 3) a petrographic analysis to identify and quantify AC content (Ghosh et al., 2003).

The Lloyd Khan TOC method was used in order to remain consistent with previous data (Kirtay et al., 2018), and to provide a point-of-comparison to measurements of BC. BC is a form of soot formed during the incomplete, high temperature combustion of fossil fuels, biofuels, wood and cellulose, and biomass. Typical BC methods use a thermal oxidation of the sample at 375° C to separate BC from natural organic matter in soils and sediments; however, this results in significant loss of AC along with the natural organic matter (up to 98% of AC; Jonker and Koelmans, 2002). The Grossman and Ghosh (2009) method uses an alternate chemical (rather than thermal) oxidation step to remove natural organic matter while retaining the AC, and the method is considered to be more accurate than TOC or other BC methods in quantifying AC content (Grossman and Ghosh, 2009; Floyd et al., 2019). Synchronous measurement of TOC and BC in the samples collected allowed a numerical relationship between the TOC measurement and BC measurement to be developed, and this may be able to provide a back-correction of TOC data previously collected at the Site. To supplement the TOC and BC measurements, petrographic analytical methods were used to provide a detailed composition analysis of the carbon present in sediment core samples collected from the 10 target stations. This method uses a small sample of sediment that is mounted, thin-sectioned, and evaluated via microscopy to visually identify carbon types present and provide a volumetric quantification that can be converted to express carbon content on a mass carbon per mass sediment basis.

Sediment profile imagery (SPI) was not included as a line of evidence to evaluate carbon presence in this study. The last monitoring survey in the previous monitoring effort under ER-201130 (33-months post-placement) suggested the optical signature of the AC amendment may be slowly “disappearing” through natural depositional processes and bioturbation of the infauna community. That is, SPI may no longer be able to visually detect changes in AC presence based on sediment color observations, despite the confirmed presence of elevated TOC content and amendment aggregate in the surface layers (Kirtay et al., 2018).

3.2.2 Success Criteria

Collectively, the selected three methods for evaluating AC presence were used to verify whether or not the amendment remains distributed within the majority of the target area laterally while also continuing to mix vertically over time. Success was based on the ability to detect and compare TOC and BC both vertically and laterally at relatively high resolution using a greater number of sampling locations and depth horizons within the amendment footprint at Pier 7. Success criteria assumed the possibility of significant layers of natural deposition and enhanced mixing due to resuspenion events and natural processes such as bioturbation, which could explain or obscure measurements of TOC/BC in surface layers. Sediment layers were increased to 25 cm (from 20 cm in ER-201131) to assess the presence of TOC/BC.

3.2.3 Extent to which success criteria were met

TOC levels measured in sediment at 82 months ranged from 2.5-3.3%, on average, and were generally consistent among the 4 depths measured**.** This range continues to be stable and comparable with levels observed in the 33-month monitoring event. For the 0-5, 5-10, and 10-15 cm layers, 33-month and 82-month results were not statistically different.

Black Carbon (BC) levels measured at 82 months ranged from 0.7-1.3%, on average. This range continues to be stable and comparable to levels observed in the 33-month event. For the 0-5, 5-10, and 10-15 cm layers 33-month and 82-month results were not statistically different.

On average, the activated carbon (AC) content indicated by carbon petrography was 0.9% among all samples (n=32).

When compared with samples for which no aggregate (associated with the delivery of the amendment to the sediment) was observed, those samples with aggregate presence had a 4.3-fold higher concentration, on average, for both BC and AC.

3.3 PERFORMANCE OBJECTIVE #3: EVALUATE LONG-TERM BENTHIC COMMUNITY CHANGES IN PRESENCE OF AMENDMENT

This task evaluated the secondary influence of the amendment on the benthic community. Secondary effects of the amendment in altering the benthic community were tracked based on comparison to baseline conditions.

3.3.1 Data Requirements

Data required to evaluate potential secondary effects of the amendment on the benthic community included a benthic taxonomic survey 82 months post placement using methods provided by Ecoanalyts, Inc. that were employed in ER-201131. Results were used to document the effects of amendment placement on the density and diversity of the benthic community, and to document changes in community structure with time after amendment placement. Invertebrates were identified to the lowest possible taxonomic level and enumerated, with results used to compute comparative ecological parameters such as organism density, species richness, and evenness. These comparative parameters allowed for evaluation of the ecological response of the benthic invertebrate community to the reactive amendment.

3.3.2 Success Criteria

Success focused on quantification of any long-term changes that occurred in relationship to the placement of the amendment. Because the amendment did alter the sediment substrate, changes in the benthic community were initially expected to some degree. However, very little data on the degree of the changes that occur have been reported, especially over long time periods.

3.3.3 Extent to which success criteria were met

Overall, there is no evidence from the 82-month data indicating an effect on benthic invertebrate communities at the amended area, as found for previous monitoring events (Kirtay et al., 2018). No statistically-significant differences among the groups for total abundance, diversity, evenness, Swartz dominance index, and percent abundance of the top 5 abundant taxa were observed, with P values of 0.11, 0.14, 0.81, 0.34, and 0.20, respectively. Differences among the groups for taxa richness were noted ($P = 0.04$). Species richness was statistically different (lower) in the baseline for the unamended area compared to the 82-month amended area, suggesting improved ecological health in the amended area compared to the reference stations. This result may be due to temporal differences, and overall results confirm that species richness in the amended area has not been adversely affected by the AC amendment. The observations in this event further confirm the findings of most scientific studies proposing that adverse effects on benthic invertebrates are not expected as a result of activated carbon amendments (Janssen and Beckingham, 2013), especially when activated carbon dosage rates remain below approximately 5% by weight in sediment (Rakowska et al., 2012; Janssen and Beckingham, 2013; Kupryianchyk, et al. 2015; Patmont et al., 2015).

3.4 PERFORMANCE OBJECTIVE #4: PROMOTE TECHNOLOGY TRANSFER AND ACCEPTANCE

This task involves collaboration with site managers and regulators and broad dissemination within the community of practice, with a particular focus on the long-term performance and persistence of the remedial technology.

3.4.1 Data Requirements

Using the results of the ER-201131 and qualitative performance criteria from this project, the technology transition effort focused on several key elements to improve the probability of implementation. These included (1) transitioning the methods and knowledge to our commercial partners in the project and other qualified commercial entities to provide the expertise and capabilities for long-term monitoring of the remedy; (2) providing publicly accessible documentation of the long-term performance of the technology at an operational site under operational conditions; and (3) disseminating information about the technology performance as widely as possible to the community of practice via conference presentations, webinars, publications and social media. Pathways for technology dissemination for DoD and commercial entities included the NAVFAC Sediment Workgroup, the Sediment Management Workgroup, SERDP/ESTCP webinars and symposia, SERDP/ESTCP websites, social media posts, and the Battelle sediments conference.

3.4.2 Success Criteria

Success was based on the relative degree to which the project team identified commercial vendors, cooperation with site managers and regulators, and publication of long-term performance through inter-agency and commercial workgroups.

3.4.3 Extent to which success criteria were met

Partnering with Geosyntec, CMA, Ecoanalysts, and AquaBlok ensured continuity of methods and continued momentum towards transition of the amendment and associated tools (e.g. passive sampling, SEA Ring bioaccumulation, AquaGate+ amendment products) that have all been commercialized. The co-investigators presented project results as part of the SERDP/ESTCP webinar series in December 2020, the SERDP Symposia in 2020, 2021, and 2022, and the Battelle International Conference on the Remediation and Management of Contaminated Sediments in 2023. A concise peer-reviewed manuscript summarizing the primary scientific contributions of this project was published in February 2022 in the journal *Environmental Toxicology and Chemistry* (Wang, Conder, Chadwick, and Rosen 2022; Appendix D) as a follow on to the primary Kirtay et al. (2018) publication resulting from ER-201131. The team plans to provide additional technology transition activities following the publication of this report.

4. SITE DESCRIPTION

The site selected for the reactive amendment demonstration is in the near-pier areas (Pier 7) of the Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS&IMF; Bremerton, WA). This project leveraged off two prior ESTCP projects, ER-201131, which involved placement and short-term performance monitoring of the amendment at this site, and ER-201130, which critically evaluated the performance of the Sediment Ecotoxicity Assessment Ring (SEA Ring), which is one of the predominant field devices used in an integrated weight-of-evidence based ecological risk assessment approach towards demonstrating the efficacy of reactive amendment addition to contaminated sediments for reducing contaminant bioavailability. The site Remedial Project Managers (formerly Ms. Pam Sargent, and currently Mr. Phil Nenninger) expressed interest in, and agreed to support, the work defined here. The specific location for the field demonstration was identified as the SW corner of Pier 7, located at the Shipyard's eastern end (Figure 6), where both PCBs and Hg (which is co-located with the PCBs) were listed as contaminants of concern. The primary expectation is that the data herein following 7 years post amendment placement answers questions frequently posed by stakeholder and regulatory communities with respect to the longevity of activated carbon amendments.

4.1 SITE LOCATION AND HISTORY

The selected demonstration site (Pier 7, Puget Sound Naval Shipyard and Intermediate Maintenance Facility; PSNS&IMF) is part of the Bremerton Naval Complex (BNC), which is located in the city of Bremerton, Kitsap County, Washington (Figure 6). The Navy maintains 1,350 acres of property along the shoreline of Sinclair Inlet, an arm of Puget Sound.

The BNC consists of two major commands: Naval Station Bremerton (NSB) and Puget Sound Naval Shipyard (PSNS). The primary role of NSB is to serve as a deep draft homeport for aircraft carriers and supply ships. Facilities on NSB property include six piers and moorings, the steam plant, parking, and housing, shopping, recreation and dining facilities for military personnel and their families. NSB also serves as host to several tenant commands including the Naval Inactive Ships Maintenance Facility, which has responsibility to provide for long-term care of inactive naval vessels, and the Fleet and Industrial Supply Center, which provides material acquisition and warehouse services to west coast Navy commands. NSB occupies the western portion of the Complex and is a fenced secure area. The primary role of PSNS is to provide overhaul, maintenance, conversion, refueling, defueling, and repair services to the naval fleet. PSNS has capabilities to drydock and work on all classes of Navy vessels and is the nation's sole nuclear submarine and ship recycling facility. PSNS has six drydocks, eight piers and moorings, and numerous industrial shops to support the industrial operations. Like NSB, PSNS is host to many tenant commands. PSNS occupies the eastern portion of the Complex and is a fenced high-security area.

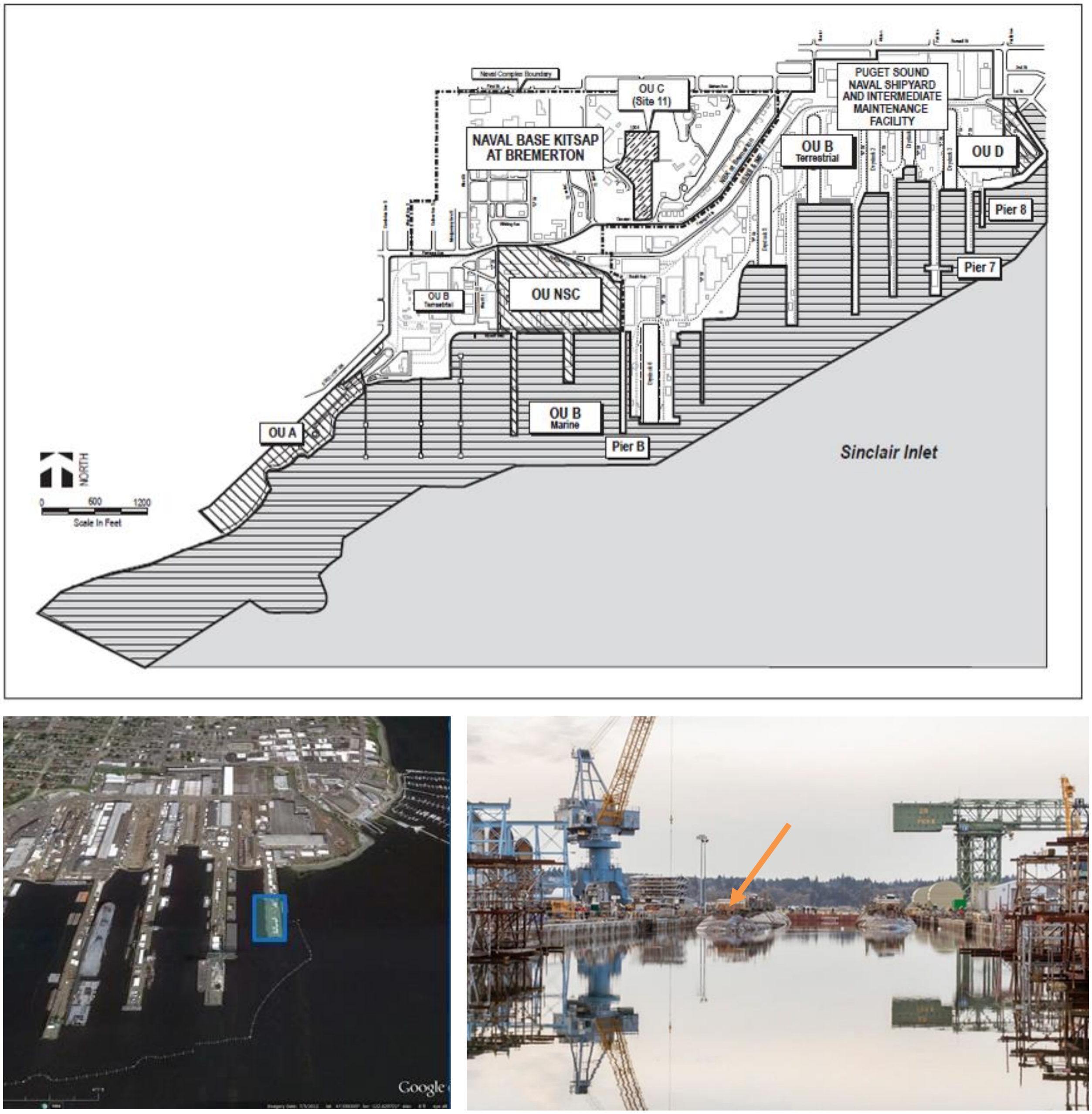

Figure 6. (Top) Bremerton Naval Complex Operable Units (from Draft Final Pier 7 SMR; US Navy 2010); (bottom left) aerial view of PSNS&IMF including Pier 7 (blue box); and (bottom right) water level view of approximate location of amended area (green arrow).

4.2 SITE GEOLOGY/HYDROLOGY

The BNC shoreline has been greatly modified from its original condition. Historically, the area consisted of tidelands, marshes, and forests. The area was cleared and filled in several stages beginning in the late 1800s to accommodate naval operations. At present, the shoreline is comprised of an industrial waterfront that is armored with quay walls and riprap, and is developed with several large over-water structures. Along the quay walls, water depth drops off more or less vertically to approximately 15 to 20 feet below mean lower low water (MLLW). In rip-rapped areas, depths at the immediate shoreline are commonly less than 5 feet MLLW, but drop off steeply beyond this. Recent bathymetric survey data at BNC reveal water depths generally ranging between 40 and 45 feet, except in dredged areas near piers and vessel berthing areas where depths increase to 45 to 50 feet. Offshore of the site, water depths are generally 40 to 45 feet. Depths increase to over 50 feet in two bathymetric depressions located south of BNC in central Sinclair Inlet (US Navy 2008).

Nearshore sediments along the north shore of Sinclair Inlet and in the central inlet are dominated by silt and clay, while those along the south shore are predominantly sandy. Coarser sediments are only present in intertidal areas affected by significant wave action (e.g., Ross Point). The implications of the depositional nature of the inlet are for contaminated sediments to remain resident in the inlet for long periods. Tidal currents and winds are the primary sources of water circulation in Sinclair Inlet. Weak tidal currents move water in and out of the inlet with a maximum velocity of 0.2 to 0.3 knots. Analysis of tidal currents in 1994 indicated residual current speeds of less than 0.2 knots (10 cm/s) for more than 90 percent of the time, regardless of site location, water depth, or season. Residual current speeds higher than 0.2 knots were rare, and speeds higher than 0.4 knots occurred less than 0.5 percent of the time. Surface currents generally flow out of the inlet, although surface current flow into the inlet has been observed during summer months. Near-bottom currents primarily flow into the inlet, regardless of season. Currents are generally not capable of resuspending bottom sediments.

Various studies have noted a predominantly clockwise gyre in the inlet that tends to redeposit most suspended sediments in the inlet. This effect and the generally weak nature of these currents make the inlet more depositional than erosional for both mud (silt and clay) and sand-sized particles. Existing sedimentation rates are 0.5 to 2 centimeters per year. Statistically significant trends have been noted for both sediment deposition and erosion within the Complex. The deposition of sediments at the Complex is a function of the circulation pattern of the inlet. The erosional trend in the northeast end of Operable Unit (OU) B indicates a separate source of sediment resuspension, likely associated with the higher water velocities common in Port Washington Narrows, adjacent to the northeast end of the Complex, and possibly also with propeller wash from Naval vessels and State ferries. Sediments picked up from the sea floor in this part of OU B may eventually redeposit within the inlet, or they may enter the higher- energy environment to the east and be transported away from the inlet.

The prevalent southwesterly winds push surface waters out of the inlet, bringing deep water to the surface for replacement. Observations during the winter and summer of 1994 showed that winds having sustained speeds of 9 or 10 mph from the southwest generated near- surface and mid-level currents out of and into the inlet, respectively. Wave climate in the inlet is dictated by wind-generated waves and vessel wakes. Vessel traffic ranges from small recreational and commercial fishing vessels to occasional larger tug and Navy ship traffic. Wind action in Sinclair Inlet generally creates a wave height range of 0.5 to 2.5 feet. Maximum wave heights are generated with winds from the southwest.

Total organic carbon (TOC) is an important characteristic of marine sediments, because of its influence on benthic habitat and bioavailability of organic compounds. The concentrations of TOC range from 0.5 to 7.9 percent within OUB, and 0.8 to 6.1 percent in the remainder of the inlet. These concentrations are within the range of TOC values found in other enclosed embayments in the Puget Sound region (US Navy 2008).

4.3 CONTAMINANT DISTRIBUTION

Pier 7 lies within an area known as Operable Unit B Marine (OUB Marine) that was previously subject to a Superfund sediment cleanup (USEPA 2000). The primary components of the remedial action included dredging, disposal in a pit excavated in the sea floor in Sinclair Inlet, capping of contaminated sediments in a small area at the southwest end of the naval complex and placement of a thin layer of clean sediment to promote recovery of sediments (enhanced natural recovery) in the area around the cap, stabilization of a section of shoreline in the center of the naval complex and allowing for the ongoing processes of sediment natural recovery to continue to decrease the residual contamination throughout the area over a period of 10 years (US Navy 2008).

The areas within OU B Marine found to have the highest PCB levels were identified for dredging. The highest levels of PCBs were found mostly in areas along the shoreline or adjacent to the moorings and piers (e.g., Pier 7) of the BNC. A limited amount of additional dredging was included in the remedial action based on a combination of elevated mercury levels and moderately-elevated levels of PCBs.

Because BNC is an active Naval facility, there is on-going maintenance and construction in the area. Sediments near Pier 7 were subject to additional rounds of sampling to document conditions in the vicinity of the pier prior to replacement of fender piles associated with the pier. Both pre- and post-sampling was carried out to meet the requirement of state water quality certification for the project (US Navy 2008; US Navy 2010).

The pre-construction sediment sampling involved collection and analysis of 11 sediment samples (0-10 cm) and analysis of these samples for PCB and total organic carbon (TOC), and grain size. PCBs were detected in all of the samples. PCB concentrations ranged from 0.12 mg/kg – 35 mg/kg (2.0 – 1,100 mg/kg OC normalized).

In 2009, work commenced at Pier 7 to remove 325 timber creosote piles and replace them with 166 concrete pilings and place a sand amendment around each replaced piling. Upon completion of this project, post-sampling was carried out. In addition to sampling the same locations again, additional arrays of sampling locations were identified in the vicinity of the locations where elevated PCBs were observed in the pre-construction samples (Figure 7). PCBs were detected in all but two samples and ranged in concentration from 0.028 mg/kg to 2.0 mg/kg (0.94 to 140 mg/kg OC normalized). In general, overall PCB concentrations were lower in the post-construction samples than were measured in the pre-construction samples. However, the highest levels were still observed in the samples collected around locations P7-04 and P7-05 (Figure 7; US Navy 2010).

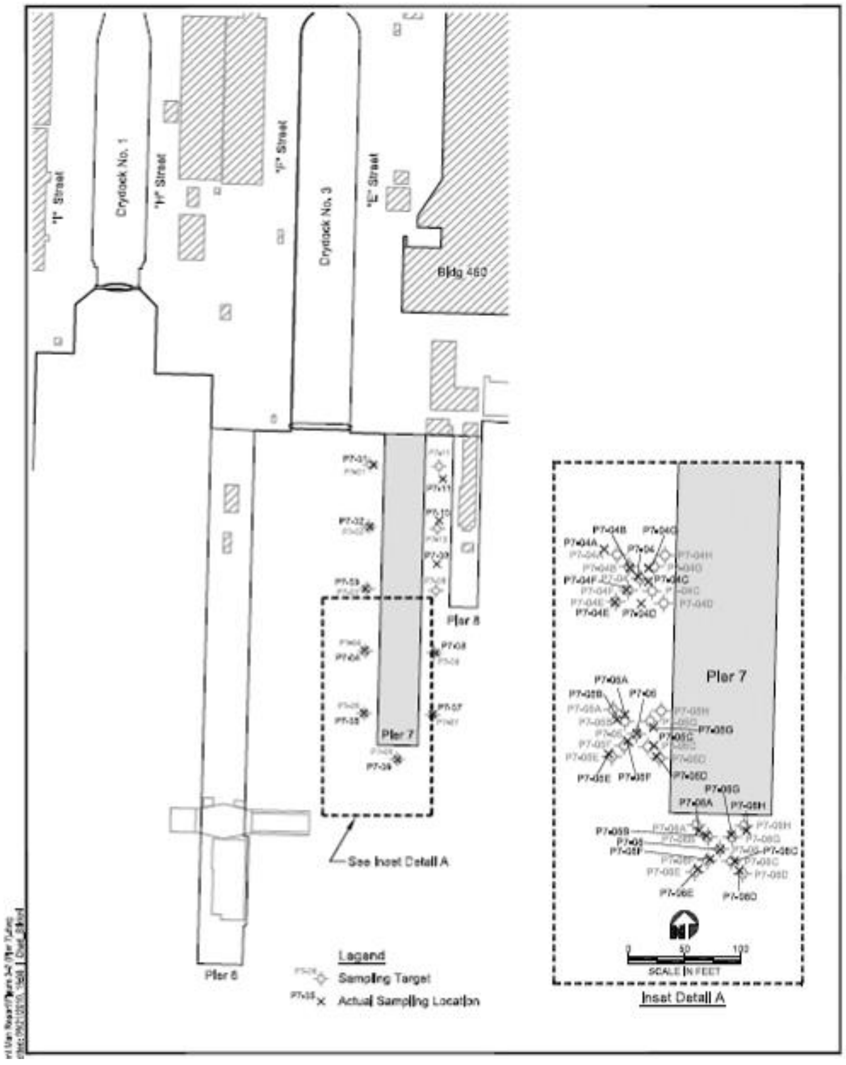

Figure 7. Pier 7 fender pile replacement sampling locations (from Draft Final Pier 7 SMR; U.S. Navy 2010).

Despite a determination that the Pier 7 construction activities would not have a direct impact on achieving the OUB Marine cleanup goals, the continual presence of elevated levels (above Washington State Sediment Quality Standards) of PCBs (and Hg) in the Pier 7 area, resulted in the desire to test alternative *in situ* treatment methods, such as reactive amendments, in this area.

The Navy has conducted several rounds of marine investigations since 1990, including extensive sediment sampling, analyses of tissues of several different marine species, and other tests for direct biological evidence of impacts within the marine environment (U.S. Navy 2008). Based on the results of previous investigations, a decision was made to address the need for marine sediment Remedial Action (RA). The basis for and approach to OU B Marine RA was documented in a Record of Decision (ROD) for OU B Marine. The results of many of these investigations are summarized in the Remedial Investigation (RI) report (U.S. Navy 2008).

The following Remedial Action Objectives established in the ROD for OU B Marine included:

- Reduce the concentration of PCBs in the biologically active shallow sediments from 0 to 10-centimeter (cm) depth within OU B Marine to below the minimum cleanup level (MCUL), as a measure expected to reduce PCB concentrations in fish tissue; Control erosion of contaminated fill material in the central shoreline area of the complex known as Site 1.
- Selectively remove sediment with high concentrations of mercury co-located with PCBs. The sediment cleanup at OU B Marine was developed on the basis of an MCUL for total PCBs of 3 mg/kg organic carbon (OC), measured on an Area Weighted Average (AWA) basis in 0 to 10 cm marine sediments throughout the OU B Marine area. The MCUL of 3 mg/kg OC for PCBs in OU B Marine sediments was developed based on natural recovery modeling that predicted this MCUL could be achieved within 10 years of completion of the RA assuming a post-RA AWA of 4.1 mg/kg OC.

The RA was initiated in June 2000 and the primary remedy elements were completed by the fall of 2001. The primary components of the RA were as follows:

- Dredging of contaminated sediments;
- Disposal of contaminated sediments in a pit excavated in the sea floor in Sinclair Inlet;
- Capping of contaminated sediments in a small area adjacent to OU A at the southwest end of the naval complex and placement of a thin layer of clean sediment to promote recovery of sediments (ENR) in the area around the cap; and Stabilization of a section of shoreline in the center of the naval complex.
- The contaminated sediment offshore of OU A was remediated via placement of a thick cap and ENR. These RAs were conducted from June 2000 through November 2001. ENR of state-owned aquatic lands adjacent to the confined aquatic disposal (CAD) pit were conducted in February and March 2004 and completed on March 14, 2004.

The intent of the RAs in OU B Marine was to perform a gross removal of PCB-contaminated sediment to support the long-term natural recovery objective of reducing the OU B Marine AWA PCB concentrations to below the MCUL of 3 mg/kg OC normalized. Attainment of this objective, as specified in the Final ROD, was to be within 10 years of the completion of RAs (US Navy 2008).

Monitoring results indicate the concentrations of PCBs and mercury were declining within OU B Marine prior to the preceding ESTCP project, ER-201131. However, the area around Pier 7 had consistently resulted in elevated concentrations of PCBs and mercury (U.S. Navy 2010). While the concentrations were not extremely elevated, they fell within the range of moderately contaminated and were representative of typical concentration ranges found at most Navy sites. More recently, the Navy has reported an overall downward trend in sediment PCB concentrations within OU B Marine (DON, 2017).

Most recently, the preceding project (ER-201131) demonstrated *in situ* amendment of surface sediment adjacent to Pier 7 with activated carbon (AC), with results showing that AC amendment was a promising technique for reducing the availability of PCBs in surface sediment at the site (Kirtay et al. 2018). The study evaluated the performance of the logistically challenging activated carbon placement in the high-energy hydrodynamic environment adjacent to and beneath Pier 7. Measurements conducted pre-amendment and 10, 21, and 33 months (mo) post-amendment using *in situ* exposures of benthic invertebrates and passive samplers indicated that the targeted 4% (by weight) addition of activated carbon (particle diameter ≤74 mm) in the uppermost 10 cm of surface sediment reduced PCB availability by an average (±standard deviation) of 81±11% in the first 10 mo after amendment. The final monitoring event (33 mo after amendment) indicated an approximate 90±6% reduction in availability, reflecting a slight increase in performance and showing the stability of the amendment. Benthic invertebrate census and sediment profile imagery (SPI) did not indicate significant differences in benthic community ecological metrics among the pre-amendment and 3 post-amendment monitoring events, supporting existing scientific literature that this approximate activated carbon dosage level does not significantly impair native benthic invertebrate communities.

5. TEST DESIGN

This section provides the detailed description of the experimental design, sampling, and analytical methods used to evaluate the long-term persistence and effectiveness of reactive amendment (AquaGate) addition to the Site. Approaches presented below focus on the physical, chemical, and biological characterization of the Site, 7 years post placement of the reactive amendment, to address the performance objectives described in Section 3.

5.1 CONCEPTUAL EXPERIMENTAL DESIGN

The experimental design used to evaluate the performance objectives, included examination of physical, chemical, and biological parameters at the Site 7 years following placement of the reactive amendment.

Physical parameters assessed in this project included the following:

- The persistence of the amendment and changes in amendment stability over time resulting from natural sedimentation, benthic mixing, ship and tug activity, and increased sediment cohesiveness over time.
- The use of TOC measurement, carbon petrography, and a chemical oxidation method (Grossman and Ghosh 2009) to quantify BC (a surrogate for AC) presence, thickness, and mixing depths.

Chemical parameters included:

- Surface sediment chemical concentrations to evaluate changes in bulk concentrations that may affect contaminant fate.
- Monitoring of the extent to which the reactive amendment surface reduces contaminant bioavailability (magnitude of the bioavailability reduction and sustainability of bioavailability reduction).

Biological parameters included:

- Assessment of benthic community conditions 7 years post amendment delivery, as well as characterization of the extent to which the amendment may affect the health and composition of the benthic community.

5.2 BASELINE CHARACTERIZATION

Baseline characterization of the sediments at Pier 7 prior to the amendment placement was described in the preceding ESTCP project, ER-201131 (Kirtay et al., 2017), and were based on sampling that occurred in 2012. The baseline characterization consisted primarily of the same measurements, with a few exceptions, of those used to conduct the 82-month post placement monitoring detailed herein. In brief, baseline characterization included benthic community census, bioavailable concentrations in tissues (*in situ* bioaccumulation with SEA Ring), bioavailable concentrations in sediment porewater (*in situ* SPME passive sampling), bulk concentrations in sediment, sediment-profile imaging (SPI), and TOC, BC, and grain size characterization of the sediment.

5.3 TREATABILITY OR LABORATORY STUDY RESULTS

In 2011, NIWC Pacific carried out laboratory treatability studies by mixing commercially available AquaGate + PAC™ with PCB- and mercury-contaminated sediments obtained from the contaminated area adjacent to Pier 7 at PSNS & IMF. Components of the treatability study included pre- screening the site to delineate the nature and extent of contamination, conducting laboratory studies to verify the effectiveness of the amendment in terms of reducing contaminant bioavailability, and testing the SPI system (Germano and Associates, 2012) for its ability to distinguish the amendment from native site sediment to support monitoring the placement, stability and mixing of the amendment after installation. The effectiveness of the amendment was evaluated on the basis of reduction in bioaccumulation of PCBs in the benthic marine polychaete, *Neanthes arenaceodentata*. Data collected for the assessment included bioaccumulation data from a control sediment, unamended sediment (Pier 7), and three sediment treatments representing differing degrees of mixing (i.e. contact time) with the reactive amendment (AquaGate), including no mix, 24-hour mix, and 1-month mix treatments. Percent reductions in biouptake were 44, 63, and 94%, for no mix, 24-hour mix, and 1-month mix treatments, respectively. These results are described in detail in the Final Report for ER-201131 (Kirtay et al. 2017).

5.4 DESIGN AND LAYOUT OF TECHNOLOGY COMPONENTS

Technology components included the AquaGate+PAC amendment itself, and multiple methods to support the physical, chemical, and biological characterization of sediments to verify the persistence and performance of the amendment at the site (Table 3). These include the SEA Ring device (ER-201130, Rosen et al. 2017) for *in situ* bioaccumulation exposures (Figure 8), *in situ* SPME passive sampling to quantify PCB concentrations in sediment porewater (Figure 9), surface sediment physical and bulk chemistry assessment, two different methods (chemical oxidation and carbon petrography for characterizing BC and AC for remedy persistence (Figure 10), and sediment coring by PSNS divers for benthic community analysis (Figure 11). The amendment is discussed in sections above, in Kirtay et al. (2017), and Appendix B. The methods for carbon characterization are described in Section 5.5.

Table 3. Overview of Technology Components.

Technology	Description
AquaGate+PAC	Patented technology that delivers powdered activated carbon to the sediment surface in relatively deep and active/dynamic waters such as Navy Shipyards
Sediment Ecotoxicity Assessment Rings (SEA Rings)	Field-deployed apparatus to contain and maintain water quality for organism *in situ* bioaccumulation exposure and assessment
Passive sampling devices	Solid-phase microextraction (SPME) fibers for *in situ* porewater PCB concentration estimation
Black Carbon quantification	Laboratory method using chemical oxidation to isolate black carbon (including activated carbon) from natural organic matter in sediments
Activated Carbon quantification	Laboratory method using carbon petrography to microscopically assess proportion of different forms of black carbon including activated carbon in sediments
Benthic Community Analysis	Collection, sorting, and identification of sediment associated benthic organisms to estimate population diversity and abundance

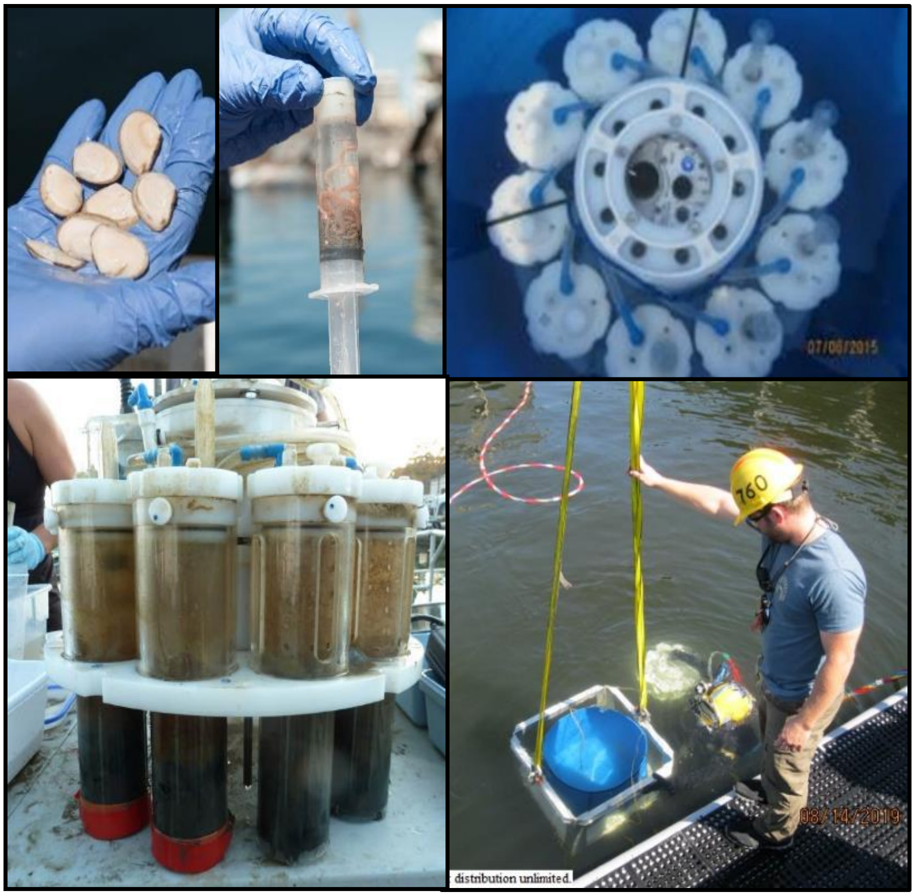

Figure 8. Pictures of SEA Ring and test organisms used for *in situ* sediment bioaccumulation. Bottom right photo shows PSNS divers recovering a SEA Ring during 82-month post-placement monitoring.

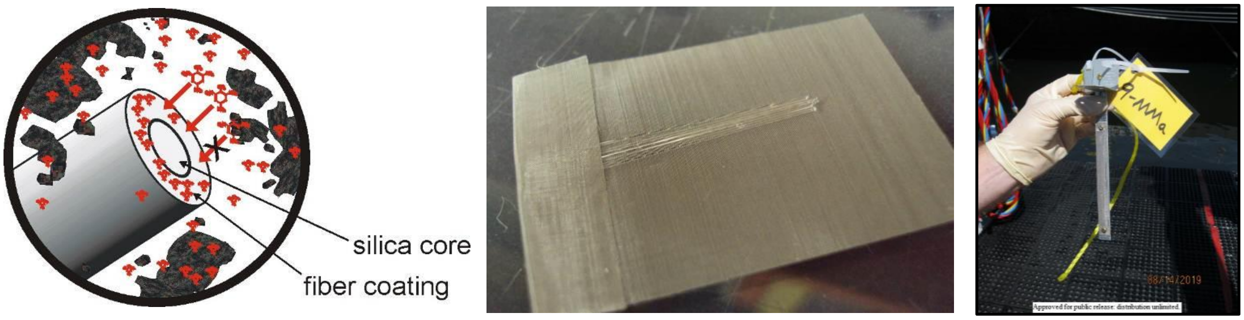

Figure 9. Solid-phase microextraction (SPME) conceptual model (left). Actual SPME fibers being added to steel mesh envelope applicator (center), and SPME field-deployment device (right) used in this study.

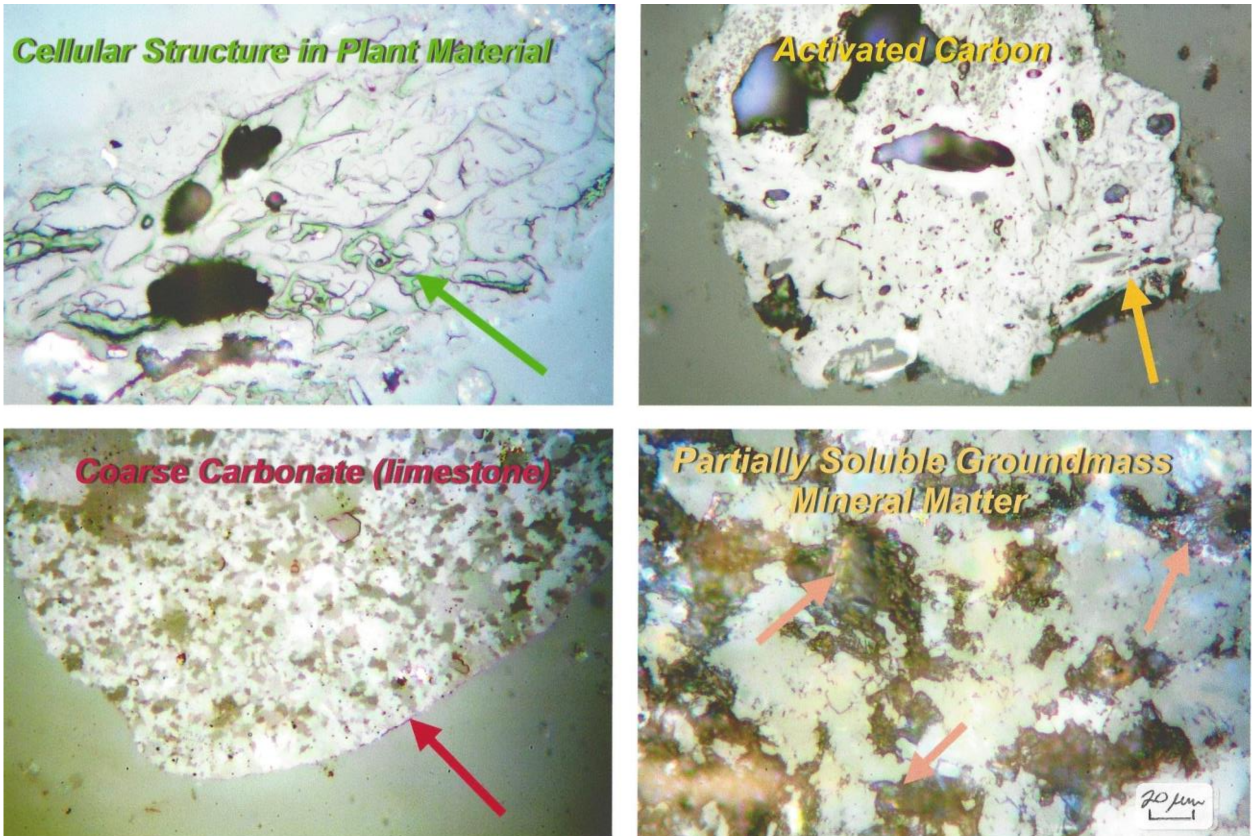

Figure 10. Example photomicrographs following petrographic analysis of sediment from PSNS&IMF Pier 7 for the 82-month sampling period.

Figure 11. Benthic community analysis (Ecoanalysts, Inc.).

5.5 FIELD TESTING

Field testing largely involved the deployment and recovery of a combination of sediment quality assessment technologies to support the objectives of this event and are primarily the same as those used in ER-201131. The field program focused on tools that could be used to meet the primary objectives of the demonstration, focusing on (1) physical characterization of site sediment, (2) biological characterization, and (3) chemical characterization. No investigation-derived waste (IDW) was generated during the study, and all sampling equipment was removed from the site following the *in situ* exposures and sediment coring, all approved by NAVFAC Northwest and PSNS&IMF.

5.5.1 Sampling Locations

The Multi-Metric (MM) sampling locations for the LTM monitoring event were the same as those associated with Project #ER-201131. This included 10 stations within the footprint of the amendment and 4 locations to north/outside of the amended area (Figure 12, Tables 3 and 4). All 14 stations were sampled and analyzed for Benthic Community Census. The 10 stations within the treated area were also analyzed for bioaccumulation by representative invertebrates deployed *in situ*, and also for porewater PCB concentrations assed *in situ*. An additional 10 samples within the amended area were added for the 82-month timepoint to optimize the spatial (both lateral and vertical) characterization of TOC, BC, and AC at the site (Figure 12).

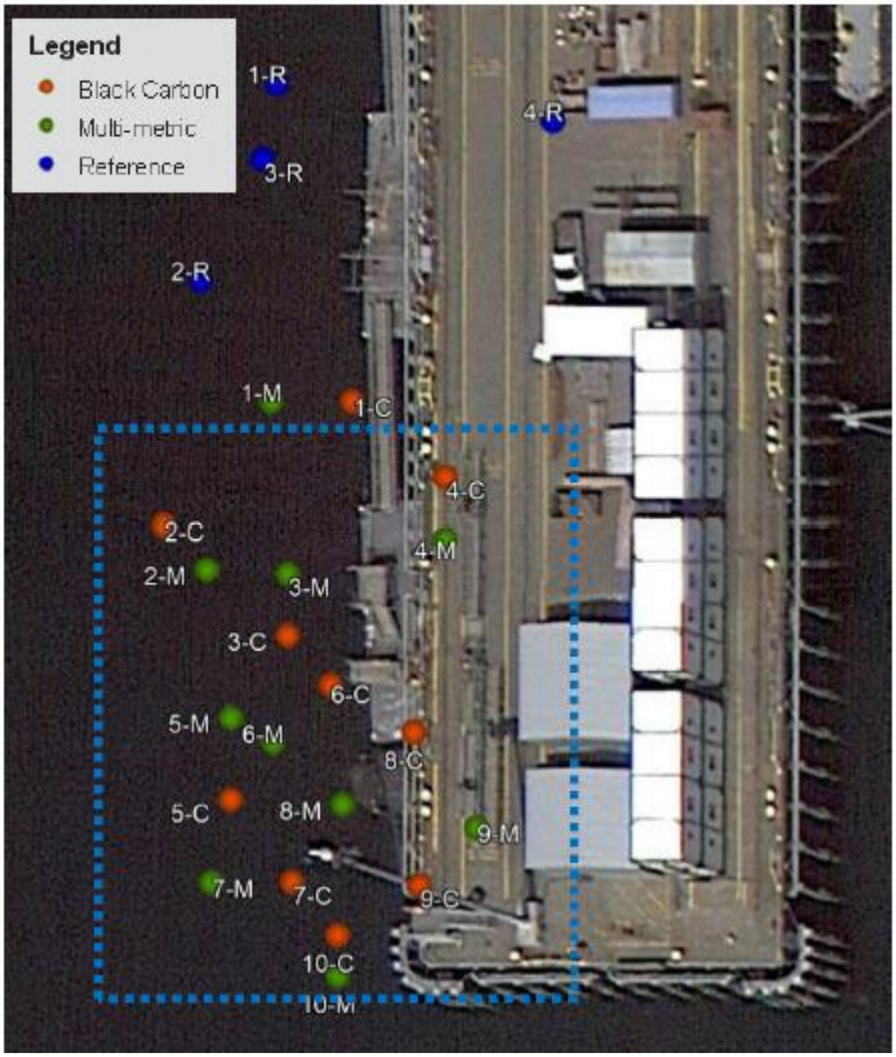

Figure 12. Google Earth images with sampling locations overlaid. Dashed lines represent outline of the amendment placement boundary.

Table 4. Multi-metric sampling locations.

Type	Station ID (Secondary ID)	Latitude	Longitude	Description	Water Depth* (feet)	Description
Multi-metric	1 (1-MM)	47.5589	-122.62901	25 ft west of the pier in front of piling RB-46. Re-positioned out from initial position due to slope and shell debris	-37	On slope
Multi-metric	2 (2-MM)	47.5588773	-122.62907	40 ft west of the pier between pilings FC-01 and RB-52 (inner piling # 8 and 9)	-49	Berthing area
Multi-metric	3 (3-MM)	47.5588745	-122.62899	20 ft west of the pier (5 ft from edge of the barge); between pilings FC-01 and RB-52	-38	On slope
Multi-metric	4 (4-MM)	47.5588972	-122.62883	18 ft east of piling FC-01 (8th inner piling); 2 ft north of Cleat 22 on top of the pier	-36	Under pier
Multi-metric	5 (5-MM)	47.5587772	-122.62905	35 ft west of the pier (2 1/4 Barge widths); In front of piling FC-04 (5th inner pile)	-49	Berthing area
Multi-metric	6 (6-MM)	47.5587602	-122.62908	25 ft west of the pier (8ft west of the barge); between pilings FC-04 and FC-05 (4th and 5th inner piling); Re-positioned out from original location due to slope and shell debris.	-49	Berthing area
Multi-metric	7 (7-MM)	47.5586658	-122.62907	35-40 ft west of the pier; In front of piling FC-08 (1st inner piling)	-50	Berthing area
Multi-metric	8 (8-MM)	47.5587184	-122.62893	8 ft west of piling FC-06 (3rd inner piling); under large black bumper; in front of Cleat #B on top of the pier.	-40	On slope
Multi-metric	9 (9-MM)	47.5587029	-122.62880	25 ft east of the outer piling, 1st cleat on top of the pier.	-36	Under pier
Multi-metric	10 (10-MM)	47.55860247	-122.6289432	8 ft west of the pier; 5th outer piling in (starting around the corner on the south facing side of the pier)	-40	On slope

Table 5. Reference sampling locations.

Type	Station ID (Secondary ID)	Latitude	Longitude	Description	Water Depth* (feet)	Description
Reference	1-RBS	47.559205	-122.62900	25 ft west of Piling RB32	-30	On slope
Reference	2-RBS	47.559072	-122.62908	45 ft west of Piling RB40	-49	Berthing area
Reference	3-RBS	47.559158	-122.62901	30 ft west of Piling RB35	-37	On slope
Reference	4-RBS	47.55917	-122.62872	From Bollard 18 under pier, south side of middle piling 10 ft from piling base	-36	Under pier

5.5.2 Physical Characterization of Site Sediment

Physical characterization focused on evaluating the long-term persistence and mixing of the reactive amendment by comparison with results documented during the first 3 years of monitoring under ER-201131. Relevant tools and methods for physical characterization included analysis of total PCB concentration in addition to Total Organic Carbon (TOC), Black Carbon (BC), and BC (including activated carbon (AC)) by carbon petrography as described below.

Sediment samples for all 3 analyses were collected from shallow cores (via SCUBA diver) at multi-metric stations (directly adjacent to the SEA Ring) and visually-examined to extent possible to evaluate reactive amendment presence, depth, and mixing (Figure 13). Cores (30-cm-long, 4.8-cm inside diameter) were inserted into the sediment surface by the diver, then top and bottom caps were placed prior to removal from the sediment. If samples did not contain at least 25 cm of sample after settling, they were recollected. At each station (20 in all including 10 multi-metric stations from ER-201131 and 10 additional stations for additional resolution for TOC, BC, and AC analysis. At station 7, duplicate samples were taken at each of the 4 depths. This sampling totaled 88 overall samples.

After all cores were collected, they were transferred to the Ecoanalysts, Inc. laboratory in Port Gamble, WA, where each one was split lengthwise and sectioned into four intervals (0-5 cm, 5-10 cm, 10-15 cm, and 15-20 cm below surface) to provide samples along a vertical profile (consistent with previous monitoring events). Each of the 4 layers for each station was submitted for TOC and BC. Carbon petrography (to specifically measure AC content) was measured in 32 samples obtained from 7 cores (4 layers per core) collected at 6 stations (one station included a duplicate core). Additional information of these methods is available in Appendix C.

Figure 13. Sediment core from Pier 7 for sectioning and analysis.

At the analytical laboratory, sediment samples obtained from the cores were air dried and sieved (#10 sieve [2-mm]) to remove any remaining aggregate. Sieved samples were analyzed for TOC via the Lloyd Kahn method (Kahn, 1988). Samples for BC analysis were analyzed at the University of Maryland Baltimore Campus (UMBC), under the direction of Dr. Upal Ghosh, using the Grossman and Ghosh (2009) method. The method separates natural organic carbon from BC based on the difference in chemical oxidation properties. The BC (including AC) is isolated using a solution of concentrated sulfuric acid and potassium dichromate to oxidize the natural organic matter while preserving the AC. In addition to here, the method has been successfully applied for the assessment of AC dose in sediments in a pilot-scale demonstration study at a USEPA Superfund site (Grossman and Ghosh, 2009), and recently for measuring AC in the Lower Duwamish Waterway AC Pilot Study (Floyd et al., 2019).

Sediment samples obtained from the cores (post-sieve) were also submitted for petrographic analysis at Koppers, Inc. The petrographic analysis of sediment particles was performed according to ASTM standard methods for coal analysis: D2797 (Preparing Coal Samples for Microscopic Analysis by Reflected Light), D2798 (Microscopic Determination of the Reflectance of Vitrinite in a Polished Specimen of Coal), and D2799 (Microscopic Determination of Volume Percent of Physical Components of Coal) as described in Ghosh et al. (2003). This method can differentiate between various forms of carbon (e.g., coal, coke, depositional carbon, tar, pitch, etc.) and sediment mineral phases. The petrographic analysis provided verification of the type(s) of carbon present in the sediment at the target area and provides an additional quantitative measure of AC in the sediment. Additional details of the sediment physical characterization procedures, specifically BC by chemical oxidation and AC by carbon petrography are available in Appendix C, and excerpted below:

5.5.2.1 Black Carbon Analysis Method

In previous sampling events, BC was measured via the Walkley Black method. In the current 82-month sampling event, black carbon was measured in 81 sediment samples by the Ghosh and Grossman method (Grossman and Ghosh, 2009), which measures BC such as soot and pyrolytic carbon. Detailed methodology is available in Ghosh and Grossman (2009). In brief, sediment samples were analyzed for BC by the Ghosh and Grossman method at the Ghosh Laboratory at University of Maryland – Baltimore County, Baltimore, MD. A chemical oxidation pre-treatment (BC-chemox) was performed on wet sediment samples. This step involves pre-treated with a sulfuric acid-potassium dichromate solution to remove natural organic carbon by oxidation while avoiding oxidation and subsequent loss of the majority of AC in the sample.

A Shimadzu TOC analyzer with a solids sample module (TOC-5000A and SSM-5000A) was used for TOC analysis. Carbon in the sample was combusted to form CO_2 at 900 ^{o}C. The CO_2 was detected by a non-dispersive infrared gas analyzer. The instrument was calibrated for carbon using reagent-grade glucose. The sediment TOC analysis followed an operating procedure recommended by the manufacturer.

The disadvantage of using this method to quantify AC in sediment is that, while the pre-treatment avoids losses associated with typical methods used to analyze TOC and BC, the analysis is not widely available from commercial analytical laboratories, as it is a specialized method. Additionally, the method does not distinguish AC from other forms of BC that may be present, such as soot. Therefore, BC measurements may overestimate post-amendment AC sediment content if the underlying sediment has a high initial BC content or if soot from natural or anthropogenic sources continue to contribute BC material to the sediment.

5.5.2.2 Carbon Petrography Method

AC content was analyzed in 32 samples via a petrographic analytical method by Koppers following ASTM standard methods for coal analysis: D2797 (Preparing Coal Samples for Microscopic Analysis by Reflected Light), D2798 (Microscopic Determination of the Reflectance of Vitrinite in a Polished Specimen of Coal), and D2799 (Microscopic Determination of Volume Percent of Physical Components of Coal) as described in Ghosh et al. (2003).

Briefly, wet sediment samples were delivered to the lab in 30-ml glass vials. Samples were removed from vials and placed on a glass plate and dried in an oven at 80°C for 2 hours. The dried samples were photographed to document characteristics of the as-received materials prior to petrographic preparation. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve. The remaining 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1.25-inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 250X and 600X magnification in air to allow visual observation and estimation of AC content and other components. The composition analysis consists of 1000 points counted for each sample at 600X magnification in air.

Laboratory reports containing details on the analyses and raw data are included in Appendix C. The AC content of the sediment was reported on a percentage volume basis (i.e., 100% × volume of AC divided by the total volume of all solids in the sediment). Measurements of TOC and BC are reported on a dry weight mass basis (i.e., 100% × dry mass of TOC or BC divided by the total dry mass of all solids in the sediment). The density of activated carbon is lighter than that of typical inorganic sediment fractions (i.e., 2 g/cm^3 for AC versus 2.7 g/cm^3 for inorganic sediment particles), the AC content reported as a volumetric percentage may be a factor of approximately 1.4 times higher (i.e., 2.7 ÷ 2.0) than if it were able to be estimated on a percent mass basis by the carbon petrography method. Because the bulk density of the sediment samples particles was not measured, a numerical factor (e.g., 1.4) was not applied to the data.

5.5.3 Chemical Characterization

Chemical characterization focused on evaluating the effectiveness of the reactive amendment in reducing contaminant bioavailability. In support of this characterization, relevant tools and methods included surface sediment sampling for bulk chemistry, *in situ* bioaccumulation study analyses, and *in situ* porewater sampling and analysis as described below.

5.5.3.1 Surface Sediment Sampling for Bulk PCB Evaluation

Undisturbed sediment from the top 30 cm was collected in 2-inch diameter by 18-inch long sediment cores by SCUBA divers by placement around the perimeter of the SEA Ring. Divers typically capped each core from the bottom, and then capped the top after removal from the sediment, in accordance with ASTM 1391 (ASTM International 2008). Cores were marked with electrical tape to a target depth of 12”, the top 6” (15 cm) of which was characterized for PCBs (72 congeners) using EPA 8082, as described in Kirtay et al. (2018).

Sediment cores were retrieved at 20 stations: 10 multi-metric stations (1MM – 10MM) and 10 additional stations (1C – 10C) by SCUBA divers to obtain the necessary samples for TOC, AC and carbon petrography. Sampling locations are shown in Figure 12 and a sampling summary is provided in Tables 3 and 4. The stations 1MM – 10 MM are the same stations that have been sampled in all previous sampling events. The additional stations of 1C – 10C were collected to provide additional spatial coverage of the site for the 82-month monitoring event.

At each station, one sediment sample core sample was collected, visually logged and sectioned into four 5-cm-thick depth intervals (0-5 cm, 5-10 cm, 10-15 cm and 15-20 cm). At station 7, duplicate samples were taken at each of the 4 depths. This sampling totaled to 88 overall samples. This allowed evaluation of a vertical profile. Additional details of the chemical physical characterization procedures are available in **Appendix C**

5.5.3.2 Tissue Bioaccumulation Analysis

Evaluation of long-term contaminant bioavailability was addressed using *in situ* bioaccumulation experiments conducted with the Sediment Ecotoxicity Assessment Rings (SEA Rings; Rosen et al., 2012; Burton et al., 2012; Rosen et al. 2017), autonomous multichamber samplers used for *in situ* toxicity and bioaccumulation testing. SEA Rings were refined and commercialized under ESTCP Project #ER201130. Field-collected organisms were deployed in the *in situ* exposure chambers for 14 days. The design included five chambers that held polychaetes (*Nephtys caecoides*) and five chambers that held bivalves (*Macoma nasuta*). Polychaete and bivalve tissues were analyzed for PCBs (72 congeners) and lipid content. SEA Rings were deployed at the 10 multi-metric stations such that organisms were exposed to approximately the top 10-15 cm of surface sediment. After retrieval of the SEA Rings, *N. caecoides* and *M. nasuta* were recovered from the chambers by extruding chamber contents onto a 500-mm stainless steel sieve and sorting contents by hand. Organisms were allowed to depurate in clean seawater overnight. *N. caecoides* (whole body) and *M. nasuta* (soft tissues) were homogenized, extracted, and analyzed for PCB congeners via US Environmental Protection Agency Method 8082A and for lipid content via a gravimetric approach (Honeycutt et al. 1995) by ERDC, as described in Kirtay et al. (2018). Additional details are provided in Appendix C.

5.5.3.3 In Situ Porewater Analysis

Solid-phase microextraction (SPME) passive samplers were used for measurement of PCBs in sediment porewater (C_{free}) *in situ,* and deployment, recovery, processing, and data analysis generally followed the same approach used under ER-201131 (Kirtay et al., 2017) and Kirtay et al. (2018). SPME fibers were placed adjacent to SEA Ring chambers at each of the 10 multi-metric stations to provide a measurement of dissolved PCBs (congeners) present in porewater of the surface sediment layer (top 10-15 cm). SPMEs were deployed in a “SPME Device” consisting of SPMEs housed in a small stainless steel mesh envelope attached to a steel rod support (Figure 9). Three SPME devices were placed around each SEA Ring and were retrieved after 14 days. At each of the 10 multi-metric stations, SPMEs from the three SPME Devices were combined and extracted with organic solvent to make a single composite sample extract (i.e., one extract per multi-metric station), and the extract was analyzed for PCBs following procedures outlined by Lu et al. (2011) and Harwood et al. (2012) and as reported by Kirtay et al. (2018). Additional details on the porewater methods and data are provided in Appendix C.

5.5.4 Biological Characterization

Biological characterization involved evaluating ecological health following placement of the amendment. The biological characterization focused on benthic community census from sediment core samples collected at each of the 10 multi-metric (MM, or M) sampling locations within the amendment footprint, and at 4 additional unamended sampling locations north of the amended area along Pier 7 (Figure 11). Five 1-foot long cores were collected and composited into one sample for each station, as with prior monitoring events. Each core had a diameter of 4.8 cm. The top 15-cm of each of the 5 cores was composited into a single sample and placed on ice. Within 24 hours of collection, the content of each sample was fixed with formalin and immediately delivered to EcoAnalysts, Inc. (Port Gamble, WA), for sieving and taxonomic processing. Invertebrates were identified to the lowest possible taxonomic level and enumerated, with results used to compute comparative ecological parameters including organism density, species richness, and evenness. These comparative parameters allowed for evaluation of the ecological response of the benthic invertebrate community to the reactive amendment. Also, temporal comparisons were made across the datasets using both univariate and multivariate statistical methods. Details associated with the calculation of these measures are provided in Appendix C.

Benthic samples arrived at the Moscow EcoAnalysts facility in good condition. Once the samples were received at the laboratory, they were transferred to 70% ethanol for long-term preservation and storage. The sorting process entailed placing small quantities of sample in a petri dish, removing all organisms under a dissecting microscope, and placing them into vials according to major taxon categories (e.g. mollusks, crustaceans, annelids, etc.). This process was continued until 100% of the sample was sorted. Sorted material was then transferred back to the original sample container and underwent a quality assurance (QA) check to control for thoroughness and consistency in sample sorting. This sorting review was performed by staff who did not initially sort the sample. All specimens were identified by qualified taxonomists down to the lowest practicable taxonomic level

(LPTL) and enumerated. In most cases this was genus or species level; those 25 organisms identified to a higher level were due to a qualifier, such as damage or immaturity of the specimen. All benthic raw data and results of the quality control (QC) are presented in Appendix C.

5.6 SAMPLING METHODS

A summary of type, numbers, and methods for analyses performed for this demonstration are provided in Table 5 and Table 6.

Table 6. Sample type and numbers.

Analysis		**Sample Efforts per Station**	**Number of Stations**	**QA/QC Samples**	**Total Number of Samples**
SEA Ring	*In-situ* bioaccumulation analysis of polychaete tissue for PCBs and lipid content	1*	10 multi-metric	3**	13
	In-situ bioaccumulation analysis of bivalve tissue for: PCBs and lipid content	1*	10 multi-metric	3**	13
SPME	PCBs in sediment porewater	3 10- to 15-cm SPMEs, composited	10 multi-metric	3	13
Core bulk chemistry samples	Sediment analysis for PCBs, limited MeHg, TOC	1 30-cm core$^{\#}$, top 0-15 cm retained	10 multi-metric	2	12
Core samples	Benthic Community Census	5 30-cm cores$^{\#}$, composited, top 0-15 cm retained	14 (10 multi-metric, 4 reference)	0	14
Core Samples	Visual confirmation of amendment mixing before sectioning (qualitative)	2 30-cm cores$^{\#}$, composited, retain top 0-5, 5-10, 10-15, 15-20 cm layers	20 (10 multi-metric, 10 additional)	8	88
	TOC in sediment sections		20 (10 multi-metric, 10 additional)	8	88
	Black Carbon in sediment sections (Chemical Oxidation)		20 (10 multi-metric, 10 additional)	8	88
	Black Carbon in sediment sections (Petrography)		7 multi-metric	4	32

**Composite of five replicates from SEA Ring at each station.*

*** QA/QC samples at T=0 (unexposed) organisms.*

#All cores are 2-inches (4.8 cm) in diameter.

Table 7. Analytical methods summary.

Matrix	**Analysis**	**Method**	**Detection Limit**	**Container**	**Preservative**	**Holding Time**	**Laboratory**
Sediment	Benthic Community Census	Taxonomic classification	NA	2 1-L LDPE Widemouth Jars	10% seawater formalin solution	Two weeks after collection (in ethanol)	EcoAnalysts
Sediment	Total Organic Carbon	Lloyd Khan	120 mg TOC/kg sediment	4 oz Glass Jar	Chill: 4º ± 2º C	28 days	ERDC
Sediment	Black/Activated Carbon Content	Petrography (Ghosh et al. 2003)	NA	4 oz Glass Jar	Chill: 4º ± 2º C	Not specified	Koppers
Sediment	Black Carbon Content	Chemical Oxidation (Grossman and Ghosh 2009)	< 1000 mg BC/kg sediment	4 oz Glass Jar	Chill: 4º ± 2º C	Not specified	University of Maryland
Sediment	PCB Congeners	EPA 8082	~0.1 µg/kg	16 oz. Glass Jar	<4ºC	28 days	ERDC
Tissue	PCB Congeners	EPA 8082	1.5 ± 0.3 µg/kg	2 oz. Glass Jar	<0ºC	14 days until extraction, 1 year after extraction	ERDC
SPME Extract	PCB Congeners	EPA 8082	0.1-1 ng/L	7-mL Ambler Glass Vial	Chill: 4º ± 2º C	Not Specified	ERDC

5.7 SAMPLING RESULTS

5.7.1 Sediment PCB concentrations

Measured concentrations of total PCBs in sediment at the 82-month event had a geometric mean of 10 ng/g, dw (Figure 14). This is statistically similar to measured total PCB concentrations in previous post-amendment sampling events and continue to be lower than the baseline. These results may suggest ongoing natural recovery. Raw data from all 72-congeners for all 10 stations (MM 1-10) used to develop Figure 14 are provided in Appendix E.

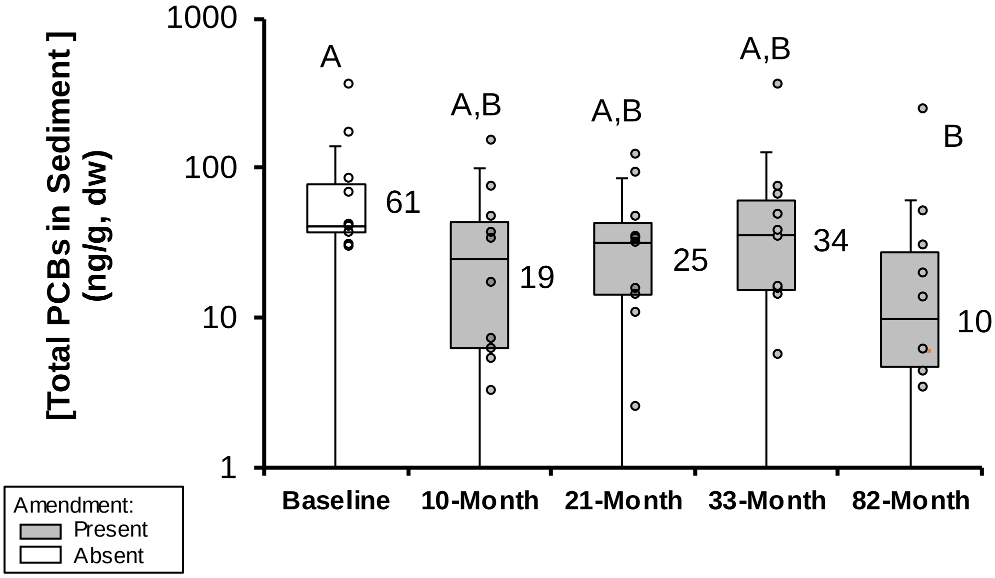

Figure 14. Total PCBs in Sediment. Numerical labels represent geometric means, and results with the same letter label are not statistically different.

5.7.2 Reductions in PCB availability as a result of the AC amendment

All three measures of PCB availability (tissue PCBs in *N. caecoides* and *M. nasuta,* and C_{free} via passive sampling) in the 82-month monitoring remained significantly decreased relative to the pre-amendment (baseline) and were consistent with results from the three rounds of post-remedy monitoring conducted by Kirtay et al. (2018).

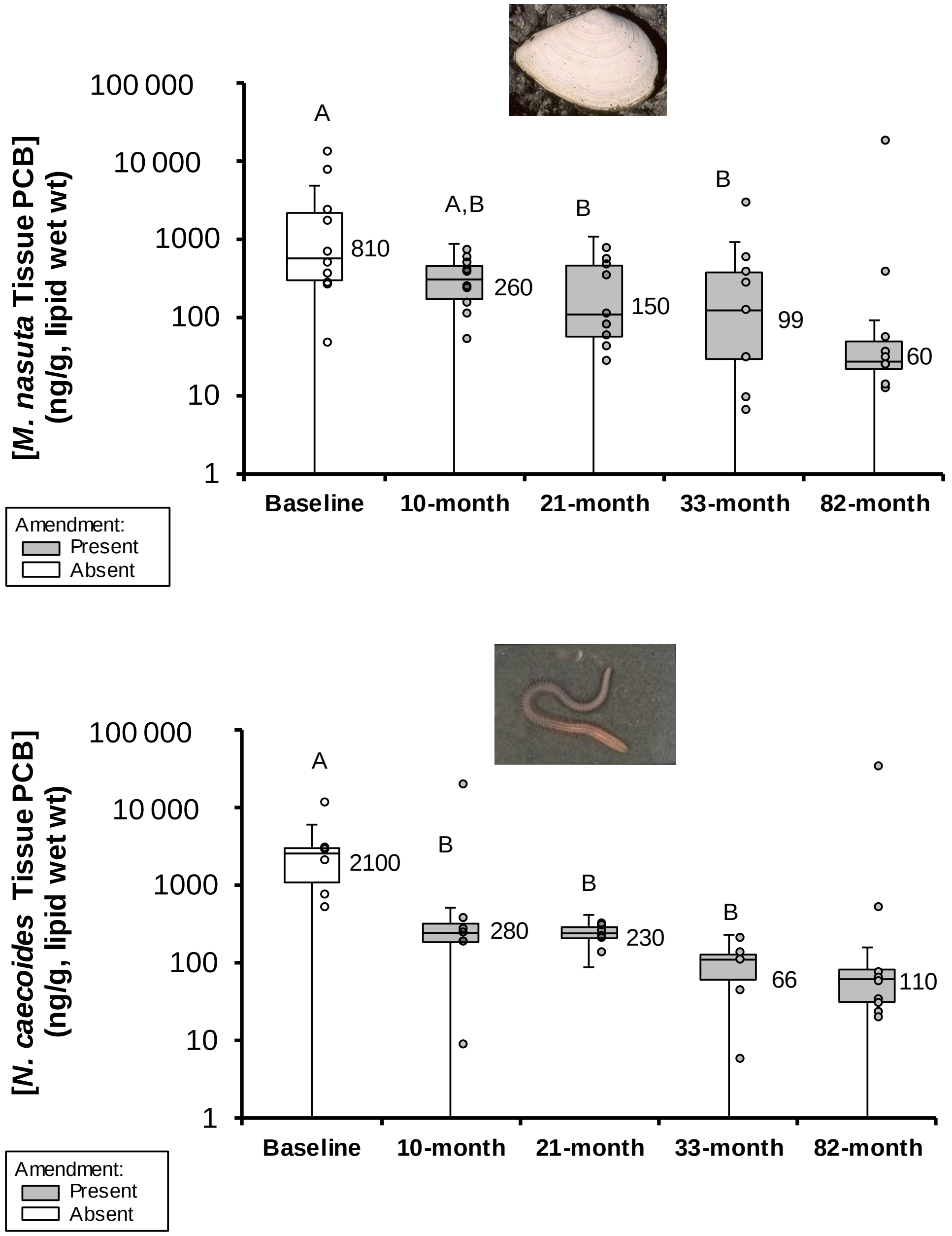

Figure 15. Tissue PCBs. Concentrations of total PCBs (lipid normalized, wet wt basis) in *Macoma nasuta* (top), and *Nephtys cacoides* (bottom) for baseline and 4 post-amendment monitoring events. Results are plotted as the median (horizontal bar) interquartile range (limits of boxes are 25th and 75th percentiles), 1.5 times the inter-quartile range (error bars), and individual data points (circles). The values shown to the right of each box indicate the geometric means. Events with the same letter (baseline to 33-month data) in each plot are not statistically different (analysis of variance with a posteriori Tukey's honestly significant difference, α = 0.05).

Approximately 80% of the 82-month tissue results were below the approximate detection limit of 70 ng/g lipid, wet weight. The 82-month data were not compared statistically to data from other monitoring events because of the high proportion of non-detect results, and non-detect values are represented as one-half the detection limit in Figure 15 and summary statistics. Geometric mean concentrations in *M. nasuta* and *N. caeoides* in the 82-month event were 93% and 90% lower than the baseline, respectively (Kirtay et al., 2018), indicating that the activated carbon amendment continued to maintain PCB availability at previous levels of 80-90% lower than the baseline. It should be noted that the highest 82-month results in Figure 15 are 2-3 orders of magnitude higher than the rest of the data. This result was obtained from the southernmost station (10-MM), which may not have been precisely located within the amendment area (see Figure 12). Sediment PCBs for station 10-MM were also considerably higher than other stations, possibly further supporting this station as a potential outlier (Figure 14).

Comparison of PCB Cfree data from 82 months was consistent with results from previous years' monitoring events, as shown in Figure 16. Approximately 80% of the 82-month results were below the approximate detection limit of 0.04 ng/L. The 82-month data were not compared statistically to data from other monitoring events because of the high proportion of nondetect results, and nondetect values are represented as one-half the detection limit in Figure 4 and summary statistics. The Cfree result from the 82-month monitoring event, as calculated using geometric means, was 73% lower than the baseline, similar to previous post-remedy monitoring events where Cfree values were 85%, 88%, and 79% lower than the baseline (Kirtay et al., 2018). As with the tissue data, it should be noted that the highest 82-month result in Figure 16 is 2–3 orders of magnitude higher than the rest of the data. This result was obtained from the southernmost station (10-MM), which may have not been precisely located within the amendment area.

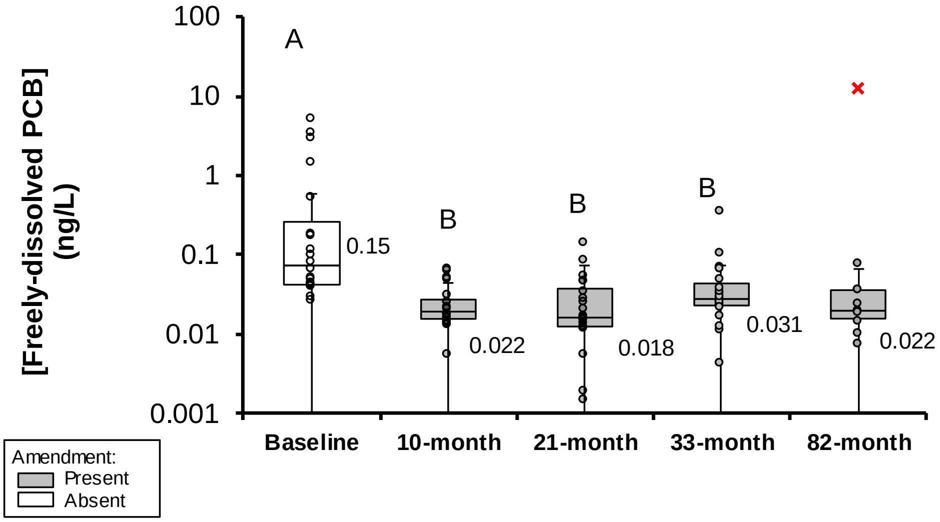

Figure 16. Cfree PCBs. Concentrations of freely dissolved total PCBs in surface sediment for the baseline and four post-amendment monitoring events, including the 82-month event. Results are plotted as the median (horizontal bar), interquartile range (limits of boxes are 25th and 75th percentiles), 1.5 times the interquartile range (error bars), and individual data points (circles). The values to the right of each box denote the geometric means. Events with the same letter (baseline to 33-month data) in each plot are not statistically different (analysis of variance with a posteriori Tukey's honestly significant difference, α = 0.05). The red "x" symbol indicates an outlier result (Station 10-MM) that was not included in the geometric mean or box and whisker.

5.7.3 Long-term Presence of Amendment as measured by TOC, BC, and AC

Comparisons of the TOC, BC, and AC methods for assessment of potential for PCB sequestration were made over time and depth.

5.7.3.1 Total Organic Carbon

The TOC levels measured in sediment at 82 months ranged from 2-2.5% on average and were generally consistent among the 4 depths measured (Figure 17). This range continues to be stable and comparable with levels observed in the 33-month monitoring event. For the 0-5, 5-10, and 10-15 cm layers 33-month and 82-month results were not statistically different. The 15-20 cm layer was not measured in earlier events, so there is no comparison with previous monitoring events.

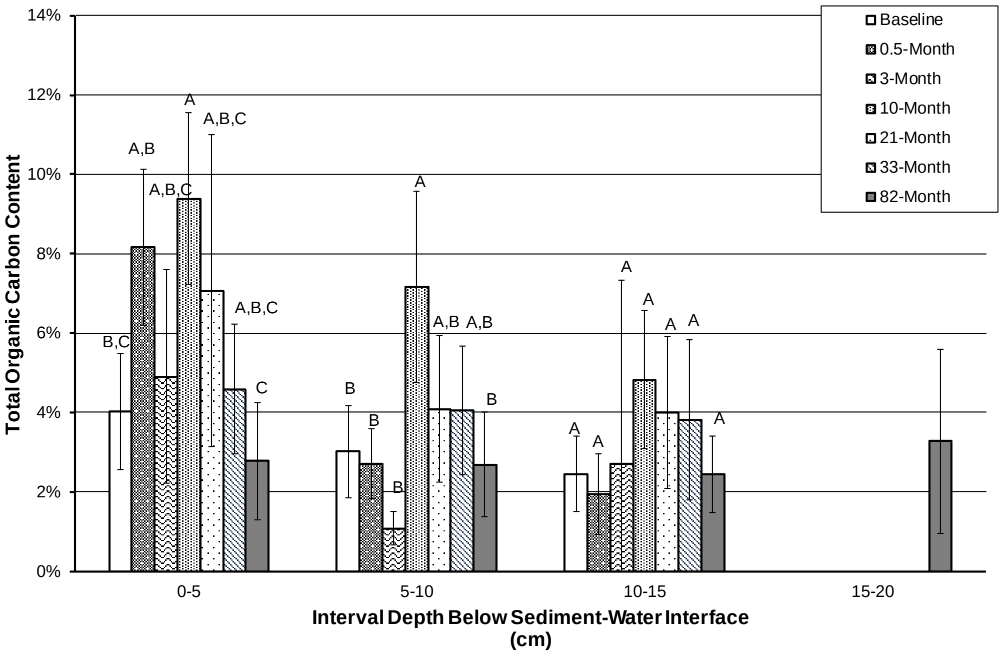

Figure 17. Total Organic Carbon (TOC) in Sediment. Results within each depth layer with the same letter label are not statistically different (i.e., comparison of data among the different monitoring events).

5.7.3.2 Black Carbon

Black Carbon levels measured at 82 months ranged from 0.8-1.3% on average, depending on depth (Figure 18). This range continues to be stable and comparable to levels observed in 33-month event. For the 0-5, 5-10, and 10-15 cm layers, 33-month and 82-month results were not statistically different.

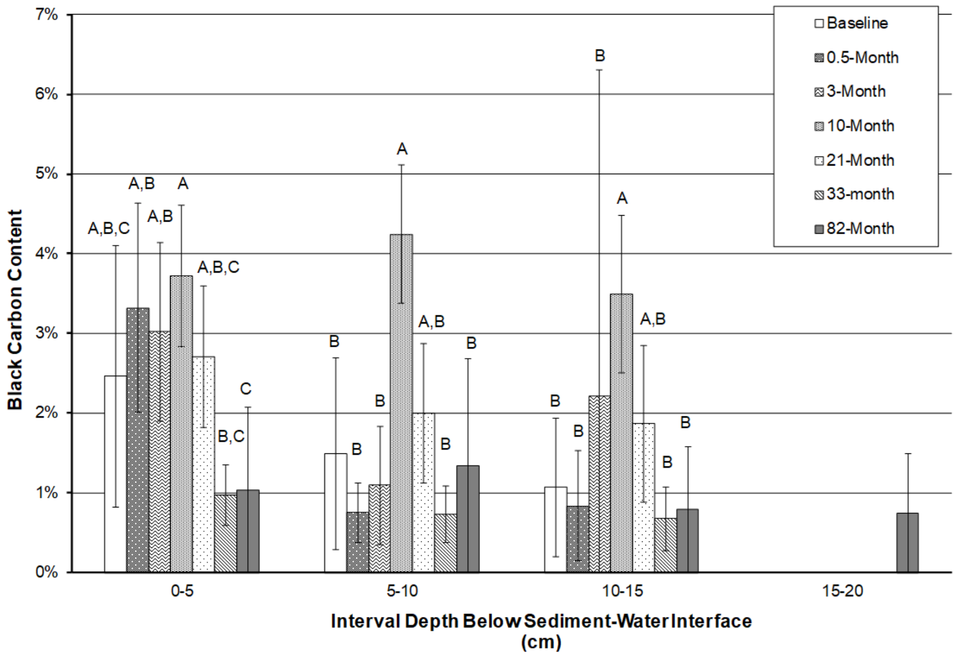

Figure 18. Black Carbon (BC) in Sediment. Results within each depth layer with the same letter label are not statistically different (i.e., comparison of data among the different monitoring events).

5.7.3.3 Activated Carbon by Carbon Petrography

Complete carbon petrography laboratory reports from Koppers are provided in Appendix C. On average, the AC content indicated by carbon petrography was 0.9% among all samples and averaged 1.0% for samples with aggregate present and 0.2% without aggregate present (Table 7).

Summary results for overall averages associated with intact sediment core samples from the 10 multi-metric (MM) and additional 10 Carbon (C) stations are provided in Table 8. For each of the 20 sampling locations, four sample depths (0-5, 5-10, 10-15, and 15-20 cm) were analyzed. Those complete results are shown in Appendix C and Appendix F, along with notes regarding the presence or absence of amendment-associated aggregate as well as qualitative observations. Sediment samples with aggregate present exhibited similar TOC levels (results were not statistically different, $P = 0.37$). TOC does not seem to be an accurate reflection of the presence of AC. In contrast, BC content of sediment samples with aggregate present was significantly higher ($P < 0.0001$) than sediment with no aggregate by an approximate factor of 4 (Table 8). The AC content of sediment samples with aggregate present was significantly higher ($P = 0.0082$) than sediment with no aggregate by an approximate factor of 5 (Table 8). The approximate 1% AC content of samples with aggregate present approximates the levels targeted for the amendment design and observed in previous sampling (Kirtay et al., 2018). Additional information associated with carbon presence at 82-months are provided in Appendix C.

Table 8. Summary statistics for TOC, BC, and AC by sample type.

Aggregate Presence	**n**	**TOC**			**BC**			**AC**		
		n	**Average**	**SD**	**n**	**Average**	**SD**	**n**	**Average**	**SD**
Samples with Aggregate	58	56	2.9%	1.7%	58	1.3%	1.2%	26	1.0%	0.7%
Samples with No Aggregate	34	32	2.6%	1.4%	30	0.3%	0.2%	6	0.2%	0.1%

TOC= total organic carbon (Lloyd Khan); BC = black carbon (Grossman and Ghosh, 2009); AC = activated carbon (Ghosh et al., 2003; carbon petrography). n= number; SD=standard deviation.

Overall, the BC analysis performed well for accurately reflecting the AC content of the sediments, assuming that the AC values indicated by the carbon petrography method provided the most specific measurement of AC in sediment. However, only a portion of the samples analyzed for BC were analyzed for AC. For example, only 26 of the samples with aggregate present were analyzed for AC, but 58 were analyzed for BC. For the 26 samples with aggregate that were analyzed for both AC and BC, the average BC content (1.1%, SD = 0.99%) was comparable to the average AC content (1.0%, SD = 0.7%), and results were not statistically different ($P = 0.30$).

In addition, there was a good correlation between the two methods if the raw data from 30 of the 32 samples are evaluated (two of the samples indicated non-detectable AC contents; BC values for these samples were at trace levels (0.2% to 0.3%)). The results from 19 of 30 samples with detectable levels of AC and BC (63%) agreed within a factor of 2 between the two methods and 97% of the samples agreed within a factor of 3 (Figure 19). Photographs of three representative samples created during preparation of sediment samples for carbon petrography are shown for reference in Figure 20, and show samples of ranging from little or no aggregate and high shell hash with low AC to samples with moderate and high aggregate presence and AC content as determined by the petrography method. The BC and AC results are discussed in more detail in Appendix C and in a peer reviewed manuscript recently published by the project team (Wang et al. 2022; Appendix D).

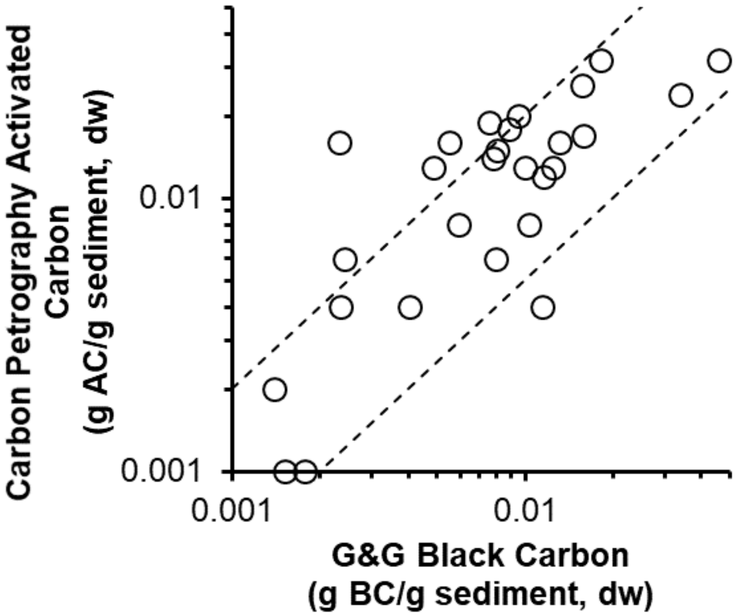

Figure 19. Activated carbon (AC) measurements (by carbon petrography) versus black carbon (BC) using the chemical oxidation method by Grossman and Ghosh (2009). Symbols between the dashed lines indicate a factor of 2 agreement (or better) between AC and BC measurements. Two samples with non-detectable AC contents were not plottable on this log-scale figure.

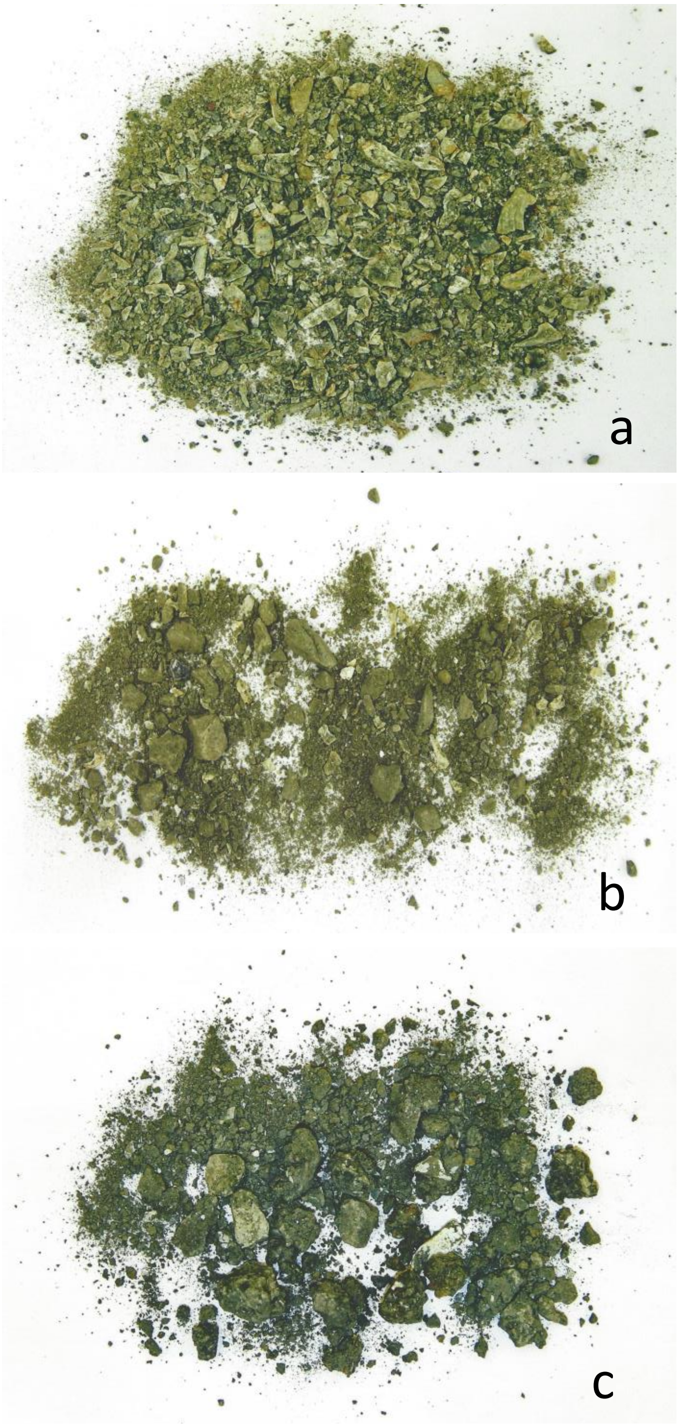

Figure 20. Example photographs of dried sediment samples in preparation for petrography representing (a) low carbon (BC 0.1%, AC 0.2%; Station T82-3-MM), (b) medium carbon (BC 1.6%, AC 2.6%; Station T82-4-MM), and (c) high carbon (BC 4.6%, AC 3.2%; Station T82-2-MM). Higher BC and AC generally corresponded with higher presence of aggregate associated with the AquaGate+PAC technology.

5.7.4 Benthic Community Assessment Results

Overall, there was no evidence from the 82-month data indicating an effect on benthic invertebrate communities at the amended area, as found for previous monitoring events (Kirtay et al., 2018). There were no statistically-significant differences among the groups for total abundance, diversity, evenness, Swartz dominance index, or percent abundance of the top 5 abundant taxa (Figures 21 to 26), with *P* values of 0.11, 0.14, 0.81, 0.34, and 0.20, respectively. Differences among the groups for taxa richness were noted (*P* = 0.04), as shown in Figure 26. Species richness was statistically different (lower) in the baseline for the unamended area compared to the 82-month amended area, suggesting improved ecological health in the amended area compared to the reference stations. This result may be due to temporal differences, and overall results confirm that species richness in the amended area has not been adversely affected by the AC amendment. The observations in this event further confirm the findings of most scientific studies proposing that adverse effects on benthic invertebrates are not expected as a result of activated carbon amendments (Janssen and Beckingham, 2013), especially when activated carbon dosage rates remain below approximately 5% by weight in sediment (Rakowska et al., 2012; Janssen and Beckingham, 2013; Kupryianchyk, et al. 2015; Patmont et al., 2015).

All benthic raw data and results of the quality control (QC) are presented in Appendix C.

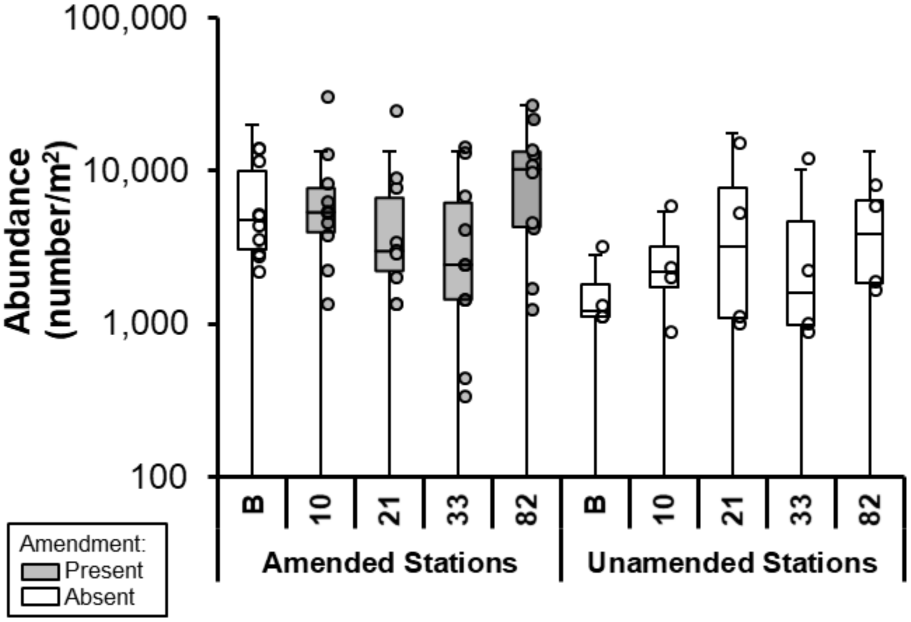

Figure 21. Total Abundance.

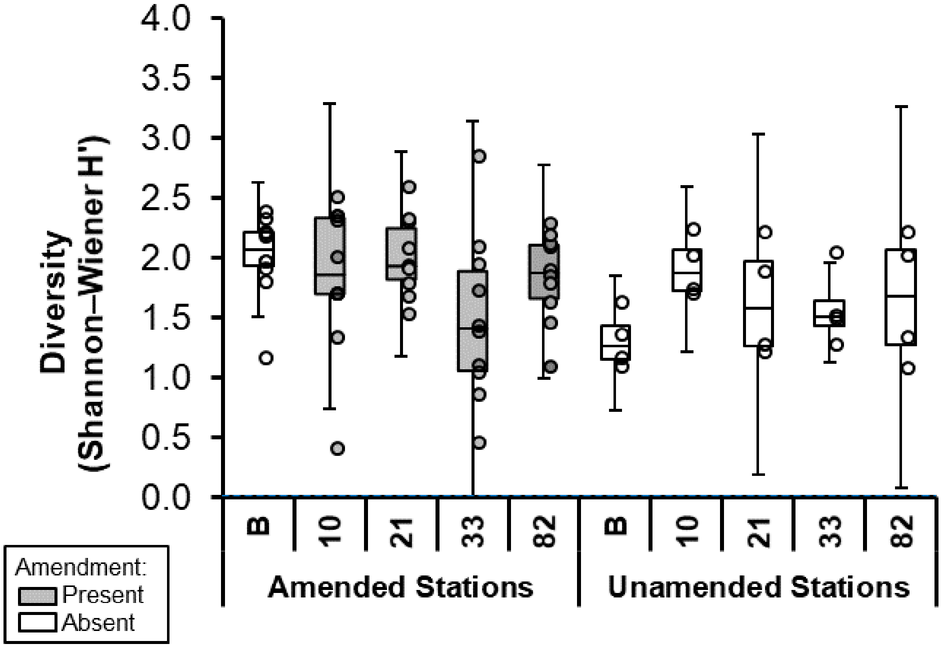

Figure 22. Diversity.

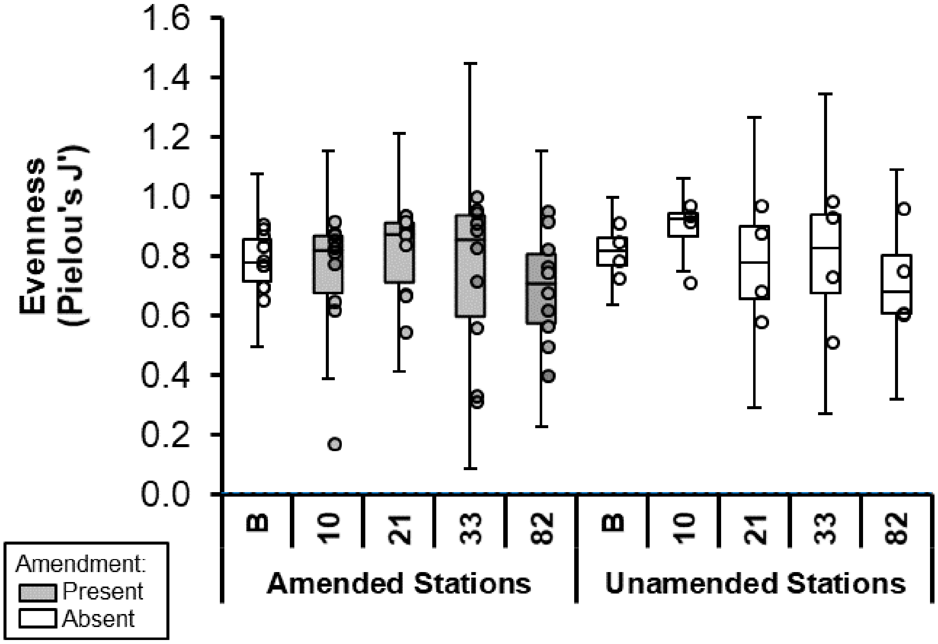

Figure 23. Evenness.

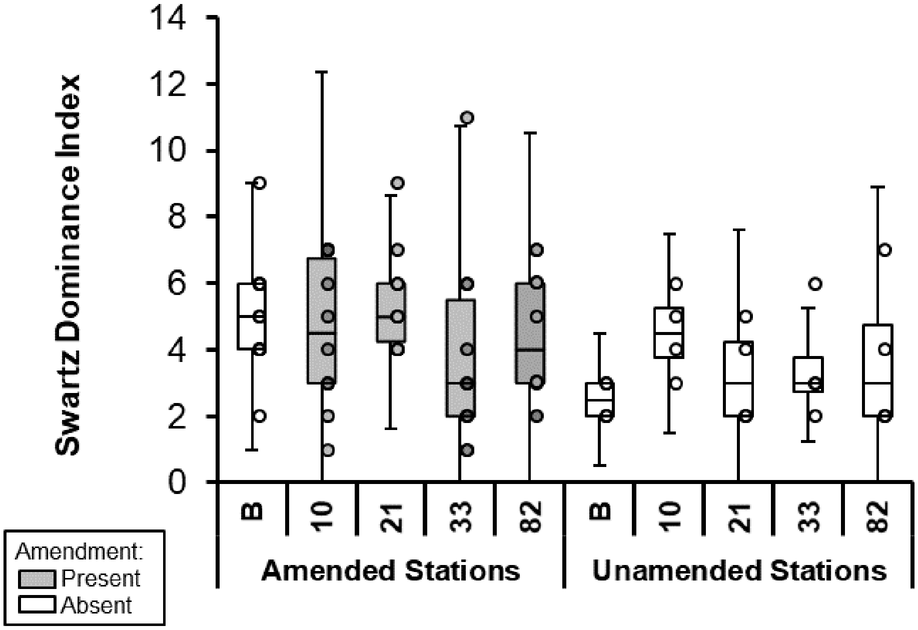

Figure 24. Swartz Dominance Index.

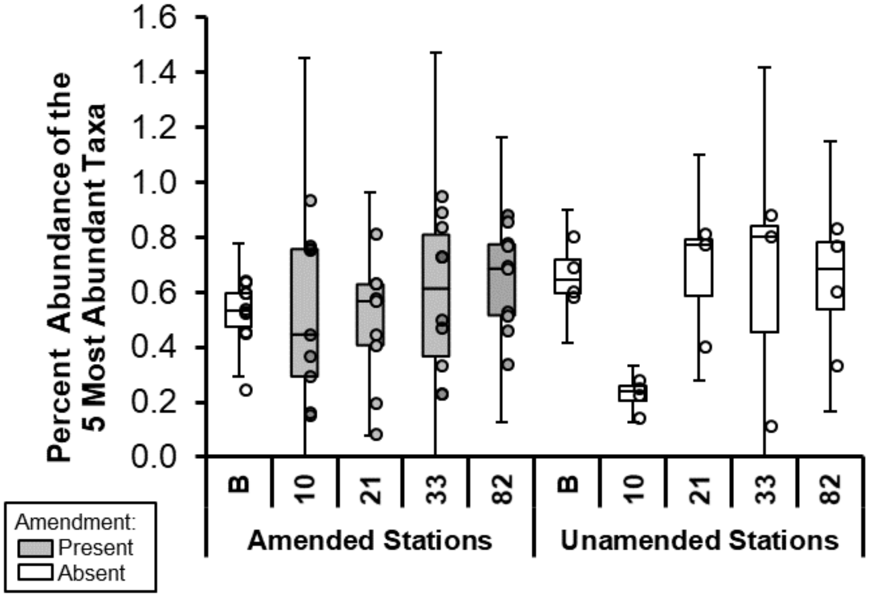

Figure 25. Percent Abundance of the Top 5 Abundant Taxa.

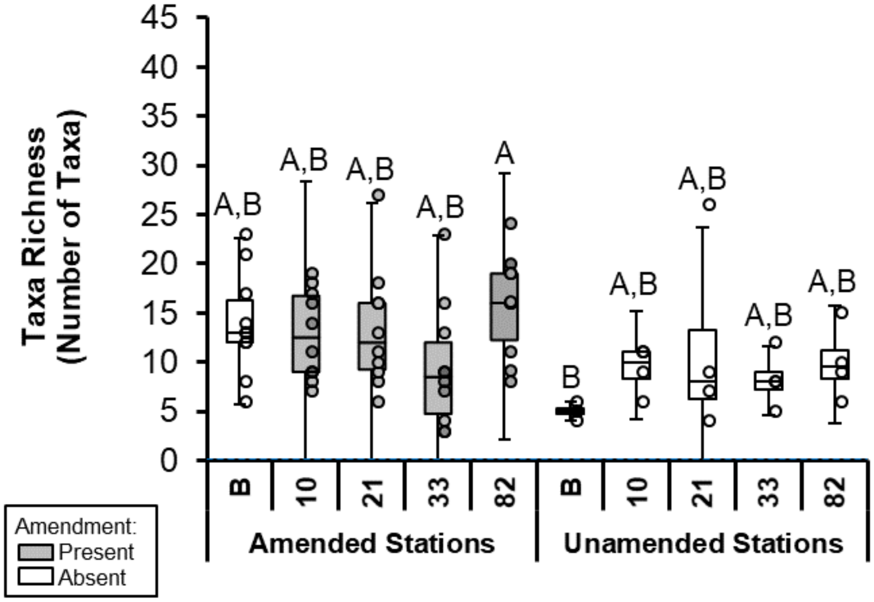

Figure 26. Taxa Richness. Results with the same letter label are not statistically different.

6. PERFORMANCE ASSESSMENT

A summary of the data collected, and analysis performed, in support of the assessment of Project performance objectives is summarized in Section 3 (Performance Objectives). A summary of the data treatment in support of the assessment of performance objectives is summarized in Section 3 (Performance Objectives) and detailed in Section 5.6 (Sampling Methods). A summary of the results and evaluation in support of the assessment of performance objectives is provided in Section 3 (Performance Objectives) and Section 5.7 (Sampling Results).

Performance objective 1 was developed to determine if the AC amendment continued to show sustained reduction of PCB availability over time, specifically at 82 months post-placement of the remedy at Pier 7. This was evaluated using *in situ* exposures of two benthic invertebrates (*M. nasuta* clams and *N. caecoides* polychaetes) that were deployed using the SEA Ring technology for bioaccumulation endpoints, and placement of passive samplers (solid-phase microextraction (SPME)), adjacent to the deployed organisms for determination of porewater PCB concentrations. Both organisms and SPME were successfully deployed, recovered, and analyzed for all 10 sampling locations, indicating that this objective was met. These results are summarized and compared with results from monitoring events from the first 3 years post-placement in Figures 15 and 16, and also in brief via Figure 27, shown again below for easy reference. The results showed that concentrations for both species continued to show a >90% reduction in PCB concentrations compared with concentrations prior to placement of the amendment. Similarly, the porewater PCB concentrations showed a >85% reduction. For both bioaccumulation and porewater, concentrations were not statistically different from the significant reductions observed in earlier events.

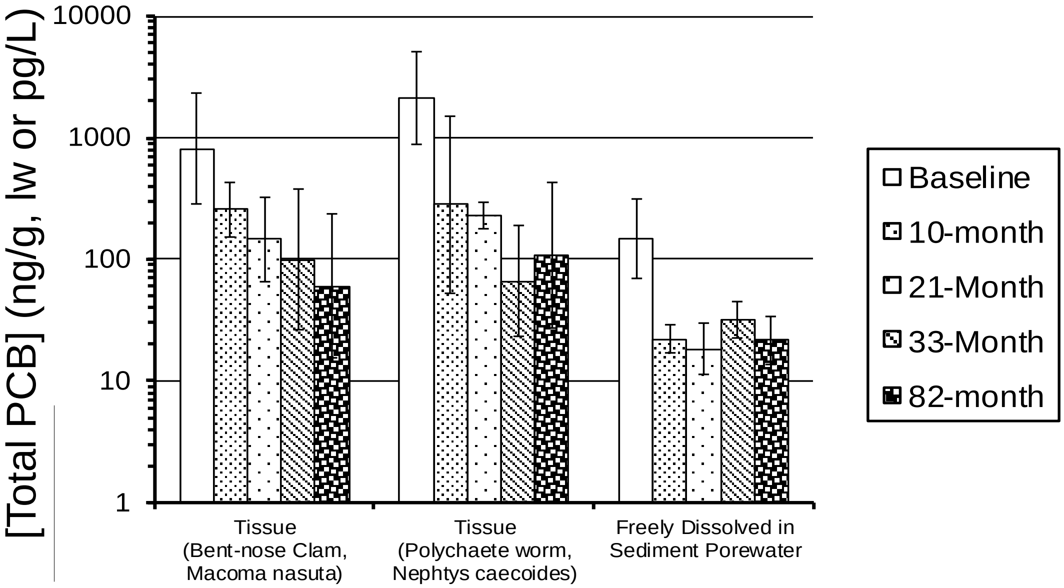

Figure 27. Summary of mean (± 95% confidence level) reduction in concentrations of total PCBs in tissue (lipid weight) normalized) and sediment porewater (pg/L) including at 82-month (long-term) monitoring event.

Performance objective 2 was developed to demonstrate how much of the activated carbon placed at the site remained in the surface sediments after 82 months. Per the data requirements for this objective, this was evaluated from the measurement of total organic carbon (TOC) and Black Carbon (BC) as had been done in previous monitoring events, but also the incorporation of carbon petrography to quantify AC specifically. The measurements were made both laterally and vertically (up to 20 cm) within the footprint of the amended area at all 10 stations where PCB availability was determined, and at an additional 10 locations for improved resolution of the long-term assessment of AC presence. All targeted samples were successfully collected, analyzed, and provided meaningful data, indicating that this objective was met. Total organic carbon at 82 months ranged from 2.5-3.3%, on average, and were generally consistent among the 4 depths measured. This range was comparable with levels observed at the last monitoring event (33-months post placement), and were not statistically different. Black carbon concentration at 82- months ranged from 0.7-1.3%, on average, and was also not statistically different from BC recorded from the 33-month monitoring event. The AC content indicated by carbon petrography was 0.9% among all samples (n=32), suggesting that most of the BC was made up by AC. It was also noted that presence of the aggregate (used to deliver the AquaGate+PAC to the sediment surface) was a decent indicator of BC and AC presence, with samples containing aggregate having a 4.3 fold higher concentration, on average, for both BC and AC.

Performance objective 3 was incorporated into the demonstration to assess any secondary effects on the benthic invertebrate community. Invertebrates were identified to the lowest possible taxonomic level and enumerated, with results used to compute comparative ecological parameters, such as organism density, species richness, and evenness. In this case, the 82-month data were compared with the pre-placement benthic community data to assess whether or not the presence of the amendment had impacted the biota. Overall, there is no evidence from the 82-month data indicating an effect on benthic invertebrate communities at the amended area, as found for previous monitoring events (Kirtay et al., 2018). No statistically-significant differences among the groups for total abundance, diversity, evenness, Swartz dominance index, and percent abundance of the top 5 abundant taxa were observed, with P values of 0.11, 0.14, 0.81, 0.34, and 0.20, respectively. Differences among the groups for taxa richness were noted (P = 0.04). Species richness was statistically different (lower) in the baseline for the unamended area compared to the 82-month amended area, suggesting improved ecological health in the amended area compared to the reference stations. This result may be due to temporal differences, and overall results confirm that species richness in the amended area has not been adversely affected by the AC amendment. The observations in this event further confirm the findings of most scientific studies proposing that adverse effects on benthic invertebrates are not expected as a result of activated carbon amendments (Janssen and Beckingham, 2013), especially when activated carbon dosage rates remain below approximately 5% by weight in sediment (Rakowska et al., 2012; Janssen and Beckingham, 2013; Kupryianchyk, et al. 2015; Patmont et al., 2015).

Performance objective 4 was to promote technology transfer and acceptance which involved collaboration with site managers and regulators and broad dissemination within the community of practice, with a particular focus on the long-term performance and persistence of the remedial technology. This objective focused largely on (1) transitioning the methods and knowledge to our commercial partners in the project and other qualified commercial entities to provide the expertise and capabilities for long-term monitoring of the remedy; (2) providing publicly accessible documentation of the long-term performance of the technology at an operational site under operational conditions; and (3) disseminating information about the technology performance as widely as possible to the community of practice via conference presentations, webinars, publications and social media. Partnering with Geosyntec, CMA, Ecoanalysts, and AquaBlok, Inc., ensured continuity of methods and continued momentum towards transition of the amendment and associated tools (e.g. passive sampling, SEA Ring, AquaGate+ amendment products) that have all been commercialized. The project principal investigator presented project results as part of the SERDP/ESTCP webinar series in December 2020, the SERDP Symposia in 2020, 2021, and 2022, and the Battelle International Conference on the Remediation and Management of Contaminated Sediments in 2023. A peer-reviewed manuscript summarizing the primary scientific contributions of this project was published in February 2022 in the journal *Environmental Toxicology and Chemistry* (Wang, Conder, Chadwick, and Rosen 2022) as a follow on to the primary Kirtay et al. (2018) publication resulting from ER-201131.

7. COST ASSESSMENT

The overall objective of this project, a follow on to ESTCP ER-201131 (Kirtay et al. 2017), was to demonstrate long-term (i.e. 82-month/~7 year) performance of an activated carbon-based powdered amendment (i.e. Aquagate+PAC^{TM}) in surface sediments and to validate the long-term placement, stability, performance and persistence of a reactive amendment. (e.g. powdered activated carbon; PAC) in DoD harbor settings. As part of the evaluation of performance, a cost evaluation and comparison to alternative contaminated sediment treatment methods, such as dredging, capping, and MNR was provided in the associate Final report by Kirtay et al. (2017) under ER-201131, which resulted in a peer-reviewed publication by Kirtay et al. (2018). For efficiency, and lack of unexpected observations during the 82-month LTM time point, we recommend the reader refer to the ER-201131 Final Report by Kirtay et al. (2017) using the link below for the most useful and sustaining review of the cost assessment objectives, including the Cost Model, Cost Drivers, and Cost Analysis.

The Cost Assessment for ER-201131 is available in the Final Report at:

https://serdp-estcp-storage.s3.us-gov-west-1.amazonaws.com/s3fs-public/project_documents/ER-201131%2BFinal%2BReport.pdf?VersionId=daV0uivX56FxaQecw2PeW2GIVSb8g2pb

8. IMPLEMENTATION ISSUES

Implementation issues identified in the Final Report associated with ER-201131 are shown in quotes below. As the results of the 82-month monitoring are largely similar to those reported from monitoring conducted during the first 3 years following the amendment placement at Pier 7, it is anticipated that regulators will increasingly view this technology as an effective and safe alternative to dredging.

"*In situ* remediation of HOC-impacted sediments with AC has been demonstrated to meet placement objectives for target area and thickness in deep waters as well as stability to remain in place over 3 years in an active shipyard. In this demonstration, AquaGate has been shown to reduce concentrations of PCBs in tissue and sediment porewater in the third year following placement in surface sediment by 81 to 97%. Most benthic invertebrate bioaccumulation studies of AC have shown reductions in concentrations of HOCs in tissue ranging from 70-90% compared to untreated control sediment (Ghosh et al 2011). AC amendment as a contaminated sediment remedy is of great interest to the research community as there have been 25 field studies of AC *in situ* treatment of contaminated sediments in the past 10 years (Patmont et al. 2015). *In situ* reactive amendment with AquaGate is well suited to be implemented in a variety of environmental conditions from shallow, quiescent, flat bottom settings to deep water, variable or sloping water depths, tidal environments with active vessel traffic and infrastructure. This technology would be of great interest as a remedy to HOC-impacted (e.g. PCBs, PAHs, and pesticides) surface sediments in association with Superfund sites and sites implementing remediation in response to equivalent state and local regulations (e.g. Clean and Abatement Orders, Total Maximum Daily Loads, etc.) associated with contaminated surface sediments. *In situ* treatment technology may be limited to sites with contamination to depths within the site specific bioturbation mixing zone (generally 10 to 20 cm below sediment-water interface) unless it is determined that there is little or no advective transport of contaminant from depths below the bioturbation mixing zone. AquaGate has an advantage in the ability to place amendments around infrastructure (e.g. piers and bulkheads) where dredging may be found to be more expensive or infeasible. Another advantage of AquaGate is the ability to place the amendment in navigational channels and berthing areas where capping may be infeasible due to water depth requirements. Costs of implementing AquaGate are competitive with alternative remedial methods; however, as with selection of any remedy, cost is depending on site specific conditions and complexity. Additionally, AquaGate has an advantage as a green remediation strategy which is of interest to the USEPA to minimize environmental footprints after cleanup.

Placement of *in situ* reactive amendment to sediments at Pier 7 presented significant challenges associated with amendment placement in active harbors including security access, scheduling, deep water placement, working near and under waterfront structures, complex bathymetry and dredge cuts in berthing areas, strong and variable tidal currents, and possible disturbance from ship movement and other harbor activities. Also, as with any pilot project, the small size of the area limited the ability of the operator to gain efficiency or improve the potential uniformity or coverage within the placement area. In total, 141 tons of AquaGate were placed on surface sediments at Pier 7 within 4 days from the arrival of the tugs to the verification of the placement by US Navy divers. There are improvements that could be made to placement, such as achieving placement within the entire target area and avoiding placement in areas outside the target area. Additionally, the evenness of the amendment thickness could be improved to place a more uniform distribution. Monitoring at Pier 7 was limited by diver assistance for deployment and retrieval of the SEA Rings and passive samplers. Also, measurements of TOC and BC content in sediment with presence of shell hash presented further challenges.

Although AC has been shown for decades to be effective at treatment of air, water, and wastewater, there remains some uncertainty as to the long-term effectiveness of sequestration treatment in the field. Because of public perception and a predisposition by the regulatory community, dredging continues to be the most common and accepted means of sediment remediation. Any remedy that leaves untreated contaminants in place, such as *in situ* sequestration, may have the potential for risk of re-exposure of the contaminants. A similar risk would be encountered for sites utilizing MNR, capping, or dredging when high concentrations in residuals are left in place. However, the risk from potential effects of re-exposure may be less if low concentrations of contaminants remain in the sediment.

It is believed that further research is still required. However, since the initiation of this project, the application of *in situ* sequestration at full-scale has been performed successfully. Long-term monitoring of these sites will be required to further support the expanded application of this technology."

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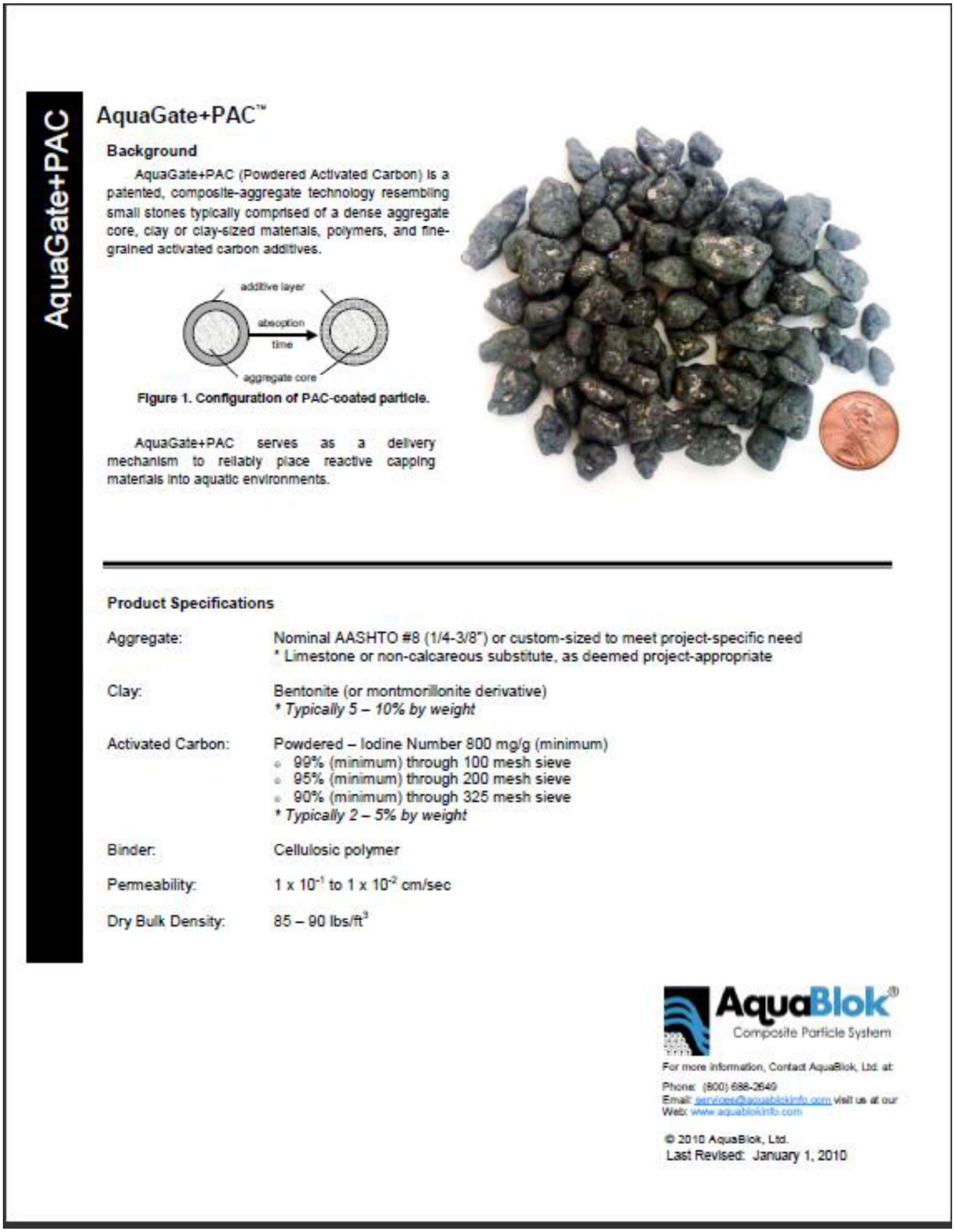
Appendix B

Aquagate+PAC™ Specifications



AquaGate+PAC

AquaGate+PAC™

Background

AquaGate+PAC (Powdered Activated Carbon) is a patented, composite-aggregate technology resembling small stones typically comprised of a dense aggregate core, clay or clay-sized materials, polymers, and fine-grained activated carbon additives.

Figure 1. Configuration of PAC-coated particle.

AquaGate+PAC serves as a delivery mechanism to reliably place reactive capping materials into aquatic environments.

Product Specifications

Aggregate:	Nominal AASHTO #8 (1/4-3/8") or custom-sized to meet project-specific need * Limestone or non-calcareous substitute, as deemed project-appropriate
Clay:	Bentonite (or montmorillonite derivative) ** Typically 5 – 10% by weight*
Activated Carbon:	Powdered – Iodine Number 800 mg/g (minimum) ○ 99% (minimum) through 100 mesh sieve ○ 95% (minimum) through 200 mesh sieve ○ 90% (minimum) through 325 mesh sieve ** Typically 2 – 5% by weight*
Binder:	Cellulosic polymer
Permeability:	1 x 10^{-1} to 1 x 10^{-2} cm/sec
Dry Bulk Density:	85 – 90 lbs/ft^3

AquaBlok®
Composite Particle System

For more information, Contact AquaBlok, Ltd. at:

Phone: (800) 688-2649
Email: services@aquablokinfo.com visit us at our
Web: www.aquablokinfo.com

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Last Revised: January 1, 2010

WPH®
Powdered Activated Carbon

CALGON
CALGON CARBON CORPORATION

Description

WPH® is a virgin, high performance powdered activated carbon (PAC) specifically designed to treat potable water. WPH® meets or exceeds all applicable AWWA standards per specification B-604-05, and is certified to ANSI/NSF Standard 61 for use in potable water treatment.

Applications

WPH® powdered activated carbon is ideally suited for removing taste and odor-causing compounds such as geosmin and methylisoborneol (MIB), as well as herbicides and pesticides such as alachlor, atrazine, and simazine, plus many other soluble organic chemical compounds. It can also be used to treat industrial wastewaters and numerous process applications to remove refractory organic chemicals.

Design Considerations

Powdered carbon is generally mixed with raw water in dosages ranging between 5 and 50 ppm. Longer mixing times result in lower doses. Similarly, higher activity carbons usually require lower doses. For the most cost-effective treatment, PAC should be fed at a point which allows the longest amount of contact time between the powdered carbon and the raw water.

Specifications

Iodine Number	800 mg/g (min)
Moisture as packed by weight	8% (max)
Screen Size by weight, U.S. Sieve Series	
Through 100 mesh	99% (min)
Through 200 mesh	95% (min)
Through 325 mesh	90% (min)

Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable Federal and State requirements.

Features	Benefits
Bituminous-based raw material	Pore structure provides a wider range of contaminant removal capabilities relative to other starting materials.
Free flowing powdered carbon	Works well in wet or dry injection systems.
High grind	Enables more rapid dispersion in water.

CALGON
CALGON CARBON CORPORATION

Making Water and Air Safer and Cleaner

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Your local representative

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NETAFIM™

Mesh vs. Micron Comparison Chart

Mesh	Microns	Inches	Millimeters	Netafim Disk Ring Color	Object
3	6730	0.2650	6.730		
4	4760	0.1870	4.760		Gravel starts at 4.75 mm
5	4000	0.1570	4.000		
6	3360	0.1320	3.360		
7	2830	0.1110	2.830		
8	2380	0.0937	2.380		
10	2000	0.0787	2.000		
12	1680	0.0661	1.680		
14	1410	0.0555	1.410		
16	1190	0.0469	1.190		Eye of a Needle = 1,230 microns
18	1000	0.0394	1.000		
20	841	0.0331	0.841		
25	707	0.0280	0.707		
28	700	0.0280	0.700		
30	595	0.0232	0.595		
35	500	0.0197	0.500		
40	420	0.0165	0.420	Blue	
45	354	0.0138	0.354		
50	297	0.0117	0.297		
60	250	0.0098	0.250		Fine Sand
70	210	0.0083	0.210		
80	177	0.0070	0.177	Yellow	
100	149	0.0059	0.149		
120	125	0.0049	0.125	Red	
140	105	0.0041	0.105	Black	
	100	0.00394	0.100		Beach Sand (100 - 2,000 microns)
170	88	0.0035	0.088		
200	74	0.0029	0.074		Portland Cement
	70	0.00276	0.070	Brown	Average Human Hair (70 - 100) / Grain of Salt
230	63	0.0024	0.063		
	55	0.00217	0.055	Green	
270	53	0.0021	0.053		
	50	0.00197	0.500		Remove Visible Particles from Liquid
325	44	0.0017	0.044		Silt (10 - 75)
	40	0.00157	0.040	Purple	Lower Limit of Visibility (Naked Eye)
400	37	0.0015	0.037		Plant Pollen
(550)*	25	0.00099	0.025		White Blood Cells / Level to Achieve 'Optical Clarity' in a Liquid
(625)	20	0.00079	0.020	Gray	
(1200)	12	0.0005	0.012		
(1250)	10	0.000394	0.010		Talcum Powder / Level to Remove Haze from Liquid / Fertilizer (10 - 1,000 microns) / Mold Spores (10 - 30 microns)
	7	0.000276	0.007		Red Blood Cells (8 - 12 microns)
(2500)	5	0.000197	0.005		Bacteria (0.5 - 20 microns)
(4800)	3	0.000118	0.003		
(5000)	2.5	0.000099	0.0025		Cigarette Smoke & Bacteria (Cocci) = 2 microns
(12000)	1	0.0000394	0.001		Cryptosporidium (1 - 10 microns)

* Mesh numbers in parentheses are too small to exist as actual screen sizes. They are only estimations and are included for reference.

What does mesh size mean? Determining mesh is very simple. Simply count how many openings there are in one inch of screen. The number of openings is the mesh size. An 80-mesh screen means there are 80 openings across one linear inch of screen. A 140-mesh screen has 140 openings, and so on. Therefore, as the mesh number increases, the size of the openings decreases. Note - Mesh size is not a precise measurement of particle size because of the size of the wire used in the screen. Beyond 400 mesh, particle size is normally defined only in "microns." That is because the finer the weave, the closer the wires get together; eventually there is no space between them.

What do the minus (-) and plus (+) plus signs mean when describing mesh sizes and particle distribution tests? To characterize particle size by mesh designation:

- A "+" before the mesh indicates the particles are retained by the sieve,
- A "-" before the mesh indicates the particles pass through the sieve, and
- Typically, 90%+ of the particles will lie within the indicated range.

For example, if the particle size of a material is described as -10 / +30 mesh, then 90% or more of the material will pass through a 10-mesh sieve (particles smaller than 2.0 mm) but will be retained by a 30-mesh sieve (particles larger than 0.595 mm). If the material is described as -30 mesh, then 90% or more of the material will pass through a 30-mesh sieve (particles smaller than 0.595 mm).

Appendix C

Detailed Data Report from Geosyntec, Inc

This work was performed under the auspices of the
U.S. Army Research Office Scientific Services Program
administered by Battelle Memorial Institute,
Contract No. W911NF-11-D-0001.

Monitoring of Activated Carbon Amendment to Reduce PCB Bioavailability in Sediments at An Active Shipyard

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September 25, 2020

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Form Approved
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1. REPORT DATE *(DD-MM-YYYY)*
25-09-2020

2. REPORT TYPE
Final Report

3. DATES COVERED *(From - To)*
02-112018 – 25-09-2020

4. TITLE AND SUBTITLE
Monitoring of Activated Carbon Amendment to Reduce PCB Bioavailability in Sediments at An Active Shipyard

5a. CONTRACT NUMBER
W911NF-11-D-0001/ W911NF18F0046

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
N/A

6. AUTHOR(S)
Conder, Jason
Wang, Alice

5d. PROJECT NUMBER
N/A

5e. TASK NUMBER
TCN 18-009

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Geosyntec Consultants
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Huntington Beach, California 92648

8. PERFORMING ORGANIZATION REPORT NUMBER
N/A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Naval Information Warfare Center Pacific (NIWC Pacific)
Energy and Environmental Sustainability, Code 71760
53475 Strothe Rd.
San Diego CA 92152-6325

10.SPONSOR/MONITOR'S ACRONYM(S)
NIWC Pacific

11.SPONSORING/MONITORING AGENCY REPORT NUMBER
N/A

12. DISTRIBUTION AVAILABILITY STATEMENT
May not be released by other than sponsoring organization without approval of US Army Research Office, P.O. Box 12211, Research Triangle Park, NC 27709.

13. SUPPLEMENTARY NOTES
N/A

14. ABSTRACT

Activated carbon (AC)-based amendments have been demonstrated widely in recent years as an effective, and relatively non-disruptive means of sequestering sediment associated hydrophobic organic contaminants, such as polychlorinated biphenyls (PCBs). In a project effort led by the Naval Information Warfare Center Pacific (NIWC Pacific), in 2012, an AC amendment (AquaGate+PAC™) was placed at a ½ acre plot adjacent to and underneath Pier 7 at the Puget Sound Naval Shipyard & Intermediated Maintenance Facility (PSNS & IMF) to reduce PCB availability. Post-placement monitoring over a three-year period, and showed a persistent 80-90% reduction in available PCBs, stability of the AC amendment, and no significant negative impacted to the native benthic invertebrate community. To help answer ongoing questions about the longevity of such remedies, in 2019 a follow on 7-year post placement monitoring event was conducted at the site with the primary objectives being evaluation of 1) the long-term effectiveness of the AC-amendment to reduce bioavailable concentrations of PCBs in porewater; 2) long-term stability of the AC amendment with observations of the persistence in surface sediments; (3) long-term potential for adverse impacts to the benthic community due to the remedy. With the exception of one monitoring station near the edge of the remedy footprint, *in situ* porewater and bioaccumulation evaluations continued to show PCB availability reductions of ~80-90% at 7-years post placement, consistent with earlier observations. Benthic invertebrate community indices (e.g. richness, abundance, evenness, diversity) were statistically indistinguishable at amended and unamended stations, also consistent with past observations. Measurement of black carbon content by chemical oxidation indicated AC presence at 87% of 23 station locations, comparable results from the 33-month post-placement monitoring time point. The results from BC and carbon petrography indicate that the quantification of AC using the BC chemical oxidation method is sufficient, with the BC results in agreement with AC results indicated by carbon petrography.

15. SUBJECT TERMS

Sediment remediation, passive sampling

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT** SAR	**18. NUMBER OF PAGES** 194	**19a. NAME OF RESPONSIBLE PERSON** Ernest Arias
a. REPORT U	**b. ABSTRACT** U	**c. THIS PAGE** U			**19b. TELEPONE NUMBER (*Include area code)*** 619-553-3579

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI-Std Z39-18

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Appendices

1. Introduction

Activated carbon (AC)-based amendments have been demonstrated widely in recent years as an effective, and relatively non-disruptive means of sequestering sediment associated hydrophobic organic contaminants, such as polychlorinated biphenyls (PCBs). In a project effort led by the Naval Information Warfare Center Pacific (NIWC Pacific), in 2012, an AC amendment (AquaGate+PAC™) was placed at a ½ acre plot adjacent to and underneath Pier 7 at the Puget Sound Naval Shipyard & Intermediated Maintenance Facility (PSNS & IMF) to reduce PCB availability.

Previous work in this study evaluated the performance of a logistically challenging activated carbon placement in a high-energy hydrodynamic environment adjacent to and beneath a pier in an active military harbor. Post-placement monitoring over a three-year period, and showed a persistent 80-90% reduction in available PCBs, stability of the AC amendment, and no significant negative impacted to the native benthic invertebrate community. Measurements were conducted pre-amendment and also at 10, 21, and 33 months post-amendment. Key results indicated that the targeted 4% (by weight) addition of AC (particle diameter ≤74 mm) in the uppermost 10 cm of surface sediment reduced polychlorinated biphenyl availability by an average (±standard deviation) of 81±11% in the first 10 months after amendment. The final monitoring event (33 months after amendment) indicated an approximate 90±6% reduction in PCB availability, reflecting a slight increase in performance and showing the stability of the amendment. Benthic invertebrate census and sediment profile imagery did not indicate significant differences in benthic community ecological metrics among the pre-amendment and 3 post-amendment monitoring events, supporting existing scientific literature that this approximate activated carbon dosage level does not significantly impair native benthic invertebrate communities (Kirtay et al. 2018).

To help answer ongoing questions about the longevity of AC remedies, in 2019 a follow on 7-year post placement monitoring event (conduced 82 months after the amendment was placed) was conducted at the site, led by NIWC Pacific. The primary objectives of the 82-month monitoring are to demonstrate the long-term stability and effectiveness of AC-based amendment as *in situ* treatment for persistent organic contaminant-impacted sediments, specifically PCBs, while ensuring the amendment does not adversely affect benthic ecological resources. The primary objectives include evaluation of (1) long-term effectiveness of AC amendment to reduce bioavailable concentrations of PCBs in biota and available concentrations of PCBs in porewater; (2) long-term stability of the AC amendment with observations of the lateral and vertical extent, uniformity, and persistence in surface sediments; (3) long-term potential for adverse impacts to the benthic community due to the remedy; and (4) promoting commercial availability and regulatory acceptance of the technology.

A variety of different measurement approaches were employed across the site at different stations (**Figure 1**), as detailed in **Table 1**. This figure and table will be referenced throughout the following report.

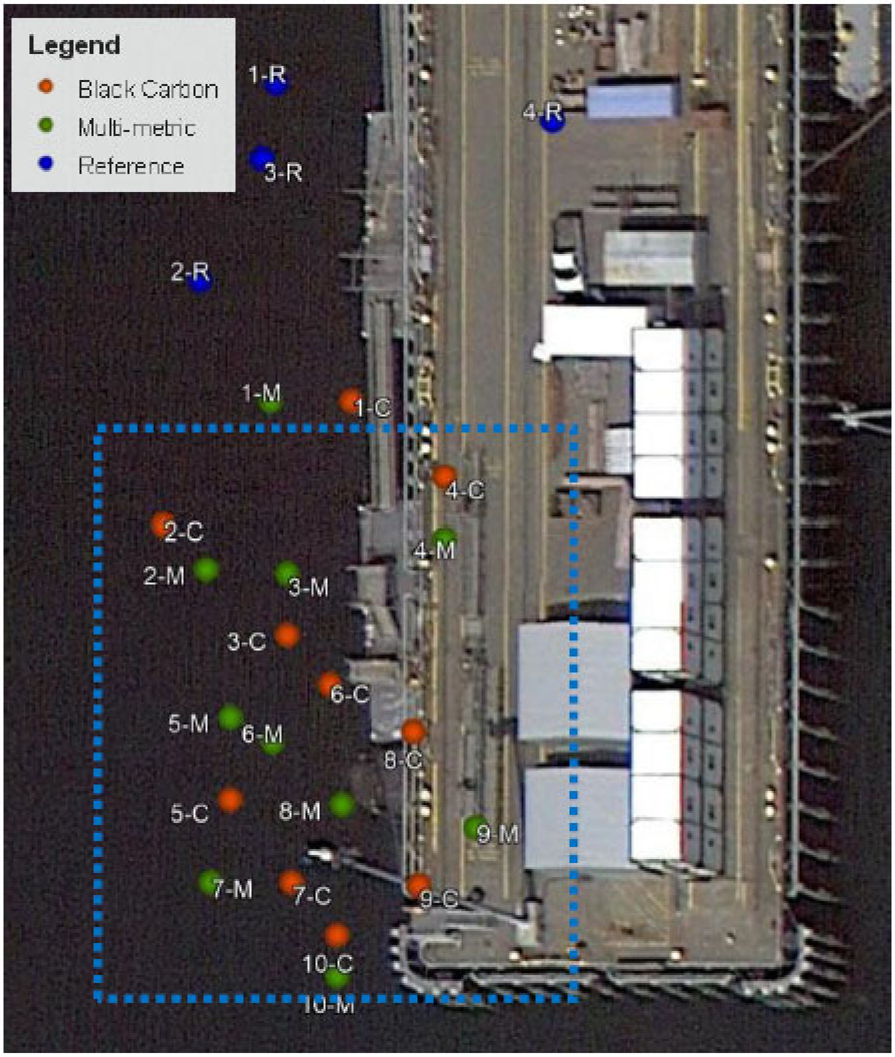

Figure 1. Sampling Locations

Table 1. Sampling Summary

Sampling Method	Analysis Type	Number of Stations	Stations Sampled	Total Number of Samples
SEA Ring	*In-situ* bioaccumulation analysis of polychaete tissue for PCBs and lipid content	10	1 - 10 MM	13
	In-situ bioaccumulation analysis of bivalve tissue for: PCBs and lipid content	10	1 - 10 MM	13
SPME	C_{free} PCBs in sediment porewater	10	1 - 10 MM	13
Core Bulk Sediment	Sediment analysis for PCBs, limited MeHg, TOC	10	1 - 10 MM	12
Core Samples	Benthic Community Census	14	1 - 10 MM, 1-4 R	14
	Visual confirmation of amendment mixing before sectioning (qualitative)	20	1 - 10 MM, 1- 10 C	88
	TOC in sediment sections (Lloyd Khan)	20	1 - 10 MM, 1- 10 C	88
	Black Carbon in sediment sections (G&G Chemical Oxidation)	20	1 - 10 MM, 1- 10 C	88
	Black Carbon in sediment sections (Koppers Petrography)	7	2 - 7 and 9 MM	32

The remainder of this report focuses on support provided by Geosyntec Consultants to NIWC Pacific, and is organized into the following sections:

- Section 2: Assessment of long-term effectiveness of PCB reduction
- Section 3: Long-term characterization of presence of amendment
- Section 4: Long term assessment of potential impacts to benthic community
- Section 5: Overall conclusions
- Section 6: References

2. Assessment of Long-Term Effectiveness of PCB Reduction

2.1. Introduction

The objective of this task was to assess the 2019 field conditions by evaluating the availability of PCBs using three different methods. The same methodology was used as in previous monitoring years. Briefly, as described below, freely dissolved concentrations C_{free} of PCBs in sediment porewater were measured using SPME passive samplers. Concentrations of PCBs in sediment and tissue samples from two in situ deployed bioaccumulation test organisms, *Nephtys caecoides* (polychaete worms) and *Macoma nasuta* (bent-nose clam) were also measured.

2.2. Methods

2.2.1. in situ PCB Passive Sampling Methods

In general, the same porewater sampling methods used for the short-term effectiveness evaluation under ER-201131 (Kirtay et al, 2017 and Kirtay et al. (2018) was utilized for measurement of PCBs in sediment porewater (C_{free}), specifically the *in situ* deployment, recovery, processing, and data analysis associated with solid-phase microextraction fibers (SPME). This approach provided a measurement of dissolved PCBs (congeners) present in porewater of the surface sediment layer (top 10-15 cm). Geosyntec worked with its environmental laboratory (SiREM), to provide the exact same design of SPME sampler employed for the previous SPME deployments at the project site.

Geosyntec provided the SPMEs to SSC Pacific for the *in-situ* deployment by the US Navy divers at 10 multi-metric stations (1MM – 10 MM, denotated as 1M – 10 M in **Figure 1** and **Table 1**) within the AC-amendment footprint (2 SPMEs per station), with an additional SPME for quality assurance purposes. These are the same stations that have been sampled in previous monitoring events.

SPMEs were deployed in a “SPME Device” consisting of SPMEs housed in a small stainless-steel mesh envelope attached to a steel rod support. Each SPME sampler consists of 125 cm of SPME fiber (ten 12.5-cm pieces of fiber with 10-µm thickness polydimethylsiloxane (PDMS) coating, 210-µm silica core diameter, obtained from Fiber-guide Industries, Stirling, NJ (“SPC210/230R, No Jacket, CL-0097-1”); 0.06908 µL PDMS/cm PDMS). The samplers are pre-loaded with performance reference compounds (PRCs). The 10 fiber pieces are contained within a 110-µm stainless steel mesh envelope approximately 14 cm by 2 cm (when folded up).

For deployment, SPME devices were removed from their protective storage bags and provided to SCUBA divers, who then descended to the sediment at the site. At each MM station, SPMEs were placed adjacent to SEA Ring chambers at each of the 10 multi-metric stations. Three SPME Devices were placed around each SEA Ring. The samplers were deployed for 2-weeks, with deployment the week of August 12, 2019 and retrieval the week of August 26, 2019.

Following a 14-d exposure period, passive samplers were retrieved by SCUBA divers and transported immediately to the recovery team above the water surface. Upon recovery, passive samplers were detached from the SEA Rings and the steel mesh envelopes containing SPMEs were individually wrapped in aluminum foil, placed in plastic bags, and stored at 4°C.

Post-processing and extracting of the SPME fibers was performed at EcoAnalysts laboratory in Port Gamble, WA the week of August 26, 2019. The SPME fibers from each MM station (3 SPME devices) were removed from their envelopes, wiped with a moist tissue, and cut into small pieces, and placed in a pre-weighed 7-mL amber glass vial. After the vial and fiber were weighed (to estimate SPME mass so that the length of SPME obtained could be quantified), 6 mL ultrapure hexane was added. Three additional SPME samples (i.e., nine devices not deployed in sediment, but kept in cold storage) were included as trip blank SPMEs. The vials were shipped to the USACE ERDC analytical laboratory where the vials were then stored at 4°C for several days, spiked with external surrogates, evaporated to a volume of approximately 100 or 200 µL with pure nitrogen, and analyzed for PCB congeners consistent with USEPA Method 8082.

After the deployment period, the samplers are extracted and analyzed for target PCBs and PRCs. C_{free} PCBs were calculated using the measured PCB concentrations in the SPME samplers and the fraction loss of the PRCs out of the samplers during deployment time, as described in Kirtay et al (2018).

Supporting data and raw data for the SPMEs are provided in **Appendix A**.

2.2.2. Tissue PCB Methods

In situ bioaccumulation tests were also deployed at the site to measure PCB bioavailability. This effort was not conducted by Geosyntec, but is described briefly here. Laboratory-provided *Nephtys caecoides* (polychaete worms) and *Macoma nasuta* (bent-nose clam) were housed in sediment ecotoxicity assessment rings (Zebra-Tech) an autonomous multichamber sampler used for in situ toxicity and bioaccumulation testing. Sediment ecotoxicity assessment rings were installed and retrieved by scuba divers at 10 multi metric stations (1MM – 10 MM, denotated as 1M – 10 M in **Figure 1**) such that organisms were exposed to approximately the top 15 cm of surface sediment for 14 days. Sampling locations are shown in **Figure 1** and a sampling summary is provided in **Table 1.** After retrieval of the sediment ecotoxicity assessment rings, *N. caecoides* and *M. nasuta* were recovered from the chambers by extruding chamber contents onto a 500-mm stainless steel sieve and sorting contents by hand. Organisms were allowed to depurate in clean seawater for 24 h. *N. caecoides* (whole body) and *M. nasuta* (soft tissues) were homogenized, extracted, and analyzed for PCB congeners via US Environmental Protection Agency Method 8082A and for lipid content via a gravimetric approach (Honeycutt et al. 1995) by ERDC, as described in Kirtay et al. (2018).

2.2.3. Sediment PCB Methods

Sediment sampling for PCBs was not conducted by Geosyntec, but is described briefly here. Total Sediment PCBs were analyzed in bulk sediment via 2-inch diameter core samples obtained using SCUBA divers from 10 multi metric stations (1MM – 10 MM, denotated as 1M – 10 M in

Figure 1). Each core was sectioned into a 0-15 cm thick sample, which was homogenized and stored at 4°C until it could be analyzed.

Sampling locations are shown in **Figure 1** and a sampling summary is provided in **Table 1.** Sediment samples were extracted, and extracts were analyzed at the USACE ERDC lab by the EPA 8082 method for 72 PCB congeners, as described in Kirtay et al. (2018).

2.3. Results

2.3.1. in situ Passive Sampling PCB Cfree Results

Ancillary and raw data for SPME C_{free} is provided in **Appendix A.** C_{free} of PCBs was detected at only 2 of the 10 stations in the 82-month sampling event in the initial analysis (Analysis 1). All PRCs were detected in both trip blanks. The analytical lab attempted to the re-concentrate the SPME extracts by evaporating solvent to achieve a lower detection limit then performing a second analysis (Analysis 2). Success of the procedure was evaluated by comparing masses of PRCs determined in the trip blanks in analysis 1 and 2. Ideally, the PRC results would not be expected to change as PRCs were detectable in trip blanks in Analysis 1. However, the results of Analysis 2 indicated radically different values PRC results from Analysis 1, on average a factor of 2.6 times lower (see **Table 2**). This discrepancy indicates an artifact in the laboratory concentration procedure, thus rendering the results of Analysis 2 unreliable.

Table 2: C_{free} PCBs (SPME) PRC results from Analysis 1 and Analysis 2.

			ng/SPME extract			
PRC	**Homologue**	**Sample**	**Analysis 1**	**Analysis 2**	**Difference (Analysis 1 ÷ Analysis 2)**	**% Difference**
PCB 14	Di	Trip Blank 1	40	18	2.2	55%
PCB 36	Tri		40	20	2.0	50%
PCB 78	Tetra		117	47	2.5	60%
PCB 121	Penta		178	58	3.1	67%
PCB 142	Hexa		426	235	1.8	45%
PCB 155	Hexa		223	68	3.3	69%
PCB 192	Hepta		303	130	2.3	57%
PCB 204	Octa		523	325	1.6	38%
PCB 14	Di	Trip Blank 2	47	18	2.6	62%
PCB 36	Tri		48	20	2.4	59%
PCB 78	Tetra		136	45	3.0	67%
PCB 121	Penta		198	56	3.5	72%
PCB 142	Hexa		496	226	2.2	54%
PCB 155	Hexa		265	66	4.0	75%
PCB 192	Hepta		361	129	2.8	64%
PCB 204	Octa		628	321	2.0	49%

Given the failure of Analysis 2, Analysis 1 results were used and are reported in **Appendix A**. Results by homologue and the sum of the total tetra, penta, and hexa PCBs (the sum of C_{free} used in Kirtay et al. (2018)) are reported in **Table 3**. To enable a comparison of these results to previous results reported in Kirtay et al. (2018), total PCB C_{free} was estimated as one half the average method detection limit (½ MDL) for Analysis 1 when all congeners were undetected. Kirtay et al. (2018) reported total PCB C_{free} data as the sum of the detects, and this data was re-compiled. Specifically, ½ MDL was also used when samples were non-detect.

Table 3: C_{free} PCBs results by Homologue and Sum PCB Values.

Vial ID	Sample ID	Station ID	Deployment Type	**Concentration of PCB Homologs in Sediment Porewater [1] (ng $_{PCB}$/L $_{Porewater}$)**									
				Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Total Tetra-Hexa PCBs [2]
1	T82-1-MM-SPME	1-MM	Device	*< 0.19*	*< 0.164*	*< 0.076*	*< 0.062*	*< 0.07*	*< 0.086*	*< 0.111*	*< 0.145*	*< 0.187*	*< 0.073*
2	T82-2-MM-SPME	2-MM	Device	*< 0.21*	*< 0.182*	*< 0.074*	*< 0.035*	*< 0.017*	*< 0.009*	*< 0.005*	*< 0.003*	*< 0.002*	*< 0.021*
3	T82-3-MM-SPME	3-MM	Device	*< 0.23*	*< 0.21*	*< 0.128*	*< 0.091*	*< 0.069*	*< 0.056*	*< 0.046*	*< 0.037*	*< 0.031*	*< 0.072*
4	T82-4-MM-SPME	4-MM	Device	*< 0.21*	*< 0.181*	*< 0.069*	*< 0.029*	*< 0.011*	*< 0.004*	*< 0.002*	*< 0.001*	*< 0*	*< 0.014*
5	T82-5-MM-SPME	5-MM	Device	*< 0.25*	*< 0.216*	*< 0.092*	*< 0.047*	**0.077**	*< 0.012*	*< 0.007*	*< 0.004*	*< 0.002*	**0.077**
6	T82-6-MM-SPME	6-MM	Device	*< 0.2*	*< 0.172*	*< 0.067*	*< 0.041*	*< 0.037*	*< 0.041*	*< 0.047*	*< 0.055*	*< 0.066*	*< 0.04*
7	T82-7-MM-SPME	7-MM	Device	*< 0.36*	*< 0.313*	*< 0.14*	*< 0.066*	*< 0.029*	*< 0.014*	*< 0.007*	*< 0.003*	*< 0.002*	*< 0.036*
8	T82-8-MM-SPME	8-MM	Device	*< 0.41*	*< 0.361*	*< 0.164*	*< 0.084*	*< 0.039*	*< 0.02*	*< 0.01*	*< 0.005*	*< 0.003*	*< 0.047*
9	T82-9-MM-SPME	9-MM	Device	*< 0.19*	*< 0.167*	*< 0.065*	*< 0.037*	*< 0.027*	*< 0.025*	*< 0.024*	*< 0.024*	*< 0.024*	*< 0.03*
10	T82-10-MM-SPME	10-MM	Device	*< 0.35*	*< 0.333*	*< 0.234*	**2.9**	**7.6**	**1.7**	*< 0.734*	*< 1.055*	*< 1.567*	**12.2**
Average Method Detection Limit for Non-Detect Results				0.26	0.23	0.11	0.08	0.07	0.08	0.10	0.13	0.19	-

Notes:

1 The concentration of PCB Homologs in each sample were calculated as the sum of the detected PCB congeners. If no congeners were detected, the maximum detection limit for the congeners within the homolog group is reported.

2 Total Tetra-Hexa PCBs was calculated as the sum of the detected PCB homologs. If concentrations were non-detect for all homologs, Total Tetra-Hexa PCBs were assumed to be equal to the highest homolog detection limit.

3 All stations are located within the target amendment area.

4 Abbreviations:

L = liter	ng = nanogram
NC = Not Calculated	PCB = polychlorobiphenyl

For the 82-month dataset, C_{free} data from station 10-MM data was ruled an outlier and excluded from the 82-month data, as it was anomalously high (12 ng/L) and was higher than baseline results from current and previous sampling events. Station 10-MM is located in an area at the edge of the amendment area (**Figure 1**) with a relatively high sediment concentration (240 ng/g, dw) and an absence of aggregate, suggesting that the Station 10-MM location monitored in the 82-month event was in an area that did not receive AC amendment. This indicates that Station 10-MM may be outside the activated carbon footprint and/or is affected by the encroachment of surrounding contaminated sediment.

Comparison of data showed that PCB C_{free} data from 82 month was consistent with previous years as shown in **Figure 2.** Statistical analysis (ANOVA followed by Tukey's Honestly Significant Difference) was obtained from Kirtay et al. (2018), although 82-month PCB C_{free} data were not included due to the high number of non-detect result. Post-remedy monitoring events were 85%, 88%, 79%, and 85% lower than the baseline (average of 84% lower for all four post-amendment results).

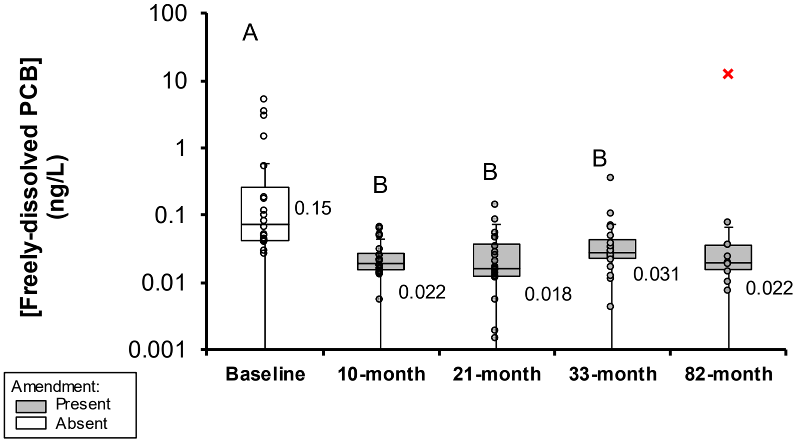

Figure 2: Cfree PCBs. Numerical labels represent geometric means, and results with the same letter label are not statistically different[1]. The red "x" symbol indicates an outlier result (station 10-MM) that was not included in the geometric mean or box and whisker.

2.3.2. Sediment PCB Results

Measured concentrations of total PCBs in sediment at the 82-month event had a geometric mean of 10 ng/g,dw. This is statistically similar to measured total PCB concentrations in previous post-amendment sampling events and continue to be lower than the baseline (**Figure 2**). These results may suggest ongoing natural recovery.

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[1] Box and whisker plots shown in this report indicate the 25th to 75th percentiles (boxes), with a mid-line representing the median, and the whiskers indicating the 10th and 90th percentiles. The small circles are the raw data points.

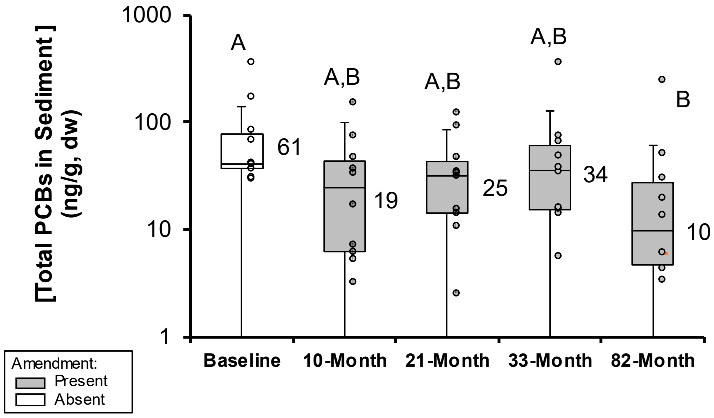

Figure 3: Total PCBs in Sediment. Numerical labels represent geometric means, and results with the same letter label are not statistically different.

2.3.3. Tissue PCB Results

M. nasuta tissue samples from 8 of the 10 stations were non-detect for PCBs. As with the C_{free} measurements, ½ the MDL values were used to represent tissue PCBs at stations with non-detect results. Results were compared to previous post amendment monitoring results. As shown in **Figure 4**, *M. nasuta* PCBs in the 82-month post-amendment sampling event are consistent with previous post-amendment monitoring results indicating that the AC amendment is continuing to keep PCB availability approximately 80% lower than the baseline. Statistical analysis (ANOVA followed by Tukey's Honestly Significant Difference) was obtained from Kirtay et al. (2018), although 82-month PCB data were not included due to the high number of non-detect result. Post-remedy monitoring events were 68%, 81%, 88%, and 93% lower than the baseline (average of 82% lower for all four post-amendment results).

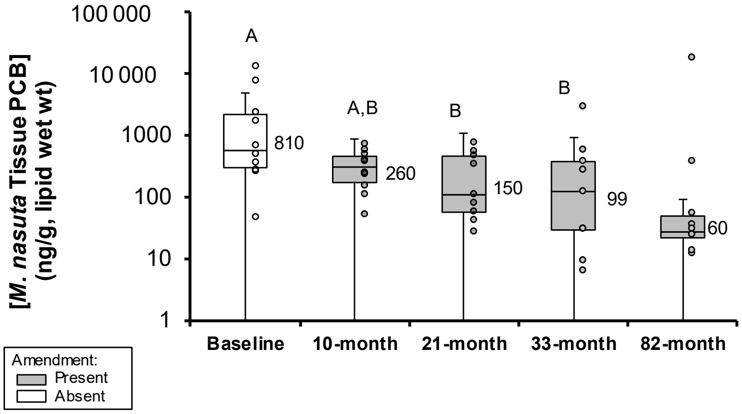

Figure 4: *M. nasuta* Tissue PCBs. Numerical labels represent geometric means, and results with the same letter label are not statistically different.

N. caecoides tissue samples from 7 of the 10 were non-detect for PCBs. As in the case of C_{free} data, ½ the MDL was used to represent tissue PCB concentrations at stations with non-detect results. Results were compared to previous post amendment monitoring results. As shown in Figure 5, *N. caeoides* PCBs in the 82-month post-amendment sampling event are consistent with previous post-amendment monitoring results indicating that the AC amendment is continuing to keep PCB availability approximately 90% lower than the baseline. Statistical analysis (ANOVA followed by Tukey's Honestly Significant Difference) was obtained from Kirtay et al. (2018), although 82-month PCB data were not included due to the high number of non-detect result. Post-remedy monitoring events were 87%, 89%, 97%, and 95% lower than the baseline (average of 82% lower for all four post-amendment results).

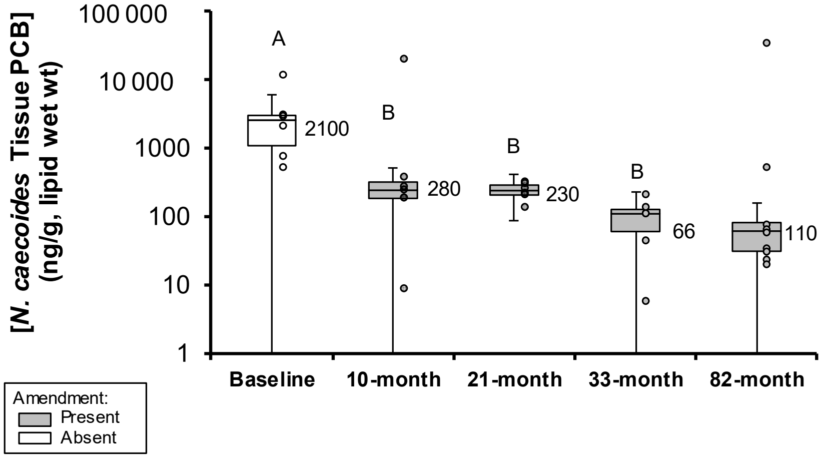

Figure 5: ***N. caecoides* Tissue PCBs.** Numerical labels represent geometric means, and results with the same letter label are not statistically different.

2.4. Conclusions

Total PCB availability, as determined from two measurement approaches (freely dissolved PCBs, and tissue PCBs) at 82-month post-amendment indicate continued low PCB availability and results are consistent with the previous post-amendment monitoring results. The AC amendment is continuing to keep PCB availability 80-90% lower than baseline at levels that would meet typical risk-based screening and management criteria for surface sediments at contaminated sites.

3. Long-term Characterization of Presence of Amendment

3.1. Introduction

The objective of this task was to evaluate the presence of the AC amendment at the site, both in terms of the spatial area covered, the depths in the sediment layers to which the AC amendment has penetrated, and the AC content of the sediment. As in previous monitoring events, this evaluation was conducted by evaluating sediment core samples via analysis of Total Organic Carbon (TOC) in bulk sediment via Lloyd Khan Thermal Oxidation, as well as the presence of Black Carbon (BC) via Grossman and Ghosh Chemical Oxidation, under the assumption that that majority of the TOC and BC measured was comprised of AC originating from the amendment. Physical examination of the sediment core samples was conducted to evaluate the presence of the Aquagate core material, as in Kirtay et al. (2018).

Because the TOC and BC methods have drawbacks to quantifying AC (as discussed below), the 82-month event included a new measurement technique to quantify the AC content of sediment via petrographic analytical methods similar to ASTM D2797 and ASTM 2799. This approach provided an additional line of evidence with regards to AC presence and allowed a confirmation of the values provided by BC, which are believed to be more accurate than TOC.

3.2. Methods

3.2.1. Sediment Sample Collection Methods

2-inch diameter sediment cores were retrieved at 20 stations 10 multi-metric stations, 1MM – 10MM and 10 additional stations, 1C – 10C (1M – 10 M and 1C – 10 C in **Figure 1**) by SCUBA divers to obtain the necessary samples for TOC, AC and carbon petrography. Sampling locations are shown in **Figure 1** and a sampling summary is provided in **Table 1.** The stations 1MM – 10 MM are the same stations that have been sampled in all previous sampling events. The additional stations of 1C – 10C were collected to provide additional spatial coverage of the site for the 82-month monitoring event.

At each station, one sediment sample core sample was collected, visually logged and sectioned into four 5-cm-thick depth intervals (0-5 cm, 5-10 cm, 10-15 cm and 15-20 cm). At station 7, duplicate samples were taken at each of the 4 depths. This sampling totaled to 88 overall samples. This allowed evaluation of a vertical profile.

All samples were analyzed for TOC and BC, using methods described below. In addition, carbon petrography (to specifically measure AC content) was measured in 32 samples obtained from 7 cores (4 layers per core) collected at 6 stations (one station included a duplicate core).

3.2.2. TOC Analysis Method

TOC was analyzed in 88 samples by the standard Lloyd Kahn method. Full details of the Lloyd Kahn Method are available from the EPA (USEPA 1998). A special preparation procedure was designed and executed according to client specific requirements. In brief, samples were weighed and pre-treaded to remove inorganic carbon by acidifying and drying. Pre-combustion was performed at 375°C for 24 h to consume natural carbon. The samples were then analyzed by a

TOC analyzer, the result is assumed to be more representative of the BC content of the original sample.

The disadvantage of using this method to quantify AC in sediment is that the pre-combustion step may oxidize AC, causing the AC content of sediment to be underestimated. TOC analyses, however, are routine, widely available from commercial analytical laboratories, and relatively inexpensive ($100 or less).

3.2.3. BC Analysis Method

In previous sampling events, BC was measured via the Walkley Black method. In the current 82-month sampling event, black carbon was measured in 81 sediment samples by the Ghosh and Grossman method (Grossman and Ghosh, 2009), which measures BC such as soot and pyrolytic carbon. Detailed methodology is available in Ghosh and Grossman (2009). In brief, sediment samples were analyzed for BC by the Ghosh and Grossman method at the Ghosh Laboratory at University of Maryland – Baltimore County, Baltimore, MD. A chemical oxidation pre-treatment (BC-chemox) was performed on wet sediment samples. This step involves pre-treated with a sulfuric acid-potassium dichromate solution to remove natural organic carbon by oxidation while avoiding oxidation and subsequent loss of the majority of AC in the sample.

A Shimadzu TOC analyzer with a solids sample module (TOC-5000A and SSM-5000A) was used for TOC analysis. Carbon in the sample was combusted to form CO_2 at 900 ºC. The CO_2 was detected by a non-dispersive infrared gas analyzer. The instrument was calibrated for carbon using reagent-grade glucose. The sediment TOC analysis followed an operating procedure recommended by the manufacturer.

The disadvantage of using this method to quantify AC in sediment is that, while the pre-treatment avoids losses associated with typical methods used to analyze TOC and BC, the analysis is not widely available from commercial analytical laboratories, as it is a specialized method. Additionally, the method does not distinguish AC from other forms of BC that may be present, such as soot. Therefore, BC measurements may overestimate post-amendment AC sediment content if the underlying sediment has a high initial BC content or if soot from natural or anthropogenic sources continue to contribute BC material to the sediment.

3.2.4. Carbon Petrography Method

AC content was analyzed in 32 samples via a petrographic analytical method by Koppers following ASTM standard methods for coal analysis: D2797 (Preparing Coal Samples for Microscopic Analysis by Reflected Light), D2798 (Microscopic Determination of the Reflectance of Vitrinite in a Polished Specimen of Coal), and D2799 (Microscopic Determination of Volume Percent of Physical Components of Coal) as described in Ghosh et al. (2003).

Briefly, wet sediment samples were delivered to the lab in 30-ml glass vials. Samples were removed from vials and placed on a glass plate and dried in an oven at 80°C for 2 hours. The dried samples were photographed to document characteristics of the as-received materials prior to petrographic preparation. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve. The remaining 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1.25-inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 250X and 600X magnification in air to allow visual observation and estimation of AC content and other components. The composition analysis consists of 1000 points counted for each sample at 600X magnification in air.

Laboratory reports containing details on the analyses and raw data are included in **Appendix B.** The AC content of the sediment was reported on a percentage volume basis (i.e., 100% × volume of AC divided by the total volume of all solids in the sediment). Measurements of TOC and BC are reported on a dry weight mass basis (i.e., 100% × dry mass of TOC or BC divided by the total dry mass of all solids in the sediment). The density of activated carbon is lighter than that of typical inorganic sediment fractions (i.e., 2 g/cm^3 for AC versus 2.7 g/cm^3 for inorganic sediment particles), the AC content reported as a volumetric percentage may be a factor of approximately 1.4 times higher (i.e., 2.7 ÷ 2.0) than if it were able to estimated on a percent mass basis by the carbon petrography method. Because the bulk density of the sediment samples particles were not measured, a numerical factor (e.g., 1.4) was not applied to the data.

3.3. Results

A tabular summary of all available aggregate presence information, sediment textural notes, and quantitative results of the TOC, BC, and carbon petrography AC results are provided in **Appendix C**. Additional details are provided below.

3.3.1. Aggregate Presence

During processing of the sediment core samples collected for TOC and PCB analysis, visual analysis of the samples confirmed AquaGate aggregate material was present at 18 of the 20 stations in the amendment area (**Appendix C**). As noted above, amendment was present at all monitoring events at all 20 stations in the locations in which the organisms and passive samplers were exposed, so the absence of core material in two of the three core samples collected at one of the stations likely reflects heterogeneity of amendment application in the area of this station. Inclusion or exclusion of the data from this station at the did not affect the results and conclusions of the study with reflect to PCB availability, benthic community health, TOC content, of concentrations of PCBs in bulk sediment.

3.3.2. TOC Results

TOC levels measured in sediment at 82 months ranged from 2 – 2.5% on average and were generally consistent among the 4 depths measured (**Figure 6).** This range continues to be stable and comparable with levels observed in the 33-month monitoring event. For the 0-5, 5-10, and 10-15 cm layers 33-month and 82-month results were not statistically different.

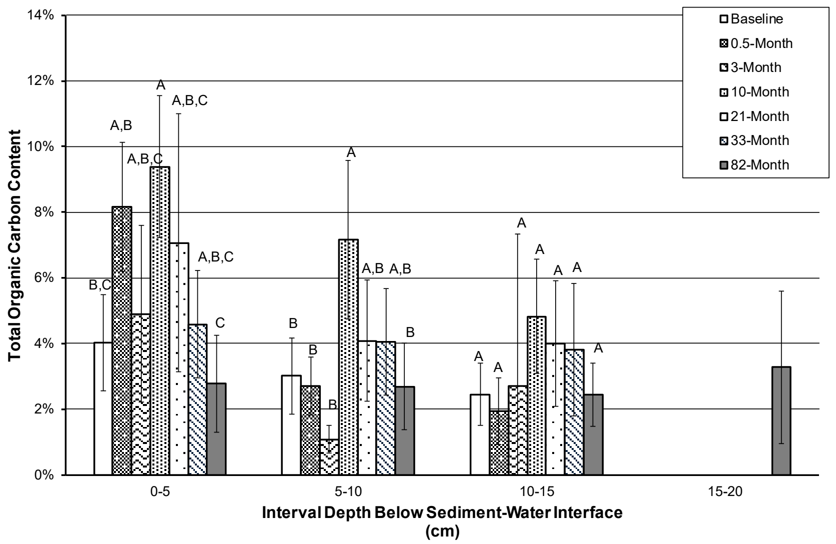

Figure 6: Total Organic Carbon (TOC) in Sediment. Results within each depth layer with the same letter label are not statistically different (i.e., comparison of data among the different monitoring events).

3.3.3. Black Carbon Results

BC levels measured at 82-months ranges from 0.8-1.3% on average (**Figure 7**). This range continues to be stable and comparable to levels observed in 33-month event. For the 0-5, 5-10, and 10-15 cm layers 33-month and 82-month results were not statistically different.

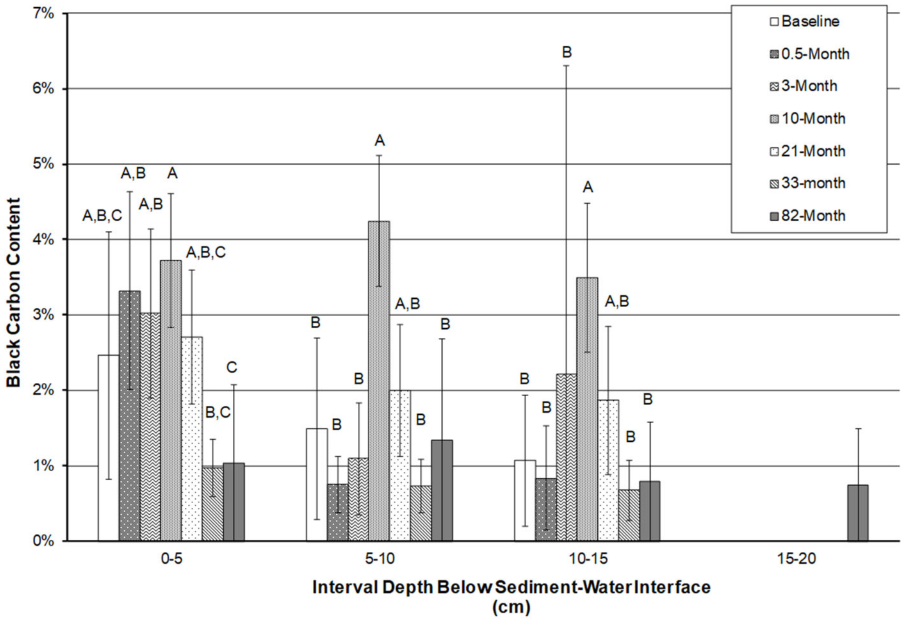

Figure 7: **Black Carbon (BC) in Sediment.** Results within each depth layer with the same letter label are not statistically different (i.e., comparison of data among the different monitoring events).

3.3.4. Activated Carbon Results via Carbon Petrography

Complete petrography laboratory reports from Koppers are provided in **Appendix B**. On average, the AC content indicated by carbon petrography was 1.1% among all samples

3.3.5. Comparison of the TOC, BC, and Carbon Petrography Methods

Table 4 summarizes the TOC, BC, and AC results, separated by samples with aggregate and samples without aggregate present. Sediment samples with aggregate present, where there was high confidence that the amendment had been placed properly, exhibited similar TOC levels (results were not statistically different, $P = 0.37$). TOC does not seem to be an accurate reflection of the presence of AC. In contrast, BC content of sediment samples with aggregate present was significantly higher ($P < 0.0001$) than sediment with no aggregate by an approximate factor of 4 (**Table 4**). The approximate 1% BC content of samples with aggregate present approximates the levels targeted for the amendment design and observed in previous sampling (Kirtay et al., 2018). As with BC, the AC content of sediment samples with aggregate present was significantly higher ($P = 0.0082$) than sediment with no aggregate by an approximate factor of 5 (**Table 4**). The approximate 1% AC content of samples with aggregate present approximates the levels targeted for the amendment design and observed in previous sampling (Kirtay et al., 2018).

Table 4: Statistics for TOC, BC, and AC by for samples.

Aggregate Present	n	TOC (EPA Method)			Black Carbon (Grossman and Ghosh)			Activated Carbon (Petrography)		
		n	Average	SD	n	Average	SD	n	Average	SD
Samples with Aggregate	58	56	2.9%	1.7%	58	1.3%	1.2%	26	1.3%	0.9%
Samples with No Aggregate	34	32	2.6%	1.4%	30	0.3%	0.2%	6	0.3%	0.2%

Overall, the BC analysis performed well for accurately reflecting the AC content of the sediments, assuming that the AC values indicated by the carbon petrography method provided the most specific measurement of AC in sediment. Mean AC content measured by the carbon petrography method for both the samples with aggregate and samples with no aggregate were the same values as found for mean BC content (**Table 4**). However, only a portion of the samples analyzed for BC were analyzed for AC. For example, only 26 of the samples with aggregate present were analyzed for AC, but 58 were analyzed for BC. For the 26 samples with aggregate that were analyzed for both AC and BC, the average BC content (1.1%, SD = 0.99%) was comparable to the average AC content (1.3%, SD = 0.9%), and results were not statistically different ($P = 0.30$). If a hypothetical 1.4X correction factor is applied to the data to attempt to estimate AC by percentage mass (instead of percentage volume), the results remain comparable, as the adjusted mean AC content of the 26 samples (0.96%, SD = 0.64%) is also not statistically different from the 1.1% mean BC content (*P* = 0.63). For the 6 samples with no aggregate that were analyzed for both AC and BC, the average BC content (0.2%, SD = 0.07%) was comparable to the average AC content (0.3%; SD = 0.2%), and results were not statistically different (*P* = 0.16). If a hypothetical 1.4X correction factor is applied to the data to attempt to estimate AC by percentage mass (instead of percentage volume), the results remain comparable, as the adjusted mean AC content of the 6 samples (0.2%, SD = 0.04%) is also not statistically different from the 0.2% mean BC content (*P* = 0.53).

In addition, there was a good correlation between the two methods if the raw data from the 30 of the 32 samples are evaluated (two of the samples indicated non-detectable AC contents; BC values for these samples were at trace levels (0.2% to 0.3%)). The results from 19 of 30 samples with detectable levels of AC and BC (63%) agreed within a factor of 2 between the two methods and 97% of the samples agreed within a factor of 3.

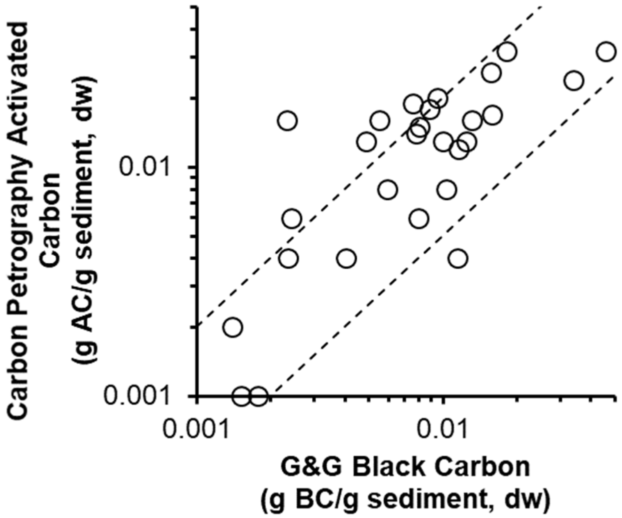

Figure 8: **AC Measurements (Carbon Petrography) versus BC Measurements using the Grossman and Ghosh method.** Symbols between the dashed lines indicate a factor of 2 agreement (or better) between AC and BC measurements. Two samples with non-detectable AC contents are unplottable on this log-scale figure (see text).

3.3.6. Conclusions

Overall, the most recent 82-month results are consistent with results from previous monitoring events and indicate that the AC continues to be present over the majority of the site at levels of approximately 1% AC content in the upper 15 cm of the sediment.

The 82-month monitoring design included an additional measurement via carbon petrography, which allowed an explicit quantification of the AC content of the sediment. Paired BC and AC measurements afforded the opportunity to evaluate the accuracy of the BC method in indicating AC at the site. There was good correspondence between the two methods, especially considering the differences in the approaches. The BC method was sufficient to quantify AC carbon-amended sites under the assumption that AC will comprise most the BC present.

For sites like Pier 7 that undergo AC amendment, there is a need for an improved method of analysis of AC contents in sediments so that post-amendment AC dosing rates can be confirmed, and remedial performance documented. While the carbon petrography method does enable separate identification of AC from other BC forms, it is not a kinemetric or gravimetric method like many methods (e.g., EPA DW846 methods) typically used to analyze sediment from contaminated sites that are being driven by state or Federal environmental regulations. Instead, this method relies on visual identification, and results can therefore be partly dependent on visual interpretations made by the operator. It is also limited to select service providers (not widely available commercially) and can be 10X more expensive than typical TOC or BC measurements.

The commonly used methods for separation of BC from natural organic matter is by thermal oxidation. This can result in significant loss of AC from sediment samples resulting in underestimation of AC. The Ghosh and Grossman (2009) method prevents this loss by utilizing chemical oxidation in place of thermal oxidation to remove natural organic carbon while preserving AC, however the resulting sample contains both AC and other forms of BC which can potentially result in overestimation of AC if other forms of BC are present. This could be partially addressed by pre-remedial measurement of BC, and ideally document that little or no BC is present such that post-amendment BC measurements represented primarily AC present as a part of the amendment. Alternately, provided the BC content of the sediment from sources other than AC do not change significantly over time, the baseline BC measurement could be subtracted from subsequent measurements to obtain a more accurate measure of AC content. In cases with a high baseline (pre-remedial) level of BC or at a site with ongoing inputs of BC that could interfere with post-amendment measurements of AC, carbon petrography could then be used on a small subset of samples to verify results.

For monitoring AC presence at sites amended with AC, it would be recommended to commercialize the Ghosh and Grossman (2009) method, which, as noted above, is a reasonably accurate approach for quantifying AC. The only current option for Ghosh and Grossman (2009) method analysis is via the University of Maryland Baltimore County, an academic laboratory which may not be best suited for on-demand high-throughput commercial analytical needs.

4. Long term Assessment of Potential Impacts to Benthic Community

4.1. Introduction

Surface sediment samples were collected to assess potential impacts to the benthic community as in previous years' monitoring events (Kirtay et al., 2018). Benthic community samples were collected from multi-metric stations (MM) as well as four reference stations that were located in the immediate area of the treatment (**Table 1**, **Figure 1**). These samples were collected following the same procedures as during the previous monitoring studies. The reference samples were intended to control the study against shifting site-specific changes and are not intended to provide an assessment of an ecologically-pristine areas within the region. Additional details are provided below.

4.2. Method for Assessment of Benthic Community

4.2.1. Benthic Sample Sorting and Taxonomy

This section describes the method for assessment of benthic community census as detailed in **Appendix D**. Samples for 82-month benthic community assessment were collected from August 27 through 29, 2019. Collection approaches followed earlier approaches for the 33-month event, as detailed in Kirtay et al. (2018).

In brief, 10 multi-metric and 4 reference stations (1MM – 10 MM, denotated as 1M – 10 M and 1R – 4 R, **Figure 1**) were sampled for benthic community analysis. Sampling locations are shown in **Figure 1** and a sampling summary is provided in **Table 1.** All samples were collected and processed by representatives from NIWC and EcoAnalysts. At each location five core samples were collected by SCUBA divers using 2-inch diameter cores. The five cores collected from each station were composited into one sample, representing 0.009 m^2 of the seafloor, and sieved through a 1.0 mm mesh screen to remove fine sediment. All residual sediment, debris, shells, and benthic organisms on the screen were carefully collected into labelled wide-mouth bottles. Samples were "fixed" on-board the vessel in formalin with a phosphate buffer diluted by seawater to create a 5% formalin preservative. The benthic samples were stored at room temperature throughout transit (shipped FedEx ground) to the EcoAnalysts benthic laboratory in Moscow, ID.

Benthic samples arrived at the Moscow EcoAnalysts facility in good condition. Once the samples were received at the laboratory, they were transferred to 70% ethanol for long-term preservation and storage. The sorting process entailed placing small quantities of sample in a petri dish, removing all organisms under a dissecting microscope, and placing them into vials according to major taxon categories (e.g. mollusks, crustaceans, annelids, etc.). This process was continued until 100% of the sample was sorted. Sorted material was then transferred back to the original sample container and underwent a quality assurance (QA) check to control for thoroughness and consistency in sample sorting. This sorting review was performed by staff who did not initially sort the sample.

All specimens were identified by qualified taxonomists down to the lowest practicable taxonomic level (LPTL) and enumerated. In most cases this was genus or species level; those organisms identified to a higher level were due to a qualifier, such as damage or immaturity of the specimen. All benthic raw data and results of the quality control (QC) are presented in **Appendix D**.

4.2.2. Data Analysis

Following the approach of Kirtay et al. (2018), six benthic metrics were calculated using the raw organism count data provided by EcoAnalysts: 1) taxa richness (the number of unique taxa in a sample); 2) total abundance (the sum of organisms in a sample); 3) the percentage abundance of the five most abundant taxa; 4) Shannon-Wiener Diversity Index; 5) Pielou's Evenness Index; and 6) Swartz Dominance Index. The calculation of these benthic metrics are shown in tables provide in **Appendix E**. Multivariate evaluation was also performed by EcoAnalysts, as detailed in **Appendix D**.

4.2.3. Data Treatment

The data files for each sampling event were reviewed prior to any analysis. During this review, it was noted that attached taxa were present whose numbers would vary based on the substrate. An example of this is the marine barnacle (i.e. *Balanus crenatus*). These taxa were removed from the assessment. A list of these removed groups is included in **Appendix D**.

4.2.4. Abundance

Invertebrate abundance is the total count of the individual organisms identified from a sample that represent the benthic community regardless of phylogenic grouping. For comparison across other data sets, abundance was converted to estimated density (individuals/m^2). Invertebrate abundance is linearly related to sample area and can be adjusted to estimate density.

4.2.5. Taxa Richness

The richness of a sample is a count of the number of taxa described for a sample. The general premise when conducting bioassessments is that the richness of a sample will decline as habitat conditions decline. To calculate true richness of a sample, all taxa need to be identified to species level. Often this level of identification can be difficult due to immature or damaged specimen. One important note is that datasets that generate richness data at different phylogenic levels do not calculate richness values that are comparable to each other.

4.2.6. Shannon Diversity Index

The Shannon Diversity Index (H') is a quantitative measurement of biodiversity within a sample and is dependent on the richness within a community as well as how evenly distributed or abundant those taxa are. Unlike richness, diversity provides a more wholistic view of community composition and the distribution of rare vs common taxa. A higher diversity score equates to a more diverse community:

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

Where R is the richness of the dataset in terms of total number of different taxa, p_i is the proportion of individuals belonging to the *ith* species in the dataset.

4.2.7. Pielou's Evenness Index

Evenness is a measure of biodiversity that quantifies how equivalent the community is numerically. The evenness index (J') describes how close in abundance each species is within a given taxonomic group for a given sample. The evenness of a population can be represented by Pielou's evenness index:

$$J' = \frac{H'}{\log_e S}$$

Where S is abundance of organisms and H' is Shannon-Wiener diversity. J' is constrained between 0 and 1, with more evenly distributed communities having higher J' values.

4.2.8. Non-Parametric Comparison Testing

Non-parametric t-tests were performed using Microsoft Excel to compare the univariate results. Comparison testing was performed to test the null hypothesis that there is no difference between the means of the compared groups. Because there is not an *a priori* expectation for the direction of change, the results were interpreted using the p-value for the two-tailed test.

Comparisons between reference and multi-metric stations performed for the 82-Month data set were assessed using t-Tests that assumed unequal variances due to the small and unequal samples sizes. When comparing multi-metric stations from baseline to multi-metric stations from the 82-Month data, t-Test were performed that assumed equal variance.

4.3. Benthic Community Assessment Results and Conclusions

Overall, there is no evidence from the 82-month data indicating an effect on benthic invertebrate communities at the amended area, as found for previous monitoring events (Kirtay et al., 2018). No statistically-significant differences among the groups for total abundance, diversity, evenness, Swartz dominance index, and percent abundance of the top 5 abundant taxa (**Figures 9 to 13**), with *P* values of 0.11, 0.14, 0.81, 0.34, and 0.20, respectively. Differences among the groups for taxa richness were noted ($P = 0.04$), as shown in **Figure 14**. Species richness was statistically different (lower) in the baseline for the unamended area compared to the 82-month amended area, suggesting improved ecological health in the amended area compared to the reference stations. This result may be due to temporal differences, and overall results confirm that species richness in the amended area has not been adversely affected by the AC amendment. The observations in this event further confirm the findings of most scientific studies proposing that adverse effects on benthic invertebrates are not expected as a result of activated carbon amendments (Janssen and Beckingham, 2013), especially when activated carbon dosage rates remain below approximately 5% by weight in sediment (Rakowska et al., 2012; Janssen and Beckingham, 2013; Kupryianchyk, et al. 2015; Patmont et al., 2015).

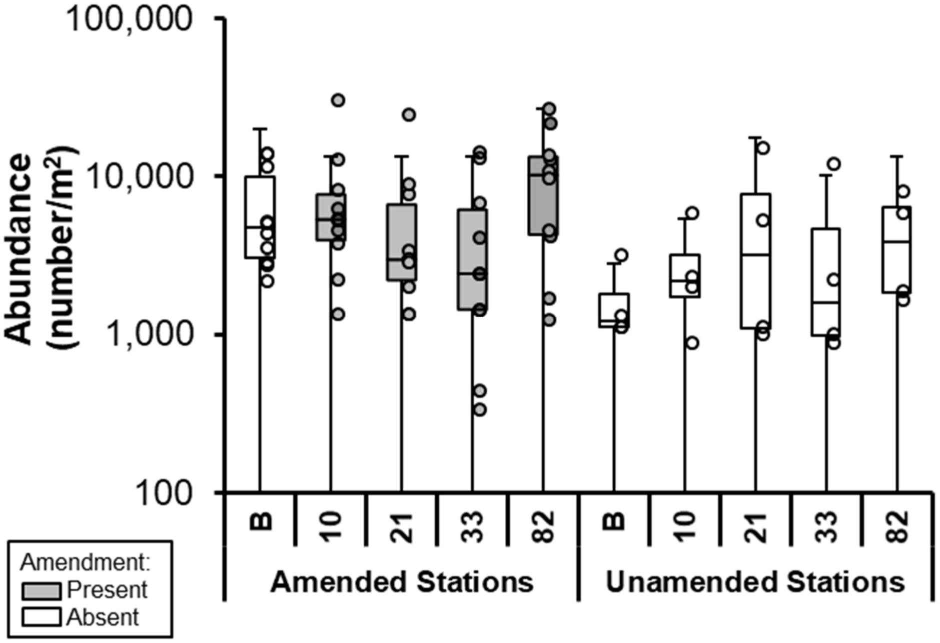

Figure 9: Total Abundance.

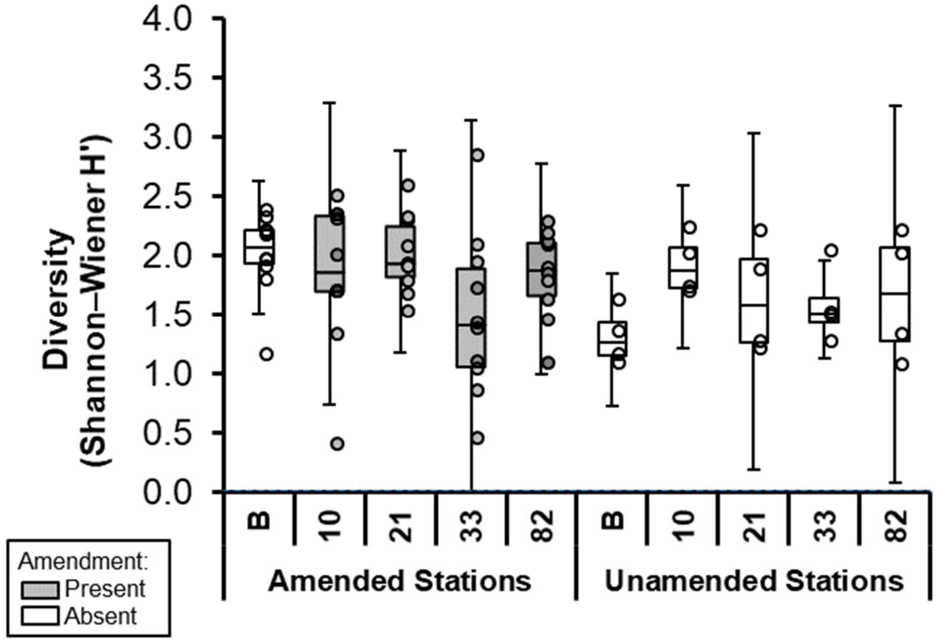

Figure 10: Diversity.

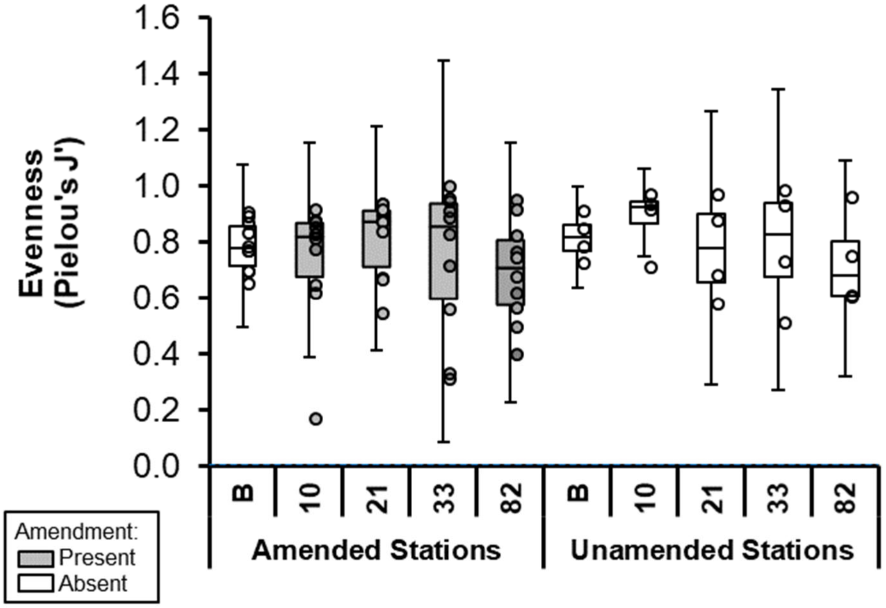

Figure 11: Evenness.

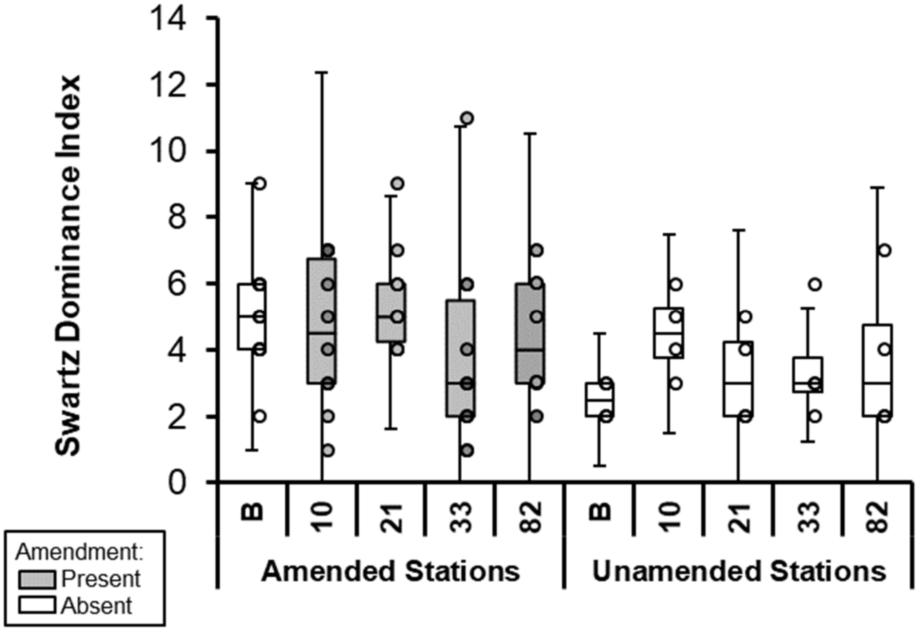

Figure 12: Swartz Dominance Index.

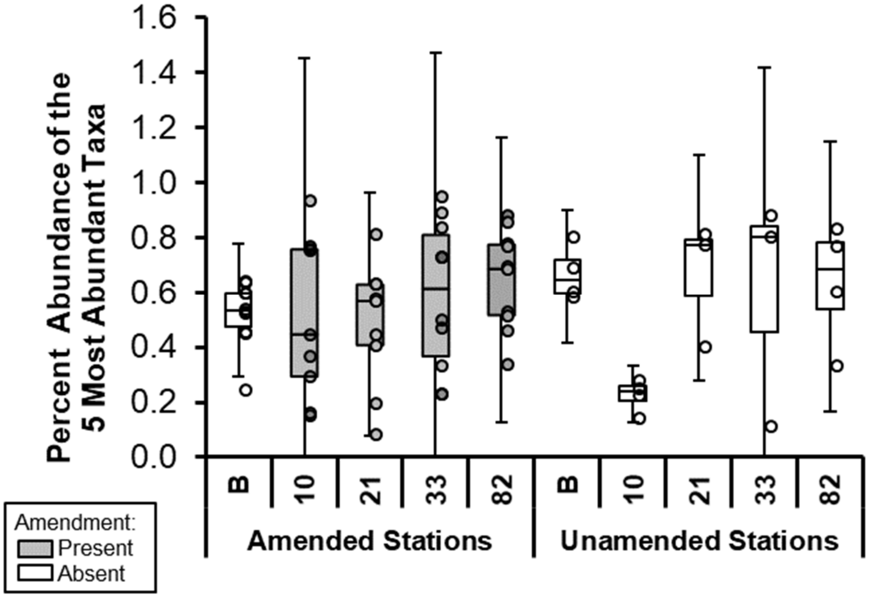

Figure 13: Percent Abundance of the Top 5 Abundant Taxa.

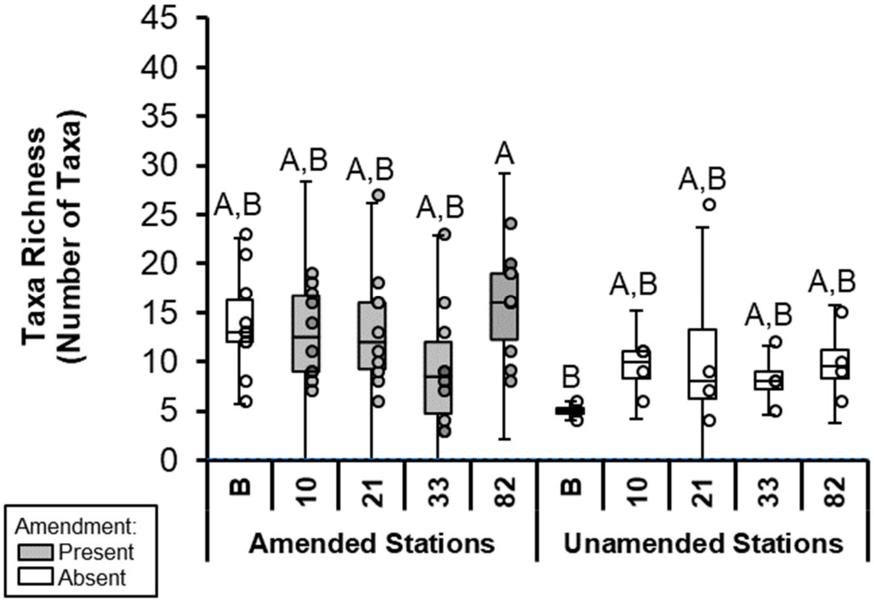

Figure 14: Taxa Richness. Results with the same letter label are not statistically different.

5. Overall Conclusions

This study successfully continued the evaluation of the performance of an AC amendment in an active harbor area throughout a multiyear monitoring period. The results showed a sustained reduction in PCB availability 82-months post application of an AC amendment (particle size ≤ 74 µm) in the uppermost 10 cm of the surface sediment. As noted in previous events, reductions in PCB availability of 80 to 90% (relative to baseline) were found using the SPME porewater and *in situ* bioaccumulation measurement approaches. These reduced PCB availability levels would meet typical risk-based screening or management criteria for surface sediments and many contaminated sites. This achievement is especially significant given that traditional sediment remedies (e.g., dredging and capping) would be challenging or infeasible for this location, which includes an area adjacent to/beneath a pier and within a vessel berth with specific water-depth requirements.

Measurements of amendment placement using TOC, BC, and aggregate presence indicated results similar to previous monitoring events: the amended area is stable and AC levels in the surficial layers continue to approximate 1% AC. A novel approach (carbon petrography) was employed to evaluate the accuracy of the BC results, and data support the use of BC measurements to confirm AC presence and dosing rates. Carbon petrography may be useful to validate BC measurements at other sites, particularly those with levels of BC that may interfere with post-amendment monitoring.

Benthic invertebrate census results from the 82-month study did not indicate differences in benthic community ecological metrics among the pre-amendment and 4 post-amendment monitoring events that would indicate a negative impact of the AC amendment. The recent data confirm previous observations noted in Kirtay et al. (2018) that the AC amendment applied at the site did not affect the benthic community.

Overall, the performance of the amendment shown in the present study, now demonstrated over a 7-year period following the AC amendment placement in 2012, will ideally encourage the consideration of activated carbon amendments for similar logistically challenging settings in contaminated sediment sites and as an alternative to traditional sediment remedies.

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Appendix A
in situ Passive Sampling Data

Table A1. Fiber Details.

Sample ID	Sample Type	Mass of Vial, Empty (g)	Mass of Vial, with Fiber (g)	Mass of Fiber (g)	Length of Fiber, based on mass (cm)	Number of Fiber Envelopes Included (approximately 125 cm/envelope)	Fiber Length Recovery (%)	Volume of PDMS (µL)	Mass of PDMS (g)	Exposure Duration (days)
T82-1-MM-SPME	Sample	8.52563	8.79678	0.2712	325	3	87%	22.5	0.0217	14
T82-2-MM-SPME	Sample	8.50464	8.75129	0.2466	296	3	79%	20.4	0.0197	14
T82-3-MM-SPME	Sample	8.49053	8.77176	0.2812	337	3	90%	23.3	0.0225	14
T82-4-MM-SPME	Sample	8.47860	8.76282	0.2842	341	3	91%	23.5	0.0227	14
T82-5-MM-SPME	Sample	8.51991	8.75132	0.2314	277	3	74%	19.2	0.0185	14
T82-6-MM-SPME	Sample	8.57394	8.83004	0.2561	307	3	82%	21.2	0.0205	14
T82-7-MM-SPME	Sample	8.51265	8.73287	0.2202	264	3	70%	18.2	0.0176	14
T82-8-MM-SPME	Sample	8.44943	8.65346	0.2040	245	2	98%	16.9	0.0163	14
T82-9-MM-SPME	Sample	8.45475	8.71990	0.2652	318	3	85%	22.0	0.0212	14
T82-10-MM-SPME	Sample	8.49554	8.64805	0.1525	183	2	73%	12.6	0.0122	14
T82-TB1-SPME	Trip Blank	8.43883	8.73217	0.2933	352	3	94%	24.3	0.0234	14
T82-TB2-SPME	Trip Blank	8.53391	8.83048	0.2966	356	3	95%	24.6	0.0237	14
T82-TB3-SPME	Trip Blank	8.50631	8.81120	0.3049	366	3	97%	25.3	0.0244	14

Notes

%: percent
g: gram
µL: microliter
cm: centimeter

Table A2. Mass of PCB Congeners in Extracts

PCB	Homolog Group	PRC	T82-1-MM-SPME			T82-2-MM-SPME			T82-3-MM-SPME			T82-4-MM-SPME			T82-5-MM-SPME			T82-6-MM-SPME			T82-7-MM-SPME			T82-8-MM-SPME			T82-9-MM-SPME			T82-10-MM-SPME			T82-TB1-SPME			T82-TB2-SPME			T82-TB3-SPME		
			PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)	PCB Mass Result (ng)	Qualifier	PCB Mass MDL (ng)
PCB 3	Mono			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 4 (2C)	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 5 (2C)	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 6	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 7 (2C)	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 8 [2C]	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 9 (2C)	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 10 (2C)	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 12	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 13	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 14	Di	PRC	10.8		0.3		U	0.3	15.4		0.3	1.88		0.3		U	0.3		U	0.3		U	0.3	8.38		0.3		U	0.3	10.5		0.3	39.5		0.3	47.1		0.3	40.5		0.3
PCB 15	Di			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 16	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 17 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 18	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 19	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 20	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 22	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 24 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 25	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 26	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 27	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 28	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 29	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 31 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 32 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 33 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 34	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 35 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 36	Tri	PRC	23.3		0.3	5.78		0.3	27.7		0.3	11.2		0.3	7.78		0.3	7.83		0.3	14.7		0.3	17.7		0.3	9.14		0.3	19.9		0.3	39.8		0.3	47.8		0.3	39.9		0.3
PCB 37 (2C)	Tri			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 40	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 41 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 42 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 44	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 45	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 46	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 47 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 48 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 49	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 51	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 52 [2C]	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3	3.79		0.3		U	0.3		U	0.3		U	0.3
PCB 53	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 54 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 56 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 59	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 60 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 63	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 64 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 66 [2C]	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 67 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 69	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 70	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 71 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 73 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 74	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		NR, U	0.3		U	0.3		U	0.3		U	0.3
PCB 75 (2C)	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 77 [2C]	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 78	Tetra	PRC	87.3		0.3	42.3		0.3	107		0.3	52.2		0.3	53.3		0.3	55.9		0.3	60		0.3	69.7		0.3	54		0.3	72.2		0.3	117		0.3	136		0.3	116		0.3
PCB 81	Tetra			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 82	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 83	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 84	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 85	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 87 [2C]	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 90/101 (2	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3	2.16	C	0.3		U	0.3		U	0.3		U	0.3
PCB 91	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 92	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 93 (2C)	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 95 (2C)	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3	2.12		0.3		U	0.3		U	0.3		U	0.3
PCB 97	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 99	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 100	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 103	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 104 (2C)	Penta	PRC		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 105	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 107	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 110	Penta			U	0.3		U	0.3		U	0.3		U	0.3	1		0.3		U	0.3		U	0.3		U	0.3		U	0.3	3.08		0.3		U	0.3		U	0.3		U	0.3
PCB 114	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 115	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 117	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 118	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 119	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 121	Penta	PRC	155	E	0.3	85.7		0.3	178	E	0.3	73.1		0.3	97.4		0.3	135	E	0.3	90.9		0.3	92.1		0.3	122	E	0.3	95.9		0.3	178	E	0.3	198	E	0.3	185	E	0.3
PCB 122	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 123	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 124	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 126	Penta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 128	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 129	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 130	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 131	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 132 (2C)	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 134	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 135 (2C)	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 136	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 137 (2C)	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 138	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3	0.67	J	0.3		U	0.3		U	0.3		U	0.3
PCB 141 (2C)	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 142 (2C)	Hexa	PRC	392	E	0.3	280	E	0.3	414	E	0.3	199	E	0.3	289	E	0.3	366	E	0.3	266	E	0.3	271	E	0.3	372	E	0.3	266	E	0.3	426	E	0.3	496	E	0.3	457	E	0.3
PCB 144 (2C)	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 146	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 147	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 149	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3	0.47	J	0.3		U	0.3		U	0.3		U	0.3
PCB 151	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 153 [2C]	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 154	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 155	Hexa	PRC	207	E	0.3	149	E	0.3	234	E	0.3	109	E	0.3	155	E	0.3	203	E	0.3	147	E	0.3	143	E	0.3	202	E	0.3	139	E	0.3	223	E	0.3	265	E	0.3	237	E	0.3
PCB 156	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 157	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 158	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 163	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 164 (2C)	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 165	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 167	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 169	Hexa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 170 [2C]	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 171	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 172 (2C)	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 173	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 174	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 175	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 176 (2C)	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 177	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 178	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 179 (2C)	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 180	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 183	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 184	Hepta	PRC		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 185	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 187	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 189	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 190 (2C)	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 191	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 192 (2C)	Hepta	PRC	298	E	0.3	214	E	0.3	302	E	0.3	152	E	0.3	211	E	0.3	255	E	0.3	191	E	0.3	192	E	0.3	274	E	0.3	194	E	0.3	303	E	0.3	361	E	0.3	328	E	0.3
PCB 193	Hepta			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 194	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 195 [2C]	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 196 (2C)	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 197	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 198	Octa			Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3		Sur	0.3
PCB 199	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 200	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 201 (2C)	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 202 (2C)	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 203 (2C)	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 204	Octa	PRC	523	E	0.3	395	E	0.3	556	E	0.3	146	E	0.3	376	E	0.3	468	E	0.3	356	E	0.3	334	E	0.3	504	E	0.3	336	E	0.3	523	E	0.3	628	E	0.3	577	E	0.3
PCB 205	Octa			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 206	Nona			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 207	Nona			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 208 (2C)	Nona			U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3		U	0.3
PCB 209	Deca			Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3		Dis	0.3
Total Detected PCB Congeners			**1696**			**1172**			**1834**			**744**			**1190**			**1491**			**1126**			**1128**			**1537**			**1146**			**1849**			**2179**			**1980**		

Notes

2C: The data were reported using a secondary column
E: Initially exceeded the calibration curve and were diluted to within the curve and re-analyzed
PCB: Polychlorinated biphenyl
ng: Nanogram
PRC: Performance Reference Compound
U: Not detected at the Detection Limit (DL) shown in the second column for each sample.
MDL: Measured detection limit
Sur: Used as a surrogate standard
Dis: Disqualified

Table A3. Elimination Rates (ke) and Percentage to Steady State Reached by Performance Reference Compounds (PRCs) During Deployment, and Resulting Statistics for the PRC Regression Models.

PCB PRC	Homolog Group	T82-1-MM-SPME		T82-2-MM-SPME		T82-3-MM-SPME		T82-4-MM-SPME		T82-5-MM-SPME		T82-6-MM-SPME		T82-7-MM-SPME		T82-8-MM-SPME		T82-9-MM-SPME		T82-10-MM-SPME	
		k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %	k_e (d^{-1})	Steady State %
PCB 14	Di	-1.041669	72%	OUTLIER		-1.166763	61%	-0.659376	95%	OUTLIER		OUTLIER		OUTLIER		-1.052283	71%	OUTLIER		-1.213401	58%
PCB 36	Tri	-1.441699	40%	-0.889489	84%	-1.578108	31%	-1.036907	72%	-0.986338	76%	-0.974524	77%	-1.265952	53%	-1.449940	39%	-0.993919	76%	-1.802782	20%
PCB 78	Tetra	-1.751462	22%	-1.202641	58%	-2.236867	8%	-1.237929	55%	-1.380418	44%	-1.381446	44%	-1.527993	34%	-1.869970	17%	-1.297254	51%	OUTLIER	
PCB 121	Penta	OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER		OUTLIER	
PCB 142 (2C)	Hexa	-2.340146	6%	-1.660774	26%	-2.484624	4%	-1.249049	55%	-1.823238	19%	-2.837198	2%	-1.759288	22%	-1.973792	14%	-2.173174	9%	-3.235129	1%
PCB 155	Hexa	-2.370296	6%	-1.678149	25%	OUTLIER		-1.272152	53%	-1.866249	17%	OUTLIER		-1.858502	18%	-1.984313	14%	-2.355455	6%	-2.989700	1%
PCB 192 (2C)	Hepta	-3.205084	1%	-1.756703	22%	-2.642368	3%	-1.283389	52%	-1.855015	18%	-2.427391	5%	-1.756067	22%	-1.931487	15%	-2.299052	7%	OUTLIER	
PCB 204	Octa	-4.097296	0%	-1.874024	17%	OUTLIER		-1.024184	73%	-1.909011	16%	OUTLIER		-1.896380	16%	-1.928238	15%	-2.948910	2%	OUTLIER	

Notes

%: percent

d: day

PCB: Polychlorinated biphenyl

The PRCs noted "OUTLIER" were removed from the calculations. See text for further details.

Table A4. Concentration of freely-dissolved (Cfree) PCB congeners.

			T82-1-MM-SPME			T82-2-MM-SPME			T82-3-MM-SPME			T82-4-MM-SPME			T82-5-MM-SPME			T82-6-MM-SPME			T82-7-MM-SPME			T82-8-MM-SPME			T82-9-MM-SPME		
PCB	Homolog Group	PRC	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)	[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)
PCB 3	Mono		ND	U	190	ND	U	210	ND	U	230	ND	U	210	ND	U	250	ND	U	200	ND	U	360	ND	U	410	ND	U	190
PCB 4 (2C)	Di		ND	U	320	ND	U	350	ND	U	340	ND	U	350	ND	U	390	ND	U	340	ND	U	560	ND	U	630	ND	U	320
PCB 5 (2C)	Di		ND	U	150	ND	U	170	ND	U	200	ND	U	170	ND	U	210	ND	U	160	ND	U	300	ND	U	350	ND	U	160
PCB 6	Di		ND	U	150	ND	U	170	ND	U	200	ND	U	170	ND	U	210	ND	U	160	ND	U	300	ND	U	350	ND	U	160
PCB 7 (2C)	Di		ND	U	150	ND	U	170	ND	U	200	ND	U	170	ND	U	210	ND	U	160	ND	U	300	ND	U	350	ND	U	160
PCB 8 [2C]	Di		ND	U	150	ND	U	170	ND	U	200	ND	U	170	ND	U	210	ND	U	160	ND	U	300	ND	U	350	ND	U	160
PCB 9 (2C)	Di		ND	U	150	ND	U	170	ND	U	200	ND	U	170	ND	U	210	ND	U	160	ND	U	300	ND	U	350	ND	U	160
PCB 10 (2C)	Di		ND	U	320	ND	U	350	ND	U	340	ND	U	350	ND	U	390	ND	U	340	ND	U	560	ND	U	630	ND	U	320
PCB 12	Di		ND	U	84	ND	U	90	ND	U	140	ND	U	86	ND	U	110	ND	U	79	ND	U	170	ND	U	200	ND	U	77
PCB 13	Di		ND	U	84	ND	U	90	ND	U	140	ND	U	86	ND	U	110	ND	U	79	ND	U	170	ND	U	200	ND	U	77
PCB 14	Di	PRC					U									U			U			U						U	
PCB 15	Di		ND	U	84	ND	U	90	ND	U	140	ND	U	86	ND	U	110	ND	U	79	ND	U	170	ND	U	200	ND	U	77
PCB 16	Tri		ND	U	85	ND	U	92	ND	U	140	ND	U	88	ND	U	110	ND	U	81	ND	U	170	ND	U	200	ND	U	79
PCB 17 (2C)	Tri		ND	U	85	ND	U	92	ND	U	140	ND	U	88	ND	U	110	ND	U	81	ND	U	170	ND	U	200	ND	U	79
PCB 18	Tri		ND	U	85	ND	U	92	ND	U	140	ND	U	88	ND	U	110	ND	U	81	ND	U	170	ND	U	200	ND	U	79
PCB 19	Tri		ND	U	130	ND	U	140	ND	U	180	ND	U	140	ND	U	170	ND	U	130	ND	U	260	ND	U	300	ND	U	130
PCB 20	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 22	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 24 (2C)	Tri		ND	U	85	ND	U	92	ND	U	140	ND	U	88	ND	U	110	ND	U	81	ND	U	170	ND	U	200	ND	U	79
PCB 25	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 26	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 27	Tri		ND	U	85	ND	U	92	ND	U	140	ND	U	88	ND	U	110	ND	U	81	ND	U	170	ND	U	200	ND	U	79
PCB 28	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 29	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 31 (2C)	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 32 (2C)	Tri		ND	U	85	ND	U	92	ND	U	140	ND	U	88	ND	U	110	ND	U	81	ND	U	170	ND	U	200	ND	U	79
PCB 33 (2C)	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 34	Tri		ND	U	68	ND	U	62	ND	U	120	ND	U	56	ND	U	79	ND	U	56	ND	U	120	ND	U	140	ND	U	54
PCB 35 (2C)	Tri		ND	U	62	ND	U	42	ND	U	98	ND	U	35	ND	U	55	ND	U	44	ND	U	80	ND	U	100	ND	U	41
PCB 36	Tri	PRC																											
PCB 37 (2C)	Tri		ND	U	62	ND	U	42	ND	U	98	ND	U	35	ND	U	55	ND	U	44	ND	U	80	ND	U	100	ND	U	41
PCB 40	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 41 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 42 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 44	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 45	Tetra		ND	U	63	ND	U	48	ND	U	100	ND	U	41	ND	U	62	ND	U	47	ND	U	90	ND	U	110	ND	U	44
PCB 46	Tetra		ND	U	63	ND	U	48	ND	U	100	ND	U	41	ND	U	62	ND	U	47	ND	U	90	ND	U	110	ND	U	44
PCB 47 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 48 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 49	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 51	Tetra		ND	U	63	ND	U	48	ND	U	100	ND	U	41	ND	U	62	ND	U	47	ND	U	90	ND	U	110	ND	U	44
PCB 52 [2C]	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 53	Tetra		ND	U	63	ND	U	48	ND	U	100	ND	U	41	ND	U	62	ND	U	47	ND	U	90	ND	U	110	ND	U	44
PCB 54 (2C)	Tetra		ND	U	62	ND	U	44	ND	U	100	ND	U	38	ND	U	58	ND	U	45	ND	U	84	ND	U	100	ND	U	42
PCB 56 (2C)	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 59	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 60 (2C)	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 63	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 64 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 66 [2C]	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 67 (2C)	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 69	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 70	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 71 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 73 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 74	Tetra		ND	U	62	ND	U	28	ND	U L	83	ND	U	21	ND	U	37	ND	U	38	ND	U	51	ND	U	66	ND	U	32
PCB 75 (2C)	Tetra		ND	U	61	ND	U	36	ND	U	92	ND	U	29	ND	U	48	ND	U	41	ND	U	68	ND	U	86	ND	U	37
PCB 77 [2C]	Tetra		ND	U L	65	ND	U	22	ND	U L	76	ND	U	15	ND	U	29	ND	U	37	ND	U	39	ND	U	51	ND	U	29
PCB 78	Tetra	PRC																											
PCB 81	Tetra		ND	U L	65	ND	U	22	ND	U L	76	ND	U	15	ND	U	29	ND	U	37	ND	U	39	ND	U	51	ND	U	29
PCB 82	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 83	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 84	Penta		ND	U L	66	ND	U	21	ND	U L	75	ND	U	14	ND	U	28	ND	U	37	ND	U	37	ND	U	48	ND	U	29
PCB 85	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 87 [2C]	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 90/101 (2C)	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 91	Penta		ND	U L	66	ND	U	21	ND	U L	75	ND	U	14	ND	U	28	ND	U	37	ND	U	37	ND	U	48	ND	U	29
PCB 92	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 93 (2C)	Penta		ND	U L	66	ND	U	21	ND	U L	75	ND	U	14	ND	U	28	ND	U	37	ND	U	37	ND	U	48	ND	U	29
PCB 95 (2C)	Penta		ND	U L	66	ND	U	21	ND	U L	75	ND	U	14	ND	U	28	ND	U	37	ND	U	37	ND	U	48	ND	U	29
PCB 97	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 99	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 100	Penta		ND	U L	66	ND	U	21	ND	U L	75	ND	U	14	ND	U	28	ND	U	37	ND	U	37	ND	U	48	ND	U	29
PCB 103	Penta		ND	U L	66	ND	U	21	ND	U L	75	ND	U	14	ND	U	28	ND	U	37	ND	U	37	ND	U	48	ND	U	29
PCB 104 (2C)	Penta	PRC		U			U			U			U			U			U			U			U			U	
PCB 105	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 107	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 110	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	77		23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 114	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 115	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 117	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 118	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 119	Penta		ND	U L	69	ND	U	17	ND	U L	69	ND	U	11	ND	U	23	ND	U	37	ND	U	29	ND	U	39	ND	U	27
PCB 121	Penta	PRC		E						E									E									E	
PCB 122	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 123	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 124	Penta		ND	U L	73	ND	U	14	ND	U L	65	ND	U	8	ND	U	19	ND	U L	38	ND	U	23	ND	U	32	ND	U	26
PCB 126	Penta		ND	U L	78	ND	U	12	ND	U L	61	ND	U	6.1	ND	U	16	ND	U L	39	ND	U	19	ND	U	26	ND	U L	26
PCB 128	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 129	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 130	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 131	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 132 (2C)	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 134	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 135 (2C)	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 136	Hexa		ND	U L	86	ND	U	9.1	ND	U L	56	ND	U	4.2	ND	U	12	ND	U L	40	ND	U	14	ND	U L	20	ND	U L	25
PCB 137 (2C)	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 138	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 141 (2C)	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 142 (2C)	Hexa	PRC		E			E			E			E			E			E			E			E			E	
PCB 144 (2C)	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 146	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 147	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 149	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 151	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 153 [2C]	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 154	Hexa		ND	U L	82	ND	U	10	ND	U L	58	ND	U	5	ND	U	14	ND	U L	39	ND	U	16	ND	U L	23	ND	U L	25
PCB 155	Hexa	PRC		E			E			E			E			E			E			E			E			E	
PCB 156	Hexa		ND	U L	92	ND	U	7.8	ND	U L	53	ND	U	3.2	ND	U	10	ND	U L	42	ND	U	11	ND	U L	16	ND	U L	25
PCB 157	Hexa		ND	U L	92	ND	U	7.8	ND	U L	53	ND	U	3.2	ND	U	10	ND	U L	42	ND	U	11	ND	U L	16	ND	U L	25
PCB 158	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 163	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 164 (2C)	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 165	Hexa		ND	U L	87	ND	U	9	ND	U L	55	ND	U	4.1	ND	U	12	ND	U L	41	ND	U	14	ND	U L	19	ND	U L	25
PCB 167	Hexa		ND	U L	92	ND	U	7.8	ND	U L	53	ND	U	3.2	ND	U	10	ND	U L	42	ND	U	11	ND	U L	16	ND	U L	25
PCB 169	Hexa		ND	U L	98	ND	U	6.7	ND	U L	50	ND	U	2.6	ND	U	9	ND	U L	44	ND	U	9.3	ND	U L	14	ND	U L	24
PCB 170 [2C]	Hepta		ND	U L	110	ND	U	5.1	ND	U L	45	ND	U	1.6	ND	U L	6.7	ND	U L	47	ND	U L	6.4	ND	U L	9.7	ND	U L	24
PCB 171	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 172 (2C)	Hepta		ND	U L	110	ND	U	5.1	ND	U L	45	ND	U	1.6	ND	U L	6.7	ND	U L	47	ND	U L	6.4	ND	U L	9.7	ND	U L	24
PCB 173	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 174	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 175	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 176 (2C)	Hepta		ND	U L	110	ND	U	4.9	ND	U L	45	ND	U	1.6	ND	U L	6.5	ND	U L	47	ND	U L	6.2	ND	U L	9.4	ND	U L	24
PCB 177	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 178	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 179 (2C)	Hepta		ND	U L	110	ND	U	4.9	ND	U L	45	ND	U	1.6	ND	U L	6.5	ND	U L	47	ND	U L	6.2	ND	U L	9.4	ND	U L	24
PCB 180	Hepta		ND	U L	110	ND	U	5.1	ND	U L	45	ND	U	1.6	ND	U L	6.7	ND	U L	47	ND	U L	6.4	ND	U L	9.7	ND	U L	24
PCB 183	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 184	Hepta	PRC		U			U			U			U			U			U			U			U			U	
PCB 185	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 187	Hepta		ND	U L	110	ND	U	5.7	ND	U L	47	ND	U	2	ND	U L	7.6	ND	U L	46	ND	U L	7.5	ND	U L	11	ND	U L	24
PCB 189	Hepta		ND	U L	120	ND	U L	4.5	ND	U L	43	ND	U	1.3	ND	U L	5.9	ND	U L	49	ND	U L	5.5	ND	U L	8.4	ND	U L	24
PCB 190 (2C)	Hepta		ND	U L	110	ND	U	5.1	ND	U L	45	ND	U	1.6	ND	U L	6.7	ND	U L	47	ND	U L	6.4	ND	U L	9.7	ND	U L	24
PCB 191	Hepta		ND	U L	110	ND	U	5.1	ND	U L	45	ND	U	1.6	ND	U L	6.7	ND	U L	47	ND	U L	6.4	ND	U L	9.7	ND	U L	24
PCB 192 (2C)	Hepta	PRC		E			E			E			E			E			E			E			E			E	
PCB 193	Hepta		ND	U L	110	ND	U	5.1	ND	U L	45	ND	U	1.6	ND	U L	6.7	ND	U L	47	ND	U L	6.4	ND	U L	9.7	ND	U L	24
PCB 194	Octa		ND	U L	150	ND	U L	2.9	ND	U L	37	ND	U	0.66	ND	U L	3.8	ND	U L	56	ND	U L	3.1	ND	U L	5	ND	U L	24
PCB 195 [2C]	Octa		ND	U L	140	ND	U L	3.2	ND	U L	38	ND	U	0.77	ND	U L	4.2	ND	U L	54	ND	U L	3.5	ND	U L	5.6	ND	U L	24
PCB 196 (2C)	Octa		ND	U L	140	ND	U L	3.2	ND	U L	38	ND	U	0.77	ND	U L	4.2	ND	U L	54	ND	U L	3.5	ND	U L	5.6	ND	U L	24
PCB 197	Octa		ND	U L	150	ND	U L	2.8	ND	U L	36	ND	U	0.6	ND	U L	3.6	ND	U L	56	ND	U L	2.9	ND	U L	4.7	ND	U L	24
PCB 198	Octa			Sur	140		Sur	3.2		Sur	38		Sur	0.77		Sur	4.2		Sur	54		Sur	3.5		Sur	5.6		Sur	24
PCB 199	Octa		ND	U L	150	ND	U L	2.8	ND	U L	36	ND	U	0.6	ND	U L	3.6	ND	U L	56	ND	U L	2.9	ND	U L	4.7	ND	U L	24
PCB 200	Octa		ND	U L	150	ND	U L	2.8	ND	U L	36	ND	U	0.6	ND	U L	3.6	ND	U L	56	ND	U L	2.9	ND	U L	4.7	ND	U L	24
PCB 201 (2C)	Octa		ND	U L	140	ND	U L	3.2	ND	U L	38	ND	U	0.77	ND	U L	4.2	ND	U L	54	ND	U L	3.5	ND	U L	5.6	ND	U L	24
PCB 202 (2C)	Octa		ND	U L	150	ND	U L	2.8	ND	U L	36	ND	U	0.6	ND	U L	3.6	ND	U L	56	ND	U L	2.9	ND	U L	4.7	ND	U L	24
PCB 203 (2C)	Octa		ND	U L	140	ND	U L	3.2	ND	U L	38	ND	U	0.77	ND	U L	4.2	ND	U L	54	ND	U L	3.5	ND	U L	5.6	ND	U L	24
PCB 204	Octa	PRC		E			E			E			E			E			E			E			E			E	
PCB 205	Octa		ND	U L	150	ND	U L	2.9	ND	U L	37	ND	U	0.66	ND	U L	3.8	ND	U L	56	ND	U L	3.1	ND	U L	5	ND	U L	24
PCB 206	Nona		ND	U L	180	ND	U L	1.9	ND	U L	32	ND	U	0.32	ND	U L	2.4	ND	U L	64	ND	U L	1.7	ND	U L	2.9	ND	U L	24
PCB 207	Nona		ND	U L	190	ND	U L	1.7	ND	U L	30	ND	U	0.24	ND	U L	2.1	ND	U L	67	ND	U L	1.4	ND	U L	2.4	ND	U L	24
PCB 208 (2C)	Nona		ND	U L	190	ND	U L	1.7	ND	U L	30	ND	U	0.24	ND	U L	2.1	ND	U L	67	ND	U L	1.4	ND	U L	2.4	ND	U L	24
PCB 209	Deca			Dis	250		Dis	1		Dis	25		Dis	0.1		Dis	1.2		Dis	80		Dis	0.68		Dis	1.2		Dis	24
Total Detected PCB Congeners			**0**			**0**			**0**			**0**			**77**			**0**			**0**			**0**			**0**		
Total Detected Tetra-Hexa Congeners			**0**			**0**			**0**			**0**			**77**			**0**			**0**			**0**			**0**		

Notes

2C: The data were reported using a secondary column

E: Initially exceeded the calibration curve and were diluted to within the curve and re-analyzed L: Percent to steady state less than 20%

PCB: Polychlorinated biphenyl

pg/L: picogram per liter

PRC: Performance Reference Compound

U: Not detected at the Detection Limit (DL) shown in the second column for each sample. MDL: Measured detection limit

ND: Not detected

Sur: Used as a surrogate standard

Dis: Disqualified

Table A4. Concentration of freely-dissolved (Cfree) PCB congeners.

PCB	Homolog Group	PRC	T82-10-MM-SPME		
			[PCB Cfree] Result (pg/L)	Qualifier	[PCB Cfree] MDL (pg/L)
PCB 3	Mono		ND	U	350
PCB 4 (2C)	Di		ND	U	570
PCB 5 (2C)	Di		ND	U	300
PCB 6	Di		ND	U	300
PCB 7 (2C)	Di		ND	U	300
PCB 8 [2C]	Di		ND	U	300
PCB 9 (2C)	Di		ND	U	300
PCB 10 (2C)	Di		ND	U	570
PCB 12	Di		ND	U	230
PCB 13	Di		ND	U	230
PCB 14	Di	PRC			
PCB 15	Di		ND	U	230
PCB 16	Tri		ND	U	230
PCB 17 (2C)	Tri		ND	U	230
PCB 18	Tri		ND	U	230
PCB 19	Tri		ND	U	270
PCB 20	Tri		ND	U	230
PCB 22	Tri		ND	U	230
PCB 24 (2C)	Tri		ND	U	230
PCB 25	Tri		ND	U	230
PCB 26	Tri		ND	U	230
PCB 27	Tri		ND	U	230
PCB 28	Tri		ND	U	230
PCB 29	Tri		ND	U	230
PCB 31 (2C)	Tri		ND	U	230
PCB 32 (2C)	Tri		ND	U	230
PCB 33 (2C)	Tri		ND	U	230
PCB 34	Tri		ND	U	230
PCB 35 (2C)	Tri		ND	U	250
PCB 36	Tri	PRC			
PCB 37 (2C)	Tri		ND	U	250
PCB 40	Tetra		ND	U L	260
PCB 41 (2C)	Tetra		ND	U L	260
PCB 42 (2C)	Tetra		ND	U L	260
PCB 44	Tetra		ND	U L	260
PCB 45	Tetra		ND	U	240
PCB 46	Tetra		ND	U	240
PCB 47 (2C)	Tetra		ND	U L	260
PCB 48 (2C)	Tetra		ND	U L	260
PCB 49	Tetra		ND	U L	260
PCB 51	Tetra		ND	U	240
PCB 52 [2C]	Tetra		2900	L	260
PCB 53	Tetra		ND	U	240
PCB 54 (2C)	Tetra		ND	U	240
PCB 56 (2C)	Tetra		ND	U L	290
PCB 59	Tetra		ND	U L	260
PCB 60 (2C)	Tetra		ND	U L	290
PCB 63	Tetra		ND	U L	290
PCB 64 (2C)	Tetra		ND	U L	260
PCB 66 [2C]	Tetra		ND	U L	290
PCB 67 (2C)	Tetra		ND	U L	290
PCB 69	Tetra		ND	U L	260
PCB 70	Tetra		ND	U L	290
PCB 71 (2C)	Tetra		ND	U L	260
PCB 73 (2C)	Tetra		ND	U L	260
PCB 74	Tetra		ND	NR, U L	290
PCB 75 (2C)	Tetra		ND	U L	260
PCB 77 [2C]	Tetra		ND	U L	320
PCB 78	Tetra	PRC			
PCB 81	Tetra		ND	U L	320
PCB 82	Penta		ND	U L	370
PCB 83	Penta		ND	U L	370
PCB 84	Penta		ND	U L	330
PCB 85	Penta		ND	U L	370
PCB 87 [2C]	Penta		ND	U L	370
PCB 90/101 (2C)	Penta		2300	C L	370
PCB 91	Penta		ND	U L	330
PCB 92	Penta		ND	U L	370
PCB 93 (2C)	Penta		ND	U L	330
PCB 95 (2C)	Penta		2000	L	330
PCB 97	Penta		ND	U L	370
PCB 99	Penta		ND	U L	370
PCB 100	Penta		ND	U L	330
PCB 103	Penta		ND	U L	330
PCB 104 (2C)	Penta	PRC		U	
PCB 105	Penta		ND	U L	400
PCB 107	Penta		ND	U L	400
PCB 110	Penta		3300	L	370
PCB 114	Penta		ND	U L	400
PCB 115	Penta		ND	U L	370
PCB 117	Penta		ND	U L	370
PCB 118	Penta		ND	U L	400
PCB 119	Penta		ND	U L	370
PCB 121	Penta	PRC			
PCB 122	Penta		ND	U L	400
PCB 123	Penta		ND	U L	400
PCB 124	Penta		ND	U L	400
PCB 126	Penta		ND	U L	450
PCB 128	Hexa		ND	U L	520
PCB 129	Hexa		ND	U L	520
PCB 130	Hexa		ND	U L	520
PCB 131	Hexa		ND	U L	480
PCB 132 (2C)	Hexa		ND	U L	480
PCB 134	Hexa		ND	U L	480
PCB 135 (2C)	Hexa		ND	U L	480
PCB 136	Hexa		ND	U L	520
PCB 137 (2C)	Hexa		ND	U L	520
PCB 138	Hexa		1000	J L	520
PCB 141 (2C)	Hexa		ND	U L	520
PCB 142 (2C)	Hexa	PRC		E	
PCB 144 (2C)	Hexa		ND	U L	480
PCB 146	Hexa		ND	U L	520
PCB 147	Hexa		ND	U L	480
PCB 149	Hexa		660	J L	480
PCB 151	Hexa		ND	U L	480
PCB 153 [2C]	Hexa		ND	U L	520
PCB 154	Hexa		ND	U L	480
PCB 155	Hexa	PRC		E	
PCB 156	Hexa		ND	U L	570
PCB 157	Hexa		ND	U L	570
PCB 158	Hexa		ND	U L	520
PCB 163	Hexa		ND	U L	520
PCB 164 (2C)	Hexa		ND	U L	520
PCB 165	Hexa		ND	U L	520
PCB 167	Hexa		ND	U L	570
PCB 169	Hexa		ND	U L	630
PCB 170 [2C]	Hepta		ND	U L	760
PCB 171	Hepta		ND	U L	700
PCB 172 (2C)	Hepta		ND	U L	760
PCB 173	Hepta		ND	U L	700
PCB 174	Hepta		ND	U L	700
PCB 175	Hepta		ND	U L	700
PCB 176 (2C)	Hepta		ND	U L	770
PCB 177	Hepta		ND	U L	700
PCB 178	Hepta		ND	U L	700
PCB 179 (2C)	Hepta		ND	U L	770
PCB 180	Hepta		ND	U L	760
PCB 183	Hepta		ND	U L	700
PCB 184	Hepta	PRC		U	
PCB 185	Hepta		ND	U L	700
PCB 187	Hepta		ND	U L	700
PCB 189	Hepta		ND	U L	820
PCB 190 (2C)	Hepta		ND	U L	760
PCB 191	Hepta		ND	U L	760
PCB 192 (2C)	Hepta	PRC		E	
PCB 193	Hepta		ND	U L	760
PCB 194	Octa		ND	U L	1100
PCB 195 [2C]	Octa		ND	U L	1000
PCB 196 (2C)	Octa		ND	U L	1000
PCB 197	Octa		ND	U L	1100
PCB 198	Octa			Sur	1000
PCB 199	Octa		ND	U L	1100
PCB 200	Octa		ND	U L	1100
PCB 201 (2C)	Octa		ND	U L	1000
PCB 202 (2C)	Octa		ND	U L	1100
PCB 203 (2C)	Octa		ND	U L	1000
PCB 204	Octa	PRC		E	
PCB 205	Octa		ND	U L	1100
PCB 206	Nona		ND	U L	1500
PCB 207	Nona		ND	U L	1600
PCB 208 (2C)	Nona		ND	U L	1600
PCB 209	Deca			Dis	2400
Total Detected PCB Congeners			**12000**		
Total Detected Tetra-Hexa Congeners			**12160**		

Notes

2C: The data were reported using a secondary column

E: Initially exceeded the calibration curve and were diluted to within the curve and re-analyzed L: Percent to steady state less than 20%

PCB: Polychlorinated biphenyl

pg/L: picogram per liter

PRC: Performance Reference Compound

U: Not detected at the Detection Limit (DL) shown in the second column for each sample. MDL: Measured detection limit

ND: Not detected

Sur: Used as a surrogate standard

Dis: Disqualified

Appendix B
Carbon Petrography Data

Daniel P. Gray
Senior Research Scientist

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March 6, 2020

Mr. Jason Conder
2100 Main Street, Suite 150
Huntington Beach, California 92648

Dear Jason,

On January 31, 2020, six sediment samples from EcoAnalysts were submitted by Michelle Knowlen for petrographic analysis. The samples are described and identified as follows:

KOPPERS No.	*DESCRIPTION*
2020-0081	EcoAnalysts – T82-3-MM-BC-0005
2020-0082	EcoAnalysts – T82-7-MM-BC-1015
2020-0083	EcoAnalysts – T82-6-MM-BC-1015
2020-0084	EcoAnalysts – T82-9-MM-BC-0005
2020-0085	EcoAnalysts – T82-2-MM-BC-0510
2020-0086	EcoAnalysts – T82-5-MM-BC-0005

Each of the six sediment samples were received in a ~20ml glass vail and all were relatively wet. The contents from each sample were removed from their container and placed on a glass plate and dried in an oven at 80°C for 1 hour. The dried samples were photographed to illustrate the characteristics of the as-received materials prior to petrographic preparation, as shown in Figures 1 through 6. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve and the other 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1 ¼ inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 135X, 250X and 600X in air to illustrate most of the materials listed in the compositional analysis (Table 1), as shown in Figures 7 through 14. The composition analysis consists of 1000 points counted for each sample at 600X in air, as listed in Table 1.

Geosyntec T82-3-MM-BC-0005 - Koppers (2020-0081)

The Geosyntec sample T82-3-MM-BC-0005 has 88.4% of total coarse mineral matter which consists mostly of carbonates at 70.2%, with 11.8% of Quartz or clear transparent minerals and 6.4% of other coarse mineral matter. Some of the carbonates are rocks that appear to be similar to dolomite or limestone and some of the carbonates are seashells (calcium carbonate), as shown in the top left and right photos in Figures 7 and 9. There is 10.2% of total groundmass material which consists of 1.2% fine and intermediate sized mineral matter, with 6.6% partially soluble mineral matter, 1.4% of plant material and 1.0% metallic material, as listed in Table 1. The T82-3 sediment sample has the lowest amount (10.2%) of groundmass material in the current group of samples. This sample contains 1.4% of total carbon which consists of 0.2% of activated carbon, 0.6% of sooty or pyrolytic carbon and 0.6% of mineral related carbon. This sample (T82-3-MM-BC-0005) has the lowest amount of activated carbon in the current group at 0.2% and the highest amount of carbon incorporated in the mineral matter at 0.6%. The sooty and pyrolytic carbon is very small in size, typically less than 3 microns, and are products of hydrocarbon combustion both natural and manmade.

Geosyntec T82-7-MM-BC-1015 - Koppers (2020-0082)

The Geosyntec sample T82-7-MM-BC-1015 has 76.2% of total coarse mineral matter which consists mostly of Quartz or clear transparent minerals at 41.6%, with 20.8% of other coarse minerals or rocks and 13.8% of carbonates & seashells, as listed in Table 1. There is 21.8% of total groundmass material which consists of 5.6% fine and intermediate sized mineral matter, with 12.0% partially soluble mineral matter, 1.6% of plant material and 2.6% of metallics. The soluble mineral matter appears as black angular voids in the polished petrographic specimens with some crystal condensation at the edges, as shown in Figures 10 and 13. The T82-7 sediment sample has the highest amount of metallic material most of which is incorporated in the coarse minerals and rocks, as shown in lower righthand photos in Figures 7 and 9. There is 2.0% of total carbon which consists of 1.6% of activated carbon, 0.2% of sooty or pyrolytic carbon and 0.2% carbon incorporated in coarse minerals or rocks.

Geosyntec T82-6-MM-BC-1015 - Koppers (2020-0083)

The Geosyntec sample T82-6-MM-BC-1015 has 80.8% of total coarse mineral matter which consists mostly of carbonates & seashell at 47.2%, with 12.6% Quartz or clear transparent minerals and 21.0% of other coarse minerals or rocks, as listed in Table 1. Most of the carbonates in the current sample are from rocks and not seashells. There is 17.2% of total groundmass mineral matter which consists of 6.8% fine and intermediate sized mineral matter, with 5.8% partially soluble mineral matter, 3.8% of plant material and 0.8% metallic material. There is 2.0% of total carbon which consists of 1.4% of activated carbon, 0.4% of sooty or pyrolytic carbon and 0.2% carbon incorporated in coarse minerals or rocks.

Geosyntec T82-9-MM-BC-0005 - Koppers (2020-0084)

The Geosyntec sample T82-9-MM-BC-0005 has 74.4% of total coarse mineral matter which consists mostly of carbonates & seashell at 40.2%, with 9.2% Quartz or clear transparent minerals and 25.0% of other coarse minerals or rocks, as listed in Table 1. Most of the carbonates in the current sample are from seashells and not rocks, as shown in Figure 4. There is 23.4% of total groundmass mineral matter which consists of 7.2% fine and intermediate sized mineral matter, with 13.8% partially soluble mineral matter and 2.4% of plant material. The current sample has the highest (13.8%) amount of partially soluble mineral matter in the current group of samples, as shown in Figures 10 and 13. There is 2.2% of total carbon which consists of 1.8% of activated carbon, 0.2% of sooty or pyrolytic carbon and 0.2% carbon incorporated in coarse minerals or rocks. The majority of the activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks, as shown in the lower righthand photos in Figures 10 and 11.

Geosyntec T82-2-MM-BC-0510 - Koppers (2020-0085)

The Geosyntec sample T82-2-MM-BC-0510 has 42.4% of total coarse mineral matter which consists mostly of carbonates & seashell at 23.6%, with 11.6% Quartz or clear transparent minerals and 7.2% of other coarse minerals or rocks, as listed in Table 1. There is 54.0% of total groundmass mineral matter which is the highest amount in the current group of samples and consists of 20.6% fine and intermediate sized mineral matter, with 11.4% partially soluble mineral matter, 21.8% of plant material and 0.2% of metallics. The current sample has the highest (21.8%) amount of plant material in the current group of samples, as shown in Figures 8, 11, 12 and 13. There is 3.6% of total carbon which is the second highest amount in the current group and consists of 3.2% activated carbon, 0.2% of sooty or pyrolytic carbon and 0.2% carbon incorporated in coarse minerals or rocks. As noted in the previous sample, the majority of the activated carbon is very small in size and incorporated in the groundmass matrix, as shown in the lower left-hand photo in Figure 12.

Geosyntec T82-5-MM-BC-0005 - Koppers (2020-0086)

The Geosyntec sample T82-5-MM-BC-0005 has 74.2% of total coarse mineral matter which consists mostly of carbonates & seashell at 53.8%, with 7.8% Quartz or clear transparent minerals and 12.6% of other coarse minerals or rocks, as listed in Table 1. There is 22.0% of total groundmass mineral matter which consists of 14.0% fine and intermediate sized mineral matter, with 2.6% partially soluble mineral matter and 5.4% of plant material. There is 3.8% of total carbon which is the highest amount in the current group and consists of 3.2% activated carbon, with 0.2% of sooty or pyrolytic carbon and 0.4% carbon incorporated in coarse minerals or rocks. Most of the activated carbon is very small in size and incorporated in the fine sized groundmass matrix.

Please call me at (412) 826-3994 or e-mail at graydp@koppers.com if you have questions or wish to discuss this work.

Sincerely,

Daniel P. Gray

Table 1

Petrographic Analysis of Six Koppers Samples 2020-0081 thru 2020-0086 of Sediment Samples from Geosyntec T82 – 2, 3, 5, 6, 7 & 9)

Description	Geosyntec T82-3-MM-BC-0005	Geosyntec T82-7-MM-BC-1015	Geosyntec T82-6-MM-BC-1015	Geosyntec T82-9-MM-BC-0005	Geosyntec T82-2-MM-BC-0510	Geosyntec T82-5-MM-BC-0005
Koppers #	2020-0081	2020-0082	2020-0083	2020-0084	2020-0085	2020-0086
Coarse MM:						
Carbonates and Seashells	70.2	13.8	47.2	40.2	23.6	53.8
Quartz & Clear MM	11.8	41.6	12.6	9.2	11.6	7.8
Other – Coarse MM	6.4	20.8	21.0	25.0	7.2	12.6
Total Coarse MM	**88.4**	**76.2**	**80.8**	**74.4**	**42.4**	**74.2**
Groundmass :						
Fine & Intermediate MM	1.2	5.6	6.8	7.2	20.6	14.0
Partially Soluble MM	6.6	12.0	5.8	13.8	11.4	2.6
Plant Material - Organic	1.4	1.6	3.8	2.4	21.8	5.4
Metallics & Pyrite	1.0	2.6	0.8	---	0.2	---
Total Groundmass	**10.2**	**21.8**	**17.2**	**23.4**	**54.0**	**22.0**
Carbon						
Activated Carbon	0.2	1.6	1.4	1.8	3.2	3.2
Soot & Pyrolytic	0.6	0.2	0.4	0.2	0.2	0.2
Graphite	---	---	---	---	---	---
Other Carbon in Min. Matrix	0.6	0.2	0.2	0.2	0.2	0.4
Total Carbon	**1.4**	**2.0**	**2.0**	**2.2**	**3.6**	**3.8**
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 1: Photograph of Koppers Sample 20-0081 from Geosyntec T82-3-MM-BC-0005

Figure 2: Photograph of Koppers Sample 20-0082 from Geosyntec T82-7-MM-BC-1015

Figure 3: Photograph of Koppers Sample 20-0083 from Geosyntec T82-6-MM-BC-1015

Figure 4: Photograph of Koppers Sample 20-0084 from Geosyntec T82-9-MM-BC-0005

Figure 5: Photograph of Koppers Sample 20-0085 from Geosyntec T82-2-MM-BC-0510

Figure 6: Photograph of Koppers Sample 20-0086 from Geosyntec T82-5-MM-BC-0005

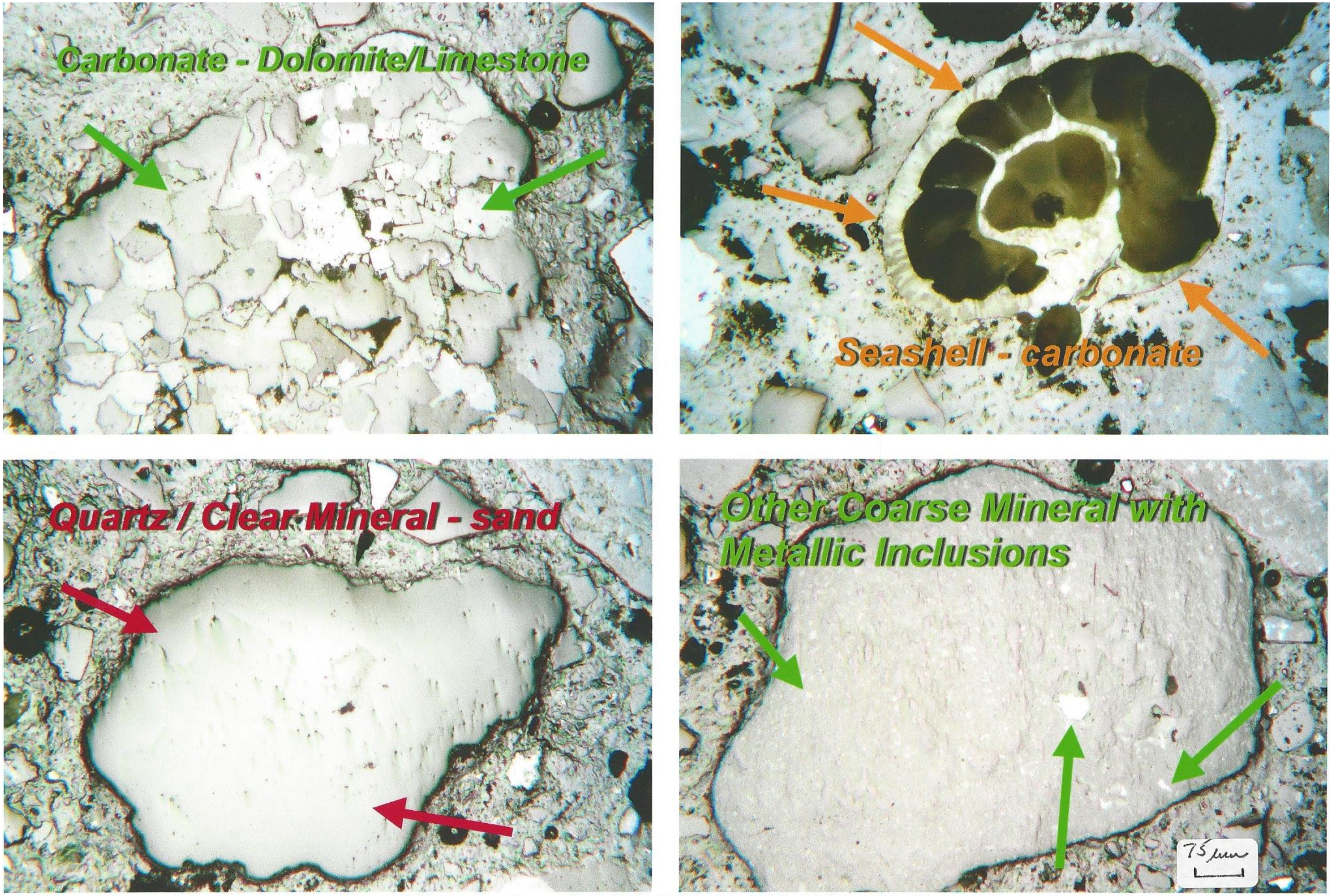

Figure 7: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Carbonate (dolomite/limestone), Seashell - carbonate, Quartz/Clear Mineral (sand) and Other Coarse Mineral with Metallic Inclusions. Reflected Light In Air, X135.

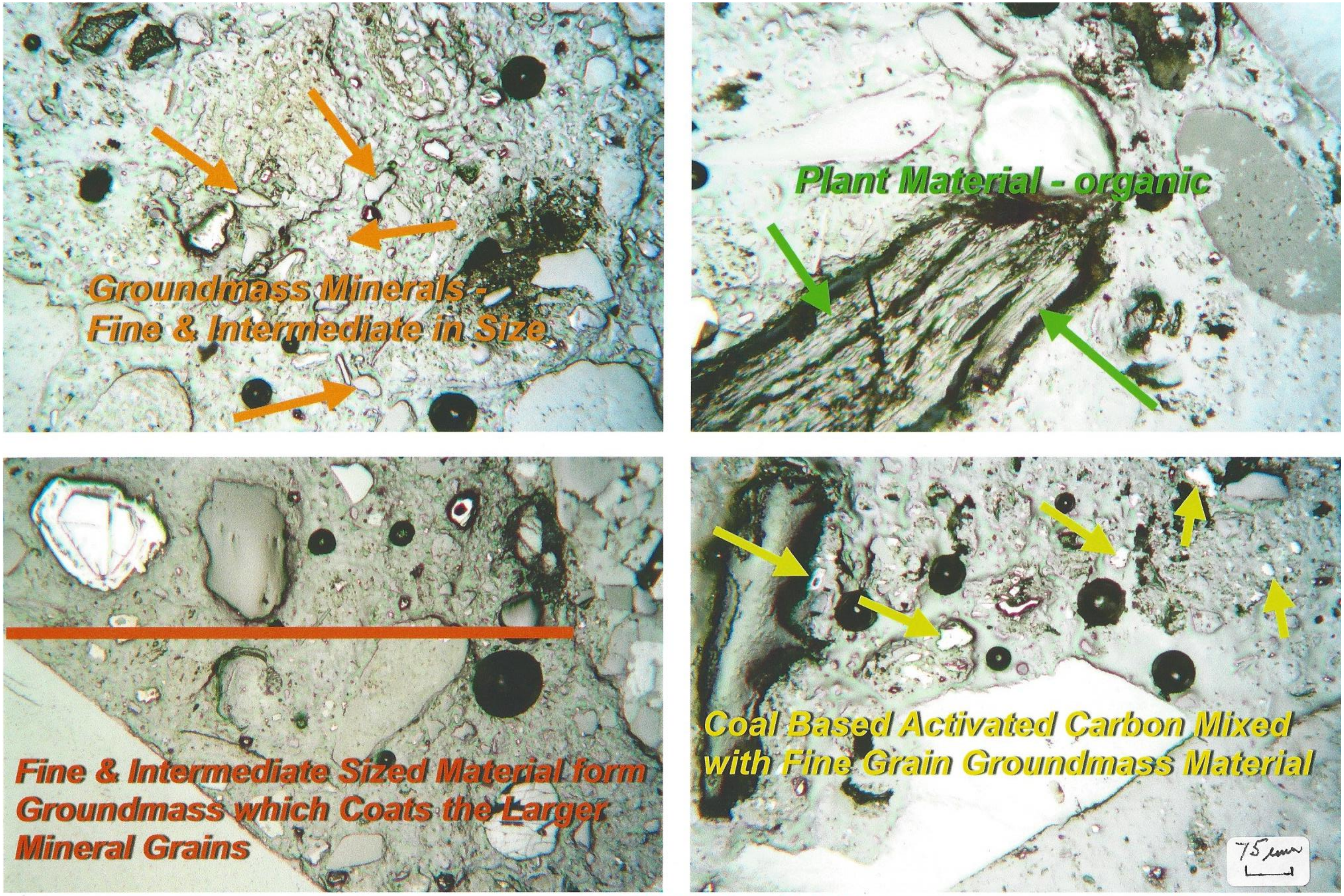

Figure 8: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Groundmass Minerals – fine and Int. in size, Plant Material – organic and Coal Based Activated Carbon Mixed with Groundmass Material. Reflected Light In Air, X135.

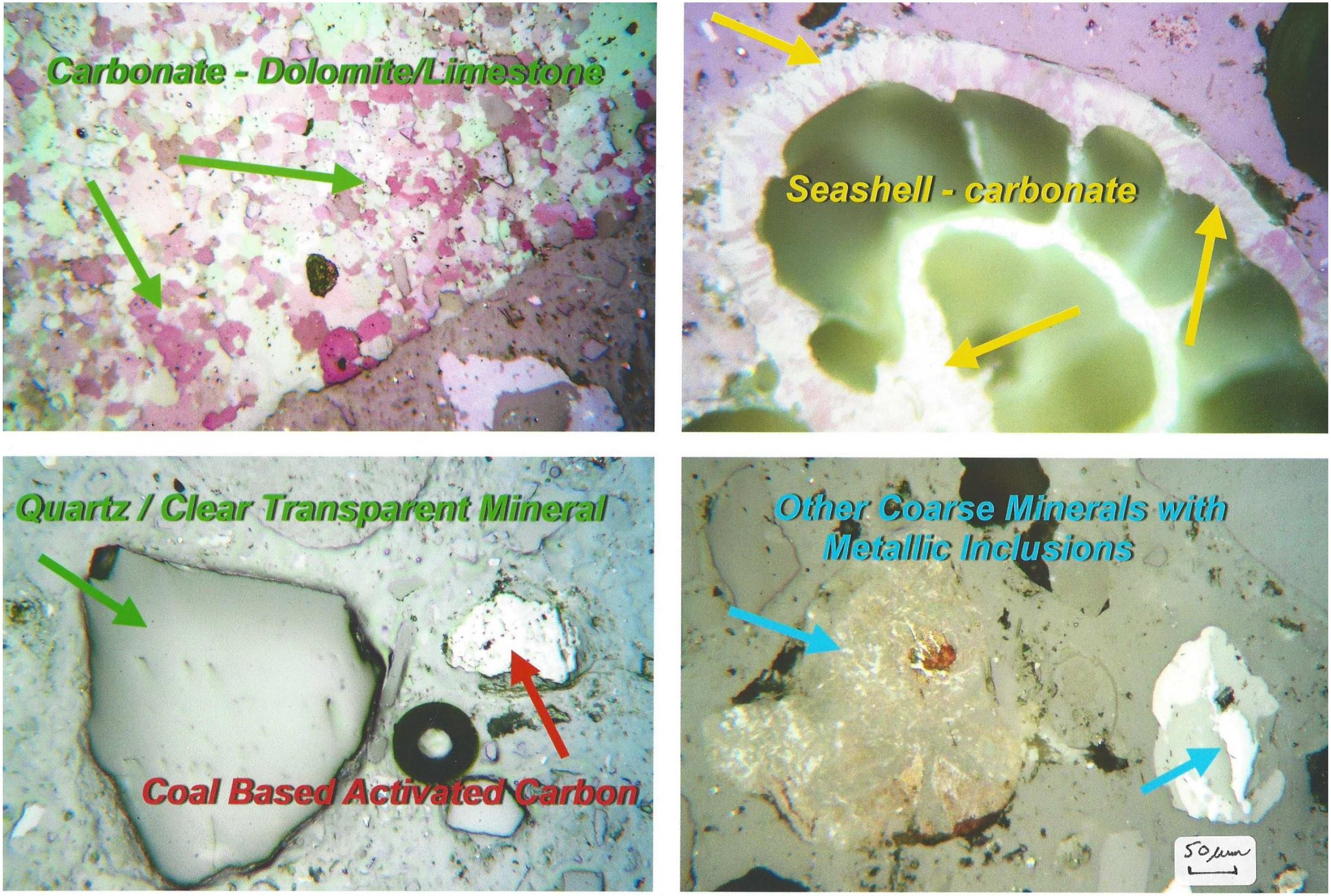

Figure 9: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Carbonate (dolomite/limestone), Seashell - carbonate, Quartz/Clear Mineral (sand) and Other Coarse Mineral with Metallic Inclusions. Reflected Light In Air, X250.

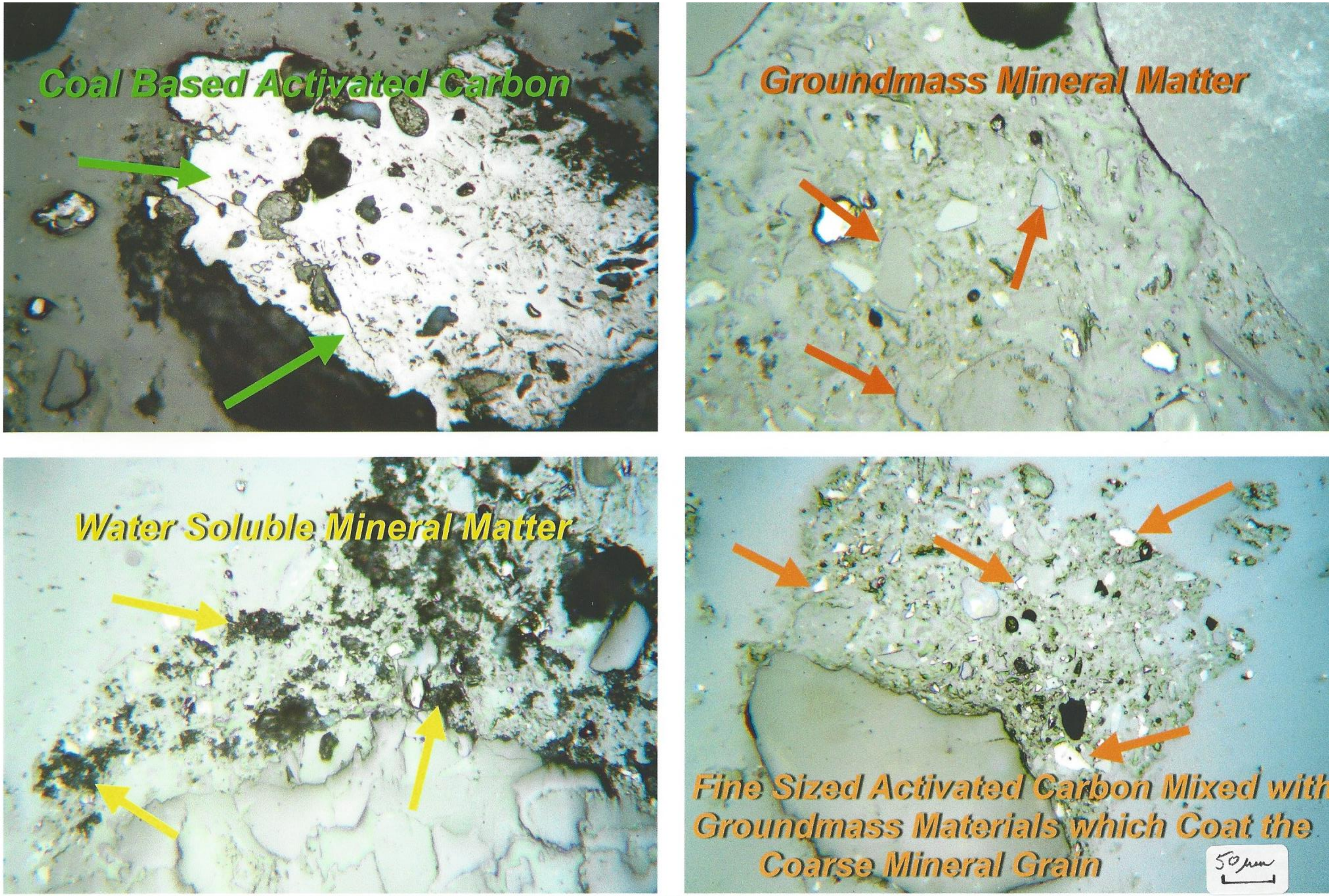

Figure 10: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Coal Based Activated Carbon, Groundmass Mineral Matter, Water Soluble Mineral and Fine Sized Activated Carbon in Groundmass. Reflected Light In Air, X250.

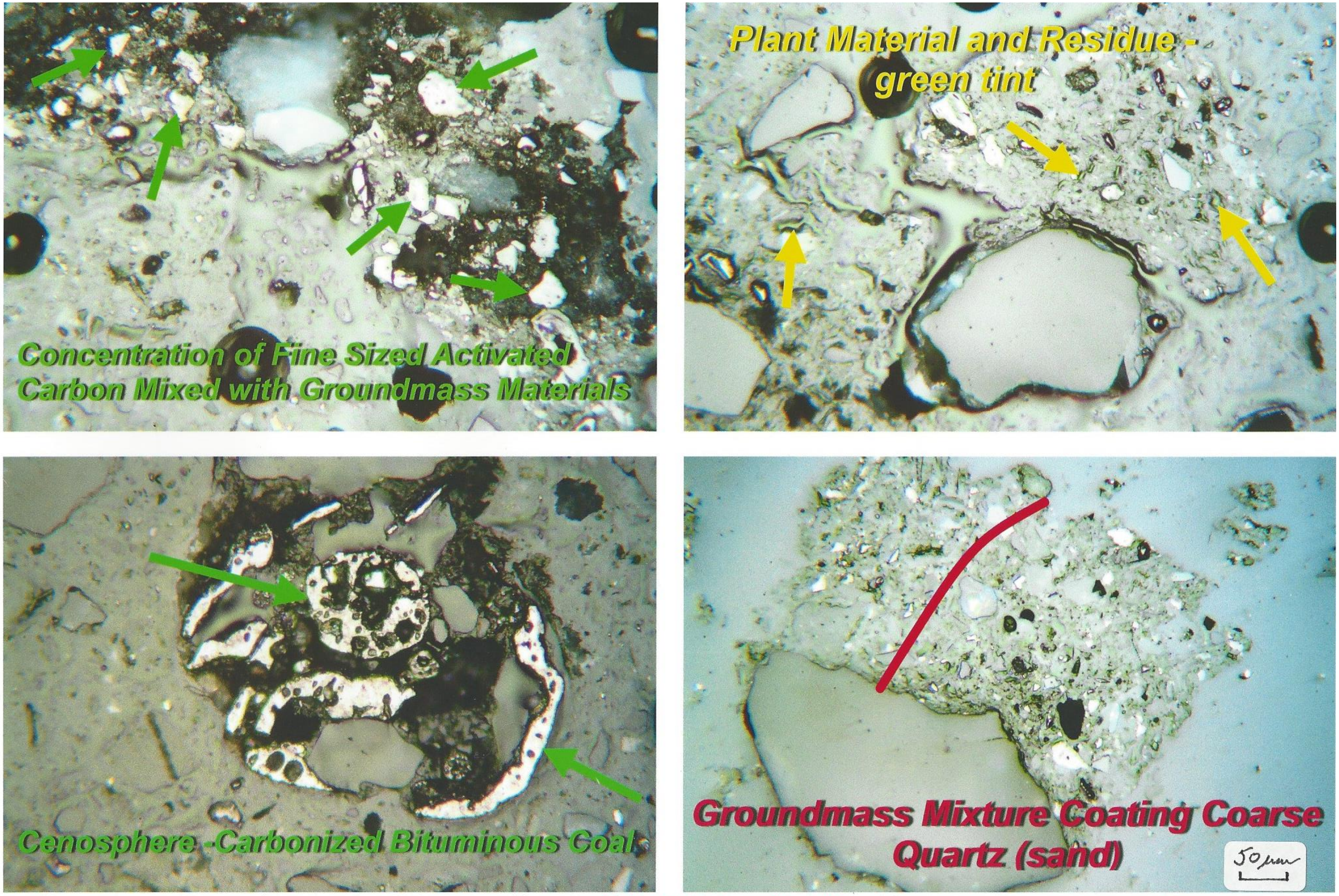

Figure 11: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Cenosphere, Fine Sized Activated Carbon in Groundmass Matrix, Plant Material – green tint and Groundmass Coating Coarse MM Quartz. Reflected Light In Air, X250.

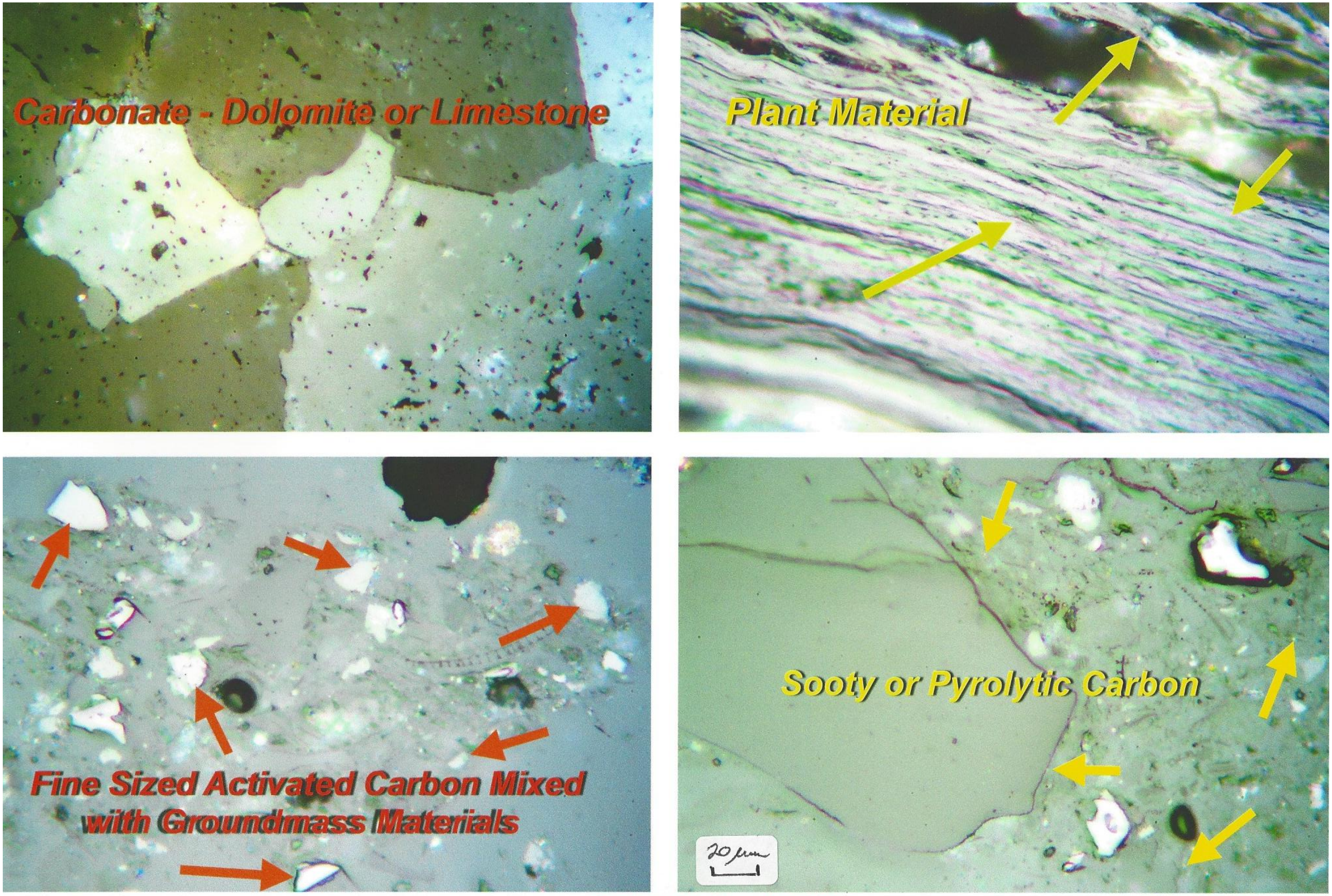

Figure 12: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Carbonate – Dolomite or Limestone, Plant Material, Fine Sized Activated Carbon in Groundmass and Sooty or Pyrolytic Carbon. Reflected Light In Air, X600.

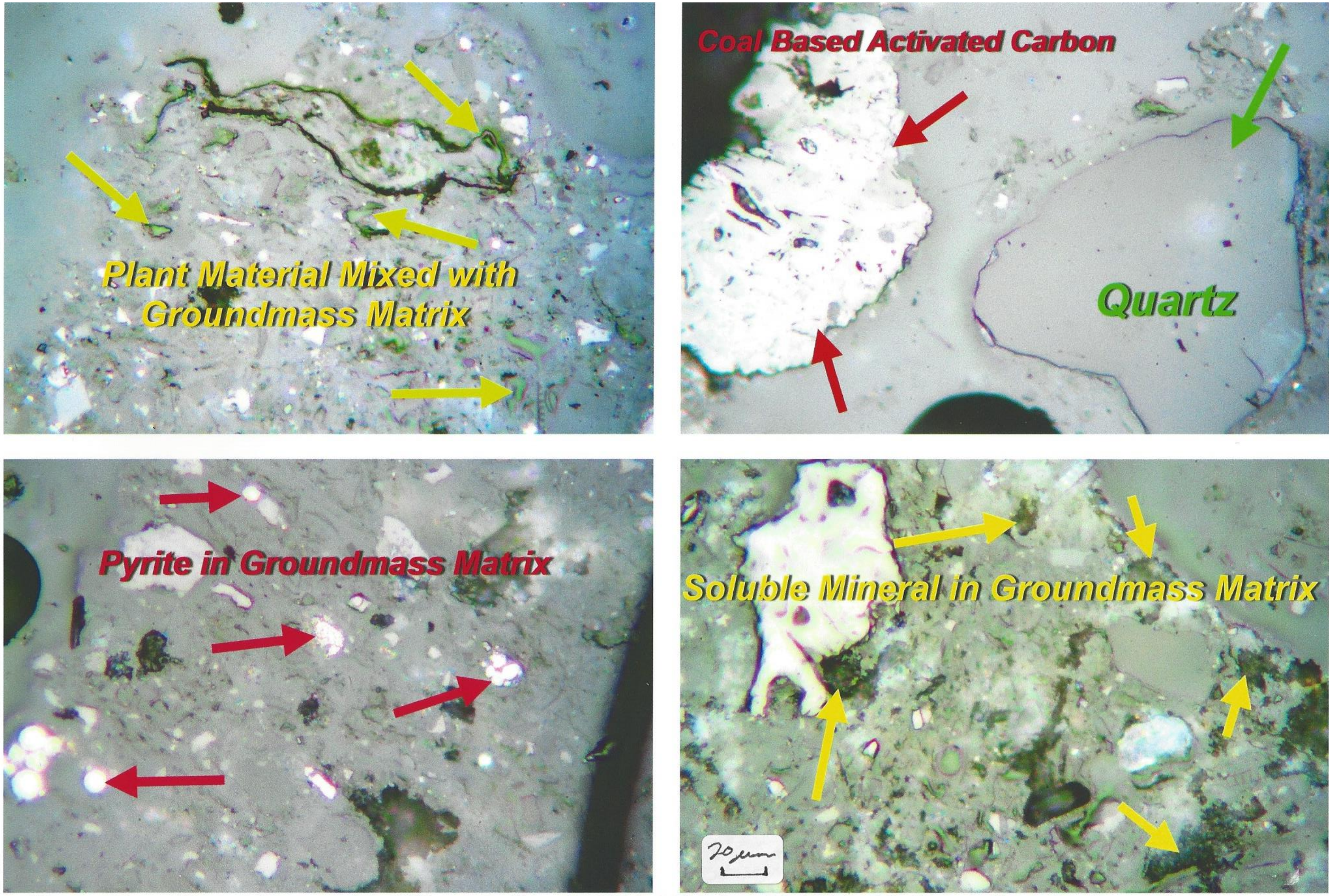

Figure 13: Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Plant Material in Groundmass Matrix, Quartz, Activated Carbon, Pyrite in Groundmass Matrix and Soluble Mineral in Groundmass. Reflected Light In Air, X600.

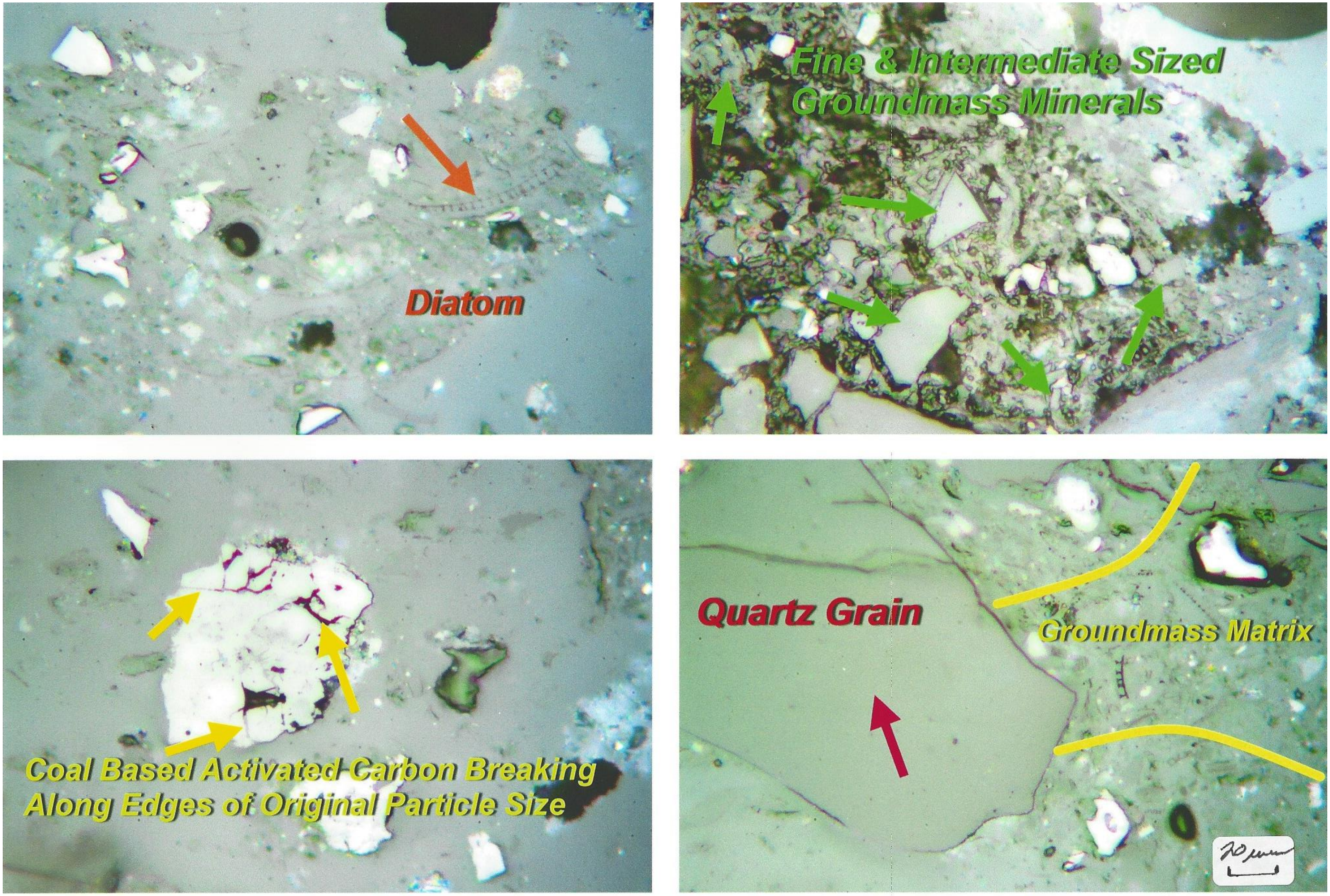

Figure 14: **Photomicrographs of Koppers Sample 2020-0081 thru 20-0086 of Sediment Samples from Geosyntec (T82-2, 3, 5, 6, 7 & 9) Showing; Plant Material in Groundmass Matrix, Quartz, Activated Carbon, Pyrite in Groundmass Matrix and Soluble Mineral in Groundmass. Reflected Light In Air, X600.**

Daniel P. Gray
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July 8, 2020

Mr. Jason Conder
2100 Main Street, Suite 150
Huntington Beach, California 92648

Dear Jason,

On June 11, 2020, twenty six sediment samples from EcoAnalysts were submitted by Michelle Knowlen for petrographic analysis. In the current report which include three from group T82-2 and three from T82-3 will be analyzed. The samples are described and identified as follows:

KOPPERS No.	*DESCRIPTION*
2020-0695	EcoAnalysts – T82-2-MM-BC-1520
2020-0696	EcoAnalysts – T82-2-MM-BC-0005
2020-0697	EcoAnalysts – T82-2-MM-BC-1015
2020-0698	EcoAnalysts – T82-3-MM-BC-0510
2020-0699	EcoAnalysts – T82-3-MM-BC-1520
2020-0700	EcoAnalysts – T82-3-MM-BC-1015

Each of the six sediment samples were received in a ~20ml glass vail and all were relatively wet. The contents from each sample were removed from their container and placed on a glass plate and dried in an oven at 80°C for 2 hour. The dried samples were photographed to illustrate the characteristics of the as-received materials prior to petrographic preparation, as shown in Figures 1 through 6. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve and the other 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1 ¼ inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 135X and 600X in air to illustrate most of the materials listed in the compositional analysis (Table 1), as shown in Figures 7 through 12. The composition analysis consists of 1000 points counted for each sample at 600X in air, as listed in Table 1.

Geosyntec T82-2-MM-BC-1520 - Koppers (2020-0695)

The Geosyntec sample T82-2-MM-BC-1520 has 37.1% of total coarse mineral matter which consists mostly of carbonates at 13.8% and Quartz like transparent minerals at 13.9% with 9.4% of other coarse mineral matter. Some of the carbonates are rocks that appear to be similar to dolomite or limestone and some of the carbonates are seashells (calcium carbonate), as shown in the top left and right photos in Figures 7 and 9. There is 62.2% of total groundmass material which consists of 29.6% fine and intermediate sized mineral matter, with

15.2% partially soluble mineral matter, 17.9% of plant material and 0.4% of metallics/pyrite. There is 0.7% of total carbon which consists mostly (0.6%) of coal based activated carbon and 0.1% of cenospheres with a trace amount of soot. The majority of the activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks, as shown in Figures 9,11 and 12.

Geosyntec T82-2-MM-BC-0005 - Koppers (2020-0696)

The Geosyntec sample T82-2-MM-BC-0005 has 21.9% of total coarse mineral matter which consists mostly of carbonates & seashell at 13.7%, with 3.1% Quartz or clear transparent minerals and 4.5% of other coarse minerals or rocks, as listed in Table 1. There is 77.6% of total groundmass mineral matter which is the highest amount in the current group of samples and consists of 42.9% fine and intermediate sized mineral matter, with 11.2% partially soluble mineral matter, 23.1% of plant material and 0.4% of metallics/pyrite. The current sample has the highest (23.1%) amount of plant material in the current group of samples, as shown in Figures 8, 10 and 11. There is only 0.5% of total carbon which consists of 0.4% activated carbon and 0.1% of cenospheres. As noted in the previous sample, the majority of the activated carbon is very small in size and incorporated in the groundmass matrix.

Geosyntec T82-2-MM-BC-1015 - Koppers (2020-0697)

The Geosyntec sample T82-2-MM-BC-1015 has 56.4% of total coarse mineral matter which consists mostly of carbonates & seashells at 51.0%, with 3.1% of Quartz-like or clear transparent minerals and 2.3% of other coarse minerals or rocks, as listed in Table 1. There is 41.2% of total groundmass material which consists mostly of plant material at 16.5%, with 12.4% fine and intermediate sized mineral matter and 12.3% partially soluble mineral matter. The soluble mineral matter appears as black angular voids in the polished petrographic specimens with some crystal condensation at the edges, as shown in Figures 8 and 10. There is 2.4% of total carbon which is the highest amount in the current group and consists entirely of coal based activated carbon which range from very small to intermediate in size.

Geosyntec T82-3-MM-BC-0510 - Koppers (2020-0698)

The Geosyntec sample T82-3-MM-BC-0510 has 80.9% of total coarse mineral matter which consists mostly of carbonates & seashell at 43.7%, with 16.2% of Quartz-like or clear transparent minerals and 21.0% of other coarse minerals or rocks, as listed in Table 1. The carbonates in the current sample are about 50% from rocks and 50% from seashells. There is 18.6% of total groundmass mineral matter which consists of 7.3% fine and intermediate sized mineral matter, with 3.5% partially soluble mineral matter, 7.1% of plant material and 0.7% metallic/pyrite material. There is 0.5% of total carbon which consists of 0.4% activated carbon and 0.1% of sooty or pyrolytic carbon which are incorporated in the fine grain groundmass mineral matter. The sooty and pyrolytic carbon is very small in size, typically less than 3 microns, and are products of hydrocarbon combustion both natural and manmade.

Geosyntec T82-3-MM-BC-1520 - Koppers (2020-0699)

The Geosyntec sample T82-3-MM-BC-1520 has 73.5% of total coarse mineral matter which consists mostly of other coarse mineral matter or rocks at 42.1%, with 22.0% of carbonates & seashell and 9.4% of Quartz-like or clear transparent minerals, as listed in Table 1. About 50% of the carbonates in the current sample are from seashells, as shown in Figures 7 and 9. There is 24.6% of total groundmass mineral matter which consists of 11.7% fine and intermediate sized mineral matter, with 11.6% of plant material, 0.6% partially soluble mineral matter and 0.7% of metallics/pyrite. There is 1.9% of total carbon which consists of 1.9% of coal based activated carbon and a trace amount of pyrolytic carbon or soot. The majority of the activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks, as shown in Figures 9,11 and 12.

Geosyntec T82-3-MM-BC-1015 - Koppers (2020-0700)

The Geosyntec sample T82-3-MM-BC-1015 has 82.4% of total coarse mineral matter which consists mostly of carbonates & seashell at 50.4%, with 9.1% Quartz or clear transparent minerals and 22.9% of other coarse minerals or rocks, as listed in Table 1. There is 16.0% of total groundmass mineral matter which consists of 9.0% fine and intermediate sized mineral matter, with 0.7% partially soluble mineral matter, 5.8% of plant material and 0.5% of metallics/pyrite. There is 1.6% of total carbon which consists mostly (1.5%) of coal based activated carbon and a small amount (0.1%) of sooty or pyrolytic carbon. Most of the activated carbon is very small in size and incorporated in the fine sized groundmass matrix.

Please call me at (412) 826-3994 or e-mail at graydp@koppers.com if you have questions or wish to discuss this work.

Sincerely,

Daniel P. Gray

Table 1

Petrographic Analysis of Six Koppers Samples 2020-0695 thru 2020-0700 of Sediment Samples from Geosyntec
(T82 – 2 -1520, 0005 & 1015, T82 – 3 - 0510, 1520 & 1015)

Description	Geosyntec T82-2-MM-BC-1520	Geosyntec T82-2-MM-BC-0005	Geosyntec T82-2-MM-BC-1015	Geosyntec T82-3-MM-BC-0510	Geosyntec T82-3-MM-BC-1520	Geosyntec T82-3-MM-BC-1015
Koppers #	2020-0695	2020-0696	2020-0697	2020-0698	2020-0699	2020-0700
Coarse MM:						
Carbonates and Seashells	13.8	13.7	51.0	43.7	22.0	50.4
Quartz & Clear MM	13.9	3.7	3.1	16.2	9.4	9.1
Other – Coarse MM	9.4	4.5	2.3	21.0	42.1	22.9
Total Coarse MM	37.1	21.9	56.4	80.9	73.5	82.4
Groundmass :						
Fine & Intermediate MM	29.6	42.9	12.4	7.3	11.7	9.0
Partially Soluble MM	15.2	11.2	12.3	3.5	0.6	0.7
Plant Material - Organic	17.0	23.1	16.5	7.1	11.6	5.8
Metallics & Pyrite	0.4	0.4	---	0.7	0.7	0.5
Total Groundmass	62.2	77.6	41.2	18.6	24.6	16.0
Carbon						
Activated Carbon	0.6	0.4	2.4	0.4	1.9	1.5
Soot & Pyrolytic	Trace	---	---	0.1	Trace	0.1
Graphite	---	---	---	---	---	---
Other Carbon - cenosphere	0.1	0.1	---	---	---	---
Total Carbon	0.7	0.5	2.4	0.5	1.9	1.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

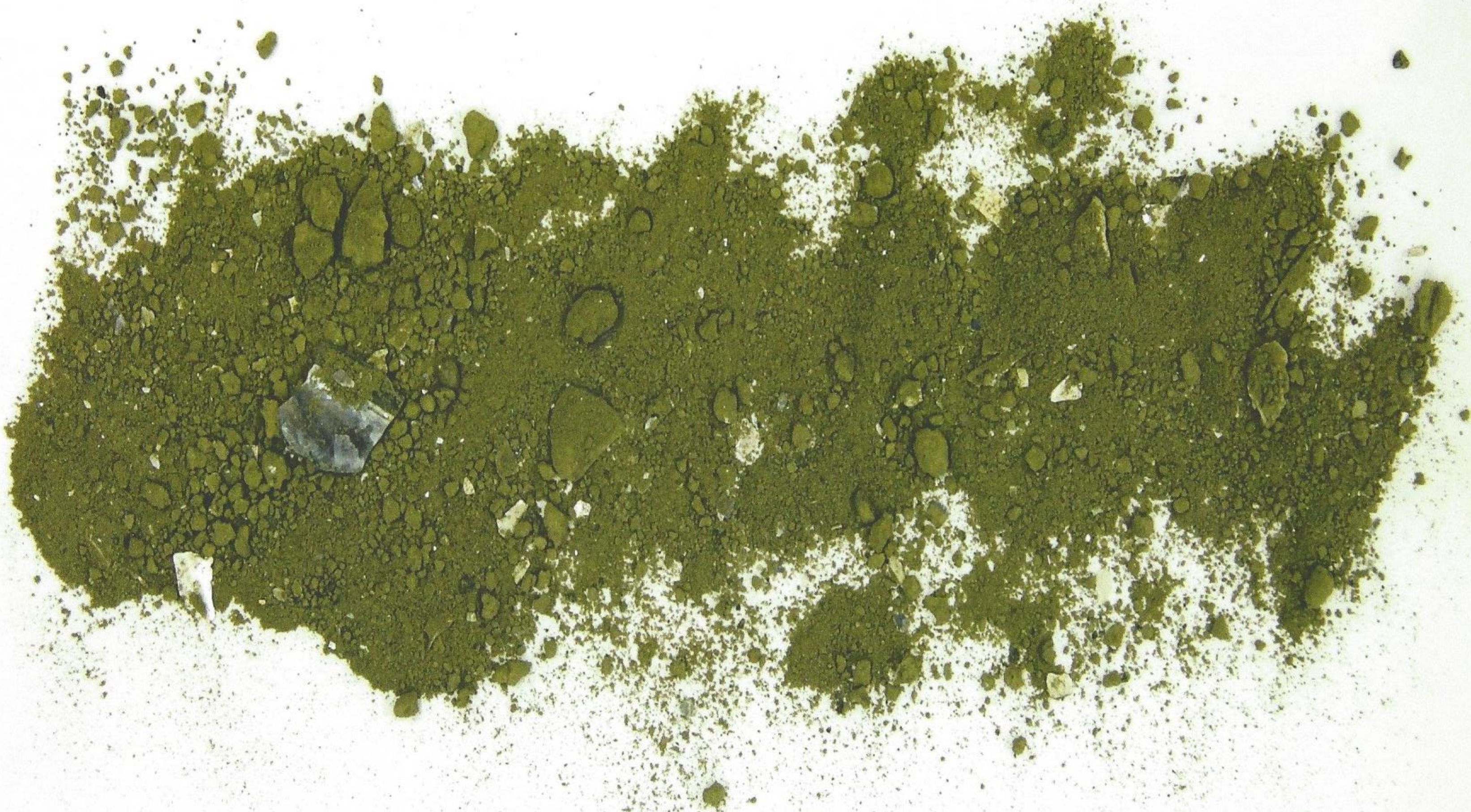

Figure 1. Geosyntec: T82-2-MM-BC-1520 (Koppers 20-0695)

Figure 2. Geosyntec: T82-2-MM-BC-0005 (Koppers 20-0696)

Figure 3. Geosyntec: T82-2-MM-BC-1015 (Koppers 20-0697)

Figure 4. Geosyntec: T82-3-MM-BC-0510 (Koppers 20-0698)

Figure 5. Geosyntec: T82-3-MM-BC-1520 (Koppers 20-0699)

Figure 6. Geosyntec: T82-3-MM-BC-1015 (Koppers 20-0700)

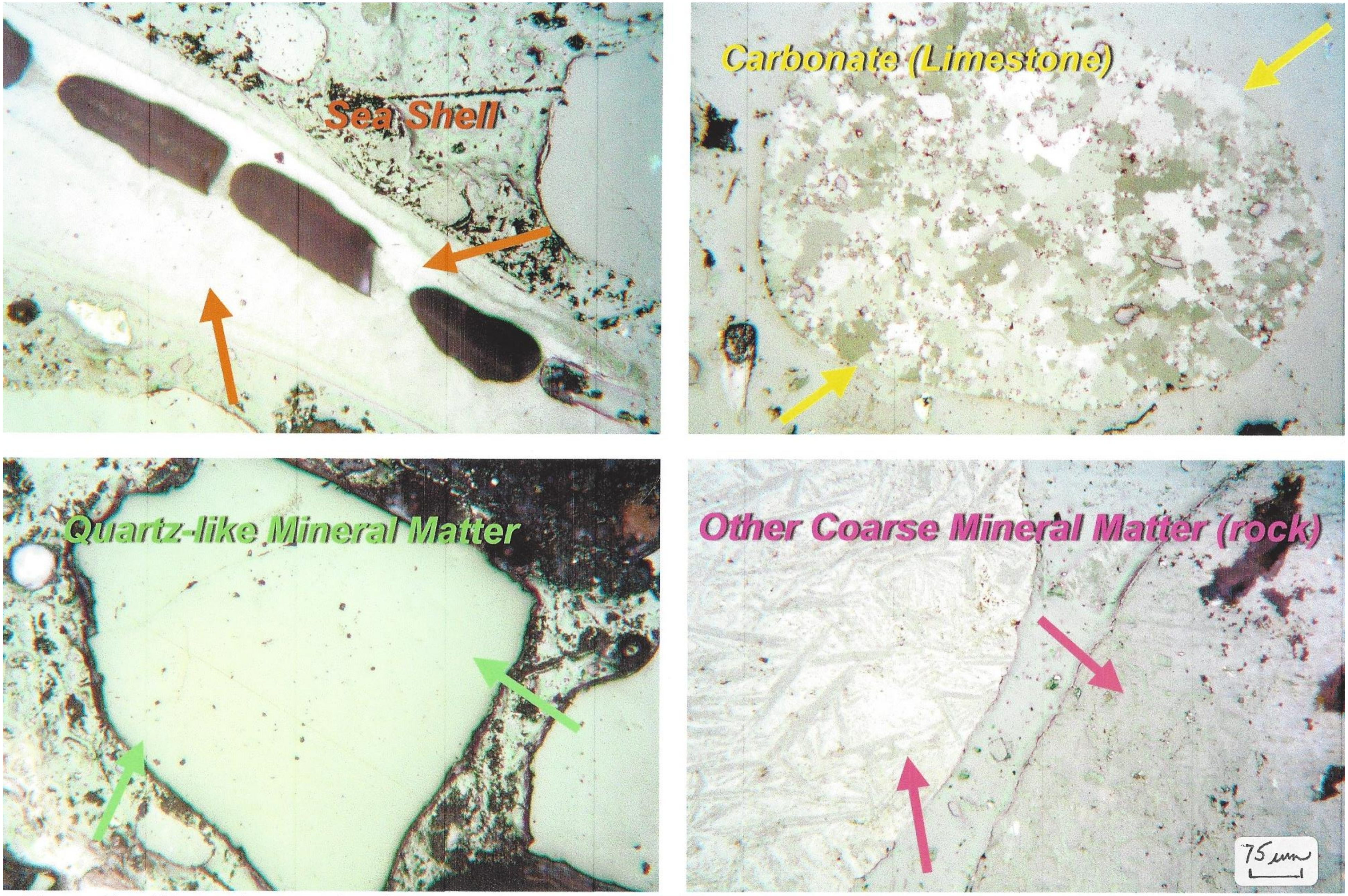

Figure 7: Photomicrographs of Koppers Samples 2020-0695 thru 2020-0700 from Geosyntec (Sediment 2-1520, 0005 & 1015, 3-0510,1520 & 1015) Showing; Sea Shell (carbonate), Coarse Carbonate (limestone), Quartz Like Coarse Mineral Matter and Other Coarse Mineral Matter (rock). Reflected Polarized Light In Air, X135.

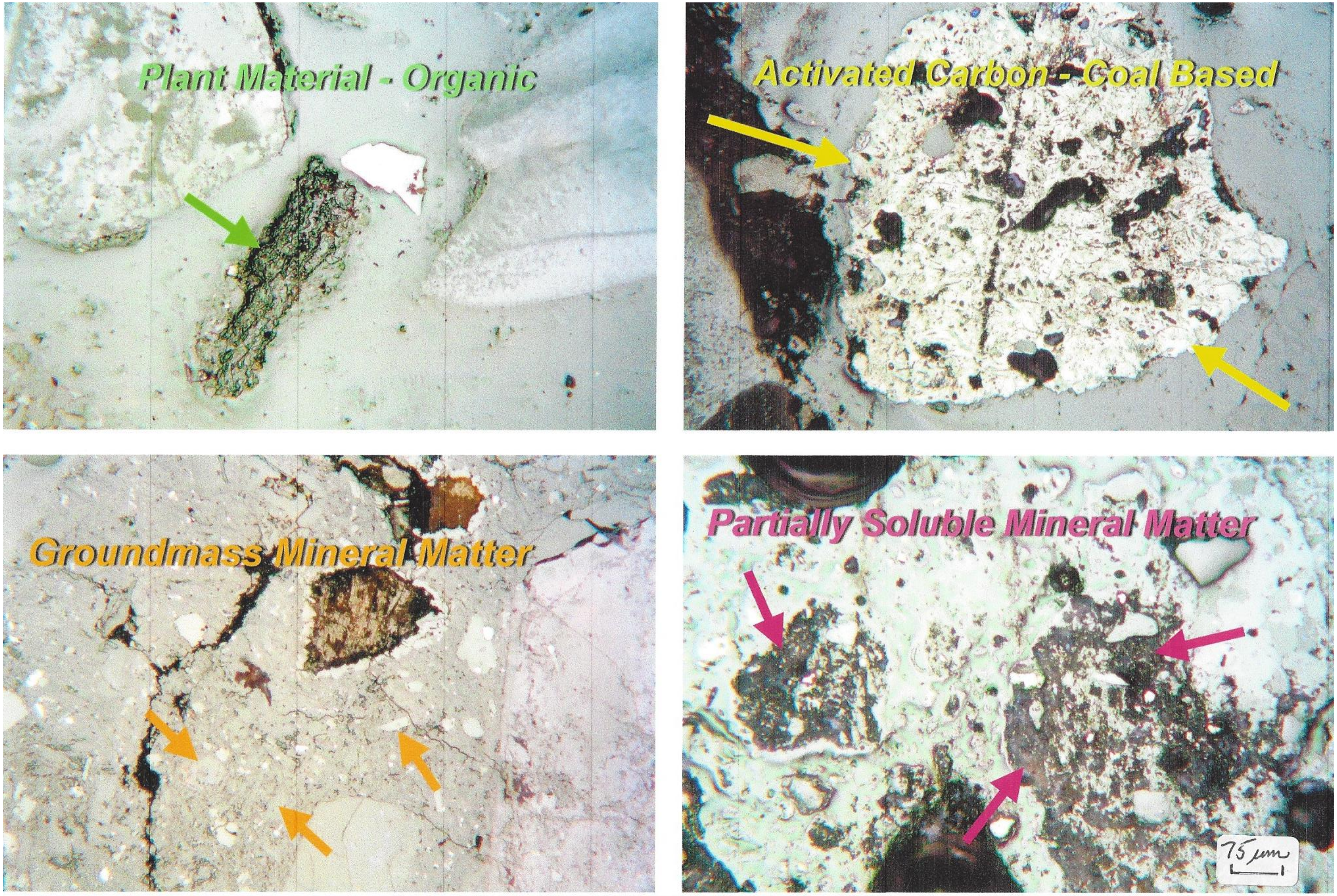

Figure 8.) Photomicrographs of Koppers Samples 2020-0695 thru 2020-0700 from Geosyntec (Sediment 2-1520, 0005 & 1015, 3-0510,1520 & 1015) Showing; Plant Material – organic, Activated Carbon -Coal Based, Groundmass MM and Partially Soluble Mineral Matter. Reflected Polarized Light In Air, X135.

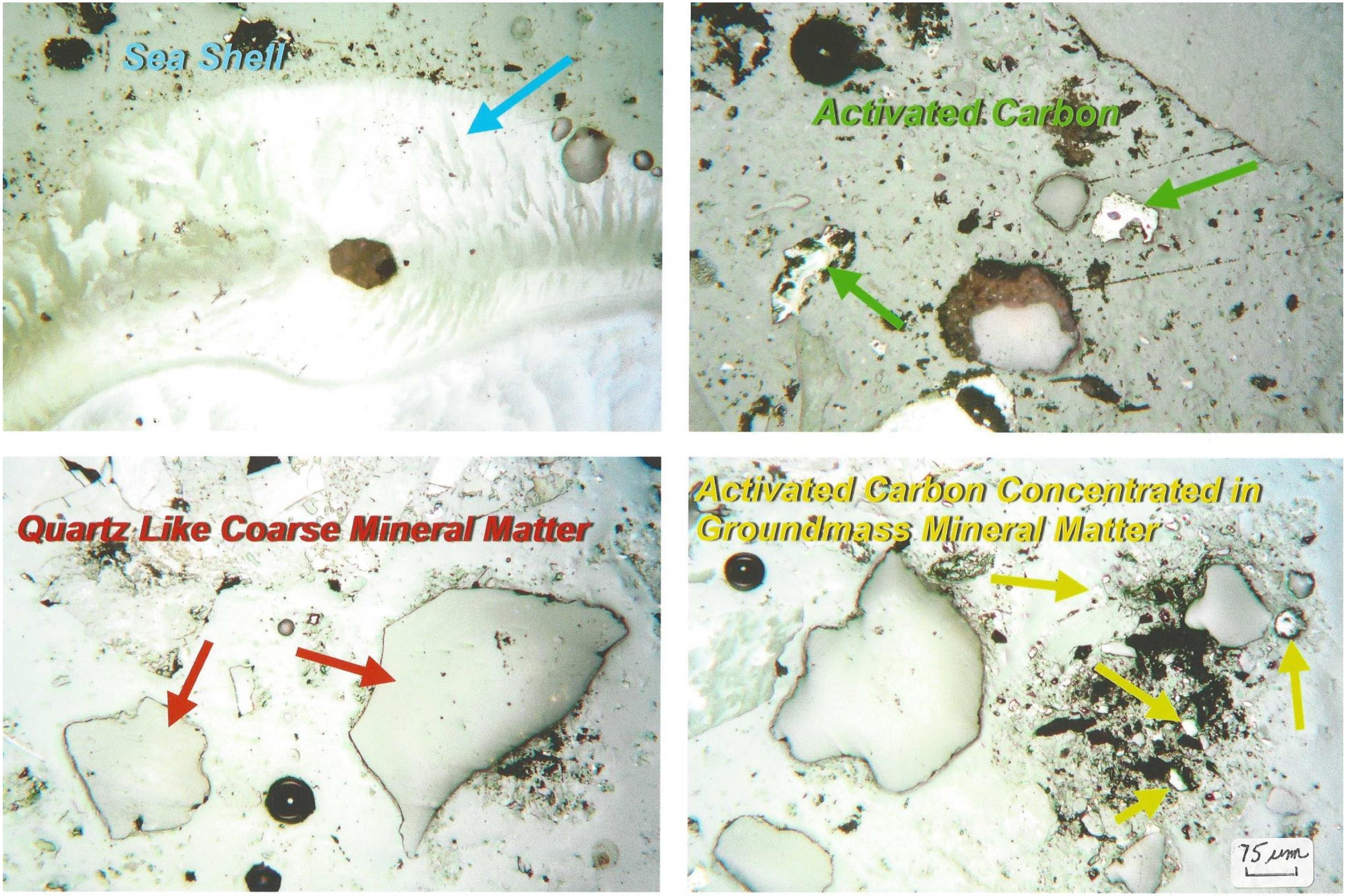

Figure 9.) Photomicrographs of Koppers Samples 2020-0695 thru 2020-0700 from Geosyntec (Sediment 2-1520, 0005 & 1015, 3-0510,1520 & 1015) Showing; Seashell – Coarse Carbonate, Activated Carbon, Quartz Like Coarse MM and Activated Carbon with Groundmass MM. Reflected Polarized Light In Air, X135.

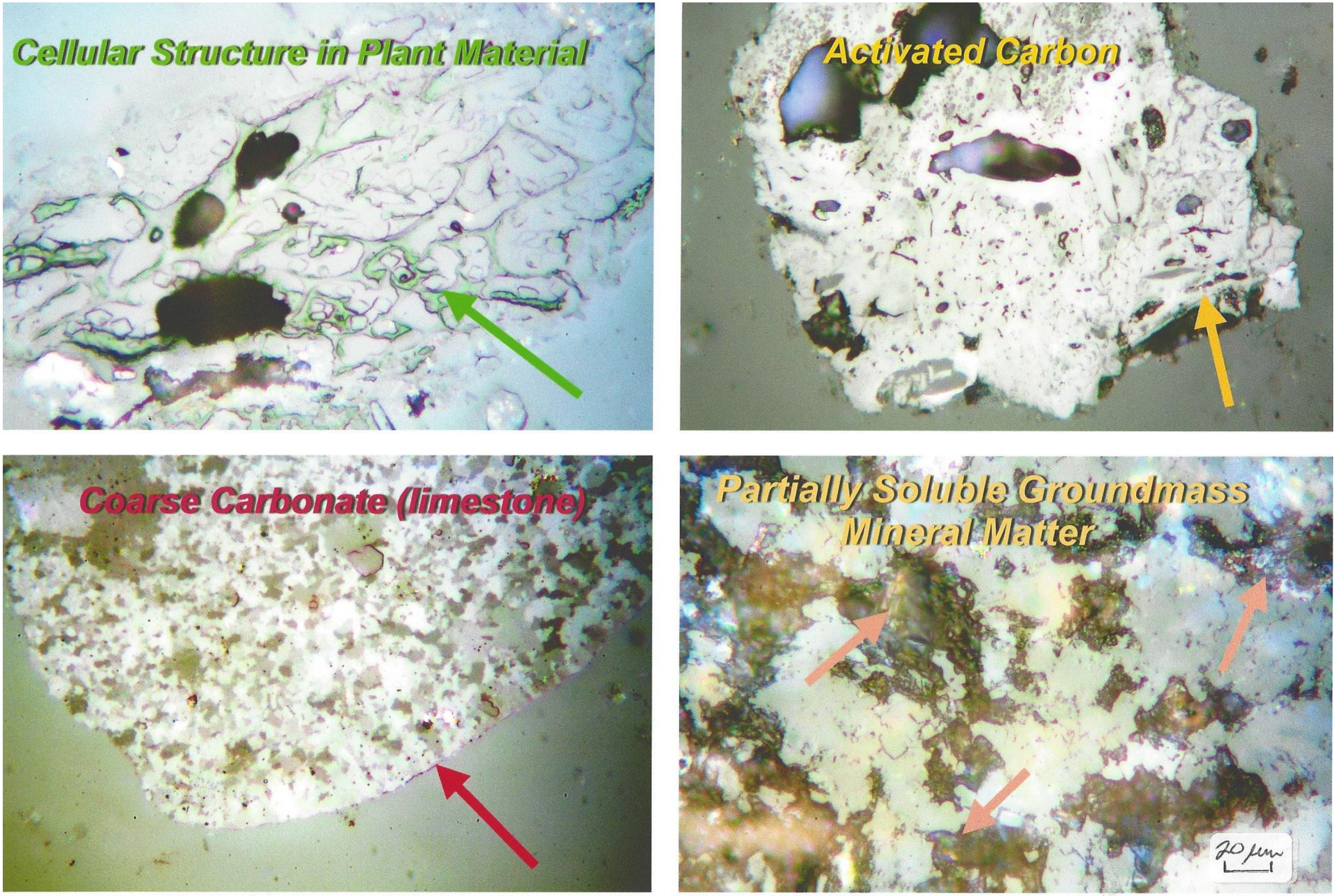

Figure 10.) Photomicrographs of Koppers Samples 2020-0695 thru 2020-0700 from Geosyntec (Sediment 2-1520, 0005 & 1015, 3-0510,1520 & 1015) Showing; Plant Material, Activated Carbon (coal based), Coarse Carbonate (limestone) and Partially Soluble Groundmass Mineral Matter. Reflected Polarized Light In Air, X600.

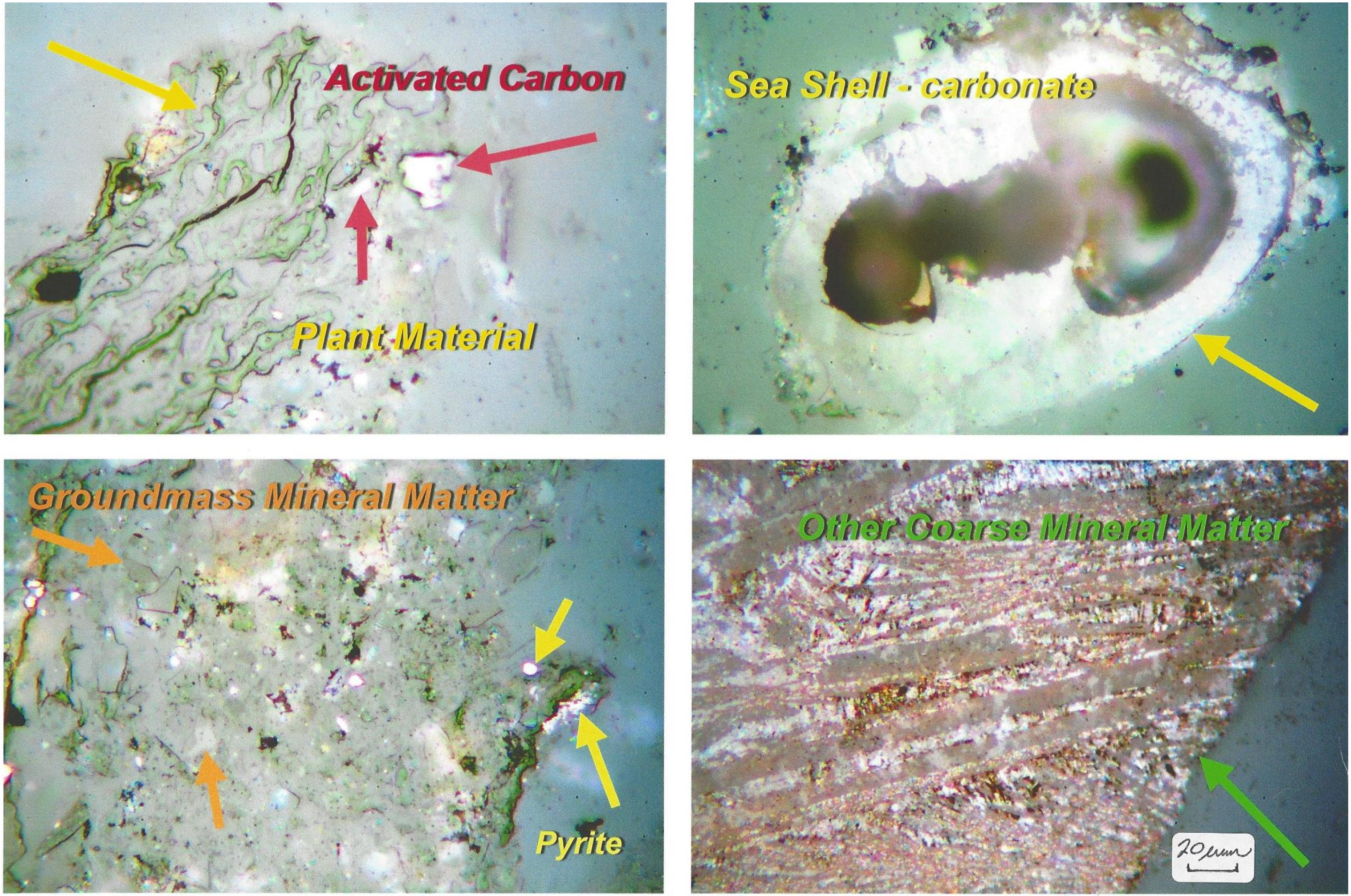

Figure 11.) Photomicrographs of Koppers Samples 2020-0695 thru 2020-0700 from Geosyntec (Sediment 2-1520, 0005 & 1015, 3-0510,1520 & 1015) Showing; Plant Material, Activated Carbon, Seashell – (carbonate), Groundmass Mineral Matter and Other Coarse Mineral Matter. Reflected Polarized Light In Air, X600.

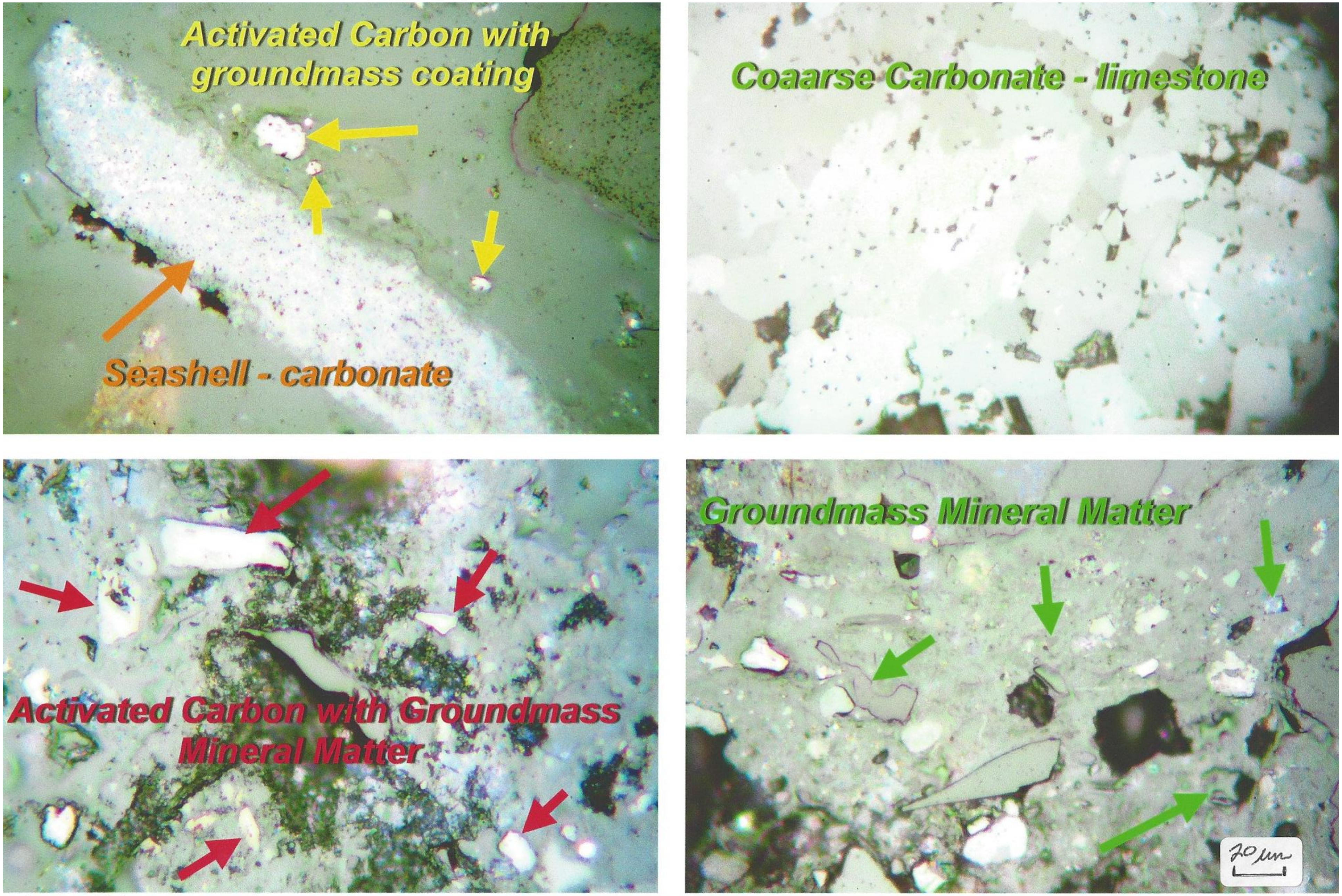

Figure 12.) Photomicrographs of Koppers Samples 2020-0695 thru 2020-0700 from Geosyntec (Sediment 2-1520, 0005 & 1015, 3-0510,1520 & 1015) Showing; Seashell - carbonate, Activated Carbon with Groundmass MM, Coarse Carbonate (limestone) and Groundmass Mineral Matter. Reflected Polarized Light In Air, X600.

Daniel P. Gray
Senior Research Scientist

August 5, 2020

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Mr. Jason Conder
2100 Main Street, Suite 150
Huntington Beach, California 92648

Dear Jason,

On June 11, 2020, twenty six sediment samples from EcoAnalysts were submitted by Michelle Knowlen for petrographic analysis. In the current report which include four from group T82-4 and three from T82-5 will be analyzed. The samples are described and identified as follows:

KOPPERS No.	*DESCRIPTION*
2020-0701	EcoAnalysts – T82-4-MM-BC-1520
2020-0702	EcoAnalysts – T82-4-MM-BC-1015
2020-0703	EcoAnalysts – T82-4-MM-BC-0005
2020-0704	EcoAnalysts – T82-4-MM-BC-0510
2020-0705	EcoAnalysts – T82-5-MM-BC-1520
2020-0706	EcoAnalysts – T82-5-MM-BC-1015
2020-0707	EcoAnalysts – T82-5-MM-BC-0510

Each of the seven sediment samples were received in a ~30ml glass vail and all were relatively wet. The contents from each sample were removed from their container and placed on a glass plate and dried in an oven at 80̊C for 2 hours. The dried samples were photographed to illustrate the characteristics of the as-received materials prior to petrographic preparation, as shown in Figures 1 through 7. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve and the other 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1 ¼ inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 250X and 600X in air to illustrate most of the materials listed in the compositional analysis (Table 1), as shown in Figures 8 through 13. The composition analysis consists of 1000 points counted for each sample at 600X in air, as listed in Table 1.

Geosyntec T82-4-MM-BC-1520 - Koppers (2020-0701)

The Geosyntec sample T82-4-MM-BC-1520 has 34.4% of total coarse mineral matter which consists mostly of carbonates at 27.6% and Quartz like transparent minerals at 3.5% with 3.3% of other coarse mineral matter. Some of the carbonates are rocks that appear to be similar to dolomite or limestone and some of the carbonates are seashells (calcium carbonate), as shown in the bottom right photo in Figure 8. There is 65.3% of total groundmass material which is the highest amount in the current group of samples and consists of 26.2% fine and intermediate sized mineral matter, with 4.9% partially soluble mineral matter, 34.0% of plant material and 0.2% of metallics/pyrite. There is 0.3% of total carbon which consists of 0.1% of coal based activated carbon, with 0.1% of cenospheres and 0.1% of sooty combustion residue. The majority of the activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks, as shown in Figures 10, 11 and 13.

Geosyntec T82-4-MM-BC-1015 - Koppers (2020-0702)

The Geosyntec sample T82-4-MM-BC-1015 has 43.5% of total coarse mineral matter which consists mostly of carbonates & seashell at 37.7%, with 2.9% Quartz or clear transparent minerals and 2.9% of other coarse minerals or rocks, as listed in Table 1. There is 56.1% of total groundmass mineral matter which is the second highest amount in the current group of samples and consists of 25.0% fine and intermediate sized mineral matter, with 6.2% partially soluble mineral matter, 24.8% of plant material and 0.1% of metallics/pyrite. There is only 0.4% of total carbon which consists of 0.2% sooty carbon and 0.2% of cenospheres.

Geosyntec T82-4-MM-BC-0005 - Koppers (2020-0703)

The Geosyntec sample T82-4-MM-BC-0005 has 71.0% of total coarse mineral matter which consists mostly of carbonates & seashells at 61.1%, with 2.9% of Quartz-like or clear transparent minerals and 7.0% of other coarse minerals or rocks, as listed in Table 1. There is 27.6% of total groundmass material which consists mostly of plant material at 14.4%, with 10.7% fine and intermediate sized mineral matter, 2.3% partially soluble mineral matter and 0.2% of metallics & pyrite. The soluble mineral matter appears as black angular voids in the polished petrographic specimens with some crystal condensation at the edges, as shown in Figures 10, 11 and 13. There is 1.4% of total carbon which consists mostly (1.3%) of coal based activated carbon which range from very small to intermediate in size and a very small amount (0.1%) sooty carbon from combustion.

Geosyntec T82-4-MM-BC-0510 - Koppers (2020-0704)

The Geosyntec sample T82-4-MM-BC-0510 has 65.3% of total coarse mineral matter which consists mostly of carbonates & seashell at 54.0%, with 3.6% of Quartz-like or clear transparent minerals and 7.7% of other coarse minerals or rocks, as listed in Table 1. There is 31.8% of total groundmass mineral matter which consists of 11.0% fine and intermediate sized mineral matter, with 3.4% partially soluble mineral matter and 17.4% of plant material. There is 2.9% of total carbon which consists of 2.6% coal based activated carbon and 0.3% of sooty or pyrolytic carbon which are incorporated in the fine grain groundmass mineral matter. The sooty and pyrolytic carbon is very small in size, typically less than 3 microns, and are products of hydrocarbon combustion both natural and manmade.

Geosyntec T82-5-MM-BC-1520 - Koppers (2020-0705)

The Geosyntec sample T82-5-MM-BC-1520 has 69.0% of total coarse mineral matter which consists of 41.9% of carbonates & seashell, with 20.1% of other coarse mineral matter and 7.0% of Quartz-like or clear transparent minerals, as listed in Table 2 and shown in Figure 8. There is 30.7% of total groundmass mineral matter which consists of 13.4% fine and intermediate sized mineral matter, with 14.2% of plant material, 1.6% partially soluble mineral matter and 1.5% of metallics/pyrite. There is 0.3% of total carbon which consists of 0.1% of coal based activated carbon, with 0.1% of sooty carbon and a 0.1% of cenospheres. The activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks.

Geosyntec T82-5-MM-BC-1015 - Koppers (2020-0706)

The Geosyntec sample T82-5-MM-BC-1015 has 64.3% of total coarse mineral matter which consists of carbonates & seashell at 26.6%, with 10.4% Quartz or clear transparent minerals and 26.8% of other coarse minerals or rocks, as listed in Table 2. There is 34.1% of total groundmass mineral matter which consists of 16.9% fine and intermediate sized mineral matter, with 2.1% partially soluble mineral matter, 14.2% of plant material and 0.9% of metallics/pyrite. There is 1.6% of total carbon which consists entirely of coal based activated carbon. The coal based activated carbon is very small in size and incorporated in the fine sized groundmass matrix.

Geosyntec T82-5-MM-BC-0510 - Koppers (2020-0707)

The Geosyntec sample T82-5-MM-BC-0510 has 58.9% of total coarse mineral matter which consists of carbonates & seashell at 37.4%, with 10.4% Quartz or clear transparent minerals and 11.1% of other coarse minerals or rocks, as listed in Table 2. There is 39.7% of total groundmass mineral matter which consists of 20.3% fine and intermediate sized mineral matter, with 1.6% partially soluble mineral matter, 17.3% of plant material and 0.5% of metallics/pyrite. There is 1.4% of total carbon which consists mostly (1.3%) of coal based activated carbon and a very small amount (0.1%) of cenospheres. The coal based activated carbon is very small in size and incorporated in the fine sized groundmass matrix.

Please call me at (412) 826-3994 or e-mail at graydp@koppers.com if you have questions or wish to discuss this work.

Sincerely,

Daniel P. Gray

Table 1

Petrographic Analysis of Four Koppers Samples 2020-0701 thru 2020-0704 of Sediment Samples from Geosyntec (T82 – 4 -1520, 1015, 0005 & 0510)

Description	Geosyntec T82-4-MM-BC-1520	Geosyntec T82-4-MM-BC-1015	Geosyntec T82-4-MM-BC-0005	Geosyntec T82-4-MM-BC-0510
Koppers #	2020-0701	2020-0702	2020-0703	2020-0704
Coarse MM:				
Carbonates and Seashells	**27.6**	**37.7**	**61.1**	**54.0**
Quartz & Clear MM	**3.5**	**2.9**	**2.9**	**3.6**
Other – Coarse MM	**3.3**	**2.9**	**7.0**	**7.7**
Total Coarse MM	**34.4**	**43.5**	**71.0**	**65.3**
Groundmass :				
Fine & Intermediate MM	**26.2**	**25.0**	**10.7**	**11.0**
Partially Soluble MM	**4.9**	**6.2**	**2.3**	**3.4**
Plant Material - Organic	**34.0**	**24.8**	**14.4**	**17.4**
Metallics & Pyrite	**0.2**	**0.1**	**0.2**	**---**
Total Groundmass	**65.3**	**56.1**	**27.6**	**31.8**
Carbon				
Activated Carbon	**0.1**	**---**	**1.3**	**2.6**
Soot & Pyrolytic	**0.1**	**0.2**	**0.1**	**0.3**
Graphite	**---**	**---**	**---**	**--**
Other Carbon - cenosphere	**0.1**	**0.2**	**---**	**---**
Total Carbon	**0.3**	**0.4**	**1.4**	**2.9**
Total	**100.0**	**100.0**	**100.0**	**100.0**

Table 2

Petrographic Analysis of Three Koppers Samples 2020-0705 thru 2020-0707 of Sediment Samples from Geosyntec (T82 – 5 -1520, 1015 & 0510)

Description	Geosyntec T82-5-MM-BC-1520	Geosyntec T82-5-MM-BC-1015	Geosyntec T82-5-MM-BC-0510
Koppers #	2020-0705	2020-0706	2020-0707
Coarse MM:			
Carbonates and Seashells	41.9	26.6	37.4
Quartz & Clear MM	7.0	10.9	10.4
Other – Coarse MM	20.1	26.8	11.1
Total Coarse MM	69.0	64.3	58.9
Groundmass :			
Fine & Intermediate MM	13.4	16.9	20.3
Partially Soluble MM	1.6	2.1	1.6
Plant Material - Organic	14.2	14.2	17.3
Metallics & Pyrite	1.5	0.9	0.5
Total Groundmass	30.7	34.1	39.7
Carbon			
Activated Carbon	0.1	1.6	1.3
Soot & Pyrolytic	0.1	---	---
Graphite	---	---	---
Other Carbon - cenosphere	0.1	---	0.1
Total Carbon	0.3	1.6	1.4
Total	100.0	100.0	100.0

Figure 1. *Geosyntec: T82-4-MM-BC-1520 (Koppers 20-0701)*

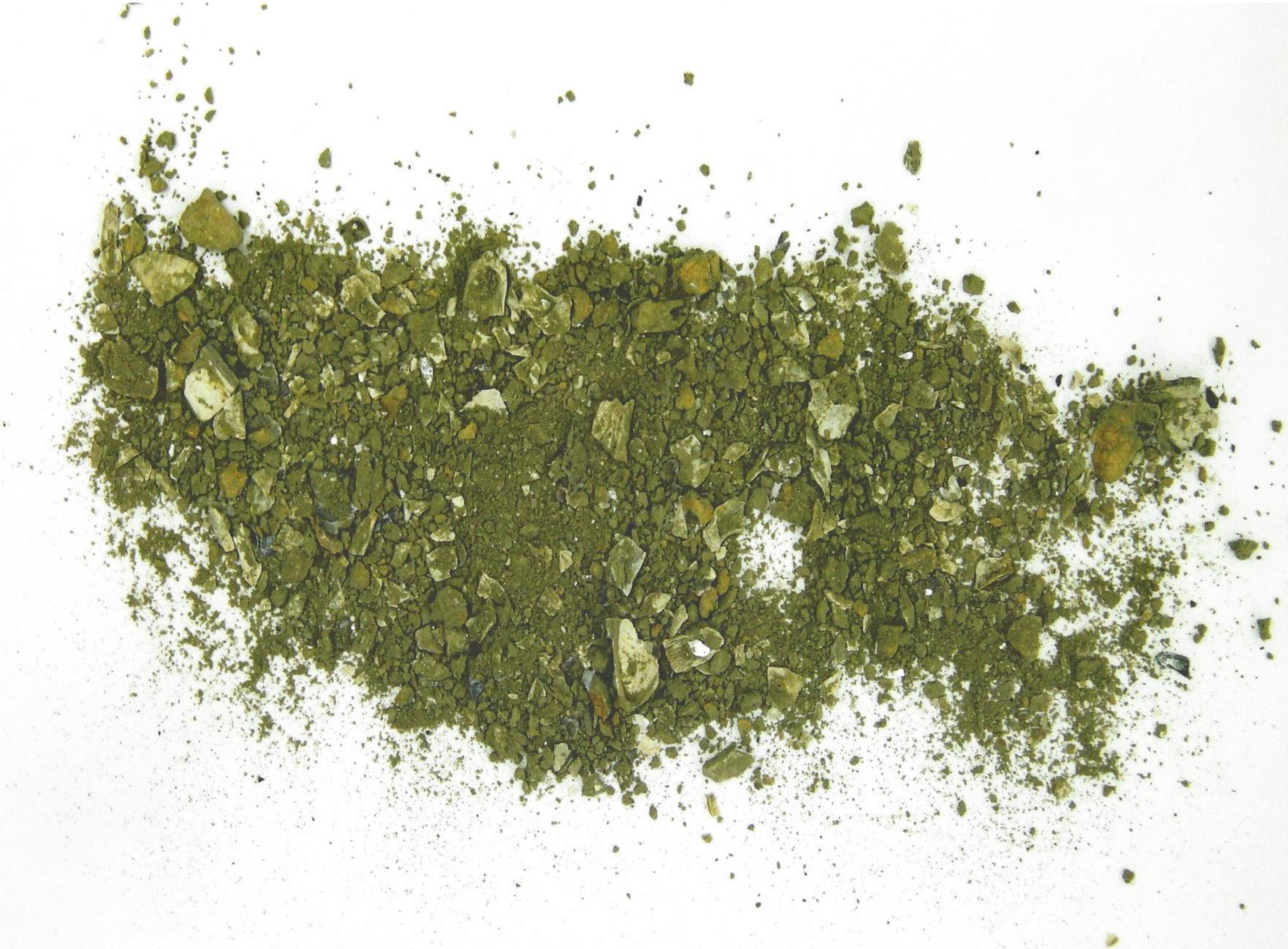

Figure 2. Geosyntec: T82-4-MM-BC-1015 (Koppers 20-0702)

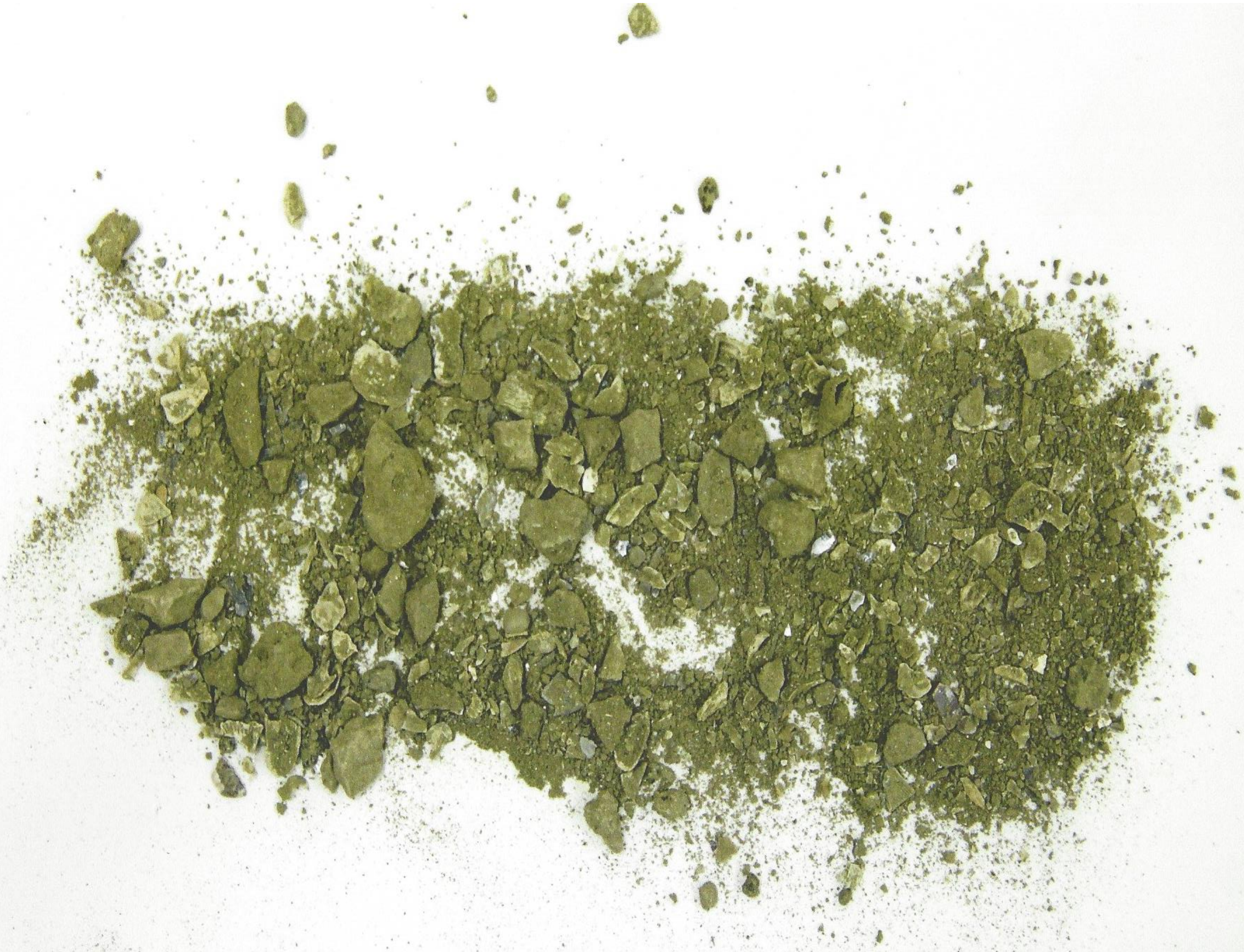

Figure 3. Geosyntec: T82-4-MM-BC-0005 (Koppers 20-0703)

Figure 4. Geosyntec: T82-4-MM-BC-0510 (Koppers 20-0704)

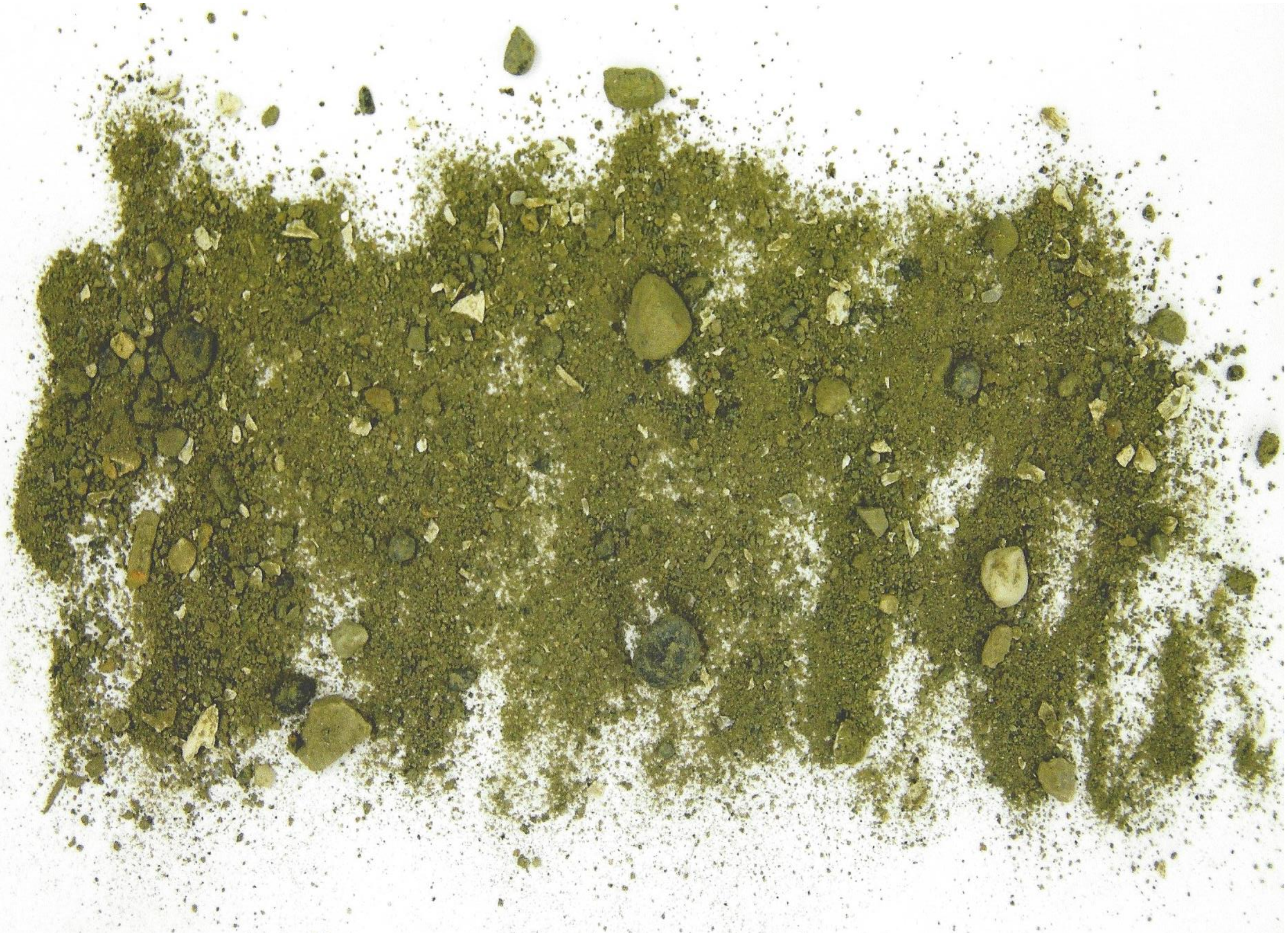

Figure 5. Geosyntec: T82-5-MM-BC-1520 (Koppers 20-0705)

Figure 6. Geosyntec: T82-5-MM-BC-1015 (Koppers 20-0706)

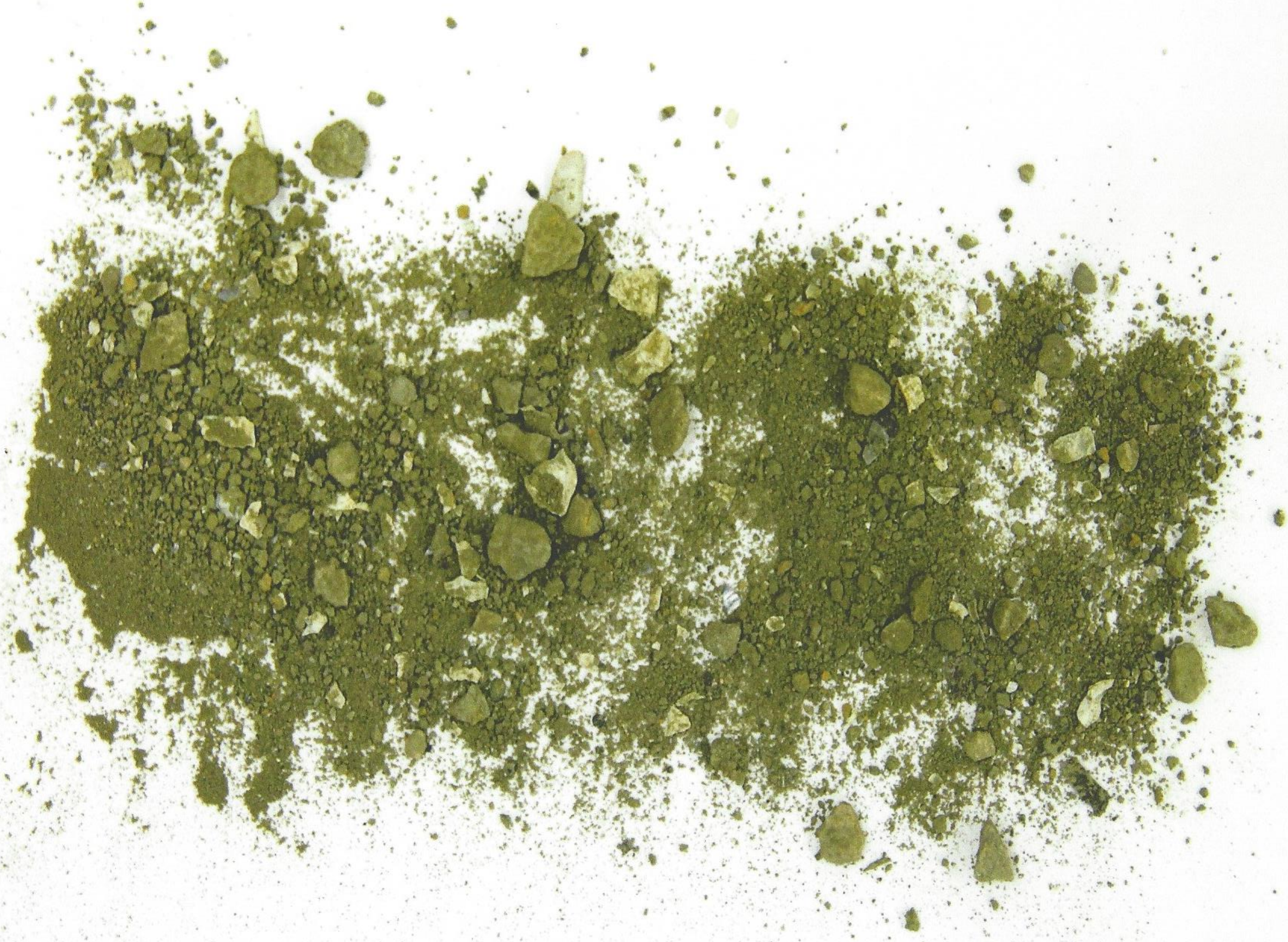

Figure 7. Geosyntec: T82-5-MM-BC-0510 (Koppers 20-0707)

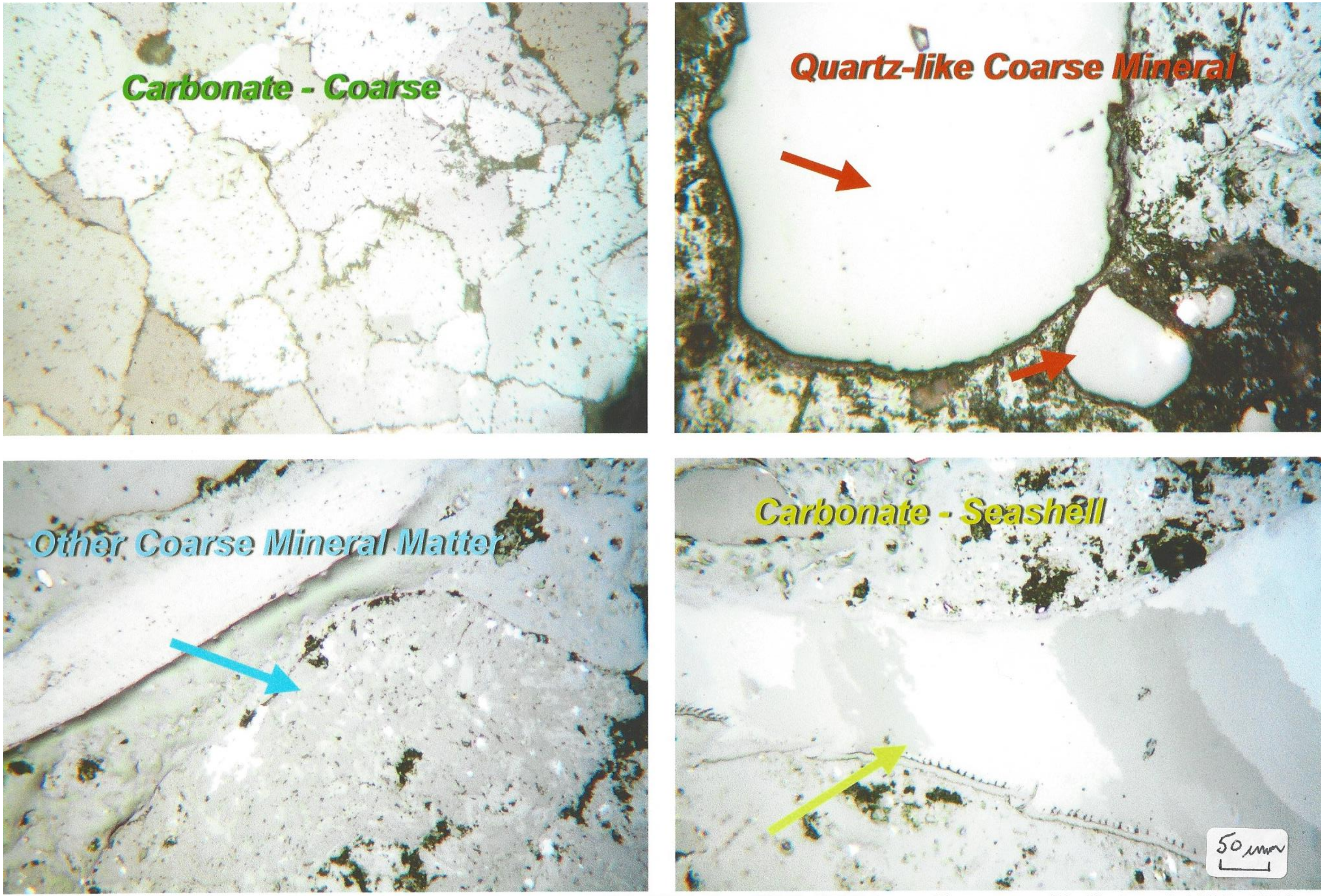

Figure 8: Photomicrographs of Koppers Samples 2020-0701 thru 2020-0707 from Geosyntec (Sediment 4-1520, 0510, 0005 & 1015, 5-0510, 1520 & 1015) Showing; Sea Shell (carbonate), Coarse Carbonate (limestone), Quartz Like Coarse Mineral and Other Coarse Mineral Matter (rock). Reflected Polarized Light In Air, X250.

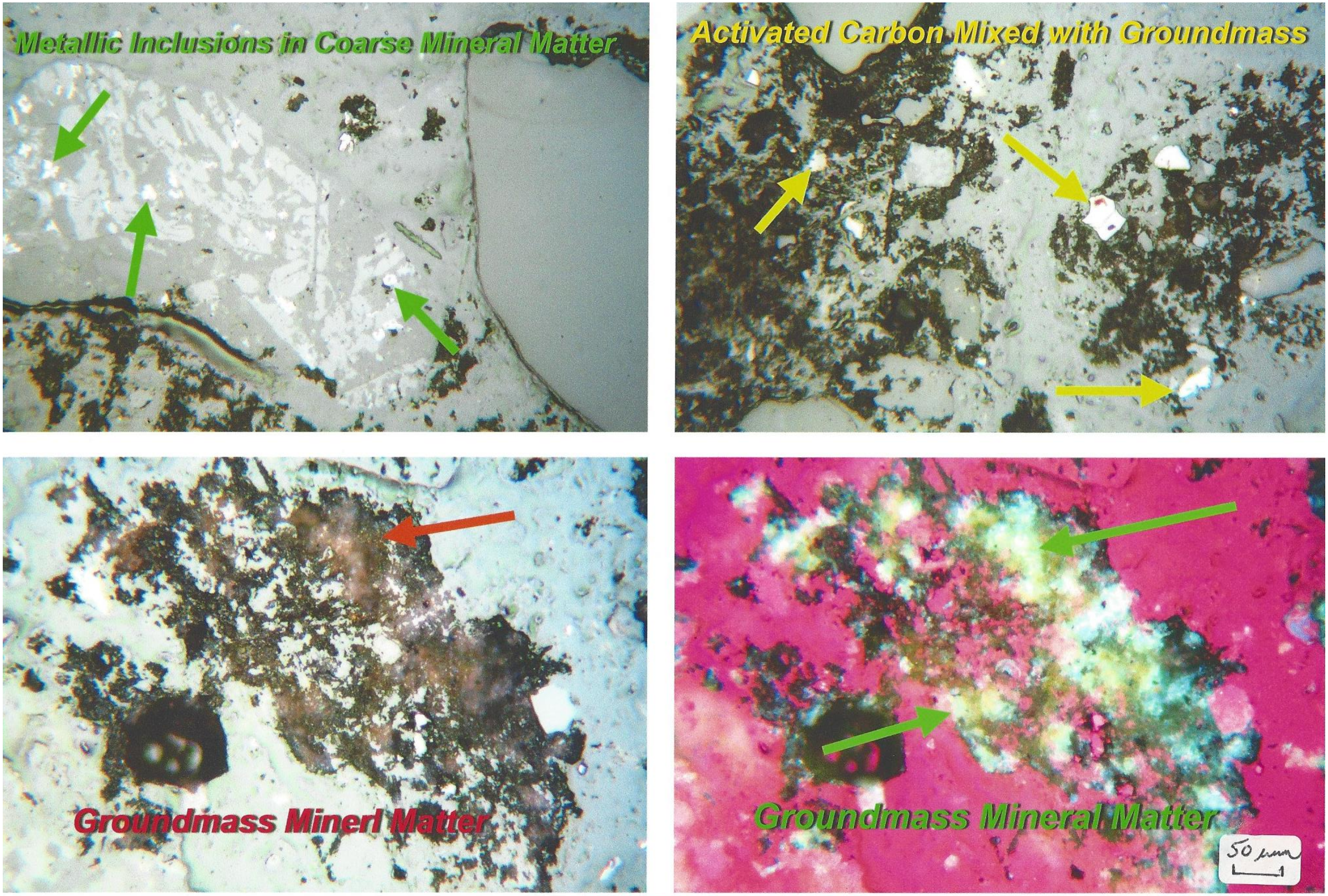

Figure 9: Photomicrographs of Koppers Samples 2020-0701 thru 2020-0707 from Geosyntec (Sediment 4-1520, 0510, 0005 & 1015, 5-0510, 1520 & 1015) Showing; Metallic Inclusions in Coarse MM, Activated Carbon Mixed with Groundmass MM, Other Coarse MM and SeaShell (carbonate). Reflected Light In Air, X250.

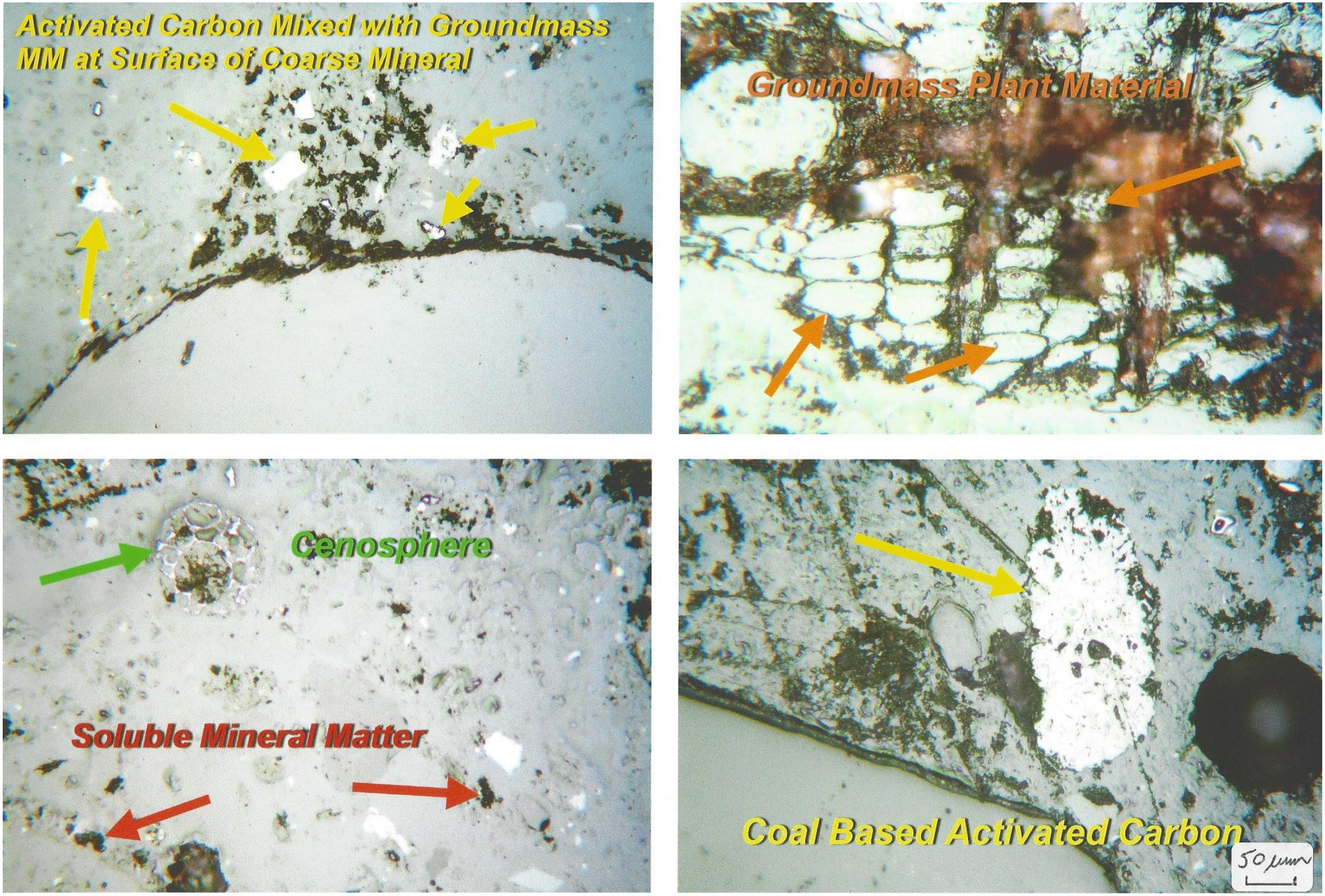

Figure 10: Photomicrographs of Koppers Samples 2020-0701 thru 2020-0707 from Geosyntec (Sediment 4-1520, 0510, 0005 & 1015, 5-0510, 1520 & 1015) Showing; Activated Carbon at Surface of Coarse MM, Plant Derived Groundmass, Cenosphere, Soluble MM and Coal Based Activated Carbon. Reflected Light In Air, X250.

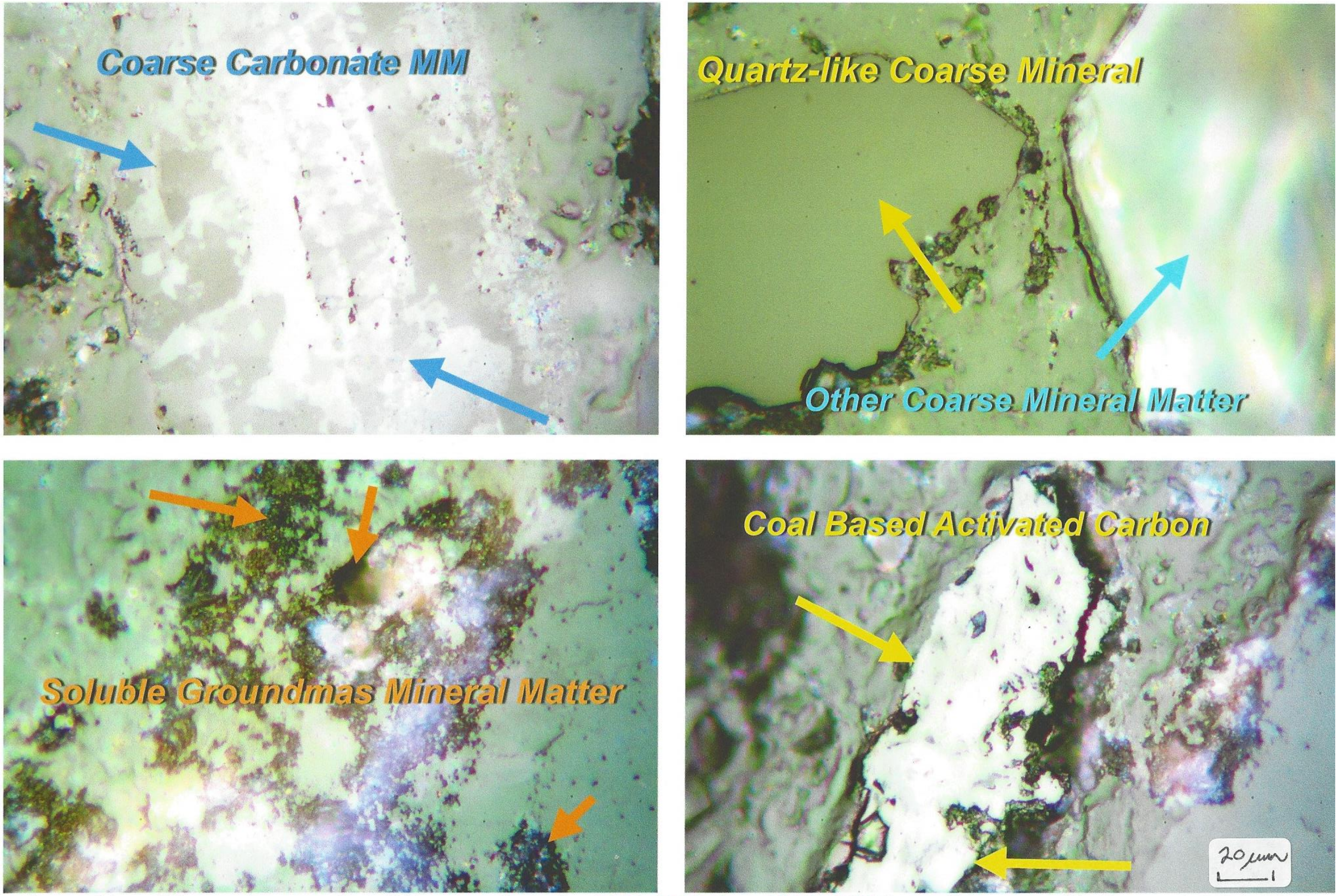

Figure 11: Photomicrographs of Koppers Samples 2020-0701 thru 2020-0707 from Geosyntec (Sediment 4-1520, 0510, 0005 & 1015, 5-0510, 1520 & 1015) Showing; Coarse Carbonate MM, Quartz-like Coarse Mineral, Other Coarse MM, Soluble Groundmass MM and Coal Based Activated Carbon. Reflected Light In Air, X600.

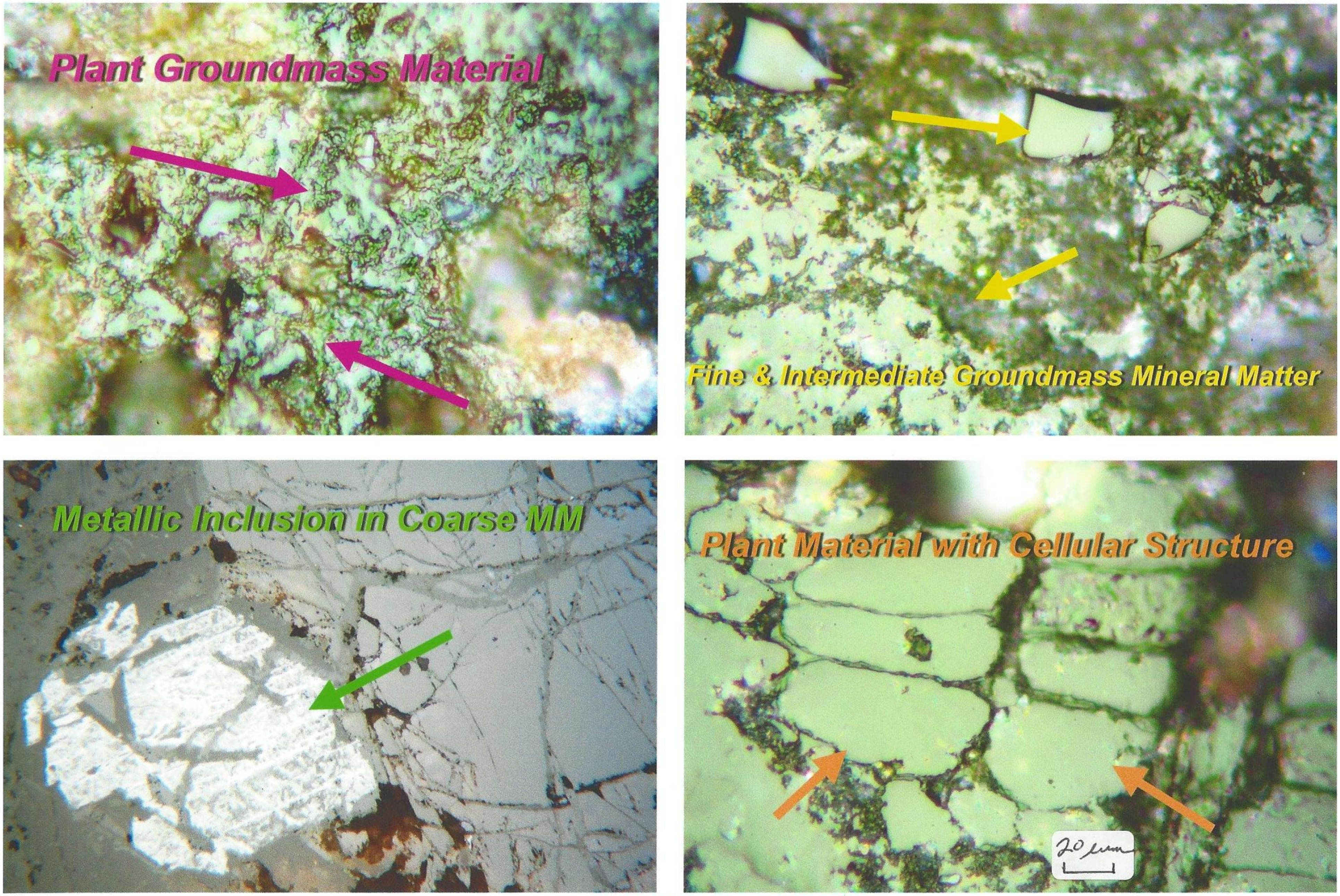

Figure 12: Photomicrographs of Koppers Samples 2020-0701 thru 2020-0707 from Geosyntec (Sediment 4-1520, 0510, 0005 & 1015, 5-0510, 1520 & 1015) Showing; Plant Groundmass MM, Fine & Intermediate Groundmass MM, Metallic inclusion and Plant Material with Cellular Structure. Reflected Light In Air, X600.

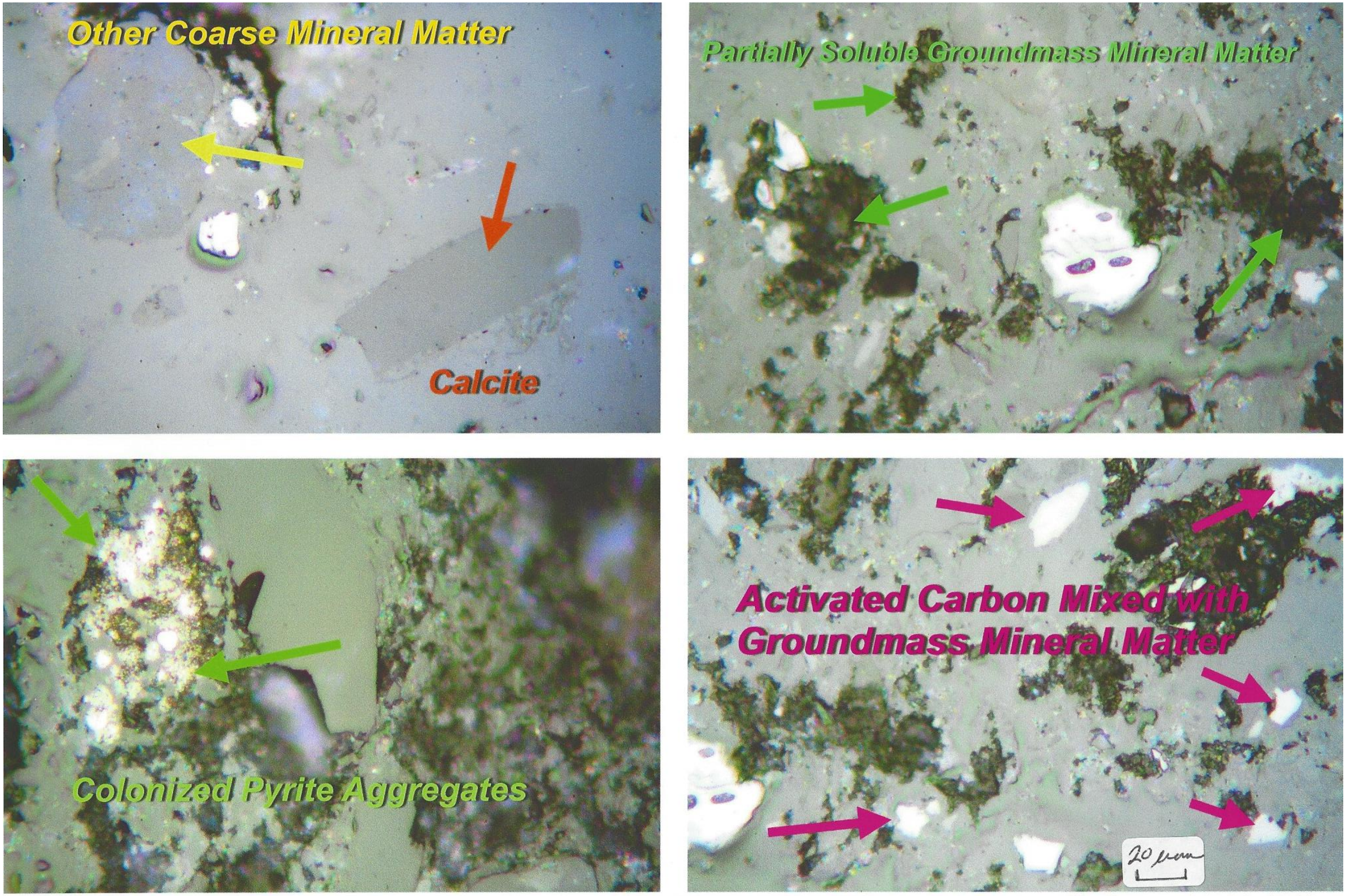

Figure 13: Photomicrographs of Koppers Samples 2020-0701 thru 2020-0707 from Geosyntec (Sediment 4-1520, 0510, 0005 & 1015, 5-0510, 1520 & 1015) Showing; Calcite, Other Coarse MM, Partially Soluble MM, Pyrite Aggregate and Activated Carbon Mixed with Groundmass Mineral Matter. Reflected Light In Air, X600.

Daniel P. Gray
Senior Research Scientist

August 21, 2020

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Mr. Jason Conder
2100 Main Street, Suite 150
Huntington Beach, California 92648

Dear Jason,

On June 11, 2020, twenty six sediment samples from EcoAnalysts were submitted by Michelle Knowlen for petrographic analysis. In the current report which include three from group T82-6 and three from T82-7 will be analyzed. The samples are described and identified as follows:

KOPPERS No.	*DESCRIPTION*
2020-0708	EcoAnalysts – T82-6-MM-BC-1520
2020-0709	EcoAnalysts – T82-6-MM-BC-0510
2020-0710	EcoAnalysts – T82-6-MM-BC-0005
2020-0711	EcoAnalysts – T82-7-MM-BC-1520
2020-0712	EcoAnalysts – T82-7-MM-BC-0005
2020-0713	EcoAnalysts – T82-7-MM-BC-0510

Each of the six sediment samples were received in a ~30ml glass vail and all were relatively wet. The contents from each sample were removed from their container and placed on a glass plate and dried in an oven at 80°C for 2 hour. The dried samples were photographed to illustrate the characteristics of the as-received materials prior to petrographic preparation, as shown in Figures 1 through 6. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve and the other 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1 ¼ inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 250X and 600X in air to illustrate most of the materials listed in the compositional analysis (Table 1), as shown in Figures 7 through 12. The composition analysis consists of 1000 points counted for each sample at 600X in air, as listed in Table 1.

Geosyntec T82-6-MM-BC-1520 - Koppers (2020-0708)

The Geosyntec sample T82-6-MM-BC-1520 has 60.7% of total coarse mineral matter which consists of 22.2% carbonates, with 25.9% other coarse mineral matter (rocks) and 12.6% and Quartz like transparent minerals. Some of the carbonates are rocks that appear to be similar to dolomite or limestone and some of the carbonates are seashells (calcium carbonate), as shown in the bottom right photo in Figure 8. There is 38.4% of total groundmass material which consists of 21.9% fine and intermediate sized mineral matter, with 2.9% partially soluble mineral matter, 13.0% of plant material and 0.6% of metallics/pyrite. There is 0.9 of total carbon which consists of 0.8% of coal based activated carbon and 0.1% of cenospheres. The majority of the activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks, as shown in Figures 9 thru 12.

Geosyntec T82-6-MM-BC-0510 - Koppers (2020-0709)

The Geosyntec sample T82-6-MM-BC-0510 has 65.7% of total coarse mineral matter which consists mostly of carbonates & seashell at 51.1%, with 5.3% Quartz or clear transparent minerals and 9.3% of other coarse minerals or rocks, as listed in Table 1. There is 32.6% of total groundmass mineral matter which consists of 15.8% fine and intermediate sized mineral matter, with 4.4% partially soluble mineral matter, 12.2% of plant material and 0.2% of metallics/pyrite. There is 1.7% of total carbon which consists mostly of coal based activated carbon and only 0.1% sooty carbon.

Geosyntec T82-6-MM-BC-0005 - Koppers (2020-0710)

The Geosyntec sample T82-6-MM-BC-0005 has 57.9% of total coarse mineral matter which consists mostly of carbonates & seashells at 45.4%, with 6.1% of Quartz-like or clear transparent minerals and 6.4% of other coarse minerals or rocks, as listed in Table 1. There is 40.4% of total groundmass material which consists of 17.1% fine and intermediate sized mineral matter, with 17.4% of plant material, 5.8% partially soluble mineral matter and 0.1% of metallics & pyrite. The soluble mineral matter appears as black angular voids in the polished petrographic specimens with some crystal condensation at the edges, as shown in Figure 11. There is 1.7% of total carbon which consists entirely of coal based activated carbon and range from very small to intermediate in size.

Geosyntec T82-7-MM-BC-1520 - Koppers (2020-0711)

The Geosyntec sample T82-7-MM-BC-1520 has 68.7% of total coarse mineral matter which consists mostly of other (rock) coarse mineral matter at 38.9%, with 17.1% of carbonates and 12.7% of Quartz-like or clear transparent minerals, as listed in Table 1. There is 31.1% of total groundmass mineral matter which consists mostly of fine and intermediate sized mineral matter at 19.4%, with 1.2% partially soluble mineral matter, 4.6% of plant material and 5.9% of metallic/pyrite. There is only 0.2% of total carbon which consists of coal based activated carbon.

Geosyntec T82-7-MM-BC-0005 - Koppers (2020-0712)

The Geosyntec sample T82-7-MM-BC-0005 has 53.7% of total coarse mineral matter which consists of 15.9% of carbonates & seashell, with 23.5% of other coarse mineral matter and 14.3% of Quartz-like or clear transparent minerals, as listed in Table 1 and shown in Figures 7 and 11. There is 44.8% of total groundmass mineral matter which consists of 21.9% fine and intermediate sized mineral matter, with 18.8% of plant material, 3.4% partially soluble mineral matter and 0.7% of metallics/pyrite. There is 1.5% of total carbon which consists of 1.3% of coal based activated carbon and 0.2% of coke and charcoal. The activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks.

Geosyntec T82-7-MM-BC-0510 - Koppers (2020-0713)

The Geosyntec sample T82-7-MM-BC-0510 has 82.7% of total coarse mineral matter which is highest amount in the current group and consists of 50.4% carbonates & seashell, with 12.2% of Quartz or clear transparent minerals and 20.1% of other coarse minerals or rocks, as listed in Table 1. There is 15.2% of total groundmass mineral matter which is lowest amount in the current group and consists of 11.3% fine and intermediate sized mineral matter, with 0.4% partially soluble mineral matter, 3.0% of plant material and 0.5% of metallics/pyrite. There is 2.1% of total carbon which is the highest amount in the current group and consists of 2.0% coal based activated carbon and 0.1% sooty carbon. As noted in earlier samples, the coal based activated carbon is very small in size and incorporated in the fine sized groundmass matrix.

Please call me at (412) 826-3994 or e-mail at graydp@koppers.com if you have questions or wish to discuss this work.

Sincerely,

Daniel P. Gray

Table 1

Petrographic Analysis of Six Koppers Samples 2020-0708 thru 2020-0713 of Sediment Samples from Geosyntec
(T82 – 6 -1520, 0510 & 0005,   T82 – 7 – 1520, 0005 & 0510)

Description	Geosyntec T82-6-MM-BC-1520	Geosyntec T82-6-MM-BC-0510	Geosyntec T82-6-MM-BC-0005	Geosyntec T82-7-MM-BC-1520	Geosyntec T82-7-MM-BC-0005	Geosyntec T82-7-MM-BC-0510
Koppers #	2020-0708	2020-0709	2020-0710	2020-0711	2020-0712	2020-0713
Coarse MM:						
Carbonates and Seashells	22.2	51.1	45.4	17.1	15.9	50.4
Quartz & Clear MM	12.6	5.3	6.1	12.7	14.3	12.2
Other – Coarse MM	25.9	9.3	6.4	38.9	23.5	20.1
Total Coarse MM	60.7	65.7	57.9	68.7	53.7	82.7
Groundmass :						
Fine & Intermediate MM	21.9	15.8	17.1	19.4	21.9	11.3
Partially Soluble MM	2.9	4.4	5.8	1.2	3.4	0.4
Plant Material - Organic	13.0	12.2	17.4	4.6	18.8	3.0
Metallics & Pyrite	0.6	0.2	0.1	5.9	0.7	0.5
Total Groundmass	38.4	32.6	40.4	31.1	44.8	15.2
Carbon						
Activated Carbon	0.8	1.6	1.7	0.2	1.3	2.0
Soot & Pyrolytic	---	0.1	---	---	---	0.1
Graphite	---	---	---	---	---	---
Other Carbon - cenosphere	0.1	---	---	---	0.2	---
Total Carbon	0.9	1.7	1.7	0.2	1.5	2.1
Total	100.0	100.0	100.0	100.0	100.0	100.0

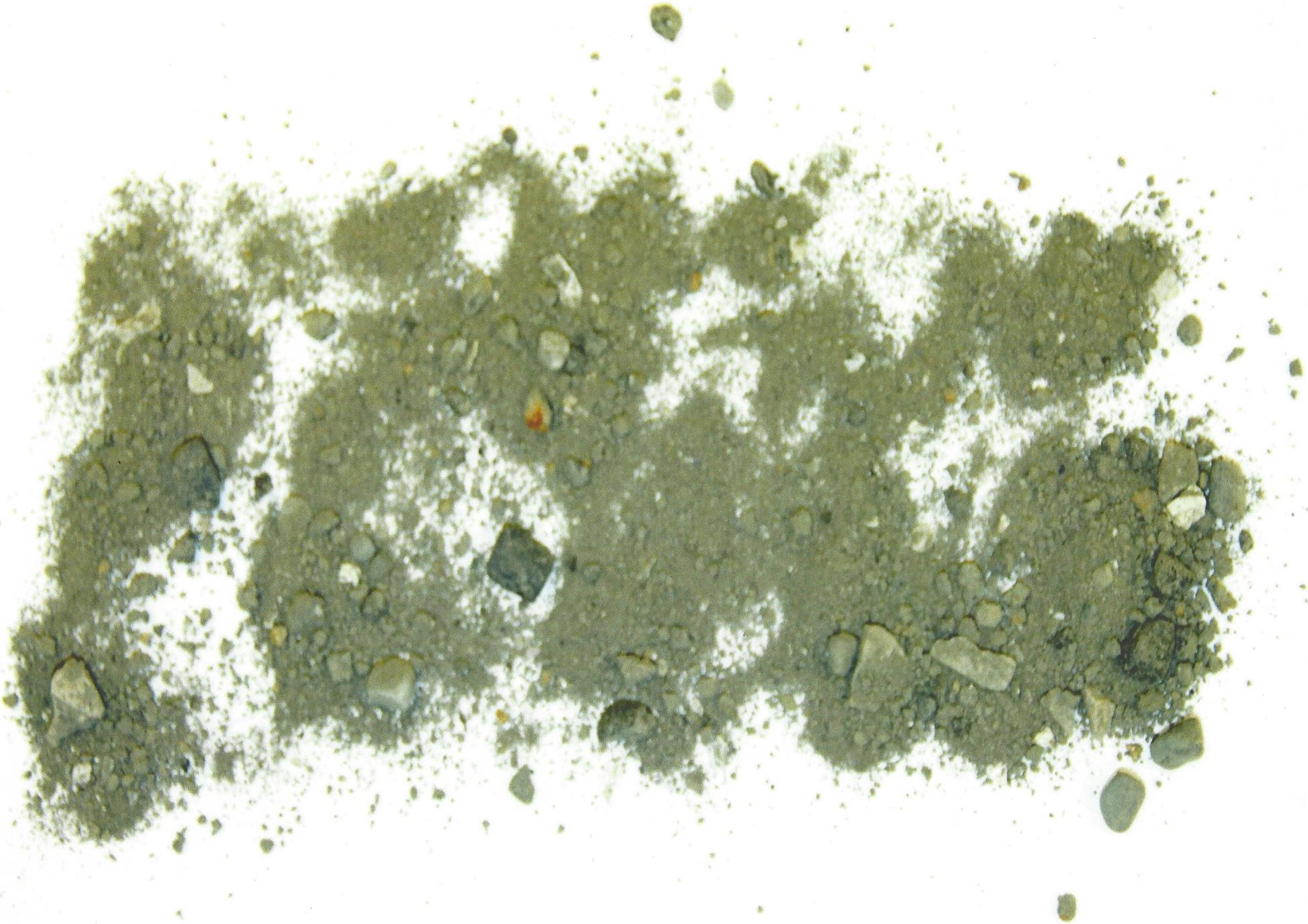


Figure 1.)	*Geosyntec: T82-6-MM-BC-1520 (Koppers 20-0708)*

Figure 2.) Geosyntec: T82-6-MM-BC-0510 (Koppers 20-0709)

Figure 3.)	Geosyntec: T82-6-MM-BC-0005 (Koppers 20-0710)

Figure 4.) Geosyntec: T82-7-MM-BC-1520 (Koppers 20-0711)

Figure 5.) Geosyntec: T82-7-MM-BC-0005 (Koppers 20-0712)

Figure 6.) Geosyntec: T82-7-MM-BC-0510 (Koppers 20-0713)

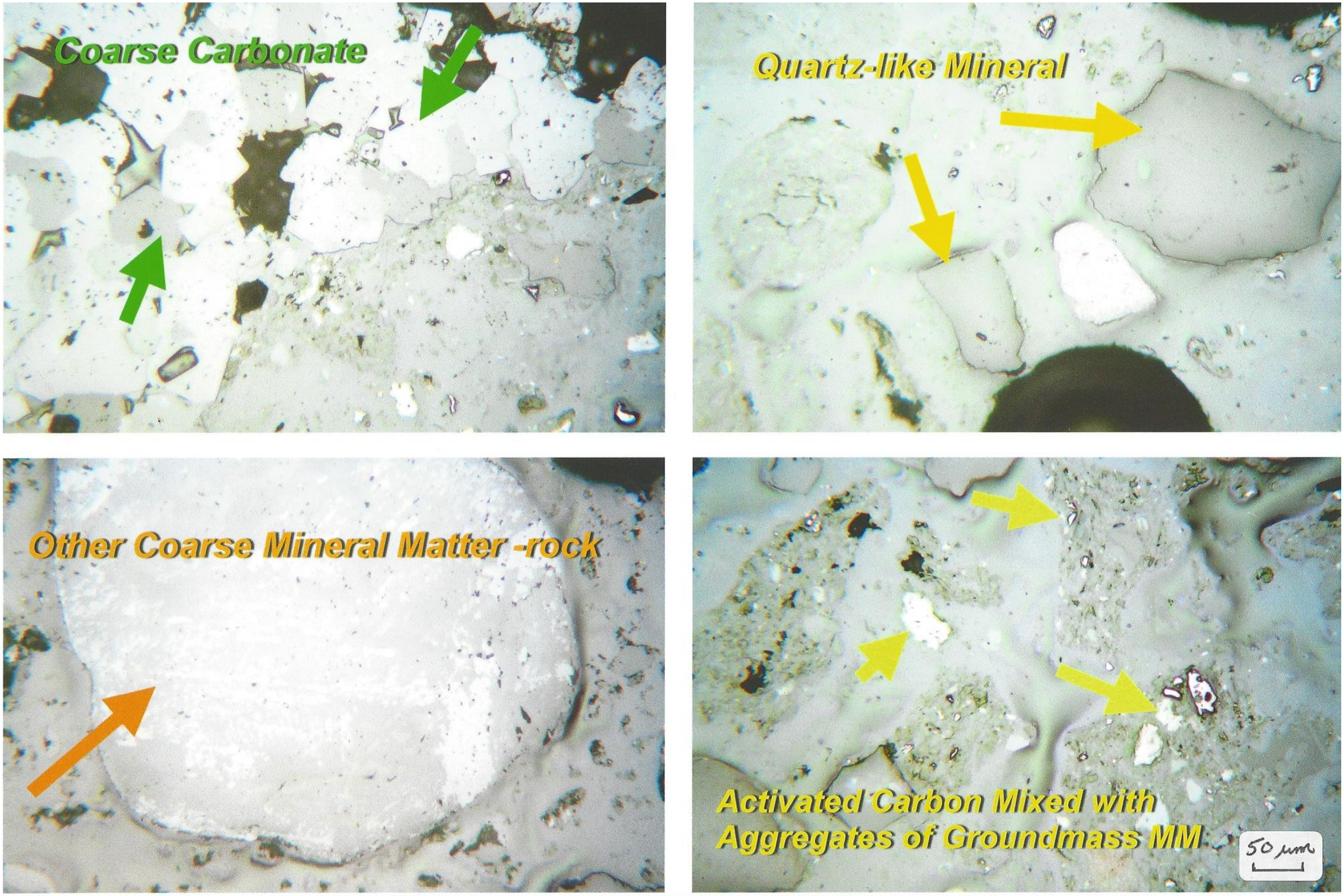


Figure 7: Photomicrographs of Koppers Samples 2020-0708 thru 2020-0713 from Geosyntec (Sediment 6-1520, 0510 & 0005, 7-1520, 0005 & 0510) Showing; Coarse Carbonate (limestone), Quartz Like Coarse Mineral Matter, Other Coarse Mineral Matter (rock) and Activated Carbon. Reflected Light In Air, X250.

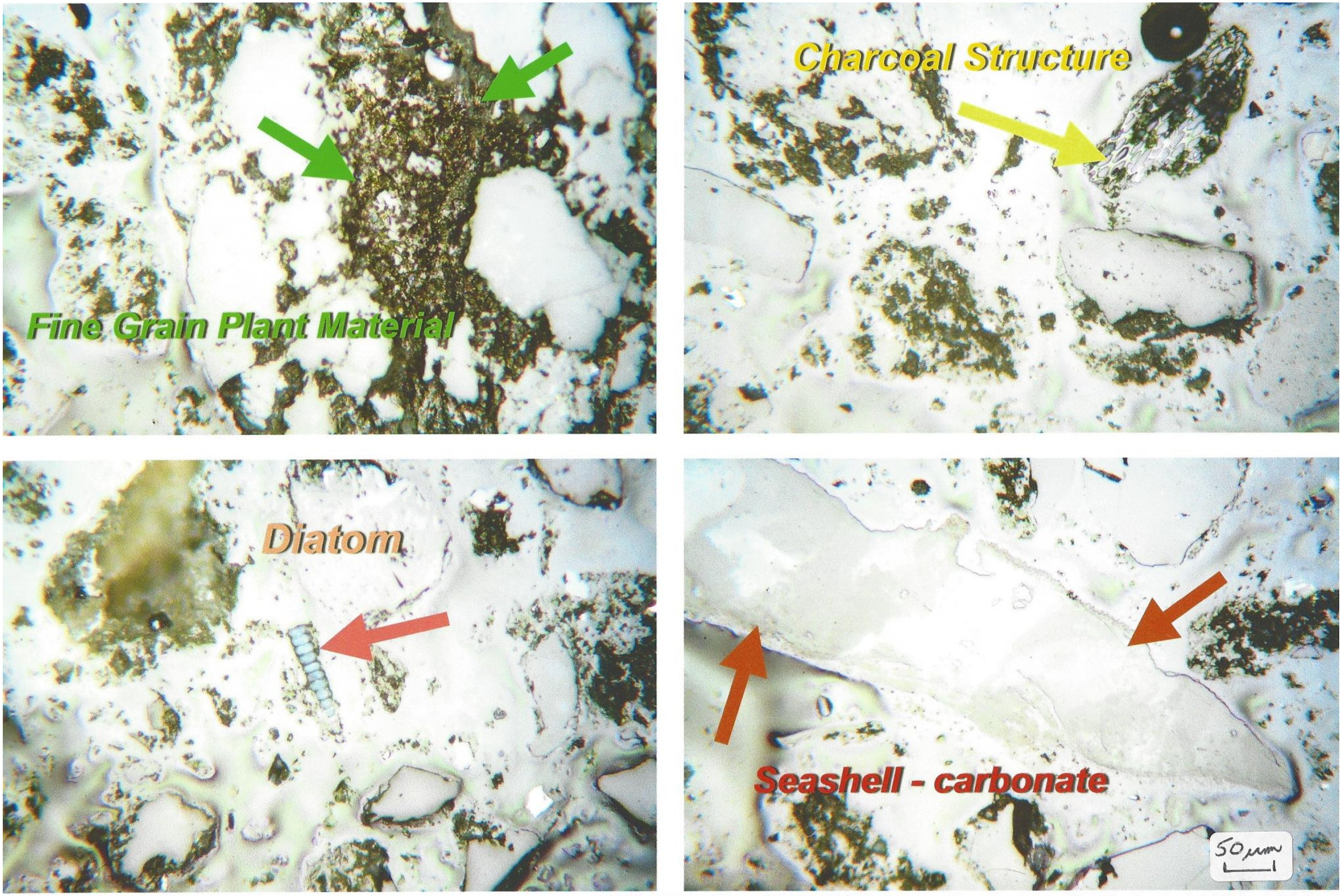


Figure 8: Photomicrographs of Koppers Samples 2020-0708 thru 2020-0713 from Geosyntec (Sediment 6-1520, 0510 & 0005, 7-1520, 0005 & 0510) Showing; Fine Grain Plant Material, Charcoal Structure, Diatom and Seashell – Carbonate. Reflected Polarized Light In Air, X250.

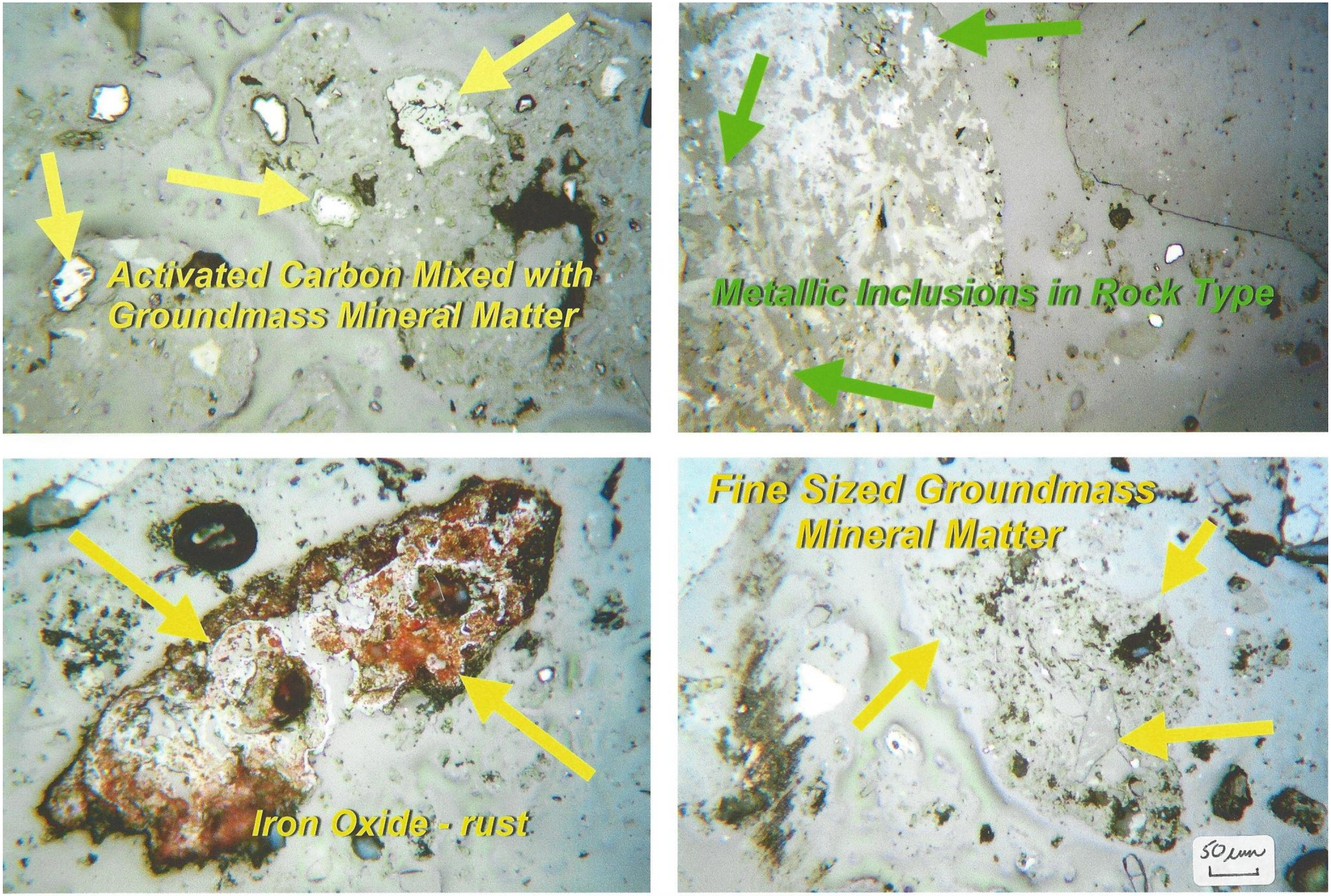


Figure 9: Photomicrographs of Koppers Samples 2020-0708 thru 2020-0713 from Geosyntec (Sediment 6-1520, 0510 & 0005, 7-1520, 0005 & 0510) Showing; Activated Carbon Mixed with Groundmass MM, Metallic Inclusions in Rock Type, Iron Oxide and Fine Grain Groundmass MM. Reflected Light In Air, X250.

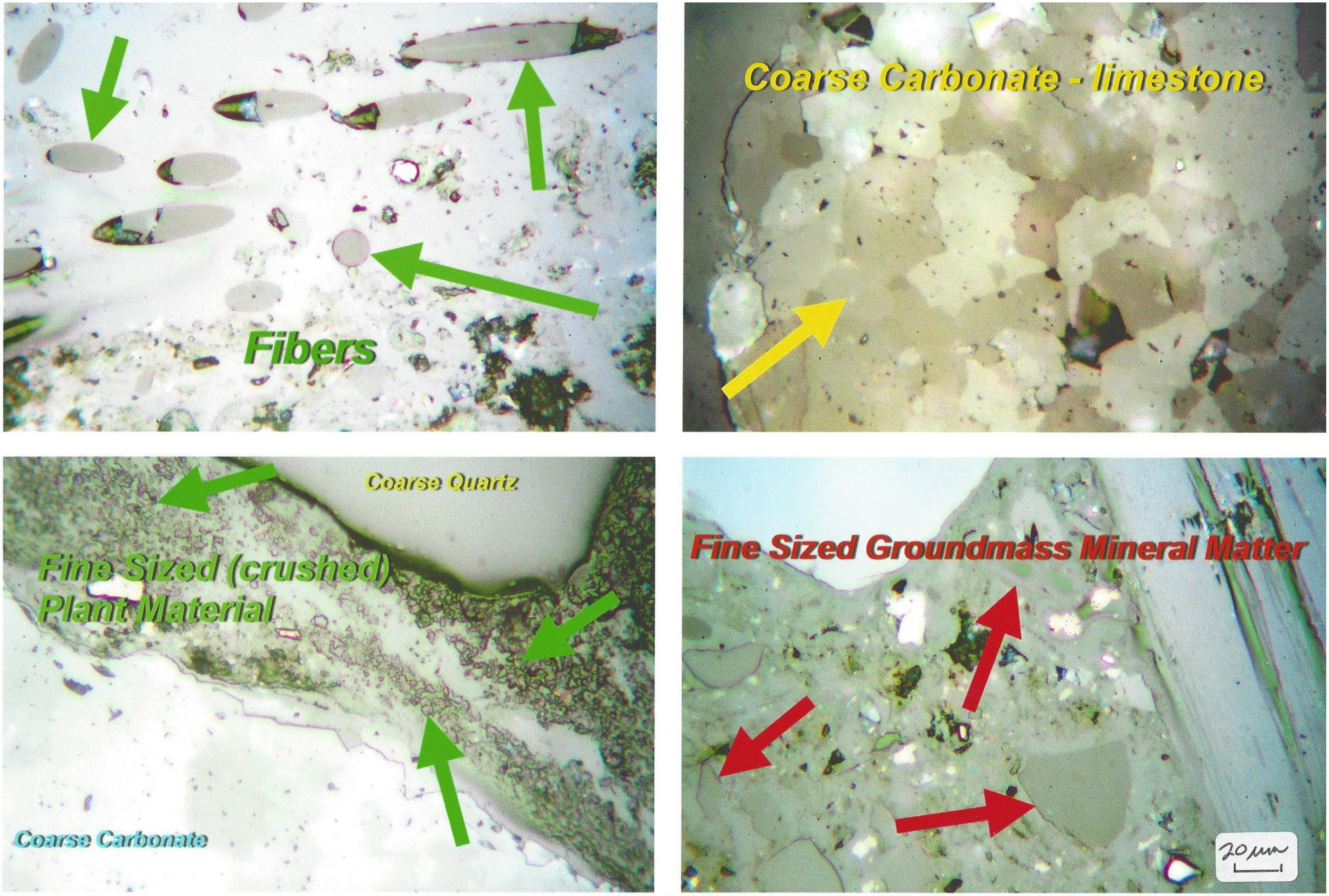


Figure 10: Photomicrographs of Koppers Samples 2020-0708 thru 2020-0713 from Geosyntec (Sediment 6-1520, 0510 & 0005, 7-1520, 0005 & 0510) Showing; Cluster of Fibers, Coarse Carbonate - limestone, Fine Sized (crushed) Plant Material and Fine Sized Groundmass MM. Reflected Polarized Light In Air, X600.

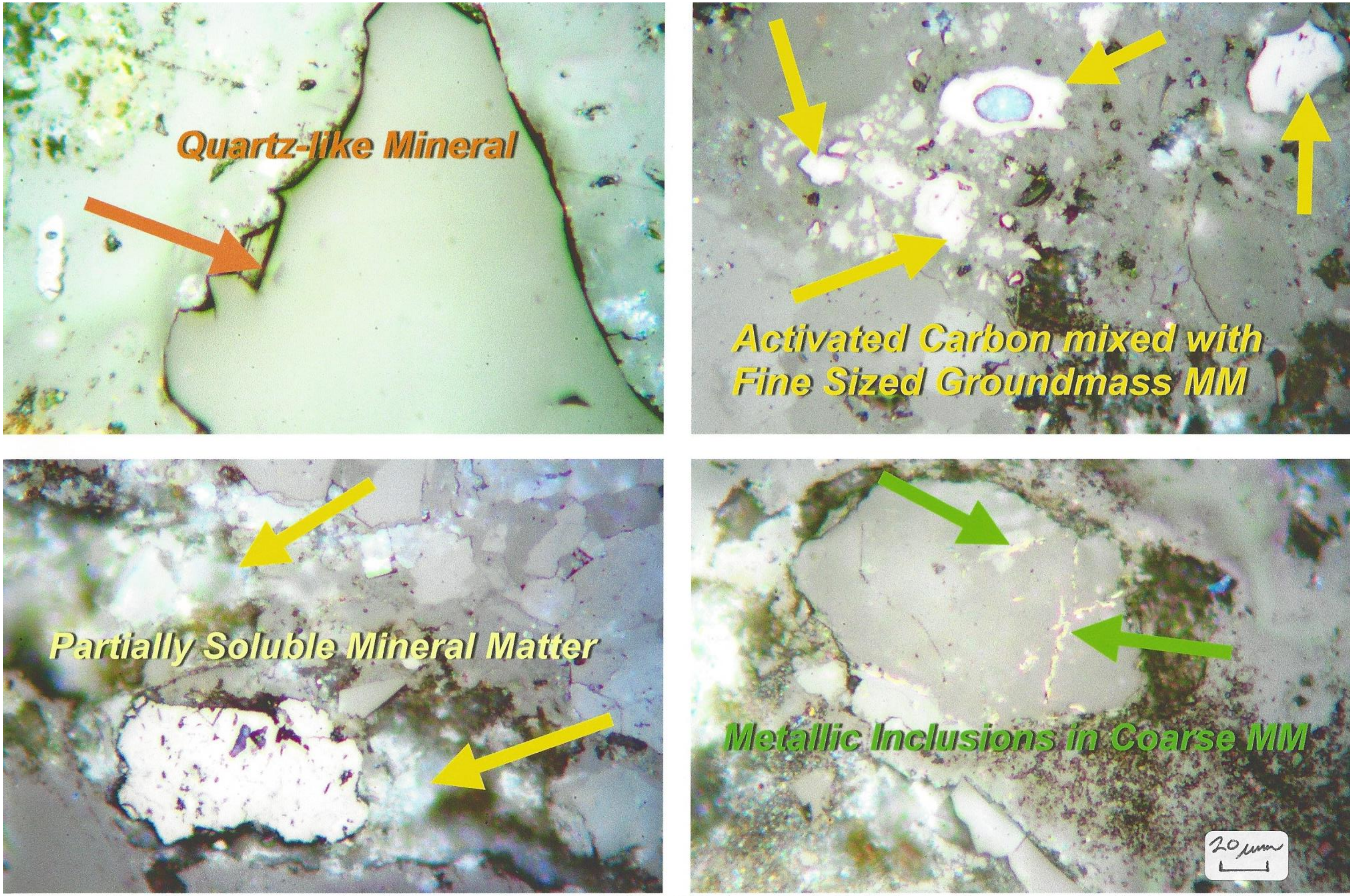
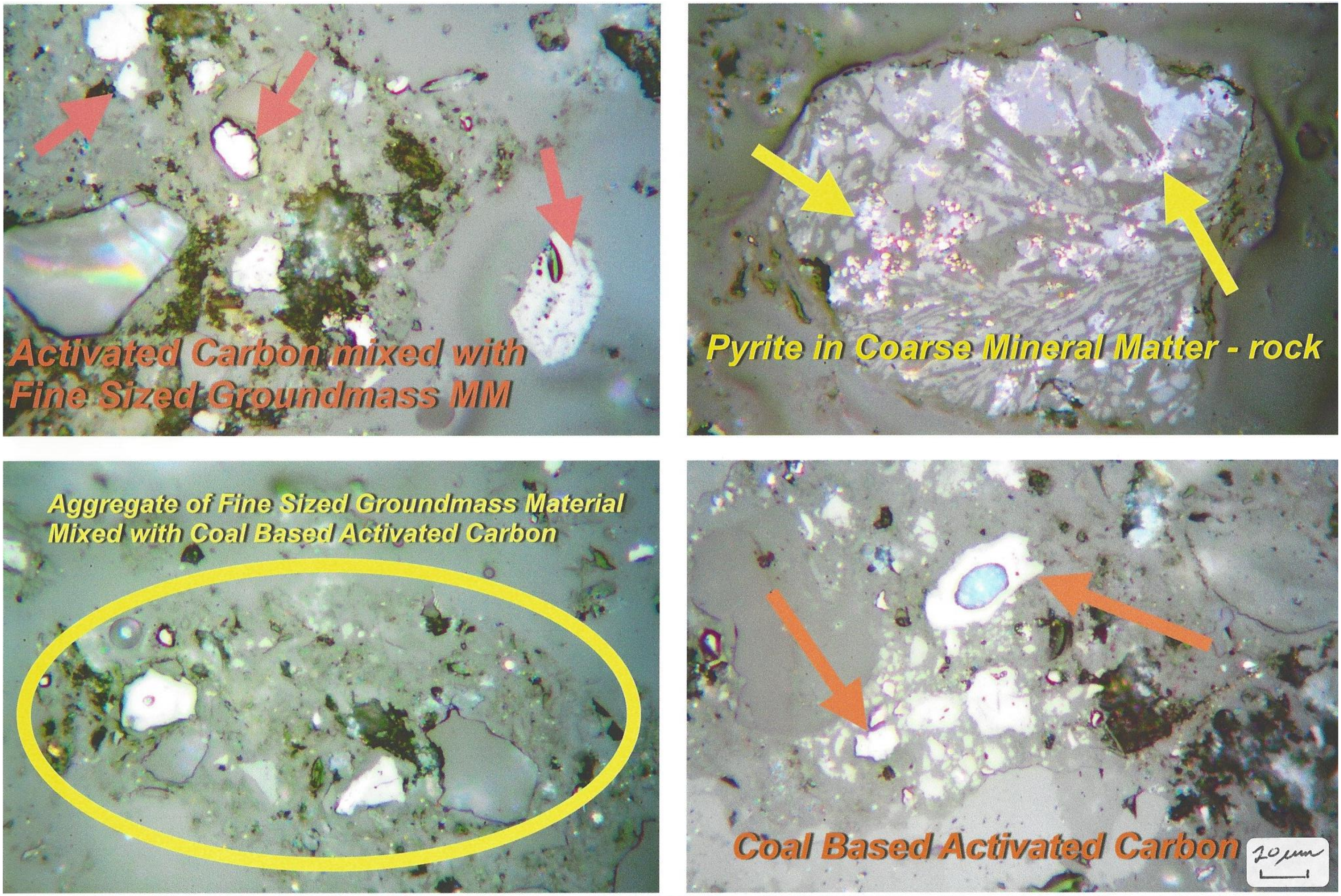


Figure 11: Photomicrographs of Koppers Samples 2020-0708 thru 2020-0713 from Geosyntec (Sediment 6-1520, 0510 & 0005, 7-1520, 0005 & 0510) Showing; Quartz-like Mineral, Activated Carbon Mixed with Groundmass MM, Partially Soluble MM and Metallic Inclusions in Coarse MM. Reflected Light In Air, X600.



<u>**Figure 12:**</u> **Photomicrographs of Koppers Samples 2020-0708 thru 2020-0713 from Geosyntec (Sediment 6-1520, 0510 & 0005, 7-1520, 0005 & 0510) Showing; Activated Carbon Mixed with Groundmass MM, Pyrite in Coarse MM, Aggregate of Fine Sized Groundmass and Coal Based Activated Carbon. Reflected Light In Air,X600.**

Daniel P. Gray
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September 1, 2020

Mr. Jason Conder
2100 Main Street, Suite 150
Huntington Beach, California 92648

Dear Jason,

On June 11, 2020, twenty six sediment samples from EcoAnalysts were submitted by Michelle Knowlen for petrographic analysis. In the current report which include three from group T82-9 and four from T82-7-DUP will be analyzed. The samples are described and identified as follows:

KOPPERS No.	DESCRIPTION
2020-0714	EcoAnalysts – T82-9-MM-BC-0510
2020-0715	EcoAnalysts – T82-9-MM-BC-1015
2020-0716	EcoAnalysts – T82-9-MM-BC-1520
2020-0717	EcoAnalysts – T82-7-MM-DUP-BC-1015
2020-0718	EcoAnalysts – T82-7-MM-DUP-BC-1520
2020-0719	EcoAnalysts – T82-7-MM-DUP-BC-0510
2020-0720	EcoAnalysts – T82-7-MM-DUP-BC-0005

Each of the seven sediment samples were received in a ~30ml glass vail and all were relatively wet. The contents from each sample were removed from their container and placed on a glass plate and dried in an oven at 80°C for 2 hour. The dried samples were photographed to illustrate the characteristics of the as-received materials prior to petrographic preparation, as shown in Figures 1 through 7. The dried material from each sample was mixed then coned and quartered in order to keep 50% of the material in reserve and the other 50% was prepared for petrographic analysis. The split for petrography was mixed with an epoxy mounting media and set in 1 ¼ inch phenolic ring mold. The prepared samples were polished to a scratch free surface and photographed in reflected light at 250X and 600X in air to illustrate most of the materials listed in the compositional analysis (Table 1 & 2), as shown in Figures 8 through 13. The composition analysis consists of 1000 points counted for each sample at 600X in air, as listed in Tables 1 and 2.

Geosyntec T82-9-MM-BC-0510 - Koppers (2020-0714)

The Geosyntec sample T82-9-MM-BC-0510 has 84.7% of total coarse mineral matter which consists mostly of carbonates at 76.5%, with 3.7% of Quartz like transparent minerals and 4.5% of other coarse mineral matter (rock). Some of the carbonates are rocks that appear to be similar to dolomite or limestone and some of the carbonates are seashells (calcium carbonate), as shown in the top left & right photos in Figure 8. There is 14.7% of total groundmass material which consists of 6.6% fine and intermediate sized mineral matter, with 1.2% partially soluble mineral matter, 6.8% of plant material and 0.1% of metallics/pyrite. There is 0.6% of total carbon which consists entirely of coal based activated carbon. The majority of the activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks, as shown in Figures 9 through 12.

Geosyntec T82-9-MM-BC-1015 - Koppers (2020-0715)

The Geosyntec sample T82-9-MM-BC-1015 has 87.5% of total coarse mineral matter which consists mostly of carbonates & seashell at 79.6%, with 3.3% Quartz or clear transparent minerals and 4.6% of other coarse minerals or rocks, as listed in Table 1. There is 11.7% of total groundmass mineral matter which consists of 6.0% fine and intermediate sized mineral matter, with 0.7% partially soluble mineral matter, 4.9% of plant material and 0.1% of metallics/pyrite. There is 0.8% of total carbon which consists entirely of coal based activated carbon. As noted earlier, most of the active carbon is small in size and disseminated within the fine sized groundmass material.

Geosyntec T82-9-MM-BC-1520 - Koppers (2020-0716)

The Geosyntec sample T82-9-MM-BC-1520 has 84.0% of total coarse mineral matter which consists mostly of carbonates & seashells at 78.1%, with 4.8% of Quartz-like or clear transparent minerals and 1.1% of other coarse minerals or rocks, as listed in Table 1. There is 14.7% of total groundmass material which consists of 8.0% of fine sized mineral matter, with 5.5% of plant material and 1.2% of partially soluble mineral matter, as listed in Table 1. The plant material occurs in various stages of decomposition. There is 1.3% of total carbon which consists mostly (1.2%) of coal based activated carbon which range from very small to intermediate in size and a very small amount (0.1%) of cenospheres which are coal particles that are rapidly carbonized without confinement.

Geosyntec T82-7-MM-DUP- BC-1015 - Koppers (2020-0717)

The Geosyntec sample T82-7-MM-DUP-BC-1015 has 66.6% of total coarse mineral matter which consists mostly of Other coarse mineral matter (rock) at 28.4%, with 21.7% of Quartz-like or clear transparent minerals and 16.5% of carbonates & seashell, as listed in Table 2. There is 33.2% of total groundmass mineral matter which consists of 10.4% fine and intermediate sized mineral matter, with 2.7% partially soluble mineral matter, 18.4% of plant material and 1.7% of metallics/pyrite. There is only 0.2% of total carbon which consists entirely of coal based activated carbon which is very small in size and incorporated in the fine grain groundmass material.

Geosyntec T82-7-MM-DUP-BC-1520 - Koppers (2020-0718)

The Geosyntec sample T82-7-MM-DUP-BC-1520 has 64.5% of total coarse mineral matter which consists of 24.7% of carbonates & seashell, with

22.7% of other coarse mineral matter and 17.1% of Quartz-like or clear transparent minerals, as listed in Table 2 and shown in Figure 8. There is 35.3% of total groundmass mineral matter which consists of 13.5% fine and intermediate sized mineral matter, with 16.2% of plant material, 3.9% partially soluble mineral matter and 1.7% of metallics/pyrite. There is 0.2% of total carbon which consists entirely of coal based activated carbon. The activated carbon is very small in size and incorporated in the groundmass matrix which coats the larger coarse minerals and rocks.

Geosyntec T82-7-MM-DUP-BC-0510 - Koppers (2020-0719)

The Geosyntec sample T82-7-MM-DUP-BC-0510 has 82.7% of total coarse mineral matter which consists mostly of carbonates & seashell at 48.0%, with 9.2% Quartz or clear transparent minerals and 25.5% of other coarse minerals or rocks, as listed in Table 2. There is 17.0% of total groundmass mineral matter which consists of 11.6% fine and intermediate sized mineral matter, with 1.6% partially soluble mineral matter, 2.5% of plant material and 1.3% of metallics/pyrite. There is only 0.3% of total carbon which consists of 0.2% fibers and 0.1% of charcoal. The fibers appear to be PAN type carbon fibers.

Geosyntec T82-7-MM-DUP-BC-0005 - Koppers (2020-0720)

The Geosyntec sample T82-7-MM-DUP-BC-0005 has 61.7% of total coarse mineral matter which consists of carbonates & seashell at 38.0%, with 14.7% Quartz or clear transparent minerals and 9.0% of other coarse minerals or rocks, as listed in Table 2. There is 37.9% of total groundmass mineral matter which consists of 14.1% fine and intermediate sized mineral matter, with 2.3% partially soluble mineral matter, 20.8% of plant material and 0.7% of metallics/pyrite. There is 0.4% of total carbon which consists wholly of coal based activated carbon which is very small in size and included in the fine sized groundmass matrix.

Please call me at (412) 826-3994 or e-mail at graydp@koppers.com if you have questions or wish to discuss this work.

Sincerely,

Daniel P. Gray

Table 1

Petrographic Analysis of Three Koppers Samples 2020-0714 thru 2020-0716 of Sediment Samples from Geosyntec (T82 – 9 -0510, 1015 & 1520)

Description	Geosyntec T82-9-MM-BC-0510	Geosyntec T82-9-MM-BC-1015	Geosyntec T82-9-MM-BC-1520
Koppers #	2020-0714	2020-0715	2020-0716
Coarse MM:			
Carbonates and Seashells	76.5	79.6	78.1
Quartz & Clear MM	3.7	3.3	4.8
Other – Coarse MM	4.5	4.6	1.1
Total Coarse MM	84.7	87.5	84.0
Groundmass :			
Fine & Intermediate MM	6.6	6.0	8.0
Partially Soluble MM	1.2	0.7	1.2
Plant Material - Organic	6.8	4.9	5.5
Metallics & Pyrite	0.1	0.1	---
Total Groundmass	14.7	11.7	14.7
Carbon			
Activated Carbon	0.6	0.8	1.2
Soot & Pyrolytic	---	---	--
Charcoal	---	---	---
Other Carbon - cenosphere	---	---	0.1
Total Carbon	0.6	0.8	1.3
Total	100.0	100.0	100.0

Table 2

Petrographic Analysis of Four Koppers Samples 2020-0717 thru 2020-0720 of Sediment Samples from Geosyntec (T82 – 7 - DUP – 1015, 1520, 0510 & 0005)

Description	Geosyntec T82-7-MM-DUP-BC-1015	Geosyntec T82-7-MM-DUP-BC-1520	Geosyntec T82-7-MM-DUP-BC-0510	Geosyntec T82-7-MM-DUP-BC-0005
Koppers #	2020-0717	2020-0718	2020-0719	2020-0720
Coarse MM:				
Carbonates and Seashells	16.5	24.7	48.0	38.0
Quartz & Clear MM	21.7	17.1	9.2	14.7
Other – Coarse MM	28.4	22.7	25.5	9.0
Total Coarse MM	**66.6**	**64.5**	**82.7**	**61.7**
Groundmass :				
Fine & Intermediate MM	10.4	13.5	11.6	14.1
Partially Soluble MM	2.7	3.9	1.6	2.3
Plant Material - Organic	18.4	16.2	2.5	20.8
Metallics & Pyrite	1.7	1.7	1.3	0.7
Total Groundmass	**33.2**	**35.3**	**17.0**	**37.9**
Carbon				
Activated Carbon	0.2	0.2	---	0.4
Soot & Pyrolytic	---	---	---	---
Fibers	---	---	0.2	---
Other Carbon - charcoal	---	---	0.1	---
Total Carbon	**0.2**	**0.2**	**0.3**	**0.4**
Total	100.0	100.0	100.0	100.0

Figure 1.) *Geosyntec: T82-9-MM-BC-0510 (Koppers# 20-0714)*

Figure 2.) Geosyntec: T82-9-MM-BC-1015 (Koppers# 20-0715)

Figure 3.) *Geosyntec: T82-9-MM-BC-1520 (Koppers# 20-0716)*

Figure 4.) Geosyntec: T82-7-MM-DUP-BC-1015 (Koppers# 20-0717)

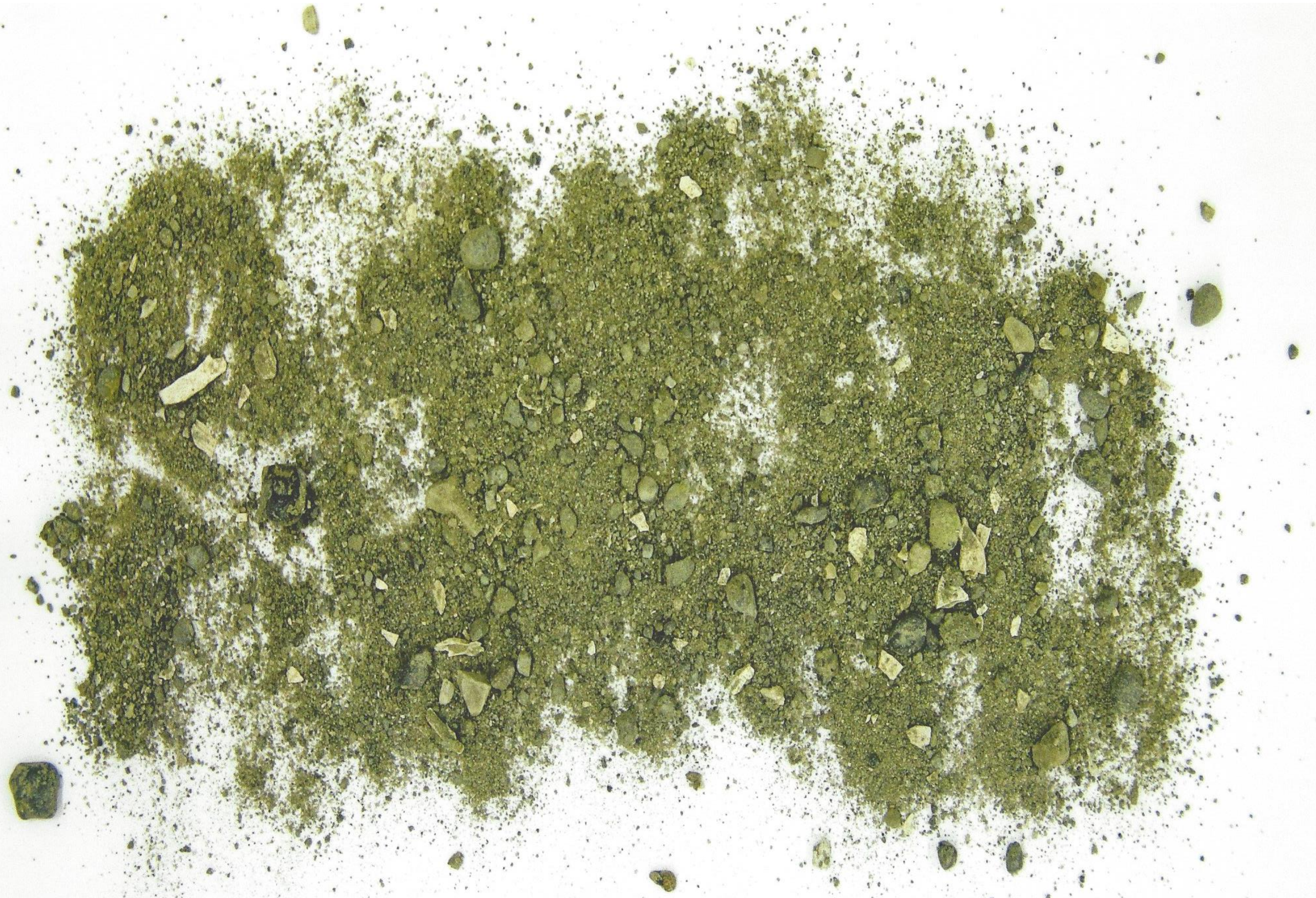

Figure 5.) Geosyntec: T82-7-MM-DUP-BC-1520 (Koppers# 20-0718)

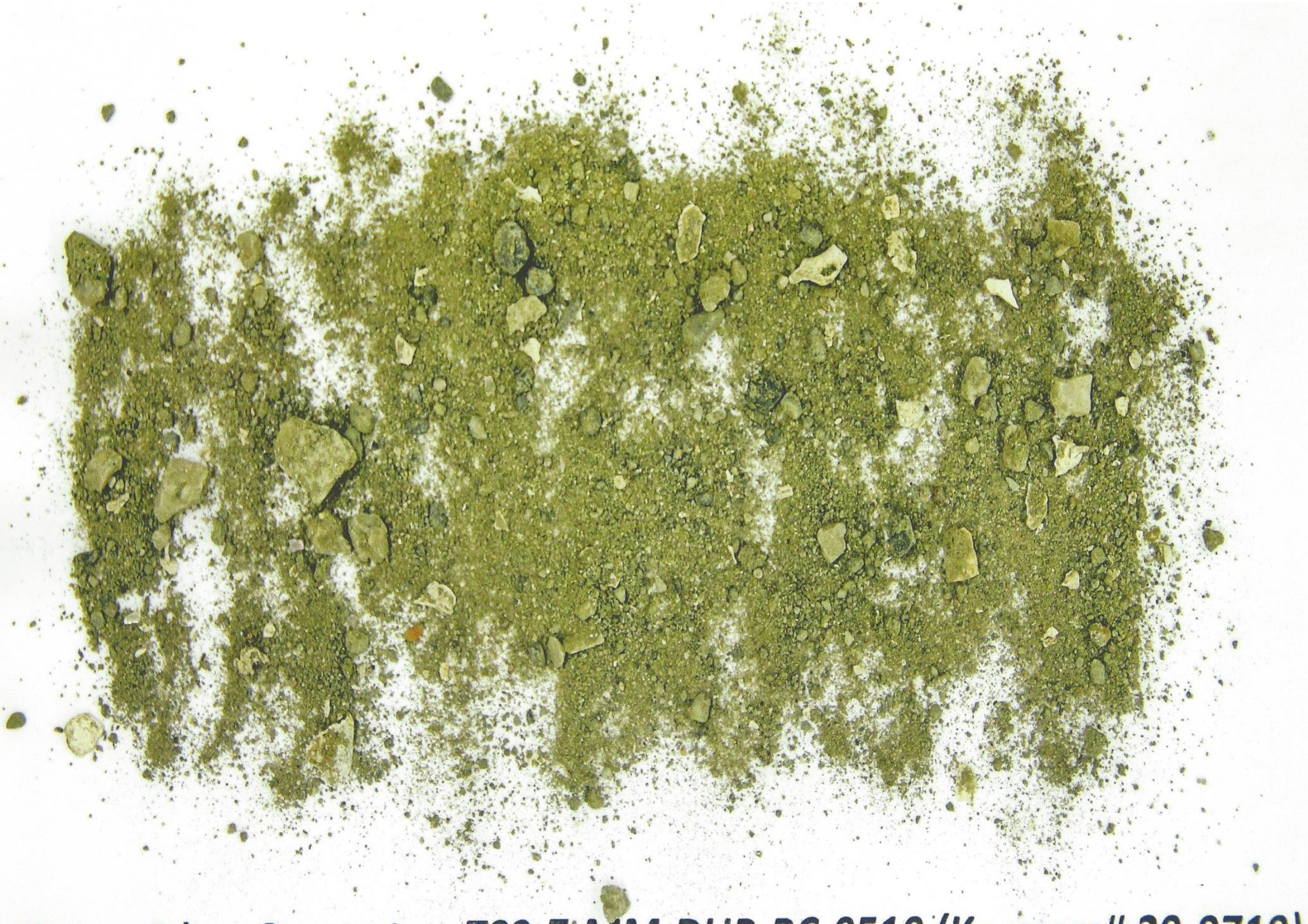

Figure 6.) Geosyntec: T82-7-MM-DUP-BC-0510 (Koppers# 20-0719)

Figure 7.)   Geosyntec: T82-7-MM-DUP-BC-0005 (Koppers# 20-0720)

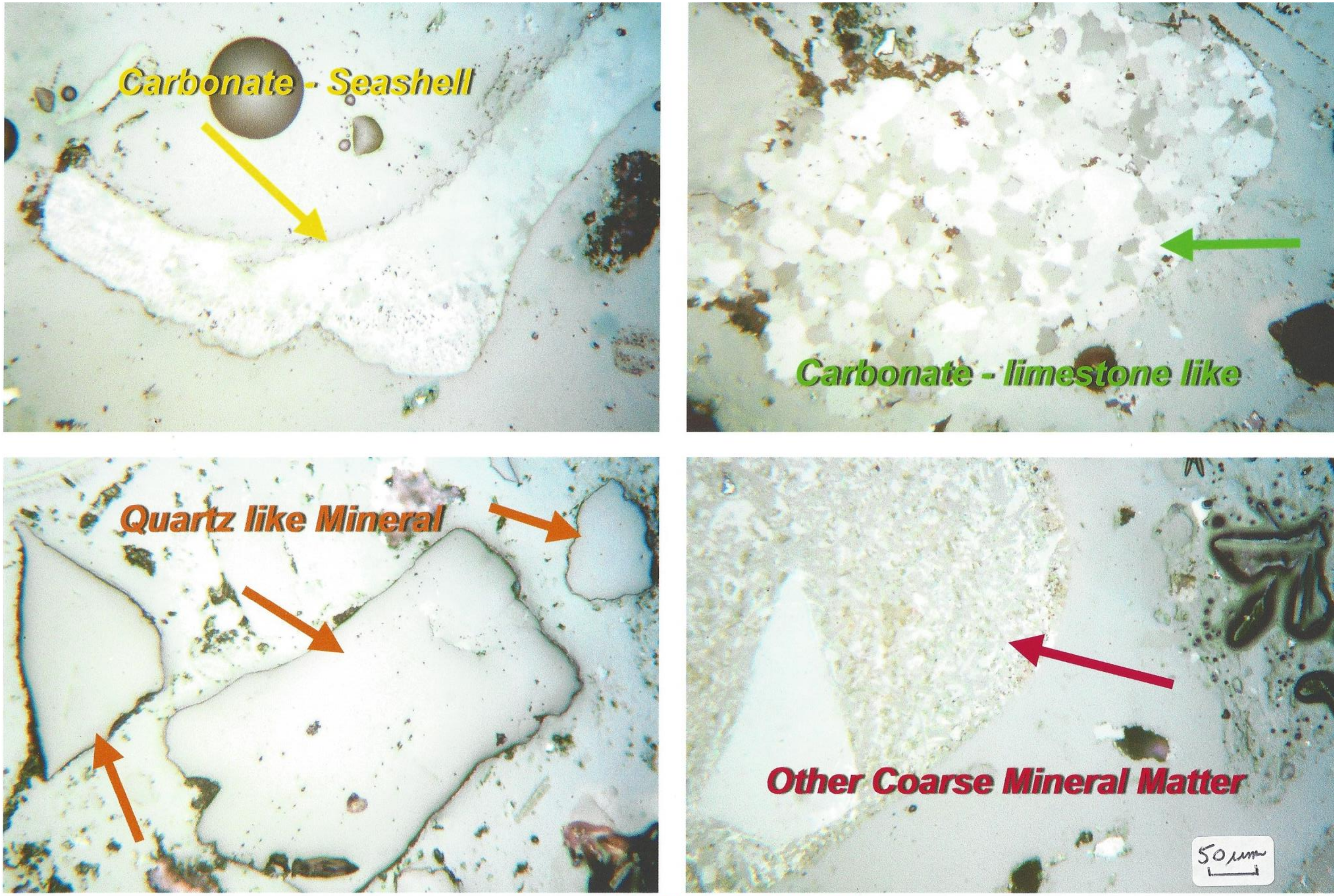

Figure 8: Photomicrographs of Koppers Samples 2020-0714 thru 2020-0720 from Geosyntec (Sediment 9- 0510, 1015 & 1520, 7-DUP-1015, 1520, 0510 & 0005) Showing; Carbonate – Seashell, Carbonate – limestone-like, Quartz-like Mineral and Other Coarse Mineral Matter. Reflected Polarized Light In Air, X250.

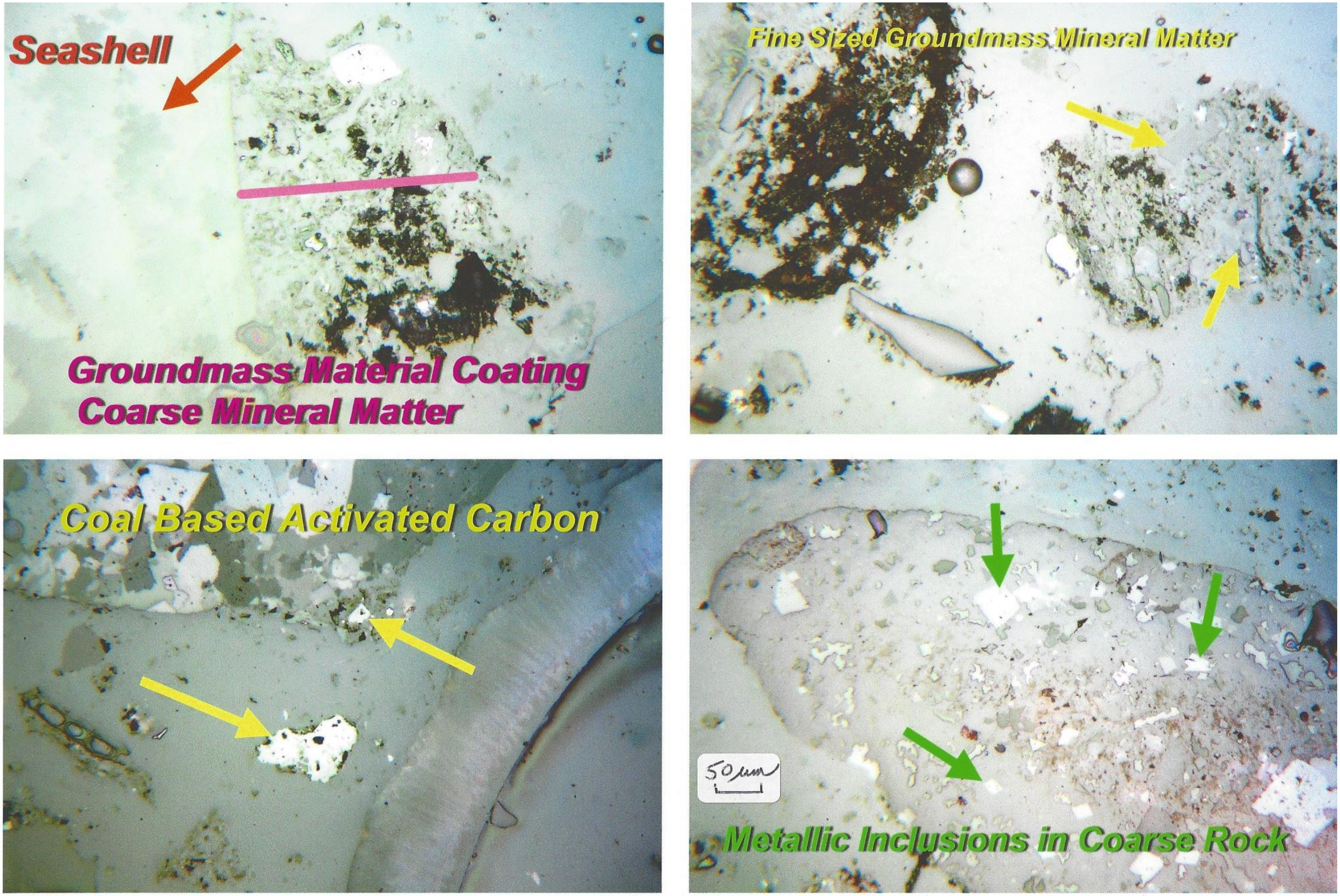

Figure 9: Photomicrographs of Koppers Samples 2020-0714 thru 2020-0720 from Geosyntec (Sediment 9- 0510, 1015 & 1520, 7-DUP-1015, 1520, 0510 & 0005) Showing; Seashell, Fine Sized Groundmass Materials, Coal Based Activated Carbon and Metallic Inclusions in Coarse Rock. Reflected Polarized Light In Air, X250.

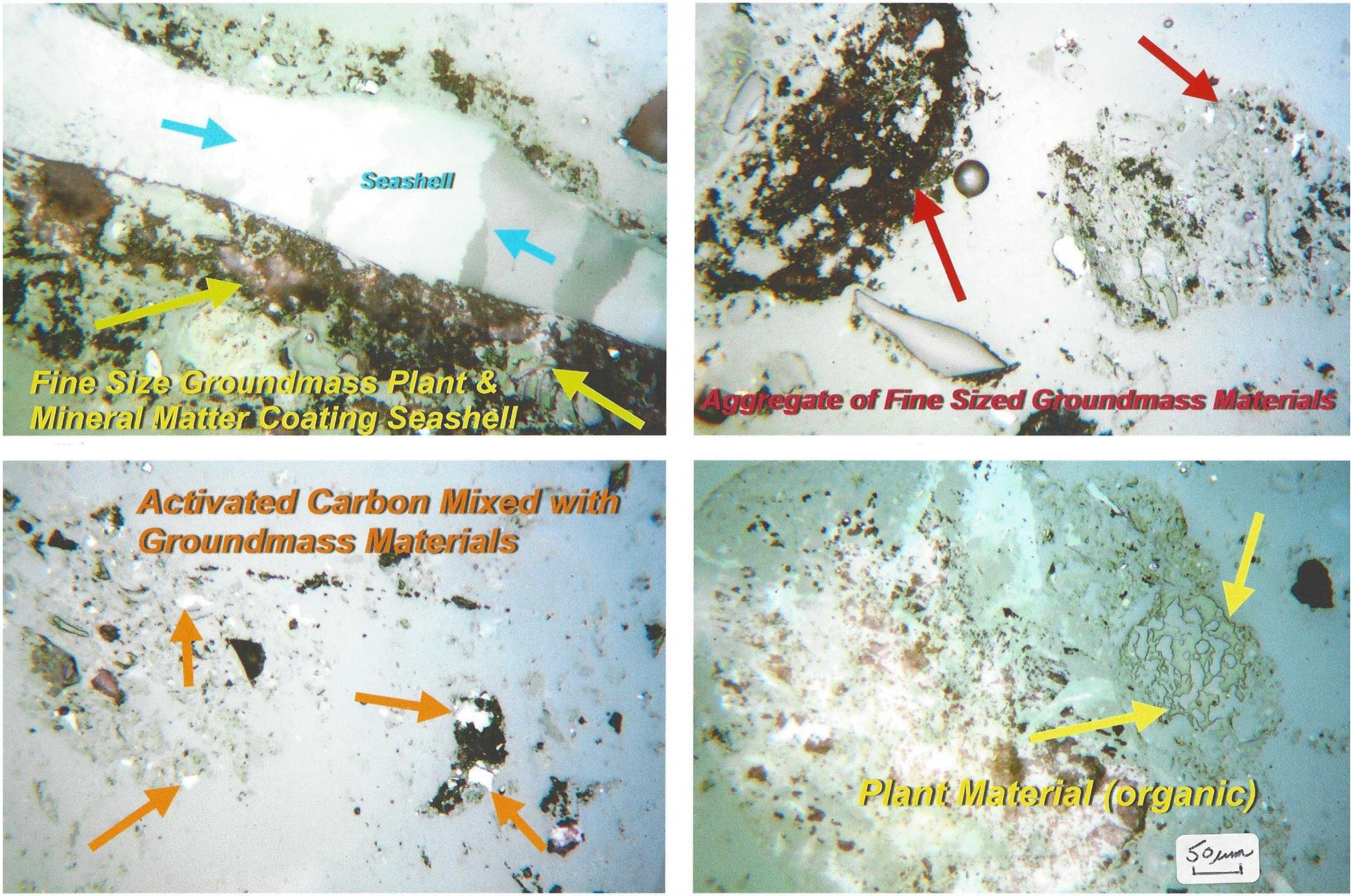

Figure 10: Photomicrographs of Koppers Samples 2020-0714 thru 2020-0720 from Geosyntec (Sediment 9- 0510, 1015 & 1520, 7-DUP-1015, 1520, 0510 & 0005) Showing; Seashell, Fine Sized Groundmass Material Coating Coarse Seashell, Activated Carbon and Plant Material (organic). Reflected Polarized Light In Air, X250.

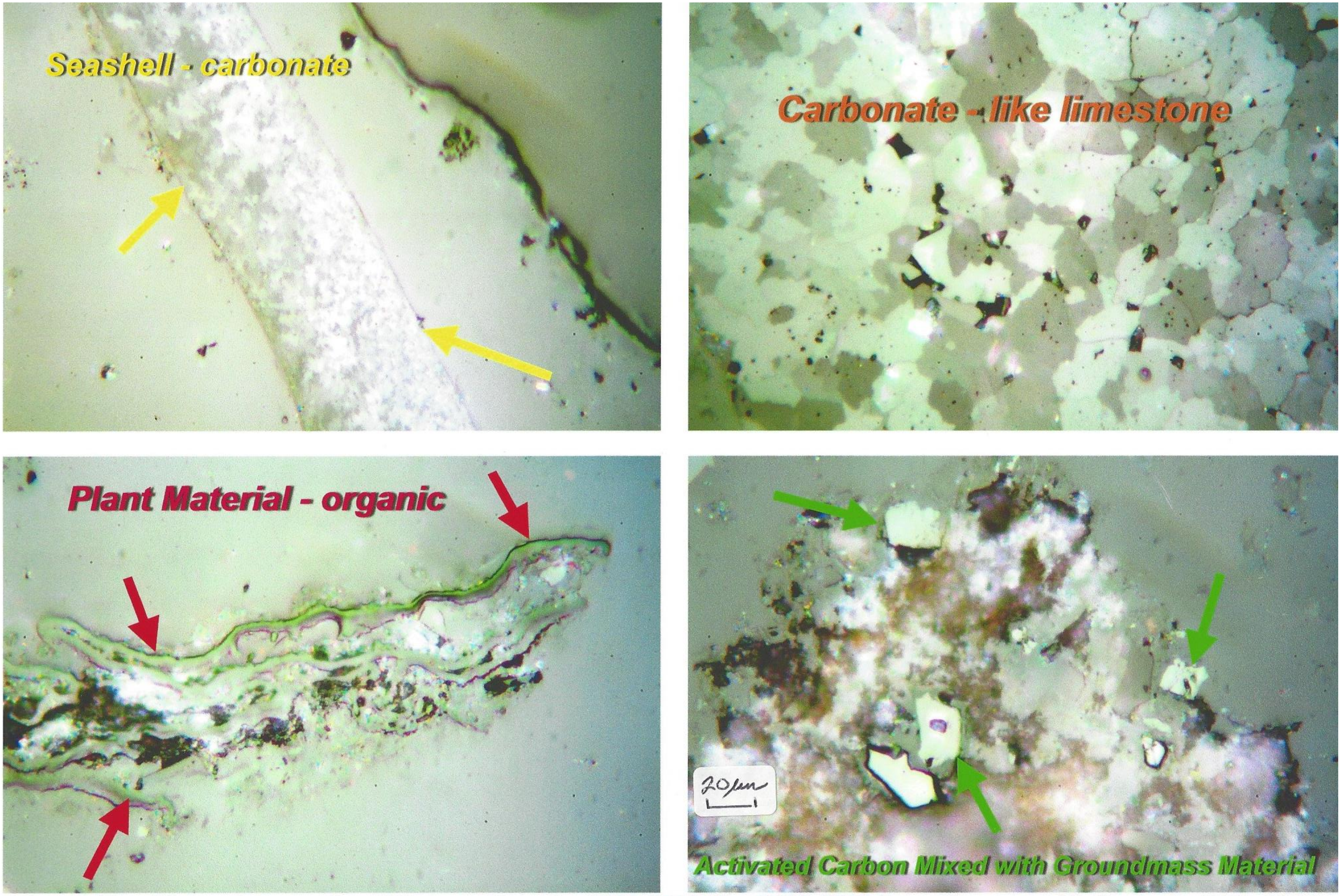

Figure 11: Photomicrographs of Koppers Samples 2020-0714 thru 2020-0720 from Geosyntec (Sediment 9- 0510, 1015 & 1520, 7-DUP-1015, 1520, 0510 & 0005) Showing; Seashell - carbonate, Carbonate – like Limestone, Plant Material – organic and Activated Carbon Mixed with GM. Reflected Polarized Light In Air, X600.

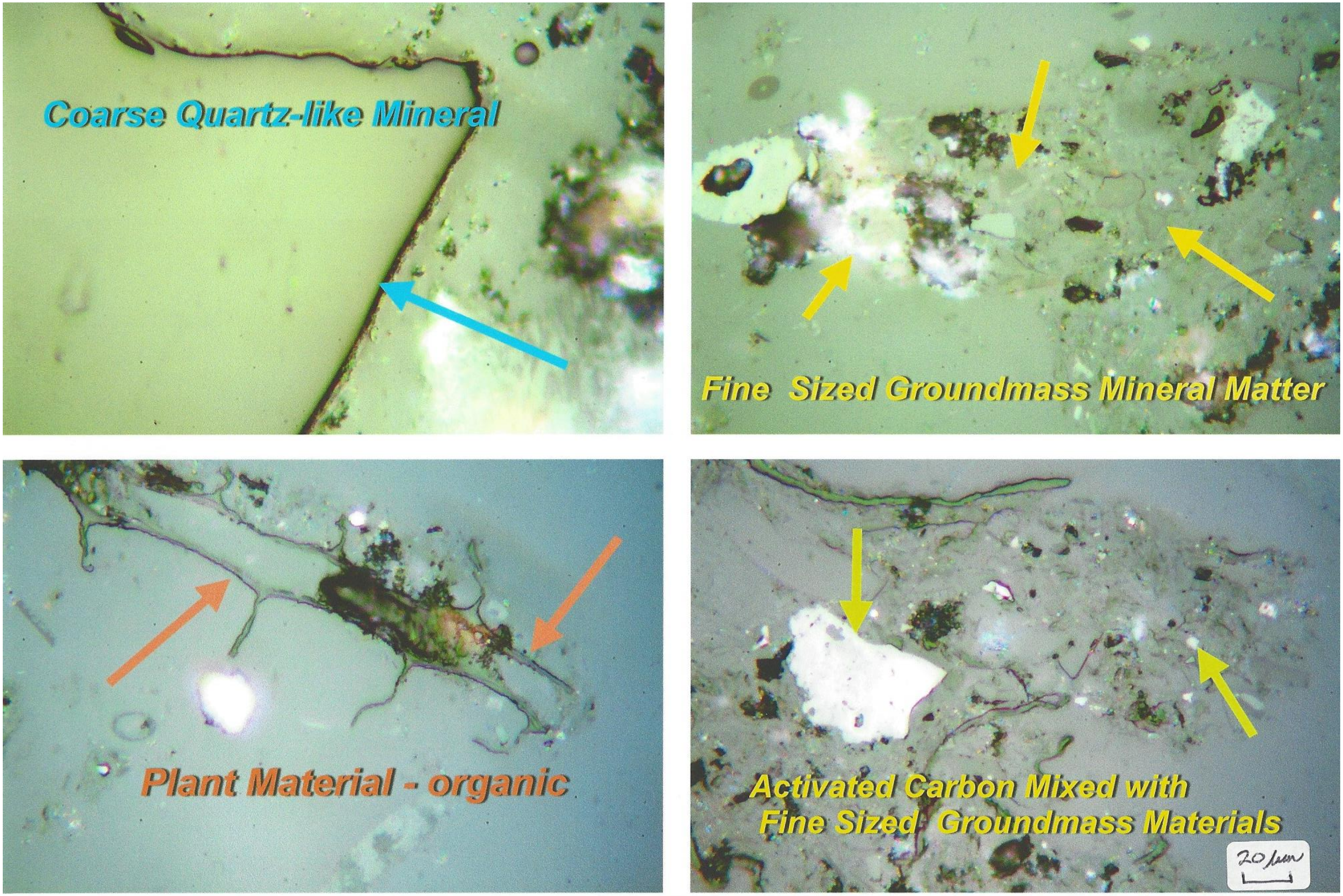

Figure 12: Photomicrographs of Koppers Samples 2020-0714 thru 2020-0720 from Geosyntec (Sediment 9- 0510, 1015 & 1520, 7-DUP-1015, 1520, 0510 & 0005) Showing; Coarse Quartz-like Mineral, Fine Size Groundmass Mineral Matter, Plant Material – organic and Activated Carbon. Reflected Polarized Light In Air, X600.

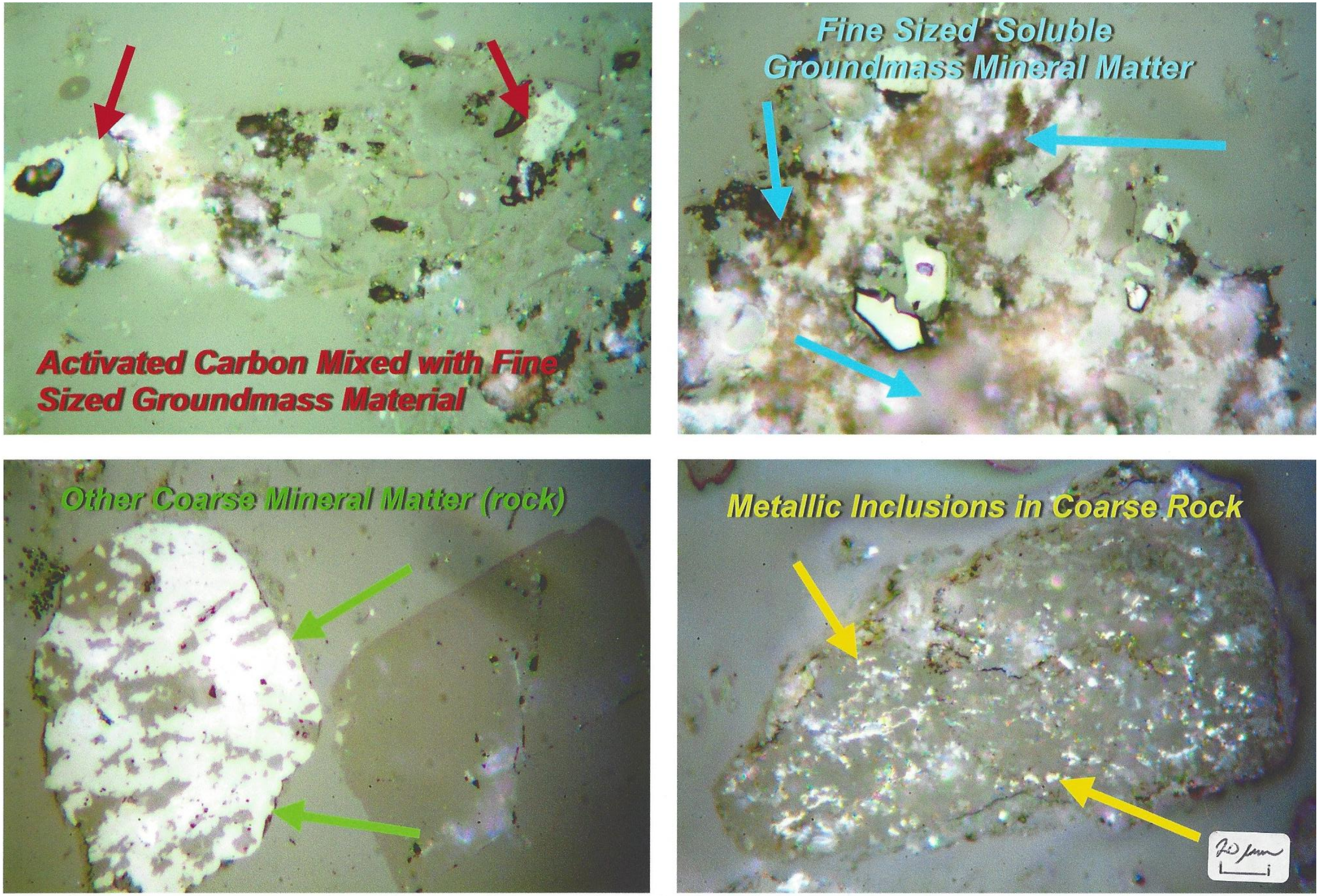

Figure 13: Photomicrographs of Koppers Samples 2020-0714 thru 2020-0720 from Geosyntec (Sediment 9- 0510, 1015 & 1520, 7-DUP-1015, 1520, 0510 & 0005) Showing; Activated Carbon in Groundmass, Fine Sized Soluble Groundmass MM, Other Coarse Rock and Metallic Inclusions. Reflected Polarized Light In Air, X600.

Appendix C
Aggregate Presence and Carbon Data Summary Table

Sample ID	Location	Sample Depth (cm)	TOC (%)	BC (%)	AC (%)	Aggregate present?	Notes
T82-1-MM	1-MM	0-5	3.0%	0.3%		N	Rocks, sandy silt
		5-10	3.5%	0.4%		N	Rocks, sandy silt
		10-15	3.1%	0.8%		N	Rocks, minor shell hash, sandy silt
		15-20	2.6%	1.2%		Y	Rocks, shell hash, sandy silt, trace aggregate
T82-2-MM	2-MM	0-5	3.6%	1.1%	0.4%	Y	Minor shell hash, sandy silt
		5-10	6.2%	4.6%	3.2%	Y	Minor shell hash, sandy silt
		10-15	2.9%	3.4%	2.4%	Y	Silty sand with some clay
		15-20	2.3%	0.2%	0.6%	N	Shell hash, sandy silt with clay
T82-2-MM-DUP	2-MM	0-5	3.4%			N	Sandy silt
		5-10	2.2%			N	Sandy silt, shell hash
		10-15	2.6%			N	Sandy silt, trace shell hash
		15-20	4.4%			N	Sandy silt, trace shell hash
T82-3-MM	3-MM	0-5	0.5%	0.1%	0.2%	Y	Shell hash, silty sand with trace aggregate
		5-10	1.5%	0.2%	0.4%	N	shells hash, silty sand
		10-15	2.2%	0.8%	1.5%	Y	Shell hash, silty sand with trace aggregate
		15-20	2.1%	0.8%	1.9%	Y	Shell hash, rocks, with trace aggregate
T82-4-MM	4-MM	0-5	3.2%	1.2%	1.3%	Y	Mostly aggregate and shell hash, sandy silt
		5-10	2.9%	1.6%	2.6%	Y	Mostly aggregate and shell hash, sandy silt
		10-15	2.5%	0.3%	0.0%	Y	Sandy silt with clay and shell hash, trace aggregate
		15-20	3.5%	0.2%	0.1%	N	Sandy silt with clay and shell hash, trace aggregate
T82-5-MM	5-MM	0-5	5.3%	1.8%	3.2%	Y	Shell hash, sandy silt with clay
		5-10	3.0%	1.0%	1.3%	Y	Rocks, shell hash, sandy silt, trace aggregate
		10-15	1.2%	0.5%	1.6%	Y	Rocks, shell hash, sandy silt, some clay
		15-20	2.2%	0.2%	0.1%	Y	Rocks, shell hash, sandy silt
T82-6-MM	6-MM	0-5	4.2%	1.6%	1.7%	Y	Sandy silt with shell hash
		5-10	0.7%	1.3%	1.6%	Y	Rocks, mostly aggregate with small amount of shell hash, sandy silt
		10-15	3.3%	0.8%	1.4%	Y	Rocks, sandy silt with clay, shell hash
		15-20	2.0%	0.6%	0.8%	Y	Rocks, sandy silt with clay, shell hash
T82-7-MM	7-MM	0-5	3.7%	0.5%	1.3%	Y	Shells, trace aggregate, sandy silt with clay
		5-10	2.4%	1.0%	2.0%	Y	Silty sand with clay, shell hash
		10-15	1.6%	0.2%	1.6%	Y	Trace aggregate, silty sand and shell hash
		15-20	6.0%	0.1%	0.2%	N	Rocks, silty sand, shell hash
T82-7-MM-DUP	7-MM	0-5		0.4%	0.4%	Y	Sandy silt with shell hash, trace aggregate
		5-10		0.2%	0.0%	Y	Silty sand with shell hash, trace aggregate
		10-15		0.1%	0.2%	N	Rocks, silty sand, shell hash
		15-20		0.1%	0.2%	N	Rocks, sandy silt with shell hash
T82-8-MM	8-MM	0-5	2.0%	0.2%		N	Shell hash, sandy silt with clay
		5-10	2.1%	0.1%		N	Shell hash, rocks, sandy silt
		10-15	2.0%	0.1%		Y	Trace aggregate, silty sand, mainly shell hash
		15-20	2.4%	0.2%		N	Silty sand, mainly shell hash

Sample ID	Location	Sample Depth (cm)	TOC (%)	BC (%)	AC (%)	Aggregate present?	Notes
T82-9-MM	9-MM	0-5	2.7%	0.9%	1.8%	Y	Shell hash, aggregate, small amount of silt
		5-10	3.5%	0.8%	0.6%	Y	Shell hash, small amount of silt, aggregate
		10-15	4.4%	1.0%	0.8%	Y	Rocks, shell hash, small amount of silt
		15-20	3.3%	1.2%	1.2%	Y	Mostly shell hash with silty sand
T82-10-MM	10-MM	0-5	1.5%	0.1%		Y	Silty sand with shell hash, trace aggregate
		5-10	0.8%	0.1%		N	Silty sand with shell hash
		10-15	0.8%	0.2%		N	Silty sand, shell hash
		15-20	1.6%	0.2%		Y	Shell hash with silty sand, trace aggregate
T82-1-C	1-C	0-5	0.3%	0.1%		Y	Silty sand with shell hash, trace aggregate
		5-10	1.2%	0.1%		Y	Gravel and shell hash, silty sand
		10-15	2.2%	0.1%		Y	Shell hash, silty clay
		15-20	2.1%	0.3%		Y	Silty clay and shell hash
T82-2-C	2-C	0-5	1.4%	0.3%		Y	Sandy silt
		5-10	1.7%	0.3%		Y	Sandy silt and shell hash
		10-15	1.7%	0.8%		Y	Sandy silt
		15-20	1.3%	1.3%		Y	Sandy silt
T82-3-C	3-C	0-5	1.6%	1.3%		Y	1 cm sandy silt, mainly hash, trace aggregate
		5-10	1.0%	0.8%		N	Sandy silt, mainly hash
		10-15	0.9%	0.2%		N	Sandy silt, mainly hash
		15-20	2.2%	0.1%		N	Small amount of sandy silt, mainly hash
T82-4-C	4-C	0-5	1.9%	0.2%		N	Shell hash, small amount of sandy silt
		5-10	1.9%	1.2%		N	Shell hash, small amount of sandy silt
		10-15	1.6%	0.3%		N	Shell hash, sandy silt
		15-20	3.6%	0.2%		N	Sandy clay, shell hash
T82-5-C	5-C	0-5	1.9%	3.1%		Y	Mostly aggregate, shell hash, sandy silt
		5-10	4.2%	4.3%		Y	Mostly aggregate, shell hash, sandy silt
		10-15	3.5%	2.6%		Y	Sandy silt with aggregate and shell hash
		15-20	7.0%	3.3%		Y	Sandy silt with clay and aggregate and shell hash
T82-6-C	6-C	0-5	2.1%	0.1%		N	Sandy clay layer on top of shell hash with silty sand
		5-10	1.8%	0.1%		N	Silty sand with shell hash, trace aggregate
		10-15	2.8%	0.2%		N	Sandy clay, shell hash, small amount of wood
		15-20	0.3%	0.2%		N	Minor shell hash, sandy silt with clay
T82-7-C	7-C	0-5	3.6%	0.6%		Y	Shells, shell hash, rocks, sandy silt, mostly aggregate
		5-10	4.1%	4.6%		Y	Shells, rocks, mostly shell hash with sandy silt
		10-15	3.9%	1.1%		Y	Rocks, shells, shell hash, sandy silt
		15-20	3.6%	0.8%		Y	Rocks, shell hash, sandy silt
T82-8-C	8-C	0-5	4.0%	3.1%		Y	Sandy silt, minor shell hash
		5-10	3.7%	2.5%		Y	Sandy silt, minor shell hash
		10-15	3.5%	0.3%		N	Sandy silt, shell hash, shells
		15-20	3.9%	3.3%		Y	Sandy silt, trace shell hash
T82-9-C	9-C	0-5	3.4%	2.9%		Y	Shell hash, sandy silt
		5-10	2.9%	2.1%		Y	Shell hash, sandy silt
		10-15	2.4%	2.4%		Y	Shell hash, sandy silt
		15-20	11.0%	0.8%		Y	Mostly shell hash, sandy silt

Sample ID	Location	Sample Depth (cm)	TOC (%)	BC (%)	AC (%)	Aggregate present?	Notes
T82-10-C	10-C	0-5	6.2%	0.1%		N	Silt sand and shell hash
		5-10	5.2%	0.2%		N	Silt sand and shell hash
		10-15	2.5%	0.2%		N	Shell hash with silty sand
		15-20	1.9%	0.3%		Y	Shell hash with silty sand, small rock, trace aggregate
T82-3.5-C	3.5-C	0-5	2.4%	2.3%		Y	Mostly aggregate and shell hash, sandy silt
		5-10	4.2%	1.2%		Y	Mostly aggregate and shell hash, sandy silt
		10-15	2.7%	0.3%		Y	Sandy silt with clay, shell hash
		15-20	3.0%	0.3%		N	Sandy silt with clay, shell hash

Appendix D
EcoAnalysts Benthic Community Assessment Report

ECOANALYSTS, INC.

Long Term Monitoring of Activated Carbon Amendment to Reduce PCB Bioavalibility in Sediments at an Active Shipyard – Benthic Community Assessment

ER18-5079

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ACRONYMS AND ABBREVIATIONS

COC:	Chain of Custody
DoD:	Department of Defense
LOE:	Line of Evidence
LPTL:	Lowest Practicable Taxon Level
MNR:	monitored natural recovery
PCB:	Polychlorinated Biphenyls
NIWC:	Naval Information Warfare Center
QA:	Quality Assurance
QC:	Quality Control

EXECUTIVE SUMMARY

During August of 2019, a demonstration and validation study (82-Month survey) was conducted at Pier 7 in the Puget Sound Naval Shipyard, Bremerton Washington to determine the long-term performance of an activated carbon amendment that was placed to treat sediments contaminated with polychlorinated biphenyls (PCBs). The current study was developed to follow up on monitoring studies that occurred at the site following the placement of this treatment in 2012. As part of these studies, benthic community samples were collected to assess potential impacts to the benthic community. Benthic community samples were collected from carbon amended multi-metric stations as well as reference stations that were located in the immediate area of the treatment. These samples were collected following the same procedures during the monitoring studies. The reference samples were intended to control the study against shifting site-specific changes and are not intended to provide an assessment of an ecologically pristine areas within the region.

The 2019 field effort was managed by Naval Information Warfare Center (NIWC) personnel with assistance from EcoAnalysts, Inc. (EcoAnalysts) personnel. Benthic community samples were collected by shipyard divers using multiple 4.7 cm diameter cores. After collection, benthic samples were sieved through a 1.0 mm mesh screen to remove fine grained sediment; the contents retained on the screen were placed into sample containers and fixed with formalin in the field. All benthic samples were processed by EcoAnalysts. Upon receipt at the lab, samples were transferred to ethanol and fully sorted to remove all organisms. Specimens were identified to the lowest practicable level by qualified taxonomists and enumerated.

Generally, the 82-Month survey samples consisted of a majority of polychaeta and mollusca surface deposit feeding taxa. The taxonomy data were analyzed using various univariate and multivariate methods. Univariate results indicated a significant difference in abundance between the multi-metric and reference stations. The significant difference noted showed that mean abundance in multi-metric samples was greater than the mean abundance in the reference. Multivariate analysis using the Bray-Curtis similarity coefficient showed no significant differences between any of the samples.

The benthic community data results from the 82-Month survey were analyzed with the benthic community data collected during the monitoring surveys at the Pier 7 location to provide a temporal comparison. Samples within both the multi-metric and reference groupings showed a lot of variability. The highest variability was observed within the abundance values, which resulted in large standard deviations. Large standard deviations reduced the confidence for determining statistical differences between these groups. Multi-metric and reference stations that were under the structure (Pier 7) tended to have greater abundance. This result could be an indication that the benthic community is responding to added nutrients falling from the attached communities to the sediment surface. The multi-variate analyses performed to compare the baseline community conditions (samples were collected 2 months prior to the treatment application in October of 2012) with the 82-Month survey results indicated a reduction in the presence of Capitella capitata and Armandia brevis in the samples collected during the 82-Month survey. This change could be related to nutrient availability. These data also indicate an increase presence of Alvania compacta and the polychaeta family Cirratulidae in the 82-Month samples from what was found in the baseline samples. These results are included in this report.

1. INTRODUCTION

Active, deep-water DoD (Department of Defense) harbor areas pose a number of significant challenges to the effective use of traditional sediment remedies such as dredging, capping, and monitored natural recovery (MNR). Successful demonstration of long-term stability and effectiveness of in-situ treatment materials that can address these challenges has the potential to reduce costs and recovery time frames for a wide range of active DoD sites and provide a more effective alternative to traditional methods of remediation.

Monitoring the invertebrate communities that inhabit the areas where the activated amendment was applied is an important line of evidence (LOE) for determining the effectiveness of the in-situ treatment of contaminated sediments. These communities are the organisms that are interacting with both the contaminated sediment as well as the treated. Any improvements or detriment to these organisms need to be taken into account when assessing the effectiveness of the treatment.

2. METHODS

2.1 Sample Collection

Samples for this program were collected from August 27 through 29, 2019. All benthic samples were collected in accordance with the project specific Demonstration Plan (Appendix A).

In brief, 14 stations (10 multi-metric and 4 reference) were sampled for benthic community analysis (Figure 2-1). All samples were collected and processed by representatives from NIWC and EcoAnalysts. At each location five core samples were collected by shipyard divers using core barrels with a 4.7 cm internal diameter. The five cores collected from each station were composited into one sample, representing 0.009 m^2 of the seafloor, and sieved through a 1.0 mm mesh screen to remove fine sediment. All residual sediment, debris, shells, and benthic organisms on the screen were carefully collected into labelled wide-mouth bottles. Samples were “fixed” on-board the vessel in formalin with a phosphate buffer diluted by seawater to create a 5% formalin preservative. The benthic samples were stored at room temperature throughout transit (shipped FedEx ground) to the EcoAnalysts benthic laboratory in Moscow, ID.

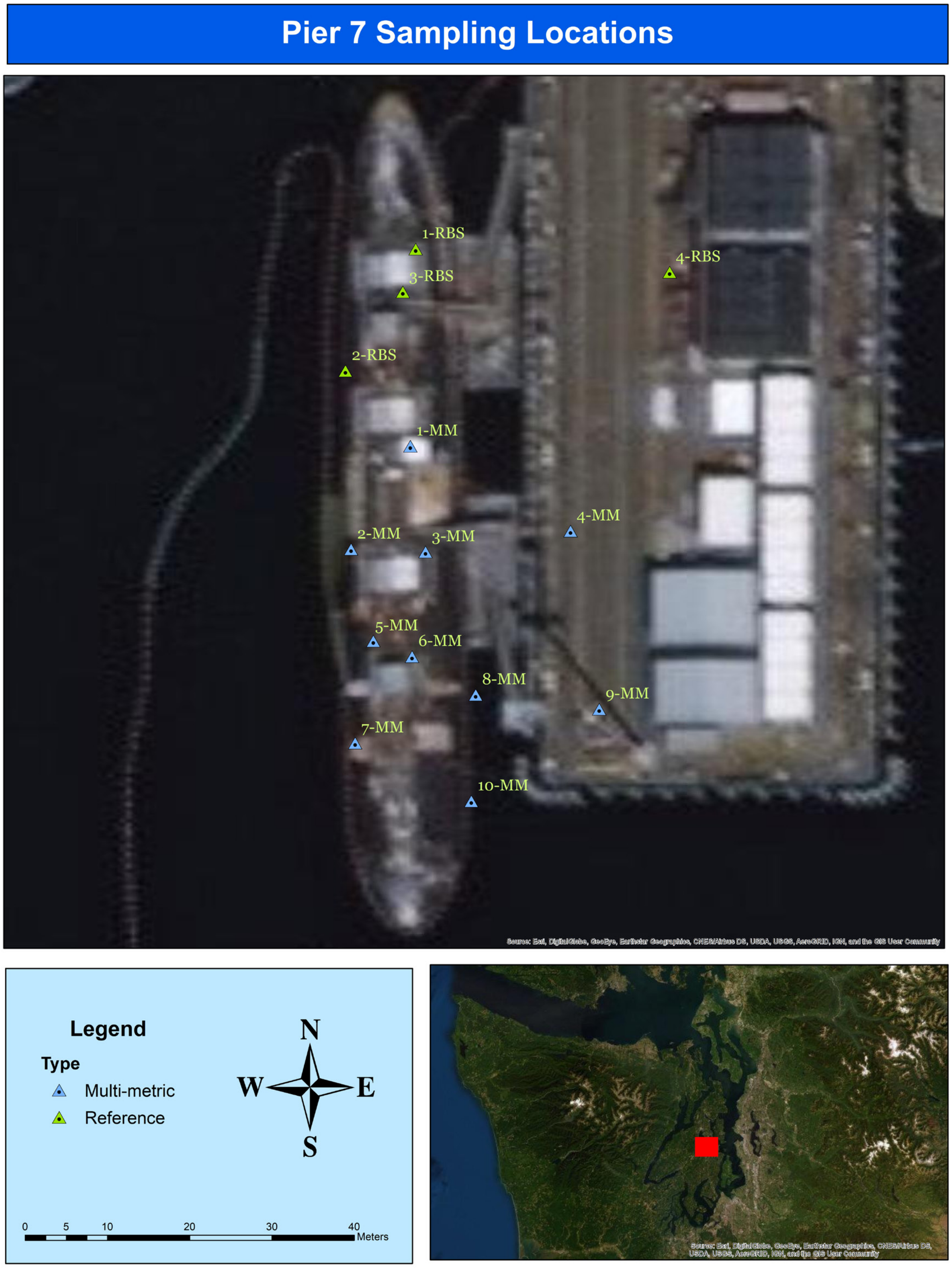


Figure 2-1. Pier 7 Sampling Locations

2.2 Benthic Sample Sorting and Taxonomy

Benthic samples arrived at the Moscow EcoAnalysts facility in good condition. Once the samples were received at the laboratory, they were transferred to 70% ethanol for long-term preservation and storage. The sorting process entailed placing small quantities of sample in a petri dish, removing all organisms under a dissecting microscope, and placing them into vials according to major taxon categories (e.g. molluscs, crustaceans, annelids, etc.). This process was continued until 100% of the sample was sorted. Sorted material was then transferred back to the original sample container and underwent a quality assurance (QA) check to control for thoroughness and consistency in sample sorting. This sorting review was performed by staff who did not initially sort the sample.

All specimens were identified by qualified taxonomists down to the lowest practicable taxonomic level (LPTL) and enumerated. In most cases this was genus or species level; those organisms identified to a higher level were due to a qualifier, such as damage or immaturity of the specimen. All benthic data and results of the quality control (QC) are presented in Appendix B.

2.3 Univariate Data Analysis

In addition to taxa richness (the number of unique taxa in a sample) and total abundance (the sum of organisms in a sample), two standard biodiversity measures were calculated to determine benthic community diversity and evenness: the Shannon-Wiener Diversity Index, and Pielou’s Evenness Index. Univariate results were compared using non-parametric t-Tests.

2.3.1 Data Treatment

The data files for each sampling event were reviewed prior to any analysis. During this review, it was noted that several taxa were present that are more associated with an encrusting community (one that attaches to structure). Although these organisms contribute to the benthic community, their presence in a sample will vary based on the presence of objects (rocks/debris, etc.) in the sample and not necessarily interactions with the active carbon or contaminants of concern in the sediment. An example of this is the marine barnacle (i.e. *Balanus crenatus*). These taxa were removed from the assessment. A list of these removed groups is included in Appendix C.

2.3.2 Abundance

Invertebrate abundance is the total count of the individual organisms identified from a sample that represent the benthic community regardless of phylogenic grouping. For comparison across other data sets, abundance was converted to estimated density (individuals/m^2). Invertebrate abundance is linearly related to sample area and can be adjusted to estimate density (Hammerstrom, et al. 2010).

2.3.3 Taxa Richness

The richness of a sample is a count of the number of taxa described for a sample. The general premise when conducting bioassessments is that the richness of a sample will decline as habitat conditions decline. To calculate true richness of a sample, all taxa need to be identified to species level. Often this level of identification can be difficult due to immature or damaged specimen. One important note is that datasets that generate richness data at different phylogenic levels do not calculate richness values that are comparable to each other.

2.3.4 Shannon Diversity Index

The Shannon Diversity Index (H’) is a quantitative measurement of biodiversity within a sample and is dependent on the richness within a community as well as how evenly distributed or abundant those taxa are. Unlike richness, diversity provides a more wholistic view of community composition and the distribution of rare vs common taxa. A higher diversity score equates to a more diverse community:

$$H' = -\sum_{i=1}^{R} p_i \ln p_i$$

Where R is the richness of the dataset in terms of total number of different taxa, p_i is the proportion of individuals belonging to the *ith* species in the dataset.

2.3.5 Pielou's Evenness Index

Evenness is a measure of biodiversity that quantifies how equivalent the community is numerically. The evenness index (J') describes how close in abundance each species is within a given taxonomic group for a given sample. The evenness of a population can be represented by Pielou's evenness index:

$$J' = \frac{H'}{\log_e \mathrm{S}}$$

Where S is abundance of organisms and H' is Shannon-Wiener diversity. J' is constrained between 0 and 1, with more evenly distributed communities having higher J' values.

2.3.6 Non-Parametric Comparison Testing

Non-parametric t-tests were performed using Microsoft Excel to compare the univariate results. Comparison testing was performed to test the null hypothesis that there is no difference between the means of the compared groups. Because there is not an *a prior* expectation for the direction of change, the results were interpreted using the p-value for the two-tailed test.

Comparisons between reference and multi-metric stations performed for the 82-Month data set were assessed using t-Tests that assumed unequal variances due to the small and unequal samples sizes. When comparing multi-metric stations from baseline to multi-metric stations from the 82-Month data, t-Test were performed that assumed equal variance.

2.4 Multivariate Data Analysis

Multivariate analyses are an important tool that can be used for interpreting benthic community data. One feature that is important to the multivariate techniques is that these analyses do not utilize structure in the sample design (i.e. replicates). Each sample is organized only from the pairwise similarity testing between all samples.

2.4.1 Data Treatment

Prior to any multivariate analyses for this project, all datasets were synonymized. An essential step for comparing multi-year datasets, synonymization accounts for changes in identification resolution or taxon name changes. To address taxon name changes, each identification was assessed for validity using the online resource, World Register of Marine Species (WoRMS 2019). A summary of the changes is included in Appendix C.

To reduce the influence of highly abundant taxa and allow for rare taxa to contribute to the Bray-Curtis Similarity matrix in the multivariate analyses, a square-root transformation of the abundance data was performed.

2.4.2 Bray-Curtis Coefficient

The Bray-Curtis coefficient is a measurement that determines similarity between two groups based on variable values. This coefficient is often used to investigate similarity of invertebrate community (taxa as variables) between biotic samples. Based on the Bray-Curtis results, a resemblance matrix is created that reports the result values for each comparison.

As defined above, data was pretreated with a square root transformation of abundance. The Bray-Curtis Similarity Index calculates the relative percent similarity between two different samples based primarily on the relative abundance of taxa present within each sample.

As defined by Bray and Curtis, the index of similarity is:

$$S_{17} = 100\left(1 - \frac{\sum_i |y_{i1} - y_{i2}|}{\sum_i y_{i1} + \sum_i y_{i2}}\right)$$

Where *Yi* is the count for the ith (of p) species from sample 1, ∑i (….) denotes summation over those species. The results from the Bray-Curtis similarity index are bound between 0 and 1, which is converted to a percentage for comparison purposes. Samples with a result of 1 have the same species composition and samples with a result of 0 do not share any common species.

2.4.3 Hierarchical Clustering

Similarity coefficient values are highly influenced by any transformations that occur during the assessment. Similarity coefficients need to be compared by the rank similarity between stations (i.e. Sample 1 is more similar to Sample 2 than it is to Sample 3) (Clarke, et al. 2014). The Bray-Curtis similarity matrix can be displayed using a hierarchical clustering diagram. This diagram is a visual representation of the results of the similarity matrix. The x-axis of this plot represents the individual samples while the y-axis defines the similarity level at which two samples, or a group of samples, can be defined.

To test the significance of the similarity between samples or sample groups in the dendrogram, a similarity profile test (SIMPROF) was performed. The SIMPROF test is a permutation test of the null hypothesis that states there is no difference between the invertebrate community between two or more samples. SIMPROF uses permutations of species values over the samples to create a set of resemblances among all pairs of samples ranked from smallest to largest which are then ordered and plotted as a dendrogram. The SIMPROF test compares the average absolute departure of the real profile from the mean of the permuted ones. The significance level is determined by the percent of permuted values that are greater than or equal to the observed value (Clarke, et al. 2014). Sample groups connected by dashed red lines indicate a fail to reject the null hypothesis and further analyses between samples withing these groups are not appropriate. Sample groups connected by solid black lines indicate that further evaluation of these communities can occur.

2.4.4 Similarity Percentages Analysis (SIMPER)

The SIMPER analysis in Primer allows for the similarity matrix, in this case based on the Bray-Curtis results, to be broken down into taxa contributions to similarity between (or dissimilarity between) groups. The sample groups can be defined during the initial sampling design (ie. reference samples vs multi-metric) or during the analysis (ie. samples from under the pier vs. samples with no overhead structure). The SIMPER analysis will first indicate what taxa groups are contributing the greatest to the similarity between samples within the group and then it will determine which taxa are contributing the greatest to the dissimilarity between groups. This process will determine the contribution percent for each taxon as well as the cumulation percent of taxa defined in an ordered rank. Also, an important result of this process is the average similarity (or dissimilarity) of each taxon divided by the standard deviation. This result is a good indication of a taxa that contributes relatively consistently to the distinction for all pairs of samples by normalizing the data to the variability of the abundance of the taxa.

3. 82-MONTH SURVEY BENTHIC COMMUNITY RESULTS

The benthic infaunal community results of the 82-Month survey are presented in the following sections. All benthic community data, taxonomy QC results, and benthic sample chain of custody (COC) forms are provided in Appendix B.

3.1 Univariate Data Analysis

The total abundance of organisms, taxa richness, and community composition indices were calculated for each station (Table 3-1). Abundance ranged from 10 to 197 individuals per 0.009 m^2, with station LTM-9-MM being the most abundant and station LTM-2-MM being the least. Station LTM-9-MM contained 21 taxa per 0.009 m^2, which was the highest taxa richness in the survey. Station sample richness ranged from 3 to 21 identified taxa. Diversity ranged from a score of 0.51 to 2.13. The least diverse station was LTM-1-RBS, which also had the least evenly distributed communities.

Box plots illustrating the univariate results grouped by multi-metric and reference stations are provided in Figure 3-1. The t-Tests comparing the reference and multi-metric samples indicated no significant differences between the univariate results except for abundance. Abundance showed a significant difference between the multi-metric and reference locations, where the multi-metric stations had the greater abundance.

Table 3-1. 82-Month Sample Metrics Results

Sample	Benthic Community Metric				
	Total Abundance (indiv./0.009 m^2)	Density (indiv./m^2)	Richness (# taxa/0.1 m^2)	Shannon-Wiener Diversity (H')	Pielou's Evenness (J')
LTM-1-MM	11	1222	7	1.85	0.95
LTM-2-MM	10	1111	7	1.75	0.90
LTM-3-MM	113	12556	19	1.77	0.60
LTM-4-MM	97	10778	11	1.62	0.68
LTM-5-MM	194	21556	14	1.02	0.39
LTM-6-MM	36	4000	14	1.98	0.75
LTM-7-MM	121	13444	18	1.41	0.49
LTM-8-MM	64	7111	17	2.13	0.75
LTM-9-MM	197	21889	21	1.55	0.51
LTM-10-MM	38	4222	14	2.12	0.80
LTM-1-RBS	14	1556	3	0.51	0.46
LTM-2-RBS	31	3444	6	0.87	0.48
LTM-3-RBS	13	1444	9	2.10	0.95
LTM-4-RBS	73	8111	15	2.03	0.75

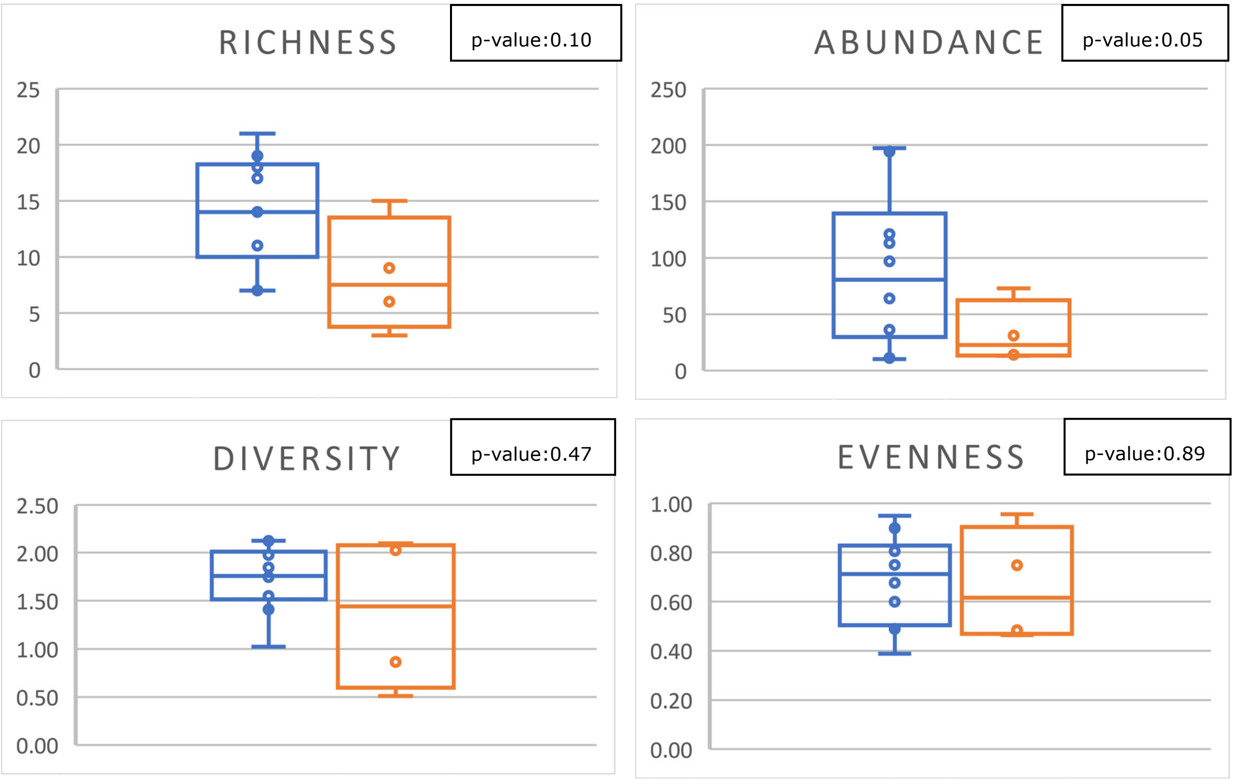
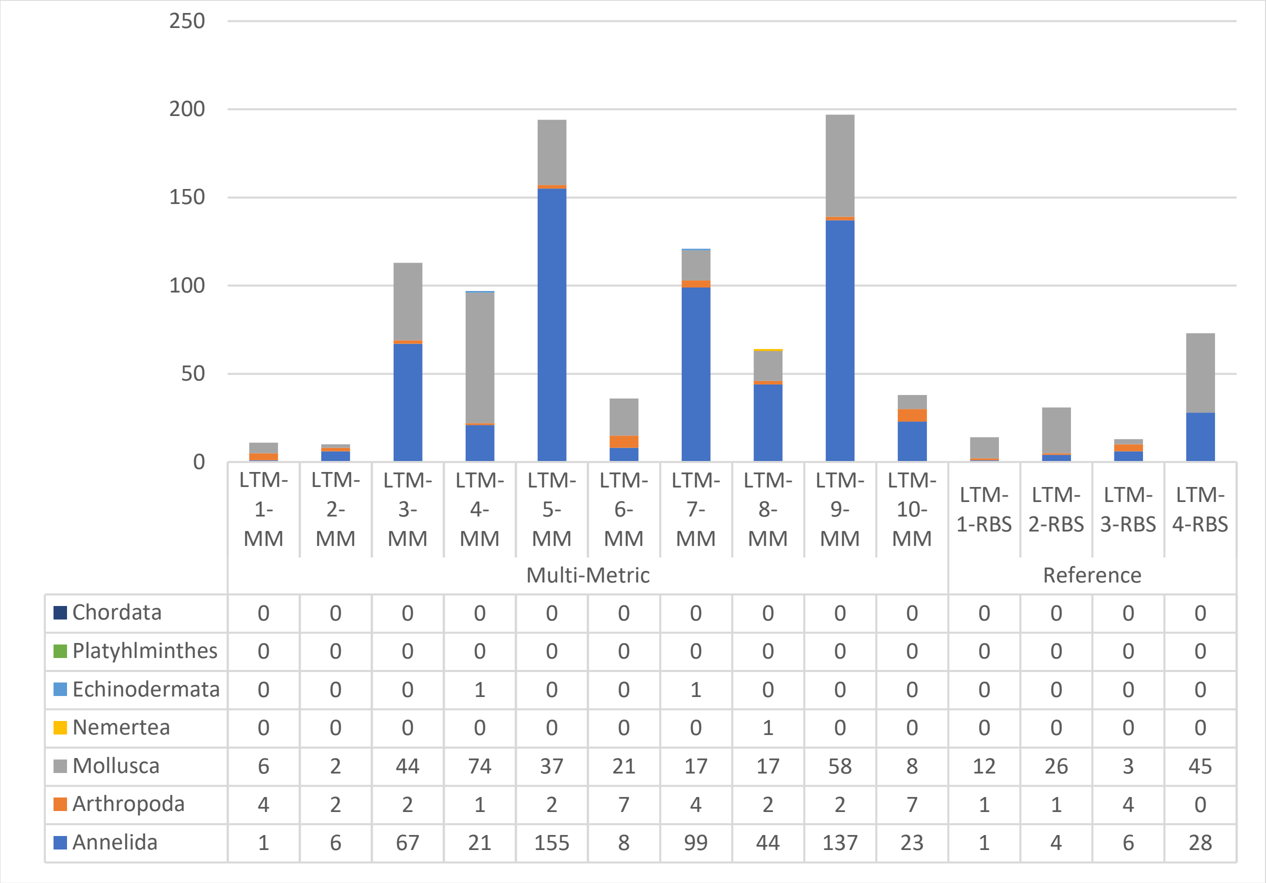


Figure 3-1. 82-Month Univariate Box Plots
(Blue box indicates Multi-Metric samples; Orange box indicates Reference samples; p-value result of t-Test)

3.2 Faunal Composition

Benthic communities in samples collected near Pier 7 were primarily composed of invertebrates that represented the annelida and mollusca phyla (Figure 3-2). Similarity between multi-metric samples was primarily driven by the relative abundance of three taxa while the similarity between reference stations was driven by two taxa (Table 3-2). *Alvania compacta* was found to drive most similarity between both reference and multi-metric stations. This organism is a gastropod that is a grazing detrital feeder that will be found interacting with the sediment surface. The Cirratulidae identification is a family of polychaete worms and are the next taxa group that provided the greatest contribution to similarity between both the reference and multi-metric samples. Although primary identifications of this family were more detailed than family level, the synonymization process ended up rolling all identifications to family level. In samples collected for the 82-Month survey, three taxa were identified in the Cirratulidae family with the most abundant of these identified as *Aphelochaeta glandaria* Complex which accounted for 333 of the 341 Cirratulidae identifications. According to Fauchald and Jumars (Minerals Management Service 1984), cirratulids are surface deposit-feeders, using palps and tentacular filaments for food collection. They may be selective in terms of particle size and composition. These organisms are indicating a benthic community that is primarily composed of mobile to static surface deposit-feeders.



	LTM-1-MM	LTM-2-MM	LTM-3-MM	LTM-4-MM	LTM-5-MM	LTM-6-MM	LTM-7-MM	LTM-8-MM	LTM-9-MM	LTM-10-MM	LTM-1-RBS	LTM-2-RBS	LTM-3-RBS	LTM-4-RBS
Chordata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Platyhlminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinodermata	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Mollusca	6	2	44	74	37	21	17	17	58	8	12	26	3	45
Arthropoda	4	2	2	1	2	7	4	2	2	7	1	1	4	0
Annelida	1	6	67	21	155	8	99	44	137	23	1	4	6	28

Figure 3-2. Faunal Composition

Table 3-2. SIMPER Results for 82-Month Samples

Multi-metric sample similarity – 38.0%					
Taxa	**Phylum**	**Average Relative Abundance**	**Similarity/ Standard Deviation**	**Contribution %**	**Cumulative %**
Alvania compacta	Mollusca	3.59	2.21	24.9	24.9
Cirratulidae	Polychaeta	4.20	0.91	18.7	43.5
Prionospio sp.	Polychaeta	1.59	1.64	11.7	55.2
Reference sample similarity – 31.7%					
Taxa	**Phylum**	**Average Relative Abundance**	**Similarity/ Standard Deviation**	**Contribution %**	**Cumulative %**
Alvania compacta	Mollusca	3.17	1.46	57.1	57.1
Cirratulidae	Polychaeta	1.22	0.84	14.6	71.7

3.3 Multivariate Data Analysis

The results from the Bray-Curtis similarity analysis and subsequent SIMPROF test are presented in Figure 3-3. Although these results show that some samples are more similar than others, there is not enough evidence to reject the null hypothesis that would indicate that these invertebrate communities are different from each other. Further multivariate analyses are not recommended on this data set alone.

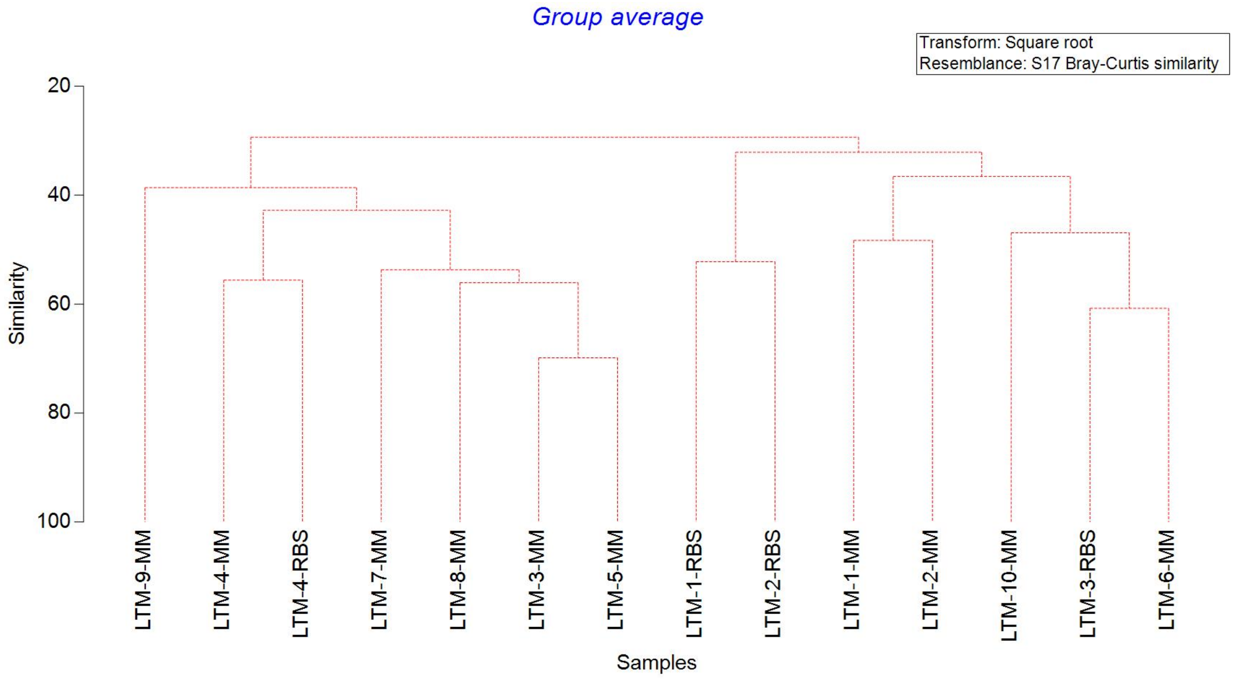


Figure 3-3. Bray-Curtis Similarity Results from 82-Month Survey

3.4 Regional Context

A previous report, ER-201131 (Kirtay, et al. 2017), compared the results for abundance, diversity, taxa richness, evenness, and dominance from the samples collected adjacent to Pier 7 to a local monitoring station (PSAMP Station 164) to provide regional context. There are sample design differences between the samples collected adjacent to Pier 7 and the PSAMP Station that make most of these comparisons inappropriate. The PSAMP program uses a 0.1 m^2 Van Veen grab sampler to collect samples. This grab collects a larger area than the composite core sample collected for the Pier 7 program. Although abundance of a sample does have a linear relationship with the sample area and the result values can be extrapolated to other areas, taxa richness and any metric that uses richness do not. Any comparison of richness related metrics will demonstrate lower results for the Pier 7 samples based on sample design alone. The organism density can be compared across these studies as it is the area normalized value of abundance and reported as individuals per square meter.

4. TEMPORAL COMPARISON

A temporal comparison of the benthic community results from the 82-Month survey was performed by comparing to the benthic community data collected during the monitoring surveys. Benthic samples were collected for the monitoring study 2-months prior to treatment (Baseline), as well as 10-months, 22-months, and 33-months post treatment.

4.1 Univariate Data Comparison

The benthic invertebrate samples univariate results showed a large amount of variability within multi-metric and reference locations during the surveys conducted at the site for these studies (Table 4-1). Station variability will be discussed further in Section 4.2. Bar graphs figures are provided to illustrate the univariate metrics results over the entire project (Figure 4-1 through Figure 4-4).

Table 4-1. Univariate Results (All Surveys)

Survey	Sample Type	Benthic Community Metric			
		Abundance (indiv./0.009 m^2) (Average ± S.D.)	Richness (# taxa/0.1 m^2) (Average ± S.D.)	Shannon-Wiener Diversity (H’) (Average ± S.D.)	Pielou’s Evenness (J’) (Average ± S.D.)
Baseline	Multi-Metric	54.8 ± 38.7	12.7 ± 5.0	1.9 ± 0.4	0.77 ± 0.1
	Reference	14.3 ± 9.9	4.5 ± 0.6	1.2 ± 0.1	0.81 ± 0.1
Month 10	Multi-Metric	39.3 ± 30.5	11.5 ± 4.3	1.9 ± 0.4	0.82 ± 0.1
	Reference	22.3 ± 18.7	8.0 ± 2.2	1.8 ± 0.3	0.88 ± 0.1
Month 22	Multi-Metric	52.5 ± 64.3	13.2 ± 6.1	2.0 ± 0.3	0.81 ± 0.1
	Reference	50.0 ± 60.1	10.8 ± 10.4	1.5 ± 0.6	0.78 ± 0.2
Month 33	Multi-Metric	18.8 ± 18.5	8.8 ± 6.1	1.8 ± 0.7	0.92 ± 0.1
	Reference	17.5 ± 13.0	7.8 ± 2.5	1.7 ± 0.4	0.84 ± 0.1
Month 82	Multi-Metric	88.1 ± 68.9	14.2 ± 4.8	1.7 ± 0.3	0.68 ± 0.2
	Reference	32.8 ± 28.1	8.3 ±5.1	1.4 ± 0.8	0.66 ± 0.2

S.D. = Standard Deviation

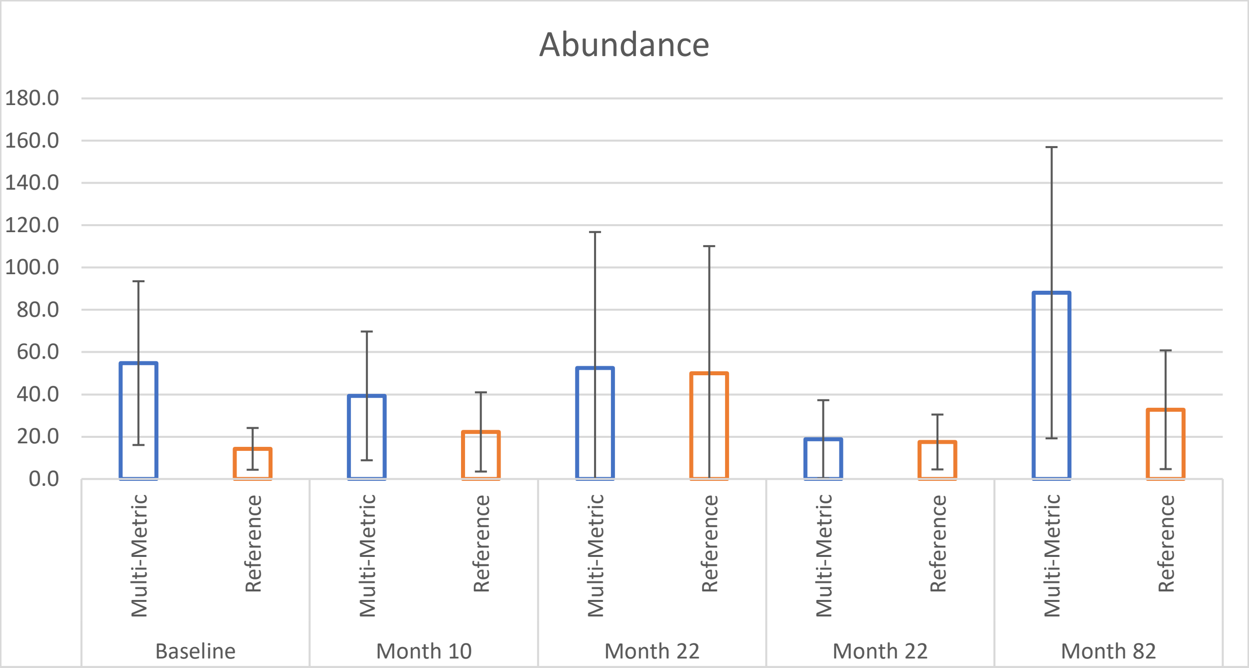


Figure 4-1. Abundance Result Comparison (error bars indicate one S.D.)

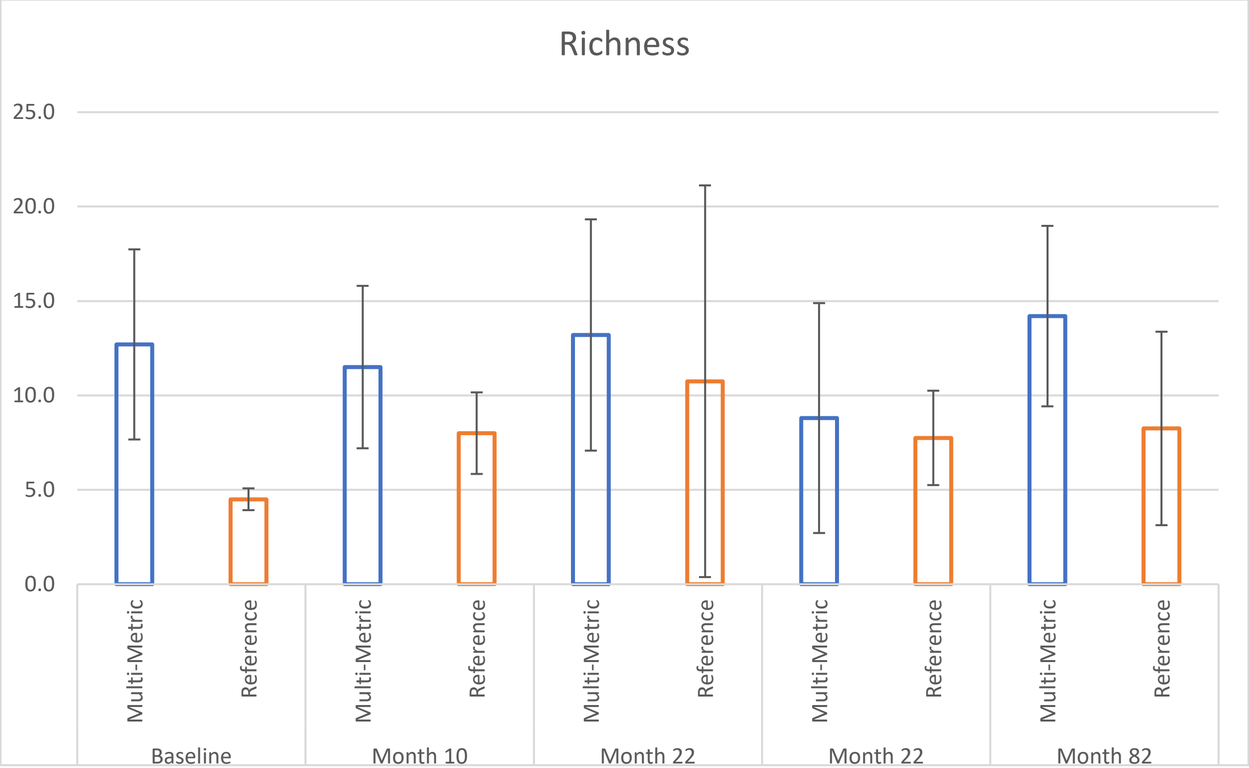


Figure 4-2. Richness Result Comparison (error bars indicate one S.D.)

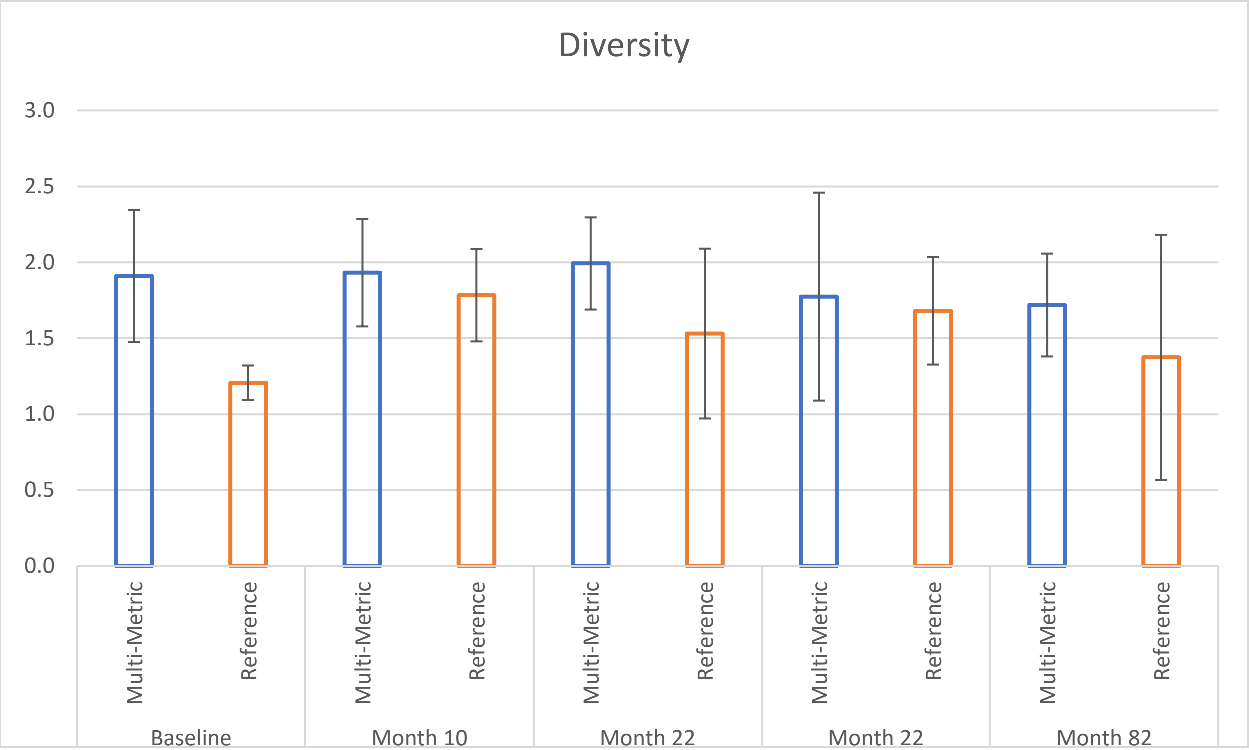


Figure 4-3. Diversity Result Comparison (error bars indicate one S.D.)

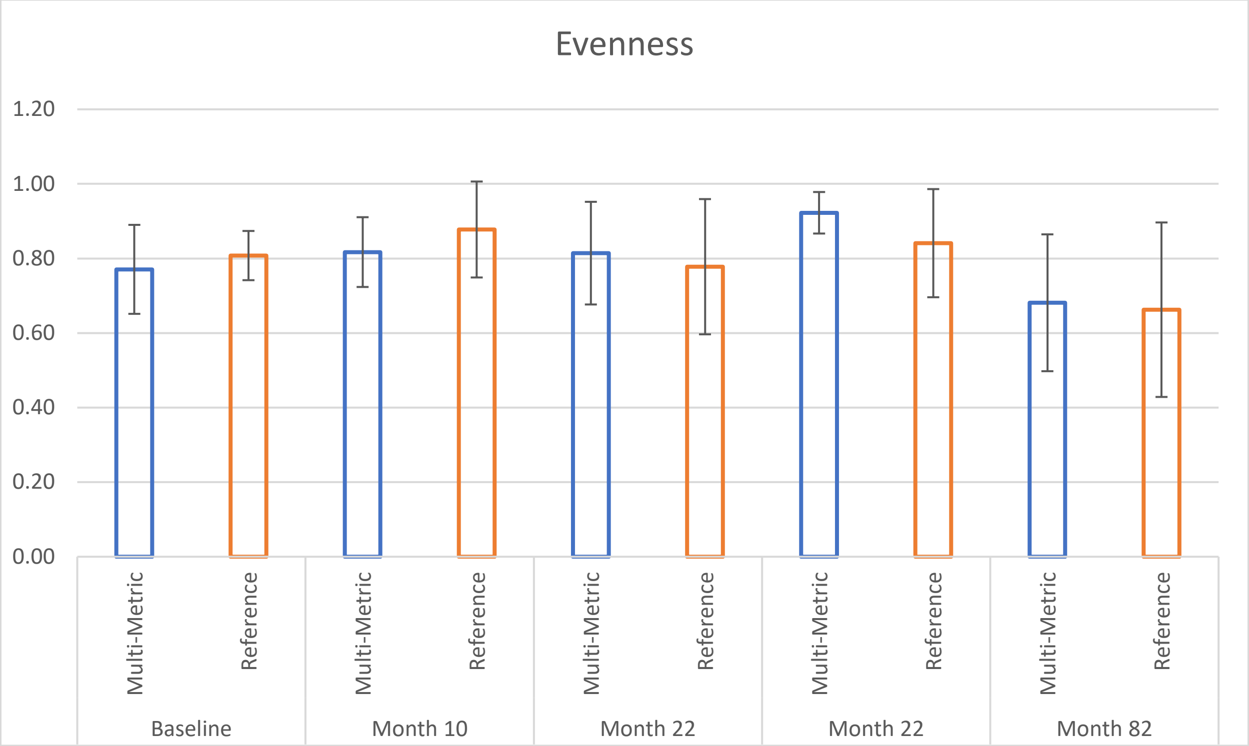


Figure 4-4. Evenness Result Comparison (error bars indicate one S.D.)

4.2 Station Variability

Figure 4-5 illustrates abundance variability over time at each location. When these results are investigated further, specific sites appear to demonstrate greater abundance variability. Samples collected at stations 4-MM, 5-MM, 9-MM, and 4-RBS generally have a greater range in abundance values over time than the other stations. Samples collected from these stations may be affecting the ability to determine a difference between the reference and multi-metric stations during the univariate analysis. There are many potential factors that could define why these samples are responding differently than the others. One could be related to the actual structure of the pier itself. Stations 4-MM, 9-MM and 4-RBS are all located under the pier. There is a potential that the benthic communities living at these stations are enhanced by the fall of organic debris from community of organisms that are attached to the pier structure.

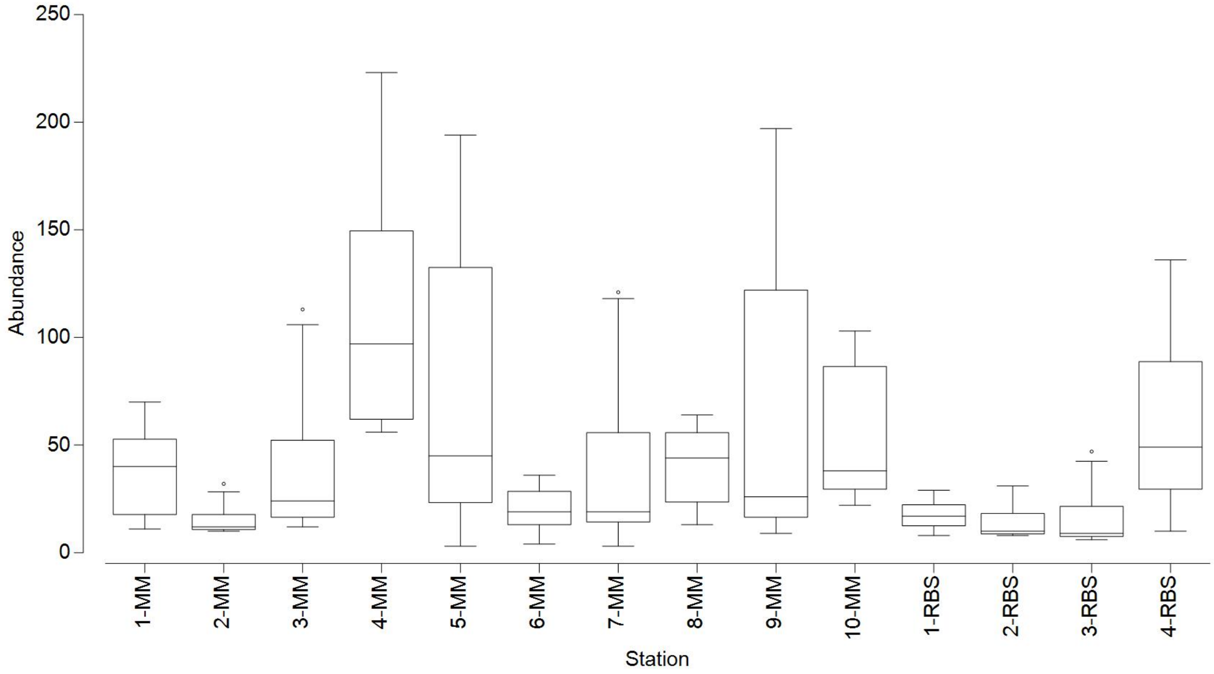


Figure 4-5. Abundance Variability at each Station

The community data collected during the baseline survey conducted in 2012 was analyzed using multivariate tools (Bray-Curtis similarity coefficient) and the results indicate the community structure of some of the samples collected from under Pier 7 are distinguishable from other samples without an overhead structure based on the SIMPROF results (Figure 4-6). Although these differences appear to be related to the pier structure there may be other variables that are more correlated with these changes. Further study could be performed by running correlation analyses (e.g. Pearsons correlation) with the environmental data (sediment chemistry, water depth, sediment conventionals, etc.) collected at these stations. If the community structure is more related to proximity to overhead structures, these stations could be removed to better investigate the variable of concern; are the benthic communities changing due to the placement of the activated carbon amendment.

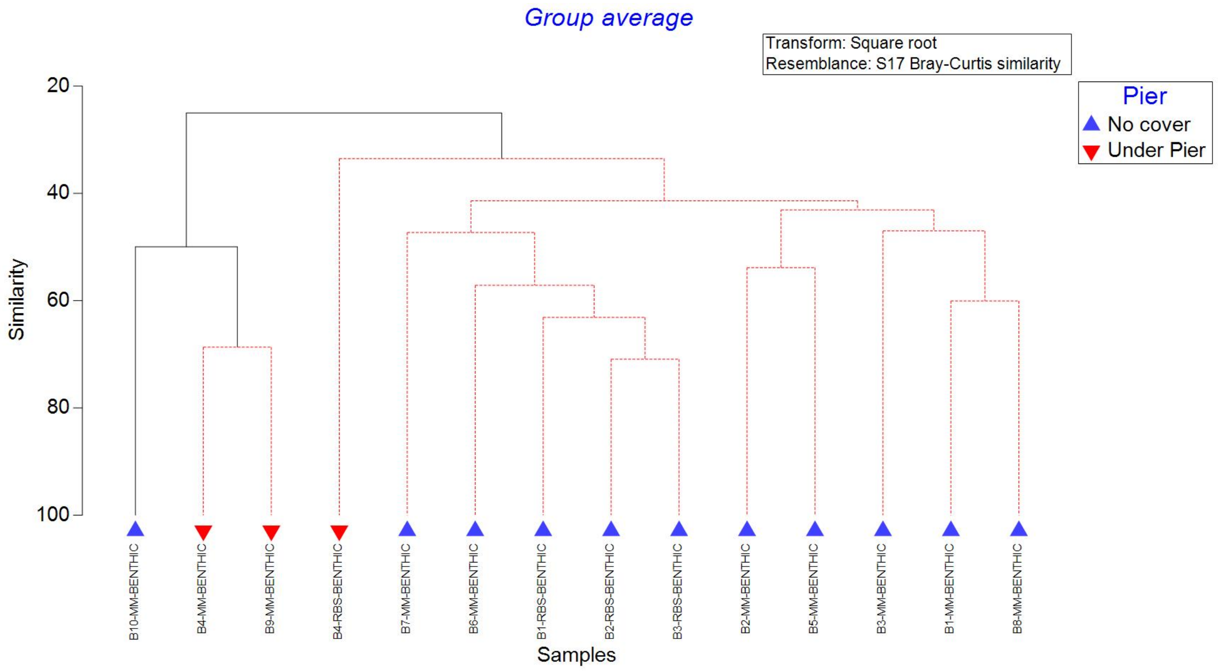


Figure 4-6. Bray-Curtis Similarity Plot (Baseline)

The changes to the benthic community from what was described in the baseline samples to the current community was investigated using Bray-Curtis similarity coefficient. Three groups of samples indicated community differences (Figure 4-7). Samples from Group A were all collected during the baseline investigation, while samples in Group C were all collected during the 82-Month survey. Group B consists of samples from both surveys. The samples collected from two stations, 4-MM and 9-MM, during both Baseline and 82-Month surveys are in Group B, indicating a similarity between the benthic communities at these stations.

The majority of similarity of benthic communities in sample Group A (all Baseline samples) is based on the abundance of three species of polychaeta, while most of Group C (all 82-Month samples) similarity is based on polychaeta, mollusca and a crustacea (Table 4-2). Reference stations are found in each sample group indicating that the benthic communities in the treated areas are similar to the benthic communities found in reference areas.

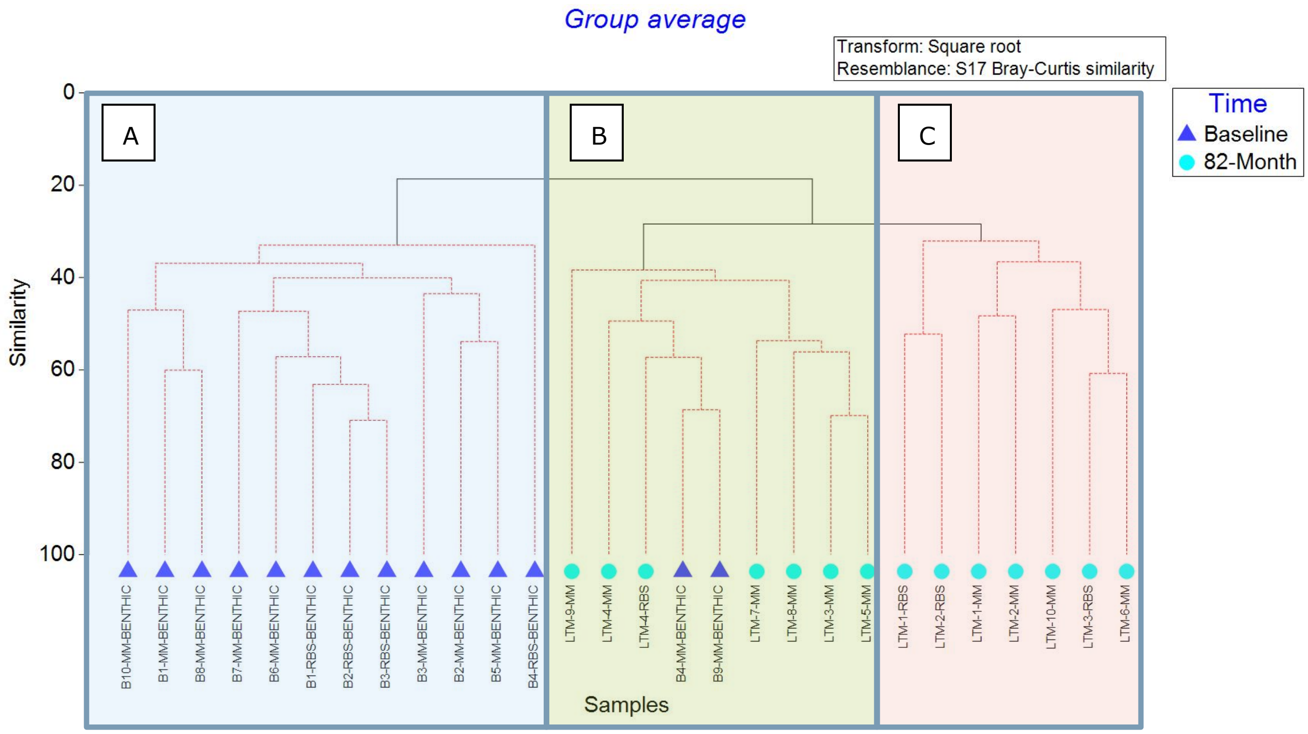


Figure 4-7. Bray-Curtis Similarity Dendrogram (Baseline and 82-Month Samples)

Table 4-2. SIMPER Sample Group Similarity (Baseline and 82-Month Samples)

Group A sample similarity – 41.0%

Taxa	Phylum	Average Relative Abundance	Similarity/ Standard Deviation	Contribution %	Cumulative %
Capitella capitata	Polychaeta	2.42	1.24	34.5	34.5
Armandia brevis	Polychaeta	2.30	3.25	26.6	61.1
Schistomeringos annulata	Polychaeta	1.36	0.78	12.0	73.1

Group B sample similarity – 45.3%

Taxa	Phylum	Average Relative Abundance	Similarity/ Standard Deviation	Contribution %	Cumulative %
Alvania compacta	Mollusca	4.40	2.78	24.6	24.6
Cirratulidae	Polychaeta	4.51	0.94	15.2	39.8
Kurtiella tumida	Mollusca	3.04	1.61	14.1	53.9

Group C sample similarity – 37.9%

Taxa	Phylum	Average Relative Abundance	Similarity/ Standard Deviation	Contribution %	Cumulative %
Alvania compacta	Mollusca	2.50	1.67	37.6	37.6
Cirratulidae	Polychaeta	1.39	0.88	14.4	52.0
Pinnotheridae	Arthropoda	1.24	0.88	13.2	65.2

SIMPER analysis also determined the primary taxa contributing to the dissimilarity between groups. These results are provided in Table 4-3. One of the primary factors that is driving the differences between these sample groups in relative abundance. For example, Cirratulidae and *Alvania compacta* have a relative abundance of 0.43 and 0.51, respectively for the samples in Group A while these same taxa demonstrated a relative abundance of 4.51 and 4.40 respectively in samples in Group B.

While Cirratulidae typically build tubes and are sedentary, *Alvania compacta* are snails that roam the surface of the sediment. Both are surface deposit feeders and increases in relative abundance of these taxa may be more related to increases in surficial detritus.

There are also major contributors that were absent in one sample grouping but present in another. For example, *Capitella capitata* and *Armandia brevis* were present in the Group A samples but absent in the Group C samples. This could be an indication of a temporal shift in the benthic community since all the samples in Group A were from baseline survey and the samples in Group C were from the 82-Month survey. *Capitella capitata* were only found at two stations (7-MM and 9-MM) during the 82-Month survey. However, they were found at all but four stations during the baseline survey. *Armandia brevis* were found at all the baseline stations but only found in around half of the 82-Month survey stations and at generally lower abundance.

Capitella capitata are a very common species of polychaeta that are found around the region. The presence of these worms, in large abundances, has often been considered as an “indicator” of pollution or environmental disturbance especially related to anthropogenic organically enriched areas (Minerals Management Service 1984). *Capitella capitata* are a tolerant opportunistic taxon and the temporal decrease in abundance is likely related to nutrient availability associated with biological detritus associated with marine growth on the pier structures rather than harm from the activated carbon treatment.

Table 4-3. SIMPER Between Sample Group Dissimilarity (Baseline and 82-Month Samples)

Group A to Group B sample dissimilarity – 78.0%

Taxa	Phylum	Group A Average Relative Abundance	Group B Average Relative Abundance	Dissimilarity/ Standard Deviation	Contribution %	Cumulative %
Cirratulidae	Polychaeta	0.43	4.51	1.07	12.5	12.5
Alvania compacta	Mollusca	0.51	4.40	2.17	11.4	23.9
Capitella capitata	Polychaeta	2.42	0.27	1.69	6.7	30.6

Group A to Group C sample dissimilarity – 85.6%

Taxa	Phylum	Group A Average Relative Abundance	Group C Average Relative Abundance	Dissimilarity/ Standard Deviation	Contribution %	Cumulative %
Capitella capitata	Polychaeta	2.42	0.00	1.61	12.7	12.7
Alvania compacta	Mollusca	0.51	2.50	1.19	11.1	23.8
Armandia brevis	Polychaeta	2.30	0.20	2.02	9.5	33.3

Group B to Group C sample dissimilarity – 71.6%

Taxa	Phylum	Group B Average Relative Abundance	Group C Average Relative Abundance	Dissimilarity/ Standard Deviation	Contribution %	Cumulative %
Cirratulidae	Polychaeta	4.51	1.39	1.05	12.6	12.6
Kurtiella tumida	Mollusca	3.04	0.14	1.44	10.0	22.6
Alvania compacta	Mollusca	4.40	2.50	1.53	7.9	30.5

5. DISCUSSION

5.1 Summary of 82-Month Comparison

The benthic communities sampled during the 82-Month survey indicated no significant difference in the community structure between carbon-amended multi-metric sites and non-amended reference locations based on the univariate metrics except for abundance. Sites treated with the activated carbon amendment demonstrated an increase in abundance over the reference locations. These metrics showed variability between grouped stations over time and there may be environmental factors outside the treatment that are influencing abundance. The multivariate analysis of these stations failed to reject the null hypothesis that these communities are not different which indicates a similar community structure between all samples

High variability between grouped stations was also noted during the temporal investigation. Again, this variability could be due to environmental factors related to specific stations that were not controlled during the sampling design. Further study could be made to better understand this variability by investigating potential correlations between the benthic communities and environmental data collected during the assessment. One such method can be with the use correlation analysis between similarity differences and environmental data. This investigation may help to determine if the variability around the baseline stations results correlated with the pier structure or other data, such as the availability of PCBs. If some of the variability can be better explained by site specific conditions, further and more refined analysis could be performed to determine impacts/enhancement of the benthic communities based on the use of the activated carbon amendment.

Since the 2019 dataset (82-Month) showed no significant differences between the reference and multi-metric stations, further investigation of possible correlations between benthic communities and environmental factors (using multivariate techniques), should not focus on this dataset alone.

6. REFERENCES

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APPENDIX A

Demonstration Plan ER18-5079

FINAL REPORT

Demonstration of In Situ Treatment with Reactive Amendments for Contaminated Sediments in Active DoD Harbors

ESTCP Project ER-201131

JANUARY 2017

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Distribution Statement A
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APPENDIX B

Benthic Community Data

Benthic Infauna Sample CoC

Geosyntec ESTCP Marine Bioassessment 2019

Taxonomy Report

ECOANALYSTS, INC.
LIFE IN WATER

SAMPLE_ID	DATE_COL	SAMPTYPE	TAXON_NAME	ABUNDANCE	IMMATURE	INDETERMINATE	CONDITION
Field Descriptor #1	Sample Collection	Benthic Sample	Unique Taxon	Number of	Specimens	Specimens	Specimens in Poor
	Date	Type	Name	Individuals	Immature (Y/N)	Indeterminate (Y/N)	Condition or Fragments (Y/N)
LTM-1-RBS	8/29/2019	Marine	Mytilidae	1	Y	N	N
LTM-1-RBS	8/29/2019	Marine	Mycale adhaerens	1	N	N	N
LTM-1-RBS	8/29/2019	Marine	Alvania compacta	12	N	N	N
LTM-1-RBS	8/29/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-1-RBS	8/29/2019	Marine	Crangonidae	1	Y	Y	N
LTM-1-RBS	8/29/2019	Marine	Aphelochaeta glandaria Complex	1	N	N	N
LTM-2-RBS	8/28/2019	Marine	Mycale adhaerens	1	N	N	N
LTM-2-RBS	8/28/2019	Marine	Alia sp.	1	Y	N	N
LTM-2-RBS	8/28/2019	Marine	Nassarius mendicus	1	N	N	N
LTM-2-RBS	8/28/2019	Marine	Alvania compacta	24	N	N	N
LTM-2-RBS	8/28/2019	Marine	Celleporella hyalina	1	N	N	N
LTM-2-RBS	8/28/2019	Marine	Crangonidae	1	Y	Y	N
LTM-2-RBS	8/28/2019	Marine	Balanus crenatus	20	N	N	N
LTM-2-RBS	8/28/2019	Marine	Paraprionospio alata	3	N	N	N
LTM-2-RBS	8/28/2019	Marine	Polycirrus sp. III sensu Banse 1980	1	N	N	N
LTM-3-RBS	8/29/2019	Marine	Macoma nasuta	2	N	N	N
LTM-3-RBS	8/29/2019	Marine	Alvania compacta	1	N	N	N
LTM-3-RBS	8/29/2019	Marine	Pinnotherinae	1	Y	Y	N
LTM-3-RBS	8/29/2019	Marine	Pinnixa occidentalis Cmplx	3	N	N	N
LTM-3-RBS	8/29/2019	Marine	Balanus crenatus	2	N	N	N
LTM-3-RBS	8/29/2019	Marine	Bipalponephtys cornuta	1	N	N	N
LTM-3-RBS	8/29/2019	Marine	Sigambra tentaculata	1	N	N	N
LTM-3-RBS	8/29/2019	Marine	Aphelochaeta glandaria Complex	2	N	N	N
LTM-3-RBS	8/29/2019	Marine	Paraprionospio alata	1	N	N	N
LTM-3-RBS	8/29/2019	Marine	Prionospio (Minuspio) lighti	1	N	N	N
LTM-4-RBS	8/29/2019	Marine	Parvilucina tenuisculpta	1	N	N	N
LTM-4-RBS	8/29/2019	Marine	Kurtiella tumida	29	N	N	N
LTM-4-RBS	8/29/2019	Marine	Macoma inquinata	2	N	N	N
LTM-4-RBS	8/29/2019	Marine	Oligochaeta	8	N	N	N
LTM-4-RBS	8/29/2019	Marine	Evalea tenuisculpta	1	N	N	N
LTM-4-RBS	8/29/2019	Marine	Nassarius mendicus	1	N	N	N
LTM-4-RBS	8/29/2019	Marine	Alvania compacta	11	N	N	N
LTM-4-RBS	8/29/2019	Marine	Pholoe glabra	1	N	N	N
LTM-4-RBS	8/29/2019	Marine	Ampharete acutifrons	1	N	N	N
LTM-4-RBS	8/29/2019	Marine	Aphelochaeta glandaria Complex	4	N	N	N
LTM-4-RBS	8/29/2019	Marine	Chaetozone acuta	2	N	N	N
LTM-4-RBS	8/29/2019	Marine	Paraprionospio alata	2	N	N	N

LTM-4-RBS	8/29/2019	Marine	Prionospio (Minuspio) lighti	2	N	N	N
LTM-4-RBS	8/29/2019	Marine	Prionospio steenstrupi	7	N	N	N
LTM-4-RBS	8/29/2019	Marine	Prionospio sp.	1	N	Y	Y
LTM-1-MM	8/27/2019	Marine	Mytilidae	1	Y	N	N
LTM-1-MM	8/27/2019	Marine	Veneridae	1	Y	N	N
LTM-1-MM	8/27/2019	Marine	Evalea tenuisculpta	1	N	N	N
LTM-1-MM	8/27/2019	Marine	Nassarius mendicus	2	N	N	N
LTM-1-MM	8/27/2019	Marine	Alvania compacta	2	N	N	N
LTM-1-MM	8/27/2019	Marine	Crangon alaskensis	3	N	N	N
LTM-1-MM	8/27/2019	Marine	Pinnotherinae	1	Y	Y	Y
LTM-1-MM	8/27/2019	Marine	Balanus crenatus	3	N	N	N
LTM-1-MM	8/27/2019	Marine	Prionospio steenstrupi	1	N	N	N
LTM-2-MM	8/27/2019	Marine	Evalea tenuisculpta	1	N	N	N
LTM-2-MM	8/27/2019	Marine	Alvania compacta	1	N	N	N
LTM-2-MM	8/27/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-2-MM	8/27/2019	Marine	Crangon alaskensis	1	N	N	N
LTM-2-MM	8/27/2019	Marine	Pinnotherinae	1	Y	Y	N
LTM-2-MM	8/27/2019	Marine	Eteone californica	1	N	N	N
LTM-2-MM	8/27/2019	Marine	Aphelochaeta glandaria Complex	4	N	N	N
LTM-2-MM	8/27/2019	Marine	Paraprionospio alata	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Cardiidae	1	Y	N	N
LTM-3-MM	8/27/2019	Marine	Kurtiella tumida	3	N	N	N
LTM-3-MM	8/27/2019	Marine	Macoma inquinata	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Veneridae	1	Y	N	N
LTM-3-MM	8/27/2019	Marine	Evalea tenuisculpta	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Nassarius mendicus	2	N	N	N
LTM-3-MM	8/27/2019	Marine	Alvania compacta	35	N	N	N
LTM-3-MM	8/27/2019	Marine	Mesocrangon munitella	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Heptacarpus pugettensis	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Balanus crenatus	4	N	N	N
LTM-3-MM	8/27/2019	Marine	Armandia brevis	3	N	N	N
LTM-3-MM	8/27/2019	Marine	Protodorvillea gracilis	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Micropodarke dubia	3	N	N	N
LTM-3-MM	8/27/2019	Marine	Podarkeopsis brevipalpa	2	N	N	N
LTM-3-MM	8/27/2019	Marine	Eteone californica	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Aphelochaeta glandaria Complex	49	N	N	N
LTM-3-MM	8/27/2019	Marine	Caulleriella hartmanae	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Chaetozone acuta	1	N	N	N
LTM-3-MM	8/27/2019	Marine	Prionospio steenstrupi	4	N	N	N
LTM-3-MM	8/27/2019	Marine	Scoloplos armiger	2	N	N	N
LTM-4-MM	8/28/2019	Marine	Kurtiella tumida	33	N	N	N
LTM-4-MM	8/28/2019	Marine	Evalea tenuisculpta	1	N	N	N
LTM-4-MM	8/28/2019	Marine	Nassarius mendicus	6	N	N	N
LTM-4-MM	8/28/2019	Marine	Alvania compacta	34	N	N	N
LTM-4-MM	8/28/2019	Marine	Desdimelita desdichada	1	N	N	N
LTM-4-MM	8/28/2019	Marine	Amphiuridae	1	N	N	Y
LTM-4-MM	8/28/2019	Marine	Notomastus tenuis	1	N	N	N
LTM-4-MM	8/28/2019	Marine	Armandia brevis	1	N	N	N
LTM-4-MM	8/28/2019	Marine	Dorvillea (Schistomeringos) annulata	12	N	N	N
LTM-4-MM	8/28/2019	Marine	Chaetozone acuta	1	N	N	N
LTM-4-MM	8/28/2019	Marine	Prionospio steenstrupi	6	N	N	N
LTM-5-MM	8/27/2019	Marine	Kurtiella tumida	1	N	N	N

LTM-5-MM	8/27/2019	Marine	Macoma inquinata	3	N	N	N
LTM-5-MM	8/27/2019	Marine	Axinopsida serricata	1	N	N	N
LTM-5-MM	8/27/2019	Marine	Leukoma staminea	1	N	N	N
LTM-5-MM	8/27/2019	Marine	Nutricola lordi	2	N	N	N
LTM-5-MM	8/27/2019	Marine	Evalea tenuisculpta	2	N	N	N
LTM-5-MM	8/27/2019	Marine	Nassarius mendicus	3	N	N	N
LTM-5-MM	8/27/2019	Marine	Alvania compacta	24	N	N	N
LTM-5-MM	8/27/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-5-MM	8/27/2019	Marine	Crangon alaskensis	2	N	N	N
LTM-5-MM	8/27/2019	Marine	Balanus crenatus	2	N	N	N
LTM-5-MM	8/27/2019	Marine	Podarkeopsis brevipalpa	1	N	N	N
LTM-5-MM	8/27/2019	Marine	Eteone californica	3	N	N	N
LTM-5-MM	8/27/2019	Marine	Cirratulidae	1	N	Y	Y
LTM-5-MM	8/27/2019	Marine	Aphelochaeta glandaria Complex	146	N	N	N
LTM-5-MM	8/27/2019	Marine	Prionospio steenstrupi	4	N	N	N
LTM-6-MM	8/28/2019	Marine	Bivalvia	2	Y	N	N
LTM-6-MM	8/28/2019	Marine	Kurtiella tumida	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Alia sp.	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Nassarius mendicus	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Alvania compacta	16	N	N	N
LTM-6-MM	8/28/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Romaleon jordani	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Pinnixa occidentalis Cmplx	6	N	N	N
LTM-6-MM	8/28/2019	Marine	Balanus crenatus	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Glycinde picta	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Micropodarke dubia	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Bipalponephtys cornuta	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Sigambra tentaculata	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Aphelochaeta glandaria Complex	2	N	N	N
LTM-6-MM	8/28/2019	Marine	Paraprionospio alata	1	N	N	N
LTM-6-MM	8/28/2019	Marine	Prionospio (Minuspio) lighti	1	N	N	N
LTM-7-MM	8/28/2019	Marine	Kurtiella tumida	6	N	N	N
LTM-7-MM	8/28/2019	Marine	Macoma nasuta	2	N	N	N
LTM-7-MM	8/28/2019	Marine	Evalea tenuisculpta	6	N	N	N
LTM-7-MM	8/28/2019	Marine	Alvania compacta	3	N	N	N
LTM-7-MM	8/28/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-7-MM	8/28/2019	Marine	Cancridae	1	N	Y	Y
LTM-7-MM	8/28/2019	Marine	Eualus sp.	1	N	Y	Y
LTM-7-MM	8/28/2019	Marine	Pinnixa occidentalis Cmplx	2	N	N	N
LTM-7-MM	8/28/2019	Marine	Amphiuridae	1	Y	N	N
LTM-7-MM	8/28/2019	Marine	Capitella capitata Complex	2	N	N	N
LTM-7-MM	8/28/2019	Marine	Dorvillea (Schistomeringos) annulata	1	N	N	N
LTM-7-MM	8/28/2019	Marine	Glycinde picta	1	N	N	N
LTM-7-MM	8/28/2019	Marine	Podarkeopsis brevipalpa	2	N	N	N
LTM-7-MM	8/28/2019	Marine	Eteone californica	2	N	N	N
LTM-7-MM	8/28/2019	Marine	Aphelochaeta glandaria Complex	84	N	N	N
LTM-7-MM	8/28/2019	Marine	Caulleriella hartmanae	1	N	N	N
LTM-7-MM	8/28/2019	Marine	Paraprionospio alata	4	N	N	N
LTM-7-MM	8/28/2019	Marine	Prionospio steenstrupi	1	N	N	N
LTM-7-MM	8/28/2019	Marine	Prionospio sp.	1	N	Y	Y
LTM-8-MM	8/28/2019	Marine	Micrura sp.	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Kurtiella tumida	1	N	N	N

LTM-8-MM	8/28/2019	Marine	Evalea tenuisculpta	3	N	N	N
LTM-8-MM	8/28/2019	Marine	Nassarius mendicus	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Crepipatella lingulata	2	N	N	N
LTM-8-MM	8/28/2019	Marine	Alvania compacta	10	N	N	N
LTM-8-MM	8/28/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Romaleon jordani	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Mesocrangon munitella	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Balanus crenatus	23	N	N	N
LTM-8-MM	8/28/2019	Marine	Armandia brevis	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Dorvillea (Schistomeringos) annulata	3	N	N	N
LTM-8-MM	8/28/2019	Marine	Glycera americana	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Podarkeopsis brevipalpa	4	N	N	N
LTM-8-MM	8/28/2019	Marine	Aphelochaeta glandaria Complex	26	N	N	N
LTM-8-MM	8/28/2019	Marine	Caulleriella hartmanae	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Brada pilosa	1	N	N	N
LTM-8-MM	8/28/2019	Marine	Prionospio (Minuspio) lighti	3	N	N	N
LTM-8-MM	8/28/2019	Marine	Prionospio steenstrupi	4	N	N	N
LTM-9-MM	8/28/2019	Marine	Kurtiella tumida	11	N	N	N
LTM-9-MM	8/28/2019	Marine	Macoma sp.	2	N	N	Y
LTM-9-MM	8/28/2019	Marine	Tellina sp.	1	Y	N	N
LTM-9-MM	8/28/2019	Marine	Evalea tenuisculpta	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Nassarius mendicus	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Crepipatella lingulata	4	N	N	N
LTM-9-MM	8/28/2019	Marine	Alvania compacta	38	N	N	N
LTM-9-MM	8/28/2019	Marine	Celleporella hyalina	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Heptacarpus sp.	1	N	Y	Y
LTM-9-MM	8/28/2019	Marine	Pagurus sp.	1	Y	Y	N
LTM-9-MM	8/28/2019	Marine	Balanus crenatus	43	N	N	N
LTM-9-MM	8/28/2019	Marine	Capitella capitata Complex	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Armandia brevis	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Paleanotus bellis	2	N	N	N
LTM-9-MM	8/28/2019	Marine	Dorvillea (Schistomeringos) annulata	8	N	N	N
LTM-9-MM	8/28/2019	Marine	Micropodarke dubia	2	N	N	N
LTM-9-MM	8/28/2019	Marine	Podarkeopsis brevipalpa	2	N	N	N
LTM-9-MM	8/28/2019	Marine	Pholoides asperus	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Eteone californica	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Eumida sanguinea	3	N	N	N
LTM-9-MM	8/28/2019	Marine	Polydora cornuta	114	N	N	N
LTM-9-MM	8/28/2019	Marine	Prionospio steenstrupi	1	N	N	N
LTM-9-MM	8/28/2019	Marine	Prionospio sp.	1	N	Y	Y
LTM-10-MM	8/28/2019	Marine	Macoma inquinata	2	N	N	N
LTM-10-MM	8/28/2019	Marine	Nutricola lordi	1	N	N	N
LTM-10-MM	8/28/2019	Marine	Mytilus edulis complex	1	N	N	N
LTM-10-MM	8/28/2019	Marine	Nassarius mendicus	1	N	N	N
LTM-10-MM	8/28/2019	Marine	Alvania compacta	3	N	N	N
LTM-10-MM	8/28/2019	Marine	Watersipora subtorquata	1	N	N	N
LTM-10-MM	8/28/2019	Marine	Caprella sp.	1	N	Y	Y
LTM-10-MM	8/28/2019	Marine	Romaleon jordani	1	N	N	N
LTM-10-MM	8/28/2019	Marine	Scleroplax granulata	5	N	N	N
LTM-10-MM	8/28/2019	Marine	Balanus crenatus	2	N	N	N
LTM-10-MM	8/28/2019	Marine	Armandia brevis	2	N	N	N

LTM-10-MM	8/28/2019	Marine	Aphelochaeta glandaria Complex	15	N	N	N
LTM-10-MM	8/28/2019	Marine	Polydora cornuta	1	N	N	N
LTM-10-MM	8/28/2019	Marine	Prionospio (Minuspio) lighti	2	N	N	N
LTM-10-MM	8/28/2019	Marine	Prionospio sp.	2	N	Y	Y
LTM-10-MM	8/28/2019	Marine	Polycirrus sp. III sensu Banse 1980	1	N	N	N

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Taxonomy Report

TAXON_NAME	KINGDOM	PHYLUM	SUBPHYLUM	CLASS	SUBCLASS	ORDER	SUBORDER	FAMILY	GENUS	SPECIES
Alia sp.	Animalia	Mollusca		Gastropoda		Neogastropoda		Columbellidae	Alia	sp.
Alvania compacta	Animalia	Mollusca		Gastropoda		Neotaenioglossa		Rissoidae	Alvania	Alvania compacta
Ampharete acutifrons	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Ampharetidae	Ampharete	Ampharete acutifrons
Amphiuridae	Animalia	Echinodermata	Asterozoa	Ophiuroidea		Ophiurida		Amphiuridae		
Aphelochaeta glandaria Complex	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Cirratulidae	Aphelochaeta	Aphelochaeta glandaria Complex
Armandia brevis	Animalia	Annelida	Aclitellata	Polychaeta	Scolecida			Opheliidae	Armandia	Armandia brevis
Axinopsida serricata	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Thyasiridae	Axinopsida	Axinopsida serricata
Balanus crenatus	Animalia	Arthropoda	Crustacea	Maxillopoda		Sessilia		Balanidae	Balanus	Balanus crenatus
Bipalponephtys cornuta	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Nephtyidae	Bipalponephtys	Bipalponephtys cornuta
Bivalvia	Animalia	Mollusca		Bivalvia						
Brada pilosa	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Flabelligeridae	Brada	Brada pilosa
Cancridae	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Cancridae		
Capitella capitata Complex	Animalia	Annelida	Aclitellata	Polychaeta	Scolecida			Capitellidae	Capitella	Capitella capitata Complex
Caprella sp.	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Caprellidea	Caprellidae	Caprella	sp.
Cardiidae	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Cardiidae		
Caulleriella hartmanae	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Cirratulidae	Caulleriella	Caulleriella hartmanae
Celleporella hyalina	Animalia	Ectoprocta		Gymnolaemata		Cheilostomatida		Hippothoidae	Celleporella	Celleporella hyalina
Chaetozone acuta	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Cirratulidae	Chaetozone	Chaetozone acuta
Cirratulidae	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Cirratulidae		
Crangon alaskensis	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Crangonidae	Crangon	Crangon alaskensis
Crangonidae	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Crangonidae		
Crepipatella lingulata	Animalia	Mollusca		Gastropoda		Neotaenioglossa		Calyptraeidae	Crepipatella	Crepipatella lingulata
Desdimelita desdichada	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Amphipoda	Gammaridea	Melitidae	Desdimelita	Desdimelita desdichada
Dorvillea (Schistomeringos) annulata	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Eunicida	Dorvilleidae	Schistomeringos	Dorvillea (Schistomeringos) annulata
Eteone californica	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Phyllodocidae	Eteone	Eteone californica
Eualus sp.	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Hippolytidae	Eualus	sp.
Eumida sanguinea	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Phyllodocidae	Eumida	Eumida sanguinea
Evalea tenuisculpta	Animalia	Mollusca		Gastropoda		Heterostropha		Pyramidellidae	Evalea	Evalea tenuisculpta
Glycera americana	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Glyceridae	Glycera	Glycera americana
Glycinde picta	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Goniadidae	Glycinde	Glycinde picta
Heptacarpus pugettensis	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Hippolytidae	Heptacarpus	Heptacarpus pugettensis
Heptacarpus sp.	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Hippolytidae	Heptacarpus	sp.
Kurtiella tumida	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Montacutidae	Kurtiella	Kurtiella tumida
Leukoma staminea	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Veneridae	Leukoma	Leukoma staminea
Macoma inquinata	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Tellinidae	Macoma	Macoma inquinata
Macoma nasuta	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Tellinidae	Macoma	Macoma nasuta
Macoma sp.	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Tellinidae	Macoma	sp.
Mesocrangon munitella	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Crangonidae	Mesocrangon	Mesocrangon munitella
Micropodarke dubia	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Hesionidae	Micropodarke	Micropodarke dubia
Micrura sp.	Animalia	Nemertea		Anopla		Heteronemertea		Lineidae	Micrura	sp.
Mycale adhaerens	Animalia	Porifera		Demospongiae		Poecilosclerida		Mycalidae	Mycale	Mycale adhaerens
Mytilidae	Animalia	Mollusca		Bivalvia		Mytiloida		Mytilidae		
Mytilus edulis complex	Animalia	Mollusca		Gastropoda		Heterostropha		Pyramidellidae	Mytilus	Mytilus edulis complex
Nassarius mendicus	Animalia	Mollusca		Gastropoda		Neogastropoda		Nassariidae	Nassarius	Nassarius mendicus
Nutricola lordi	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Veneridae	Nutricola	Nutricola lordi
Oligochaeta	Animalia	Annelida		Clitellata	Oligochaeta					
Pagurus sp.	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Paguridae	Pagurus	sp.
Paleanotus bellis	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Chrysopetalidae	Paleanotus	Paleanotus bellis
Paraprionospio alata	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Spionida	Spionidae	Paraprionospio	Paraprionospio alata
Parvilucina tenuisculpta	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Lucinidae	Parvilucina	Parvilucina tenuisculpta
Pholoe glabra	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Pholoidae	Pholoe	Pholoe glabra
Pholoides asperus	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Pholoidae	Pholoides	Pholoides asperus
Pinnixa occidentalis Cmplx	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Pinnotheridae	Pinnixa	Pinnixa occidentalis Cmplx
Pinnotherinae	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Pinnotheridae		
Podarkeopsis brevipalpa	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Hesionidae	Podarkeopsis	Podarkeopsis brevipalpa

Polycirrus sp. III sensu Banse 1980	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Terebellida	Terebellidae	Polycirrus	Polycirrus sp. III sensu Banse 1980
Polydora cornuta	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Spionida	Spionidae	Polydora	Polydora cornuta
Prionospio (Minuspio) lighti	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Spionida	Spionidae	Prionospio	Prionospio (Minuspio) lighti
Prionospio sp.	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Spionida	Spionidae	Prionospio	sp.
Prionospio steenstrupi	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Canalipalpata	Spionida	Spionidae	Prionospio	Prionospio steenstrupi
Protodorvillea gracilis	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Eunicida	Dorvilleidae	Protodorvillea	Protodorvillea gracilis
Romaleon jordani	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Cancridae	Romaleon	Romaleon jordani
Scleroplax granulata	Animalia	Arthropoda	Crustacea	Malacostraca	Eumalacostraca	Decapoda	Pleocyemata	Pinnotheridae	Scleroplax	Scleroplax granulata
Scoloplos armiger	Animalia	Annelida	Aclitellata	Polychaeta	Scolecida	Orbiniida		Orbiniidae	Scoloplos	Scoloplos armiger
Sigambra tentaculata	Animalia	Annelida	Aclitellata	Polychaeta	Palpata	Aciculata	Phyllodocida	Pilargidae	Sigambra	Sigambra tentaculata
Tellina sp.	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Tellinidae	Tellina	sp.
Veneridae	Animalia	Mollusca		Bivalvia	Heterodonta	Veneroida		Veneridae		
Watersipora subtorquata	Animalia	Ectoprocta		Gymnolaemata		Cheilostomatida		Watersiporidae	Watersipora	Watersipora subtorquata

CHAIN OF CUSTODY

ECO ANALYSTS

8075.1

EcoAnalysts, Inc.
4770 NE View Dr., Port Gamble, WA. 98364
Tel: (360) 297-6040

Destination: EcoAnalysts
Destination Contact: Rob Bobier
Date: 8/30/19
Turn-Around-Time: 8 weeks
Project Name: GeoSyntec Estcp
Contract/PO:

Sample Originator (Organization): EcoAnalysts
PERSON WHO COLLECTED SAMPLE: Jay Ward
Address:
Phone:
Fax:
E-mail:

Report Results To: Jay Ward
Contact Name:
Address:

Phone:
Fax:
Email: Jword@ecoAnalysts.com

Inoicing To:
Comments or Special Instructions:

No.	Sample ID	Secondary ID: Replicate, X of Y, etc.	Matrix	Volume/Mass	Date	Time	Analyses: BCA						Preservation	Sample Temp Upon Receipt	LAB ID
1	LTM-1-RBS ✓		Grunge	1-1L ✓	8/29	NA	X						Formalin		
2	LTM-2-RBS ✓			1-1L ✓	8/28										
3	LTM-3-RBS ✓			1-1L ✓	8/29										
4	LTM-4-RBS ✓✓			2-1L ✓	8/29										
5	LTM-1-MM ✓			1-1L ✓	8/27										
6	LTM-2-MM ✓			1-1L ✓	8/27										
7	LTM-3-MM ✓✓			2-1L ✓	8/27 ✓										
8	LTM-4-MM ✓✓			2-1L ✓	8/28										
9	LTM-5-MM ✓✓			2-1L ✓	8/27										
10	LTM-6-MM ✓✓			2-1L ✓	8/28 ✓										
11	LTM-7-MM ✓			1-1L ✓	8/28										
12	LTM-8-MM ✓✓			2-1L ✓	8/28 ✓										
13	LTM-9-MM ✓✓			2-1L ✓	8/28 ✓										
14	LTM-10-MM ✓✓		↓	2-1L ✓	8/28 ✓	↓	↓						↓		
15															
16															
17															
18															
19															
20															

	Relinquished by:	Recieved by:	Relinquished by:	Recieved by:
Print Name:	Michelle Knowlen	Max Rios		
Signature:	M. K			
Affiliation:	EcoAnalysts	EcoAnalysts, Inc.		
Date/Time:	9/3/19 1200	9/9/19 11:00		

Matrix Codes
FW = Fresh Water
SB = Salt & Brackish Water
SS = Soil & Sediment
TS = Tissue

APPENDIX C

Benthic Data Treatment – Univariate analysis

Benthic Data Treatment – Multivariate analysis

Synonymization Sheet

🟨 Removed from data for both univariate and multivariate analyses

🟩 Name changed for multivariate anlayses based on synonymization

Dataset	Class	Family	Scientific Name	Synonymized Name
10-month	Mollusca	Columbellidae	Alia gausapata	Alia sp.
10-month	Mollusca	Rissoidae	Alvania compacta	Alvania compacta
10-month	Mollusca	Rissoidae	Alvania sp.	Alvania compacta
10-month	Annelida	Ampharetidae	Ampharete finmarchica	Ampharete finmarchica
10-month	Nemertea	Amphiporidae	Amphiporus cruentatus	Nemertea
10-month	Annelida	Cirratulidae	Aphelochaeta multifilis	Cirratulidae
10-month	Annelida	Serpulidae	Apomatus geniculata	Apomatus geniculata
10-month	Annelida	Opheliidae	Armandia brevis	Armandia brevis
10-month	Mollusca	Thyasiridae	Axinopsida serricata	Axinopsida serricata
10-month	Arthropoda	Balanidae	Balanus crenatus	Remove
10-month	Annelida	Nephtyidae	Bipalponephtys cornuta	Bipalponephtys cornuta
10-month	Mollusca	-	Bivalvia	Remove
10-month	Arthropoda	Cancridae	Cancridae	Cancridae
10-month	Annelida	Capitellidae	Capitella capitata	Capitella capitata
10-month	Annelida	Cirratulidae	Cirratulidae	Cirratulidae
10-month	Mollusca	Cardiidae	Clinocardium nuttallii	Clinocardium nuttallii
10-month	Arthropoda	Corophiidea (subor	Corophiidea	Corophiidae
10-month	Arthropoda	Crangonidae	Crangon sp.	Crangonidae
10-month	Mollusca	Calyptraeidae	Crepidula sp.	Crepidula sp.
10-month	Echinodermata	-	Echinodermata	Remove
10-month	Annelida	Phyllodocidae	Eteone longa	Eteone sp.
10-month	Mollusca	Eubranchidae	Eubranchidae	Nudibranchia
10-month	Annelida	Polynoidae	Eunoe sp.	Eunoe sp.
10-month	Mollusca	-	Gastropoda	Remove
10-month	Annelida	Glyceridae	Glycera americana	Glycera americana
10-month	Annelida	Goniadidae	Glycinde picta	Glycinde picta
10-month	Annelida	Polynoidae	Harmothoinae (subfamily)	Harmothoe imbricata
10-month	Mollusca	Hiatellidae	Hiatella arctica	Hiatella arctica
10-month	Arthropoda	Hippolytidae	Hippolytidae	Hippolytidae
10-month	Annelida	Hesionidae	Kefersteinia cirrata	Kefersteinia cirrata
10-month	Nemertea	Lineidae	Lineidae	Nemertea
10-month	Annelida	Lumbrineridae	Lumbrineris sp.	Lumbrineris sp.
10-month	Mollusca	Tellinidae	Macoma carlottensis	Macoma sp.
10-month	Mollusca	Tellinidae	Macoma expansa	Macoma sp.
10-month	Mollusca	Tellinidae	Macoma nasuta	Macoma sp.
10-month	Cnidaria	Metridiidae	Metridium senile	Remove
10-month	Mollusca	Mytilidae	Mytilidae	Mytilidae
10-month	Mollusca	Nassariidae	Nassarius mendicus	Nassarius mendicus
10-month	Nematoda	-	Nematoda	Remove
10-month	Nemertea	-	Nemertea	Nemertea
10-month	Annelida	Nephtyidae	Nephtyidae	Bipalponephtys cornuta
10-month	Mollusca	-	Nudibranchia	Nudibranchia
10-month	Mollusca	Pyramidellidae	Odostomia sp.	Odostomia sp.
10-month	Annelida	-	Oligochaeta	Oligochaeta
10-month	Annelida	Hesionidae	Oxydromus pugettensis	Oxydromus pugettensis
10-month	Nemertea	-	Palaenemertea	Nemertea
10-month	Annelida	Spionidae	Paraprionospio pinnata	Paraprionospio pinnata
10-month	Annelida	Pholoidae	Pholoe minuta	Pholoe minuta
10-month	Annelida	Phyllodocidae	Phyllodocidae	Remove
10-month	Arthropoda	Pinnotheridae	Pinnixa eburna	Pinnotheridae
10-month	Arthropoda	Pinnotheridae	Pinnixa sp.	Pinnotheridae
10-month	Annelida	Nereididae	Platynereis bicanaliculata	Platynereis bicanaliculata
10-month	Annelida	Hesionidae	Podarkeopsis brevipalpa	Podarkeopsis brevipalpa
10-month	Annelida	Spionidae	Polydora cornuta	Polydora cornuta

10-month	Annelida	Spionidae	Prionospio lighti	Prionospio sp.
10-month	Annelida	Spionidae	Prionospio sp.	Prionospio sp.
10-month	Annelida	Spionidae	Prionospio steenstrupi	Prionospio sp.
10-month	Annelida	Dorvilleidae	Protodorvillea gracilis	Protodorvillea gracilis
10-month	Mollusca	Lasaeidae	Rochefortia tumida	Kurtiella tumida
10-month	Annelida	Dorvilleidae	Schistomeringos annulata	Schistomeringos annulata
10-month	Annelida	Lumbrineridae	Scoletoma sp.	Scoletoma sp.
10-month	Arthropoda	-	Sessilia	Remove
10-month	Annelida	Spionidae	Spionidae	Remove
10-month	Mollusca	Tellinidae	Tellinidae	Remove
10-month	Arthropoda	Atelecyclidae	Telmessus cheiragonus	Telmessus cheiragonus
10-month	Mollusca	Veneridae	Veneridae	Veneridae
22-month	Mollusca	Rissoidae	Alvania compacta	Alvania compacta
22-month	Annelida	Ampharetidae	Ampharete finmarchica	Ampharete finmarchica
22-month	Arthropoda	-	Amphipoda	Remove
22-month	Echinodermata	Amphiuridae	Amphiuridae	Amphiuridae
22-month	Annelida	Cirratulidae	Aphelochaeta glandaria Complex	Cirratulidae
22-month	Annelida	Opheliidae	Armandia brevis	Armandia brevis
22-month	Arthropoda	-	Balanomorpha	Remove
22-month	Annelida	Nephtyidae	Bipalponephtys cornuta	Bipalponephtys cornuta
22-month	Mollusca	-	Bivalvia	Remove
22-month	Arthropoda	Cancridae	Cancer sp.	Cancridae
22-month	Annelida	Capitellidae	Capitella capitata	Capitella capitata
22-month	Annelida	Capitellidae	Capitellidae	Capitella capitata
22-month	Arthropoda	Caridea	Caridea	Caridea
22-month	Annelida	Cirratulidae	Caulleriella cf. alata	Cirratulidae
22-month	Annelida	Cirratulidae	Chaetozone acuta	Cirratulidae
22-month	Annelida	Cirratulidae	Cirratulidae	Cirratulidae
22-month	Annelida	Cirratulidae	Cirratulus spectabilis	Cirratulidae
22-month	Mollusca	Cardiidae	Clinocardium nuttallii	Clinocardium nuttallii
22-month	Arthropoda	Corophiidae	Corophiidae	Corophiidae
22-month	Annelida	Spionidae	Dipolydora socialis	Dipolydora socialis
22-month	Annelida	Phyllodocidae	Eulalia levicornuta Cmplx	Eulalia sp.
22-month	Annelida	Phyllodocidae	Eulalia sp.	Eulalia sp.
22-month	Annelida	Phyllodocidae	Eumida longicornuta	Eumida longicornuta
22-month	Annelida	Terebellidae	Eupolymnia heterobranchia	Eupolymnia heterobranchia
22-month	Mollusca	-	Gastropoda	Remove
22-month	Annelida	Goniadidae	Glycinde picta	Glycinde picta
22-month	Annelida	Goniadidae	Goniada littorea	Goniada littorea
22-month	Annelida	Polynoidae	Harmothoe imbricata	Harmothoe imbricata
22-month	Arthropoda	Hippolytidae	Heptacarpus sp.	Hippolytidae
22-month	Arthropoda	Hippolytidae	Heptacarpus taylori	Hippolytidae
22-month	Mollusca	Lasaeidae	Kurtiella tumida	Kurtiella tumida
22-month	Annelida	Polynoidae	Lepidonotus spiculus	Lepidonotus spiculus
22-month	Platyhelminthes	Leptoplanidae	Leptoplanidae	Leptoplanidae
22-month	Nemertea	Lineidae	Lineus sp.	Nemertea
22-month	Annelida	Lumbrineridae	Lumbrineris latreilli	Lumbrineris sp.
22-month	Mollusca	Tellinidae	Macoma calcarea	Macoma sp.
22-month	Mollusca	Tellinidae	Macoma nasuta	Macoma sp.
22-month	Mollusca	Tellinidae	Macoma sp.	Macoma sp.
22-month	Arthropoda	Melitidae	Melitidae	Desdimelita desdichada
22-month	Arthropoda	Crangonidae	Mesocrangon munitella	Crangonidae
22-month	Cnidaria	Metridiidae	Metridium senile	Remove
22-month	Annelida	Hesionidae	Micropodarke dubia	Micropodarke dubia
22-month	Mollusca	Mytilidae	Modiolus sp.	Mytilidae
22-month	Annelida	Phyllodocidae	Mystides borealis	Mystides borealis
22-month	Mollusca	Nassariidae	Nassarius mendicus	Nassarius mendicus
22-month	Arthropoda	Crangonidae	Neocrangon communis	Crangonidae

22-month	Mollusca	-	Nudibranchia	Nudibranchia
22-month	Annelida	-	Oligochaeta	Oligochaeta
22-month	Mollusca	Onchidorididae	Onchidorididae	Onchidorididae
22-month	Annelida	Hesionidae	Oxydromus pugettensis	Oxydromus pugettensis
22-month	Arthropoda	Paguroidea	Paguroidea	Paguridae
22-month	Annelida	Chrysopetalidae	Paleanotus bellis	Paleanotus bellis
22-month	Annelida	Spionidae	Paraprionospio alata	Paraprionospio alata
22-month	Annelida	Pholoidae	Pholoe minuta	Pholoe minuta
22-month	Annelida	Sigalionidae	Pholoides asperus	Pholoides asperus
22-month	Annelida	Phyllodocidae	Phyllodoce groenlandica	Phyllodoce groenlandica
22-month	Arthropoda	Pinnotheridae	Pinnixa sp.	Pinnotheridae
22-month	Arthropoda	Pinnotheridae	Pinnotheridae	Pinnotheridae
22-month	Annelida	Nereididae	Platynereis bicanaliculata	Platynereis bicanaliculata
22-month	Mollusca	Anomiidae	Pododesmus macrochisma	Pododesmus macrochisma
22-month	Annelida	Terebellidae	Polycirrus sp.	Polycirrus sp.
22-month	Annelida	Spionidae	Polydora cornuta	Polydora cornuta
22-month	Annelida	Spionidae	Prionospio sp.	Prionospio sp.
22-month	Annelida	Spionidae	Prionospio steenstrupi	Prionospio sp.
22-month	Annelida	Dorvilleidae	Schistomeringos rudolphi	Schistomeringos rudolphi
22-month	Annelida	Pilargidae	Sigambra tentaculata	Sigambra tentaculata
22-month	Mollusca	Veneridae	Veneridae	Veneridae
33-month	Arthropoda	Chironomidae	Ablabesmyia sp.	Remove
33-month	Mollusca	Rissoidae	Alvania compacta	Alvania compacta
33-month	Arthropoda	--	Amphipoda	Remove
33-month	Annelida	Opheliidae	Armandia brevis	Armandia brevis
33-month	Arthropoda	Balanidae	Balanidae	Remove
33-month	Arthropoda	Balanidae	Balanus crenatus	Remove
33-month	Arthropoda	Aoridae	Bemlos sp.	Bemlos sp.
33-month	Annelida	Nephtyidae	Bipalponephtys cornuta	Bipalponephtys cornuta
33-month	Mollusca	--	Bivalvia	Remove
33-month	Annelida	Cirratulidae	Caulleriella hamata	Cirratulidae
33-month	Annelida	Cirratulidae	Chaetozone acuta	Cirratulidae
33-month	Annelida	Cirratulidae	Cirratulidae	Cirratulidae
33-month	Arthropoda	Crangonidae	Crangonidae	Crangonidae
33-month	Mollusca	Calyptraeidae	Crepidula sp.	Crepidula sp.
33-month	Arthropoda	Melitidae	Desdimelita desdichada	Desdimelita desdichada
33-month	Arthropoda	Chironomidae	Dicrotendipes sp.	Remove
33-month	Annelida	Dorvilleidae	Dorvilleidae	Schistomeringos rudolphi
33-month	Annelida	Ampharetidae	Eclysippe trilobata	Eclysippe trilobata
33-month	Annelida	Goniadidae	Glycinde armigera	Glycinde armigera
33-month	Annelida	Goniadidae	Goniadidae	Glycinde armigera
33-month	Annelida	Polynoidae	Harmothoe imbricata	Harmothoe imbricata
33-month	Arthropoda	Hippolytidae	Heptacarpus pugettensis	Hippolytidae
33-month	Annelida	Hesionidae	Hesionidae	Remove
33-month	Arthropoda	Janiridae	Ianiropsis sp.	Ianiropsis sp.
33-month	Annelida	Hesionidae	Kefersteinia cirrata	Kefersteinia cirrata
33-month	Mollusca	Tellinidae	Macoma inquinata	Macoma sp.
33-month	Mollusca	Tellinidae	Macoma nasuta	Macoma sp.
33-month	Mollusca	Tellinidae	Macoma sp.	Macoma sp.
33-month	Arthropoda	Cancridae	Metacarcinus gracilis	Cancridae
33-month	Mollusca	Mytilidae	Mytilidae	Mytilidae
33-month	Mollusca	Nassariidae	Nassarius mendicus	Nassarius mendicus
33-month	Arthropoda	Nebaliidae	Nebalia pugettensis Cmplx	Nebalia pugettensis Cmplx
33-month	Annelida	--	Oligochaeta	Oligochaeta
33-month	Arthropoda	Chironomidae	Orthocladius Complex	Remove
33-month	Annelida	Hesionidae	Oxydromus pugettensis	Oxydromus pugettensis
33-month	Arthropoda	Paguridae	Paguridae	Paguridae
33-month	Arthropoda	Paguridae	Pagurus beringanus	Paguridae

33-month	Arthropoda	Paguridae	Pagurus sp.	Paguridae
33-month	Annelida	Chrysopetalidae	Paleanotus bellis	Paleanotus bellis
33-month	Annelida	Spionidae	Paraprionospio alata	Paraprionospio alata
33-month	Annelida	Pholoidae	Pholoe minuta	Pholoe minuta
33-month	Annelida	Sigalionidae	Pholoides asperus	Pholoides asperus
33-month	Annelida	Phyllodocidae	Phyllodocidae	Remove
33-month	Arthropoda	Pinnotheridae	Pinnixa sp.	Pinnotheridae
33-month	Annelida	Nereididae	Platynereis bicanaliculata	Platynereis bicanaliculata
33-month	Annelida	Hesionidae	Podarkeopsis brevipalpa	Podarkeopsis brevipalpa
33-month	Annelida	Terebellidae	Polycirrus sp. II sensu Banse 1980	Polycirrus sp.
33-month	Arthropoda	Chironomidae	Polypedilum sp.	Remove
33-month	Arthropoda	Porcellanidae	Porcellanidae	Porcellanidae
33-month	Annelida	Spionidae	Prionospio cirrifera	Prionospio sp.
33-month	Annelida	Spionidae	Prionospio sp.	Prionospio sp.
33-month	Annelida	Spionidae	Prionospio steenstrupi	Prionospio sp.
33-month	Arthropoda	Chironomidae	Rheotanytarsus sp.	Remove
33-month	Mollusca	Lasaeidae	Rochefortia tumida	Kurtiella tumida
33-month	Mollusca	Veneridae	Saxidomus gigantea	Veneridae
33-month	Annelida	Dorvilleidae	Schistomeringos rudolphi	Schistomeringos rudolphi
33-month	Annelida	Lumbrineridae	Scoletoma luti	Scoletoma sp.
33-month	Annelida	Lumbrineridae	Scoletoma sp.	Scoletoma sp.
33-month	Annelida	Pilargidae	Sigambra tentaculata	Sigambra tentaculata
33-month	Arthropoda	Chironomidae	Tanytarsus sp.	Remove
33-month	Arthropoda	Chironomidae	Thienemannimyia gr. sp.	Remove
82-month	Mollusca	Columbellidae	Alia sp.	Alia sp.
82-month	Mollusca	Rissoidae	Alvania compacta	Alvania compacta
82-month	Annelida	Ampharetidae	Ampharete acutifrons	Ampharete acutifrons
82-month	Echinodermata	Amphiuridae	Amphiuridae	Amphiuridae
82-month	Annelida	Cirratulidae	Aphelochaeta glandaria Complex	Cirratulidae
82-month	Annelida	Opheliidae	Armandia brevis	Armandia brevis
82-month	Mollusca	Thyasiridae	Axinopsida serricata	Axinopsida serricata
82-month	Arthropoda	Balanidae	Balanus crenatus	Remove
82-month	Annelida	Nephtyidae	Bipalponephtys cornuta	Bipalponephtys cornuta
82-month	Mollusca		Bivalvia	Remove
82-month	Annelida	Flabelligeridae	Brada pilosa	Brada pilosa
82-month	Arthropoda	Cancridae	Cancridae	Cancridae
82-month	Annelida	Capitellidae	Capitella capitata Complex	Capitella capitata
82-month	Arthropoda	Caprellidae	Caprella sp.	Caprella sp.
82-month	Mollusca	Cardiidae	Cardiidae	Clinocardium nuttallii
82-month	Annelida	Cirratulidae	Caulleriella hartmanae	Cirratulidae
82-month	Ectoprocta	Hippothoidae	Celleporella hyalina	Celleporella hyalina
82-month	Annelida	Cirratulidae	Chaetozone acuta	Cirratulidae
82-month	Annelida	Cirratulidae	Cirratulidae	Cirratulidae
82-month	Arthropoda	Crangonidae	Crangon alaskensis	Crangonidae
82-month	Arthropoda	Crangonidae	Crangonidae	Crangonidae
82-month	Mollusca	Calyptraeidae	Crepipatella lingulata	Crepipatella lingulata
82-month	Arthropoda	Melitidae	Desdimelita desdichada	Desdimelita desdichada
82-month	Annelida	Dorvilleidae	Dorvillea (Schistomeringos) annulata	Schistomeringos annulata
82-month	Annelida	Phyllodocidae	Eteone californica	Eteone sp.
82-month	Arthropoda	Hippolytidae	Eualus sp.	Eualus sp.
82-month	Annelida	Phyllodocidae	Eumida sanguinea	Eumida sanguinea
82-month	Mollusca	Pyramidellidae	Evalea tenuisculpta	Evalea tenuisculpta
82-month	Annelida	Glyceridae	Glycera americana	Glycera americana
82-month	Annelida	Goniadidae	Glycinde picta	Glycinde picta
82-month	Arthropoda	Hippolytidae	Heptacarpus pugettensis	Hippolytidae
82-month	Arthropoda	Hippolytidae	Heptacarpus sp.	Hippolytidae
82-month	Mollusca	Montacutidae	Kurtiella tumida	Kurtiella tumida
82-month	Mollusca	Veneridae	Leukoma staminea	Veneridae

82-month	Mollusca	Tellinidae	Macoma inquinata	Macoma sp.
82-month	Mollusca	Tellinidae	Macoma nasuta	Macoma sp.
82-month	Mollusca	Tellinidae	Macoma sp.	Macoma sp.
82-month	Arthropoda	Crangonidae	Mesocrangon munitella	Crangonidae
82-month	Annelida	Hesionidae	Micropodarke dubia	Micropodarke dubia
82-month	Nemertea	Lineidae	Micrura sp.	Nemertea
82-month	Porifera	Mycalidae	Mycale adhaerens	Mycale adhaerens
82-month	Mollusca	Mytilidae	Mytilidae	Mytilidae
82-month	Mollusca	Mytilidae	Mytilus edulis complex	Mytilidae
82-month	Mollusca	Nassariidae	Nassarius mendicus	Nassarius mendicus
82-month	Annelida	Capitellidae	Notomastus tenuis	Notomastus tenuis
82-month	Mollusca	Veneridae	Nutricola lordi	Veneridae
82-month	Annelida		Oligochaeta	Oligochaeta
82-month	Arthropoda	Paguridae	Pagurus sp.	Paguridae
82-month	Annelida	Chrysopetalidae	Paleanotus bellis	Paleanotus bellis
82-month	Annelida	Spionidae	Paraprionospio alata	Paraprionospio alata
82-month	Mollusca	Lucinidae	Parvilucina tenuisculpta	Lucinidae
82-month	Annelida	Pholoidae	Pholoe glabra	Pholoe glabra
82-month	Annelida	Pholoidae	Pholoides asperus	Pholoides asperus
82-month	Arthropoda	Pinnotheridae	Pinnixa occidentalis Cmplx	Pinnotheridae
82-month	Arthropoda	Pinnotheridae	Pinnotherinae	Pinnotheridae
82-month	Annelida	Hesionidae	Podarkeopsis brevipalpa	Podarkeopsis brevipalpa
82-month	Annelida	Terebellidae	Polycirrus sp. III sensu Banse 1980	Polycirrus sp.
82-month	Annelida	Spionidae	Polydora cornuta	Polydora cornuta
82-month	Annelida	Spionidae	Prionospio (Minuspio) lighti	Prionospio sp.
82-month	Annelida	Spionidae	Prionospio sp.	Prionospio sp.
82-month	Annelida	Spionidae	Prionospio steenstrupi	Prionospio sp.
82-month	Annelida	Dorvilleidae	Protodorvillea gracilis	Protodorvillea gracilis
82-month	Arthropoda	Cancridae	Romaleon jordani	Cancridae
82-month	Arthropoda	Pinnotheridae	Scleroplax granulata	Pinnotheridae
82-month	Annelida	Orbiniidae	Scoloplos armiger	Scoloplos armiger
82-month	Annelida	Pilargidae	Sigambra tentaculata	Sigambra tentaculata
82-month	Mollusca	Tellinidae	Tellina sp.	Tellina sp.
82-month	Mollusca	Veneridae	Veneridae	Veneridae
82-month	Ectoprocta	Watersiporidae	Watersipora subtorquata	Watersipora subtorquata
Baseline	Mollusca	Rissoidae	Alvania compacta	Alvania compacta
Baseline	Arthropoda	--	Amphipoda	Remove
Baseline	Annelida	Cirratulidae	Aphelochaeta sp.	Cirratulidae
Baseline	Annelida	Opheliidae	Armandia brevis	Armandia brevis
Baseline	Annelida	Ampharetidae	Asabellides lineata	Asabellides lineata
Baseline	Arthropoda	Balanidae	Balanidae	Remove
Baseline	Arthropoda	--	Balanomorpha	Remove
Baseline	Arthropoda	Balanidae	Balanus crenatus	Remove
Baseline	Arthropoda	Balanidae	Balanus sp.	Remove
Baseline	Mollusca	--	Bivalvia	Remove
Baseline	Arthropoda	Cancridae	Cancridae	Cancridae
Baseline	Annelida	Capitellidae	Capitella capitata	Capitella capitata
Baseline	Annelida	Cirratulidae	Caulleriella pacifica	Cirratulidae
Baseline	Annelida	Cirratulidae	Cirratulidae	Cirratulidae
Baseline	Arthropoda	Crangonidae	Crangonidae	Crangonidae
Baseline	Annelida	Syllidae	Dioplosyllis sp.	Dioplosyllis sp.
Baseline	Annelida	Dorvilleidae	Dorvilleidae	Schistomeringos annulata
Baseline	Annelida	Phyllodocidae	Eteone sp.	Eteone sp.
Baseline	Annelida	Polynoidae	Gaudichadius iphionelloides	Gaudichadius iphionelloides
Baseline	Annelida	Glyceridae	Glycera americana	Glycera americana
Baseline	Annelida	Goniadidae	Glycinde picta	Glycinde picta
Baseline	Annelida	Polynoidae	Harmothoe imbricata	Harmothoe imbricata
Baseline	Annelida	Hesionidae	Hesionidae	Remove

Baseline	Mollusca	Hiatellidae	Hiatella arctica	Hiatella arctica
Baseline	Annelida	Hesionidae	Kefersteinia cirrata	Kefersteinia cirrata
Baseline	Mollusca	Conidae	Kurtzia arteaga	Kurtzia arteaga
Baseline	Mollusca	Littorinidae	Littorina sp.	Littorina sp.
Baseline	Mollusca	Lucinidae	Lucinidae	Lucinidae
Baseline	Mollusca	Tellinidae	Macoma balthica	Macoma balthica
Baseline	Mollusca	Tellinidae	Macoma sp.	Macoma sp.
Baseline	Mollusca	Mactridae	Mactromeris polynyma	Mactromeris polynyma
Baseline	Annelida	Hesionidae	Microphthalmus sp.	Microphthalmus sp.
Baseline	Mollusca	Mytilidae	Mytilidae	Mytilidae
Baseline	Mollusca	Nassariidae	Nassarius mendicus	Nassarius mendicus
Baseline	Nematoda	--	Nematoda	Remove
Baseline	Nemertea	--	Nemertea	Nemertea
Baseline	Annelida	Nephtyidae	Nephtys sp.	Nephtys sp.
Baseline	Annelida	Capitellidae	Notomastus tenuis	Notomastus tenuis
Baseline	Mollusca	Veneridae	Nutricola lordi	Veneridae
Baseline	Mollusca	Pyramidellidae	Odostomia sp.	Odostomia sp.
Baseline	Annelida	--	Oligochaeta	Oligochaeta
Baseline	Arthropoda	Paguridae	Paguridae	Paguridae
Baseline	Annelida	Chrysopetalidae	Paleanotus bellis	Paleanotus bellis
Baseline	Annelida	Pectinariidae	Pectinaria californiensis	Pectinaria californiensis
Baseline	Arthropoda	Phoxocephalidae	Phoxocephalidae	Phoxocephalidae
Baseline	Arthropoda	Pinnotheridae	Pinnixa sp.	Pinnotheridae
Baseline	Annelida	Hesionidae	Podarke pugettensis	Podarke pugettensis
Baseline	Annelida	Hesionidae	Podarkeopsis glabra	Podarkeopsis glabra
Baseline	Annelida	Polynoidae	Polynoidae	Remove
Baseline	Annelida	Spionidae	Prionospio jubata	Prionospio sp.
Baseline	Annelida	Spionidae	Prionospio lighti	Prionospio sp.
Baseline	Mollusca	Veneridae	Protothaca staminea	Veneridae
Baseline	Mollusca	Lasaeidae	Rochefortia tumida	Kurtiella tumida
Baseline	Annelida	Dorvilleidae	Schistomeringos annulata	Schistomeringos annulata
Baseline	Tunicata	--	Tunicata	Tunicata

🟨 removed to calculate benthic community metrics

Taxonomy validity

Color Code	Final Identification
🟥	Removed
🟧	Kefersteinia cirrata
🟪	Macoma sp.
🟦	Odostomia sp.
🟩	Oxydromus pugettensis

	Validity (WoRMS)	Average baseline	Average other
Alvania compacta	accepted		
Armandia brevis	accepted	8.93	6.41
Asabellides lineata	Unaccepted (Amparete lineata)	0.07	0.00
Cancridae	accepted	0.07	0.50
Capitella capitata	accepted	6.43	0.45
Cirratulidae	accepted	0.93	9.77
Crangonidae	accepted	0.07	0.36
Dioplosyllis sp.	accepted	0.14	0.00
Eteone sp.	accepted	0.21	0.20
Gaudichaudius iphionelloides	accepted	0.07	0.00
Glycera americana	accepted	0.07	0.04
Glycinde picta	accepted	0.14	0.34
Harmothoe imbricata	accepted	0.07	0.20
Hiatella arctica	accepted	0.07	0.02
Kefersteinia cirrata	Unaccepted (Kefersteinia cirrhata)	2.79	1.23
Kurtiella tumida	accepted	4.14	3.66
Kurtzia arteaga	accepted	0.07	0.00
Littorina sp.	accepted	0.07	0.00
Lucinidae	accepted	0.14	0.02
Macoma balthica	Unaccepted (Limecola balthica)	0.14	0.00
Macoma sp.	accepted	0.21	0.86
Mactromeris polynyma	accepted	0.07	0.00
Microphthalmus sp.	accepted	0.21	0.00
Mytilidae	accepted	0.50	0.52
Nassarius mendicus	accepted	0.29	0.55
Nemertea	accepted	0.07	0.14
Nephtys sp.	accepted	0.07	0.00
Notomastus tenuis	accepted	0.07	0.02
Odostomia sp.	accepted	0.14	0.04
Oligochaeta	accepted	4.43	0.66
Paguridae	accepted	0.07	0.36
Paleanotus bellis	accepted	0.57	0.16
Pectinaria californiensis	accepted	0.14	0.00
Phoxocephalidae	accepted	0.07	0.00
Pinnotheridae	accepted	1.57	0.54
Podarke pugettensis	Unaccepted (Oxydromus pugettensis)	0.71	0.00
Podarkeopsis glabra	Unaccepted (Podarkeopsis glabrus)	0.21	0.00
Prionospio sp.	accepted	2.14	1.77
Schistomeringos annulata	accepted	2.79	0.55
Tunicata	accepted	0.21	0.00
Veneridae	accepted	0.36	0.20
Alia sp.	accepted	0.00	0.05
Ampharete finmarchica	accepted	0.00	0.09
Amphiuridae	accepted	0.00	0.09
Apomatus geniculata	Unaccepted (Apomatus geniculatus)	0.00	0.02
Axinopsida serricata	accepted	0.00	0.04
Bipalponephtys cornuta	Unaccepted (Micronephthys cornuta)	0.00	0.54

Clinocardium nuttallii	accepted	0.00	0.07
Corophiidae	accepted	0.00	0.04
Crepidula sp.	accepted	0.00	0.04
Eunoe sp.	accepted	0.00	0.02
Hippolytidae	accepted	0.00	0.39
Lumbrineris sp.	accepted	0.00	0.05
Nudibranchia	accepted	0.00	0.11
Oxydromus pugettensis	accepted	0.00	0.45
Paraprionospio pinnata	accepted	0.00	0.07
Pholoe minuta	accepted	0.00	0.13
Platynereis bicanaliculata	accepted	0.00	0.14
Podarkeopsis brevipalpa	accepted	0.00	0.29
Polydora cornuta	accepted	0.00	2.18
Protodorvillea gracilis	accepted	0.00	0.04
Scoletoma sp.	accepted	0.00	0.05
Telmessus cheiragonus	accepted	0.00	0.02
Caridea	accepted	0.00	0.02
Desdimelita desdichada	accepted	0.00	0.25
Dipolydora socialis	accepted	0.00	0.04
Eulalia sp.	accepted	0.00	0.05
Eumida longicornuta	accepted	0.00	0.02
Eupolymnia heterobranchia	accepted	0.00	0.02
Goniada littorea	accepted	0.00	0.04
Lepidonotus spiculus	accepted	0.00	0.04
Leptoplanidae	accepted	0.00	0.02
Micropodarke dubia	accepted (Look at Kefersteinia)	0.00	1.59
Mystides borealis	accepted	0.00	0.02
Onchidorididae	accepted	0.00	0.07
Paraprionospio alata	accepted	0.00	0.25
Pholoides asperus	accepted	0.00	0.07
Phyllodoce groenlandica	accepted	0.00	0.02
Pododesmus macrochisma	accepted	0.00	0.02
Polycirrus sp.	accepted	0.00	0.07
Schistomeringos rudolphi	accepted	0.00	0.50
Sigambra tentaculata	accepted	0.00	0.09
Bemlos sp.	accepted	0.00	0.02
Eclysippe trilobata	accepted	0.00	0.02
Glycinde armigera	accepted	0.00	0.07
Ianiropsis sp.	accepted	0.00	0.02
Nebalia pugettensis Cmplx	nomen nudum	0.00	0.04
Porcellanidae	accepted	0.00	0.04
Ampharete acutifrons	accepted	0.00	0.02
Brada pilosa	Unaccepted (Bradabyssa pilosa)	0.00	0.02
Caprella sp.	accepted	0.00	0.02
Celleporella hyalina	accepted	0.00	0.04
Crepipatella lingulata	accepted	0.00	0.11
Eualus sp.	accepted	0.00	0.02
Eumida sanguinea	accepted	0.00	0.05
Evalea tenuisculpta	Not present (Evalea sp. or Odeostomia)	0.00	0.30
Mycale adhaerens	Unaccepted (Mycale (Aegogropila)adhaerens)	0.00	0.04
Pholoe glabra	accepted	0.00	0.02
Scoloplos armiger	accepted	0.00	0.04
Tellina sp.	accepted	0.00	0.02
Watersipora subtorquata	accepted	0.00	0.14

Appendix E
Benthic Community Metrics Tables

Table E1. Benthic Community Census Count by Species, Total Abundance, and Species Richness

Bremerton Pier 7 82-month, NIWC Pacific

TAXON_NAME	Phylum (unless otherwise specified)	Class (unless otherwise specified)	Order (unless otherwise specified)	Family (unless otherwise specified)	Scientific Name (unless otherwise specified)	Number of Individuals per Composite Sample														Taxa Abundance [8]
						LTM-1-MM	LTM-2-MM	LTM-3-MM	LTM-4-MM	LTM-5-MM	LTM-6-MM	LTM-7-MM	LTM-8-MM	LTM-9-MM	LTM-10-MM	LTM-1-RBS	LTM-2-RBS	LTM-3-RBS	LTM-4-RBS	
Alia sp.	Mollusca	Gastropoda	Neogastropoda	Columbellidae	*sp.*						1						1			0.2%
Alvania compacta	Mollusca	Gastropoda	Neotaenioglossa	Rissoidae	*Alvania compacta*	2	1	35	34	24	16	3	10	38	3	12	24	1	11	19.0%
Ampharete acutifrons	Annelida	Polychaeta	Canalipalpata	Ampharetidae	*Ampharete acutifrons*														1	0.1%
Amphiuridae	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae					1			1								0.2%
Aphelochaeta glandaria	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Aphelochaeta glandaria Complex*		4	49		146	2	84	26		15	1		2	4	29.6%
Armandia brevis	Annelida	Polychaeta		Opheliidae	*Armandia brevis*			3	1				1	1	2					0.7%
Axinopsida serricata	Mollusca	Bivalvia	Veneroida	Thyasiridae	*Axinopsida serricata*					1										0.1%
Balanus crenatus	Arthropoda	Maxillopoda	Sessilia	Balanidae	*Balanus crenatus*	3		4		2	1		23	43	2		20	2		8.9%
Bipalponephtys cornuta	Annelida	Polychaeta	Aciculata	Nephtyidae	*Bipalponephtys cornuta*						1							1		0.2%
Bivalvia	Mollusca	Bivalvia									2									0.2%
Brada pilosa	Annelida	Polychaeta	Canalipalpata	Flabelligeridae	*Brada pilosa*								1							0.1%
Cancridae	Arthropoda	Malacostraca	Decapoda	Cancridae								1								0.1%
Capitella capitata Compl	Annelida	Polychaeta		Capitellidae	*Capitella capitata Complex*							2		1						0.3%
Caprella sp.	Arthropoda	Malacostraca	Amphipoda	Caprellidae	*sp.*										1					0.1%
Cardiidae	Mollusca	Bivalvia	Veneroida	Cardiidae				1												0.1%
Caulleriella hartmanae	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Caulleriella hartmanae*			1				1	1							0.3%
Celleporella hyalina	Ectoprocta	Gymnolaemata	Cheilostomatida	Hippothoidae	*Celleporella hyalina*									1			1			0.2%
Chaetozone acuta	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Chaetozone acuta*			1	1										2	0.4%
Cirratulidae	Annelida	Polychaeta	Canalipalpata	Cirratulidae						1										0.1%
Crangon alaskensis	Arthropoda	Malacostraca	Decapoda	Crangonidae	*Crangon alaskensis*	3	1			2										0.5%
Crangonidae	Arthropoda	Malacostraca	Decapoda	Crangonidae												1	1			0.2%
Crepipatella lingulata	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	*Crepipatella lingulata*								2	4						0.5%
Desdimelita desdichada	Arthropoda	Malacostraca	Amphipoda	Melitidae	*Desdimelita desdichada*				1											0.1%
Dorvillea (Schistomering	Annelida	Polychaeta	Aciculata	Dorvilleidae	*Dorvillea (Schistomeringos) annulata*				12			1	3	8						2.1%
Eteone californica	Annelida	Polychaeta	Aciculata	Phyllodocidae	*Eteone californica*		1	1		3		2		1						0.7%
Eualus sp.	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*sp.*							1								0.1%
Eumida sanguinea	Annelida	Polychaeta	Aciculata	Phyllodocidae	*Eumida sanguinea*									3						0.3%
Evalea tenuisculpta	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Evalea tenuisculpta*	1	1	1	1	2		6	3	1					1	1.5%
Glycera americana	Annelida	Polychaeta	Aciculata	Glyceridae	*Glycera americana*								1							0.1%
Glycinde picta	Annelida	Polychaeta	Aciculata	Goniadidae	*Glycinde picta*						1	1								0.2%
Heptacarpus pugettensis	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*Heptacarpus pugettensis*			1												0.1%
Heptacarpus sp.	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*sp.*									1						0.1%
Kurtiella tumida	Mollusca	Bivalvia	Veneroida	Montacutidae	*Kurtiella tumida*			3	33	1	1	6	1	11					29	7.5%
Leukoma staminea	Mollusca	Bivalvia	Veneroida	Veneridae	*Leukoma staminea*					1										0.1%
Macoma inquinata	Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma inquinata*			1		3					2				2	0.7%
Macoma nasuta	Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma nasuta*							2						2		0.4%
Macoma sp.	Mollusca	Bivalvia	Veneroida	Tellinidae	*sp.*									2						0.2%
Mesocrangon munitella	Arthropoda	Malacostraca	Decapoda	Crangonidae	*Mesocrangon munitella*			1					1							0.2%
Micropodarke dubia	Annelida	Polychaeta	Aciculata	Hesionidae	*Micropodarke dubia*			3			1			2						0.5%
Micrura sp.	Nemertea	Anopla	Heteronemertea	Lineidae	*sp.*								1							0.1%
Mycale adhaerens	Porifera	Demospongiae	Poecilosclerida	Mycalidae	*Mycale adhaerens*											1	1			0.2%
Mytilidae	Mollusca	Bivalvia	Mytiloida	Mytilidae		1										1				0.2%
Mytilus edulis complex	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Mytilus edulis complex*										1					0.1%
Nassarius mendicus	Mollusca	Gastropoda	Neogastropoda	Nassariidae	*Nassarius mendicus*	2		2	6	3	1		1	1	1		1		1	1.7%
Nutricola lordi	Mollusca	Bivalvia	Veneroida	Veneridae	*Nutricola lordi*					2					1					0.3%
Oligochaeta	Annelida	Clitellata																	8	0.7%

Table E1. Benthic Community Census Count by Species, Total Abundance, and Species Richness

Bremerton Pier 7 82-month, NIWC Pacific

TAXON_NAME	Phylum (unless otherwise specified)	Class (unless otherwise specified)	Order (unless otherwise specified)	Family (unless otherwise specified)	Scientific Name (unless otherwise specified)	Number of Individuals per Composite Sample														Taxa Abundance [8]
						LTM-1-MM	LTM-2-MM	LTM-3-MM	LTM-4-MM	LTM-5-MM	LTM-6-MM	LTM-7-MM	LTM-8-MM	LTM-9-MM	LTM-10-MM	LTM-1-RBS	LTM-2-RBS	LTM-3-RBS	LTM-4-RBS	
Pagurus sp.	Arthropoda	Malacostraca	Decapoda	Paguridae	*sp.*									1						0.1%
Paleanotus bellis	Annelida	Polychaeta	Aciculata	Chrysopetalidae	*Paleanotus bellis*									2						0.2%
Paraprionospio alata	Annelida	Polychaeta	Canalipalpata	Spionidae	*Paraprionospio alata*		1				1	4					3	1	2	1.1%
Parvilucina tenuisculpta	Mollusca	Bivalvia	Veneroida	Lucinidae	*Parvilucina tenuisculpta*														1	0.1%
Pholoe glabra	Annelida	Polychaeta	Aciculata	Pholoidae	*Pholoe glabra*														1	0.1%
Pholoides asperus	Annelida	Polychaeta	Aciculata	Pholoidae	*Pholoides asperus*									1						0.1%
Pinnixa occidentalis Cmp	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Pinnixa occidentalis Cmplx*						6	2						3		1.0%
Pinnotherinae	Arthropoda	Malacostraca	Decapoda	Pinnotheridae		1	1											1		0.3%
Podarkeopsis brevipalpa	Annelida	Polychaeta	Aciculata	Hesionidae	*Podarkeopsis brevipalpa*			2		1		2	4	2						1.0%
Polycirrus sp. III sensu B	Annelida	Polychaeta	Canalipalpata	Terebellidae	*Polycirrus sp. III sensu Banse 1980*										1		1			0.2%
Polydora cornuta	Annelida	Polychaeta	Canalipalpata	Spionidae	*Polydora cornuta*									114	1					10.2%
Prionospio (Minuspio) lig	Annelida	Polychaeta	Canalipalpata	Spionidae	*Prionospio (Minuspio) lighti*						1		3		2			1	2	0.8%
Prionospio sp.	Annelida	Polychaeta	Canalipalpata	Spionidae	*sp.*							1		1	2				1	0.4%
Prionospio steenstrupi	Annelida	Polychaeta	Canalipalpata	Spionidae	*Prionospio steenstrupi*	1		4	6	4		1	4	1					7	2.5%
Protodorvillea gracilis	Annelida	Polychaeta	Aciculata	Dorvilleidae	*Protodorvillea gracilis*			1												0.1%
Romaleon jordani	Arthropoda	Malacostraca	Decapoda	Cancridae	*Romaleon jordani*						1		1		1					0.3%
Scleroplax granulata	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Scleroplax granulata*										5					0.4%
Scoloplos armiger	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos armiger*			2												0.2%
Sigambra tentaculata	Annelida	Polychaeta	Aciculata	Pilargidae	*Sigambra tentaculata*						1							1		0.2%
Tellina sp.	Mollusca	Bivalvia	Veneroida	Tellinidae	*sp.*									1						0.1%
Veneridae	Mollusca	Bivalvia	Veneroida	Veneridae		1		1												0.2%
Watersipora subtorquata	Ectoprocta	Gymnolaemata	Cheilostomatida	Watersiporidae	*Watersipora subtorquata*		1			1	1	1	1	1	1	1				0.7%
					Notomastus Tenuis				1											
Number of Individuals [2]						**15**	**11**	**117**	**97**	**197**	**38**	**122**	**88**	**242**	**41**	**17**	**53**	**15**	**73**	
Total Abundance (number of individuals per m^2) [3]						**1667**	**1222**	**13000**	**10778**	**21889**	**4222**	**13556**	**9778**	**26889**	**4556**	**1889**	**5889**	**1667**	**8111**	
Species Richness (number of taxa) [4]						**9**	**8**	**20**	**11**	**16**	**16**	**19**	**19**	**24**	**16**	**6**	**9**	**10**	**15**	
Total abundance of the 5 most abundant taxa [5]					***Alvania compacta***	**222**	**111**	**3889**	**3778**	**2667**	**1778**	**333**	**1111**	**4222**	**333**	**1333**	**2667**	**111**	**1222**	
					Aphelochaeta glandaria Complex	**0**	**444**	**5444**	**0**	**16222**	**222**	**9333**	**2889**	**0**	**1667**	**111**	**0**	**222**	**444**	
					Balanus crenatus	**333**	**0**	**444**	**0**	**222**	**111**	**0**	**2556**	**4778**	**222**	**0**	**2222**	**222**	**0**	
					Kurtiella tumida	**0**	**0**	**333**	**3667**	**111**	**111**	**667**	**111**	**1222**	**0**	**0**	**0**	**0**	**3222**	
					Polydora cornuta	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**12667**	**111**	**0**	**0**	**0**	**0**	
					Total Abundance [6]	**556**	**556**	**10111**	**7444**	**19222**	**2222**	**10333**	**6667**	**22889**	**2333**	**1444**	**4889**	**556**	**4889**	
					Percentage of Total Abundance [7]	**33.3%**	**45.5%**	**77.8%**	**69.1%**	**87.8%**	**52.6%**	**76.2%**	**68.2%**	**85.1%**	**51.2%**	**76.5%**	**83.0%**	**33.3%**	**60.3%**	

Notes:

[1] Samples were collected by ENVIRON International Corporation, benthic macroinvertebrate were identified to the lowest taxonomic level by EcoAnalysts, Inc. Taxa structure corresponds to World Register of Marine Species (http://www.marinespecies.org).

[2] Number of Individuals is the total number of identifiable benthic invertebrate collected in each composite sample.

[3] Total Abundance is the number of individuals divided by the sample area (US EPA 1987). Area sampled at each station was 0.009 m^2.

[4] Species Richness is the number of different taxon collected in each composite sample.

[5] The five most abundant taxa were determined overall for the sampling event. Total abundance for these taxa was calculated as the number of individuals divided by the sample area (US EPA 1987).

[6] Total abundance of the 5 most abundant taxa is the sum of the total abundance for the five most abundant taxa in this sampling event.

[7] Percentage of Total Abundance is the Total abundance of the 5 most abundant taxa divided by the total abundance overall for the sample.

[8] Taxa Abundance is the sum of the number of individuals for each taxa divided by the total number of individuals for all samples.

[9] Taxa Rank is the rank of the taxa abundance for all samples.

Table E2. Shannon–Weiner Diversity (H') and Pielou’s Evenness (J')

Bremerton Pier 7 82-month, NIWC Pacific

TAXON_NAME	Phylum (unless otherwise specified)	Class (unless otherwise specified)	Order (unless otherwise specified)	Family (unless otherwise specified)	Scientific Name (unless otherwise specified)	$p_i \times \ln(p_i)$ [1]													
						LTM-1-MM	LTM-2-MM	LTM-3-MM	LTM-4-MM	LTM-5-MM	LTM-6-MM	LTM-7-MM	LTM-8-MM	LTM-9-MM	LTM-10-MM	LTM-1-RBS	LTM-2-RBS	LTM-3-RBS	LTM-4-RBS
Alia sp.	Mollusca	Gastropoda	Neogastropoda	Columbellidae	*sp.*						-0.10						-0.07		
Alvania compacta	Mollusca	Gastropoda	Neotaenioglossa	Rissoidae	*Alvania compacta*	-0.27	-0.22	-0.36	-0.37	-0.26	-0.36	-0.09	-0.25	-0.29	-0.19	-0.25	-0.36	-0.18	-0.29
Ampharete acutifrons	Annelida	Polychaeta	Canalipalpata	Ampharetidae	*Ampharete acutifrons*														-0.06
Amphiuridae	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae					-0.05			-0.04							
Aphelochaeta glandaria	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Aphelochaeta glandaria*		-0.37	-0.36		-0.22	-0.15	-0.26	-0.36		-0.37	-0.17		-0.27	-0.16
Armandia brevis	Annelida	Polychaeta		Opheliidae	*Armandia brevis*			-0.09	-0.05				-0.05	-0.02	-0.15				
Axinopsida serricata	Mollusca	Bivalvia	Veneroida	Thyasiridae	*Axinopsida serricata*					-0.03									
Balanus crenatus	Arthropoda	Maxillopoda	Sessilia	Balanidae	*Balanus crenatus*	-0.32		-0.12		-0.05	-0.10		-0.35	-0.31	-0.15		-0.37	-0.27	
Bipalponephtys cornuta	Annelida	Polychaeta	Aciculata	Nephtyidae	*Bipalponephtys cornuta*						-0.10							-0.18	
Bivalvia	Mollusca	Bivalvia									-0.15								
Brada pilosa	Annelida	Polychaeta	Canalipalpata	Flabelligeridae	*Brada pilosa*								-0.05						
Cancridae	Arthropoda	Malacostraca	Decapoda	Cancridae								-0.04							
Capitella capitata Comp	Annelida	Polychaeta		Capitellidae	*Capitella capitata Complex*							-0.07		-0.02					
Caprella sp.	Arthropoda	Malacostraca	Amphipoda	Caprellidae	*sp.*										-0.09				
Cardiidae	Mollusca	Bivalvia	Veneroida	Cardiidae				-0.04											
Caulleriella hartmanae	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Caulleriella hartmanae*			-0.04				-0.04	-0.05						
Celleporella hyalina	Ectoprocta	Gymnolaemata	Cheilostomatida	Hippothoidae	*Celleporella hyalina*									-0.02			-0.07		
Chaetozone acuta	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Chaetozone acuta*			-0.04	-0.05										-0.10
Cirratulidae	Annelida	Polychaeta	Canalipalpata	Cirratulidae						-0.03									
Crangon alaskensis	Arthropoda	Malacostraca	Decapoda	Crangonidae	*Crangon alaskensis*	-0.32	-0.22			-0.05									
Crangonidae	Arthropoda	Malacostraca	Decapoda	Crangonidae												-0.17	-0.07		
Crepipatella lingulata	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	*Crepipatella lingulata*								-0.09	-0.07					
Desdimelita desdichada	Arthropoda	Malacostraca	Amphipoda	Melitidae	*Desdimelita desdichada*				-0.05										
Dorvillea (Schistomerin	Annelida	Polychaeta	Aciculata	Dorvilleidae	*Dorvillea (Schistomeringos)*				-0.26			-0.04	-0.12	-0.11					
Eteone californica	Annelida	Polychaeta	Aciculata	Phyllodocidae	*Eteone californica*		-0.22	-0.04		-0.06		-0.07		-0.02					
Eualus sp.	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*sp.*							-0.04							
Eumida sanguinea	Annelida	Polychaeta	Aciculata	Phyllodocidae	*Eumida sanguinea*									-0.05					
Evalea tenuisculpta	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Evalea tenuisculpta*	-0.18	-0.22	-0.04	-0.05	-0.05		-0.15	-0.12	-0.02					-0.06
Glycera americana	Annelida	Polychaeta	Aciculata	Glyceridae	*Glycera americana*								-0.05						
Glycinde picta	Annelida	Polychaeta	Aciculata	Goniadidae	*Glycinde picta*						-0.10	-0.04							
Heptacarpus pugettens	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*Heptacarpus pugettensis*			-0.04											
Heptacarpus sp.	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*sp.*									-0.02					
Kurtiella tumida	Mollusca	Bivalvia	Veneroida	Montacutidae	*Kurtiella tumida*			-0.09	-0.37	-0.03	-0.10	-0.15	-0.05	-0.14					-0.37
Leukoma staminea	Mollusca	Bivalvia	Veneroida	Veneridae	*Leukoma staminea*					-0.03									
Macoma inquinata	Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma inquinata*			-0.04		-0.06					-0.15				-0.10
Macoma nasuta	Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma nasuta*							-0.07						-0.27	
Macoma sp.	Mollusca	Bivalvia	Veneroida	Tellinidae	*sp.*									-0.04					
Mesocrangon munitella	Arthropoda	Malacostraca	Decapoda	Crangonidae	*Mesocrangon munitella*			-0.04					-0.05						
Micropodarke dubia	Annelida	Polychaeta	Aciculata	Hesionidae	*Micropodarke dubia*			-0.09			-0.10			-0.04					
Micrura sp.	Nemertea	Anopla	Heteronemertea	Lineidae	*sp.*								-0.05						
Mycale adhaerens	Porifera	Demospongiae	Poecilosclerida	Mycalidae	*Mycale adhaerens*											-0.17	-0.07		
Mytilidae	Mollusca	Bivalvia	Mytiloida	Mytilidae		-0.18										-0.17			

Table E2. Shannon–Weiner Diversity (H') and Pielou’s Evenness (J')

Bremerton Pier 7 82-month, NIWC Pacific

						p*i* × ln(p*i*) [1]													
TAXON_NAME	**Phylum (unless otherwise specified)**	**Class (unless otherwise specified)**	**Order (unless otherwise specified)**	**Family (unless otherwise specified)**	**Scientific Name (unless otherwise specified)**	**LTM-1-MM**	**LTM-2-MM**	**LTM-3-MM**	**LTM-4-MM**	**LTM-5-MM**	**LTM-6-MM**	**LTM-7-MM**	**LTM-8-MM**	**LTM-9-MM**	**LTM-10-MM**	**LTM-1-RBS**	**LTM-2-RBS**	**LTM-3-RBS**	**LTM-4-RBS**
Mytilus edulis complex	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Mytilus edulis complex*										-0.09				
Nassarius mendicus	Mollusca	Gastropoda	Neogastropoda	Nassariidae	*Nassarius mendicus*	-0.27		-0.07	-0.17	-0.06	-0.10		-0.05	-0.02	-0.09		-0.07		-0.06
Nutricola lordi	Mollusca	Bivalvia	Veneroida	Veneridae	*Nutricola lordi*					-0.05					-0.09				
Oligochaeta	Annelida	Clitellata																	-0.24
Pagurus sp.	Arthropoda	Malacostraca	Decapoda	Paguridae	*sp.*									-0.02					
Paleanotus bellis	Annelida	Polychaeta	Aciculata	Chrysopetalidae	*Paleanotus bellis*									-0.04					
Paraprionospio alata	Annelida	Polychaeta	Canalipalpata	Spionidae	*Paraprionospio alata*		-0.22				-0.10	-0.11					-0.16	-0.18	-0.10
Parvilucina tenuisculpta	Mollusca	Bivalvia	Veneroida	Lucinidae	*Parvilucina tenuisculpta*														-0.06
Pholoe glabra	Annelida	Polychaeta	Aciculata	Pholoidae	*Pholoe glabra*														-0.06
Pholoides asperus	Annelida	Polychaeta	Aciculata	Pholoidae	*Pholoides asperus*									-0.02					
Pinnixa occidentalis Cm	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Pinnixa occidentalis Cmplx*						-0.29	-0.07						-0.32	
Pinnotherinae	Arthropoda	Malacostraca	Decapoda	Pinnotheridae		-0.18	-0.22											-0.18	
Podarkeopsis brevipalp	Annelida	Polychaeta	Aciculata	Hesionidae	*Podarkeopsis brevipalpa*			-0.07		-0.03		-0.07	-0.14	-0.04					
Polycirrus sp. III sensu	Annelida	Polychaeta	Canalipalpata	Terebellidae	*Polycirrus sp. III sensu*										-0.09		-0.07		
Polydora cornuta	Annelida	Polychaeta	Canalipalpata	Spionidae	*Polydora cornuta*									-0.35	-0.09				
Prionospio (Minuspio) li	Annelida	Polychaeta	Canalipalpata	Spionidae	*Prionospio (Minuspio) lighti*						-0.10		-0.12		-0.15			-0.18	-0.10
Prionospio sp.	Annelida	Polychaeta	Canalipalpata	Spionidae	*sp.*							-0.04		-0.02	-0.15				-0.06
Prionospio steenstrupi	Annelida	Polychaeta	Canalipalpata	Spionidae	*Prionospio steenstrupi*	-0.18		-0.12	-0.17	-0.08		-0.04	-0.14	-0.02					-0.22
Protodorvillea gracilis	Annelida	Polychaeta	Aciculata	Dorvilleidae	*Protodorvillea gracilis*			-0.04											
Romaleon jordani	Arthropoda	Malacostraca	Decapoda	Cancridae	*Romaleon jordani*						-0.10		-0.05		-0.09				
Scleroplax granulata	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Scleroplax granulata*										-0.26				
Scoloplos armiger	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos armiger*			-0.07											
Sigambra tentaculata	Annelida	Polychaeta	Aciculata	Pilargidae	*Sigambra tentaculata*						-0.10							-0.18	
Tellina sp.	Mollusca	Bivalvia	Veneroida	Tellinidae	*sp.*									-0.02					
Veneridae	Mollusca	Bivalvia	Veneroida	Veneridae		-0.18		-0.04											
Watersipora subtorquat	Ectoprocta	Gymnolaemata	Cheilostomatida	Watersiporidae	*Watersipora subtorquata*		-0.22			-0.03	-0.10	-0.04	-0.05	-0.02	-0.09	-0.17			
					Notomastus Tenuis				-0.05										
Shannon-Weiner Diversity (H') [2]						**2.08**	**1.89**	**1.85**	**1.62**	**1.10**	**2.11**	**1.45**	**2.18**	**1.78**	**2.28**	**1.08**	**1.34**	**2.21**	**2.03**
Pielou’s Evenness (J') [3]						**0.95**	**0.91**	**0.62**	**0.68**	**0.40**	**0.76**	**0.49**	**0.74**	**0.56**	**0.82**	**0.60**	**0.61**	**0.96**	**0.75**

Notes:

[1] p*i* is the proportion of individuals in species *i* to the total number of individuals in each sample. Ln is the natural logarithm of p*i*.

[2] Shannon-Wiener Diversity (H') is calculated as the sum of p*i*×ln(p*i*) for each species in each sample (Becker et al. 2011, USEPA 1987).

[3] Pielou’s Evenness (J') is calculated as H' divided by the natural logarithm of the number of taxa (Becker et al. 2011, USEPA 1987).

Table E3. Swartz's Dominance Index (SDI)

Bremerton Pier 7 82-month, NIWC Pacific

TAXON_NAME	Phylum (unless otherwise specified)	Class (unless otherwise specified)	Order (unless otherwise specified)	Family (unless otherwise specified)	Scientific Name (unless otherwise specified)	*pi* [1]													
						LTM-1-MM	**LTM-2-MM**	**LTM-3-MM**	**LTM-4-MM**	**LTM-5-MM**	**LTM-6-MM**	**LTM-7-MM**	**LTM-8-MM**	**LTM-9-MM**	**LTM-10-MM**	**LTM-1-RBS**	**LTM-2-RBS**	**LTM-3-RBS**	**LTM-4-RBS**
Alia sp.	Mollusca	Gastropoda	Neogastropoda	Columbellidae	*sp.*						2.6%						1.9%		
Alvania compacta	Mollusca	Gastropoda	Neotaenioglossa	Rissoidae	*Alvania compacta*	13.3%	9.1%	29.9%	35.1%	12.2%	42.1%	2.5%	11.4%	15.7%	7.3%	70.6%	45.3%	6.7%	15.1%
Ampharete acutif	Annelida	Polychaeta	Canalipalpata	Ampharetidae	*Ampharete acutifrons*														1.4%
Amphiuridae	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae					1.0%			0.8%							
Aphelochaeta gla	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Aphelochaeta glandaria*		36.4%	41.9%		74.1%	5.3%	68.9%	29.5%		36.6%	5.9%		13.3%	5.5%
Armandia brevis	Annelida	Polychaeta		Opheliidae	*Armandia brevis*			2.6%	1.0%				1.1%	0.4%	4.9%				
Axinopsida serric	Mollusca	Bivalvia	Veneroida	Thyasiridae	*Axinopsida serricata*					0.5%									
Balanus crenatus	Arthropoda	Maxillopoda	Sessilia	Balanidae	*Balanus crenatus*	20.0%		3.4%		1.0%	2.6%		26.1%	17.8%	4.9%		37.7%	13.3%	
Bipalponephtys c	Annelida	Polychaeta	Aciculata	Nephtyidae	*Bipalponephtys cornuta*						2.6%							6.7%	
Bivalvia	Mollusca	Bivalvia									5.3%								
Brada pilosa	Annelida	Polychaeta	Canalipalpata	Flabelligeridae	*Brada pilosa*								1.1%						
Cancridae	Arthropoda	Malacostraca	Decapoda	Cancridae								0.8%							
Capitella capitata	Annelida	Polychaeta		Capitellidae	*Capitella capitata Complex*							1.6%		0.4%					
Caprella sp.	Arthropoda	Malacostraca	Amphipoda	Caprellidae	*sp.*										2.4%				
Cardiidae	Mollusca	Bivalvia	Veneroida	Cardiidae				0.9%											
Caulleriella hartm	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Caulleriella hartmanae*			0.9%				0.8%	1.1%						
Celleporella hyali	Ectoprocta	Gymnolaemata	Cheilostomatida	Hippothoidae	*Celleporella hyalina*									0.4%			1.9%		
Chaetozone acuta	Annelida	Polychaeta	Canalipalpata	Cirratulidae	*Chaetozone acuta*			0.9%	1.0%										2.7%
Cirratulidae	Annelida	Polychaeta	Canalipalpata	Cirratulidae						0.5%									
Crangon alasken	Arthropoda	Malacostraca	Decapoda	Crangonidae	*Crangon alaskensis*	20.0%	9.1%			1.0%									
Crangonidae	Arthropoda	Malacostraca	Decapoda	Crangonidae												5.9%	1.9%		
Crepipatella lingu	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	*Crepipatella lingulata*								2.3%	1.7%					
Desdimelita desd	Arthropoda	Malacostraca	Amphipoda	Melitidae	*Desdimelita desdichada*				1.0%										
Dorvillea (Schisto	Annelida	Polychaeta	Aciculata	Dorvilleidae	*Dorvillea (Schistomeringos)*				12.4%			0.8%	3.4%	3.3%					
Eteone californica	Annelida	Polychaeta	Aciculata	Phyllodocidae	*Eteone californica*		9.1%	0.9%		1.5%		1.6%		0.4%					
Eualus sp.	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*sp.*							0.8%							
Eumida sanguine	Annelida	Polychaeta	Aciculata	Phyllodocidae	*Eumida sanguinea*									1.2%					
Evalea tenuisculp	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Evalea tenuisculpta*	6.7%	9.1%	0.9%	1.0%	1.0%		4.9%	3.4%	0.4%					1.4%
Glycera american	Annelida	Polychaeta	Aciculata	Glyceridae	*Glycera americana*								1.1%						
Glycinde picta	Annelida	Polychaeta	Aciculata	Goniadidae	*Glycinde picta*						2.6%	0.8%							
Heptacarpus pug	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*Heptacarpus pugettensis*			0.9%											
Heptacarpus sp.	Arthropoda	Malacostraca	Decapoda	Hippolytidae	*sp.*									0.4%					
Kurtiella tumida	Mollusca	Bivalvia	Veneroida	Montacutidae	*Kurtiella tumida*			2.6%	34.0%	0.5%	2.6%	4.9%	1.1%	4.5%					39.7%
Leukoma stamine	Mollusca	Bivalvia	Veneroida	Veneridae	*Leukoma staminea*					0.5%									
Macoma inquinat	Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma inquinata*			0.9%		1.5%					4.9%				2.7%
Macoma nasuta	Mollusca	Bivalvia	Veneroida	Tellinidae	*Macoma nasuta*							1.6%						13.3%	
Macoma sp.	Mollusca	Bivalvia	Veneroida	Tellinidae	*sp.*									0.8%					
Mesocrangon mu	Arthropoda	Malacostraca	Decapoda	Crangonidae	*Mesocrangon munitella*			0.9%					1.1%						
Micropodarke dub	Annelida	Polychaeta	Aciculata	Hesionidae	*Micropodarke dubia*			2.6%			2.6%			0.8%					
Micrura sp.	Nemertea	Anopla	Heteronemertea	Lineidae	*sp.*								1.1%						
Mycale adhaeren	Porifera	Demospongiae	Poecilosclerida	Mycalidae	*Mycale adhaerens*											5.9%	1.9%		
Mytilidae	Mollusca	Bivalvia	Mytiloida	Mytilidae		6.7%										5.9%			
Mytilus edulis com	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	*Mytilus edulis complex*										2.4%				
Nassarius mendic	Mollusca	Gastropoda	Neogastropoda	Nassariidae	*Nassarius mendicus*	13.3%		1.7%	6.2%	1.5%	2.6%		1.1%	0.4%	2.4%		1.9%		1.4%

Table E3. Swartz's Dominance Index (SDI)

Bremerton Pier 7 82-month, NIWC Pacific

						pi [1]													
TAXON_NAME	**Phylum (unless otherwise specified)**	**Class (unless otherwise specified)**	**Order (unless otherwise specified)**	**Family (unless otherwise specified)**	**Scientific Name (unless otherwise specified)**	**LTM-1-MM**	**LTM-2-MM**	**LTM-3-MM**	**LTM-4-MM**	**LTM-5-MM**	**LTM-6-MM**	**LTM-7-MM**	**LTM-8-MM**	**LTM-9-MM**	**LTM-10-MM**	**LTM-1-RBS**	**LTM-2-RBS**	**LTM-3-RBS**	**LTM-4-RBS**
Nutricola lordi	Mollusca	Bivalvia	Veneroida	Veneridae	*Nutricola lordi*					1.0%					2.4%				
Oligochaeta	Annelida	Clitellata																	11.0%
Pagurus sp.	Arthropoda	Malacostraca	Decapoda	Paguridae	*sp.*									0.4%					
Paleanotus bellis	Annelida	Polychaeta	Aciculata	Chrysopetalidae	*Paleanotus bellis*									0.8%					
Paraprionospio a	Annelida	Polychaeta	Canalipalpata	Spionidae	*Paraprionospio alata*		9.1%				2.6%	3.3%					5.7%	6.7%	2.7%
Parvilucina tenuis	Mollusca	Bivalvia	Veneroida	Lucinidae	*Parvilucina tenuisculpta*														1.4%
Pholoe glabra	Annelida	Polychaeta	Aciculata	Pholoidae	*Pholoe glabra*														1.4%
Pholoides asperu	Annelida	Polychaeta	Aciculata	Pholoidae	*Pholoides asperus*									0.4%					
Pinnixa occidenta	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Pinnixa occidentalis Cmplx*						15.8%	1.6%						20.0%	
Pinnotherinae	Arthropoda	Malacostraca	Decapoda	Pinnotheridae		6.7%	9.1%											6.7%	
Podarkeopsis bre	Annelida	Polychaeta	Aciculata	Hesionidae	*Podarkeopsis brevipalpa*			1.7%		0.5%		1.6%	4.5%	0.8%					
Polycirrus sp. III s	Annelida	Polychaeta	Canalipalpata	Terebellidae	*Polycirrus sp. III sensu*										2.4%		1.9%		
Polydora cornuta	Annelida	Polychaeta	Canalipalpata	Spionidae	*Polydora cornuta*									47.1%	2.4%				
Prionospio (Minus	Annelida	Polychaeta	Canalipalpata	Spionidae	*Prionospio (Minuspio) lighti*						2.6%		3.4%		4.9%			6.7%	2.7%
Prionospio sp.	Annelida	Polychaeta	Canalipalpata	Spionidae	*sp.*							0.8%		0.4%	4.9%				1.4%
Prionospio steens	Annelida	Polychaeta	Canalipalpata	Spionidae	*Prionospio steenstrupi*	6.7%		3.4%	6.2%	2.0%		0.8%	4.5%	0.4%					9.6%
Protodorvillea gra	Annelida	Polychaeta	Aciculata	Dorvilleidae	*Protodorvillea gracilis*			0.9%											
Romaleon jordan	Arthropoda	Malacostraca	Decapoda	Cancridae	*Romaleon jordani*						2.6%		1.1%		2.4%				
Scleroplax granul	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	*Scleroplax granulata*										12.2%				
Scoloplos armige	Annelida	Polychaeta	Orbiniida	Orbiniidae	*Scoloplos armiger*			1.7%											
Sigambra tentacu	Annelida	Polychaeta	Aciculata	Pilargidae	*Sigambra tentaculata*						2.6%							6.7%	
Tellina sp.	Mollusca	Bivalvia	Veneroida	Tellinidae	*sp.*									0.4%					
Veneridae	Mollusca	Bivalvia	Veneroida	Veneridae		6.7%		0.9%											
Watersipora subt	Ectoprocta	Gymnolaemata	Cheilostomatida	Watersiporidae	*Watersipora subtorquata*		9.1%			0.5%	2.6%	0.8%	1.1%	0.4%	2.4%	5.9%			
					Notomastus Tenuis				1.0%										
Swartz's Dominance Index (SDI) [2]						**6**	**6**	**3**	**3**	**2**	**7**	**3**	**5**	**3**	**7**	**2**	**2**	**7**	**4**

Notes:

[1] *pi* is the proportion of individuals in species *i* to the total number of individuals in each sample.

[2] Swartz's Dominance Index (SDI) is the minimum number of species required to account for 75 percent of individuals in a sample (Becker et al. 2011, USEPA 1987).

Appendix D

Peer Reviewed Journal Article

Environmental Toxicology and Chemistry—Volume 41, Number 6—pp. 1568–1574, 2022
Received: 25 October 2021 | Revised: 21 December 2021 | Accepted: 18 February 2022

Remediation and Restoration

Long-Term Monitoring of an In Situ Activated Carbon Treatment to Reduce Polychlorinated Biphenyl Availability in an Active Harbor

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Abstract: Activated carbon–based amendments have been demonstrated as a means of sequestering sediment-associated organic compounds such as polychlorinated biphenyls (PCBs). In a 2012 effort, an activated carbon amendment was placed at a 0.5-acre amendment area adjacent to and underneath Pier 7 at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility, Bremerton, Washington, USA to reduce PCB availability. Multiple postplacement monitoring events over a 3-year period showed an 80%–90% reduction in PCBs, stability of activated carbon, and no significant negative impacts to the benthic community. To further evaluate the long-term performance, a follow-on to the approximately 7-year (82-month) postplacement monitoring event was conducted in 2019. The results of in situ porewater and bioaccumulation evaluations were consistent with previous observations, indicating overall PCB availability reductions of approximately 80%–90% from preamendment conditions. Multiple measurement approaches for quantifying activated carbon and amendment presence indicated that the amendment was present and stable in the amendment area and that the activated carbon content was similar to levels observed previously. As in the previous investigation, benthic invertebrate community metrics indicated that the amendment did not significantly impair benthic health. An application of carbon petrography to quantify activated carbon content in surface sediments was also explored. The results were found to correspond within a factor of 1.3 (on average) with those of data for the black carbon content via a black carbon chemical oxidation method, an approach that quantifies all forms of black carbon (including activated carbon). The results suggest that at sites with low soot-derived black carbon content in sediment (relative to the targeted activated carbon dose), the black carbon chemical oxidation method would be a reasonable method for measurement of activated carbon dosage in sediment at sites amended with activated carbon. *Environ Toxicol Chem* 2022;41:1568–1574. © 2022 SETAC

Keywords: Bioavailability; Polychlorinated biphenyls; Benthic invertebrates; Bioaccumulation; Activated carbon; Sediment remediation

INTRODUCTION

Activated carbon–based amendments have been demonstrated widely in recent years as an effective and relatively nondisruptive means of reducing the availability of sediment-associated hydrophobic organic contaminants (Patmont et al., 2015; Rakowska et al., 2012, 2014; US Army Corps of Engineers, 2020; US Environmental Protection Agency [USEPA], 2013). In a 2012 project effort led by the Naval Information Warfare Center Pacific, an activated carbon amendment (AquaGate + PAC™; www.aquablok.com) was placed at a 0.5-acre study area adjacent to and underneath Pier 7 at the Puget Sound Naval Shipyard and Intermediate Maintenance Facility, Bremerton, Washington, USA to reduce polychlorinated biphenyl (PCB) availability in surface sediments (Kirtay et al., 2018). This amendment was applied to target a dosage of 0.04 g activated carbon/g sediment dry weight (i.e., 4% by weight) in surface sediment, which was achieved based on measurements 0.5 months after placement (Kirtay et al., 2018). Multiple postplacement monitoring events over a 3-year period indicated a persistent 80%–90% reduction in available PCBs, stability of the activated carbon amendment, and no significant negative

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This article includes online-only Supporting Information.

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Published online 23 February 2022 in Wiley Online Library (wileyonlinelibrary.com).

DOI: 10.1002/etc.5318

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impacts to the native benthic invertebrate community (Kirtay et al., 2018).

To provide an additional evaluation of the longevity of activated carbon remedy, a follow-on approximately 7-year postplacement monitoring event (conducted 82 months after the amendment was placed) was conducted in 2019. The primary objective of the 82-month monitoring was to repeat the key monitoring efforts of Kirtay et al. (2018) to assess the long-term stability and effectiveness of activated carbon-based amendment, as well as the health of the benthic invertebrate community. A secondary objective of the effort was to evaluate a novel quantitative adaptation of a sediment carbon petrography method (Ghosh et al., 2003) to provide a measurement of the activated carbon content of sediment (i.e., grams of activated carbon per gram of sediment) in the amendment area. This petrographic technique allows the ability to distinguish activated carbon from other forms of carbon that may be in sediment, presenting potential advantages to the analysis of total organic carbon (TOC) or black carbon in sediment, two methods that have been used in many activated carbon field studies to confirm the postamendment in situ presence and dosage of activated carbon (Beckingham & Ghosh, 2011; Wood Environment and Infrastructure Solutions et al., 2019).

MATERIALS AND METHODS

A variety of measurement approaches were employed across the Pier 7 amendment area (Kirtay et al., 2018) at different stations (Figure 1) in August 2019, as detailed in Supporting Information, Table S1. Consistent with Kirtay et al. (2018), PCB availability within the amendment area was evaluated at 10 stations (white circles shown in Figure 1, stations 1-MM to 10-MM in Supporting Information, Table S1). The first approach used the analysis of PCBs in tissue samples from two in situ deployed bioaccumulation test organisms, *Nephtys caecoides* (polychaete worms) and *Macoma nasuta* (bent-nose clam). Laboratory-provided *N. caecoides* and *M. nasuta* (collected from an unimpaired field site) were housed in sediment ecotoxicity assessment (SEA) rings (Zebra-Tech), which are autonomous multichamber samplers used for in situ toxicity and bioaccumulation testing (details described in Kirtay et al., 2018; Supporting Information, Section 5). The SEA rings were installed and retrieved by Navy SCUBA divers such that organisms were exposed to approximately the top 15 cm of surface sediment for 14 days. After retrieval of the SEA rings, *N. caecoides* and *M. nasuta* were recovered from the chambers and sieved by hand using a 500-μm stainless-steel sieve. Organisms were allowed to depurate in clean seawater for 24 h. *Nephtys caecoides* (whole body) and *M. nasuta* (soft tissues) were homogenized, extracted, and analyzed for PCB congeners via USEPA Method 8082A and lipid content (Inouye & Lotufo, 2006; Van Handel, 1985).

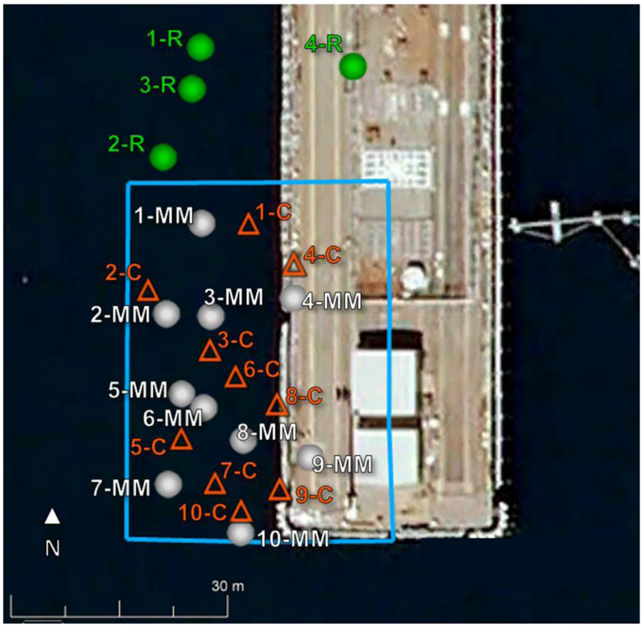

FIGURE 1: Sample station locations inside (white circles and orange triangles) and outside (green squares) the amendment area (blue outline) adjacent to and beneath Pier 7, Puget Sound Naval Shipyard and Intermediate Maintenance Facility, Bremerton, Washington, USA. (Image from Google Earth).

The second approach for PCB availability measurement involved the measurement of freely dissolved concentrations (C_{free}) of PCBs in sediment porewater, determined via in situ deployment of solid-phase microextraction (SPME) passive samplers. Methods followed those used by Kirtay et al. (2018). Briefly, SPMEs were deployed in a SPME Device (www.siremlab.com) consisting of SPMEs housed in a small stainless-steel mesh envelope attached to a steel rod support. Each SPME Device envelope contained 125 cm of SPME fiber (ten 12.5-cm pieces of fiber with 10-μm thickness polydimethylsiloxane coating, 210-μm silica core diameter; Fiber-Guide Industries). The SPME fibers were prespiked with performance reference compounds (PRCs). Three SPME Devices were deployed at 10 stations (white circles shown in Figure 1, stations 1-MM to 10-MM in Supporting Information Table S1), adjacent to the SEA rings. The SPMEs were retrieved by SCUBA divers 14 days after deployment and stored at 4 °C until they could be extracted (SPME fibers from the three devices at each station were combined in a composite sample consisting of 375 cm of fiber) and analyzed for target analyte PCBs and PRCs. Nine additional SPME Devices (not deployed in sediment) were used to provide three trip blank samples. The C_{free} PCBs were calculated using the measured PCB concentrations in the SPME samplers and the fraction loss of the PRCs out of the samplers during deployment time, as described in Kirtay et al. (2018).

Consistent with Kirtay et al. (2018), a census of the benthic invertebrate community was performed within the amendment area at 10 stations (white circles shown in Figure 1, stations 1-MM to 10-MM in Supporting Information, Table S1) and outside the amendment area (green circles shown in Figure 1, stations 1-R to 4-R in Supporting Information, Table S1). Briefly, at each station, five sediment core samples were collected by SCUBA divers using 4.8-cm-diameter, 45-cm-length core tubes. At each benthic invertebrate community sample location, the uppermost 15 cm of sediment retained in five cores were composited into one sample and sieved through a 1.0-mm mesh screen to remove fine sediment. Residual sediment, debris, shells, and benthic organisms on the screen were carefully collected into labeled wide-mouth bottles, preserved, and stored until the invertebrates could be identified by qualified taxonomists down to the lowest practicable taxonomic level and subsequently enumerated.

Sediment core samples were also collected by SCUBA divers in accordance with ASTM 1391 (ASTM International, 2008) within the amendment area (white circles shown in Figure 1, stations 1-MM to 10-MM in Supporting Information, Table S1) to determine the concentration of PCBs and content of TOC, black carbon, and activated carbon in bulk sediment. The activated carbon content was not analyzed in stations 1-MM, 8-MM, and 10-MM because of sample material limitations. Ten additional stations (orange triangles shown in Figure 1, stations 1-C to 10-C in Supporting Information, Table S1) were cored to provide additional measurements of TOC and black carbon. After collection, cores were split lengthwise and visually and tactilely analyzed for the presence of the AquaGate + PAC aggregate (aggregate remaining in sediment after the activated carbon coating sloughs off the AquaGate + PAC material). Samples of the fine sediment (excluding debris and aggregate >0.5 cm) were collected to obtain samples of the sediment layers at 0–5, 5–10, 10–15, and 15–20 cm below the sediment–water interface. Samples (placed in sample storage jars) were stored at 4 °C before analysis of TOC, black carbon, and PCB congeners via Lloyd Kahn (USEPA, 1998), Grossman and Ghosh (2009), and USEPA 8082 methods, respectively, as described in Kirtay et al. (2018).

Core samples for the quantification of activated carbon via carbon petrography were analyzed by D. Gray (Koppers, Pittsburgh, PA) following ASTM standard methods for coal analysis: D2797 (preparing coal samples for microscopic analysis by reflected light), D2798 (microscopic determination of the reflectance of vitrinite in a polished specimen of coal), and D2799 (microscopic determination of volume percent of physical components of coal) as described in Ghosh et al. (2003). In this method, an aliquot of sediment is mounted on epoxy media, set in a 1.25-inch phenolic ring mold, polished to a scratch-free surface, and photographed in reflected light at ×250 and ×600 magnification (in air). Visual identification and quantification of activated carbon content (volume of activated carbon relative to other solid materials) were based on 1000 evaluation points for each sample at ×600 magnification. As shown in an example photograph (Figure 2), activated carbon particles approximately 10–50 μm in diameter (indicated by the yellow arrows) are observable at the resolution of the photograph. This observation is consistent with expectations of particle sizes for the activated carbon used in the AquaGate + PAC material, which was primarily composed of activated carbon particles with diameters <74 μm (Kirtay et al., 2018). Particle sizes of powdered activated carbon used for many activated carbon sediment amendment projects range from 1 to 300 μm (Kupryianchyk et al., 2015; Rakowska et al., 2014), so the petrographic method appears to be of sufficient sensitivity to detect activated carbon in sediment.

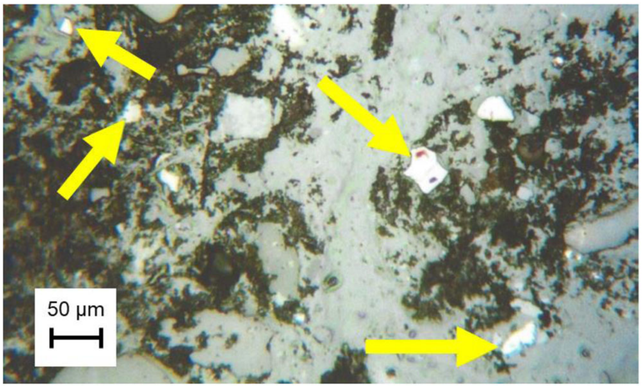

FIGURE 2: Example carbon petrography photograph. Four activated carbon particles (several are present) are indicated by the yellow arrows. Images depict reflected light in air, so the activated carbon particles appear white instead of black.

Although carbon petrography analysis has been successfully applied in previous studies to qualitatively differentiate various types of natural particles in sediment samples from sites including Hunters Point, CA, USA; Milwaukee Harbor, WI, USA; and Harbor Point, NY, USA (Ghosh et al., 2003), the approach used in the present investigation was novel because the activated carbon content of sediment on a mass basis (i.e., grams of activated carbon per gram of sediment, dry wt) was estimated quantitatively using the volume-based measurement quantified visually from the equation

$$\text{Sediment AC Content}\left(\frac{\text{g AC}}{\text{g sediment, dry wt}}\right) = \frac{(\text{VCAC} \times \text{DAC})}{(\text{VCAC} \times \text{DAC}) + [\text{DSQ} \times (1 - \text{VCAC})]} \tag{1}$$

where AC is activated carbon, VCAC is the volumetric content of activated carbon in sediment (cubic centimeters of activated carbon per cubic centimeter of sediment; determined by the area of particles identified as activated carbon relative to the area of other solid particles via carbon petrography), DAC is the density of activated carbon (assumed to be 2.0 g, dry wt/cm^3), and DSQ is the density of sediment quartz (assumed to be 2.7 g, dry wt/cm^3). This approach assumes that the majority of the solid mass in a sediment is composed of quartz or minerals with a similar density of quartz. This assumption is appropriate for most mineral sediments but may be invalid if a significant amount of other solid non-activated carbon material (shells, wood, etc.) is present in sediment. In those cases, measurement of solid particle density of the sediment could be helpful in improving the accuracy of this approach.

Data analysis methods were consistent with those used in Kirtay et al. (2018). In addition, it should be noted that the coring and bioaccumulation efforts performed in Kirtay et al. (2018) and in the present study do remove amendment and sediment. Repeatedly coring the same core insertion point over the course of several monitoring events would not provide useful information with regard to amendment presence or performance. Given the precision in the placement of the MM stations from event to event (i.e., on a scale of several meters) and subsequent coring and placement of SEA rings, it is unlikely that the exact location of any individual core from a previous monitoring event was cored again during this monitoring event.

RESULTS AND DISCUSSION

Reductions in PCB availability as a result of the activated carbon amendment

All three measures of PCB availability (tissue PCBs in *N. caecoides* and *M. nasuta*, C_{free} via passive sampling) in the 82-month monitoring remained significantly decreased relative to the preamendment (baseline) and were consistent with results from the three rounds of postremedy monitoring conducted by Kirtay et al. (2018). Concentration of total PCBs in *M. nasuta* and *N. caeoides* in the 82-month postamendment sampling event are consistent with previous postamendment monitoring results, as shown in Figure 3. Approximately 80% of the 82-month results were below the approximate detection limit of 70 ng/g lipid, wet weight. The 82-month data were not compared statistically to data from other monitoring events because of the high proportion of nondetect results, and nondetect values are represented as one-half the detection limit in Figure 3 and summary statistics. Geometric mean concentrations in *M. nasuta* and *N. caeoides* in the 82-month event were 93% and 90% lower than the baseline, respectively (Kirtay et al., 2018), indicating that the activated carbon amendment is continuing to maintain PCB availability approximately 80%–90% lower than the baseline. It should be noted that the highest 82-month results in Figure 3 are 2–3 orders of magnitude higher than the rest of the data. This result was obtained from the southernmost station (10-MM) shown in Figure 1. The presence of activated and black carbon at this station was extremely low, only a trace presence of aggregate being detected (Supporting Information, Table S2); and concentrations of PCBs in bulk sediment were 240 ng/g, dry weight sediment, approximately 10 times higher than measured at other stations. This suggests that the placement of this station may have not been within the amendment area (or at the edge). If this result is excluded, the 82-month tissue data for *M. nasuta* and *N. caeoides* would indicate geometric means (±range of geometric means − 1 standard deviation [SD] to geomean + 1 SD) of 32 (21–58) and 56 (35–94) ng/g lipid, wet weight, representing a 96%–97% reduction from baseline conditions measured in Kirtay et al. (2018).

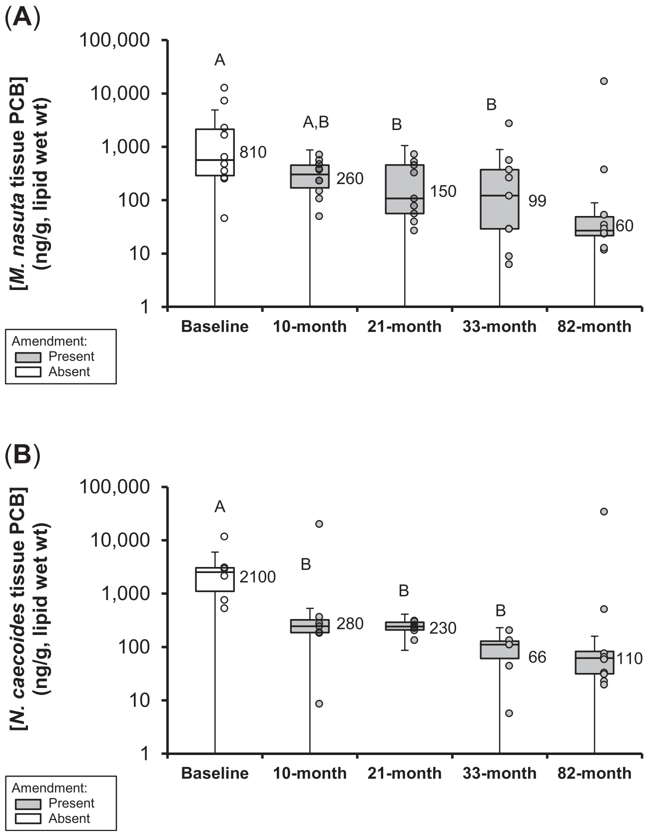

FIGURE 3: Concentrations of total polychlorinated biphenyls (lipid-normalized, wet wt basis) in *Macoma nasuta* (**A**) and *Nephtys caecoides* (**B**) for the baseline and four postamendment monitoring events. Results are plotted as the median (horizontal bar), interquartile range (limits of boxes are 25th and 75th percentiles), 1.5 times the interquartile range (error bars), and individual data points (circles). The values shown to the right of each box indicate the geometric means. Events with the same letter (baseline to 33-month data) in each plot are not statistically different (analysis of variance with a posteriori Tukey's honestly significant difference, $\alpha = 0.05$). PCB = polychlorinated biphenyl.

Comparison of PCB C_{free} data from 82 months was consistent with results from previous years' monitoring events, as shown in Figure 4. Approximately 80% of the 82-month results were below the approximate detection limit of 0.04 ng/L. The 82-month data were not compared statistically to data from other monitoring events because of the high proportion of nondetect results, and nondetect values are represented as one-half the detection limit in Figure 4 and summary statistics. The C_{free} result from the 82-month monitoring event, as calculated using geometric

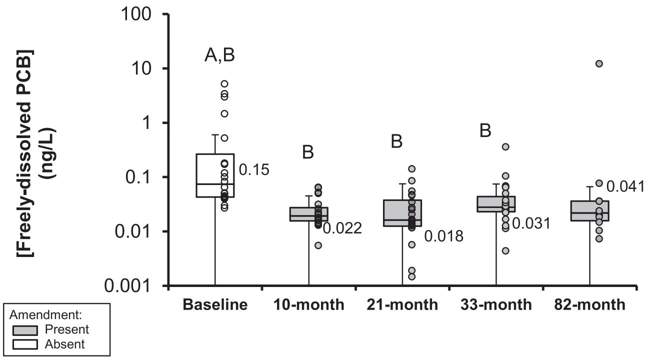

FIGURE 4: Concentrations of freely dissolved total polychlorinated biphenyls in surface sediment for the baseline and four postamendment monitoring events. Results are plotted as the median (horizontal bar), interquartile range (limits of boxes are 25th and 75th percentiles), 1.5 times the interquartile range (error bars), and individual data points (circles). The values to the right of each box denote the geometric means. Events with the same letter (baseline to 33-month data) in each plot are not statistically different (analysis of variance with a posteriori Tukey's honestly significant difference, $\alpha = 0.05$). PCB = polychlorinated biphenyl.

means, was 73% lower than the baseline, similar to previous postremedy monitoring events where C_{free} values were 85%, 88%, and 79% lower than the baseline (Kirtay et al., 2018). On average, the activated carbon amendment is continuing to maintain PCB availability approximately 80% lower than the baseline. It should be noted that the highest 82-month result in Figure 4 is 2–3 orders of magnitude higher than the rest of the data. This result was obtained from the southernmost station (10-MM), which may have not been precisely located within the amendment area, as discussed. If this result is excluded, the 82-month geometric mean C_{free} would be 0.022 ng/L, indicating an 85% reduction from baseline C_{free}.

Characterization of the presence of the activated carbon amendment

The visual observation of aggregate presence in core, and subsequent analysis of TOC, black-, and activated carbon in core samples confirmed the results of Kirtay et al. (2018) that the amendment was stable and in place throughout the 82-month evaluation, with activated carbon levels in the surficial layers of approximately 1% observed in the final (33-month postamendment) monitoring event. The 82-month evaluation was consistent with the previous lines of evidence (sediment profile imagery, carbon measurements, tactile analysis of cores) that indicated that approximately 80% or more of the area received the amendment. For example, on an area-wide evaluation of the data, in the upper 5 cm of sediment, showed that activated- and black carbon contents in the 82-month event were not statistically significantly different from those measured in the 33-month event (Supporting Information, Figures S1 and S2); this observation was also evident for the 5–10 and 10–15 cm layer results. During processing of the sediment core samples, visual and tactile analysis of the samples confirmed that aggregate material was present at 18 of the 20 stations in the amendment area (Supporting Information, Table S2). The presence of aggregate was used to segregate TOC, black-, and activated carbon sample results (Table 1). Sediment samples with and without aggregate presence exhibited similar TOC levels of approximately 3% and were not statistically different ($p = 0.37$). Levels of TOC in the 82-month data were similar to those in Kirtay et al. (2018) and reflect mostly natural organic carbon. In contrast, average black carbon content of sediment samples with aggregate present was 1.3%, significantly higher ($p < 0.0001$) than sediment with no aggregate (average of 0.3%) by an approximate factor of 4 (Table 1). The black carbon chemical oxidation method used (Grossman & Ghosh, 2009) is likely more accurate than the Lloyd Khan TOC method for measuring activated carbon. The black carbon chemical oxidation approach relies on chemical oxidation methods, rather than combustion, the latter of which can lead to losses of activated carbon prior to quantification in TOC methods (i.e., Lloyd Khan method) and other black carbon analytical methods (Gustafsson et al., 1997). In addition, the black carbon chemical oxidation method does not quantify natural organic carbon, which, from the TOC data, is naturally abundant in the native sediment (Supporting Information, Figure S1).

As with black carbon content, the activated carbon content of the 82-month sediment samples with aggregate present was significantly higher ($p = 0.0082$) than sediment with no aggregate by a factor of approximately 5 (Table 1). The average 1.0% activated carbon content of samples with aggregate present approximates the levels targeted for the amendment design and is similar to levels of black carbon observed in the 82-month data and in previous sampling events (Kirtay et al., 2018). The measurement of activated carbon is hypothetically more accurate because it is able to distinguish activated carbon from soot carbon, both of which are included in the measurement of black carbon by the chemical oxidation method. From the soot carbon data available from the carbon petrography (approximate Table S2), the average (SD) soot carbon content of samples with aggregate present was 0.08% (0.11%). This amount of soot carbon is much less than the activated carbon content and represents a very small portion of the black carbon content (<10%). Given this, measurement of black carbon in this case would provide a reasonably accurate measurement of activated carbon content. The data bear this out because there was a good agreement between black carbon and activated carbon for the two methods (Figure 5) if the raw data from 30 of the 32 samples are compared (two of the samples indicated nondetectable activated carbon contents; black carbon values for these samples were at trace levels [0.2%–0.3%]). The results from 25 of 30 samples with detectable levels of both activated carbon and black carbon (83% of samples) agreed within a factor of 2 between the two methods, and 93% of the samples agreed within a factor of 3.

Benthic community health

There was no evidence from the 82-month data that indicated an adverse effect on benthic invertebrate communities at the amended area, which is consistent with findings from the

TABLE 1: Summary statistics for the total organic carbon, black carbon, and activated carbon content in sediment samples collected in the amendment area in the 82-month sampling event

		TOC			BC			AC		
Aggregate presence	*n*	*n*	Average (%)	SD (%)	*n*	Average (%)	SD (%)	*n*	Average (%)	SD (%)
Samples with aggregate	58	56	2.9	1.7	58	1.3	1.2	26	1.0	0.7
Samples with no aggregate	34	32	2.6	1.4	30	0.3	0.2	6	0.2	0.1

TOC = total organic carbon; BC = black carbon; AC = activated carbon; SD = standard deviation.

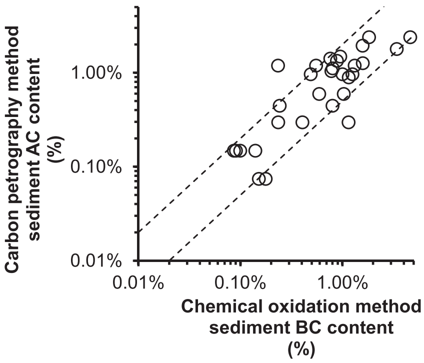

FIGURE 5: Comparison of sediment activated carbon (AC) content (via carbon petrography) versus sediment black carbon (BC) content using the black carbon chemical oxidation method. Symbols between the dashed lines indicate a factor of 2 agreement (or better) between activated carbon and black carbon measurements. Two samples with nondetectable activated carbon contents were not included in this log-scale figure (see text).

previous three monitoring events (Kirtay et al., 2018). No statistically significant differences among the five monitoring events were detected for total abundance, diversity, evenness, Swartz dominance index, or percent abundance of the top five abundant taxa within the amended area (Supporting Information, Figure S4). Differences among the groups for taxa richness were noted ($p = 0.04$), with the 82-month results (Supporting Information, Figure S4f), indicating higher richness compared to results from the other monitoring events. Taxa richness was statistically different (lower) in the baseline for the unamended area results (Kirtay et al., 2018) when compared to the amended area 82-month results. Overall, this may suggest slight improvement of ecological health in the amended area in the 82-month results compared to the reference stations. This result may be due to temporal differences, and overall results confirm that taxa richness in the amended area has not been adversely affected by the activated carbon amendment. The observations in this event further confirm the findings of most scientific studies proposing that adverse effects on benthic invertebrates are not expected as a result of activated carbon amendments (Janssen & Beckingham, 2013), especially when activated carbon dosage rates remain below approximately 5% by weight in sediment (Janssen & Beckingham, 2013; Kupryianchyk et al., 2015; Patmont et al., 2015; Rakowska et al., 2012).

CONCLUSIONS

The present study successfully augmented the evaluation of the performance of an activated carbon amendment in an active harbor via additional data beyond the 3-year monitoring (Kirtay et al., 2018) to include a new evaluation nearly 7 years (82 months) postamendment. Porewater and in situ bioaccumulation measurements indicated a sustained reduction in PCB availability of 80%–90% (relative to baseline, as measured in Kirtay et al., 2018). Confirmation of amendment stability and presence using measurements of TOC, black-, and activated carbon content in surface sediment samples, as well as the observation of aggregate presence in samples, indicated results similar to previous monitoring events, that is, that the amended area is stable and that activated carbon levels in the surficial layers continue to approximate the 1% activated carbon content observed in the final 33-month monitoring event conducted by Kirtay et al. (2018). Benthic invertebrate census results from the 82-month study did not indicate differences in benthic community ecological metrics among the preamendment baseline and four postamendment monitoring events, indicating the absence of an adverse effect of the activated carbon amendment, as noted in Kirtay et al. (2018).

A secondary objective of the present study was to demonstrate an exploratory approach (carbon petrography) to explicitly identify activated carbon presence in sediment samples and provide a quantification of its content in sediment. In our investigation, there was no demonstrable advantage to using the more activated carbon-specific carbon petrography method compared to the black carbon chemical oxidation method because results for paired samples were in relatively close agreement with regard to confirming activated carbon presence and measuring dosage levels in the amended area. The black carbon chemical oxidation method may be preferable for many regulatory investigations involving activated carbon sediment remediation applications because this method follows a gravimetric (rather than visual) analytical approach similar to many USEPA SW-846 methods (USEPA, 2007) used for decision-making at US state and federal contaminated sediment sites. To our knowledge, the black carbon chemical oxidation method is not currently available from a commercial environmental analytical laboratory. Widespread commercialization of the black carbon chemical oxidation method would likely be helpful to sediment remediation practitioners who need to incorporate measurements of activated carbon into confirmation and monitoring programs at sites using activated carbon amendments. In special cases, carbon petrography measurements of activated carbon content may be useful to validate the accuracy of the black carbon chemical oxidation measurements to provide a reasonable measurement of activated carbon at sites where relatively high levels of soot carbon in native sediment (compared to activated carbon dosing levels) could bias postremedy black carbon measurements high. The need for this confirmation could be evaluated via preremediation black carbon measurements to evaluate the soot carbon content.

Supporting Information—The Supporting Information is availableon the Wiley Online Library at https://doi.org/10.1002/etc.5318.

Acknowledgment—The authors gratefully acknowledge the tremendous support of a number of individuals and organizations that contributed to the success of the present study (see Supporting Information). Funding for this research was provided by the US Department of Defense Environmental Security Technology Certification Program (ER18-5079) and the US Naval Facilities Engineering Command Northwest.

Disclaimer—The authors are not aware of any conflicts of interest that may affect this work.

Author Contributions Statement—**Alice Peiying Wang**: Formal analysis; Visualization; Writing—original draft, review, and editing. **Jason Conder**: Conceptualization; Investigation; Formal analysis; Validation; Visualization; Writing—original draft, review, and editing. **Gunther Rosen**: Conceptualization; Investigation; Formal analysis; Validation; Visualization; Writing—original draft, review, and editing. **Bart Chadwick**: Conceptualization; Formal analysis.

Data Availability Statement—Data, associated metadata, and calculation tools are available from the corresponding author (jconder@geosyntec.com).

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Appendix E

Analytical Laboratory Raw Sediment PCB data

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

20 March 2020

James Leather
SPAWAR
53475 Strothe Rd, Bldg 111
San Diego, CA 92152

RE: Bremerton ESTCP ER18-5079

Enclosed are the results of analyses for samples received by the laboratory on 10-Sep-2019. The samples associated with this report will be held for 90 days from the date of this report. The raw data associated with this report will be held for 5 years from the date of this report. If you need us to hold onto the samples or the data longer then these specified times, you will need to notify us in writing at least 30 days before the expiration dates. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Allyson Wooley For Jenifer Milam Netchaev
Database Manager

USACE ERDC-EP-C
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

SPAWAR
53475 Strothe Rd, Bldg 111
San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

WORK ORDER SUMMARY

Sample ID	Laboratory ID	Matrix	Date Sampled	Date of Work Order
T82-1-MM-SedChem	19I1009-01	Soil/Sediment	27-Aug-2019	10-Sep-2019
T82-2-MM-SedChem	19I1009-02	Soil/Sediment	27-Aug-2019	10-Sep-2019
T82-3-MM-SedChem	19I1009-03	Soil/Sediment	27-Aug-2019	10-Sep-2019
T82-4-MM-SedChem	19I1009-04	Soil/Sediment	28-Aug-2019	10-Sep-2019
T82-4-MM-DUP-SedChem	19I1009-05	Soil/Sediment	28-Aug-2019	10-Sep-2019
T82-5-MM-SedChem	19I1009-06	Soil/Sediment	27-Aug-2019	10-Sep-2019
T82-6-MM-SedChem	19I1009-07	Soil/Sediment	28-Aug-2019	10-Sep-2019
T82-6-MM-DUP-SedChem	19I1009-08	Soil/Sediment	28-Aug-2019	10-Sep-2019
T82-7-MM-SedChem	19I1009-09	Soil/Sediment	28-Aug-2019	10-Sep-2019
T82-8-MM-SedChem	19I1009-10	Soil/Sediment	28-Aug-2019	10-Sep-2019

Case Narrative

Samples from work orders, 19I1009 and 19I1010, were re-extracted due to low surrogate recoveries with the initial extraction. These samples were concentrated down to 0.5 mL and treated with elemental mercury to precipitate sulfur which interfered with the quantitation of the congeners. However, the initial mercury treatment did not remove all of the sulfur. Therefore, multiple samples underwent multiple mercury treatments which resulted in having to dilute and re-concentrate the samples. These steps negatively impacted the recovery of surrogates and spiked compounds. Concentrating the samples resulted in matrix effects that caused active sites in the inlets which lead to instrument failures such as loss of sensitivity and continuing calibration verification standard (CCVs) failures. The sediment samples for 19I1009 and 19I1010 were originally analyzed on Jan 30, 2020 but due to failing CCVs the samples had to be analyzed multiple times. SW-846 Update Chapter VI Revision 6 December 2018 states in Table 4-1 that polychlorinated biphenyls do not have a holding time for solid samples that were kept cool between 0-6°C. No bias was suspected for the PCBs due to the holding time violation. In order to correct the issue the instrument required maintenance and replacement of parts such as liners, gold inlet seals and columns. In order to correct for the instrument drift additional internal standards (PCB 11, 186 and 188) were added to the calibration standards and samples. This accounted and corrected for the loss of sensitivity during the analysis. However, only congener 11 was used as the corrective internal standard due to the fact that 186 and 188 had co-elutions with analytes of interest on either the primary or secondary column.

The following congeners are reported as a combination of more than one congener due to co-elutions - 90/101, 115/87, 117/81, 126/129, 132/153, 138/163/164, 15/16, 28/31, 110/77, and 149/123.

Notes and Definitions

Z-03	See case narrative.
X	Surrogate is outside control limits
U	Analyte included in the analysis, but not detected
S-GC	Surrogate recovery outside of control limits. The data was accepted based on valid recovery of the remaining surrogate/s.
RPD-06	RPD exceeds acceptance limit.
RPD-02	The RPD result exceeded the QC control limits; however, both percent recoveries were acceptable. Sample results for the QC batch were accepted based on percent recoveries and completeness of QC data.
QM-08	Spike or surrogate was inadvertently left out of this sample.
Q	Value is outside of acceptance limits.
NR	Can not be resolved due to coelutions with other analytes on both columns.
J	Detected but below the Reporting Limit (Limit of Quantitation); therefore, result is an estimated concentration.
H3	Sample was received and analyzed past holding time.
H	Sample was prepped or analyzed beyond the specified holding time
C	Due to coelutions, the value reported in the some of more than one congener. See case narrative.
0.00	0.00
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

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T82-1-MM-SedChem

19I1009-01 (Soil/Sediment)

ERDC-EL-EP-C

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
Classical Chemistry Parameters								
% Solids	**97.7**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	
EPA 1630 Methyl Mercury (GC)								
Methyl Mercury	**5.6**	0.76	1.0	ug/Kg dry	16-Oct-2019	17-Oct-2019	EPA 1630	H3, H
Surrogate: n-Propyl Mercury Chloride	**0.82**		*78 %*	*13-133*	*16-Oct-2019*	*17-Oct-2019*	*EPA 1630*	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

T82-1-MM-SedChem

19I1009-01RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 100	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 103	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 104	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 105	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 107 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 110	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 114	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 115	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 117	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 118	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 119	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 12	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 121	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 124	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 126	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 128	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 13 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 130	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 131	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 132	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 134	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 135	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 136	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 137	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 138	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 14	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 141 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 142 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 144	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 146	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 147	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 149	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 15 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 151	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U

T82-1-MM-SedChem

19I1009-01RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 155	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 156	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 157	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 158	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 165 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 167	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 169	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 17 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 170 [2C]	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 171 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 173	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 174	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 175 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 176	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 177 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 178 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 179 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 18	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 180	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 183	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 185	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 187	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 189	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 190 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 191 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 192 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 193	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 194	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 195 [2C]	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 196 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 197	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 199	**0.043**	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	J

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19I1009-01RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 200	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 201 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 202 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 203 (2C)	**0.038**	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	J
PCB 204 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 205	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 206	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 207 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 209	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 22	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 24	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 25	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 26	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 27	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 28	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 32	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 33	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 34	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 35	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 36	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 42 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 44	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 45	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 47 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 48 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 49	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 5	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 51	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U

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T82-1-MM-SedChem

19I1009-01RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 53	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 54	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 6	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 63	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 64 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 66 [2C]	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 67	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 70	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 71 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 73 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 74 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 75 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 78 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 8 [2C]	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 82	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 83	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 84	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 85	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 9 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 90 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 91	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 92	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 93	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 95 (2C)	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 97	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 99	ND	0.021	0.060	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**1.2**		*66.8 %*	*30-130*	*24-Jan-2020*	*12-Mar-2020*	*EPA 8082*	
Surrogate: PCB 198	**0.074**		*4.10 %*	*45-135*	*24-Jan-2020*	*12-Mar-2020*	*EPA 8082*	*S-GC*

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T82-2-MM-SedChem

19I1009-02 (Soil/Sediment)

ERDC-EL-EP-C

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
Classical Chemistry Parameters								
% Solids	**80.9**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

SPAWAR
53475 Strothe Rd, Bldg 111
San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

T82-2-MM-SedChem

19I1009-02RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 100	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 103	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 104	**0.054**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 105	**0.062**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 107 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 110	**0.350**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 114	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 115	**0.091**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 117	**0.052**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, J
PCB 118	**0.331**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 119	**0.034**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 12	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 121	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 122 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 124	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 126	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, U
PCB 128	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 13 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 130	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 131	**0.044**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 132	**0.348**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 134	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 135	**0.057**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	NR, J
PCB 136	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 137	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 138	**0.258**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 14	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 141 (2C)	**0.071**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 142 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 144	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 146	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 147	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 149	**0.260**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 15 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, U
PCB 151	**0.035**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J

SPAWAR
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San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

T82-2-MM-SedChem

19I1009-02RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	**0.041**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 155	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 156	**0.031**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 157	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 158	**0.034**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 165 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 167	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 169	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 17 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 170 [2C]	**0.071**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 171 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 172 (2C)	**0.043**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 173	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 174	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 175 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 176	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 177 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 178 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 179 (2C)	**0.055**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 18	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 180	**0.134**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 183	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 184 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 185	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 187	**0.096**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 189	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 19 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 190 (2C)	**0.027**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 191 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 192 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 193	**0.035**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 194	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 195 [2C]	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 196 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 197	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 199	**0.037**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J

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San Diego CA, 92152	Project Manager: James Leather	20-Mar-2020

T82-2-MM-SedChem

19I1009-02RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 200	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 201 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 202 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 203 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 204 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 205	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 206	**0.081**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 207 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 208 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 209	**0.089**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 22	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 24	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 25	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 26	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 27	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 28	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, U
PCB 29	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 32	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 33	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 34	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 35	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 36	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 37 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 4 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 40 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 41 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 42 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 44	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 45	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 46 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 47 (2C)	**0.086**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 48 (2C)	**0.068**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 49	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 5	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 51	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

T82-2-MM-SedChem

19I1009-02RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	**0.422**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 53	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 54	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 56 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 59 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 6	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 60 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 63	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 64 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 66 [2C]	**0.212**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 67	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 69 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 7 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 70	**0.066**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 71 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 73 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 74 (2C)	**0.440**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 75 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 78 (2C)	**0.091**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 8 [2C]	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 82	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 83	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	NR, U
PCB 84	**0.164**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 85	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 9 (2C)	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 90 (2C)	**0.378**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 91	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 92	**0.108**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 93	ND	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 95 (2C)	**0.301**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 97	**0.141**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 99	**0.179**	0.022	0.062	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**0.50**		*13.6 %*	*30-130*	*24-Jan-2020*	*27-Feb-2020*	*EPA 8082*	*Q, Z-03*
Surrogate: PCB 198	**0.45**		*12.2 %*	*45-135*	*24-Jan-2020*	*27-Feb-2020*	*EPA 8082*	*Q, Z-03*

T82-3-MM-SedChem

19I1009-03 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**98.7**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

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San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
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19I1009-03RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Polychlorinated Biphenyls (as Congeners) by EPA Method 8082								
PCB 10 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 100	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 103	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 104	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 105	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 107 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 110	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 114	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 115	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 117	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 118	**0.225**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 119	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 12	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 121	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 124	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 126	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 128	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 13 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 130	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 131	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 132	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 134	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 135	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 136	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 137	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 138	**0.327**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C
PCB 14	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 141 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 142 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 144	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 146	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 147	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 149	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 15 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 151	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U

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Project: Bremerton ESTCP ER18-5079
Project Manager: James Leather

Reported:
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19I1009-03RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 155	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 156	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 157	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 158	**1.58**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 165 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 167	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 169	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 17 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 170 [2C]	**0.203**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 173	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 174	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 175 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 176	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 177 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 178 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 179 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 18	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 180	**0.120**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 183	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 185	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 187	**0.047**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 189	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 190 (2C)	**0.193**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 191 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 192 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 193	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 194	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 195 [2C]	**0.266**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 196 (2C)	**0.171**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	
PCB 197	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 199	**0.045**	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	J

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

SPAWAR	Project: Bremerton ESTCP ER18-5079	
53475 Strothe Rd, Bldg 111		**Reported:**
San Diego CA, 92152	Project Manager: James Leather	20-Mar-2020

T82-3-MM-SedChem

19I1009-03RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 200	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 201 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 202 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 203 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 204 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 205	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 206	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 207 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 209	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 22	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 24	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 25	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 26	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 27	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 28	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 32	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 33	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 34	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 35	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 36	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 42 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 44	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 45	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 47 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 48 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 49	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 5	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 51	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-3-MM-SedChem

19I1009-03RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 53	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 54	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 6	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 63	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 64 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 66 [2C]	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 67	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 70	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 71 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 73 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 74 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 75 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 78 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 8 [2C]	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 82	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 83	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 84	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 85	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 9 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 90 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	C, U
PCB 91	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 92	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 93	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 95 (2C)	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 97	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
PCB 99	ND	0.016	0.047	ug/kg dry	24-Jan-2020	12-Mar-2020	EPA 8082	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**0.19**		*6.92 %*	*30-130*	*24-Jan-2020*	*12-Mar-2020*	*EPA 8082*	*Q, Z-03*
Surrogate: PCB 198	**0.18**		*6.49 %*	*45-135*	*24-Jan-2020*	*12-Mar-2020*	*EPA 8082*	*Q, Z-03*

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-4-MM-SedChem

19I1009-04 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**47.3**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

SPAWAR	Project: Bremerton ESTCP ER18-5079	
53475 Strothe Rd, Bldg 111		**Reported:**
San Diego CA, 92152	Project Manager: James Leather	20-Mar-2020

T82-4-MM-SedChem

19I1009-04RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 100	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 103	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 104	**0.364**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 105	**0.382**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 107 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 110	**0.644**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 114	**0.134**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 115	**0.182**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 117	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 118	**0.928**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 119	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 12	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 121	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 124	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 126	**0.548**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 128	**0.306**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 13 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 130	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 131	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 132	**0.654**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 134	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 135	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 136	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 137	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 138	**0.976**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 14	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 141 (2C)	**0.089**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 142 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 144	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 146	**0.064**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 147	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 149	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 15 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 151	**0.119**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

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T82-4-MM-SedChem

19I1009-04RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 155	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 156	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 157	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 158	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 165 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 167	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 169	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 17 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 170 [2C]	**0.238**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 173	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 174	**0.388**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 175 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 176	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 177 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 178 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 179 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 18	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 180	**0.587**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 183	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 185	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 187	**0.437**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 189	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 190 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 191 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 192 (2C)	**0.038**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 193	**0.129**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 194	**0.393**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 195 [2C]	**0.182**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 196 (2C)	**0.260**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 197	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 199	**0.252**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

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SPAWAR
53475 Strothe Rd, Bldg 111
San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

T82-4-MM-SedChem

19I1009-04RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 200	**0.226**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 201 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 202 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 203 (2C)	**0.163**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 204 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 205	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 206	**0.381**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 207 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 209	**0.273**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 22	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 24	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 25	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 26	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 27	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 28	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 32	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 33	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 34	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 35	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 36	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 42 (2C)	**0.150**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 44	**0.205**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 45	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 47 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 48 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 49	**0.204**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 5	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 51	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

T82-4-MM-SedChem

19I1009-04RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	**0.374**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 53	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 54	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 6	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 63	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 64 (2C)	**0.129**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 66 [2C]	**0.350**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 67	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 70	**0.310**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 71 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 73 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 74 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 75 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 78 (2C)	**0.459**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 8 [2C]	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 82	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 83	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 84	**0.143**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 85	**0.772**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 9 (2C)	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 90 (2C)	**0.783**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 91	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 92	**0.311**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 93	ND	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 95 (2C)	**0.449**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 97	**0.500**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 99	**0.492**	0.036	0.102	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**3.3**		*52.9 %*	*30-130*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	
Surrogate: PCB 198	**2.3**		*37.9 %*	*45-135*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*S-GC*

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-4-MM-DUP-SedChem

19I1009-05 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**71.3**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

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T82-4-MM-DUP-SedChem

19I1009-05RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 100	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 103	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 104	**0.223**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 105	**0.097**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 107 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 110	**0.596**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 114	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 115	**0.082**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 117	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, U
PCB 118	**0.473**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 119	**0.027**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 12	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 121	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 122 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 124	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 126	**0.025**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, J
PCB 128	**0.314**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 13 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 130	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 131	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 132	**0.732**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 134	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 135	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	NR, U
PCB 136	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 137	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 138	**0.427**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 14	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 141 (2C)	**0.076**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 142 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 144	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 146	**0.080**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 147	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 149	**0.372**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 15 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C, U
PCB 151	**0.065**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J

T82-4-MM-DUP-SedChem

19I1009-05RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
			ERDC-EL-EP-C					
Polychlorinated Biphenyls (as Congeners) by EPA Method 8082								
PCB 154	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 155	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 156	**0.054**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 157	**0.111**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 158	**0.063**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 165 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 167	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 169	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 17 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 170 [2C]	**0.195**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 171 (2C)	**0.066**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 172 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 173	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 174	**0.186**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 175 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 176	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 177 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 178 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 179 (2C)	**0.101**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 18	**0.123**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 180	**0.366**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 183	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 184 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 185	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 187	**0.243**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 189	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 19 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 190 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 191 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 192 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 193	**0.055**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 194	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 195 [2C]	**0.073**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 196 (2C)	**0.123**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 197	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 199	**0.124**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	

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SPAWAR
53475 Strothe Rd, Bldg 111
San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

T82-4-MM-DUP-SedChem

19I1009-05RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 200	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 201 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 202 (2C)	**0.075**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 203 (2C)	**0.117**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 204 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 205	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 206	**0.207**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 207 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 208 (2C)	**0.087**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 209	**0.386**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 22	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 24	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 25	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 26	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 27	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 28	**0.140**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 29	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 32	**0.071**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 33	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 34	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 35	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 36	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 37 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 4 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 40 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 41 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 42 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 44	**0.047**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 45	**0.106**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 46 (2C)	**0.074**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 47 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 48 (2C)	**0.073**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 49	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 5	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 51	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

T82-4-MM-DUP-SedChem

19I1009-05RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 53	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 54	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 56 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 59 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 6	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 60 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 63	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 64 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 66 [2C]	**0.188**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 67	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 69 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 7 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 70	**0.151**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 71 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 73 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 74 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 75 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 78 (2C)	**0.122**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 8 [2C]	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 82	**0.051**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	J
PCB 83	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	NR, U
PCB 84	**0.222**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 85	**0.075**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 9 (2C)	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 90 (2C)	**0.472**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	C
PCB 91	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 92	**0.132**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 93	ND	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	U
PCB 95 (2C)	**0.434**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 97	**0.154**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
PCB 99	**0.151**	0.024	0.067	ug/kg dry	24-Jan-2020	27-Feb-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**1.3**		*33.0 %*	*30-130*	*24-Jan-2020*	*27-Feb-2020*	*EPA 8082*	
Surrogate: PCB 198	**0.81**		*20.0 %*	*45-135*	*24-Jan-2020*	*27-Feb-2020*	*EPA 8082*	*S-GC*

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-5-MM-SedChem

19I1009-06 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
			ERDC-EL-EP-C					
Classical Chemistry Parameters								
% Solids	**84.9**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	
EPA 1630 Methyl Mercury (GC)								
Methyl Mercury	**6.8**	0.19	0.26	ug/Kg dry	16-Oct-2019	18-Oct-2019	EPA 1630	H, H3
Surrogate: n-Propyl Mercury Chloride	**0.00**		*0 %*	*13-133*	*16-Oct-2019*	*18-Oct-2019*	*EPA 1630*	*X*

SPAWAR
53475 Strothe Rd, Bldg 111
San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

T82-5-MM-SedChem

19I1009-06RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 100	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 103	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 104	**0.269**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 105	**1.15**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 107 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 110	**2.78**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 114	**0.130**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 115	**0.987**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 117	**0.262**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 118	**2.98**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 119	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 12	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 121	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 124	**0.157**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 126	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 128	**0.791**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 13 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 130	**0.226**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 131	**0.147**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 132	**2.32**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 134	**0.205**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 135	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	NR, U
PCB 136	**0.414**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 137	**0.228**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 138	**3.39**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 14	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 141 (2C)	**0.734**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 142 (2C)	**0.146**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 144	**0.395**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 146	**0.402**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 147	**0.078**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 149	**1.57**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 15 (2C)	**0.115**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 151	**0.345**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 154	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

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19I1009-06RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 155	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 156	**0.467**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 157	**0.084**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 158	**2.23**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 165 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 167	**0.125**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 169	**0.328**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 17 (2C)	**0.176**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 170 [2C]	**0.568**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 172 (2C)	**0.136**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 173	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 174	**0.228**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 175 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 176	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 177 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 178 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 179 (2C)	**0.945**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 18	**0.179**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 180	**0.521**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 183	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 185	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 187	**0.206**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 189	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 190 (2C)	**0.086**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 191 (2C)	**0.029**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 192 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 193	**0.042**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 194	**0.178**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 195 [2C]	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 196 (2C)	**0.121**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 197	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 199	**0.105**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 20 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

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19I1009-06RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 200	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 201 (2C)	**0.077**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 202 (2C)	**0.069**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 203 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 204 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 205	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 206	**0.189**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 207 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 209	**0.114**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 22	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 24	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 25	**0.079**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 26	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 27	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 28	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 32	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 33	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 34	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 35	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 36	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 42 (2C)	**0.268**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 44	**0.465**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 45	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 46 (2C)	**0.064**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 47 (2C)	**0.514**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 48 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 49	**0.963**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 5	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 51	**0.202**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 52 [2C]	**1.97**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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19I1009-06RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 53	**0.417**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 54	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 6	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 63	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 64 (2C)	**0.497**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 66 [2C]	**0.817**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 67	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 70	**0.888**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 71 (2C)	**0.358**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 73 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 74 (2C)	**1.55**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 75 (2C)	**0.078**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 78 (2C)	**1.17**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 8 [2C]	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 82	**0.292**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 83	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	NR, U
PCB 84	**0.761**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 85	**0.474**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 9 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 90 (2C)	**4.14**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 91	**0.628**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 92	**0.544**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 93	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 95 (2C)	**2.41**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 97	**1.35**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 99	**1.42**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**0.49**		*13.8 %*	*30-130*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*Q, Z-03*
Surrogate: PCB 198	**0.48**		*13.5 %*	*45-135*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*Q, Z-03*

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T82-6-MM-SedChem

19I1009-07 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**80.8**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

T82-6-MM-SedChem

19I1009-07RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 100	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 103	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 104	**0.071**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 105	**0.626**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 107 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 110	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 114	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 115	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 117	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 118	**0.711**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 119	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 12	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 121	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 124	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 126	**4.00**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 128	**0.235**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 13 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 130	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 131	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 132	**1.29**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 134	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 135	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 136	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 137	**0.490**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 138	**0.665**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 14	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 141 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 142 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 144	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 146	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 147	**0.044**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 149	**0.365**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 15 (2C)	**0.171**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 151	**0.083**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

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19I1009-07RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 155	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 156	**0.175**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 157	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 158	**4.79**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 165 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 167	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 169	**0.167**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 17 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 170 [2C]	**0.090**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 173	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 174	**0.275**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 175 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 176	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 177 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 178 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 179 (2C)	**0.955**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 18	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 180	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 183	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 185	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 187	**0.261**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 189	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 190 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 191 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 192 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 193	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 194	**0.126**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 195 [2C]	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 196 (2C)	**0.061**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 197	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 199	**0.083**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

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T82-6-MM-SedChem

19I1009-07RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Polychlorinated Biphenyls (as Congeners) by EPA Method 8082								
PCB 20 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 200	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 201 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 202 (2C)	**0.855**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 203 (2C)	**0.037**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 204 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 205	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 206	**0.143**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 207 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 209	**0.113**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 22	**0.096**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 24	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 25	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 26	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 27	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 28	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 32	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 33	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 34	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 35	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 36	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 42 (2C)	**0.078**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 44	**0.100**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 45	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 47 (2C)	**0.027**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 48 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 49	**0.136**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 5	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 51	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

T82-6-MM-SedChem

19I1009-07RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	**0.281**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 53	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 54	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 6	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 63	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 64 (2C)	**0.172**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 66 [2C]	**0.125**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 67	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 70	**0.139**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 71 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 73 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 74 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 75 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 78 (2C)	**0.344**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 8 [2C]	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 82	**0.077**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 83	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	NR, U
PCB 84	**0.108**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 85	**0.205**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 9 (2C)	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 90 (2C)	**0.611**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 91	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 92	**0.118**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 93	ND	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 95 (2C)	**0.430**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 97	**0.317**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 99	**0.392**	0.021	0.059	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**1.6**		*45.9 %*	*30-130*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	
Surrogate: PCB 198	**0.86**		*24.2 %*	*45-135*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*S-GC*

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T82-6-MM-DUP-SedChem

19I1009-08 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**67.9**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

T82-6-MM-DUP-SedChem

19I1009-08RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 100	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 103	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 104	**0.115**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 105	**0.383**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 107 (2C)	**0.046**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 110	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 114	**0.113**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 115	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 117	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 118	**0.902**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 119	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 12	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 121	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 124	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 126	**0.087**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 128	**0.245**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 13 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 130	**0.044**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 131	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 132	**0.700**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 134	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 135	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	NR, U
PCB 136	**0.089**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 137	**0.066**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 138	**1.17**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 14	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 141 (2C)	**0.270**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 142 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 144	**0.167**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 146	**0.067**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 147	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 149	**0.736**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 15 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 151	**0.178**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

SPAWAR	Project: Bremerton ESTCP ER18-5079	
53475 Strothe Rd, Bldg 111		**Reported:**
San Diego CA, 92152	Project Manager: James Leather	20-Mar-2020

T82-6-MM-DUP-SedChem

19I1009-08RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 155	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 156	**0.036**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 157	**0.026**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 158	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 165 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 167	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 169	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 17 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 170 [2C]	**0.441**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 173	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 174	**0.367**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 175 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 176	**0.111**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 177 (2C)	**0.085**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 178 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 179 (2C)	**0.104**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 18	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 180	**0.874**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 183	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 185	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 187	**0.485**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 189	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 190 (2C)	**0.068**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 191 (2C)	**0.037**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 192 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 193	**0.061**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 194	**0.400**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 195 [2C]	**0.209**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 196 (2C)	**0.204**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 197	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 199	**0.280**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

T82-6-MM-DUP-SedChem

19I1009-08RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 200	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 201 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 202 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 203 (2C)	**0.199**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 204 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 205	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 206	**0.248**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 207 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 208 (2C)	**0.047**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 209	**0.210**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 22	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 24	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 25	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 26	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 27	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 28	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 32	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 33	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 34	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 35	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 36	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 37 (2C)	**0.425**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 4 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 42 (2C)	**0.082**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 44	**0.155**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 45	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 47 (2C)	**0.066**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 48 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 49	**0.174**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 5	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 51	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-6-MM-DUP-SedChem

19I1009-08RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	**0.481**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 53	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 54	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 6	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 63	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 64 (2C)	**0.145**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 66 [2C]	**0.178**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 67	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 70	**0.253**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 71 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 73 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 74 (2C)	**0.413**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 75 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 78 (2C)	**0.347**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 8 [2C]	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 82	**0.099**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 83	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	NR, U
PCB 84	**0.219**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 85	**0.185**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 9 (2C)	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 90 (2C)	**0.865**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 91	**0.124**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 92	**0.155**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 93	ND	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 95 (2C)	**0.927**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 97	**0.378**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 99	**0.446**	0.024	0.068	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**1.1**		*26.5 %*	*30-130*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*Q*
Surrogate: PCB 198	**0.95**		*23.1 %*	*45-135*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*Q*

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-7-MM-SedChem

19I1009-09 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**98.4**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

T82-7-MM-SedChem

19I1009-09RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 10 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 100	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 103	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 104	**0.100**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 105	**0.163**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 107 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 110	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 114	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 115	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 117	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 118	**0.338**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 119	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 12	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 121	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 124	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 126	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 128	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 13 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 130	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 131	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 132	**0.349**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 134	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 135	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 136	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 137	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 138	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 14	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 141 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 142 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 144	**0.052**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 146	**0.024**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 147	**0.067**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 149	**0.280**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 15 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 151	**0.052**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

T82-7-MM-SedChem

19I1009-09RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 155	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 156	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 157	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 158	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 165 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 167	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 169	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 17 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 170 [2C]	**0.180**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 173	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 174	**0.060**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 175 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 176	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 177 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 178 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 179 (2C)	**0.034**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 18	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 180	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 183	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 185	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 187	**0.123**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 189	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 190 (2C)	**0.021**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 191 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 192 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 193	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 194	**0.109**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 195 [2C]	**0.102**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 196 (2C)	**0.105**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 197	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 199	**0.069**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-7-MM-SedChem

19I1009-09RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 200	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 201 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 202 (2C)	**0.070**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 203 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 204 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 205	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 206	**0.106**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 207 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 209	**0.215**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 22	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 24	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 25	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 26	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 27	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 28	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 32	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 33	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 34	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 35	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 36	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 42 (2C)	**0.091**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 44	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 45	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 47 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 48 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 49	**0.090**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 5	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 51	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

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SPAWAR	Project: Bremerton ESTCP ER18-5079	
53475 Strothe Rd, Bldg 111		**Reported:**
San Diego CA, 92152	Project Manager: James Leather	20-Mar-2020

T82-7-MM-SedChem

19I1009-09RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Polychlorinated Biphenyls (as Congeners) by EPA Method 8082								
PCB 52 [2C]	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 53	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 54	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 56 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 59 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 6	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 63	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 64 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 66 [2C]	**0.074**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 67	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 70	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 71 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 73 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 74 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 75 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 78 (2C)	**0.071**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 8 [2C]	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 82	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 83	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 84	**0.066**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 85	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 9 (2C)	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 90 (2C)	**0.063**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 91	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 92	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 93	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 95 (2C)	**0.289**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 97	ND	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 99	**0.153**	0.017	0.048	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**1.1**		*38.3 %*	*30-130*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	
Surrogate: PCB 198	**0.78**		*27.2 %*	*45-135*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*S-GC*

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SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

T82-8-MM-SedChem

19I1009-10 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
ERDC-EL-EP-C								
Classical Chemistry Parameters								
% Solids	**98.4**	0.500	0.500	% Solids	08-Oct-2019	10-Oct-2019	ASTM D2216-98	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

SPAWAR
53475 Strothe Rd, Bldg 111
San Diego CA, 92152

Project: Bremerton ESTCP ER18-5079

Project Manager: James Leather

Reported:
20-Mar-2020

T82-8-MM-SedChem

19I1009-10RE1 (Soil/Sediment)

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

PCB 10 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 100	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 103	**0.018**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 104	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 105	**0.115**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 107 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 110	**0.784**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 114	**0.035**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 115	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 117	**0.047**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, J
PCB 118	**0.578**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 119	**0.021**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 12	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 121	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 122 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 124	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 126	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 128	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 13 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 130	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 131	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 132	**0.235**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 134	**0.023**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 135	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 136	**0.044**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 137	**0.034**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 138	**0.440**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 14	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 141 (2C)	**0.664**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 142 (2C)	**0.248**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 144	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 146	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 147	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 149	**0.139**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 15 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 151	**0.017**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J

T82-8-MM-SedChem

19I1009-10RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 154	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 155	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 156	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 157	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 158	**1.64**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 165 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 167	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 169	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 17 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 170 [2C]	**0.393**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 171 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 172 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 173	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 174	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 175 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 176	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 177 (2C)	**0.019**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 178 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 179 (2C)	**0.022**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 18	**0.040**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 180	**0.059**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 183	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 184 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 185	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 187	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 189	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 19 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 190 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 191 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 192 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 193	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 194	**0.044**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 195 [2C]	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 196 (2C)	**0.030**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 197	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 199	**0.047**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J

SPAWAR 53475 Strothe Rd, Bldg 111 San Diego CA, 92152	Project: Bremerton ESTCP ER18-5079 Project Manager: James Leather	**Reported:** 20-Mar-2020

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19I1009-10RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 20 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 200	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 201 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 202 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 203 (2C)	**0.034**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 204 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 205	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 206	**0.068**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 207 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 208 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 209	**0.066**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 22	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 24	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 25	**0.066**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 26	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 27	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 28	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C, U
PCB 29	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 32	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 33	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 34	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 35	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 36	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 37 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 4 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 40 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 41 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 42 (2C)	**0.382**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 44	**0.358**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 45	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 46 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 47 (2C)	**0.981**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 48 (2C)	**0.185**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 49	**0.432**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 5	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 51	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

T82-8-MM-SedChem

19I1009-10RE1 (Soil/Sediment)

ERDC-EL-EP-C

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082

Analyte	Result	Detection Limit	Reporting Limit	Units	Prepared	Analyzed	Method	Notes
PCB 52 [2C]	**5.50**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 53	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 54	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 56 (2C)	**0.041**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	J
PCB 59 (2C)	**1.01**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 6	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 60 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 63	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 64 (2C)	**0.983**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 66 [2C]	**1.39**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 67	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 69 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 7 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 70	**0.283**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 71 (2C)	**0.663**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 73 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 74 (2C)	**0.576**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 75 (2C)	**0.894**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 78 (2C)	**0.435**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 8 [2C]	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 82	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 83	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 84	**0.194**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 85	**0.055**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 9 (2C)	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 90 (2C)	**4.75**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	C
PCB 91	**0.118**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 92	**0.125**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 93	ND	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	U
PCB 95 (2C)	**4.25**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 97	**0.194**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
PCB 99	**0.299**	0.017	0.050	ug/kg dry	24-Jan-2020	11-Mar-2020	EPA 8082	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	**ND**		*%*	*30-130*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*QM-08, U*
Surrogate: PCB 198	**ND**		*%*	*45-135*	*24-Jan-2020*	*11-Mar-2020*	*EPA 8082*	*QM-08, U*

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Blank (B20A046-BLK1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 10 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 100	ND	0.012	0.033	ug/kg wet							U
PCB 103	ND	0.012	0.033	ug/kg wet							U
PCB 104	ND	0.012	0.033	ug/kg wet							U
PCB 105	ND	0.012	0.033	ug/kg wet							U
PCB 107 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 110	ND	0.012	0.033	ug/kg wet							C, U
PCB 114	ND	0.012	0.033	ug/kg wet							U
PCB 115	ND	0.012	0.033	ug/kg wet							U
PCB 117	ND	0.012	0.033	ug/kg wet							C, U
PCB 118	ND	0.012	0.033	ug/kg wet							U
PCB 119	ND	0.012	0.033	ug/kg wet							U
PCB 12	ND	0.012	0.033	ug/kg wet							U
PCB 121	ND	0.012	0.033	ug/kg wet							U
PCB 122 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 124	ND	0.012	0.033	ug/kg wet							U
PCB 126	ND	0.012	0.033	ug/kg wet							C, U
PCB 128	ND	0.012	0.033	ug/kg wet							U
PCB 13 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 130	ND	0.012	0.033	ug/kg wet							U
PCB 131	ND	0.012	0.033	ug/kg wet							U
PCB 132	ND	0.012	0.033	ug/kg wet							C, U
PCB 134	ND	0.012	0.033	ug/kg wet							U
PCB 135	ND	0.012	0.033	ug/kg wet							U
PCB 136	ND	0.012	0.033	ug/kg wet							U
PCB 137	ND	0.012	0.033	ug/kg wet							U
PCB 138	ND	0.012	0.033	ug/kg wet							C, U
PCB 14	ND	0.012	0.033	ug/kg wet							U
PCB 141 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 142 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 144	ND	0.012	0.033	ug/kg wet							U
PCB 146	ND	0.012	0.033	ug/kg wet							U
PCB 147	ND	0.012	0.033	ug/kg wet							U
PCB 149	ND	0.012	0.033	ug/kg wet							C, U
PCB 15 (2C)	ND	0.012	0.033	ug/kg wet							C, U
PCB 151	ND	0.012	0.033	ug/kg wet							U
PCB 154	ND	0.012	0.033	ug/kg wet							U
PCB 155	ND	0.012	0.033	ug/kg wet							U
PCB 156	ND	0.012	0.033	ug/kg wet							U
PCB 157	ND	0.012	0.033	ug/kg wet							U
PCB 158	ND	0.012	0.033	ug/kg wet							U

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Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Blank (B20A046-BLK1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 165 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 167	ND	0.012	0.033	ug/kg wet							U
PCB 169	ND	0.012	0.033	ug/kg wet							U
PCB 17 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 170 [2C]	ND	0.012	0.033	ug/kg wet							U
PCB 171 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 172 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 173	ND	0.012	0.033	ug/kg wet							U
PCB 174	ND	0.012	0.033	ug/kg wet							U
PCB 175 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 176	ND	0.012	0.033	ug/kg wet							U
PCB 177 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 178 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 179 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 18	ND	0.012	0.033	ug/kg wet							U
PCB 180	ND	0.012	0.033	ug/kg wet							U
PCB 183	ND	0.012	0.033	ug/kg wet							U
PCB 184 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 185	ND	0.012	0.033	ug/kg wet							U
PCB 187	ND	0.012	0.033	ug/kg wet							U
PCB 189	ND	0.012	0.033	ug/kg wet							U
PCB 19 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 190 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 191 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 192 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 193	ND	0.012	0.033	ug/kg wet							U
PCB 194	ND	0.012	0.033	ug/kg wet							U
PCB 195 [2C]	ND	0.012	0.033	ug/kg wet							U
PCB 196 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 197	ND	0.012	0.033	ug/kg wet							U
PCB 199	ND	0.012	0.033	ug/kg wet							U
PCB 20 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 200	ND	0.012	0.033	ug/kg wet							U
PCB 201 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 202 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 203 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 204 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 205	ND	0.012	0.033	ug/kg wet							U
PCB 206	ND	0.012	0.033	ug/kg wet							U
PCB 207 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 208 (2C)	ND	0.012	0.033	ug/kg wet							U

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Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Blank (B20A046-BLK1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 209	ND	0.012	0.033	ug/kg wet							U
PCB 22	ND	0.012	0.033	ug/kg wet							U
PCB 24	ND	0.012	0.033	ug/kg wet							U
PCB 25	ND	0.012	0.033	ug/kg wet							U
PCB 26	ND	0.012	0.033	ug/kg wet							U
PCB 27	ND	0.012	0.033	ug/kg wet							U
PCB 28	ND	0.012	0.033	ug/kg wet							C, U
PCB 29	ND	0.012	0.033	ug/kg wet							U
PCB 32	ND	0.012	0.033	ug/kg wet							U
PCB 33	ND	0.012	0.033	ug/kg wet							U
PCB 34	ND	0.012	0.033	ug/kg wet							U
PCB 35	ND	0.012	0.033	ug/kg wet							U
PCB 36	ND	0.012	0.033	ug/kg wet							U
PCB 37 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 4 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 40 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 41 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 42 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 44	ND	0.012	0.033	ug/kg wet							U
PCB 45	ND	0.012	0.033	ug/kg wet							U
PCB 46 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 47 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 48 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 49	ND	0.012	0.033	ug/kg wet							U
PCB 5	ND	0.012	0.033	ug/kg wet							U
PCB 51	ND	0.012	0.033	ug/kg wet							U
PCB 52 [2C]	ND	0.012	0.033	ug/kg wet							U
PCB 53	ND	0.012	0.033	ug/kg wet							U
PCB 54	ND	0.012	0.033	ug/kg wet							U
PCB 56 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 59 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 6	ND	0.012	0.033	ug/kg wet							U
PCB 60 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 63	ND	0.012	0.033	ug/kg wet							U
PCB 64 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 66 [2C]	ND	0.012	0.033	ug/kg wet							U
PCB 67	ND	0.012	0.033	ug/kg wet							U
PCB 69 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 7 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 70	ND	0.012	0.033	ug/kg wet							U
PCB 71 (2C)	ND	0.012	0.033	ug/kg wet							U

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Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Blank (B20A046-BLK1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 73 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 74 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 75 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 78 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 8 [2C]	ND	0.012	0.033	ug/kg wet							U
PCB 82	ND	0.012	0.033	ug/kg wet							U
PCB 83	ND	0.012	0.033	ug/kg wet							U
PCB 84	ND	0.012	0.033	ug/kg wet							U
PCB 85	ND	0.012	0.033	ug/kg wet							U
PCB 9 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 90 (2C)	ND	0.012	0.033	ug/kg wet							C, U
PCB 91	ND	0.012	0.033	ug/kg wet							U
PCB 92	ND	0.012	0.033	ug/kg wet							U
PCB 93	ND	0.012	0.033	ug/kg wet							U
PCB 95 (2C)	ND	0.012	0.033	ug/kg wet							U
PCB 97	ND	0.012	0.033	ug/kg wet							U
PCB 99	ND	0.012	0.033	ug/kg wet							U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.84*			*ug/kg wet*	*1.000*		*84.0*	*30-130*			
Surrogate: PCB 198	*0.50*			*ug/kg wet*	*1.000*		*50.0*	*45-135*			

LCS (B20A046-BS1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 10 (2C)	0.36	0.012	0.033	ug/kg wet	0.6667		54.7	45-125			
PCB 100	0.75	0.012	0.033	ug/kg wet	1.333		56.4	45-125			
PCB 103	0.37	0.012	0.033	ug/kg wet	0.6667		55.0	45-125			
PCB 104	0.97	0.012	0.033	ug/kg wet	1.333		72.6	45-125			
PCB 105	0.43	0.012	0.033	ug/kg wet	0.6667		64.6	45-125			
PCB 107 (2C)	0.44	0.012	0.033	ug/kg wet	0.6667		65.7	45-125			
PCB 110	0.82	0.012	0.033	ug/kg wet	1.333		61.7	45-125			C
PCB 114	0.35	0.012	0.033	ug/kg wet	0.6667		52.0	45-125			
PCB 115	0.77	0.012	0.033	ug/kg wet	1.333		57.5	45-125			
PCB 117	0.80	0.012	0.033	ug/kg wet	1.333		60.1	45-125			C
PCB 118	0.43	0.012	0.033	ug/kg wet	0.6667		65.0	45-125			
PCB 119	0.32	0.012	0.033	ug/kg wet	0.6667		47.9	45-125			
PCB 12	1.3	0.012	0.033	ug/kg wet	1.333		94.9	45-125			
PCB 121	0.32	0.012	0.033	ug/kg wet	0.6667		48.7	45-125			
PCB 122 (2C)	0.48	0.012	0.033	ug/kg wet	0.6667		72.4	45-125			
PCB 124	0.50	0.012	0.033	ug/kg wet	0.6667		75.5	45-125			
PCB 126	1.1	0.012	0.033	ug/kg wet	2.000		54.1	45-125			C
PCB 128	0.36	0.012	0.033	ug/kg wet	0.6667		54.5	45-125			
PCB 13 (2C)	1.1	0.012	0.033	ug/kg wet	2.000		56.2	45-125			
PCB 130	0.37	0.012	0.033	ug/kg wet	0.6667		55.7	45-125			

SPAWAR	Project: Bremerton ESTCP ER18-5079	
53475 Strothe Rd, Bldg 111		**Reported:**
San Diego CA, 92152	Project Manager: James Leather	20-Mar-2020

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS (B20A046-BS1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 131	0.71	0.012	0.033	ug/kg wet	1.333		52.9	45-125			
PCB 132	0.79	0.012	0.033	ug/kg wet	1.333		59.0	45-125			C
PCB 134	0.34	0.012	0.033	ug/kg wet	0.6667		50.9	45-125			
PCB 135	0.76	0.012	0.033	ug/kg wet	1.333		56.8	45-125			
PCB 136	0.59	0.012	0.033	ug/kg wet	0.6667		88.7	45-125			
PCB 137	0.38	0.012	0.033	ug/kg wet	0.6667		57.4	45-125			
PCB 138	1.1	0.012	0.033	ug/kg wet	2.000		55.0	45-125			C
PCB 14	0.55	0.012	0.033	ug/kg wet	0.6667		82.2	45-125			
PCB 141 (2C)	0.41	0.012	0.033	ug/kg wet	0.6667		60.9	45-125			
PCB 142 (2C)	0.38	0.012	0.033	ug/kg wet	0.6667		56.9	45-125			
PCB 144	0.74	0.012	0.033	ug/kg wet	1.333		55.6	45-125			
PCB 146	0.34	0.012	0.033	ug/kg wet	0.6667		51.3	45-125			
PCB 147	0.34	0.012	0.033	ug/kg wet	0.6667		50.6	45-125			
PCB 149	0.66	0.012	0.033	ug/kg wet	1.333		49.2	45-125			C
PCB 15 (2C)	0.98	0.012	0.033	ug/kg wet	1.333		73.5	45-125			C
PCB 151	0.40	0.012	0.033	ug/kg wet	0.6667		59.8	45-125			
PCB 154	0.36	0.012	0.033	ug/kg wet	0.6667		53.5	45-125			
PCB 155	0.36	0.012	0.033	ug/kg wet	0.6667		53.3	45-125			
PCB 156	0.43	0.012	0.033	ug/kg wet	0.6667		64.1	45-125			
PCB 157	0.83	0.012	0.033	ug/kg wet	1.333		62.3	45-125			
PCB 158	0.38	0.012	0.033	ug/kg wet	0.6667		57.6	45-125			
PCB 165 (2C)	0.64	0.012	0.033	ug/kg wet	0.6667		95.8	45-125			
PCB 167	0.28	0.012	0.033	ug/kg wet	0.6667		42.5	45-125			Q
PCB 169	0.47	0.012	0.033	ug/kg wet	0.6667		70.7	45-125			
PCB 17 (2C)	0.31	0.012	0.033	ug/kg wet	0.6667		46.8	45-125			
PCB 170 [2C]	0.43	0.012	0.033	ug/kg wet	0.6667		65.2	45-125			
PCB 171 (2C)	0.85	0.012	0.033	ug/kg wet	1.333		64.1	45-125			
PCB 172 (2C)	0.35	0.012	0.033	ug/kg wet	0.6667		52.9	45-125			
PCB 173	0.39	0.012	0.033	ug/kg wet	0.6667		58.6	45-125			
PCB 174	0.48	0.012	0.033	ug/kg wet	0.6667		72.3	45-125			
PCB 175 (2C)	0.39	0.012	0.033	ug/kg wet	0.6667		58.9	45-125			
PCB 176	0.76	0.012	0.033	ug/kg wet	0.6667		115	45-125			
PCB 177 (2C)	0.42	0.012	0.033	ug/kg wet	0.6667		62.4	45-125			
PCB 178 (2C)	0.41	0.012	0.033	ug/kg wet	0.6667		61.2	45-125			
PCB 179 (2C)	0.36	0.012	0.033	ug/kg wet	0.6667		53.8	45-125			
PCB 18	0.44	0.012	0.033	ug/kg wet	0.6667		66.3	45-125			
PCB 180	0.50	0.012	0.033	ug/kg wet	0.6667		74.5	45-125			
PCB 183	0.40	0.012	0.033	ug/kg wet	0.6667		60.6	45-125			
PCB 184 (2C)	0.42	0.012	0.033	ug/kg wet	0.6667		62.8	45-125			
PCB 185	0.44	0.012	0.033	ug/kg wet	0.6667		66.2	45-125			
PCB 187	0.41	0.012	0.033	ug/kg wet	0.6667		61.1	45-125			

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS (B20A046-BS1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 189	0.48	0.012	0.033	ug/kg wet	0.6667		72.7	45-125			
PCB 19 (2C)	0.43	0.012	0.033	ug/kg wet	0.6667		64.7	45-125			
PCB 190 (2C)	0.45	0.012	0.033	ug/kg wet	0.6667		67.8	45-125			
PCB 191 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		60.4	45-125			
PCB 192 (2C)	0.71	0.012	0.033	ug/kg wet	0.6667		107	45-125			
PCB 193	0.46	0.012	0.033	ug/kg wet	0.6667		68.6	45-125			
PCB 194	0.43	0.012	0.033	ug/kg wet	0.6667		64.8	45-125			
PCB 195 [2C]	0.49	0.012	0.033	ug/kg wet	0.6667		74.0	45-125			
PCB 196 (2C)	0.66	0.012	0.033	ug/kg wet	0.6667		98.9	45-125			
PCB 197	0.39	0.012	0.033	ug/kg wet	0.6667		57.9	45-125			
PCB 199	0.37	0.012	0.033	ug/kg wet	0.6667		55.5	45-125			
PCB 20 (2C)	1.4	0.012	0.033	ug/kg wet	2.000		69.8	45-125			
PCB 200	0.31	0.012	0.033	ug/kg wet	0.6667		47.2	45-125			
PCB 201 (2C)	0.45	0.012	0.033	ug/kg wet	0.6667		68.2	45-125			
PCB 202 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		59.3	45-125			
PCB 203 (2C)	0.67	0.012	0.033	ug/kg wet	0.6667		101	45-125			
PCB 204 (2C)	0.33	0.012	0.033	ug/kg wet	0.6667		50.0	45-125			
PCB 205	0.41	0.012	0.033	ug/kg wet	0.6667		61.7	45-125			
PCB 206	0.60	0.012	0.033	ug/kg wet	0.6667		89.4	45-125			
PCB 207 (2C)	0.50	0.012	0.033	ug/kg wet	0.6667		74.9	45-125			
PCB 208 (2C)	0.46	0.012	0.033	ug/kg wet	0.6667		69.2	45-125			
PCB 209	0.65	0.012	0.033	ug/kg wet	0.6667		97.0	45-125			
PCB 22	0.36	0.012	0.033	ug/kg wet	0.6667		53.2	45-125			
PCB 24	0.77	0.012	0.033	ug/kg wet	1.333		58.0	45-125			
PCB 25	0.44	0.012	0.033	ug/kg wet	0.6667		65.3	45-125			
PCB 26	0.39	0.012	0.033	ug/kg wet	0.6667		58.0	45-125			
PCB 27	0.91	0.012	0.033	ug/kg wet	1.333		68.0	45-125			
PCB 28	0.80	0.012	0.033	ug/kg wet	1.333		60.1	45-125			C
PCB 29	0.85	0.012	0.033	ug/kg wet	1.333		64.1	45-125			
PCB 32	0.77	0.012	0.033	ug/kg wet	1.333		57.7	45-125			
PCB 33	0.65	0.012	0.033	ug/kg wet	1.333		48.7	45-125			
PCB 34	0.62	0.012	0.033	ug/kg wet	0.6667		93.6	45-125			
PCB 35	0.94	0.012	0.033	ug/kg wet	1.333		70.6	45-125			
PCB 36	0.55	0.012	0.033	ug/kg wet	0.6667		81.9	45-125			
PCB 37 (2C)	0.47	0.012	0.033	ug/kg wet	0.6667		70.6	45-125			
PCB 4 (2C)	0.44	0.012	0.033	ug/kg wet	0.6667		65.9	45-125			
PCB 40 (2C)	0.86	0.012	0.033	ug/kg wet	1.333		64.9	45-125			
PCB 41 (2C)	0.34	0.012	0.033	ug/kg wet	0.6667		50.7	45-125			
PCB 42 (2C)	0.32	0.012	0.033	ug/kg wet	0.6667		47.4	45-125			
PCB 44	0.32	0.012	0.033	ug/kg wet	0.6667		48.4	45-125			
PCB 45	0.31	0.012	0.033	ug/kg wet	0.6667		46.2	45-125			

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS (B20A046-BS1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 46 (2C)	0.47	0.012	0.033	ug/kg wet	0.6667		70.5	45-125			
PCB 47 (2C)	0.51	0.012	0.033	ug/kg wet	0.6667		76.8	45-125			
PCB 48 (2C)	0.41	0.012	0.033	ug/kg wet	0.6667		61.8	45-125			
PCB 49	0.35	0.012	0.033	ug/kg wet	0.6667		52.9	45-125			
PCB 5	1.0	0.012	0.033	ug/kg wet	1.333		78.3	45-125			
PCB 51	0.39	0.012	0.033	ug/kg wet	0.6667		57.9	45-125			
PCB 52 [2C]	0.37	0.012	0.033	ug/kg wet	0.6667		55.6	45-125			
PCB 53	0.35	0.012	0.033	ug/kg wet	0.6667		52.7	45-125			
PCB 54	0.86	0.012	0.033	ug/kg wet	1.333		64.2	45-125			
PCB 56 (2C)	0.42	0.012	0.033	ug/kg wet	0.6667		62.6	45-125			
PCB 59 (2C)	0.52	0.012	0.033	ug/kg wet	0.6667		77.9	45-125			
PCB 6	0.34	0.012	0.033	ug/kg wet	0.6667		51.3	45-125			
PCB 60 (2C)	0.65	0.012	0.033	ug/kg wet	1.333		49.1	45-125			
PCB 63	0.42	0.012	0.033	ug/kg wet	0.6667		62.4	45-125			
PCB 64 (2C)	0.38	0.012	0.033	ug/kg wet	0.6667		56.4	45-125			
PCB 66 [2C]	0.45	0.012	0.033	ug/kg wet	0.6667		68.1	45-125			
PCB 67	0.76	0.012	0.033	ug/kg wet	1.333		56.7	45-125			
PCB 69 (2C)	0.76	0.012	0.033	ug/kg wet	1.333		57.2	45-125			
PCB 7 (2C)	0.36	0.012	0.033	ug/kg wet	0.6667		54.5	45-125			
PCB 70	0.34	0.012	0.033	ug/kg wet	0.6667		50.4	45-125			
PCB 71 (2C)	0.80	0.012	0.033	ug/kg wet	1.333		60.3	45-125			
PCB 73 (2C)	0.44	0.012	0.033	ug/kg wet	0.6667		65.7	45-125			
PCB 74 (2C)	0.71	0.012	0.033	ug/kg wet	0.6667		107	45-125			
PCB 75 (2C)	0.39	0.012	0.033	ug/kg wet	0.6667		58.7	45-125			
PCB 78 (2C)	0.39	0.012	0.033	ug/kg wet	0.6667		58.4	45-125			
PCB 8 [2C]	0.42	0.012	0.033	ug/kg wet	0.6667		62.3	45-125			
PCB 82	0.37	0.012	0.033	ug/kg wet	0.6667		55.0	45-125			
PCB 83	0.96	0.012	0.033	ug/kg wet	1.333		71.9	45-125			
PCB 84	0.34	0.012	0.033	ug/kg wet	0.6667		50.6	45-125			
PCB 85	0.40	0.012	0.033	ug/kg wet	0.6667		59.6	45-125			
PCB 9 (2C)	0.56	0.012	0.033	ug/kg wet	0.6667		84.1	45-125			
PCB 90 (2C)	0.77	0.012	0.033	ug/kg wet	1.333		57.8	45-125			C
PCB 91	0.35	0.012	0.033	ug/kg wet	0.6667		52.4	45-125			
PCB 92	0.37	0.012	0.033	ug/kg wet	0.6667		55.7	45-125			
PCB 93	0.99	0.012	0.033	ug/kg wet	2.000		49.3	45-125			
PCB 95 (2C)	0.41	0.012	0.033	ug/kg wet	0.6667		60.8	45-125			
PCB 97	0.40	0.012	0.033	ug/kg wet	0.6667		59.2	45-125			
PCB 99	0.36	0.012	0.033	ug/kg wet	0.6667		54.5	45-125			
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.83*			*ug/kg wet*	*1.000*		*83.1*	*50-120*			
Surrogate: PCB 198	*0.58*			*ug/kg wet*	*1.000*		*58.2*	*45-125*			

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS Dup (B20A046-BSD1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 10 (2C)	0.34	0.012	0.033	ug/kg wet	0.6667		51.3	45-125	6.44	30	
PCB 100	0.72	0.012	0.033	ug/kg wet	1.333		53.9	45-125	4.49	30	
PCB 103	0.35	0.012	0.033	ug/kg wet	0.6667		53.2	45-125	3.41	30	
PCB 104	0.88	0.012	0.033	ug/kg wet	1.333		65.8	45-125	9.94	30	
PCB 105	0.46	0.012	0.033	ug/kg wet	0.6667		68.4	45-125	5.68	30	
PCB 107 (2C)	0.43	0.012	0.033	ug/kg wet	0.6667		64.3	45-125	2.10	30	
PCB 110	0.76	0.012	0.033	ug/kg wet	1.333		56.7	45-125	8.55	30	C
PCB 114	0.36	0.012	0.033	ug/kg wet	0.6667		54.1	45-125	3.85	30	
PCB 115	0.76	0.012	0.033	ug/kg wet	1.333		57.1	45-125	0.685	30	
PCB 117	0.78	0.012	0.033	ug/kg wet	1.333		58.3	45-125	3.05	30	C
PCB 118	0.39	0.012	0.033	ug/kg wet	0.6667		57.8	45-125	11.7	30	
PCB 119	0.35	0.012	0.033	ug/kg wet	0.6667		51.9	45-125	7.87	30	
PCB 12	1.2	0.012	0.033	ug/kg wet	1.333		87.5	45-125	8.11	30	
PCB 121	0.30	0.012	0.033	ug/kg wet	0.6667		45.4	45-125	7.01	30	
PCB 122 (2C)	0.46	0.012	0.033	ug/kg wet	0.6667		69.6	45-125	3.97	30	
PCB 124	0.53	0.012	0.033	ug/kg wet	0.6667		79.2	45-125	4.77	30	
PCB 126	1.0	0.012	0.033	ug/kg wet	2.000		52.2	45-125	3.60	30	C
PCB 128	0.36	0.012	0.033	ug/kg wet	0.6667		54.7	45-125	0.293	30	
PCB 13 (2C)	1.1	0.012	0.033	ug/kg wet	2.000		53.2	45-125	5.48	30	
PCB 130	0.36	0.012	0.033	ug/kg wet	0.6667		54.1	45-125	2.88	30	
PCB 131	0.67	0.012	0.033	ug/kg wet	1.333		50.4	45-125	4.72	30	
PCB 132	0.66	0.012	0.033	ug/kg wet	1.333		49.9	45-125	16.8	30	C
PCB 134	0.35	0.012	0.033	ug/kg wet	0.6667		53.0	45-125	4.13	30	
PCB 135	0.72	0.012	0.033	ug/kg wet	1.333		53.8	45-125	5.31	30	
PCB 136	0.48	0.012	0.033	ug/kg wet	0.6667		71.3	45-125	21.7	30	
PCB 137	0.35	0.012	0.033	ug/kg wet	0.6667		51.9	45-125	9.98	30	
PCB 138	1.1	0.012	0.033	ug/kg wet	2.000		53.1	45-125	3.41	30	C
PCB 14	0.53	0.012	0.033	ug/kg wet	0.6667		80.0	45-125	2.71	30	
PCB 141 (2C)	0.36	0.012	0.033	ug/kg wet	0.6667		54.3	45-125	11.4	30	
PCB 142 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		59.4	45-125	4.21	30	
PCB 144	0.73	0.012	0.033	ug/kg wet	1.333		54.6	45-125	1.78	30	
PCB 146	0.35	0.012	0.033	ug/kg wet	0.6667		51.8	45-125	1.11	30	
PCB 147	0.28	0.012	0.033	ug/kg wet	0.6667		41.4	45-125	20.0	30	Q
PCB 149	0.65	0.012	0.033	ug/kg wet	1.333		48.8	45-125	0.908	30	C
PCB 15 (2C)	0.89	0.012	0.033	ug/kg wet	1.333		66.9	45-125	9.39	30	C
PCB 151	0.39	0.012	0.033	ug/kg wet	0.6667		59.0	45-125	1.49	30	
PCB 154	0.34	0.012	0.033	ug/kg wet	0.6667		50.3	45-125	6.25	30	
PCB 155	0.36	0.012	0.033	ug/kg wet	0.6667		54.6	45-125	2.42	30	
PCB 156	0.35	0.012	0.033	ug/kg wet	0.6667		52.8	45-125	19.3	30	
PCB 157	0.77	0.012	0.033	ug/kg wet	1.333		58.1	45-125	6.99	30	
PCB 158	0.37	0.012	0.033	ug/kg wet	0.6667		55.8	45-125	3.09	30	

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS Dup (B20A046-BSD1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 165 (2C)	0.70	0.012	0.033	ug/kg wet	0.6667		105	45-125	9.43	30	
PCB 167	0.43	0.012	0.033	ug/kg wet	0.6667		64.2	45-125	40.7	30	RPD-02
PCB 169	0.41	0.012	0.033	ug/kg wet	0.6667		61.4	45-125	14.0	30	
PCB 17 (2C)	0.31	0.012	0.033	ug/kg wet	0.6667		47.0	45-125	0.523	30	
PCB 170 [2C]	0.40	0.012	0.033	ug/kg wet	0.6667		59.4	45-125	9.34	30	
PCB 171 (2C)	0.75	0.012	0.033	ug/kg wet	1.333		56.6	45-125	12.4	30	
PCB 172 (2C)	0.32	0.012	0.033	ug/kg wet	0.6667		48.2	45-125	9.38	30	
PCB 173	0.36	0.012	0.033	ug/kg wet	0.6667		54.7	45-125	6.94	30	
PCB 174	0.39	0.012	0.033	ug/kg wet	0.6667		59.2	45-125	20.0	30	
PCB 175 (2C)	0.33	0.012	0.033	ug/kg wet	0.6667		49.2	45-125	17.8	30	
PCB 176	0.73	0.012	0.033	ug/kg wet	0.6667		110	45-125	4.26	30	
PCB 177 (2C)	0.36	0.012	0.033	ug/kg wet	0.6667		54.6	45-125	13.3	30	
PCB 178 (2C)	0.37	0.012	0.033	ug/kg wet	0.6667		54.8	45-125	11.0	30	
PCB 179 (2C)	0.34	0.012	0.033	ug/kg wet	0.6667		51.2	45-125	4.88	30	
PCB 18	0.36	0.012	0.033	ug/kg wet	0.6667		54.0	45-125	20.6	30	
PCB 180	0.40	0.012	0.033	ug/kg wet	0.6667		59.9	45-125	21.7	30	
PCB 183	0.37	0.012	0.033	ug/kg wet	0.6667		55.2	45-125	9.40	30	
PCB 184 (2C)	0.42	0.012	0.033	ug/kg wet	0.6667		62.6	45-125	0.223	30	
PCB 185	0.40	0.012	0.033	ug/kg wet	0.6667		59.8	45-125	10.1	30	
PCB 187	0.37	0.012	0.033	ug/kg wet	0.6667		55.4	45-125	9.86	30	
PCB 189	0.44	0.012	0.033	ug/kg wet	0.6667		65.7	45-125	10.2	30	
PCB 19 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		60.2	45-125	7.16	30	
PCB 190 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		60.7	45-125	11.1	30	
PCB 191 (2C)	0.37	0.012	0.033	ug/kg wet	0.6667		55.2	45-125	9.02	30	
PCB 192 (2C)	0.79	0.012	0.033	ug/kg wet	0.6667		118	45-125	9.94	30	
PCB 193	0.39	0.012	0.033	ug/kg wet	0.6667		58.6	45-125	15.6	30	
PCB 194	0.44	0.012	0.033	ug/kg wet	0.6667		65.3	45-125	0.784	30	
PCB 195 [2C]	0.43	0.012	0.033	ug/kg wet	0.6667		65.0	45-125	12.9	30	
PCB 196 (2C)	0.57	0.012	0.033	ug/kg wet	0.6667		85.8	45-125	14.2	30	
PCB 197	0.39	0.012	0.033	ug/kg wet	0.6667		58.8	45-125	1.60	30	
PCB 199	0.38	0.012	0.033	ug/kg wet	0.6667		57.4	45-125	3.29	30	
PCB 20 (2C)	1.4	0.012	0.033	ug/kg wet	2.000		69.2	45-125	0.868	30	
PCB 200	0.36	0.012	0.033	ug/kg wet	0.6667		54.2	45-125	13.7	30	
PCB 201 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		59.4	45-125	13.8	30	
PCB 202 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		60.3	45-125	1.65	30	
PCB 203 (2C)	0.52	0.012	0.033	ug/kg wet	0.6667		77.3	45-125	26.5	30	
PCB 204 (2C)	0.33	0.012	0.033	ug/kg wet	0.6667		48.9	45-125	2.21	30	
PCB 205	0.39	0.012	0.033	ug/kg wet	0.6667		59.1	45-125	4.37	30	
PCB 206	0.55	0.012	0.033	ug/kg wet	0.6667		82.1	45-125	8.50	30	
PCB 207 (2C)	0.43	0.012	0.033	ug/kg wet	0.6667		65.1	45-125	14.0	30	
PCB 208 (2C)	0.43	0.012	0.033	ug/kg wet	0.6667		64.2	45-125	7.46	30	

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS Dup (B20A046-BSD1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 209	0.55	0.012	0.033	ug/kg wet	0.6667		81.9	45-125	16.8	30	
PCB 22	0.33	0.012	0.033	ug/kg wet	0.6667		49.7	45-125	6.83	30	
PCB 24	0.79	0.012	0.033	ug/kg wet	1.333		59.0	45-125	1.73	30	
PCB 25	0.39	0.012	0.033	ug/kg wet	0.6667		58.2	45-125	11.4	30	
PCB 26	0.33	0.012	0.033	ug/kg wet	0.6667		49.7	45-125	15.4	30	
PCB 27	0.72	0.012	0.033	ug/kg wet	1.333		54.1	45-125	22.7	30	
PCB 28	0.73	0.012	0.033	ug/kg wet	1.333		54.7	45-125	9.47	30	C
PCB 29	0.83	0.012	0.033	ug/kg wet	1.333		62.0	45-125	3.24	30	
PCB 32	0.68	0.012	0.033	ug/kg wet	1.333		50.7	45-125	12.9	30	
PCB 33	0.72	0.012	0.033	ug/kg wet	1.333		54.0	45-125	10.3	30	
PCB 34	0.58	0.012	0.033	ug/kg wet	0.6667		86.8	45-125	7.57	30	
PCB 35	0.85	0.012	0.033	ug/kg wet	1.333		63.9	45-125	9.90	30	
PCB 36	0.41	0.012	0.033	ug/kg wet	0.6667		61.2	45-125	29.0	30	
PCB 37 (2C)	0.61	0.012	0.033	ug/kg wet	0.6667		91.0	45-125	25.2	30	
PCB 4 (2C)	0.72	0.012	0.033	ug/kg wet	0.6667		107	45-125	47.9	30	RPD-06
PCB 40 (2C)	0.86	0.012	0.033	ug/kg wet	1.333		64.5	45-125	0.537	30	
PCB 41 (2C)	0.32	0.012	0.033	ug/kg wet	0.6667		48.6	45-125	4.28	30	
PCB 42 (2C)	0.30	0.012	0.033	ug/kg wet	0.6667		45.3	45-125	4.67	30	
PCB 44	0.32	0.012	0.033	ug/kg wet	0.6667		48.0	45-125	0.924	30	
PCB 45	0.31	0.012	0.033	ug/kg wet	0.6667		46.2	45-125	0.0325	30	
PCB 46 (2C)	0.45	0.012	0.033	ug/kg wet	0.6667		68.1	45-125	3.52	30	
PCB 47 (2C)	0.45	0.012	0.033	ug/kg wet	0.6667		68.1	45-125	12.1	30	
PCB 48 (2C)	0.34	0.012	0.033	ug/kg wet	0.6667		51.6	45-125	17.9	30	
PCB 49	0.35	0.012	0.033	ug/kg wet	0.6667		53.0	45-125	0.302	30	
PCB 5	0.90	0.012	0.033	ug/kg wet	1.333		67.6	45-125	14.6	30	
PCB 51	0.31	0.012	0.033	ug/kg wet	0.6667		46.6	45-125	21.6	30	
PCB 52 [2C]	0.36	0.012	0.033	ug/kg wet	0.6667		53.6	45-125	3.78	30	
PCB 53	0.32	0.012	0.033	ug/kg wet	0.6667		47.7	45-125	10.0	30	
PCB 54	0.85	0.012	0.033	ug/kg wet	1.333		63.5	45-125	1.10	30	
PCB 56 (2C)	0.38	0.012	0.033	ug/kg wet	0.6667		57.3	45-125	8.96	30	
PCB 59 (2C)	0.45	0.012	0.033	ug/kg wet	0.6667		67.3	45-125	14.6	30	
PCB 6	0.35	0.012	0.033	ug/kg wet	0.6667		52.0	45-125	1.36	30	
PCB 60 (2C)	0.60	0.012	0.033	ug/kg wet	1.333		45.2	45-125	8.38	30	
PCB 63	0.34	0.012	0.033	ug/kg wet	0.6667		50.3	45-125	21.4	30	
PCB 64 (2C)	0.37	0.012	0.033	ug/kg wet	0.6667		55.7	45-125	1.17	30	
PCB 66 [2C]	0.46	0.012	0.033	ug/kg wet	0.6667		68.8	45-125	0.986	30	
PCB 67	0.72	0.012	0.033	ug/kg wet	1.333		53.8	45-125	5.23	30	
PCB 69 (2C)	0.74	0.012	0.033	ug/kg wet	1.333		55.5	45-125	3.03	30	
PCB 7 (2C)	0.39	0.012	0.033	ug/kg wet	0.6667		58.0	45-125	6.18	30	
PCB 70	0.32	0.012	0.033	ug/kg wet	0.6667		48.0	45-125	4.83	30	
PCB 71 (2C)	0.82	0.012	0.033	ug/kg wet	1.333		61.6	45-125	2.25	30	

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

LCS Dup (B20A046-BSD1) Prepared: 24-Jan-2020 Analyzed: 26-Feb-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 73 (2C)	0.41	0.012	0.033	ug/kg wet	0.6667		61.5	45-125	6.65	30	
PCB 74 (2C)	0.77	0.012	0.033	ug/kg wet	0.6667		116	45-125	8.01	30	
PCB 75 (2C)	0.40	0.012	0.033	ug/kg wet	0.6667		60.3	45-125	2.66	30	
PCB 78 (2C)	0.39	0.012	0.033	ug/kg wet	0.6667		59.0	45-125	1.07	30	
PCB 8 [2C]	0.47	0.012	0.033	ug/kg wet	0.6667		70.8	45-125	12.8	30	
PCB 82	0.37	0.012	0.033	ug/kg wet	0.6667		55.3	45-125	0.671	30	
PCB 83	0.96	0.012	0.033	ug/kg wet	1.333		72.0	45-125	0.101	30	
PCB 84	0.32	0.012	0.033	ug/kg wet	0.6667		47.9	45-125	5.52	30	
PCB 85	0.43	0.012	0.033	ug/kg wet	0.6667		63.8	45-125	6.93	30	
PCB 9 (2C)	0.39	0.012	0.033	ug/kg wet	0.6667		58.3	45-125	36.3	30	RPD-06
PCB 90 (2C)	0.73	0.012	0.033	ug/kg wet	1.333		54.9	45-125	5.23	30	C
PCB 91	0.35	0.012	0.033	ug/kg wet	0.6667		51.9	45-125	1.09	30	
PCB 92	0.34	0.012	0.033	ug/kg wet	0.6667		51.1	45-125	8.61	30	
PCB 93	0.99	0.012	0.033	ug/kg wet	2.000		49.7	45-125	0.899	30	
PCB 95 (2C)	0.41	0.012	0.033	ug/kg wet	0.6667		61.6	45-125	1.34	30	
PCB 97	0.37	0.012	0.033	ug/kg wet	0.6667		54.9	45-125	7.64	30	
PCB 99	0.35	0.012	0.033	ug/kg wet	0.6667		52.5	45-125	3.81	30	
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.85*			*ug/kg wet*	*1.000*		*85.2*	*50-120*			
Surrogate: PCB 198	*0.51*			*ug/kg wet*	*1.000*		*50.9*	*45-125*			

Duplicate (B20A046-DUP1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 10 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 100	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 103	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 104	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 105	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 107 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 110	ND	0.016	0.047	ug/kg dry		ND				30	C, U
PCB 114	0.14	0.016	0.047	ug/kg dry		ND				30	
PCB 115	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 117	ND	0.016	0.047	ug/kg dry		ND				30	C, U
PCB 118	0.75	0.016	0.047	ug/kg dry		0.23			108	30	RPD-06
PCB 119	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 12	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 121	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 122 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 124	1.1	0.016	0.047	ug/kg dry		ND				30	
PCB 126	ND	0.016	0.047	ug/kg dry		ND				30	C, U
PCB 128	0.29	0.016	0.047	ug/kg dry		ND				30	
PCB 13 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 130	0.11	0.016	0.047	ug/kg dry		ND				30	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Duplicate (B20A046-DUP1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 131	0.11	0.016	0.047	ug/kg dry		ND				30	
PCB 132	0.56	0.016	0.047	ug/kg dry		ND				30	C
PCB 134	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 135	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 136	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 137	0.086	0.016	0.047	ug/kg dry		ND				30	
PCB 138	0.93	0.016	0.047	ug/kg dry		0.33			96.3	30	C, RPD-06
PCB 14	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 141 (2C)	0.82	0.016	0.047	ug/kg dry		ND				30	
PCB 142 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 144	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 146	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 147	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 149	0.50	0.016	0.047	ug/kg dry		ND				30	C
PCB 15 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	C, U
PCB 151	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 154	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 155	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 156	0.039	0.016	0.047	ug/kg dry		ND				30	J
PCB 157	0.21	0.016	0.047	ug/kg dry		ND				30	
PCB 158	2.3	0.016	0.047	ug/kg dry		1.6			36.0	30	RPD-06
PCB 165 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 167	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 169	0.15	0.016	0.047	ug/kg dry		ND				30	
PCB 17 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 170 [2C]	ND	0.016	0.047	ug/kg dry		0.20				30	U
PCB 171 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 172 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 173	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 174	0.21	0.016	0.047	ug/kg dry		ND				30	
PCB 175 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 176	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 177 (2C)	0.082	0.016	0.047	ug/kg dry		ND				30	
PCB 178 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 179 (2C)	0.91	0.016	0.047	ug/kg dry		ND				30	
PCB 18	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 180	0.29	0.016	0.047	ug/kg dry		0.12			82.6	30	RPD-06
PCB 183	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 184 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 185	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 187	0.15	0.016	0.047	ug/kg dry		0.047			105	30	RPD-06

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Duplicate (B20A046-DUP1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 189	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 19 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 190 (2C)	ND	0.016	0.047	ug/kg dry		0.19				30	U
PCB 191 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 192 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 193	0.049	0.016	0.047	ug/kg dry		ND				30	
PCB 194	0.14	0.016	0.047	ug/kg dry		ND				30	
PCB 195 [2C]	0.092	0.016	0.047	ug/kg dry		0.27			97.1	30	RPD-06
PCB 196 (2C)	0.19	0.016	0.047	ug/kg dry		0.17			7.83	30	
PCB 197	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 199	0.063	0.016	0.047	ug/kg dry		0.045			33.7	30	RPD-06
PCB 20 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 200	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 201 (2C)	0.40	0.016	0.047	ug/kg dry		ND				30	
PCB 202 (2C)	0.029	0.016	0.047	ug/kg dry		ND				30	J
PCB 203 (2C)	0.15	0.016	0.047	ug/kg dry		ND				30	
PCB 204 (2C)	0.15	0.016	0.047	ug/kg dry		ND				30	
PCB 205	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 206	0.15	0.016	0.047	ug/kg dry		ND				30	
PCB 207 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 208 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 209	0.26	0.016	0.047	ug/kg dry		ND				30	
PCB 22	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 24	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 25	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 26	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 27	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 28	ND	0.016	0.047	ug/kg dry		ND				30	C, U
PCB 29	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 32	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 33	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 34	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 35	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 36	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 37 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 4 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 40 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 41 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 42 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 44	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 45	ND	0.016	0.047	ug/kg dry		ND				30	U

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Duplicate (B20A046-DUP1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 46 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 47 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 48 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 49	0.16	0.016	0.047	ug/kg dry		ND				30	
PCB 5	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 51	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 52 [2C]	0.18	0.016	0.047	ug/kg dry		ND				30	
PCB 53	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 54	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 56 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 59 (2C)	0.22	0.016	0.047	ug/kg dry		ND				30	
PCB 6	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 60 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 63	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 64 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 66 [2C]	0.26	0.016	0.047	ug/kg dry		ND				30	
PCB 67	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 69 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 7 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 70	0.13	0.016	0.047	ug/kg dry		ND				30	
PCB 71 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 73 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 74 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 75 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 78 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 8 [2C]	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 82	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 83	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 84	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 85	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 9 (2C)	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 90 (2C)	1.8	0.016	0.047	ug/kg dry		ND				30	C
PCB 91	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 92	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 93	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 95 (2C)	0.48	0.016	0.047	ug/kg dry		ND				30	
PCB 97	ND	0.016	0.047	ug/kg dry		ND				30	U
PCB 99	ND	0.016	0.047	ug/kg dry		ND				30	U
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.50*			*ug/kg dry*	*1.409*		*35.2*	*30-130*			
Surrogate: PCB 198	*0.30*			*ug/kg dry*	*1.409*		*21.2*	*45-135*			*Q*

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Matrix Spike (B20A046-MS1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 10 (2C)	0.84	0.018	0.050	ug/kg dry	1.009	ND	83.1	40-120			
PCB 100	0.91	0.018	0.050	ug/kg dry	2.019	ND	45.3	40-120			
PCB 103	0.44	0.018	0.050	ug/kg dry	1.009	ND	44.0	40-120			
PCB 104	0.87	0.018	0.050	ug/kg dry	2.019	ND	43.3	40-120			
PCB 105	1.1	0.018	0.050	ug/kg dry	1.009	ND	107	40-120			
PCB 107 (2C)	0.52	0.018	0.050	ug/kg dry	1.009	ND	51.4	40-120			
PCB 110	3.3	0.018	0.050	ug/kg dry	2.019	ND	162	40-120			C, Q
PCB 114	0.49	0.018	0.050	ug/kg dry	1.009	ND	48.7	40-120			
PCB 115	1.4	0.018	0.050	ug/kg dry	2.019	ND	69.9	40-120			
PCB 117	0.89	0.018	0.050	ug/kg dry	2.019	ND	43.9	40-120			C
PCB 118	2.2	0.018	0.050	ug/kg dry	1.009	0.23	198	40-120			Q
PCB 119	0.41	0.018	0.050	ug/kg dry	1.009	ND	41.0	40-120			
PCB 12	1.2	0.018	0.050	ug/kg dry	2.019	ND	58.0	40-120			
PCB 121	0.40	0.018	0.050	ug/kg dry	1.009	ND	40.0	40-120			
PCB 122 (2C)	0.42	0.018	0.050	ug/kg dry	1.009	ND	41.5	40-120			
PCB 124	0.81	0.018	0.050	ug/kg dry	1.009	ND	79.8	40-120			
PCB 126	1.4	0.018	0.050	ug/kg dry	3.028	ND	47.5	40-120			C
PCB 128	0.94	0.018	0.050	ug/kg dry	1.009	ND	93.5	40-120			
PCB 13 (2C)	1.3	0.018	0.050	ug/kg dry	3.028	ND	43.6	40-120			
PCB 130	0.56	0.018	0.050	ug/kg dry	1.009	ND	55.5	40-120			
PCB 131	0.86	0.018	0.050	ug/kg dry	2.019	ND	42.4	40-120			
PCB 132	1.8	0.018	0.050	ug/kg dry	2.019	ND	87.7	40-120			C
PCB 134	0.45	0.018	0.050	ug/kg dry	1.009	ND	44.5	40-120			
PCB 135	1.0	0.018	0.050	ug/kg dry	2.019	ND	50.3	40-120			
PCB 136	0.75	0.018	0.050	ug/kg dry	1.009	ND	74.8	40-120			
PCB 137	0.53	0.018	0.050	ug/kg dry	1.009	ND	52.3	40-120			
PCB 138	3.8	0.018	0.050	ug/kg dry	3.028	0.33	114	40-120			C
PCB 14	0.73	0.018	0.050	ug/kg dry	1.009	ND	71.9	40-120			
PCB 141 (2C)	1.1	0.018	0.050	ug/kg dry	1.009	ND	110	40-120			
PCB 142 (2C)	0.79	0.018	0.050	ug/kg dry	1.009	ND	78.5	40-120			
PCB 144	0.96	0.018	0.050	ug/kg dry	2.019	ND	47.7	40-120			
PCB 146	0.66	0.018	0.050	ug/kg dry	1.009	ND	65.8	40-120			
PCB 147	0.42	0.018	0.050	ug/kg dry	1.009	ND	42.0	40-120			
PCB 149	1.8	0.018	0.050	ug/kg dry	2.019	ND	90.2	40-120			C
PCB 15 (2C)	0.73	0.018	0.050	ug/kg dry	2.019	ND	36.0	40-120			C, Q
PCB 151	0.60	0.018	0.050	ug/kg dry	1.009	ND	59.5	40-120			
PCB 154	0.49	0.018	0.050	ug/kg dry	1.009	ND	48.5	40-120			
PCB 155	0.73	0.018	0.050	ug/kg dry	1.009	ND	72.6	40-120			
PCB 156	0.84	0.018	0.050	ug/kg dry	1.009	ND	82.9	40-120			
PCB 157	0.96	0.018	0.050	ug/kg dry	2.019	ND	47.5	40-120			
PCB 158	2.3	0.018	0.050	ug/kg dry	1.009	1.6	71.1	40-120			

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Matrix Spike (B20A046-MS1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 165 (2C)	0.62	0.018	0.050	ug/kg dry	1.009	ND	61.2	40-120			
PCB 167	0.48	0.018	0.050	ug/kg dry	1.009	ND	47.9	40-120			
PCB 169	0.68	0.018	0.050	ug/kg dry	1.009	ND	67.7	40-120			
PCB 17 (2C)	0.42	0.018	0.050	ug/kg dry	1.009	ND	41.6	40-120			
PCB 170 [2C]	1.1	0.018	0.050	ug/kg dry	1.009	0.20	86.6	40-120			
PCB 171 (2C)	0.93	0.018	0.050	ug/kg dry	2.019	ND	45.8	40-120			
PCB 172 (2C)	0.70	0.018	0.050	ug/kg dry	1.009	ND	69.6	40-120			
PCB 173	0.47	0.018	0.050	ug/kg dry	1.009	ND	46.1	40-120			
PCB 174	0.81	0.018	0.050	ug/kg dry	1.009	ND	80.0	40-120			
PCB 175 (2C)	1.1	0.018	0.050	ug/kg dry	1.009	ND	105	40-120			
PCB 176	0.46	0.018	0.050	ug/kg dry	1.009	ND	45.7	40-120			
PCB 177 (2C)	0.61	0.018	0.050	ug/kg dry	1.009	ND	60.6	40-120			
PCB 178 (2C)	0.61	0.018	0.050	ug/kg dry	1.009	ND	60.6	40-120			
PCB 179 (2C)	1.0	0.018	0.050	ug/kg dry	1.009	ND	101	40-120			
PCB 18	0.55	0.018	0.050	ug/kg dry	1.009	ND	54.3	40-120			
PCB 180	1.2	0.018	0.050	ug/kg dry	1.009	0.12	107	40-120			
PCB 183	0.59	0.018	0.050	ug/kg dry	1.009	ND	58.8	40-120			
PCB 184 (2C)	0.45	0.018	0.050	ug/kg dry	1.009	ND	44.2	40-120			
PCB 185	0.38	0.018	0.050	ug/kg dry	1.009	ND	37.6	40-120			Q
PCB 187	0.87	0.018	0.050	ug/kg dry	1.009	0.047	81.8	40-120			
PCB 189	0.49	0.018	0.050	ug/kg dry	1.009	ND	48.1	40-120			
PCB 19 (2C)	0.45	0.018	0.050	ug/kg dry	1.009	ND	44.6	40-120			
PCB 190 (2C)	0.59	0.018	0.050	ug/kg dry	1.009	0.19	39.8	40-120			Q
PCB 191 (2C)	0.55	0.018	0.050	ug/kg dry	1.009	ND	54.9	40-120			
PCB 192 (2C)	0.78	0.018	0.050	ug/kg dry	1.009	ND	77.8	40-120			
PCB 193	0.41	0.018	0.050	ug/kg dry	1.009	ND	40.9	40-120			
PCB 194	0.80	0.018	0.050	ug/kg dry	1.009	ND	79.1	40-120			
PCB 195 [2C]	0.77	0.018	0.050	ug/kg dry	1.009	0.27	50.1	40-120			
PCB 196 (2C)	0.74	0.018	0.050	ug/kg dry	1.009	0.17	56.0	40-120			
PCB 197	0.40	0.018	0.050	ug/kg dry	1.009	ND	40.0	40-120			
PCB 199	0.51	0.018	0.050	ug/kg dry	1.009	0.045	46.1	40-120			
PCB 20 (2C)	1.0	0.018	0.050	ug/kg dry	3.028	ND	33.1	40-120			Q
PCB 200	0.49	0.018	0.050	ug/kg dry	1.009	ND	48.3	40-120			
PCB 201 (2C)	0.69	0.018	0.050	ug/kg dry	1.009	ND	68.5	40-120			
PCB 202 (2C)	0.81	0.018	0.050	ug/kg dry	1.009	ND	80.7	40-120			
PCB 203 (2C)	0.86	0.018	0.050	ug/kg dry	1.009	ND	84.9	40-120			
PCB 204 (2C)	0.53	0.018	0.050	ug/kg dry	1.009	ND	52.4	40-120			
PCB 205	0.45	0.018	0.050	ug/kg dry	1.009	ND	44.2	40-120			
PCB 206	0.70	0.018	0.050	ug/kg dry	1.009	ND	69.1	40-120			
PCB 207 (2C)	0.50	0.018	0.050	ug/kg dry	1.009	ND	50.0	40-120			
PCB 208 (2C)	0.53	0.018	0.050	ug/kg dry	1.009	ND	52.3	40-120			

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Batch B20A046 - EPA 3545

Matrix Spike (B20A046-MS1) **Source: 19I1009-03RE1** Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
PCB 209	1.0	0.018	0.050	ug/kg dry	1.009	ND	102	40-120			
PCB 22	0.66	0.018	0.050	ug/kg dry	1.009	ND	65.3	40-120			
PCB 24	0.67	0.018	0.050	ug/kg dry	2.019	ND	33.4	40-120			Q
PCB 25	0.41	0.018	0.050	ug/kg dry	1.009	ND	41.1	40-120			
PCB 26	0.42	0.018	0.050	ug/kg dry	1.009	ND	41.2	40-120			
PCB 27	0.68	0.018	0.050	ug/kg dry	2.019	ND	33.5	40-120			Q
PCB 28	0.88	0.018	0.050	ug/kg dry	2.019	ND	43.5	40-120			C
PCB 29	0.84	0.018	0.050	ug/kg dry	2.019	ND	41.6	40-120			
PCB 32	0.67	0.018	0.050	ug/kg dry	2.019	ND	33.1	40-120			Q
PCB 33	0.90	0.018	0.050	ug/kg dry	2.019	ND	44.6	40-120			
PCB 34	0.43	0.018	0.050	ug/kg dry	1.009	ND	42.5	40-120			
PCB 35	0.88	0.018	0.050	ug/kg dry	2.019	ND	43.4	40-120			
PCB 36	0.57	0.018	0.050	ug/kg dry	1.009	ND	56.2	40-120			
PCB 37 (2C)	0.43	0.018	0.050	ug/kg dry	1.009	ND	42.1	40-120			
PCB 4 (2C)	0.46	0.018	0.050	ug/kg dry	1.009	ND	45.7	40-120			
PCB 40 (2C)	0.84	0.018	0.050	ug/kg dry	2.019	ND	41.6	40-120			
PCB 41 (2C)	0.48	0.018	0.050	ug/kg dry	1.009	ND	48.0	40-120			
PCB 42 (2C)	0.48	0.018	0.050	ug/kg dry	1.009	ND	47.1	40-120			
PCB 44	0.56	0.018	0.050	ug/kg dry	1.009	ND	55.5	40-120			
PCB 45	0.54	0.018	0.050	ug/kg dry	1.009	ND	53.8	40-120			
PCB 46 (2C)	0.50	0.018	0.050	ug/kg dry	1.009	ND	49.7	40-120			
PCB 47 (2C)	0.68	0.018	0.050	ug/kg dry	1.009	ND	67.8	40-120			
PCB 48 (2C)	0.41	0.018	0.050	ug/kg dry	1.009	ND	41.1	40-120			
PCB 49	0.80	0.018	0.050	ug/kg dry	1.009	ND	78.9	40-120			
PCB 5	0.75	0.018	0.050	ug/kg dry	2.019	ND	36.9	40-120			Q
PCB 51	0.41	0.018	0.050	ug/kg dry	1.009	ND	40.6	40-120			
PCB 52 [2C]	1.4	0.018	0.050	ug/kg dry	1.009	ND	134	40-120			Q
PCB 53	0.72	0.018	0.050	ug/kg dry	1.009	ND	71.4	40-120			
PCB 54	0.83	0.018	0.050	ug/kg dry	2.019	ND	41.1	40-120			
PCB 56 (2C)	0.88	0.018	0.050	ug/kg dry	1.009	ND	87.5	40-120			
PCB 59 (2C)	0.39	0.018	0.050	ug/kg dry	1.009	ND	38.6	40-120			Q
PCB 6	0.39	0.018	0.050	ug/kg dry	1.009	ND	39.0	40-120			Q
PCB 60 (2C)	0.80	0.018	0.050	ug/kg dry	2.019	ND	39.7	40-120			Q
PCB 63	0.52	0.018	0.050	ug/kg dry	1.009	ND	51.6	40-120			
PCB 64 (2C)	0.66	0.018	0.050	ug/kg dry	1.009	ND	65.3	40-120			
PCB 66 [2C]	1.2	0.018	0.050	ug/kg dry	1.009	ND	119	40-120			
PCB 67	0.82	0.018	0.050	ug/kg dry	2.019	ND	40.4	40-120			
PCB 69 (2C)	1.3	0.018	0.050	ug/kg dry	2.019	ND	64.0	40-120			
PCB 7 (2C)	0.46	0.018	0.050	ug/kg dry	1.009	ND	45.3	40-120			
PCB 70	0.75	0.018	0.050	ug/kg dry	1.009	ND	74.0	40-120			
PCB 71 (2C)	0.47	0.018	0.050	ug/kg dry	2.019	ND	23.5	40-120			Q

Polychlorinated Biphenyls (as Congeners) by EPA Method 8082 - Quality Control

ERDC-EL-EP-C

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B20A046 - EPA 3545											
Matrix Spike (B20A046-MS1)	**Source: 19I1009-03RE1**	Prepared: 24-Jan-2020 Analyzed: 12-Mar-2020									
PCB 73 (2C)	0.27	0.018	0.050	ug/kg dry	1.009	ND	26.8	40-120			Q
PCB 74 (2C)	0.50	0.018	0.050	ug/kg dry	1.009	ND	49.2	40-120			
PCB 75 (2C)	0.48	0.018	0.050	ug/kg dry	1.009	ND	47.4	40-120			
PCB 78 (2C)	0.67	0.018	0.050	ug/kg dry	1.009	ND	66.6	40-120			
PCB 8 [2C]	0.45	0.018	0.050	ug/kg dry	1.009	ND	44.3	40-120			
PCB 82	0.52	0.018	0.050	ug/kg dry	1.009	ND	51.6	40-120			
PCB 83	1.1	0.018	0.050	ug/kg dry	2.019	ND	55.7	40-120			
PCB 84	0.74	0.018	0.050	ug/kg dry	1.009	ND	73.6	40-120			
PCB 85	0.72	0.018	0.050	ug/kg dry	1.009	ND	70.9	40-120			
PCB 9 (2C)	0.38	0.018	0.050	ug/kg dry	1.009	ND	37.9	40-120			Q
PCB 90 (2C)	3.0	0.018	0.050	ug/kg dry	2.019	ND	146	40-120			C, Q
PCB 91	0.62	0.018	0.050	ug/kg dry	1.009	ND	61.3	40-120			
PCB 92	0.87	0.018	0.050	ug/kg dry	1.009	ND	86.3	40-120			
PCB 93	1.4	0.018	0.050	ug/kg dry	3.028	ND	44.7	40-120			
PCB 95 (2C)	1.7	0.018	0.050	ug/kg dry	1.009	ND	169	40-120			Q
PCB 97	0.96	0.018	0.050	ug/kg dry	1.009	ND	94.9	40-120			
PCB 99	1.1	0.018	0.050	ug/kg dry	1.009	ND	113	40-120			
Surrogate: 2,4,5,6 Tetrachloro-m-xylene	*0.90*			*ug/kg dry*	*1.514*		*59.5*	*40-120*			
Surrogate: PCB 198	*0.62*			*ug/kg dry*	*1.514*		*40.6*	*40-120*			

EPA 1630 Methyl Mercury (GC) - Quality Control

Eurofins TestAmerica, Canton

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 406015 - 1630_P_USGS											
MB (240-4060151-A)					Prepared: 16-Oct-2019 Analyzed: 17-Oct-2019						
Methyl Mercury	ND	0.073	0.099	ug/Kg				-			
Surrogate: n-Propyl Mercury Chloride	*0.875*			*ug/Kg*	*0.994*		*88*	*13-133*			
LCS (240-4060152-A)					Prepared: 16-Oct-2019 Analyzed: 17-Oct-2019						
Methyl Mercury	0.986	0.073	0.10	ug/Kg	0.997		99	44-133			
Surrogate: n-Propyl Mercury Chloride	*1.03*			*ug/Kg*	*0.997*		*104*	*13-133*			

ERDC SAMPLE RECEIPT CHECKLIST

Client:
SPAWAR

Work Order:
19I1007-12

Project:
Bremerton ESTCP ER18-5079

Date/Time Received
9/4/19 1200

Shipping Company:
FedEx

Suspected Hazard Information	**Yes**	**No**	**NA**	**Comments:**
Shipped as DOT Hazardous?		X		
Samples identified as Foreign Material?		X		

Sample Receipt Criteria	**Yes**	**No**	**NA**	**Comments:**
1. Shipping containers received intact and sealed?	X			
2. Chain of Custody documents included with shipment?	X			
3. COC form is properly signed in relinquished/received sections?	X			
4. Samples requiring chemical preservation at proper pH?	X			
5. Samples requiring cold preservation within 0-5°C?	X			3.5°C
6. Samples IDs on COC match IDs on containers?	X			
7. Date and time of COC match date and time on containers?	X			
8. Number of containers received match number indicated on COC?	X			
9. Samples received within holding time?	X			
10. Aqueous samples found to have visible solids?			X	

Additional Comments:

Checklist preformed by:
Kelli Hartman HARTMAN.KELLI.LYNN.1538170522
Digitally signed by HARTMAN.KELLI.LYNN.1538170522
Date: 2019.09.17 10:38:57 -05'00'

Time/Date Completed:
9/10/19 1600

Naval Information Warfare Center
PACIFIC

ENERGY AND ENVIRONMENTAL SUSTAINABILITY, Code 71760
53475 Strothe Road, Building 111
San Diego, CA 92152-5000

Chain of Custody Record

Date: 8/30/2019
Page 1 1

Project Title/Project Number: Bremerton
Sampler(s): SPME extracts
Project Leader: Gunther Rosen
Contact Tel: 410-302-6660
Tel: (619) 553-0886
Fax: (619) 553-6305
Email: rosen@spawar.navy.mil
Special Instructions/Comments:

Sample Identification	Collection Date	Collection Time	Matrix	Sample Type	Container Type	Collection Temp (°C)	Requested Analyses										Temperature upon arrival at Lab (°C)
							PCB congeners (EPA 1668)										
T82-1-MM-SPME	8/29/2019	16:00	Hexane	Solvent	7 mL glass vial		×										
T82-2-MM-SPME	8/29/2019	16:20	Hexane	Solvent	7 mL glass vial		×										
T82-3-MM-SPME	8/29/2019	16:40	Hexane	Solvent	7 mL glass vial		×										
T82-4-MM-SPME	8/30/2019	9:00	Hexane	Solvent	7 mL glass vial		×										
T82-5-MM-SPME	8/30/2019	9:25	Hexane	Solvent	7 mL glass vial		×										
T82-6-MM-SPME	8/30/2019	9:45	Hexane	Solvent	7 mL glass vial		×										
T82-7-MM-SPME	8/30/2019	10:05	Hexane	Solvent	7 mL glass vial		×										
T82-8-MM-SPME	8/30/2019	10:20	Hexane	Solvent	7 mL glass vial		×										
T82-9-MM-SPME	8/30/2019	10:45	Hexane	Solvent	7 mL glass vial		×										
T82-10-MM-SPME	8/30/2019	11:10	Hexane	Solvent	7 mL glass vial		×										
T82-TB1-SPME	8/30/2019	11:30	Hexane	Solvent	7 mL glass vial		×										
T82-TB2-SPME	8/30/2019	11:55	Hexane	Solvent	7 mL glass vial		×										
T82-TB3-SPME	8/30/2019	12:20	Hexane	Solvent	7 mL glass vial		×										

Relinquished by: (Signature) **Meg Jalalizadeh**	**Received by: (Signature)**	**Date:** 9/4/19	**Time:** 1200
Relinquished by: (Signature)	**Received by: (Signature)**	**Date:**	**Time:**

Naval Information Warfare Center
PACIFIC

NAVAL INFORMATION WARFARE CENTER (NIWC) PACIFIC
CYBER SCIENCE & TECHNOLOGY DEPARTMENT
ADVANCED SYSTEMS & APPLIED SCIENCES DIVISION
ENERGY & ENVIRONMENTAL SUSTAINABILITY BRANCH
53475 STROTHE ROAD   SAN DIEGO, CA 92152-5000

Chain of Custody Record

Date: **3-Sep-2019**
Page: 1 of 2

Project Title/№: Long Term Monitoring (LTM) of Activated Carbon Amendments with Sediment Ecosystem Assessment Protocols (SeaRings) - ESTCP Proj. **# ER18-5079**

NIWC Project PI: Gunther Rosen

Contact: *Joel Guerrero*

Sampler(s): Joel Guerrero / Gunther Rosen / Nicholas Hayman / Marianne Colvin: c/71760

Contact Tel: 619-850-2109

Tel: 619-890-9692

Fax: 619-553-6305

Email: *gunther.rosen@navy.mil*

Special Instructions/Comments:
Sediment samples kept dark & cold- [see ERDC quote # xxxxxx for specific analysis]

Field/Sample ID ***Location:*** PSNS&IMF: OUB-M Pier 7 Bremerton WA	***Date/Time Collection***	***№ / Type Containers***		***Sample Matrix***	***Sample Type***	***Analyses***	**PCB Congeners EPA 8082**		**Methyl Mercury MeHg EPA 1630**			
T82- 1 -MM-SedChem	27Aug19 - 1000	1	16 oz glass bottle	sediments	core-comp		**x**		**x**			
T82- 2 -MM-SedChem	27Aug19 - 1255	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 3 -MM-SedChem	27Aug19 - 1145	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 4 -MM-SedChem	28Aug19 - 1430	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 4 -MM- DUP -SedChem	28Aug19 - 1430	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 5 -MM-SedChem	27Aug19 - 1425	1	16 oz glass bottle	sediments	core-comp		**x**		**x**			
T82- 6 -MM-SedChem	28Aug19 - 1000	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 6 -MM- DUP -SedChem	28Aug19 - 1000	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 7 -MM-SedChem	28Aug19 - 1055	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 8 -MM-SedChem	28Aug19 - 1130	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 9 -MM-SedChem	28Aug19 - 0915	1	16 oz glass bottle	sediments	core-comp		**x**					
T82- 10 -MM-SedChem	28Aug19 - 1345	1	16 oz glass bottle	sediments	core-comp		**x**		**x**			
					TOTAL				12			

Relinquished by: ***Joel Guerrero/Gunther Rosen (NIWC-c/71760)***	***(Signature)***	***Date:*** ***09/03/2019***	***Time:*** ***1030***
Recieved by: Kelli Hartman	***(Signature)***	***Date:*** 9/4/19	***Time:*** 1200

Table 3. TOC Core Processing Notes

	Sample ID	Processing date	Station	Layer (cm)	Aggregate Present?	Sample Notes	Sample Container
1	T82-1-MM-TOC-0005	8-28-19	1-MM	0-5		See BC notes	1 4-oz glass
2	T82-1-MM-TOC-0510			5-10			1 4-oz glass
3	T82-1-MM-TOC-1015			10-15			1 4-oz glass
4	T82-1-MM-TOC-1520			15-20			1 4-oz glass
8	T82-2-MM-TOC-0005	8-28-19	2-MM	0-5			1 4-oz glass
9	T82-2-MM-TOC-0510			5-10			1 4-oz glass
10	T82-2-MM-TOC-1015			10-15			1 4-oz glass
11	T82-2-MM-TOC-1520			15-20			1 4-oz glass
12	T82-3-MM-TOC-0005	8-28-19	3-MM	0-5			1 4-oz glass
13	T82-3-MM-TOC-0510			5-10			1 4-oz glass
14	T82-3-MM-TOC-1015			10-15			1 4-oz glass
15	T82-3-MM-TOC-1520			15-20			1 4-oz glass
16	T82-4-MM-TOC-0005	8-29-19	4-MM	0-5			1 4-oz glass
17	T82-4-MM-TOC-0510			5-10			1 4-oz glass
18	T82-4-MM-TOC-1015			10-15			1 4-oz glass
19	T82-4-MM-TOC-1520			15-20			1 4-oz glass
20	T82-5-MM-TOC-0005	8-28-19	5-MM	0-5			1 4-oz glass
21	T82-5-MM-TOC-0510			5-10			1 4-oz glass
22	T82-5-MM-TOC-1015			10-15			1 4-oz glass
23	T82-5-MM-TOC-1520			15-20			1 4-oz glass

Table 3. TOC Core Processing Notes

Sample ID	Processing date	Station	Layer (cm)	Aggregate Present?	Sample Notes	Sample Container
24 T82-6-MM-TOC-0005	8/29/19	6-MM	0-5		See BC notes	1 4-oz glass
25 T82-6-MM-TOC-0510			5-10			1 4-oz glass
26 T82-6-MM-TOC-1015			10-15			1 4-oz glass
27 T82-6-MM-TOC-1520			15-20			1 4-oz glass
28 T82-7-MM-TOC-0005		7-MM	0-5			1 4-oz glass
29 T82-7-MM-TOC-0510			5-10			1 4-oz glass
30 T82-7-MM-TOC-1015			10-15			1 4-oz glass
31 T82-7-MM-TOC-1520			15-20			1 4-oz glass
32 T82-8-MM-TOC-0005		8-MM	0-5			1 4-oz glass
33 T82-8-MM-TOC-0510			5-10			1 4-oz glass
34 T82-8-MM-TOC-1015			10-15			1 4-oz glass
35 T82-8-MM-TOC-1520			15-20			1 4-oz glass
36 T82-9-MM-TOC-0005		9-MM	0-5			1 4-oz glass
37 T82-9-MM-TOC-0510			5-10			1 4-oz glass
38 T82-9-MM-TOC-1015			10-15			1 4-oz glass
39 T82-9-MM-TOC-1520			15-20			1 4-oz glass
40 T82-10-MM-TOC-0005		10-MM	0-5			1 4-oz glass
41 T82-10-MM-TOC-0510			5-10			1 4-oz glass
42 T82-10-MM-TOC-1015			10-15			1 4-oz glass
43 T82-10-MM-TOC-1520			15-20			1 4-oz glass

Table 3. TOC Core Processing Notes

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Sample ID	Processing date	Station	Layer (cm)	Aggregate Present?	Sample Notes	Sample Container
44 T82-1-C-TOC-0005	8/27/19	1-C	0-5		see BC notes	1 4-oz glass
T82-1-C-TOC-0510			5-10			1 4-oz glass
T82-1-C-TOC-1015			10-15			1 4-oz glass
T82-1-C-TOC-1520			15-20			1 4-oz glass
1 T82-2-C-TOC-0005	8/27/19	2-C	0-5			1 4-oz glass
2 T82-2-C-TOC-0510			5-10			1 4-oz glass
3 T82-2-C-TOC-1015			10-15			1 4-oz glass
4 T82-2-C-TOC-1520			15-20			1 4-oz glass
5 T82-3-C-TOC-0005	8/28/19	3-C	0-5			1 4-oz glass
6 T82-3-C-TOC-0510			5-10			1 4-oz glass
7 T82-3-C-TOC-1015			10-15			1 4-oz glass
8 T82-3-C-TOC-1520			15-20			1 4-oz glass
9 T82-4-C-TOC-0005	8/28/19	4-C	0-5			1 4-oz glass
10 T82-4-C-TOC-0510			5-10			1 4-oz glass
11 T82-4-C-TOC-1015			10-15			1 4-oz glass
12 T82-4-C-TOC-1520			15-20			1 4-oz glass
13 T82-5-C-TOC-0005	8/29/19	5-C	0-5			1 4-oz glass
14 T82-5-C-TOC-0510			5-10			1 4-oz glass
15 T82-5-C-TOC-1015			10-15			1 4-oz glass
16 T82-5-C-TOC-1520			15-20			1 4-oz glass

Table 3. TOC Core Processing Notes

Sample ID	Processing date	Station	Layer (cm)	Aggregate Present?	Sample Notes	Sample Container
17 T82-6-C-TOC-0005	8/28/19	6-C	0-5		see BC notes	1 4-oz glass
18 T82-6-C-TOC-0510			5-10			1 4-oz glass
19 T82-6-C-TOC-1015			10-15			1 4-oz glass
20 T82-6-C-TOC-1520			15-20			1 4-oz glass
21 T82-7-C-TOC-0005		7-C	0-5			1 4-oz glass
22 T82-7-C-TOC-0510			5-10			1 4-oz glass
23 T82-7-C-TOC-1015			10-15			1 4-oz glass
24 T82-7-C-TOC-1520			15-20			1 4-oz glass
25 T82-8-C-TOC-0005	8/29/19	8-C	0-5			1 4-oz glass
26 T82-8-C-TOC-0510			5-10			1 4-oz glass
27 T82-8-C-TOC-1015			10-15			1 4-oz glass
28 T82-8-C-TOC-1520			15-20			1 4-oz glass
29 T82-9-C-TOC-0005	8/28/19	9-C	0-5			1 4-oz glass
30 T82-9-C-TOC-0510			5-10			1 4-oz glass
31 T82-9-C-TOC-1015			10-15			1 4-oz glass
32 T82-9-C-TOC-1520			15-20			1 4-oz glass
33 T82-10-C-TOC-0005		10-C	0-5			1 4-oz glass
34 T82-10-C-TOC-0510			5-10			1 4-oz glass
35 T82-10-C-TOC-1015			10-15			1 4-oz glass
36 T82-10-C-TOC-1520			15-20			1 4-oz glass

Table 3. TOC Core Processing Notes

Sample ID	Processing date	Station	Layer (cm)	Aggregate Present?	Sample Notes	Sample Container
37 T82-2-MM-Dup-TOC-0005	8/29/19	2-MM	0-5	N	Extra Duplicate to collect at randomly selected MM station sandy silt	1 4-oz glass
38 T82-2-MM-Dup-TOC-0510	8/29/19		5-10	N	Extra Duplicate to collect at randomly selected MM station Sandy silt, Shell hash	1 4-oz glass
39 T82-2-MM-Dup-TOC-1015	8/29/19		10-15	N	Extra Duplicate to collect at randomly selected MM station sandy silt, trace shell hash	1 4-oz glass
40 T82-2-MM-Dup-TOC-1520	|		15-20	N	Extra Duplicate to collect at randomly selected MM station Sandy silt, trace shell hash	1 4-oz glass
41 T82- -TOC-0005			0-5		Extra Duplicate to collect at randomly selected MM station	1 4-oz glass
42 T82- -TOC-0510			5-10		Extra Duplicate to collect at randomly selected MM station	1 4-oz glass
43 T82- -TOC-1015			10-15		Extra Duplicate to collect at randomly selected MM station	1 4-oz glass
44 T82- -TOC-1520			15-20		Extra Duplicate to collect at randomly selected MM station	1 4-oz glass

Items for Project Manager Review

LabNumber	Analysis	Analyte	Exception
			Data included from: W:\TransferIn\19I1009 TRANSFER 24 Oct 2019 1508.mdb

Appendix F

TOC, BC, and AC Results by Sampling Location

Table F1. Average total organic carbon (TOC), black carbon (BC) and activated carbon (ac) laterally (station #) and vertically (by sample depth) at Pier 7 from July 2019 (82-month) sampling event. Samples are from the **10 multi-metric (10-MM)** sampling locations used in this project and ESTCP #ER-201131 for earlier events.

Sample ID	Location	Sample Depth	Lloyd Kahn Method TOC (%)	Chemical Oxidation Method BC (%)	Carbon Petrography Method AC (%)	Carbon Petrography Method Soot (%)	Aggregate present?	Notes
T82-1-MM	1-MM	0 to 5	3.00%	0.30%			N	Rocks, sandy silt
		5 to 10	3.50%	0.40%			N	Rocks, sandy silt
		10 to 15	3.10%	0.80%			N	Rocks, minor shell hash, sandy silt
		15 to 20	2.60%	1.20%			Y	Rocks, shell hash, sandy silt, trace aggregate
T82-2-MM	2-MM	0 to 5	3.60%	1.10%	0.30%	0.00%	Y	Minor shell hash, sandy silt
		5 to 10	6.20%	4.60%	2.40%	0.10%	Y	Minor shell hash, sandy silt
		10 to 15	2.90%	3.40%	1.80%	0.00%	Y	Silty sand with some clay
		15 to 20	2.30%	0.20%	0.40%	0.00%	N	Shell hash, sandy silt with clay
T82-2-MM-DUP	2-MM	0 to 5	3.40%				N	Sandy silt
		5 to 10	2.20%				N	Sandy silt, shell hash
		10 to 15	2.60%				N	Sandy silt, trace shell hash
		15 to 20	4.40%				N	Sandy silt, trace shell hash
T82-3-MM	3-MM	0 to 5	0.50%	0.10%	0.10%	0.40%	Y	Shell hash, silty sand with trace aggregate
		5 to 10	1.50%	0.20%	0.30%	0.10%	N	shells hash, silty sand
		10 to 15	2.20%	0.80%	1.10%	0.10%	Y	Shell hash, silty sand with trace aggregate
		15 to 20	2.10%	0.80%	1.40%	0.00%	Y	Shell hash, rocks, with trace aggregate
T82-4-MM	4-MM	0 to 5	3.20%	1.20%	1.00%	0.10%	Y	Mostly aggregate and shell hash, sandy silt
		5 to 10	2.90%	1.60%	1.90%	0.20%	Y	Mostly aggregate and shell hash, sandy silt
		10 to 15	2.50%	0.30%	0.00%	0.10%	Y	Sandy silt with clay and shell hash, trace aggregate
		15 to 20	3.50%	0.20%	0.10%	0.10%	N	Sandy silt with clay and shell hash, trace aggregate
T82-5-MM	5-MM	0 to 5	5.30%	1.80%	2.40%	0.10%	Y	Shell hash, sandy silt with clay
		5 to 10	3.00%	1.00%	1.00%	0.00%	Y	Rocks, shell hash, sandy silt, trace aggregate
		10 to 15	1.20%	0.50%	1.20%	0.00%	Y	Rocks, shell hash, sandy silt, some clay
		15 to 20	2.20%	0.20%	0.10%	0.10%	Y	Rocks, shell hash, sandy silt
T82-6-MM	6-MM	0 to 5	4.20%	1.60%	1.30%	0.00%	Y	Sandy silt with shell hash
		5 to 10	0.70%	1.30%	1.20%	0.10%	Y	Rocks, mostly aggregate w/small amt. shell hash, sandy silt
		10 to 15	3.30%	0.80%	1.00%	0.30%	Y	Rocks, sandy silt with clay, shell hash
		15 to 20	2.00%	0.60%	0.60%	0.00%	Y	Rocks, sandy silt with clay, shell hash
T82-7-MM	7-MM	0 to 5	3.70%	0.50%	1.00%	0.00%	Y	Shells, trace aggregate, sandy silt with clay
		5 to 10	2.40%	1.00%	1.50%	0.10%	Y	Silty sand with clay, shell hash
		10 to 15	1.60%	0.20%	1.20%	0.10%	Y	Trace aggregate, silty sand and shell hash
		15 to 20	6.00%	0.10%	0.10%	0.00%	N	Rocks, silty sand, shell hash
T82-7-MM-DUP	7-MM	0 to 5		0.40%	0.30%	0.00%	Y	Sandy silt with shell hash, trace aggregate
		5 to 10		0.20%	0.00%	0.00%	Y	Silty sand with shell hash, trace aggregate
		10 to 15		0.10%	0.10%	0.00%	N	Rocks, silty sand, shell hash
		15 to 20		0.10%	0.10%	0.00%	N	Rocks, sandy silt with shell hash
T82-8-MM	8-MM	0 to 5	2.00%	0.20%			N	Shell hash, sandy silt with clay
		5 to 10	2.10%	0.10%			N	Shell hash, rocks, sandy silt
		10 to 15	2.00%	0.10%			Y	Trace aggregate, silty sand, mainly shell hash
		15 to 20	2.40%	0.20%			N	Silty sand, mainly shell hash
T82-9-MM	9-MM	0 to 5	2.70%	0.90%	1.30%	0.10%	Y	Shell hash, aggregate, small amount of silt
		5 to 10	3.50%	0.80%	0.40%	0.00%	Y	Shell hash, small amount of silt, aggregate
		10 to 15	4.40%	1.00%	0.60%	0.00%	Y	Rocks, shell hash, small amount of silt
		15 to 20	3.30%	1.20%	0.90%	0.00%	Y	Mostly shell hash with silty sand
T82-10-MM	10-MM	0 to 5	1.50%	0.10%			Y	Silty sand with shell hash, trace aggregate
		5 to 10	0.80%	0.10%			N	Silty sand with shell hash
		10 to 15	0.80%	0.20%			N	Silty sand, shell hash
		15 to 20	1.60%	0.20%			Y	Shell hash with silty sand, trace aggregate

Table F2. Average total organic carbon (TOC), black carbon (BC) and activated carbon (ac) laterally (station #) and vertically (by sample depth) at Pier 7 from July 2019 (82-month) sampling event. Samples are from the **10 additional carbon stations (1-10 C)** used in this project for enhanced spatial characterization of carbon amendment.

Sample ID	Location	Sample Depth	Lloyd Kahn Method TOC (%)	Chemical Oxidation Method BC (%)	Carbon Petrography Method AC (%)	Carbon Petrography Method Soot (%)	Aggregate present?	Notes
T82-1-C	1-C	0 to 5	0.30%	0.10%			Y	Silty sand with shell hash, trace aggregate
		5 to 10	1.20%	0.10%			Y	Gravel and shell hash, silty sand
		10 to 15	2.20%	0.10%			Y	Shell hash, silty clay
		15 to 20	2.10%	0.30%			Y	Silty clay and shell hash
T82-2-C	2-C	0 to 5	1.40%	0.30%			Y	Sandy silt
		5 to 10	1.70%	0.30%			Y	Sandy silt and shell hash
		10 to 15	1.70%	0.80%			Y	Sandy silt
		15 to 20	1.30%	1.30%			Y	Sandy silt
T82-3-C	3-C	0 to 5	1.60%	1.30%			Y	1 cm sandy silt, mainly hash, trace aggregate
		5 to 10	1.00%	0.80%			N	Sandy silt, mainly hash
		10 to 15	0.90%	0.20%			N	Sandy silt, mainly hash
		15 to 20	2.20%	0.10%			N	Small amount of sandy silt, mainly hash
T82-4-C	4-C	0 to 5	1.90%	0.20%			N	Shell hash, small amount of sandy silt
		5 to 10	1.90%	1.20%			N	Shell hash, small amount of sandy silt
		10 to 15	1.60%	0.30%			N	Shell hash, sandy silt
		15 to 20	3.60%	0.20%			N	Sandy clay, shell hash
T82-5-C	5-C	0 to 5	1.90%	3.10%			Y	Mostly aggregate, shell hash, sandy silt
		5 to 10	4.20%	4.30%			Y	Mostly aggregate, shell hash, sandy silt
		10 to 15	3.50%	2.60%			Y	Sandy silt with aggregate and shell hash
		15 to 20	7.00%	3.30%			Y	Sandy silt with clay and aggregate and shell hash
T82-6-C	6-C	0 to 5	2.10%	0.10%			N	Sandy clay layer on top of shell hash with silty sand
		5 to 10	1.80%	0.10%			N	Silty sand with shell hash, trace aggregate
		10 to 15	2.80%	0.20%			N	Sandy clay, shell hash, small amount of wood
		15 to 20	0.30%	0.20%			N	Minor shell hash, sandy silt with clay
T82-7-C	7-C	0 to 5	3.60%	0.60%			Y	Shells, shell hash, rocks, sandy silt, mostly aggregate
		5 to 10	4.10%	4.60%			Y	Shells, rocks, mostly shell hash with sandy silt
		10 to 15	3.90%	1.10%			Y	Rocks, shells, shell hash, sandy silt
		15 to 20	3.60%	0.80%			Y	Rocks, shell hash, sandy silt
T82-8-C	8-C	0 to 5	4.00%	3.10%			Y	Sandy silt, minor shell hash
		5 to 10	3.70%	2.50%			Y	Sandy silt, minor shell hash
		10 to 15	3.50%	0.30%			N	Sandy silt, shell hash, shells
		15 to 20	3.90%	3.30%			Y	Sandy silt, trace shell hash
T82-9-C	9-C	0 to 5	3.40%	2.90%			Y	Shell hash, sandy silt
		5 to 10	2.90%	2.10%			Y	Shell hash, sandy silt
		10 to 15	2.40%	2.40%			Y	Shell hash, sandy silt
		15 to 20	11.00%	0.80%			Y	Mostly shell hash, sandy silt
T82-10-C	10-C	0 to 5	6.20%	0.10%			N	Silt sand and shell hash
		5 to 10	5.20%	0.20%			N	Silt sand and shell hash
		10 to 15	2.50%	0.20%			N	Shell hash with silty sand
		15 to 20	1.90%	0.30%			Y	Shell hash with silty sand, small rock, trace aggregate
T82-3.5-C	3.5-C	0 to 5	2.40%	2.30%			Y	Mostly aggregate and shell hash, sandy silt
		5 to 10	4.20%	1.20%			Y	Mostly aggregate and shell hash, sandy silt
		10 to 15	2.70%	0.30%			Y	Sandy silt with clay, shell hash
		15 to 20	3.00%	0.30%			N	Sandy silt with clay, shell hash

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1. REPORT DATE *(DD-MM-YYYY)*
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2. REPORT TYPE
Final

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE

Long Term Monitoring of Activated Carbon Amendment to Reduce Bioavailability of Polychlorinated Biphenyls (PCBs) in Sediments at an Active Shipyard

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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TR-3319

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Long Term Monitoring of Activated Carbon Amendment to Reduce Bioavailability of Polychloride Biphenyls (PCBs) in Sediments at an Active Shipyard. Activated carbon (AC)-based amendments have been demonstrated widely in recent years as an effective, and relatively non-disruptive means of sequestering sediment associated hydrophobic organic contaminants (e.g. polychlorinated biphenyls (PCBs). In 2012, an AC amendment (AquaGate+PAC™) was placed at a ½ acre plot adjacent to and underneath Pier 7 at the Puget Sound Naval Shipyard & Intermediated Maintenance Facility (PSNS & IMF) to reduce PCB availability. Post-placement monitoring over a 3-year period showed a persistent 80-90% reduction in available PCBs, stability of the AC amendment, and no significant negative impacts to the native benthic invertebrate community. To help answer ongoing questions about the longevity of such remedies, in 2019 a follow on monitoring event was conducted at the site with the primary objectives being evaluation of 1) the long-term effectiveness of the AC-amendment to reduce bioavailable concentrations of PCBs in porewater; 2) long-term stability of the AC amendment with observations of the persistence in surface sediments; (3) long-term potential for adverse impacts to the benthic community due to the remedy. This report highlights the results of the 7-year post placement monitoring which showed sustained reduced availability and no adverse impacts to the native biological community.

15. SUBJECT TERMS

activated carbon, reactive amendment, sediment, contaminant sequestration, PCBs, passive sampling, PSNS&IMF, *Nephtys caecoides*, *Macoma nasuta*, solid-phase microextraction

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**		
U	U	U	SAR	370

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