Concentrations of Polycyclic Aromatic Hydrocarbons in New Jersey Soils

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ABSTRACT

The primary purpose of this study was to characterize the polycyclic aromatic hydrocarbon concentrations found in soils across New Jersey where the population density was 2,000 people per square mile or greater and in areas not known to be directly impacted by a discharge or historic fill. The large majority of the concentrations measured did not exceed the lowest levels of regulatory concern. Typically, surface concentrations exceeded subsurface concentrations at a given location.

Although not the primary focus of the study, assessments of railroad track beds and asphalt surfaces as sources of polycyclic aromatic hydrocarbons were secondary purposes. Naphthalene concentrations decreased with increased distance from railroad track beds. Several polycyclic aromatic hydrocarbons decreased with increasing distance from asphalt surfaces.

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ACRONYMS

ASTM	American Society of Testing and Materials
BaP	Benzo(a)pyrene
BEERA	Bureau of Environmental Evaluation and Risk Assessment
BEMSA	Bureau of Environmental Measurement and Site Assessment
BGWPA	Bureau of Ground Water Pollution Abatement
BIS	Bureau of Information Systems
CLP	Contract Laboratory Program
DSR	Division of Science and Research, formerly the Division of Science, Research, and Environmental Health or DSREH
FSPM	Field Sampling Procedures Manual
GIS	Geographic Information Systems
GPS	Global Positioning System
HASP	Health and Safety Plan
HSSE	Hazardous Site Science Element
ICP	Inductively Coupled Plasma
N.J.A.C.	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection or Department
N.J.S.A.	New Jersey Statutes Annotated
ODQ	Office of Data Quality
OOSH	Office of Occupational Safety and Health
PAH	Polycyclic Aromatic Hydrocarbons
QAPP	Quality Assurance Project Plan
SD	Standard Deviation
SE	Standard Error
SRWMP	Site Remediation and Waste Management Program
TCL/TAL	Target Compound List/Target Analyte List
TOC	Total Organic Carbon
TRSR	Technical Requirements for Site Remediation or Technical Rules
USEPA	United States Environmental Protection Agency

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I. INTRODUCTION

A. Purpose

Many parties have expressed their opinions about the background concentrations of polycyclic aromatic hydrocarbons (PAH) in the State of New Jersey. These estimates of PAH magnitude in soils varied widely, but generally exceeded the most stringent remediation standards set by Remediation Standards (N.J.A.C. 7:26D). One PAH, benzo(a)pyrene (BaP) proved to be especially problematic for the regulated community because of its low remediation standard, currently 0.5 milligrams BaP per kilogram of dry weight soil (mg/kg) via the ingestion-dermal exposure pathway for a residential exposure, and its frequent observation in remedial investigations. The consequence of these allegations, made primarily by the regulated community, implied that there was no need to remediate certain PAHs because the observed concentrations were actually background and did not require remediation under the Technical Requirements for Site Remediation (N.J.A.C. 7:26E) (TRSR). Separate claims were also made that "clean" material, as defined by the TRSR, needed for remediation could not be found because of the "ubiquitous" presence of PAHs like BaP.

Much of this communication occurred during the amendment effort of the Remediation Standards. Because of this the New Jersey Department of Environmental Protection (Department) and in particular the Site Remediation and Waste Management Program (SRWMP) made a commitment to study and measure PAH concentrations throughout the state, with the purpose of examining the PAH distribution in New Jersey and potentially establishing a PAH background value.

These concerns are not unique to New Jersey. Other states and entities have undertaken efforts to investigate these topics to try to establish a scientifically based path forward. These states include Delaware, Illinois, Wisconsin, Florida, Massachusetts, and New Jersey. However, even ignoring variability between differing physical conditions and the regulatory climates in the various states, the approaches varied largely because of differences on how background was defined. In part, this is also why the discussions between the Department and the regulated community regarding New Jersey background are so challenging. Some issues include: 1) Was an appropriate background level established by strictly natural processes or conditions in the absence of anthropogenic influences; 2) Should background be established reflecting some level of anthropogenic activity; and 3) Were historic fill, atmospheric deposition, and even specific discharges to be considered as acceptable components of background? Furthermore, comparison of the various other studies was also complicated by the use of different sampling strategies and statistical methodologies. This challenge continues to exist in trying to integrate the results of the other work with the current study. The net result is that for this effort, the output from other

similar efforts will only be used to provide context rather than attempt to directly incorporate any specific data into the numerical evaluation conducted in this document.

PAHs are defined as a group of semi-volatile organic compounds characterized by multiple aromatic rings. They are nonpolar and lipophilic, and naturally occur in coal, crude oil, and gasoline. PAHs are also produced as a result of combustion. The PAHs studied here include:

1. Acenaphthene
2. Acenaphthylene
3. Anthracene
4. Benzo(a)anthracene
5. Benzo(a)pyrene
6. Benzo(b)fluoranthene
7. Benzo(g,h,i)perylene
8. Benzo(k)fluoranthene
9. Chrysene
10. Dibenz(a,h)anthracene
11. Fluoranthene
12. Fluorene
13. Indeno(1,2,3-cd)pyrene
14. Napthalene
15. Phenanthrene
16. Pyrene

The primary purpose of this study was to measure PAH concentrations across the state with particular emphasis on areas that are potentially impacted, but not specifically by a known discharge or historic fill. Establishment of a background value of some type was also to be considered if the data warranted doing so. The secondary purpose of this study was to further investigate, on a preliminary basis, potential sources or influences on the observed PAH concentrations.

B. **Conceptual Design**

Previous studies (Sanders 1997, 1998, 2002) had already established that in rural areas of New Jersey PAH concentrations in soils were below the existing remediation standards or criteria established at that time for the PAHs in question. Urban areas were also studied, but to a lesser degree. Allegations were made that the previous studies were biased towards clean areas. Consequently, this study chose to focus on the more urban areas of the state and do so in a manner that included a broader area than was done in other studies. Nevertheless, funding limitations still necessitated focusing the scope of the investigation in order to obtain sufficient data to draw conclusions.

More specifically, the purpose of the first year of this study was to collect PAH concentration data from selected sites throughout the state with the intent of creating a database. This was identified as Phase I. Excluded would be areas known to be affected by single point type discharges or by historic fill. Municipalities with population densities above 2,000 people per square mile were selected for sampling. Doing so allowed for all 21 counties in New Jersey to be evaluated to varying degrees. Note that for the purposes of this document, areas meeting

these criteria will be designated as "developed areas". Metals data (aluminum and iron) were also collected to determine if they were an effective indicator of single point discharges and consequently would allow differentiation of contamination from background situations. Other environmental factors associated with the selected locations were also recorded to determine if contaminant concentration varied as a function of these factors.

One purpose of the second year efforts was in part to fill data gaps from the first year as well as provide a means to refine the preliminary observations derived from an ongoing evaluation of the database established in the first year. However, the main goal was to examine specific sources of PAHs such as railroad track beds and asphalt surfaces and to investigate, in a limited fashion, if factors such as distance impacted the observed distribution. This work was termed Phase II.

II. METHODOLOGY

Within SRWMP, overall direction of the project was the responsibility of the Hazardous Site Science Element (HSSE). Sampling location selection was accomplished by Bureau of Environmental Evaluation and Risk Assessment (BEERA) personnel. Soil sample collection was accomplished by personnel from the Bureau of Environmental Monitoring and Sampling Assistance (BEMSA) in accordance with the Field Sampling and Procedures Manual (FSPM) (NJDEP 2005, 2011). Analysis of the collected samples was primarily done through the Analytical Laboratory Services Contract that the Office of Data Quality (ODQ) oversees and BEMSA utilizes. Consequently, these analyses were done by a New Jersey certified laboratory following USEPA Contract Laboratory Program (CLP) methods. The Quality Assurance Project Plan was prepared by BEERA (Appendix 1). The Health and Safety Plan was prepared by the Office of Occupational Safety and Health (OOSH; Appendix 2). The collected information was stored in an ACCESS database that was specifically designed for this purpose by the Bureau of Information Systems (BIS). Ongoing monitoring and evaluation of the results was the responsibility of HSSE; however, BIS provided major input in this area too. Division of Science and Research (DSR) personnel participated as needed. This was particularly relevant in the area of statistical analysis as DSR performed the bulk of the data interpretation in the report. Report writing was assigned to BEERA with as needed support provided by the other participants.

A. Site Selection

Site Selection for Phase I:

Instructions were provided and included the following directions:

The priority was to evaluate developed areas of New Jersey, but to do so in a manner that included the entire state. All 21 counties were to be sampled. To do this, all municipalities with

population densities above 2,000 people per square mile were identified in a given county. Optimally, 10 municipalities per county would be identified as candidates for sampling. Sampling was to be conducted over the entire range of population densities observed and locations preferentially selected. Population density was based on available 2010 census information. Actual population distributions within the counties constrained the number of samples taken. If there were less than 10 candidate municipalities in a given county, then additional locations within the already sampled municipalities in that county could be selected to supplement the sampling. In addition, one location per county would have two additional samples collected to produce a triplicate replicate with 25 foot horizontal spacing. Selection of the specific replicate location in each county was left to BEMSA to make in the field. Aerial photography as well as Geographic Information System (GIS), Google Earth, and GeoWeb tools were employed to find and select the sampling locations. Locations impacted by the following were avoided in Phase I:

1. Active playgrounds
2. Infields and demarcated ballfields
3. Sports fields with indicated boundaries
4. Parking lots and other asphalt surfaces
5. Mapped historic fill
6. Construction areas
7. Disposal areas or areas with debris
8. Cemeteries
9. Locations immediately adjacent to known contaminated sites

This meant that sampling locations would likely be “parks”, “public areas”, or “open spaces” within municipalities. This had the advantage of facilitating access. Location information such as the following was also noted for each location for evaluation purposes. The last four items on the list were included to determine if there was any relationship between PAH concentration and these factors. The location information recorded included:

1. Unique sample identification code
2. County
3. Municipality
4. State plane coordinates
5. Population density
6. Distance to known contaminated site
7. Soil type (to include disturbed soil types)
8. Forested or Open cover type

The summary of the number of municipal locations selected for sampling within a county follows:

Atlantic	5	Middlesex	9
Bergen	8	Monmouth	10
Burlington	10	Morris	10
Camden	10	Ocean	10
Cape May	2	Passaic	10
Cumberland	1	Salem	2
Essex	10	Somerset	6
Gloucester	8	Sussex	3
Hudson	10	Union	10
Hunterdon	2	Warren	3
Mercer	6		
		Total	**145**

A map of the selected municipalities is included as Figure 1.

The total number of samples collected including both surface and sub-surface intervals at 190 locations (including replicates) for Phase I was:

1. 380 semi-volatile organic compounds
2. 380 metals (analyzed for both aluminum and iron)
3. 100 particle size (surface only)
4. 100 total organic carbon (surface only)

It should be noted that part of the Phase I plan was to evaluate if there was a relationship between PAH concentrations and soil type. However, preliminary analysis indicated establishing a relationship between PAH concentration and soil type would be problematic because the statistical models could not incorporate the numerous soil type categories. Thus, the sampling suite was modified to include total organic carbon analyses and particle size analyses as substitutes for soil type. Because of time and funding constraints, 100 surface locations from the previously sampled Phase I locations (190) were selected to provide representative coverage for the entire state. This was done by BGWPA. The actual sampling was conducted during Phase II.

Site Selection for Phase II:

Aerial photography as well as GIS, Google Earth, and GeoWeb tools were used to find five railroad track beds (also called railroad sites) and five asphalt surface sites to investigate. The

search for these sites was facilitated by the previous work done in the Phase I site selection effort. The railroad sites were required to be used by diesel or historically used by coal fired locomotives. The asphalt surface sites could either be roadways used by significant traffic levels or active parking lots. Additional selection criteria for both railroad and asphalt surface sites included the ability to allow an approximately 400 foot transect in a direction that was downgradient or across a relatively level topography.

For the railroad sites, a total of five locations were selected including two in Burlington County near BURL03 (RR03) and BURL10 (RR10); one in Gloucester County near GLOU08T (RR08); one in Ocean County near OCEA07 (RR07); and one in Union County near UNIO21 (RR21). Transects were established with the initial transect point approximately 25 feet from the railroad track bed with subsequent transect points taken generally at 100-foot intervals. Single surface samples (0–6") were collected in all cases. Representations of these transects are in Figure 2.

For the asphalt surface sites, a total of five locations were selected (AS01, AS02, AS03, AS04, and AS05). These were located along Route 295, Route 206, Route 1, the parking lot/access road at Batsto Village, and Route 78, respectively.

Transects consisting of 5 points were used to investigate each of the different locations. At each point of the transect, 3 soil samples were collected. The 3 soil samples were approximately 25 feet apart horizontally at any given transect point. Surface (0-6") depths only were evaluated. All transects started 2 to 5 feet from the asphalt surface, except for the Route 78 transect which started 30 feet from the road due to the steep local topography. Subsequent transect points were 50, 100, 200, and 300 feet from the initial point along the direction of the transect. Representations of these transects are in Figure 3.

One additional sampling for PAHs was collected at the asphalt surface sites. Asphalt source material was obtained from the area near the first transect point and subjected to PAH analysis to provide insight into the starting concentrations. These samples were designated AS01-00, AS02-00, AS03-00, AS04-00, and AS05-00.

B. Sampling and Analysis

As stated previously, soil sample collection was accomplished by personnel from BEMSA in accordance with the FSPM and analyzed using laboratory services contracts. PAH, total organic carbon (TOC), aluminum, and iron analyses were performed by a New Jersey certified laboratory following USEPA Contract Laboratory Program (CLP) methods. Aspects of the analysis were also done using the Field Sampling Contract for particle size analysis using ASTM D422. For this document, the term "particle size" should be considered synonymous with percent of silt, clay, and colloids.

Specific sample locations were adjusted in the field to avoid confounding features such as trails, pathways, or signs of disturbance. Locations were documented photographically as well as by Global Positioning System (GPS) coordinates.

In Phase I, soils at surface (0-6") and subsurface (12–18") depths were evaluated at each location. In addition, each county was evaluated for horizontal variability at one location (replicate testing using a triplicate approach described previously).

Discrete 6-inch samples were collected to be consistent with N.J.A.C. 7:26E and the FSPM. Samples were collected from April 13, 2016 through December 13, 2016. Phase 1 particle size samples and total organic carbon samples were collected April 24, 2018 through May 14, 2018 at selected Phase I locations and only at the surface.

Phase II sampling targeted two categories of sites, railroad sites and asphalt surface sites and was performed by BEMSA. There were five locations selected for the railroad site category. Sampling transects were established perpendicular to the railroad track bed and extended ideally 400 feet from the selected start point. Sampling was targeted at 100-foot intervals. Only surface samples (discrete 0 - 6 inch) were collected. Analytical parameters were the PAH compounds, particle size, and total organic carbon.

Sampling at the five asphalt surface sites was performed by BEMSA in the same manner as the railroad sites. The transect extended ideally 300 feet from the selected start point. Again, only surface samples (0-6") were collected and analyzed for PAH compounds, particle size, and total organic carbon. One difference for the asphalt surface sites was that at each distance interval, triplicate samples were collected instead of the single samples collected at the railroad sites. A horizontal 25 foot spacing between samples was employed for the triplicate samples. Source asphalt samples from near the transect origin were also subsequently sampled and analyzed.

Analytical methods used for Phase I and Phase II:

1. Semivolatile organic compounds - USEPA Method 8270C or CLP equivalent
2. Metals – ISMO 2.4, EPA Method 200.8, or equivalent
3. Particle size - ASTM Method D422-63 or equivalent
4. Total organic carbon - SW-846 Method 9060A or equivalent

C. Data Evaluation for Phase I and Phase II

The PAH data results were subject to standard data validation review by ODQ.

The outputs from the laboratories were organized by placing them in an ACCESS database. Excel spreadsheets were then generated to support the various evaluation activities, as well as final report data summary plots. The data pertinent to this report are found in Appendix 3 (Phase I: PAH data), Appendix 4 (Phase II: PAH Data); Appendix 5 (Phase I: Particle Size and Total Organic Carbon), Appendix 6 (Phase II: Particle Size and Total Organic Carbon), and Appendix 7 (2010 Census Population Density).

Phase I Statistical Analysis:

The main evaluation of the Phase I data was statistical in nature and was based on analyses of 380 samples. Summary statistics, including mean, Standard Deviation (SD), Standard Error (SE), and percentiles, were calculated for each of the sixteen PAHs using the Kaplan-Meier method to allow inclusion of the left-censored values (i.e., values below detection). Although parametric summary statistics were calculated (mean, SD, and SE), the data distributions were non-normally distributed because of the overabundance of small measurements. Instead of a normal distribution, the PAH concentrations followed a left-censored, skewed distribution. Therefore, nonparametric summary statistics (i.e., percentiles such as medians) were more valid to describe the data than parametric measures. Furthermore, the summary statistics for each PAH were calculated separately for surface and subsurface samples (190 samples each).

To determine whether the concentrations of contaminants in background soil varied as a function of various parameters (distance to contaminated site, population density, forest/open, TOC, and percent of silt, clay, and colloids), a multiple regression model was fit using a maximum likelihood estimation (MLE) approach. Because TOC and particle size (percent of silt, clay, and colloids) were sampled only at 100 surface locations for Phase I, the evaluation was restricted to the 100 relevant samples (not 380) to assess any relationship between PAHs, TOC, and particle size. The same left-censored regression approach was utilized to determine whether the concentrations of two metals, iron (Fe) and aluminum (Al), varied as a function of the same parameters.

Phase II Statistical Analysis:

For Phase II, the potential relationships between PAH concentrations and distance to potential sources (railroad track bed or asphalt surface) were statistically assessed. For this analysis, the correlation coefficient, Kendall's tau, was computed. Kendall's tau is a nonparametric statistic used to measure the ordinal association between two measured quantities (e.g., PAH and distance to source). It can be thought of as a nonparametric analog of the correlation coefficient. The value of Kendall's tau can range from -1 to 1, and the relationship between variables is stronger when tau is closer to -1 or 1 than it is when tau is closer to zero. When tau is negative, it suggests a negative relationship between the two variables and vice versa when positive. To

perform the Kendall's tau approach on the asphalt triplicate samples, the triplicate measurements were averaged prior to running the analysis. After Kendall's tau was estimated, the Akritas-Theil-Sen nonparametric line was plotted to robustly fit a line through the data points based on median slope.

The decision to average the replicate samples was made because of the limited number of samples available. Also note that this decision was the basis for discontinuing any evaluation of sample variation which was the original reason for collecting replicate samples in both Phase I and Phase II.

In addition, multiple regression models were performed to determine whether contaminant concentration varied as a function of distance to potential source (railroad track bed or asphalt surface), TOC, and/or particle size (percent of silt, clay, and colloids). These multiple regressions were performed using the same approach as conducted in Phase I.

All statistical analyses were performed in program R (3.4.3) (R Core Team, 2017) and the statistical models were fit using the NADA package (Lee 2017) which allowed for the inclusion of the left-censored data (U-qualified values). Statistical significance was assumed when $p \leq 0.05$.

III. RESULTS AND DISCUSSION

A. Phase I: Establishing Background PAH Levels

Because the sample results were only from developed areas, calculating a statewide background PAH value would be challenging. Combining this study with previous New Jersey PAH studies was considered. This would increase the size of the database for the developed areas and potentially allow incorporation of data from non-developed areas. However, Paul Sanders (BEERA), who was lead in these studies, raised the concern about the compatibility of the different data sets and this idea was rejected.

A background value for just developed areas was then considered. However, statistical analysis of the PAH data from this study using the Wilcoxon test at a p-value of < 0.05 indicated PAH concentrations varied significantly by county (see Figure 4). In general, higher levels of PAHs were found in Bergen, Hudson, Mercer, and Somerset counties than in other counties in the State. This meant that even for the developed areas with population densities greater than 2,000 people per square mile, calculating a single, "typical" background value would be problematic. The counties were too variable to be represented appropriately by a single background value.

Consequently, any attempts to develop background values reflecting a state-wide or other more restricted range was deemed not appropriate.

B. Phase I: General PAH Levels

The PAH concentrations observed are found in Appendix 3. Generally, they were of lower magnitude than anticipated considering sampling was conducted in developed areas with many having long term high population densities. Many of the observed concentrations were below all levels of regulatory concern. For reference purposes the relevant remediation standards or criteria are listed in Table 1. The soil water partitioning impact to ground water criteria are listed in Table 1 because of the current regulatory environment. However, this is probably a non-issue for the PAHs if the mobility of the PAHs are considered (NJDEP 2008; https://www.nj.gov/dep/srp/guidance/rs/immobile_chemicals.pdf), or alternatively, if the samples in question were subjected to a synthetic precipitation leaching procedure evaluation.

Table 2 presents the Phase I data on a contaminant basis and allows comparison to the levels of regulatory concern listed above. It is derived from a total of 380 surface and subsurface samples combined.

Most of the PAHs concentrations observed were below all levels of regulatory concern. Only in the case of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were any exceedances observed. These exceedances were restricted at most to the upper 10% of the respective observed populations. Stated another way, 90% of all the concentrations observed for even these five PAHs did not exceed any level of regulatory concern.

Overall, the medians of the individual PAHs ranged from 0.007 to 0.078 mg/kg. None of the mean PAH concentrations exceeded the residential direct contact soil remediation standards which for PAHs is the most relevant level of regulatory concern. Similarly, none of the 50th percentile (medians) or the 75th percentiles of the PAHs observed exceeded their respective residential direct contact soil remediation standards as well as their more restrictive impact to groundwater soil water partitioning criteria.

The most recent study (external to New Jersey) comparable to this one was EA Engineering, Science, and Technology Inc. (2016). That study evaluated multiple Rural/Suburban and Urban Areas in each of Delaware's three counties where the sites had "no history of industrial use, development, or suspected contamination". Like the current study, low PAH concentrations were observed. This is illustrated by the following. Of the 258 benzo(a)pyrene samples, there were 83 detections with a maximum observed concentration of 0.210 mg/kg. The computed background threshold value for benzo(a)pyrene for this study was 0.242 mg/kg.

C. Phase I: Surface Versus Subsurface Concentration Patterns

Table 3 presents the Phase I data in a manner that allows analysis of the surface versus subsurface centration patterns. When comparing medians for surface and subsurface samples (Table 3), the PAH concentration was generally higher in the surface samples than in the subsurface samples. The only exception was that the naphthalene subsurface samples (0.009 mg/kg) had a higher median than the corresponding surface samples (0.007 mg/kg).

When paired surface PAH concentrations and subsurface PAH concentrations were drawn for Total PAHs, benzo(a)pyrene, and dibenzo(a,h)anthracene from the raw data from Appendix 3, comparison of the surface and subsurface pairs yielded the following results:

Comparison of selected PAH surface and subsurface values:

	Total PAH		Benzo(a)pyrene		Dibenzo(a,h) anthracene	
	Count	Percent	Count	Percent	Count	Percent
Surface > subsurface*	144	75.8%	137	72.1%	72	37.9%
Surface = subsurface*	35	18.4%	42	22.1%	109	57.4%
Subsurface > surface*	11	5.8%	11	5.8%	9	4.7%
Total:	190	100%	190	100%	190	100%

* Note that "surface>subsurface" and "subsurface>surface" indicate an exceedance of more than double the concentration. "Surface = subsurface" is more an indication of similarity.

Benzo(a)pyrene is typically a major contaminant of concern where PAHs are involved in a remediation. Surface benzo(a)pyrene concentrations greatly exceeded their subsurface counterparts 72.1% of the time. Surface concentrations were exceeded or were "equal" to subsurface concentrations in 94.2% of the observed comparisons. A similar conclusion was reached when total PAH concentrations were evaluated. In the case of dibenzo(a,h)anthracene, because there the most observations were of "equal" concentration, the argument is weaker. However, the fact remains that only for 4.7% of the observed pairs did subsurface concentration greatly exceed the surface concentration.

D. Phase I: PAH Trends Relative to Other Factors

For Phase I, the following trends were statistically significant for most PAHs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene (Table 4). For these PAHs, the contaminant concentrations were higher in areas with high population density (p-values < 0.03) and higher percentages of silt, clay, and colloids (particle size) (p-values < 0.043). For

anthracene and benzo(k)fluoranthene, the concentration was higher when population density was high ($p = 0.03$). Direct associations between PAH concentrations and higher population density is to be expected as it reflects the greater potential for anthropogenic activity. Association with particle size and PAH concentration is also expected because PAHs are known to adsorb to particles (Hussain, 2019) and the greater surface area of smaller particles provides a higher probability of attachment. For naphthalene, the contaminant concentration was higher when total organic carbon was high ($p = 0.04$). It would not be unexpected for naphthalene to be found absorbed to total organic carbon. No other predictor variables were found to be statistically significant. In regard to metals, the concentration of Al and Fe increased as the percent of silt, clay, and colloids increased (p-values < 0.0001; Table 4) (Figure 5). There were no other significant trends in aluminum or iron concentrations based on population density, forest/open areas, distance to contaminated site, or total organic carbon.

These findings were derived from an evaluation of a data set of 100 surface samples. While there were other evaluations done to establish preliminary findings, this particular data set was selected for presentation in this document because it included particle size and total organic carbon data. As a surface focused evaluation, it was also more pertinent because the other factors being related to the PAH concentrations were generally surface oriented. The greater magnitude of the PAH concentrations typically observed at the surface would also more easily reflect the potential impacts by the factors being evaluated versus a dataset with both surface and subsurface information.

E. Phase II: PAH Trends for Railroad Sites

In regard to Phase II railroad sites, the naphthalene concentration decreased as distance from railroad track bed increased ($p < 0.001$; Table 5). See Appendix 4 for raw data. However, this relationship between contaminant concentration and distance to railroad track bed did not exist for any other PAH. Furthermore, the multiple regressions suggested that some PAH concentrations (acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene) were significantly higher when percent of silt, clay, and colloids was high (p-values < 0.002; Table 6). The multiple regression confirmed that naphthalene concentration decreased as distance to railroad track bed increased ($p = 0.002$), but it also suggested that naphthalene concentration was greater when total organic carbon was higher ($p = 0.031$). The explanation offered previously for PAH association with particle size and total organic carbon again apply here.

F. Phase II: PAH Trends for Asphalt Surface Sites

For Phase II asphalt surface sites, when asphalt was considered as the potential source, contaminant concentration decreased significantly as distance to the asphalt surface increased for the following PAHs (p-values < 0.05): benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene (Table 7). See Appendix 4 for raw data. Observation of a decreasing concentration gradient with increasing distance from the source would not be unexpected. Transport due to erosion or wind would likely result in a reduction of the original source concentration proportional to the inverse of the distance, along the lines of the inverse square law. There was no significant relationship between the other PAH concentrations and the distance to the asphalt surface. When multiple regressions were performed, some PAH models could not be run because of too many censored values. No significant relationships were found between PAHs and total organic carbon or percent of silt, clay, and colloids (particle size) in the multiple regressions.

G. Phase II: PAH Concentrations in Source Material

Because of the low levels observed, sampling of the source material for the asphalt surfaces tested was done. The results obtained are in Table 8.

While the sampling was extremely limited, these PAH concentrations are much lower than expected. This may offer a partial explanation for the magnitude of the PAH concentrations observed in the transect samples. Certainly, the pure asphalt sample material obtained in all five cases was aged, but it is unclear if that is the reason for the low PAH concentrations observed. However, the low PAH concentrations found in the source material could also be characterized as being less than the concentrations observed in the transect samples. No explanation is offered as to why the results for the source material were obtained. However, because of the small dataset size and lack of replication, drawing firm conclusions or extrapolating this data without additional investigation would not be recommended.

Other studies have investigated highways as a source of PAH contamination. Blumer et al. (1977) found in Switzerland high PAH concentrations (110 to 300 mg/kg) were associated with highways and the origin attributed to car exhaust. While possible PAH contribution from tire wear was discussed, asphalt as a potential PAH source was not mentioned. Bradley et al. (1994) in a New England study also found elevated total PAH concentrations associated with highways, a mean of 22 mg/kg near the pavement versus a mean of 8 mg/kg not near the pavement. Vehicle exhaust was again identified as the most likely PAH source. But, the presence of asphalt and of vehicular oil runoff were cited as potential influences. Durand et al. 2004 in a French study went further and attributed the origin of PAHs in road associated depositional areas to be

from diesel fuel and motor oil. Finally, Mahler et al. (2005) made a case that coal tar emulsion with mean PAH concentrations of 3,500 mg/kg was the source of PAHs found in parking lot runoff. Mahler et al. (2016) also wrote that coal tar-based sealcoat used east of the Continental Divide typically contains 50,000 to 100, 000 mg/kg PAHs.

Clearly, assuming the PAHs originate from the asphalt itself is overly simplistic. There may be other more important sources for a given asphalt surface as indicated by the cited studies. This would offer an explanation how the PAH concentrations observed in the asphalt surface source material yielded observable downgradient PAH concentration trends. Note also that this effort had a presumed focus on overland movement or erosion. The airborne movement of PAHs is a very important contribution route and would require further emphasis if a serious study is to be done. In any event, the extremely small size of the database also is an important factor that must be kept in mind when assigning validity to any observations. The Phase II sampling was never intended to provide definitive answers, but rather open lines of possible future investigation.

H. Site Specific Background Determinations

Background studies are done only to determine if remedial measures can be avoided under the constraints of the TRSR. Because this study found existing PAH concentrations generally to be below levels of regulatory concern even in developed areas not subject to discharge, the need to establish a site-specific background to preclude remediation would not typically be anticipated. Currently, site-specific background values are calculated using TRSR (N.J.A.C. 7:26E-3.8) and the recommendations of the Technical Guidance for Site Investigation of Soil, Remediation and Investigation of Soil, and Remedial Action Verification Sampling for Soil (NJDEP 2015). This approach would allow for selecting the highest value of the appropriate data set. The current study indicates the use of a median may be more suitable in the development of a site-specific background value.

IV. CONCLUSIONS

1. The selection of sampling locations in populated areas ranging from 2,000 people per square mile and greater provides an assessment of developed areas throughout New Jersey. The decision to exclude known discharges and historic fill does not mean the sampling was restricted to only pristine or undisturbed areas. The PAH concentrations sampled would include those originating from general atmospheric deposition and runoff. Consequently, these PAH concentrations would reflect non-specific anthropogenic impacts that have occurred over time particularly in the older and more industrialized areas.

2. The measurement of PAH concentrations in developed areas throughout the 21 counties in New Jersey resulted in lower than expected levels. Consequently, the concern about remediation being required below background levels is not supported by this study. This is particularly true since the September 17, 2017 update to the remediation standards increased the PAH residential and non-residential soil remediation standards.

3. Similarly, the concern that clean fill does not exist in New Jersey is not supported by this study. This is particularly true considering that PAH concentrations in rural areas of New Jersey, like those in the developed areas in this study, exhibit PAH concentrations as low as or lower than the PAH residential and non-residential soil remediation standards.

4. PAH concentrations varied significantly by county, with the highest levels of PAHs found in Bergen, Hudson, Mercer, and Somerset counties. The establishment of a single background concentration for developed areas of New Jersey is not feasible.

5. A trend was observed that PAH concentrations were generally higher in surface samples than in subsurface samples.

6. Another trend observed was that concentrations of many PAHs were greater in high population density areas and also in areas with higher percent of silt, clay, and colloids in the soil.

7. Aluminum concentrations did not vary significantly with PAH concentrations; however, iron concentrations increased with eight PAH concentrations.

8. PAH concentrations did not correlate significantly with forested or open cover type. PAH concentrations also did not correlate significantly with distance to known contaminated sites.

9. The following Phase II observations were made to generate further study and are not to be considered definitive conclusions. This is due in part to the limited amount of data collected as well as the complexity of the potential issues involved.

   For railroad sites, PAH concentrations were not significantly related to distance to the railroad track bed with the exception of naphthalene concentrations which decreased as distance to the railroad track bed increased.

   For asphalt surface sites, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-

cd)pyrene, phenanthrene, and pyrene concentrations decreased as distance to the asphalt surface site increased.

For asphalt surface sites, no relationships were found between PAH concentrations, TOC, or percent of silt, clay, and colloids.

V. FIGURES

Figure 1. Map of municipalities sampled.

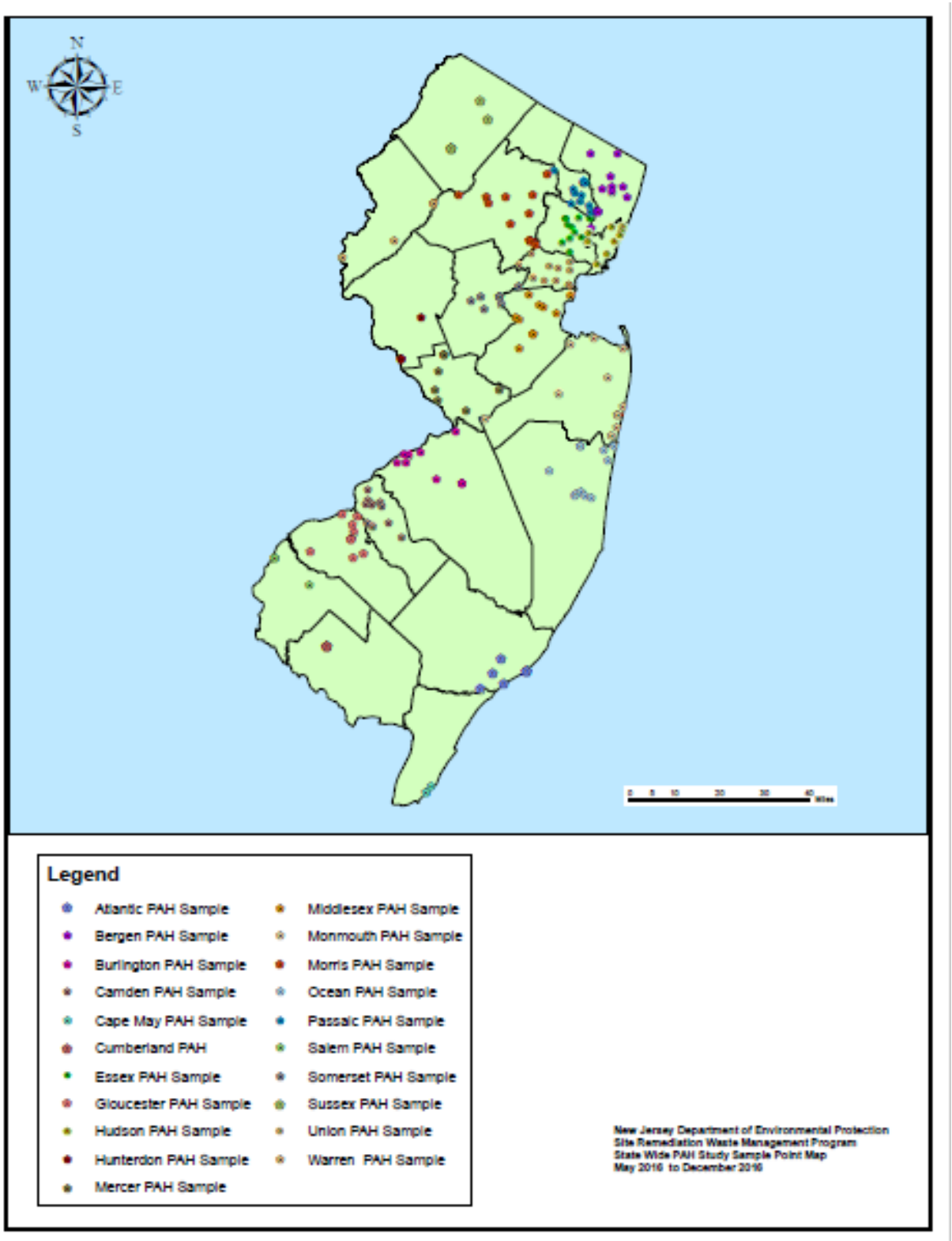
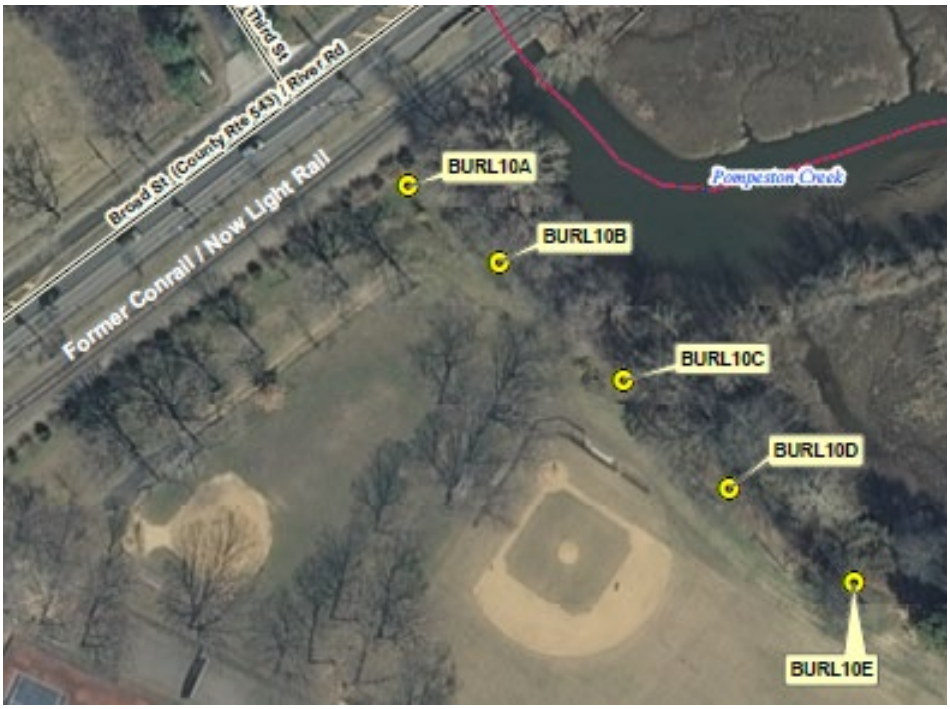


Figure 2. Railroad Site transects:




E Mantua Ave (County Rte 632) / Mantua Ave
S East Ave / East Ave
Prsl Railroad
GLOU08T1
GLOU08T2
GLOU08T3
GLOU08T4
GLOU08T5


Cincinnati Ave (State Hwy 38)
Conrail
OCEA07A
OCEA07B
OCEA07C
OCEA07D
OCEA07E
Forman Ave

Actual sample distances from the railroad track bed were as follows:

RR03 A 25 feet B 100 feet C 208 feet D 304 feet E 404 feet;

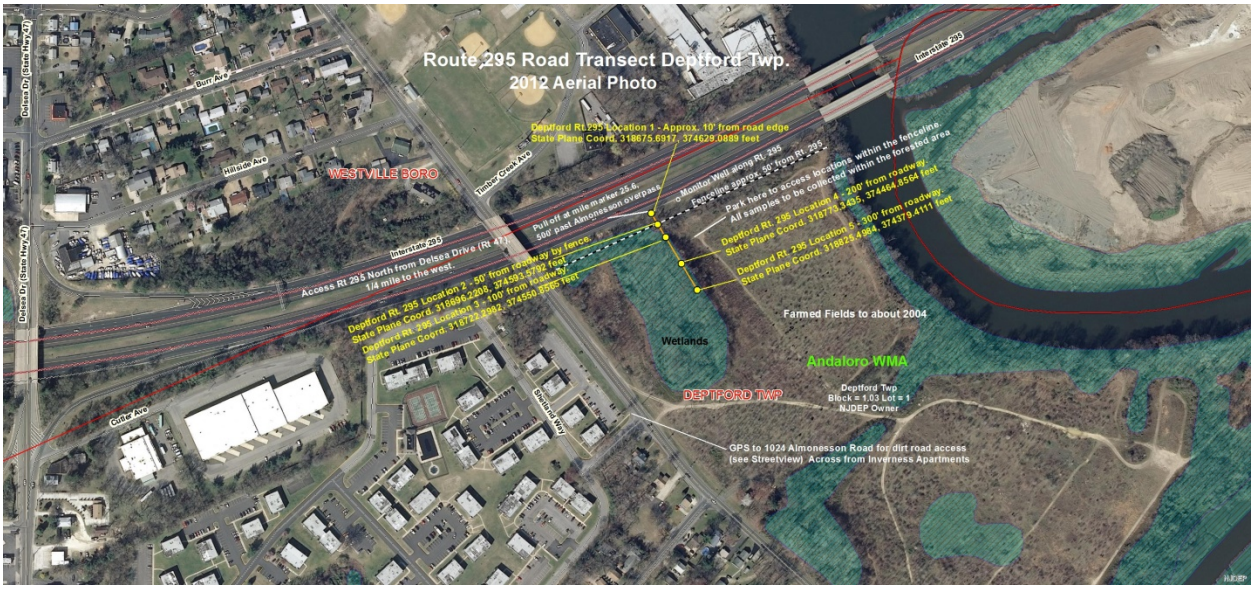
RR10 A 40 feet B 100 feet C 193 feet D 307 feet E 403 feet;

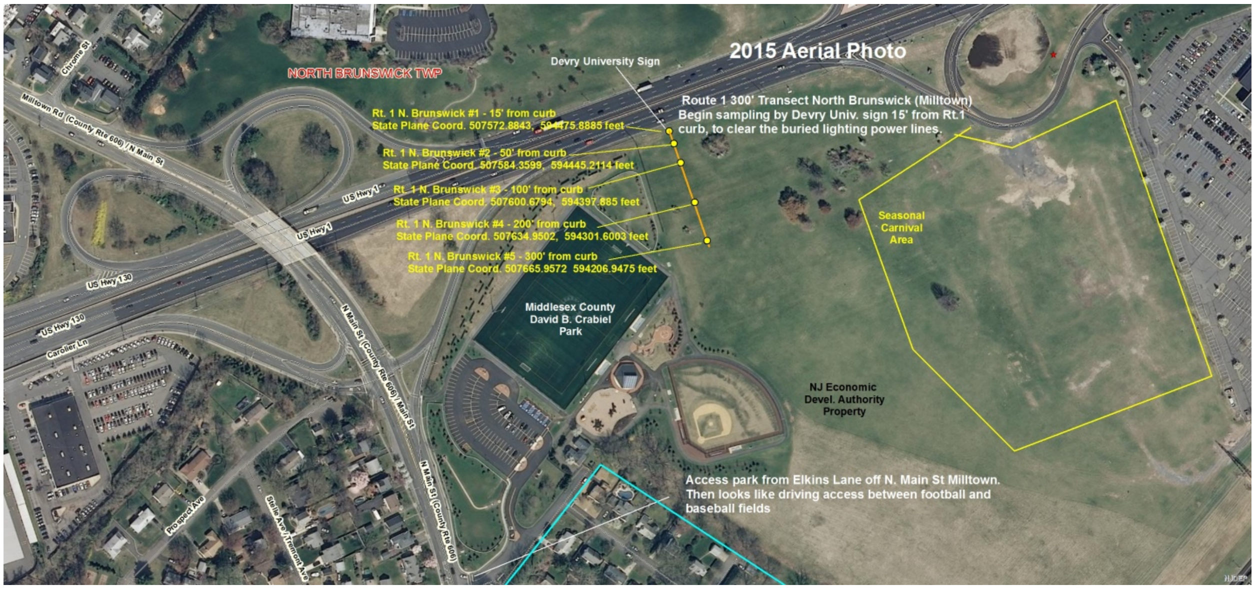
RR08 A 21 feet B 106 feet C 208 feet D 296 feet E 400 feet;

RR07 A 25 feet B 92 feet C 195 feet; D 292 feet E 396 feet; and

RR21 A 27 feet B 113 feet C 216 feet D 315 feet E 456 feet.

Figure 3. Asphalt Surface Site transects




2015 Aerial Photo
NORTH BRUNSWICK TWP
Devry University Sign
Route 1 300' Transect North Brunswick (Milltown)
Begin sampling by Devry Univ. sign 15' from Rt.1 curb, to clear the buried lighting power lines.
Rt. 1 N. Brunswick #1 - 15' from curb
State Plane Coord. 507572.8843, 594475.8885 feet
Rt. 1 N. Brunswick #2 - 50' from curb
State Plane Coord. 507584.3599, 594445.2114 feet
Rt. 1 N. Brunswick #3 - 100' from curb
State Plane Coord. 507600.6794, 594397.885 feet
Rt. 1 N. Brunswick #4 - 200' from curb
State Plane Coord. 507634.9502, 594301.6003 feet
Rt. 1 N. Brunswick #5 - 300' from curb
State Plane Coord. 507665.9572 594206.9475 feet
Seasonal Carnival Area
Middlesex County David B. Crabiel Park
NJ Economic Devel. Authority Property
Access park from Elkins Lane off N. Main St Milltown.
Then looks like driving access between football and baseball fields
US Hwy 1
US Hwy 130
Milltown Rd (County Rte 606) / N Main St
N Main St (County Rte 606)
Cardiar Ln
Prospect Ave


2015 Aerial Photo
Batsto Village
Batsto Village/ Wharton State Forest Parking Lot
Batsto Village Location 1 at edge of road by parking lot
State Plane Coord. - 450878.1861, 295528.6166 feet
Batsto Village Location 2 - 50' from edge of road
State Plane Coord. - 450927.8823, 295527.8766 feet
Batsto Village Location 3 - 100' from edge of road
State Plane Coord. - 450977.8348, 295525.486 feet
Batsto Village Location 4 - 200' from edge of road
State Plane Coord. - 451078.3046, 295523.1166 feet
Batsto Village Location 5 - 300' from edge of road
State Plane Coord. - 451177.9066, 295520.0459 feet
Washington Twp.
Burlington County
Can set GPS to 31 Batsto Village Road, Hammonton
for park entrance off Route 542 (Hammonton Rd).

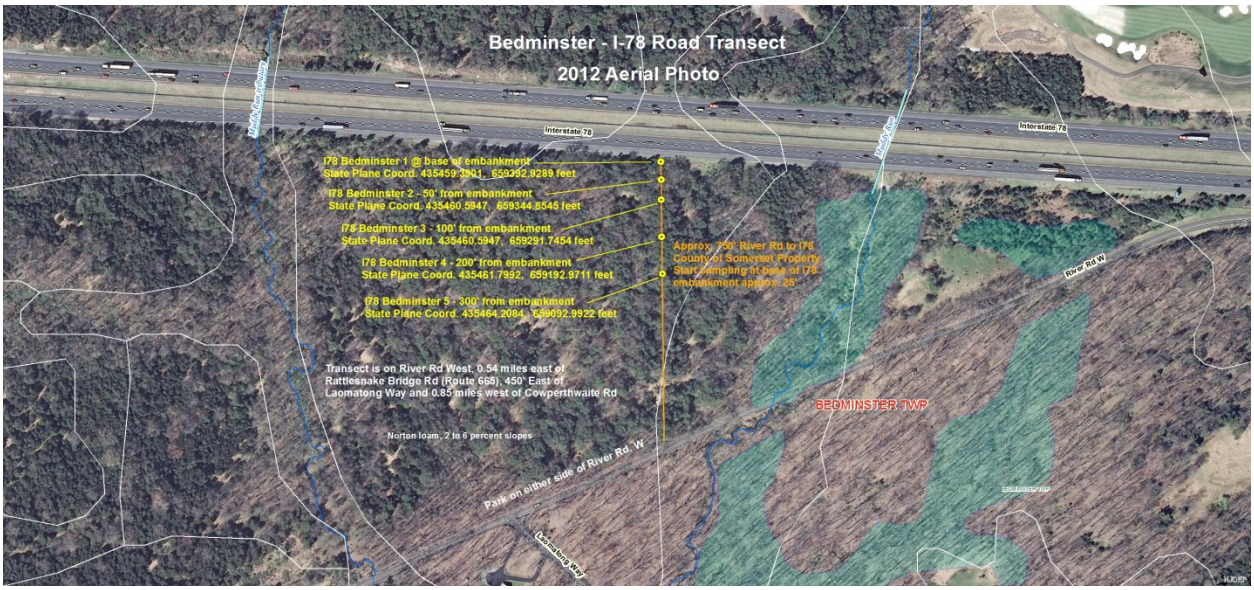
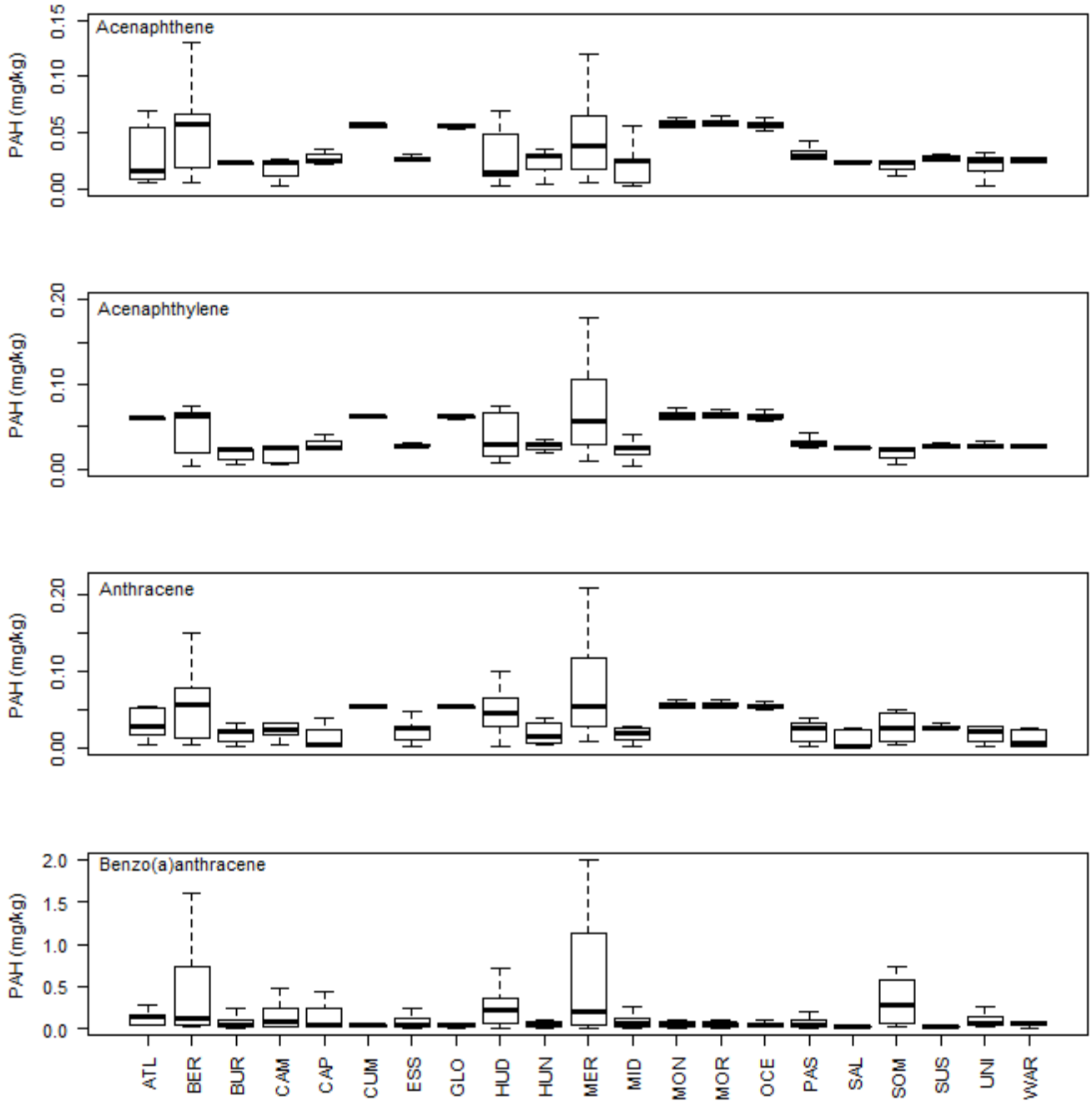
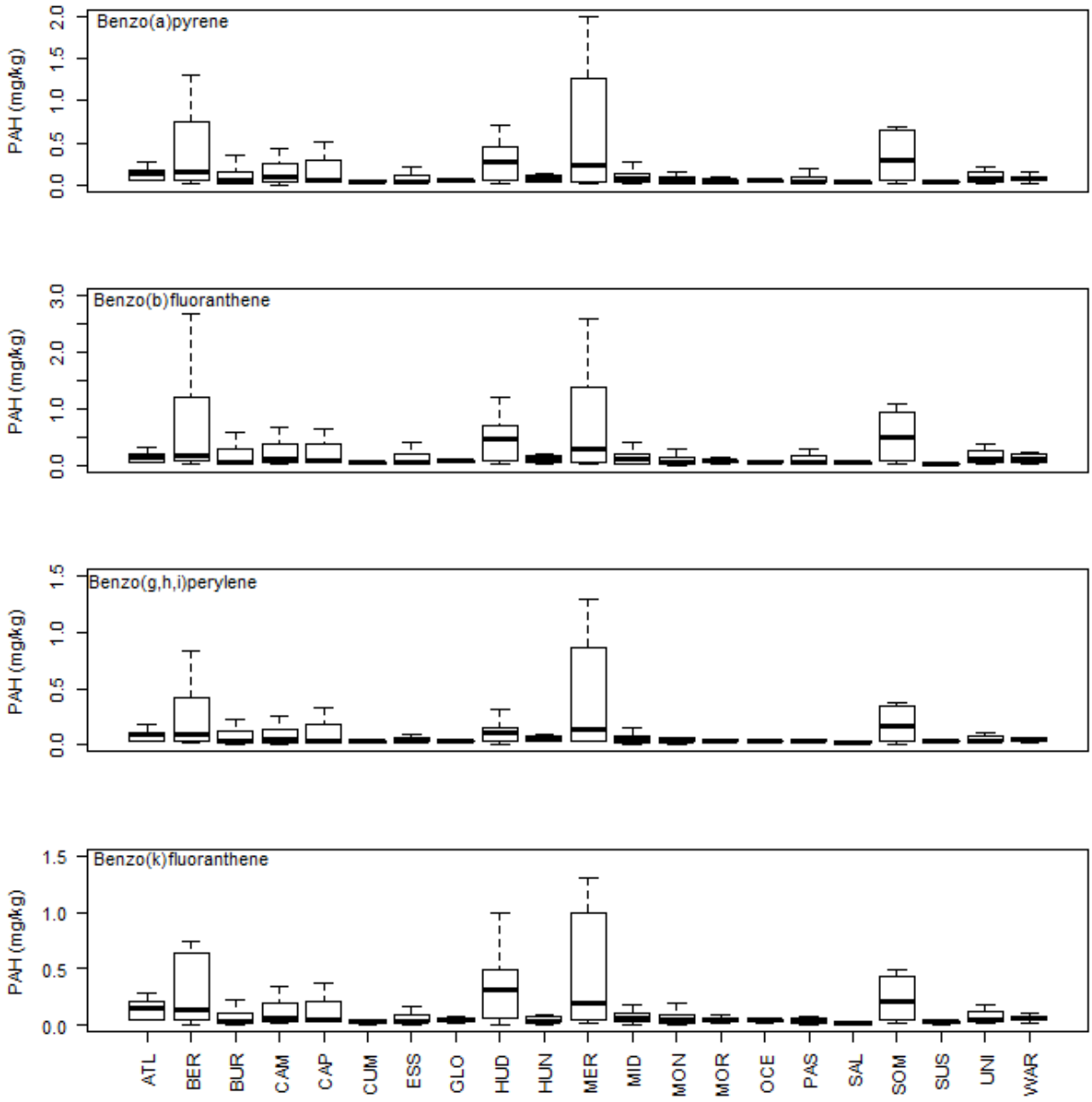
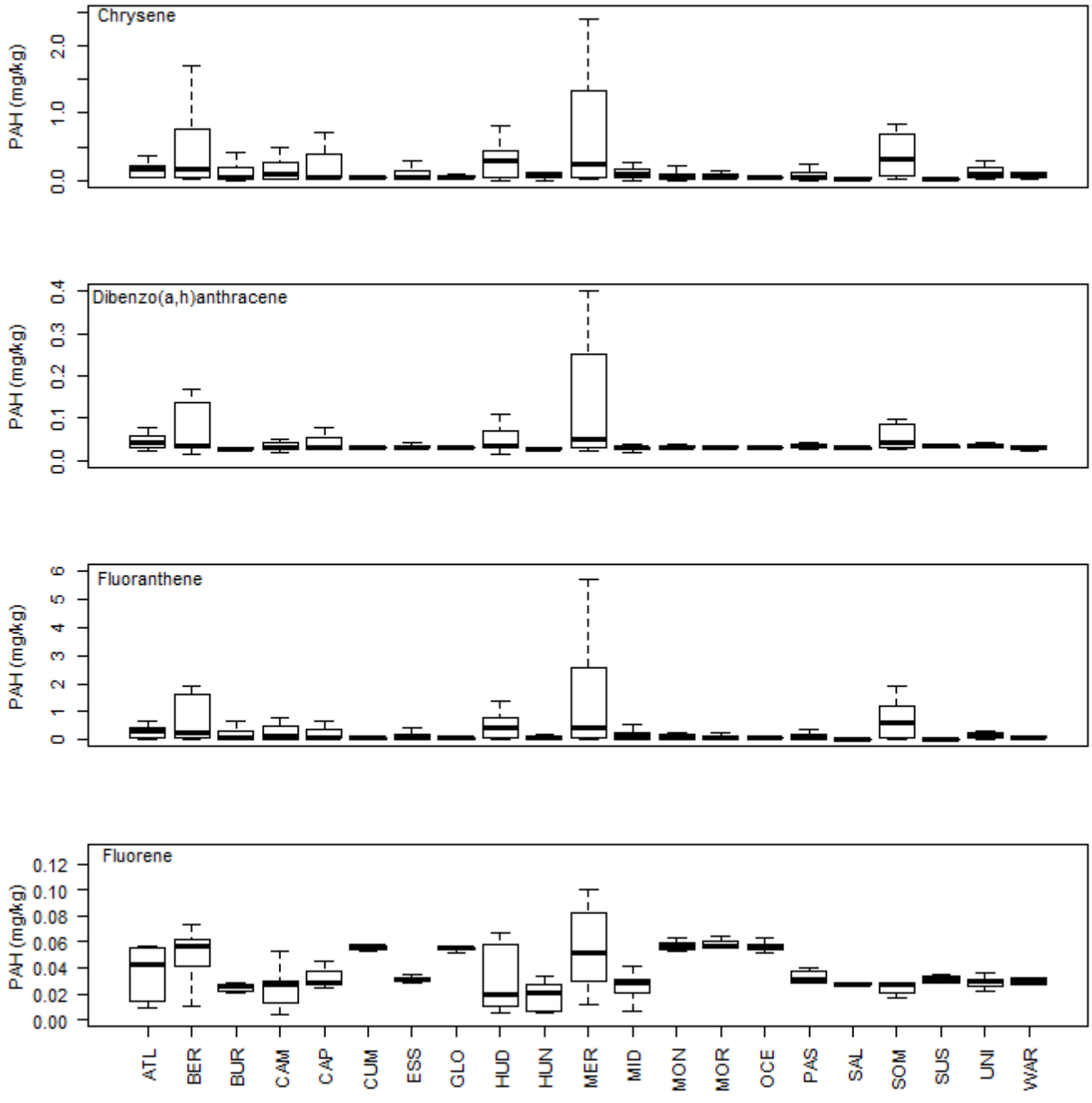
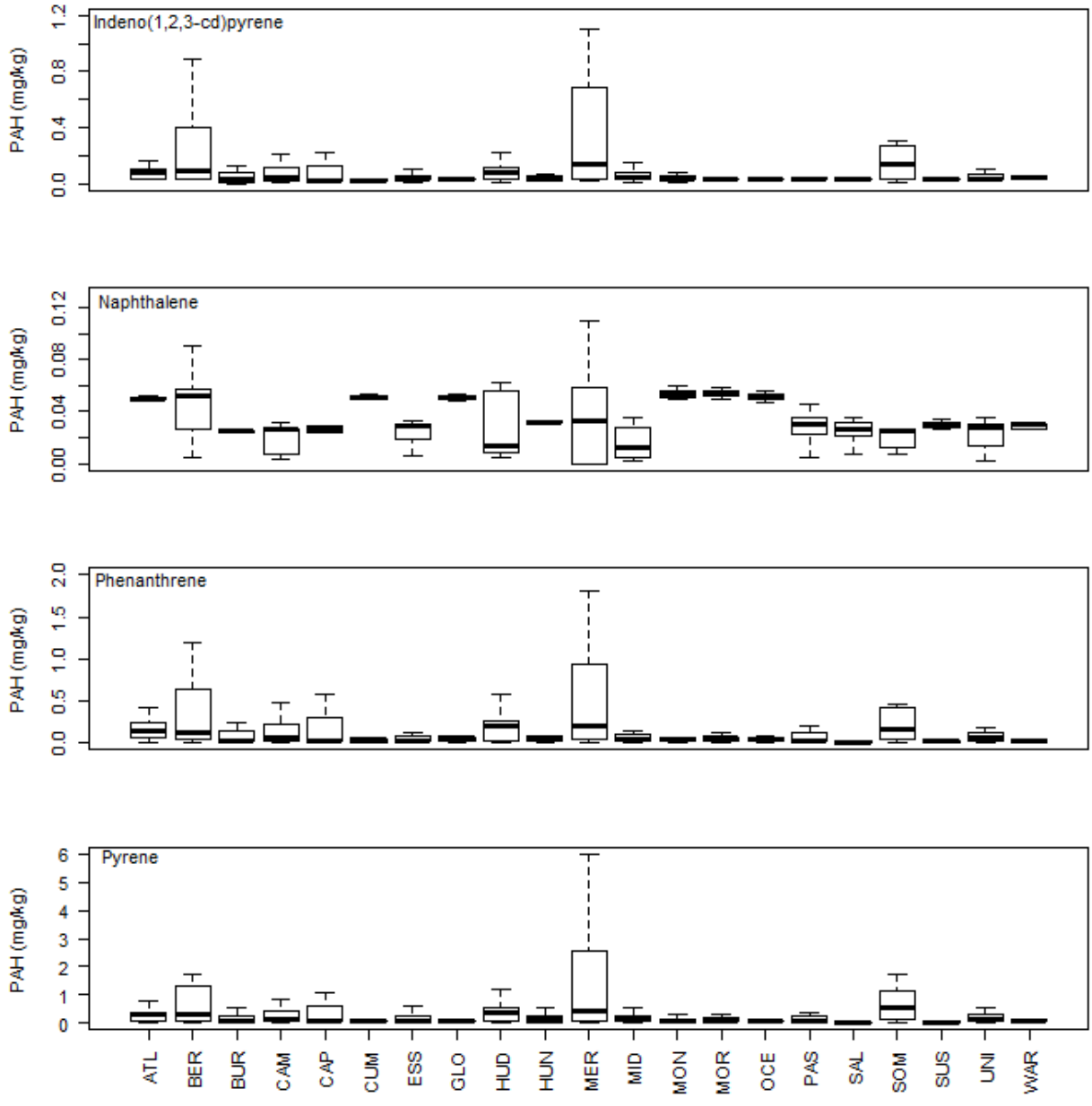

Bedminster - I-78 Road Transect
2012 Aerial Photo
Interstate 78
Interstate 78
I78 Bedminster 1 @ base of embankment
State Plane Coord. 435459.3901, 659392.9289 feet
I78 Bedminster 2 - 50' from embankment
State Plane Coord. 435460.5947, 659344.8545 feet
I78 Bedminster 3 - 100' from embankment
State Plane Coord. 435460.5947, 659291.7454 feet
I78 Bedminster 4 - 200' from embankment
State Plane Coord. 435461.7992, 659192.9711 feet
I78 Bedminster 5 - 300' from embankment
State Plane Coord. 435464.2084, 659092.9922 feet
Approx. 750' River Rd to I78
County of Somerset Property
Start sampling at base of I78
embankment approx. 25'
River Rd W
Transect is on River Rd West, 0.54 miles east of
Rattlesnake Bridge Rd (Route 665), 450' East of
Laomatong Way and 0.85 miles west of Cowperthwaite Rd
BEDMINSTER TWP
Norton loam, 2 to 6 percent slopes
Park on Either side of River Rd. W
Laomatong Way

Figure 4. Boxplots of PAH concentrations (mg/kg) by county.




Benzo(a)pyrene
PAH (mg/kg)
0.0
0.5
1.0
1.5
2.0
Benzo(b)fluoranthene
PAH (mg/kg)
0.0
1.0
2.0
3.0
Benzo(g,h,i)perylene
PAH (mg/kg)
0.0
0.5
1.0
1.5
Benzo(k)fluoranthene
PAH (mg/kg)
0.0
0.5
1.0
1.5
ATL
BER
BUR
CAM
CAP
CUM
ESS
GLO
HUD
HUN
MER
MID
MON
MOR
OCE
PAS
SAL
SOM
SUS
UNI
WAR

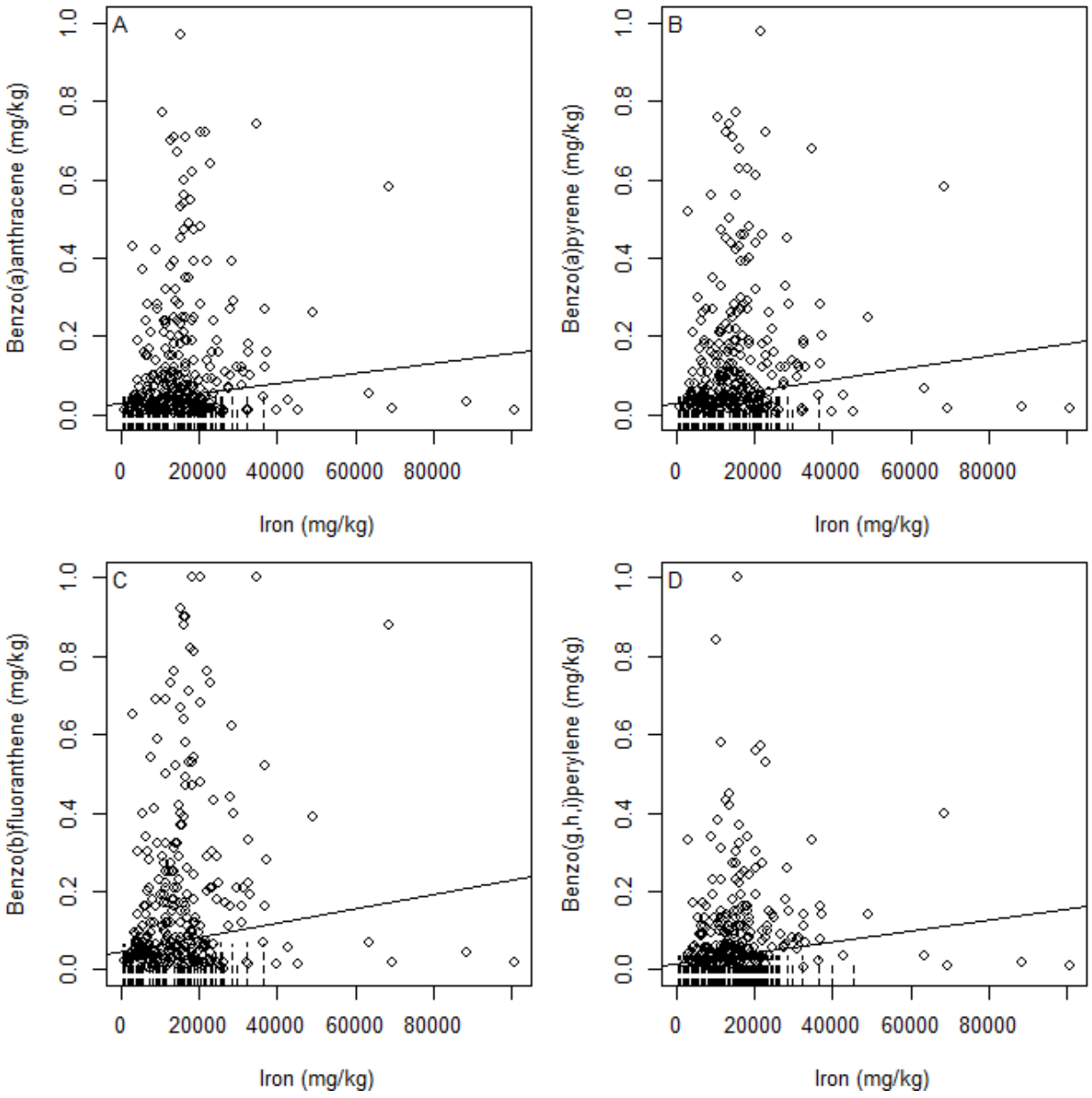

Chrysene
PAH (mg/kg)
0.0
1.0
2.0
Dibenzo(a,h)anthracene
PAH (mg/kg)
0.0
0.1
0.2
0.3
0.4
Fluoranthene
PAH (mg/kg)
0
1
2
3
4
5
6
Fluorene
PAH (mg/kg)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
ATL
BER
BUR
CAM
CAP
CUM
ESS
GLO
HUD
HUN
MER
MID
MON
MOR
OCE
PAS
SAL
SOM
SUS
UNI
WAR

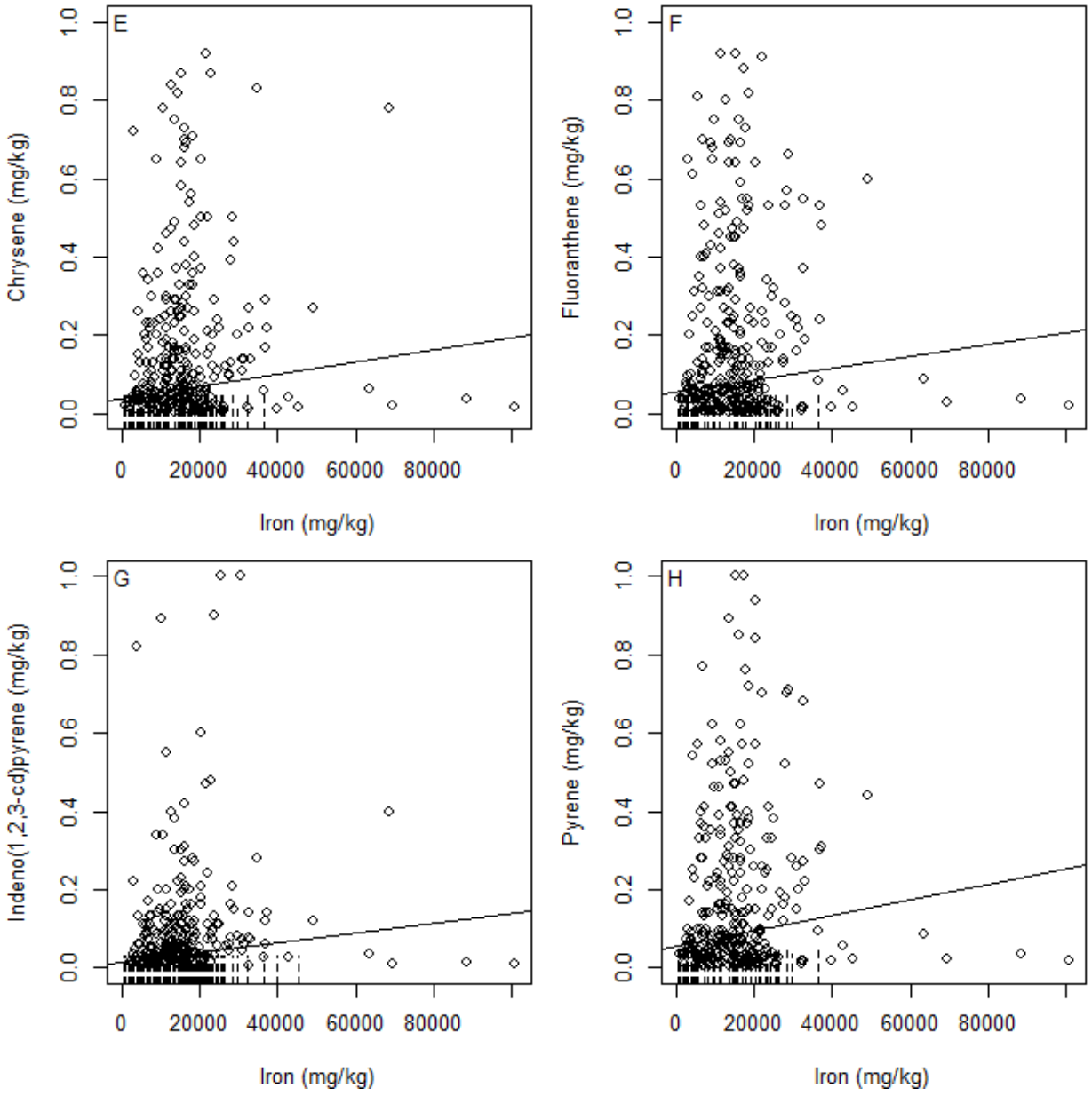

Indeno(1,2,3-cd)pyrene
PAH (mg/kg)
0.0
0.4
0.8
1.2
Naphthalene
PAH (mg/kg)
0.00
0.04
0.08
0.12
Phenanthrene
PAH (mg/kg)
0.0
0.5
1.0
1.5
2.0
Pyrene
PAH (mg/kg)
0
1
2
3
4
5
6
ATL
BER
BUR
CAM
CAP
CUM
ESS
GLO
HUD
HUN
MER
MID
MON
MOR
OCE
PAS
SAL
SOM
SUS
UNI
WAR

Note that the scale is truncated, and county abbreviations are indicated below.

County	Abbreviation
Atlantic	ATL
Bergen	BER
Burlington	BUR
Camden	CAM
Cape May	CAP
Cumberland	CUM
Essex	ESS
Gloucester	GLO
Hudson	HUD
Hunterdon	HUN
Mercer	MER
Middlesex	MID
Monmouth	MON
Morris	MOR
Ocean	OCE
Passaic	PAS
Salem	SAL
Somerset	SOM
Sussex	SUS
Union	UNI
Warren	WAR

Figure 5. Kendall's Tau (τ) Rank Correlations of PAHs versus Iron. The concentrations of the PAHs (both surface and subsurface samples) shown above significantly increased as the concentration of Iron increased (Akritas-Theil-Sen line). Censored values are represented by dashed lines spanning from the censored threshold to zero. Note: y-axes are truncated.




E
Chrysene (mg/kg)
Iron (mg/kg)
F
Fluoranthene (mg/kg)
Iron (mg/kg)
G
Indeno(1,2,3-cd)pyrene (mg/kg)
Iron (mg/kg)
H
Pyrene (mg/kg)
Iron (mg/kg)
0.0
0.2
0.4
0.6
0.8
1.0
0
20000
40000
60000
80000

VI. TABLES

Table 1. Remediation standards and criteria for PAHs

PAH	Residential Remediation Standard (mg/kg)	Non-residential Remediation Standard (mg/kg)	Impact to Ground Water Soil Water Partitioning Criteria (mg/kg)
Acenaphthene	3,400	37,000	110
Acenaphthylene	Not applicable	300,000	Not applicable
Anthracene	17,000	30,000	2,400
Benzo(a)anthracene	5	17	0.8
Benzo(a)pyrene	0.5	2	0.2
Benzo(b)fluoranthene	5	17	2
Benzo(g,h,i)perylene	380,000	30,000	Not applicable
Benzo(k)fluoranthene	45	170	25
Chrysene	450	1,700	80
Dibenz(a,h)anthracene	0.5	2	0.8
Fluoranthene	2,300	24,000	1,300
Fluorene	2,300	24,000	170
Indeno(1,2,3-cd)pyrene	5	17	7
Naphthalene	6	17	25
Phenanthrene	Not applicable	300,000	Not applicable
Pyrene	1,700	18,000	840

Table 2. Summary statistics for PAHs (mg/kg; both surface and subsurface) including mean and percentiles (50 = median).

PAH	Mean	Min	25	50	75	90	95	99	Max
Acenaphthene	0.024	< 0.0027	0.006	0.011	0.015	0.034	0.051	0.210	2.60
Acenaphthylene	0.017	< 0.0021	0.007	0.009	0.015	0.024	0.037	0.170	0.78
Anthracene	0.052	< 0.0022	0.006	0.011	0.024	0.065	0.120	0.450	8.20
Benzo(a)anthracene	0.230	< 0.0043	0.016	0.044	0.150	0.420	0.720	**2.800**	**19.00**
Benzo(a)pyrene	**0.231**	< 0.0050	0.021	0.048	0.170	**0.450**	**0.720**	**3.200**	**15.00**
Benzo(b)fluoranthene	0.319	< 0.0053	0.020	0.065	0.220	0.690	1.200	**4.000**	**19.00**
Benzo(g,h,i)perylene	0.135	< 0.0069	0.018	0.031	0.100	0.240	0.420	1.600	8.00
Benzo(k)fluoranthene	0.184	< 0.0042	0.018	0.043	0.150	0.410	0.690	2.600	7.80
Chrysene	0.264	< 0.0035	0.021	0.055	0.200	0.500	0.830	3.100	17.00
Dibenzo(a,h)anthracene	0.053	< 0.0120	0.017	0.023	0.031	0.084	0.120	**0.610**	**2.90**
Fluoranthene	0.529	< 0.0028	0.022	0.075	0.310	0.800	1.900	8.300	42.00
Fluorene	0.037	< 0.0037	0.008	0.013	0.022	0.032	0.045	0.260	5.60
Indeno(1,2,3-cd)pyrene	0.121	< 0.0040	0.017	0.028	0.086	0.200	0.400	1.400	**7.90**
Naphthalene	0.014	< 0.0025	0.005	0.007	0.013	0.019	0.029	0.140	0.98
Phenanthrene	0.303	< 0.0025	0.014	0.040	0.150	0.400	0.670	4.600	40.00
Pyrene	0.483	< 0.0056	0.026	0.078	0.300	0.840	1.400	6.000	39.00

Note: Cells highlighted in blue with bold font exceed the impact to ground water soil water partitioning criterion.
Cells highlighted in green with bold font exceed the residential remediation standard.
Cells highlighted in yellow with bold font exceed the non-residential remediation standard.

Table 3. Summary statistics for PAHs (mg/kg) at different depths including mean and percentiles (50 = median).

PAH	Depth	Mean	Min	25	50	75	90	95	99	Max
Acenaphthene	Surface	0.019	< 0.0027	0.007	0.012	0.016	0.035	0.051	0.180	0.260
	Subsurface	0.028	< 0.0028	0.006	0.010	0.014	0.020	0.047	0.220	2.600
Acenaphthylene	Surface	0.017	< 0.0028	0.007	0.010	0.018	0.028	0.037	0.170	0.180
	Subsurface	0.018	< 0.0021	0.006	0.009	0.014	0.021	0.036	0.320	0.780
Anthracene	Surface	0.036	< 0.0022	0.007	0.013	0.029	0.076	0.140	0.550	0.780
	Subsurface	0.066	< 0.0027	0.005	0.009	0.017	0.041	0.100	0.450	8.200
Benzo(a)anthracene	Surface	0.247	< 0.0092	0.033	0.085	0.230	0.550	**1.100**	**3.400**	**4.500**
	Subsurface	0.213	< 0.0043	0.011	0.018	0.055	0.250	0.560	**2.800**	**19.000**
Benzo(a)pyrene	Surface	**0.264**	< 0.0110	0.043	0.099	**0.230**	**0.560**	**1.300**	**3.600**	**3.900**
	Subsurface	0.198	< 0.0050	0.014	0.022	0.062	**0.260**	**0.610**	**3.200**	**15.000**
Benzo(b)fluoranthene	Surface	0.387	< 0.0087	0.056	0.150	0.370	0.880	2.000	**4.300**	**5.800**
	Subsurface	0.251	< 0.0058	0.014	0.021	0.083	0.390	0.900	**2.800**	**19.000**
Benzo(g,h,i)perylene	Surface	0.157	< 0.0094	0.026	0.059	0.140	0.340	0.570	1.600	2.400
	Subsurface	0.112	< 0.0069	0.012	0.020	0.039	0.130	0.300	1.900	8.000
Benzo(k)fluoranthene	Surface	0.235	< 0.0049	0.035	0.079	0.210	0.480	1.200	2.800	3.100
	Subsurface	0.133	< 0.0042	0.010	0.022	0.052	0.230	0.520	1.800	7.800
Chrysene	Surface	0.305	< 0.0058	0.045	0.120	0.270	0.680	1.400	3.600	4.800
	Subsurface	0.221	< 0.0035	0.013	0.020	0.064	0.290	0.720	3.100	17.000
Dibenzo(a,h)anthracene	Surface	0.057	< 0.0120	0.019	0.024	0.051	0.100	0.230	**0.630**	**0.710**
	Subsurface	0.048	< 0.0140	0.016	0.021	0.024	0.047	0.100	**0.610**	**2.900**
Fluoranthene	Surface	0.590	< 0.0082	0.063	0.170	0.510	1.200	2.400	8.300	11.000
	Subsurface	0.467	< 0.0028	0.010	0.023	0.100	0.570	1.300	8.400	42.000
Fluorene	Surface	0.023	< 0.0037	0.010	0.014	0.023	0.036	0.044	0.048	0.260
	Subsurface	0.050	< 0.0048	0.007	0.011	0.021	0.027	0.045	0.590	5.600
Indeno(1,2,3-cd)pyrene	Surface	0.139	< 0.0084	0.023	0.055	0.120	0.270	0.600	1.400	2.100
	Subsurface	0.103	< 0.0040	0.011	0.020	0.035	0.120	0.220	1.700	**7.900**

Naphthalene	Surface	0.012	< 0.0025	0.005	0.007	0.011	0.019	0.035	0.140	0.190
	Subsurface	0.017	< 0.0028	0.004	0.009	0.015	0.021	0.022	0.190	0.980
Phenanthrene	Surface	0.254	< 0.0054	0.028	0.076	0.220	0.510	0.820	4.000	5.100
	Subsurface	0.350	< 0.0025	0.007	0.014	0.050	0.250	0.590	5.500	40.000
Pyrene	Surface	0.543	< 0.0110	0.060	0.180	0.460	1.100	2.100	9.200	9.400
	Subsurface	0.422	< 0.0056	0.012	0.026	0.093	0.440	1.100	6.000	39.000

Note: Cells highlighted in blue with bold font exceed the impact to ground water soil water partitioning criterion.
Cells highlighted in green with bold font exceed the residential remediation standard.
Cells highlighted in yellow with bold font exceed the non-residential remediation standard.

Table 4. Results from multiple regression models fit with a Maximum Likelihood Estimation (MLE) approach for each PAH and metal. Table continued on next two pages.

PAH	*n*	Censored	Parameter	Coefficient	SE	Z	*P*	Sig
Acenaphthene	100	55	(Intercept)	2.01	0.47	4.28	0.000	*
			Distance	0.00	0.00	-1.21	0.228	
			Density	0.00	0.00	1.38	0.169	
			TOC	0.01	0.00	1.08	0.281	
			% Silt, Clay, Colloids	0.00	0.01	0.38	0.704	
			Open Area	0.25	0.27	0.92	0.357	
Acenaphthylene	100	64	(Intercept)	1.95	0.54	3.58	0.000	*
			Distance	0.00	0.00	-0.92	0.359	
			Density	0.00	0.00	0.63	0.531	
			TOC	0.01	0.01	1.08	0.280	
			% Silt, Clay, Colloids	0.00	0.01	0.59	0.557	
			Open Area	0.31	0.29	1.10	0.273	
Anthracene	100	28	(Intercept)	1.96	0.47	4.14	0.000	*
			Distance	0.00	0.00	-1.08	0.282	
			Density	0.01	0.00	2.17	0.030	*
			TOC	0.01	0.01	1.27	0.204	
			% Silt, Clay, Colloids	0.01	0.01	1.00	0.318	
			Open Area	0.17	0.28	0.60	0.548	
Benzo(a)anthracene	100	2	(Intercept)	2.79	0.45	6.17	0.000	*
			Distance	0.00	0.00	-0.82	0.415	
			Density	0.01	0.00	3.03	0.002	*
			TOC	0.01	0.00	1.67	0.096	
			% Silt, Clay, Colloids	0.02	0.01	2.69	0.007	*
			Open Area	0.51	0.29	1.75	0.079	
Benzo(a)pyrene	100	6	(Intercept)	3.10	0.44	7.07	0.000	*
			Distance	0.00	0.00	-0.74	0.461	
			Density	0.01	0.00	2.77	0.006	*
			TOC	0.01	0.00	1.70	0.090	
			% Silt, Clay, Colloids	0.02	0.01	2.46	0.014	*
			Open Area	0.50	0.28	1.77	0.078	

Table 4. cont.

PAH	*n*	Censored	Parameter	Coefficient	SE	Z	*P*	Sig
Benzo(b)fluoranthene	100	3	(Intercept)	3.32	0.46	7.16	0.000	*
			Distance	0.00	0.00	-0.80	0.425	
			Density	0.01	0.00	2.70	0.007	*
			TOC	0.01	0.00	1.62	0.105	
			% Silt, Clay, Colloids	0.02	0.01	2.74	0.006	*
			Open Area	0.49	0.30	1.63	0.103	
Benzo(g,h,i)perylene	100	19	(Intercept)	2.62	0.47	5.62	0.000	*
			Distance	0.00	0.00	-0.64	0.525	
			Density	0.01	0.00	2.39	0.017	*
			TOC	0.01	0.00	1.34	0.181	
			% Silt, Clay, Colloids	0.02	0.01	2.54	0.011	*
			Open Area	0.52	0.29	1.78	0.075	
Benzo(k)fluoranthene	100	4	(Intercept)	3.06	0.47	6.58	0.000	*
			Distance	0.00	0.00	-0.73	0.466	
			Density	0.01	0.00	2.84	0.005	*
			TOC	0.01	0.00	1.91	0.056	
			% Silt, Clay, Colloids	0.01	0.01	1.36	0.174	
			Open Area	0.52	0.30	1.74	0.083	
Chrysene	100	2	(Intercept)	3.17	0.44	7.16	0.000	*
			Distance	0.00	0.00	-0.78	0.437	
			Density	0.01	0.00	2.86	0.004	*
			TOC	0.01	0.00	1.85	0.065	
			% Silt, Clay, Colloids	0.02	0.01	2.45	0.014	*
			Open Area	0.49	0.29	1.72	0.086	
Dibenzo(a,h)anthracene	100	53	(Intercept)	2.10	0.54	3.89	0.000	*
			Distance	0.00	0.00	-1.01	0.313	
			Density	0.01	0.00	1.64	0.101	
			TOC	0.01	0.01	1.09	0.277	
			% Silt, Clay, Colloids	0.01	0.01	1.62	0.105	
			Open Area	0.49	0.32	1.54	0.123	
Fluoranthene	100	2	(Intercept)	3.61	0.48	7.46	0.000	*
			Distance	0.00	0.00	-0.61	0.545	
			Density	0.01	0.00	2.80	0.005	*
			TOC	0.01	0.01	1.78	0.075	
			% Silt, Clay, Colloids	0.01	0.01	2.02	0.043	*
			Open Area	0.52	0.31	1.65	0.099	

Table 4. cont.

PAH	*n*	Censored	Parameter	Coefficient	SE	Z	*P*	Sig
Fluorene	100	58	(Intercept)	2.06	0.52	4.00	0.000	*
			Distance	0.00	0.00	-1.14	0.253	
			Density	0.00	0.00	1.11	0.268	
			TOC	0.01	0.00	1.22	0.222	
			% Silt, Clay, Colloids	0.00	0.01	0.73	0.463	
			Open Area	0.35	0.26	1.36	0.173	
Indeno(1,2,3-cd)pyrene	100	16	(Intercept)	2.58	0.44	5.86	0.000	*
			Distance	0.00	0.00	-0.41	0.682	
			Density	0.01	0.00	2.47	0.013	*
			TOC	0.01	0.00	1.34	0.179	
			% Silt, Clay, Colloids	0.02	0.01	2.44	0.015	*
			Open Area	0.47	0.28	1.67	0.095	
Naphthalene	100	63	(Intercept)	-1.65	1.44	-1.14	0.253	
			Distance	0.01	0.01	0.82	0.410	
			Density	0.01	0.01	1.85	0.065	
			TOC	0.03	0.01	2.06	0.040	*
			% Silt, Clay, Colloids	-0.01	0.02	-0.61	0.541	
			Open Area	-0.86	0.80	-1.07	0.285	
Phenanthrene	100	3	(Intercept)	2.62	0.47	5.62	0.000	*
			Distance	0.00	0.00	-0.34	0.735	
			Density	0.01	0.00	3.15	0.002	*
			TOC	0.01	0.00	1.91	0.056	
			% Silt, Clay, Colloids	0.02	0.01	2.29	0.022	*
			Open Area	0.36	0.30	1.18	0.238	
Pyrene	100	2	(Intercept)	3.50	0.47	7.39	0.000	*
			Distance	0.00	0.00	-0.81	0.419	
			Density	0.01	0.00	2.98	0.003	*
			TOC	0.01	0.01	1.85	0.064	
			% Silt, Clay, Colloids	0.02	0.01	2.41	0.016	*
			Open Area	0.45	0.31	1.47	0.141	
Aluminum	100	0	(Intercept)	7.77	0.17	46.69	0.000	*
			Distance	0.00	0.00	0.43	0.667	
			Density	0.00	0.00	0.82	0.415	
			TOC	0.00	0.00	1.29	0.197	
			% Silt, Clay, Colloids	0.02	0.00	9.43	0.000	*
			Open Area	0.00	0.11	0.00	0.996	

Table 4. cont.

PAH	*n*	Censored	Parameter	Coefficient	SE	Z	*P*	Sig
Iron	100	0	(Intercept)	8.49	0.18	47.34	0.000	*
			Distance	0.00	0.00	-0.87	0.384	
			Density	0.00	0.00	1.42	0.155	
			TOC	0.00	0.00	0.93	0.352	
			% Silt, Clay, Colloids	0.02	0.00	7.00	0.000	*
			Open Area	0.21	0.12	1.81	0.071	

Note: An asterisk (*) indicates a statistically significant finding.

Table 5. Kendall's Tau (τ) Rank Correlations of PAHs and Distance to Railroads.

PAH	Slope	*Y*-intercept	Kendall's Tau (τ)	*p*-value	Significance
Acenaphthene	0.02	-0.17	0.05	0.716	
Acenaphthylene	-0.06	29.46	-0.15	0.298	
Anthracene	-0.05	32.46	-0.16	0.271	
Benzo(a)anthracene	-0.24	199.29	-0.12	0.413	
Benzo(a)pyrene	-0.22	234.63	-0.07	0.623	
Benzo(b)fluoranthene	-0.36	345.12	-0.13	0.386	
Benzo(g,h,i)perylene	-0.42	261.23	-0.19	0.182	
Benzo(k)fluoranthene	-0.29	293.91	-0.09	0.528	
Chrysene	-0.50	324.58	-0.16	0.282	
Dibenzo(a,h)anthracene	-0.18	92.73	-0.12	0.395	
Fluoranthene	-0.79	609.66	-0.16	0.262	
Fluorene	0.02	-0.12	0.03	0.845	
Indeno(1,2,3-cd)pyrene	-0.26	186.61	-0.16	0.281	
Naphthalene	-0.18	71.81	-0.51	0.000	*
Phenanthrene	-0.40	258.43	-0.20	0.168	
Pyrene	-0.87	524.27	-0.23	0.112	

Note: An asterisk (*) indicates a statistically significant finding.

Table 6. Results from multiple regression models fit with a Maximum Likelihood Estimation (MLE) approach for each PAH. Models were designed to predict PAH concentration from variables including distance to railroads, Total Organic Carbon (TOC), and percent of silt, clay, and colloids. Table continued on next page.

PAH	*n*	Censored	Parameter	Coefficient	SE	Z-value	*P*-value	Sig
Acenaphthene	25	15	(Intercept)	-3.66	1.69	-2.16	0.031	*
			Distance	0.00	0.00	1.25	0.210	
			TOC	0.00	0.00	1.90	0.058	
			% Silt, Clay, Colloids	0.09	0.04	2.28	0.023	*
Acenaphthylene	25	8	(Intercept)	1.04	1.10	0.94	0.346	
			Distance	0.00	0.00	-0.48	0.632	
			TOC	0.00	0.00	1.78	0.075	
			% Silt, Clay, Colloids	0.04	0.03	1.09	0.276	
Anthracene	25	4	(Intercept)	0.87	0.84	1.05	0.296	
			Distance	0.00	0.00	-0.46	0.647	
			TOC	0.00	0.00	1.49	0.135	
			% Silt, Clay, Colloids	0.07	0.03	2.76	0.006	*
Benzo(a)anthracene	25	2	(Intercept)	2.51	0.96	2.63	0.008	*
			Distance	0.00	0.00	-0.55	0.582	
			TOC	0.00	0.00	1.43	0.153	
			% Silt, Clay, Colloids	0.08	0.03	2.70	0.007	*
Benzo(a)pyrene	25	2	(Intercept)	2.83	0.93	3.05	0.002	*
			Distance	0.00	0.00	-0.64	0.524	
			TOC	0.00	0.00	1.29	0.196	
			% Silt, Clay, Colloids	0.08	0.03	2.73	0.006	*
Benzo(b)fluoranthene	25	2	(Intercept)	3.09	0.98	3.17	0.002	*
			Distance	0.00	0.00	-0.66	0.507	
			TOC	0.00	0.00	1.31	0.189	
			% Silt, Clay, Colloids	0.08	0.03	2.53	0.011	*
Benzo(g,h,i)perylene	25	3	(Intercept)	2.64	1.05	2.52	0.012	*
			Distance	0.00	0.00	-0.77	0.442	
			TOC	0.00	0.00	1.41	0.158	
			% Silt, Clay, Colloids	0.08	0.03	2.40	0.017	*
Benzo(k)fluoranthene	25	2	(Intercept)	3.11	0.99	3.16	0.002	*
			Distance	0.00	0.00	-0.67	0.506	
			TOC	0.00	0.00	1.23	0.218	
			% Silt, Clay, Colloids	0.08	0.03	2.48	0.013	*
Chrysene	25	1	(Intercept)	3.37	0.88	3.84	0.000	*
			Distance	0.00	0.00	-0.62	0.537	
			TOC	0.00	0.00	1.56	0.118	
			% Silt, Clay, Colloids	0.07	0.03	2.44	0.015	*

Table 6. cont.

PAH	*n*	Censored	Parameter	Coefficient	SE	Z-value	*P*-value	Sig
Dibenzo(a,h)anthracene	25	8	(Intercept)	0.45	1.52	0.30	0.766	
			Distance	0.00	0.00	-0.42	0.674	
			TOC	0.00	0.00	1.51	0.130	
			% Silt, Clay, Colloids	0.09	0.05	1.86	0.063	
Fluoranthene	25	0	(Intercept)	3.47	0.84	4.11	0.000	*
			Distance	0.00	0.00	-0.38	0.702	
			TOC	0.00	0.00	1.85	0.064	
			% Silt, Clay, Colloids	0.07	0.03	2.90	0.004	*
Fluorene	25	17	(Intercept)	-3.23	2.09	-1.54	0.123	
			Distance	0.00	0.00	0.24	0.814	
			TOC	0.00	0.00	0.13	0.895	
			% Silt, Clay, Colloids	0.13	0.06	2.13	0.033	*
Indeno(1,2,3-cd)pyrene	25	3	(Intercept)	2.21	1.08	2.04	0.041	*
			Distance	0.00	0.00	-0.62	0.537	
			TOC	0.00	0.00	1.36	0.174	
			% Silt, Clay, Colloids	0.08	0.03	2.50	0.012	*
Naphthalene	25	6	(Intercept)	2.34	0.67	3.48	0.001	*
			Distance	-0.01	0.00	-3.09	0.002	*
			TOC	0.00	0.00	2.16	0.031	*
			% Silt, Clay, Colloids	0.03	0.02	1.29	0.198	
Phenanthrene	25	1	(Intercept)	2.85	0.79	3.60	0.000	*
			Distance	0.00	0.00	-0.78	0.439	
			TOC	0.00	0.00	1.61	0.107	
			% Silt, Clay, Colloids	0.07	0.02	3.07	0.002	*
Pyrene	25	0	(Intercept)	3.86	0.80	4.81	0.000	*
			Distance	0.00	0.00	-0.68	0.499	
			TOC	0.00	0.00	1.90	0.057	
			% Silt, Clay, Colloids	0.06	0.02	2.42	0.016	*

Note: An asterisk (*) indicates a statistically significant finding.

Table 7. Kendall's Tau (τ) Rank Correlations of PAHs and Distance to Asphalt.

PAH	Slope	*Y*-intercept	Kendall's Tau (τ)	*p*-value	Significance
Acenaphthene	-0.70	72.44	-0.06	0.676	
Acenaphthylene	-1.44	146.75	-0.07	0.601	
Anthracene	-0.81	83.42	-0.08	0.530	
Benzo(a)anthracene	-0.20	59.33	-0.33	0.019	*
Benzo(a)pyrene	-0.29	88.00	-0.31	0.028	*
Benzo(b)fluoranthene	-0.31	92.67	-0.29	0.040	*
Benzo(g,h,i)perylene	-0.69	143.43	-0.34	0.011	*
Benzo(k)fluoranthene	-0.20	70.55	-0.32	0.023	*
Chrysene	-0.19	61.33	-0.33	0.020	*
Dibenzo(a,h)anthracene	-0.14	32.77	-0.18	0.170	
Fluoranthene	-0.28	94.12	-0.32	0.025	*
Fluorene	-0.81	84.31	-0.06	0.673	
Indeno(1,2,3-cd)pyrene	-0.55	111.74	-0.31	0.021	*
Naphthalene	-0.73	74.83	-0.06	0.676	
Phenanthrene	-0.17	51.15	-0.35	0.011	*
Pyrene	-0.27	97.69	-0.31	0.030	*

Note: An asterisk (*) indicates a statistically significant finding.

Table 8. PAH Concentrations in mg/kg of Source Material from the Asphalt Surface Sites

PAH	AS01-00	AS02-00	AS03-00	AS04-00	AS05-00
Acenaphthene	0.000	0.000	0.000	0.000	0.000
Acenaphtylene	0.000	0.000	0.000	0.000	0.000
Anthracene	0.000	0.000	0.000	0.000	0.000
Benzo(a)anthracene	0.000	0.000	0.000	0.000	0.000
Benzo(a)pyrene	0.000	0.000	0.000	0.000	0.000
Benzo(b)fluoranthene	0.000	0.000	0.000	0.000	0.000
Benzo(g,h,i)perylene	0.000	0.000	0.000	0.000	0.000
Benzo(k)fluoranthene	0.000	0.000	0.000	0.000	0.000
Chrysene	0.450	0.270	0.240	0.430	0.380
Dibenz(a,h)anthracene	0.000	0.000	0.000	0.000	0.000
Fluoranthene	0.210	0.000	0.150	0.000	0.000
Fluorene	0.000	0.000	0.000	0.000	0.000
Indeno(1,2,3-cd)pyrene	0.000	0.000	0.000	0.000	0.000
Naphthalene	0.000	0.000	0.000	0.000	0.000
Phenanthrene	0.000	0.000	0.000	0.000	0.000
Pyrene	0.390	0.000	0.370	0.250	0.000

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APPENDICES

APPENDIX 1

Quality Assurance Project Plan
For
Polycyclic Aromatic Hydrocarbons Study

QUALITY ASSURANCE PROJECT PLAN
FOR THE NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION POLYCYCLIC AROMATIC HYDROCARBON STUDY IN SOILS ACROSS THE STATE

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SITE REMEDIATION AND WASTE MANAGEMENT PROGRAM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

OCTOBER 2019

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared for the investigation of polycyclic aromatic hydrocarbons (PAHs) concentrations from a variety of developed areas located across the State. The QAPP is developed from a QAPP (with only minor modifications) provided by Kenneth Petrone, Bureau of Site Management (BSM) which is in the standard format for a BSM project.

This QAPP has been prepared consistent with the Technical Requirements for Site Remediation, N.J.A.C. 7:26 E-1 et seq., and the New Jersey Department of Environmental Protection (NJDEP) 2005 Field Sampling Procedures Manual (FSPM, amended April 2011). The QAPP defines processes and procedures to be followed so that the scientific data acquired are definitive and of known quality, based on their intended uses.

The project quality objectives for this investigation are as follows:

- Field measurement and laboratory analytical data are valid through adherence to the NJDEP FSPM (2005, 2011),
- Samples are identified and controlled through chain-of-custody (COC) procedures.
- Records are retained as documentary evidence of field activities and observations.
- Generated data are validated consistent with respective NJDEP data validation guidelines and this QAPP. Evaluations of the data are accurate, complete, and consistent throughout the project.

The content of this QAPP is based on the NJDEP requirements as stated in the NJDEP Technical Requirements for Site Remediation (N.J.A.C. 7:26E-2.2), and includes:

- Project Objectives and Scope
- Project Organization and Responsibility
- Sample Collection and Field Data Acquisition Procedures
- Sample Analysis and Laboratory Data Deliverable Format
- Sample Quality Assurance
- Quality Control Procedures.

2.0 PROJECT OBJECTIVES AND SCOPE

The overall objective of the study is to characterize the nature of soil with respect to PAH concentrations in developed areas of the State. For the purpose of this project, developed areas will be considered those areas where the population density is 2,000 people per square mile (p/mi^2) or greater. Areas below 2,000 p/mi^2 may be subject to investigation on an as needed basis.

This will be a two year study to evaluate concentrations of PAHs throughout New Jersey. This study is intended as an extension of previous background work that the Department had performed between 1996 and 2001. The primary focus of the conceptual plan is to collect paired surface and subsurface samples from locations not subject to a known discharge from an identifiable/distinct source. The collected soil will be analyzed for PAHs (inclusive of the necessary QA/QC). The intent of the sampling plan design is to assess whether the range of PAH background concentrations within developed areas correlates with proximity to discharges or increased population density. Potential relationship of PAHs with other metals is an additional topic of interest.

Results of surface samples from background studies conducted by the Department from 1996 to 2001 indicated PAH concentrations to be below or near analytical detection levels in “rural” settings. The trend was considered consistent enough to conclude that elevated background concentrations of PAHs would not be significantly above the regulatory limits. The review of the 1996 to 2001 work indicated some physiographic provinces of the state did not have “urban” site results. The sampling of developed areas is adjusted here to allow appropriate assessment of these provinces.

It is anticipated that 200 or more locations may be evaluated over the course of the two years. Year one will provide an understanding of the magnitude of concentrations present in these areas. Year two will be used to fill data gaps as well as refine any relationship between population density and/or known discharges.

Initially all sample locations will be evaluated for PAH concentrations and metal concentrations at 0 to 6 inches below ground surface and 12 to 18 inches below ground surface. Subsurface samples may be reduced or eliminated if other contracting needs (such as development of sample design, sampling location selection, or report generation) constrain the available funding. There is a presumption that surface concentrations should be greater than subsurface concentrations, which might form a basis for extrapolation. The purpose of taking these subsurface samples would be to

quantitatively assess the vertical variability of PAH and metal concentrations. Limited horizontal sampling will also provide additional information about variability of PAH and metal distribution in that dimension.

Information will also be obtained regarding the proximity of the selected sample locations to contaminated sites in the vicinity. This will allow evaluation of the relationship, if any, between the PAH and metal concentrations at the sample locations and proximity to a discharge.

Division of Science and Research (DSR) will administer the funding of the proposed work. Because of previous involvement with this topic and/or this type of effort, Site Remediation Waste Management Program (SRWMP) Bureau of Environmental Evaluation and Risk Assessment (BEERA) will have primary responsibility for design and management aspects. BEERA personnel will accomplish sample location selection.

SRWMP Bureau of Environmental Measurements and Site Assessment (BEMSA) personnel will collect the samples and provide additional relevant information such as GPS location, sample/location description, and photographic records. Analysis of the collected samples will be done through the Analytical Laboratory Services Contract that Office of Data Quality (ODQ) oversees and BEMSA utilizes. Consequently, these analyses will be done by a New Jersey certified laboratory following USEPA Contract Laboratory Program (CLP) methods (OLMO 2.1) or (ISM01.3).

The collected information will be stored in an ACCESS database that is being designed for this purpose. Ongoing evaluation of the results will be the responsibility of HSSE with support from DSR as needed. BEERA will likely also assume responsibility for generating reports unless this task is contracted to an outside agent.

Funding will be $150,000 of the expected $250,000 DSR Hazardous Waste Research Funding for Fiscal Year 2016, as well as $100,000 for Fiscal Year 2017 to accomplish the tasks described above. An additional $50,000 has been obtained from SRWMP to cover the costs of the metal analytical costs.

Task #	Task Description
1	Project Setup and Initial Task Coordination

2	Health & Safety Plan (HASP) and Quality Assurance Project Plan (QAPP) Generation
3	Sample Location Selection
4	Soil Sampling
5	Obtain Sample Location Documentation (GPS, photos, descriptions, etc.)
6	Management of Investigation Derived Waste (IDW)
7	Sample Analysis
8	Data Validation and Electronic Data Deliverables (EDDs) As Needed
9	Insertion of Analytical Results into Database
10	Data Evaluation
11	Progress Report Generation
12	Future Action Planning
13	Execution of Planned Future Actions
14	Final Report Generation
15	
16	
17	
18	
19	

3.0 PROJECT ORGANIZATION

Project personnel are as follows:

Project Co-leader – Teruo Sugihara, Site Remediation and Waste Management Program (SRWMP), Bureau of Environmental Evaluation and Risk Assessment (BEERA) is responsible for overall study design and management, data interpretation, and report generation.

Project Co-leader – Robert Mueller, Division of Science, Research, and Environmental Health is primarily responsible for funding management.

Sample Location Selection and Review
Kevin Schick, BEERA
John Boyer, BEERA
Allan Motter, BEERA
Gregory Neumann, BEERA

Sample Location Selection
David Barskey, BEERA
Steven Byrnes, BEERA
Carey Compton, BEERA
Haydar Erdogan, BEERA
Anne Hayton, BEERA
James Kealy, BEERA
Kathleen Kunze, BEERA
Ron Poustchi, BEERA
John Ruhl, BEERA
Bridget Sweeney, BEERA

Field Team
John Evenson, BEMSA is responsible for field operations management and analytical services contract engagement as well as sample collection.
Robert Fowler, BEMSA is responsible for sample collection.
Michael Oudersluys, BEMSA is responsible for sample collection.

Technical Support

Paul Sanders, BEERA will provide data evaluation, design, and report generation support.

David Froehlich, Bureau of Information Services (BIS) will develop the Access database to store the collected data and provide database support.

Lori Lester, Division of Science, Research, and Environmental Health, will provide statistical and design support as needed.

Nick Procopio, Division of Science, Research, and Environmental Health, will provide statistical and design support as needed.

Harry Wertz, Office of Occupational Safety and Health (OOSH) is responsible for HASP development.

Stephanie Oliveira, Office of Occupational Safety and Health (OOSH) is responsible for HASP development.

4.0 QUALITY ASSURANCE OBJECTIVES

This section describes the overall QA objectives for data generated from soil collection. The types of sampling and analytical methods, including the QA/QC procedures, to be implemented are based on the project objectives discussed in **Section 1**.

The data collected and used shall meet overall QA objectives of this QAPP, including the data collection and assessment procedures. The data used during the decision-making process will also be within specified tolerances discussed below.

4.1. DATA MEASUREMENT OBJECTIVES

Data measurement objectives define data quality requirements to be met in order to support project objectives. Data measurement objectives are the data quality indicators needed to support specific decisions or regulatory actions, and include the following:

- The specification of particular analytical method(s) and reporting limit requirements
- The identification of the appropriate laboratory analytical QC requirements
- The selection of the appropriate levels of other precision, accuracy, representativeness, completeness, comparability and sensitivity (PARCCS) criteria for the data
- The specific sample-handling issues or other project-specific issues.

4.2. PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, COMPARABILITY, AND SENSITIVITY CRITERIA

PARCCS criteria are the qualitative and quantitative indicators of data quality. An objective of this QAPP is to provide quality parameters so that data are precise, accurate, representative, complete, comparable, and sensitive to actual site conditions. PARCCS criteria are defined as follows:

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is evaluated for analytical results using field and laboratory duplicates and duplicate matrix spike samples. It is expressed in terms of the relative percent difference (RPD) as shown below:

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

where:

C1 = concentration of sample or matrix spike (MS)

C2 = concentration of duplicate or matrix spike duplicate (MSD)

The acceptable limits of precision for this effort are 30%.

Accuracy is the degree of agreement of a measurement (or an average of the same measurement type), with an accepted reference or true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components due to sampling and analytical operations. Accuracy is evaluated using laboratory control samples (LCSs), MS and MSD samples, and surrogates, where applicable. Accuracy is typically expressed as percent recovery (%R), as shown below:

$$\%R = \frac{S - U}{C_{sa}} \times 100$$

where:

S = measured concentration of spiked aliquot

U = measured concentration of unspiked aliquot

Csa = concentration of spike added

The acceptable limits of accuracy for this effort are 70 to 130%.

Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, or an environmental condition. Representativeness is influenced by the number and location of the sampling points, sampling timing and frequency of monitoring efforts, as well as the field and laboratory procedures. The representativeness of data will be maintained by the use and consistent application of established field and laboratory procedures. The representativeness of data is established in the RI along with implementation of this QAPP, which is based on proven sampling and analysis techniques.

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. The data quality assessment process will be used to evaluate the validity of the data, and whether the number of samples and analyses proposed were actually obtained during the RI. Percent completeness is defined as:

$$Percent\ Completeness = \frac{V}{T} \times 100$$

where:

V = number of valid (not rejected) measurements over a given time; and

T = total number of measurements over a given time.

The overall completeness goal for this project will be **90** percent for all project data.

Comparability expresses the confidence with which one data set is similar to another, based on using standardized techniques and procedures (i.e., United States Environmental Protection Agency [USEPA]-approved procedures and methods), standard reference materials, QC samples and surrogates, as well as by reporting each data type in consistent units. Analytical methods employed will be the same or equivalent for all rounds of sampling. If USEPA procedures are not available, the procedures have been defined or referenced in this document.

Sensitivity is the capability of an analytical method or instrument to discriminate between measurement responses representing different concentrations of an analyte of interest. Additionally, sensitivity is evaluated using LCS, method detection limit (MDL) studies, initial calibration low standards at the quantitation limit.

A further discussion of QC samples to be analyzed is presented in Section 6 of this QAPP. Procedures for assessing precision, accuracy, and completeness are presented in Section 7.

The NJDEP FSPM (2005, 2011), will be used for quality management of the field activities outlined in the study. The following sections provide a detailed description of field data and notes collection, instrument calibration and maintenance, decontamination procedures, and residual management.

4.3. MANAGEMENT PROCEDURES

4.3.1. FIELD LOGBOOKS

Field logbooks contain the documentary evidence for procedures as performed by field personnel. Hard cover, bound field logbooks will be used for this RI. The pages of the notebook will be numbered consecutively and will not be removed.

Entries will be made in waterproof, indelible blue or black ink. No erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike mark, and the correction initialed and dated by the team member making the correction.

Each entry will be dated. Entries will be legible and contain accurate and complete documentation of the individual or sampling team's activities or observations made. The level of detail will be sufficient to explain and reconstruct the activity conducted for an individual independent of the field activities. Each entry will be signed by the person(s) making the entry.

The following types of information will be provided for each sampling task, as appropriate:

- Project name and number
- Reasons for being on-site or taking the sample, such as quarterly sampling, re-sampling to confirm previous analysis, initial site assessment, etc.
- Date and time of activity
- Sample identification number
- Geographical location of the sampling point with reference to site (or other) facilities or a map coordinate system. Sketches will be made in the field logbook, when appropriate
- Physical location of the sampling point, such as depth below ground surface or water surface
- Description of the sampling method including procedures followed, equipment used, and any departure from the specified procedures. Volume of water purged and water levels will be included for ground water samples
- Description of the sample, such as physical characteristics, odor, etc.

- Results of field measurements, such as temperature, specific conductivity, hydrogen ion concentration (pH), dissolved oxygen, organic vapors, etc.
- Readings obtained from health and safety monitoring equipment
- Weather conditions at the time of sampling and previous meteorological events that may affect the representative nature of a sample
- Photographic information, including a brief description of what was photographed, the date and time, the compass direction of the picture, and the number of the negative on the roll (for film) or the number of the photograph (for digital). Once the film has been developed, each slide or photographic print should be serialized corresponding to its notebook entry and labeled with the signature of the photographer, the time and date of the photograph, and site location. For digital photographs, each picture should be downloaded from the camera as soon as possible and electronically incorporated into a photo log with captions that include pertinent information.
- Reference numbers from all serialized forms on which the sample is listed or labels which are attached to the sample (i.e., chain of custody forms, air bill numbers, etc.)
- Other pertinent observations, such as the presence of other persons on the site (those associated with the job or members of the press, special interest groups, or passers-by), actions by others that may affect performance of site tasks, or any unusual activities, etc.
- Names of sampling personnel and signature of persons making entries.

4.3.2. DECONTAMINATION PROCEDURES

Equipment and personnel decontamination areas will be conducted consistent with the NJDEP FSPM (2005, 2011). A designated area will be selected on-site to conduct the appropriate decontamination procedures. General decontamination for personnel and equipment are provided below.

Personnel

Decontamination of personnel is discussed in the Site-Specific Health & Safety Plan.

Sampling Equipment

Sampling equipment will be decontaminated prior to the sampling event.

Decontamination of Sampling and Field Measurement Equipment

Clean, wrapped, disposable sampling spoons/trowels, and/or bowls will be used to collect soil samples for chemical analysis. The equipment will be decontaminated prior to the sampling event.

Field decontamination will be performed as needed to minimize the potential for cross-contamination between sampling locations and contamination to off-site areas. Non-disposable sampling equipment will be decontaminated in the field consistent with the following procedures:

1. Laboratory grade glassware non-phosphate detergent (e.g., Liquinox™) and tap water scrub to remove visual contamination
2. Tap water rinse
3. Final distilled/deionized water rinse

If gross contamination is suspected or visual contamination is observed, the full eight step decontamination procedure will be performed, as outlined in Section 2.4.1 of the NJDEP FSPM (2005, 2011).

4.3.3. RESIDUALS MANAGEMENT

Debris (e.g., wood, paper, plastic, polyethylene tubing and personnel protective equipment) will be collected and disposed of as municipal solid waste.

Residual solids, such as drill cuttings, will be used as backfill or stored in Department of Transportation (DOT)-approved 55-gallon drums for later off-site disposal by a qualified waste disposal subcontractor. Residual fluids (e.g., monitoring well development and purge water), will be discharged back on-site to a permeable surface, unless free or residual product has contaminated the material. If free or residual product is encountered, then the residual solids will be properly disposed off-site. The residual materials will be disposed of consistent with applicable federal and state regulations, including N.J.A.C. 7:26E-1 et seq.

5.0 ANALYTICAL METHODS

Soil samples will be collected consistent with the NJDEP FSPM (2005, 2011) and USEPA method requirements, and submitted for chemical analyses to a National Environmental Laboratory Accreditation Program (NELAP) and State of New Jersey-accredited off-site analytical laboratory. The following analyses will be performed for the specific matrices:

Analytical Parameters	Analytical Method	Media
Investigation Analyses		
SVO+TICs ^	USEPA Method 8270C or CLP equivalent	Soil
TAL metals	USEPA CLP ISM01.3	Soil

Notes
SVO+TICs ^ - NJDEP acronym for USEPA Target Compound List (TCL) semivolatile organic compounds (SVOCs) with a library search of the 15 highest Tentatively Identified Compounds (TICs).

5.1. DATA REDUCTION AND DOCUMENTATION

The laboratory will be responsible for maintaining supporting documentation as per the analytical services contract in the form of sample preparation logs, instrument run logs, maintenance logs, standards receipt and preparation logs, instrument printouts, and chromatograms. Calculations should be clearly identified in the sample analysis records or in laboratory standard operating procedures (SOPs).

The laboratory will maintain records documenting each phase of sample handling, from receipt to final report of analysis. Accountable documents used by laboratories include sample receipt forms, laboratory operation logbooks, COC records, bench work sheets, and other documents relating to sample preparation or analysis. The laboratory will utilize a document numbering and identification system for all documents/logs.

The analytical laboratory will record all observations, pre-screening data, and results on either pre-printed laboratory forms or permanently-bound laboratory logbooks, or entered into secure computer systems. Pages, in both the bound and unbound logbooks, will be sequentially-numbered. Pre-printed laboratory forms will contain the project laboratory's name, date (month/day/year) and time of activity, and signature of the person(s) performing associated laboratory activities. Permanently-bound laboratory logbooks will include the date (month/day/year) and time of activity, and signature of the person(s) performing associated laboratory activities. All logbook entries will be in chronological order and recorded in indelible ink. Corrections will consist of line-out deletions that will be initialed and dated by the person making the correction. Each entry will be signed and dated, and the remaining space on each page will be crossed out. Computer forms will contain the project laboratory's name, date, and signature of the person performing the activity when the form is printed.

Computer systems will be configured for restricted access and provide for appropriate backups and audit trails. Instrument run logs will be maintained to allow for a complete reconstruction of the run sequence for each instrument and will include calibration, QC samples, and project sample data. Computer logs can be used if all of the preceding information is captured. Computer/instrument printouts, or other independent information, can be incorporated into logbooks if permanently affixed to the instrument-specific logbook.

Analytical data generated by the laboratory for this project will undergo a QC review prior to release of the reported data. Each step of this review process involves evaluation of data quality based on both the results of the QC data and the professional judgment of those performing the review. This application of technical knowledge and experience to the data evaluation is essential so that data of high quality are generated consistently.

5.2. LABORATORY DATA DELIVERABLE FORMAT

Each sample delivery group (SDG) generated by the project laboratory will be reported in hardcopy format and as an electronic data deliverable (EDD). The hardcopy deliverable package will conform to the requirements for a Full Laboratory Data Deliverable - Non-United States Environmental Protection Agency/Contract Laboratory Program (Non-USEPA/CLP) Methods (as specified in N.J.A.C 7:26E, Appendix A) including the laboratory receipt form, which must include recording of the temperature of the cooler upon receipt at the laboratory, and all raw data (Level IV equivalent). EDDs will be required to be formatted in accordance with the NJDEP Site Remediation Program's (SRP) "Electronic Data Interchange Manual," which is available at www.nj.gov/dep/srp/hazsite/docs/.

All EDDs shall be correct, complete, and compliant with the final hard copy data report. The laboratory subcontractor will implement the necessary QA/QC prior to delivery to ensure complete agreement of hard copy and EDD. The hard copy report and EDD shall be delivered at the same time

5.3. QUALITY CONTROL DATA REVIEW

Level 1: Analyst Review

Each analyst will review the quality of his/her work based on an established set of guidelines. The review criteria as established in each method, in this document, or within the laboratory will be used. The analyst review will be documented by using a check list, dated and signed by the reviewer.

Level 2: Peer Review.

The Level 2 (or peer) review will be performed by a supervisor or data review specialist whose function is to provide an independent, peer review of the data package. This review will also be performed according to an established set of laboratory guidelines.

The peer review will be structured to include all calibration, QC samples, and project sample data at a minimum frequency of 25 percent and will be checked against the raw data and/or bench sheets. If no discrepancies are found with the data package, the review will be complete. If discrepancies are identified, then all sample results will be checked. All errors and corrections will be documented on a check list, with the signature of the reviewer, and date.

Level 3: Administrative Review

The Level 3 (or administrative) review will be performed by the Laboratory Program Administrator. This review will provide a total overview of the data package to ensure its consistency and compliance with project-specific requirements. All errors will be corrected and documented. If significant errors are identified, samples may need to be re-extracted and reanalyzed. The administrative review will also be documented on a checklist, dated, and signed by the reviewer.

Quality Assurance Review

The QA review will be performed by the Laboratory QA Office and is similar to the Level 3 review. This review is independent of the data reduction and production operations. The QA Officer will randomly select the data packages to be reviewed, at a minimum of 10 percent of the data generated. As a result of the QA review, additional analytical data or quality control parameters may be reviewed. Noncompliant reports will be required for any discrepancies noted.

5.4. TREATMENT OF OUTLIERS

During the QC review process, laboratory data qualifiers (or flags) will be applied to any outlying data. These qualifiers will be applied when acceptance criteria and/or corrective actions remain out-of-control. Some of the laboratory flags that may be applied during this project are as follows:

U - The analyte was analyzed for, but was not detected above the adjusted sample reporting limit.

J - The analyte was detected, but the result is an estimated concentration of the analyte. This qualifier may also be applied for reported values between the method reporting limit (MRL) and the MDL.

E - The reported value exceeds the instrument calibration range.

D – The reported value is the result of a dilution.

B - The analyte was detected in the associated method blank.

Each flag used by the laboratory will be defined in the case narrative of the SDG. These flags will also identify any suspected bias in the data, either low or high.

6.0 SAMPLE COLLECTION

6.1. SAMPLING PROGRAM

Samples, per media, will be collected consistent with the NJDEP FSPM (2005, 2011) and USEPA analytical method requirements. A sampling summary for tasks specific to the investigation and sampling of soil is presented in Section 2. The analytical method planned for use in analyzing collected soil is for semi-volatile organic compounds in a soil medium is (CLP OLMO 2.1 or SW8070C or equivalent. Similarly, the analytical method planned for use in analyzing collected soil for metals is CLP ISM01.3.

QA information is as follows: field duplicates (as needed) and matrix spike/matrix spike duplicate (MS/MSD) samples per sample delivery group of 20. Laboratory analysis turn-around-time is as per the Sampling Assistance Contract in effect at the time of sampling, Preservation will be at 4° C in an appropriate sized glass container with a Teflon lined cap for semi-volatile organic compounds. Maximum holding time will be 14 days until extraction and 40 days after extraction. Preservation will be at 4° C in an appropriate sized plastic or glass container for metals. Maximum holding time will be 6 months after collection.

6.2. SAMPLE LABELING

Each sample collected will be placed in an appropriate sample container in accordance with the analytical method and assigned a unique identification number. Each sample container will have a waterproof sample label affixed to the outside of the container with the following information provided in waterproof ink:

- Project name
- Sample identification number
- Date and time of sample collection
- Analysis required
- Preservatives (if any)
- Sampler's initials.

A **unique** "sample ID" will be assigned to each matrix sample and field QC sample collected, using an alphanumeric sequence as specified below. The sample ID shall not exceed 20

alphanumeric characters, although individual laboratories may be limited to fewer characters. For this project, the selected laboratory will be contacted to confirm the number of sample ID characters permitted by NJDEP HazSite Electronic Data Deliverable File Format. The sample ID is equivalent to the "location ID," as shown below, along with the sample depth (for soil, groundwater and soil vapor) and sampling date appended to it. Sample result tables will be generated from EQuIS using the location ID and the sample date.

Sample Type	Sample ID Location ID	Details
Soil	XXXX##DRQA/QC ESSE01SAMSMSD	XXXX## = Sampling location where the first 4 characters are the initial letters of the county of origin followed by a two digit sequential number; Depth (D) is either S = surface soil or B = subsurface soil; Additional modifiers to be added at the end include Horizontal Replicate (R) = A, B or C; QA/QC: MS = matrix spike, MSD = matrix spike duplicate, DUP = duplicate. Associated sample collection date will be added later.

If the laboratory is required to conduct MS/MSD analyses for a sample, the field sampler will collect three times the sample volume and note on the COC that MS/MSD are to be run. For example, when collecting groundwater samples, 3 vials will be collected for VOCs but 9 vials will be collected for VOC analysis with MS/MSD.

6.3. SAMPLE CONTAINERS

The sample containers will be supplied by the analytical laboratory and will be the proper container as required by the analytical methods to be performed. The laboratory-supplied containers will be cleaned and QC-tested consistent with the appropriate USEPA-approved methods prior to shipping the containers to the field sampling team.

Preservatives, when required, will be added to the sample container by the laboratory before shipment to the field with labeling identifying the preservative in the container. Sample containers with caps (e.g., glass jars, volatile organic analysis [VOA] vials, amber bottles, or polyethylene bottles) will be shipped in protective cardboard cartons or other wrapping to the user with sample coolers. Glass containers (including VOA vials) will be provided with Teflon®-lined caps or Teflon septa, and all polyethylene containers will be provided with polypropylene closures

The sampler must use the appropriate sample container as specified by the analytical method for each sample type**.**

6.4. SAMPLE HANDLING

Samples collected in the field for laboratory analysis will be placed directly into the laboratory-supplied sample containers as required by the analytical methods to be performed. Possession of samples collected in the field will be traceable from the time of collection through analysis and disposal by an analytical laboratory using COC documentation procedures. Samples will be packaged and shipped as described in Section 6.8. The COC procedures to be followed are described in Section 6.9.

Sample containers, including the field QC samples, will be placed into metal or plastic coolers. The coolers will be filled with ice in re-sealable plastic bags to maintain a temperature of less than or equal to 4 degrees Celsius (°C), not frozen. Coolers containing the sample containers and associated field (equipment rinsate) blanks and trip blanks will be received at the laboratory within

24 hours of their shipment from the field. The temperature in the coolers containing samples, including field QC samples, will be maintained at a temperature of less than or equal to 4°C (not frozen) while on-site and upon arrival at the analytical laboratory.

6.5. SAMPLE PRESERVATION

Sample preservation, used to minimize sample decomposition by contamination, degradation, biological transformation, chemical interactions, and other factors characteristics, and may include refrigeration of samples at less than or equal to 4°C (not frozen), pH adjustment, and/or addition of chemical preservative. Samples are preserved consistent with the requirements of the specific analytical method selected (Section 5.0). The analytical laboratory will add the required preservatives to the method-specific sample containers (with preservative recorded on the containers, if applicable) before shipment to the field. The following procedures summarize the requirements per media selected for this investigation. The analytical method, preservation, container type and size, and holding times are provided on Section 6.1.

- For soil/sediment samples, fill laboratory supplied sample container, seal with the supplied lid or cap with a custody seal, and place sample on sufficient ice to preserve to less than or equal to 4°C until receipt by the laboratory.

6.6. SAMPLE BLANKS AND DUPLICATE

Field duplicate samples will collected as needed on a project-specific basis, if appropriate for the study objectives. Field duplicate samples will be collected and must be submitted to the laboratory as “blind” samples per the FSPM. Field duplicates if needed will be collected at a frequency of 1 duplicate per 20 samples (or 5 percent) for each matrix. Field duplicate samples will be analyzed for the same suite of analytes as the parent sample.

6.7. MATRIX SPIKE AND MATRIX SPIKE DUPLICATE

MS/MSD samples are to be obtained for each analytical parameter. As stated in the NJDEP FSPM (2005, 2011), the frequency of MS/MSD collection should be one of the following:

- Each case of field samples, or
- Each 20 field samples within a case, or

- Each 14 calendar day period during which field samples in a case are received (said period beginning with the receipt of the first sample delivery group), or
- Whichever comes first.

The sample location selected for MS/MSD sample collection will require that triple the sample volume (soil) be obtained so that there is sufficient sample to prepare and analyze the MS/MSD samples at the above frequency. The sample designated for MS/MSD analysis will be noted on the record.

6.8. SAMPLE HANDLING AND SHIPMENT

Based on previous analytical data, the samples are expected to contain low concentrations of chemical contaminants, and will be packaged and shipped as environmental samples consistent with applicable federal and state regulations.

Packaging

Field personnel will use the following procedures when packing and transporting samples to the laboratory:

- Use waterproof metal or equivalent strength plastic ice chests.
- Attach label to the top of container that identifies the name of the project and NJDEP as the responsible for the samples.
- Wrap each glass container in "bubble wrap" or similar material.
- Package wet ice or a combination of wet ice and “blue ice” in plastic bags and place a "layer" of bags at the bottom of the ice chest.
- Place two sheets of cushion material, such as "bubble wrap" on the top of the layer of ice packages.
- Package samples in individual plastic bags prior to placement in the ice chest.
- Package wet ice or a combination of wet ice and “blue ice” in plastic bags and place bags around, among and on top of samples.
- Place "bubble wrap", bagged Styrofoam "peanuts" or other cushion material on top of the bags of ice.
- Put paperwork (chain-of-custody record, etc.) in a waterproof plastic bag and tape it to the inside lid of the sample shipment container.
- Tape the container shut with fiber-reinforced tape.

- Signed custody seals will be placed on the front and both sides of the cooler, before the cooler is placed in the custody of the overnight carrier.

Sample packaging and shipping procedures are based on USEPA specifications, as well as U.S. Department of Transportation regulations (49 *Code of Federal Regulations*). "Blue ice" packs and/or wet ice will be included in coolers containing samples that require temperature control, as specified in Section 6.1**.** The samples will be delivered to the laboratory by field personnel, transported by a laboratory courier, or shipped to the laboratory via an express mail service within 12 hours of sample collection.

The laboratory will be notified of a shipment of samples either by phone or sending copies of the COC records by email or fax. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed. Upon receipt by the laboratory, samples will be stored consistent with procedures established by the USEPA in the CLP Statement of Work (SOW).

6.9. CHAIN-OF-CUSTODY (COC) PROCEDURES

The COC record documents the transfer of sample custody from the time of sampling to laboratory disposal. The COC records will be completed by the sampler and will accompany the samples from the field to the analytical laboratory. Each individual that takes custody of the samples will sign the COC record at the time of transfer. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person or service who takes possession of the samples is responsible for sample integrity and safe keeping. The use of a courier service for sample shipping will be recorded on the COC and shipping documentation (i.e. air bill, etc.) will be tracked accordingly.

All entries will be made in waterproof, indelible blue or black ink. Erasures are not permitted. All applicable information on the COC record, including signatures, will be filled out completely and legibly. Unused space (rows) for sample/analysis information will be crossed out, initialed, and dated. Samples requiring different turnaround times will not be included together on the same COC record.

The COC procedures are discussed below:

- At the time of sample collection, the COC record will be completed for each sample collected by the sample collector, as well as the field QC samples, including the trip blanks. The sample identification number, date and time of sample collection, sample collector's name, analyses requested and other pertinent information (e.g., preservatives) will be recorded on the COC record. Additional sample volume collected for MS/MSD analysis by the laboratory will also be noted on the COC record.
- Field samplers will be responsible for the care and custody of the samples collected until the samples are transferred to another party, dispatched to the laboratory, or disposed, with the relinquishment of the samples recorded on the COC record. The sampling team leader will be responsible for enforcing COC procedures during field work.
- The sampling team leader will check the COC record(s) against the samples in the associated cooler to verify both the sample labels and the COC records are complete and correct. If the COC records are deemed correct and complete, the sampling team leader will sign each COC record. Necessary corrections will be made to the record with a single line strike-out, dated, and initialed by the person making the correction.
- Each cooler will be accompanied by the associated COC records that will be stored in a resealable plastic bag and placed on top of the samples or taped to the inside of the cooler lid.
- If samples are shipped by a third party courier, a shipping bill will be completed for each cooler and the shipping bill number recorded on the COC record.

Samples will be packaged for shipment and transported to the analytical laboratory under the appropriate COC record. A copy of the COC record will be sent to the laboratory and, and will also be retained by the sampling team for the project file and the original will be sent with the samples. Bills of lading will also be retained as part of the documentation for the COC records.

6.10. LABORATORY CUSTODY AND DOCUMENTATION

The analytical laboratory used during this study will be required to establish custody procedures that conform to those required by the CLP, as outlined in the USEPA's *User's Guide to the Contract Laboratory Program* (USEPA, 1991). These procedures include:

- designation of a laboratory sample custodian;
- completion by the custodian of the COC record, any sample tags, and laboratory request sheets, including documentation of sample condition upon receipt;

- laboratory sample tracking and documentation procedures;
- secure sample storage with the appropriate environment (e.g., refrigerated, dry); and
- proper data logging and documentation procedures, including custody of all original laboratory records.

A designated sample custodian will take custody of all samples upon their arrival at the laboratory. The custodian will inspect all sample labels and COC records to verify correspondence between information on the labels and COC records. The custodian will also inspect all samples and document any signs of damage or tampering and temperature discrepancies, and report these discrepancies or any missing samples to BEMSA who will then coordinate with the BEERA project leader within 24 hours. The custodian will then assign a unique laboratory number to each sample and will distribute the samples to the appropriate analysts or to secured storage areas. All sample transfers in the laboratory will be recorded.

7.0 ANALYTICAL QUALITY CONTROL PROCEDURES

Analytical QC procedures encompass the requirements established by the USEPA method-specific criteria, the NJDEP Site Remediation Program Data of Known Quality Protocols Technical Guidance Document (Version 1.0, April, 2014) and this QAPP. These procedures will be provided for by the laboratory QA program; be supported by SOPs; and will address QC samples, instrument calibration, preventive maintenance, internal QC checks and corrective action, and data review and reporting.

Both field and laboratory QC checks will be employed to evaluate the performance of field and laboratory analytical procedures. The QC checks will take the form of samples introduced into the sampling, sample transport, and analytical stream to enable evaluation of analytical accuracy and precision, as well representativeness.

7.1. LABORATORY QUALITY ASSURANCE PROGRAM

The project laboratories will maintain a current, written QA Plan, and will have the appropriate current state accreditations or NELAP accreditation.

7.1.1. LABORATORY STANDARD OPERATING PROCEDURES

The project laboratories shall maintain a controlled set of SOPs that shall serve as the implementing procedures for the laboratory QA program. The SOPs must be clear, comprehensive, current (reviewed annually), and sufficiently detailed to permit duplication of analytical results by qualified analysts. The laboratories must have an SOP for each of the reference methods performed on the project prior to commencement of work. Controlled revision to SOPs must be provided for in the laboratory QA program.

7.1.2. LABORATORY QUALITY CONTROL SAMPLES

The laboratory QC samples are used to assess data quality in terms of precision and accuracy, and verify that laboratory handling, extraction, and analytical procedures, are not introducing variables into the sampling chain that could compromise the validity of sample data. Such QC samples are regularly prepared in the laboratory so that all phases of the sample handling process are monitored. The types of QC samples to be collected during the project are discussed below.

7.1.2.1. DUPLICATES

A laboratory duplicate consists of two aliquots of the same sample taken in the laboratory and analyzed separately with identical preparation and analytical procedures. Analyses of both samples indicate precision associated with laboratory procedure, but not with sample collection, preservation or storage. Laboratory duplicates are not a substitute for field duplicates, but the RPDs are reviewed to evaluate the laboratory's performance, as discussed in Section 4.2.

7.1.2.2. BLANKS

A variety of QC blank samples will be used to assess the potential for sample contamination during the sampling and analysis processes. Laboratory QC samples, used for assessing the impact of contamination on sample results, include method blanks, calibration blanks, instrument blanks, and refrigerator storage blanks. The laboratory will utilize these QC sample types consistent with USEPA method-specific requirements.

7.1.2.3. SPIKES

The types of QC spike samples to be employed by the project laboratory include LCS and LCS duplicate (or blank spike/blank spike duplicate) and surrogates. A blank spike is a clean matrix (i.e., same used for a method blank) spiked with known concentration(s) of target analyte(s). The blank spike is carried through the entire analytical procedure to assess the overall accuracy of the method. The LCS is an independent sample from the continuing calibration verification standard and is not to be used for calibration verification purposes. A surrogate is a non-target analyte spiked at a known concentration prior to sample preparation. Surrogate analytes are used to monitor method performance on a matrix-specific/sample-specific basis.

For this project, the acceptance limits for precision and accuracy are presented in Section 4.2. One blank spike/blank spike duplicate set must be included with each analytical preparation batch of a maximum of 20 samples, or each SDG.

7.2. LABORATORY QUALITY CONTROL CHECKS

Laboratory checks will include the procedures detailed below.

- The reagents, gases, and standards required by a method will use the highest quality standards available. Materials and procedures will be recorded in a logbook to document

complete traceability a certified reference standard and source such as the National Institute of Standards and Technology.

- Instruments will be calibrated according to the manufacturer's instructions and as required by the USEPA analytical method. Where there are no specifications for each parameter, a five-point calibration curve will be implemented.
- Calibration of instruments will be documented in a bound logbook dedicated to each instrument, and records will be maintained.
- Continuing calibration standards will be analyzed and documented in a logbook for each analytical method during sample analysis as required by the method.
- The percent recovery and percent difference criteria for inorganics and organics continuing calibration shall be within the QC criteria of the requested analytical method.
- Laboratory method blanks will be included in every preparation batch or analytical batch at a minimum frequency of one per 20 samples.
- An analysis of one blank spike sample will be made for every 20 samples and will be fortified with representative compounds for each analytical method performed.

7.3. CONTROL CHARTS

Control charts will be used by the project laboratories to assess variability in QC parameters over time. At a minimum, the project laboratory shall control chart LCS or blank spike results for each method of analysis. In addition, all surrogate spike recoveries (from LCS/LCSD results) shall be monitored by use of control charts. In cases for which surrogate spikes are not applicable, LCS or blank spikes shall be monitored for accuracy. The project laboratories will include in their QA plan a description of the methodology used in control charting.

7.4. INSTRUMENT CALIBRATION

The project laboratories are required to document calibration procedures, and will be consistent with specified analytical method requirements. Multi-level initial calibrations are to be performed as required by the analytical method, and include an acceptable initial calibration verification standard (ICV), analyzed immediately after the initial calibration curve. If the relative standard deviations of the initial calibration or the ICV do not meet the analytical method requirements, a new calibration curve with an acceptable ICV is to be performed prior to sample analysis. Additionally, an acceptable continuing calibration verification standard (CCV) will be analyzed prior to the analysis of the samples. If two consecutive CCVs fail, then an acceptable initial

calibration curve is to be performed prior to sample analysis. All samples analyzed after a failed CCV will be reanalyzed with acceptable calibration standards – initial calibration curve, ICV, and CCV.

Calibration of field equipment and instrumentation will be consistent with the relevant manufacturer's specifications or applicable test method specifications.

7.5. PREVENTIVE MAINTENANCE

The project laboratory will perform and maintain records of preventive maintenance on instruments used for analysis of project samples. Preventive maintenance documentation is incorporated into NELAP or state laboratory accreditation requirements, and is an element of the laboratory QA plan.

7.6. INTERNAL QUALITY CONTROL AND CORRECTIVE ACTION

A method blank will be analyzed with every batch of 20 or fewer samples to measure laboratory contamination. The method blank will consist of ultrapure air or "clean" matrix, and will be carried through the entire preparation and analytical procedure. Acceptance criteria for method blanks must conform to reference method requirements when specified. Generally, corrective action is required if target compound concentrations in the method blank are greater than the MDL. Corrective action, including data flagging, is required when method blank concentrations are greater than the reporting detection limit, and the samples must be reprocessed if sample target compound/analyte concentrations are not greater than 10 times the method blank concentrations.

An LCS or blank spike set will be analyzed with every batch containing 20 samples or less to measure accuracy. The LCS or blank spike will consist of a method blank spiked with a known amount of analyte, and it will be carried through the entire preparation and analysis procedure. The standards source will be separate from that used to prepare calibration standards. The recoveries will be plotted on control charts, and control limits will be calculated based upon historical data. If control limits are exceeded, the analysis will be stopped and the problem corrected. Samples associated with the out-of-control LCS will be reanalyzed in another batch, unless documented evidence is presented to show that associated samples were not affected.

A laboratory duplicate will be analyzed for one out of every 20 samples to measure precision. If the RPD does not meet the required acceptance limits, the problem will be investigated and corrected. Any affected samples will be re-analyzed in a separate batch. Acceptance limits for precision in Section 4.2 will be used.

Surrogate spikes will be added to each sample submitted for organic analyses (as applicable) to measure sample-specific accuracy. The minimum number of surrogates for each parameter and the corresponding acceptance limits are listed in Section 4.2.

The laboratory will make every attempt to analyze the project samples submitted to laboratory for the same parameter utilizing the same instrument, not multiple instruments. If the laboratory is not able to utilize the same instrument, the laboratory will notify BEMSA and the BEERA project lead.

7.7. DATA CALCULATION AND REPORTING UNITS

Calculations of results will be documented in the laboratory SOPs and must be consistent with the reference method. Reporting units will be consistent with applicable regulatory and decision thresholds.

7.8. DOCUMENTATION AND DELIVERABLES

The project laboratory is responsible for maintaining supporting documentation in the form of sample preparation logs; instrument run logs; maintenance logs; standards, receipt, and preparation logs; instrument printouts; and chromatograms. Calculations should be clearly identified in the sample analysis records or in laboratory SOPs

8.0 DATA QUALITY MANAGEMENT

Data quality management includes data management, data quality assessment (i.e., data review, verification, validation, and usability assessment), preventive maintenance, and corrective actions as described below.

8.1. DATA MANAGEMENT

Data collected during this investigation will consist of various types of information, ranging from field measurements to laboratory analyses. Data requirements for this investigation will be governed by the specific type of data and the project-specific objectives. Chemical data management for this project will be directed and supervised by BEERA. Field data management will be directed and supervised by BEMSA.

8.2. DATA RECEIPT AND TRACKING

Data generated by the analytical laboratory will be submitted to ODQ in electronic and hard copy formats at the same time. Data submitted to ODQ will duplicate original data, which will be secured at the laboratory. Any laboratory sample ID system applied to the samples by the laboratory will be clearly cross-referenced in both the hard copy and electronic report formats to the original sample ID number designated on the COC record.

8.3. ELECTRONIC DATA DELIVERABLE

The laboratory will submit, at the same time as the hard copy data report, an EDD in ODQ and analytical services contract requirements for EQuIS EDD format and NJDEP EDD format. The EDD may be submitted by e-mail, the Internet, or compact disk with the hard copy report in the portable document format (pdf). The project laboratory will have a laboratory information management system (LIMS) that stores and reports the data. Manual creation of the deliverable (data entry by hand) is unacceptable. The data received in EDD formats must correspond exactly to the hard copy data. The laboratory will be submitting the data to ODQ to allow generation of a results summary in Excel format prior to uploading to the database.

8.4. DATA ARCHIVE

Hard copies of all SDGs will be managed by BEERA and will be archived in the project files. Laboratory data will also be archived in a project-wide database. The laboratory will maintain all data associated with the project in a locked and secure location for a minimum of 5 years following submittal of the hard copy and EDDs.

Field data documentation, including completed daily field reports, measurement logs, and photographs, will also be archived in the project files. Field data archival will be the responsibility of BEMSA initially.

8.5. DATA QUALITY ASSESSMENT

Data quality assessment is the process in which data is examined and evaluated throughout the project and will include data review, verification, validation, and usability assessment in terms of the PARCCS criteria. However, all project personnel, including field personnel and the project chemist, will be responsible for performing some level of data review and verification, and should have a clear understanding of field documentation protocols and procedures, as well as the types of data being generated under these procedures.

Data verification and validation will be performed under the guidance of the USEPA's *Guidance on Environmental Data Verification and Data Validation,* EPA QA/G-8 (November 2002, reissued 2008). If deficiencies are identified, personnel involved in the review and verification process are responsible for documenting deficiencies and whether corrective action should be taken, if any. Field and laboratory documentation will be evaluated to verify that the data are complete, correct, and conform to the criteria defined in this QAPP.

8.5.1. DATA VERIFICATION

The objective of data verification is to assess whether the data required for the project are correct, complete, and compliant with contractual, method, or procedural requirements. Verification is a completeness check that is performed before the data quality assessment process continues in order to evaluate whether the required information (the complete data package) is available for further review. It is an evaluation of performance compared to the specified or pre-established parameters presented in the SSIP, field and laboratory SOPs, and this QAPP. Field and laboratory data will be managed using manual and electronic systems. Data stored, evaluated,

and reported electronically will be potentially subject (at the discretion of BEERA) to approximately 10 percent verification against hard copy data reports. Discrepancies will be corrected either internally or via a resubmittal by the laboratory within 72 hours of the resubmittal request and documented. If significant discrepancies or errors are identified during the 10 percent verification, the percentage of data verified may increase to full verification, as warranted. Although verification is not designed for use in a qualitative review, it is essential for assessing the availability of information for subsequent steps of the data quality assessment process.

The requirements for performance of analytical laboratory analysis are specified in the analytical services contract under which the work is performed. The contract specifies deliverables, turnaround time, and performance standards. Outstanding items will be resolved before the project closed.

8.5.2. DATA VALIDATION

The data validation process consists of a systematic assessment and verification of data quality through independent review. Validation will be performed at the discretion of BEERA. Data validation procedures will be consistent with this QAPP and USEPA CLP National Functional Guidelines, modified as necessary to accommodate non-CLP methods. Level II, III and IV data validation requirements and criteria are described below:

- Level IV data validation follows the USEPA protocols and CLP criteria set forth in the USEPA National Functional Guidelines for evaluating organic and inorganic analyses (USEPA 2008 and 2010, respectively). These guidelines apply to full (CLP-like) analytical data reports that include the raw data (e.g., spectra and chromatograms) and backup documentation for calibration standards, analysis run logs, instrument tuning, internal standards, LCS, dilution factors, and other types of information. This additional information is utilized in the Level IV data validation process for checking calculations of quantified analytical data. Calculations are checked for QC samples (e.g., MS/MSD and LCS data) and routine field samples (including field duplicates, field and equipment rinsate blanks, and trip blanks). To verify that the detection limit and data values are appropriate, an evaluation is made of instrument performance, method of calibration, and the original data for calibration standards.
- For Level III data validation, the data values for routine and QC samples are generally assumed to be correctly reported by the laboratory. Data quality is assessed by comparing the QC parameters listed above to the appropriate criteria (or limits), as specified in this

QAPP, by CLP requirements, or by method-specific requirements (e.g., USEPA CLP, SW-846). If calculations for quantitation are verified, it is done on a limited basis and may require raw data, in addition to, the standard data forms normally present in a laboratory analytical report.

- The Level II data validation consists of the review of the COC documentation that accompanied the samples to the laboratory, as well as the laboratory sample and QC summary results in the laboratory analytical report. Verification of calculations is not performed in this Level II review unless a "gross" deficiency that may affect data quality is noted during the review of the COC documents, laboratory case narrative, or results summary pages in the laboratory analytical report.

Data validation will be performed on the analytical laboratory data consistent with this QAPP and under the guidance of USEPA CLP *National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA, June 2008), *National Functional Guidelines for Inorganic Superfund Data Review* (USEPA, January 2010), and NJDEP SOPs for Analytical Data Validation. The following parameters, at a minimum, will be reviewed as part of the Level II (summary) data validation:

- COC records and sample condition (i.e. preservation, damage, etc.)
- Technical Holding Time
- Laboratory and field blanks,
- Laboratory duplicate or field duplicate samples,
- Initial and Continuing Calibration
- MS/MSD recoveries,
- LCS recoveries,
- Surrogate recoveries, if applicable,
- Compound identification
- Compound quantitation and sample reporting limits, including dilutions.

Following the completion of Level IV data validation process, a signed Data Validation Report will be prepared and provided to the NJDEP. The Data Validation Report will summarize the data validation process and its findings and qualifications consistent with the aforementioned guidance documents. Following the completion of the Level II data validation process, a Level II Data

Validation Checklist will be prepared for each SDG to be included in the final RI report. The Level II Checklists will be retained in the project files.

8.5.3. USABILITY ASSESSMENT

The usability assessment process is used to assess and document the usability of the data by considering quality objectives (e.g., PARCCS) and whether the data are suitable as a basis for the decision. All data types (e.g., sampling, field screening data, and laboratory analytical data) are relevant to the usability assessment. Data usability will include the entry of data validation flags to the project database.

The assessment should consider each type of data, the relationship to the entire data set, and the adequacy of the data to fulfill the data quality goals of the project. Data sets are assessed for completeness and compliance to method-specific or project-specific QA/QC requirements, including the results of the independent data validation process.

8.6. DATA DELIVERABLES

The analytical laboratory will submit a data quality deliverable for each batch of samples in hardcopy and electronic formats consistent with the data deliverable requirements discussed in Section 5.2. The laboratory will also provide the data as an EDD (Equis) for uploading to the database and in NJDEP EDD format. The EDDs will be verified at a minimum of approximately 10 percent of the sample data to the hard copy laboratory data deliverable(s) to verify that the EDDs include the same information as the hard copy report. Similarly, data that are reduced into tables and/or electronically re-formatted to facilitate data evaluation (e.g., data summary tables highlighting exceedances of cleanup standards) will be verified at a minimum of 10 percent of the sample data. If inaccuracies are detected, corrections will be made and additional data will be checked with appropriate corrective actions taken, including the request for resubmittals within 72 hours.

8.7. DATA REPORTING

Data reporting will be reviewed by qualified individuals independent of those performing the initial analysis. Preliminary or informal analysis of calculations may be performed by one or more reviewers and need not be completely checked but may be reviewed by ODQ. Final calculations and summary data tables will be made on calculation sheets or spreadsheets, respectively that have signoff blocks for peer review documentation.

Conclusions and/or recommendations will be reviewed by one or more peers, independent of the preparation of the conclusion/recommendation, to evaluate for accuracy of the information based on the data. Technical and/or quality peer reviews will be performed by independent qualified senior professionals who have the necessary technical knowledge and skill to perform the review. Technical or quality peer reviews will be documented and retained in the file.

9.0 REFERENCES

New Jersey Department of Environmental Protection (NJDEP). *Field Sampling Procedures Manual*. August 2005, amended April 2011.

New Jersey Department of Environmental Protection (NJDEP) Standard Operating Procedures for Analytical Data Validation. Bureau of Environmental Measurements and Quality Assurance. 5.a.15 (Revision 2 - October 31, 2001), 5.a.13 (Revision 3 - October 31, 2001), and 5.a.16 (Revision 1 - June 17, 2002).

United States Environmental Protection Agency (USEPA). *User's Guide to the Contract Laboratory Program.* EPA 540 P-91-002. January 1991.

USEPA. *EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. EPA-540-R-08-01. June 2008.

USEPA. *EPA Guidance on Environmental Data Verification and Data Validation*. USEPA QA/G-8, November 2002, reissued 2008.

USEPA. *Validating Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, SW-846 Method 8270D*. USEPA SOP #HW-22, August 2008 (revision 4).

APPENDIX 2

E-Z HASP FOR
Site Name: POLYCYCLIC AROMATIC HYDROCARBONS STUDY

E-Z HASP FOR
Site Name: POLYCYCLIC AROMATIC HYDROCARBONS STUDY

INTRODUCTION

This site health and safety plan (HASP) provides site specific guidelines and information for on-site activities. In general, all field activities are to be performed in accordance with all applicable health and safety standard operating procedures (SOPS) and policies of both the Department and the Site Remediation and Waste Management Program as well as the site-specific procedures presented herein. Initial selection or approval of the level of protection (LOP) for a site or task shall be made by the assigned Health and Safety Coordinator. If site conditions necessitate a modification of the initial selection, the team leader or ranking division representative at the site must notify the Office of Site Safety and Health (OSSH) of the change as soon as possible. All modifications shall be made in accordance with applicable SOPs. When practical, agreement shall be reached with OSSH on all on-site modifications before they are implemented.

SECTION 1 - GENERAL SITE INFORMATION

Site: Polycyclic Aromatic Hydrocarbons Study
Location: Statewide
City/Town: TBD **County:** All
Site Description: The Site Remediation and Waste Management Program (SRP) is interested in performing a two year study to evaluate background concentrations of polycyclic aromatic hydrocarbons (PAH) throughout New Jersey. This study is intended as an extension of previous background work that the Department had performed between 1996 and 2001. The primary focus of the conceptual plan is to collect paired surface and subsurface samples from locations not subject to a known discharge from an identifiable/distinct source. The collected soil will be analyzed for PAHs (inclusive of the necessary QA/QC).

The sample locations will primarily be from developed areas throughout the state. Developed areas are defined for this study as being more densely populated and utilized areas of the state. Sampling of parks and public areas within these developed areas is favored to minimize access issues. The intent of this effort, in part, is to assess whether or not the range of PAH background concentrations within developed areas correlates either with proximity to discharges or with increased utilization of the area as reflected by population density.

DEP Case Lead: Teruo Sugihara
DEP Site Personnel: *Name Bureau/office phone #*
Project Manager: Teruo Sugihara BEERA 609.633.1356
Health and Safety Coordinator: Stephanie Oliveira OSSH 609.530.2144
Project Coordinator: Kevin Schick BEERA 609.984.1825
Personnel Proposed for Site Activities: Sampling Team
Other DEP personnel: Sampling Teams

Dates of Proposed Work: January 2016– July 2017 **Anticipated duration of field work:** _18_ months

SECTION 2 - SITE HAZARDS

Contaminant/Waste Characteristics:

General Forms: _X_solid ___ liquid ____sludge ___ gas/vapor

Contaminant/Waste classes:

____ corrosive ____radioactive ____reactive ___ volatile _X_ toxic ____ignitable
____ unknown _____ other

Known or suspected contaminant/wastes present: (attach Hazardous Substance Fact Sheets)
Substances Concentration/Media TWA (ppm/mp/m3) Primary Hazard suspected:

PAHs unknown NIOSH REL: Carcinogen; Inhalation
0.1 mg/m3 and Dermal exposure. Target
Organs: Liver & Kidneys

Safety hazards:

_X_ poison ivy/oak
_X_ wet or slippery surfaces
____ darkness
____ excessive noise (drill rig)
_X_ surface debris (broken glass, sharp objects)
____ excavations
_X_ unstable building structures
____ heavy equipment
_X_ stacked drums
_X_ automotive traffic
_X_ ticks or other insects
_X_ infectious waste/biohazards
_X_ above ground or underground utilities**
____ confined spaces (non-permit required)
_X_ hoses, tools, debris etc.. lying on ground (slip, trip, fall)

Other safety hazards: Sampling will be done throughout the entire state of New Jersey in many season changes. Weather related hazards should be considered. Other hazards include roadway traffic and the hazards associated with entering unknown sites.

****Under Ground Utilities:** *(gas, water, sewer, cable, phone and electric or process related)* No ground intrusive work is to commence without a **current** (less than 10 working days from original call date to One-Call System) under ground utility mark out and an inspection/check of the area by OSSH if digging is to be done by DEP personnel.

Potential for heat/cold stress: Temperatures are expected to be in the _20_ to _90_ ° range. There is a minimal, moderate to severe potential for either heat/cold stress depending sampling dates. (see Section 7.3 a & b)

SECTION 3 - SITE OPERATIONS

Tasks to be performed:

Indicate number of each below, if known:

____ Hydropunch ____ Potable wells ____ Building demolition
____ Geoprobe ____ Monitoring wells ____ UST removal
____ Hand auger for soil samples ____ Soil gas ____ capping/paving
____ Ground water samples ____ Soil samples ____ waste sampling
____ Surface water samples ____ Trenching/Excavation ____ drum removal
_n/a_ Trowel samples

Site Map: Attach to HASP

Describe the locations of the following and indicate their locations on the attached work zone map:

Eye wash: (required for work w/corrosives associated with preservation of samples)
First Aid Kit: in at least one vehicle on site
Fire Extinguisher: in at least one vehicle on site
Rest Area: in "clean area", preferably in shade if in summer, or warm, dry location in winter

SECTION 4 - PERSONAL PROTECTION

All persons shall comply with the Department's and the SRP's policies and procedures for Personal Protective Clothing and Respiratory Protection:

1. Shall have their assigned respiratory protection, on site if there is a reasonable potential for an upgrade to Level C.
2. When it is established that there is a potential need for upgrade to Level C, be devoid of facial hair, or items that would interfere with the sealing of the respirator face piece.
3. Shall have a sufficient supply of appropriate protective clothing for the duration of each day at the job.

Indicate the Level of Protection to be employed for each site task

TASK INITIAL L.O.P.: Level D/Modified D*

* Modified Level D is defined as any chemical protective clothing ensemble worn without inclusion of an air purifying respirator (latex gloves, tyvek etc.)

UPGRADE L.O.P.: Level C
Protective Equipment for each level of protection is as follows:

Level D/Modified D:

_X_ steel toe/shank safety shoes or steel toed/shank rubber boots
_X_ work coveralls
___ Tyvec coveralls (Modified D)
___ outer gloves (Modified. D - Nitrile gloves will be used for general , low level contaminant site work unless otherwise noted)
_X_ Nitrile or Latex inner gloves (Modified D)
___ Dust mask (Modified D)
_X_ hard hat (heavy equipment or other overhead hazard)
_X_ safety glasses
___ hearing protection
_X_ work gloves

Level C:

_X_ steel toe/shank safety shoes
_X_ rubber overboots or disposable boot covers
_X_ full-face respirator with fresh GMEP100 cartridges
_X_ Tyvec (white or yellow PVC coveralls, depending on contaminants)
_X_ outer gloves (type dependent on hazardous materials/contaminants present, Nitrile, on Neoprene will generally be used unless handling high concentration liquids or pure product) - Consult OSSH
_X_ Latex or Nitrile inner gloves
_X_ hard hat
___ hearing protection

Other safety equipment:

___ face shields
___ duct tape
_X_ tick spray ___ other(s) _____
_X_ sunscreen _____
_X_ cooler(s) with ice
_X_ gatorade and cups
___ work lights
___ generator with extension cords
___ flashlights
_X_ dust mask (nuisance dust only)
_X_ traffic cones/traffic safety signs (street and near street work anticipated)
_X_ safety vest (street, near street, parking lots and other areas with vehicle traffic)
_X_ temporary, magnetic flashing warning lights (street work)

SECTION 5 - AIR MONITORING

Monitoring instruments selected: As Needed
Instrument Settings Calibrant Frequency
(make/model) (span, etc.) (type/cone) of Use

FOXBORO TVA 1000 methane and breathing zone at sample collection
(FID and PID) isobutyene areas
*continuously, if Level C and above
MultiRAE Multi Gas
Monitor (PID & CGI/02/CO) isobutyene
MSA Orion pentane
(Equivalent instrumentation may be provided/used by DEP contractors with OSSH prior approval)

Air Quality Action Levels

Unknown Organic Vapors: Background Level D
*>Background-5ppm in breathing zone Level C
* 5-500 in breathing zone Level B
* 500-1000 in breathing zone Level A
* Concentrations above background in breathing zone sustained for one minute or longer
** NOTE: These action levels established by the USEPA Emergency Response Team when contaminants are unknown and are guidance only and do not apply to substances with very low TLVs or IDLH concentrations. Action levels should be revised when these substances are known or suspected to be on site. There are also substances against which full-face, cartridge equipped masks do not protect.

Oxygen: Less than 19.5% or more than 23.5% - leave site
Combustible Gases: >10% LEL - Leave site
Radiation: > 0.08 mR/hr - proceed with caution
> 1 mR/hr - continue only upon advice of health physicist

OTHER MONITORING OR SAMPLING: None

SECTION 6 – DECONTAMINATION

(As Needed)
All personnel and portable equipment used on site shall be thoroughly decontaminated before leaving work areas or exclusion zones.

6.2 Decontamination Procedure for Non Exclusion Zone Activities (no, or minimal contamination present)

1. Remove outer gloves (if present)
2. Remove inner surgical gloves
3. Wash hands, arms and face

6.3 Decontamination of Equipment and Instruments

When potential contaminants are present, electronic instruments should be wrapped in plastic for protection to avoid washing instruments with water. Heavy equipment such as drill rigs, backhoes and coring rods will be steam cleaned. Sampling equipment will be washed in Alconox and water, rinsed, or steam cleaned, with tap water and bagged for return to the DEP Environmental Equipment Center or the contractor's decontamination area/facility.

6.4 Disposal of Contaminated Material

Contaminated rinsate from decontamination of personnel and equipment will be disposed of per state/federal guidelines, unless other arrangements have been made. Contaminants introduced into the decon. solution during decontamination will consists primarily of surface, or ground water, contaminants and soil contaminants present at the site. Since most spent decontamination solutions originate at sites where there is already soil and/or ground water contamination and in most cases the contaminant concentration of the rinsate is relatively low, and since trisodium phosphate is relatively biodegradable, there should normally be no statutory restriction from discharging the spent solution to the surface of the site. In cases where the spent solution is suspected to be highly contaminated, appropriate treatment, containment, storage and disposal shall be sought by the responsible NJDEP supervisor.

Solid waste, such as single use sampling equipment, gloves, booties and other single use protective clothing, once used, shall be stored in polyethylene trash bags (available at the EESC) and be transported to the nearest outdoor State owned solid waste disposal container, including, but not limited to:

1. The EESC solid waste disposal container
2. The solid waste disposal container at any NJDEP satellite location
3. The solid waste container at any NJDOT maintenance yard

In some cases, such as secured sites, where activities are being performed by either a responsible party, or publicly funded contractor, it may be appropriate to leave contaminated items at the site for disposal by the contractor.

6.5 Decontamination Equipment and Supply Checklist

___ steam cleaner/power washer
_X_ buckets
___ other _____
___ water sprayers
_X_ scrub brushes
_X_ Alconox
_X_ deionized water
_X_ tap water
___ garden hoses
_X_ plastic garbage bags
_X_ disposable wipes

___ poly sheeting
___ 55- gallon drums

SECTION 7 - EMERGENCY RESPONSE

7.1 Communication

Team members will always work in groups of a minimum of two while on site. Visual contact distance among team members must be maintained at all times. Should an emergency occur other team members will be alerted via two-way radios, air horns, or other device. It is recommended that at least one cellular phone be available during site work. All site workers should be told where the cell phone is going to be kept so it can be easily located in the event of an emergency.

THREE HORN BLASTS is the emergency signal to indicate that all personnel should leave site, or
work area, and assemble at a previously agreed upon area (case manager's
vehicle, site entrance*)* for instructions

CONTINUOUS HORN BLAST is the emergency signal to indicate personnel injury in the work area and assemble at case manager's vehicle for instructions

7.2 Evacuation

In the event of an emergency, such as fire, explosion, gas release etc, personnel will leave the site, or work area, and meet at a location agreed upon before starting work (case manager's support vehicle, nearest street, facility entrance etc..)

7.3 Personnel Injury or Exposure

Emergency basic first aid shall be applied on-site as necessary. An eyewash station and First Aid kit shall be
available in at least one support vehicle.

- Skin or eye contact: Flush with water, decon and transport to hospital or, contact 911 if severity warrants
- Inhalation: Move person to fresh air, transport to hospital if signs of injury exposure persist, provide rescue breathing and contact 911 for respiratory emergencies.
- Ingestion: Call Poison Control or, 911 for instructions

7.3a Symptoms and First Aid for Heat Related Injuries:

Symptoms of **heat stress** include: fatigue and muscle weakness; reddening of extremities (ears); cramping of stomach, arms and legs.

Suggested Treatment/Prevention of More Severe Injury:

- Increase fluid intake
- Rest in shaded area
- Shorter work periods

 More frequent breaks

Symptoms of **severe heat injury** requiring IMMEDIATE MEDICAL ATTENTION include: seizures, fainting, loss of consciousness, bizarre behavior; profuse sweating then cessation of sweating resulting in hot dry skin.

Suggested First Aid:
 Cool victim
 Remove victim out sun into shaded area or air conditioned vehicle
 Dampen victims clothing and remove excess impervious garments
 Provide water, if conscious and not vomiting

CALL 911 AND ADMINISTER TREATMENT WHILE WAITING FOR EMTs FOR SEVERE HEAT INJURIES

An adequate supply of cool drinking water (at least 1 gallon per person) with an ample supply of disposable cups shall be present during each day of site operations, and be readily available to site personnel.

7.3b Symptoms and First Aid for Cold Related Injuries:

Symptoms of **cold stress** include: drowsiness, slurred speech, uncontrolled shivering (hypothermia), reduced sensation in fingers and toes (early stage of frostbite)
Symptoms of **severe cold injury** requiring IMMEDIATE MEDICAL ATTENTION include: frozen fingers or toes, uncontrolled shivering that persist after moving from cold, loss of consciousness.

Suggested First Aid:
 Remove victim out cold into warm/dry area (heated vehicle)
 Change from wet to dry clothing, add extra layers and or blanket if available
 Provide warm liquids, if conscious
 For frostbite, immerse affected area in warm, not hot water (DO NOT RUB)

CONTACT 911 OR, TRANSPORT TO HOSPITAL WHILE ADMINISTERING TREATMENT FOR SEVERE COLD INJURY OR SYMPTOMS THAT PERSIST.

7.4 Emergency Decon Procedures

If decon can be performed without aggravating injuries, or delaying life-saving treatment, protective clothing must be washed, and rinsed or cut off personnel.
If decon cannot be done, the victim must be wrapped in blankets, plastic or rubber to reduce contamination of other on-site personnel and rescue workers. Rescue workers and hospital personnel must be informed if victim is contaminated.

7.5 Emergency Information

Emergency Service Phone Number
Ambulance 911
Hospital Emergency Room:
List of approved hospitals attached.
Police 911
Fire Department 911
Poison Control Center 800-962-1253
NJDEP Communications Center / **DEP "Hot Line" 1-877-927-6337 (1-877-WARNDEP)**
Office of Site Safety and Health 609-588-2848
USEPA National Response Center 800-424-8802

If a field employee becomes injured or ill while on the job, transport to the nearest hospital which can be found on the approved hospital attachment. This is the nearest hospital and a Horizon Casualty Services, New Jersey State Worker, Workers Compensation approved medical facility. Also, contact the DEP, Employee Services Unit (ESU) **(609) 292-2156**. If no answer, or after normal business hours (8:00am-5:00 pm) contact the NJDEP Communications Center-Environmental Hotline **1-877-927-6337 (1-877-WARNDEP)**. DO NOT provide personal health care insurance information (Blue Cross/ HMO etc) to treating facility. State that the injury or illness is an "on the job injury" and Workers Compensation eligible.

If a DEP contractor employee becomes injured, he/she should be transported to the same hospital identified for DEP field employees, which will generally be the closest medical emergency facility. Procedures regarding insurance coverage of employee's company policy should be followed.

*** If the medical emergency is life threatening, call 911 and the NJDEP Communications Center and treat until emergency personnel arrive. If using a cell phone, be clear in providing your location. The 911 system cannot trace cell phone calls.**
*** * In case of emergency hospitalization, do not give personal insurance information. Inform hospital personnel that:**

1) PATIENT IS A NJDEP EMPLOYEE
2) INJURY/ILLNESS IS OCCUPATIONAL
3) BILL TO: HORIZON CASUALTY SERVICES
   33 WASHINGTON STREET
   NEWARK, N.J. 07102

***** Any occupational accident, injury, or illness that results in an emergency room visit, or fatality must be reported to the NJ Department of Labor (DOL), Public Employee Occupational Safety and Health (PEOSH) Program, within 8 hours (including weekends and Holidays) by contacting the following numbers:**

Core Business Hours (Mon - Fri : 8:00 am -5:00 pm)
NJDEP Employee Services Unit (ESU) 609-292-2156
AFTER Core Hours (Mon-Fri: 5:00 pm- 8:00 am & Weekends and Holidays)
NJDEP Communications Center (DEP HOT LINE) 1-877-927-6337 (1-877-WARNDEP)

SECTION 8 - GENERAL REQUIREMENTS

8.1 Training

Personnel engaging in exclusion zone activities must have completed a minimum of 40 hours of environmental safety and health training with a current 8-hour annual refresher. On-site managers and supervisors directly responsible for or who supervise personnel engaging in field activities shall have completed additional training in the supervision of those activities.

A site safety meeting shall be conducted prior to the start of on-site activities, and before each day's work, if necessary. This meeting is especially important when site activities are being performed by field workers provided through the Sampling Assistance Contract.

8.la. The following requirements must be addressed in order to comply with 29 CFR1910.120(b)(1)(iv) and (1)(v) of the OSHA Standard for Hazardous Waste Operations and the NJDEP *Minimum*

Requirements **for DEP contractors conducting work at hazardous waste sites and other related**
site work:

All DEP contractors must provide a Health and Safety Plan (Generic, or Programmatic HASP) for approval by the Office of Site Safety and Health (OSSH), Division of Emergency Management Program, New Jersey Department of Environmental Protection. It is the contractor's responsibility to insure that any subcontractors it brings on site have met the minimum training requirements and that any workers potentially exposed to hazardous materials are enrolled in a medical surveillance program.
The Generic HASP and all other related documentation for NJDEP, Site Remediation Program personnel is maintained by the Office of Site Safety and Health.

8.2 Medical Surveillance

All personnel, including contractors, who are potentially exposed to hazardous substances must be enrolled in a medical surveillance program (MSP) and must have had an up-to-date physical.

8.3 General Safety Rules (may or, may not apply, depending on site conditions)

a. All personnel shall wash hands, arms and face before eating, smoking or drinking and at the end of the work day.
b. Where required and practical, all tools/equipment will be spark proof, explosion resistant, and/or bonded and grounded.

c. Fire extinguishers will be on-site for use on equipment or small fires only.

8.4 Other Safety Precautions and Hazardous Operations

a. Confined Space Operations:
Generally, no confined space entries are permitted by DEP personnel.

b. Limited Space Activities: (basements and crawl spaces, buildings)
Hazards: overhead beams, exposed nails, electric wiring, pipes, insulation material, dust, molds, poor lighting, vermin
Precautions:

1. wear coveralls, gloves, hardhat, dusk mask
2. flashlight
3. have an outside attendant

c. Site Security:
All personnel have been briefed (at safety meeting and site visit) of the secured areas.
All secured and limited entry areas have been barricaded and marked at their perimeter and entry points.

d. Excavation and Trenching:
Trenching and Excavation operations are to be performed at (locations):
Compliance with the 29 CFR1926 and other federal and local agencies shall be enforced.

If you hit a gas line:

- Extinguish all open flames immediately (steam cleaner). Prohibit Smoking.
- Avoid any activity that could cause a spark, turn off all machinery. Do not use cellular phone until away from and upwind from area.
- Alert everyone on premises, or in area of potential danger. Keep public and traffic away.
- Evacuate area or site.
- Call 911.
- Place cones around area. Stay upwind.
- Call appropriate gas utility below:
  PSE&G 1-800-880-PSEG
  NJNG 1-800-GAS-LEAK
  So. Jersey Gas 1-800-582-7060
  Elizabethtown Gas 1-800-492-4009
- Wait for professionals to arrive.

APPENDIX 3

Phase I: PAH Data

Phase I: PAH Data

Aalytical Parameter	Abbreviation
Acenaphthene	Ace
Acenaphthylene	Acy
Anthracene	A
Benzo(a)anthracene	BaA
Benzo(a)pyrene	BaP
Benzo(b)fluoranthene	BbFl
Benzo(g,h,i)perylene	BPer
Benzo(k)fluoranthene	BkFl
Chrysene	Chry
Dibenzo(a,h)anthracene	DahA
Fluoranthene	Fl
Fluorene	F
Indeno(1,2,3-cd)pyrene	IndP
Naphthalene	Naph
Phenanthrene	Phen
Pyrene	P

Atlantic County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
ATLA02A	0.015	0.0065	0.045	0.28	0.26	0.3	0.17	0.29	0.34	0.077	0.7	0.017	0.17	0	0.29	0.77
ATLA02B	0.0087	0	0.022	0.15	0.13	0.2	0.091	0.15	0.17	0.051	0.32	0	0.071	0	0.14	0.28
ATLA02C	0.013	0	0.029	0.17	0.18	0.21	0.11	0.21	0.22	0.067	0.48	0.011	0.11	0	0.17	0.41
ATLA05	0.0061	0	0.011	0.072	0.08	0.1	0.059	0.092	0.13	0.026	0.31	0	0.059	0	0.14	0.23
ATLA07	0	0	0.0055	0.05	0.081	0.096	0.044	0.072	0.096	0.023	0.2	0	0.047	0	0.078	0.17
ATLA09	0	0	0	0	0	0	0	0	0	0	0.0093	0	0	0	0.0058	0.015
ATLA10	0	0.014	0.017	0.27	0.27	0.32	0.19	0.28	0.36	0.11	0.68	0.032	0.14	0	0.43	0.62

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
ATLA02A	0.0091	0	0.029	0.15	0.14	0.14	0.089	0.15	0.19	0.042	0.4	0.009	0.088	0	0.16	0.37
ATLA02B	0.015	0	0.031	0.16	0.17	0.16	0.091	0.2	0.2	0.041	0.35	0.024	0.081	0.015	0.24	0.33
ATLA02C	0.016	0	0.031	0.21	0.21	0.27	0.11	0.24	0.25	0.052	0.46	0.009	0.12	0	0.22	0.39
ATLA05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATLA07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATLA09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ATLA10	0.0075	0.0076	0.018	0.14	0.16	0.16	0.095	0.19	0.2	0.057	0.43	0.014	0.087	0.0042	0.28	0.35

Bergen County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
BERG01	0	0	0	0.033	0.045	0.045	0	0.04	0.045	0	0.064	0	0	0	0.03	0.07
BERG02	0.035	0.028	0.07	0.71	0.74	1.2	0.45	0.46	0.75	0.11	1.3	0.037	0.38	0.014	0.56	1.2
BERG04	0.015	0.0093	0.077	0.77	0.76	1.2	0.38	0.58	0.78	0.1	1.4	0.017	0.34	0.005	0.35	1.2
BERG05	0.0098	0.0058	0.013	0.15	0.16	0.25	0.086	0.13	0.18	0.026	0.31	0.011	0.084	0.0068	0.18	0.29
BERG07	0.16	0.032	0.24	1.6	1.8	2.7	1	2.4	2.2	0.45	4.7	0.11	1.2	0.019	2.2	4
BERG08	0.13	0.074	0.29	2.1	2.2	2.4	1.3	2.8	2.9	0.71	6.7	0.1	1.4	0.035	3	5.7
BERG10	0.011	0	0.023	0.13	0.15	0.15	0.089	0.2	0.17	0.034	0.35	0	0.095	0	0.14	0.27
BERG11	0.0081	0.0041	0.015	0.17	0.19	0.28	0.13	0.14	0.23	0.038	0.4	0.0051	0.13	0	0.13	0.36
BERG12A	0.0084	0.0097	0.039	0.17	0.21	0.25	0.15	0.21	0.22	0.072	0.31	0	0.15	0	0.14	0.34
BERG12B	0	0	0.009	0.076	0.11	0.12	0.062	0.12	0.11	0	0.16	0	0.067	0	0.061	0.16
BERG12C	0.0052	0	0.014	0.12	0.17	0.21	0.11	0.16	0.17	0.057	0.26	0	0.12	0	0.11	0.28
BERG13	0.073	0.018	0.15	1.1	1.3	2	0.84	1.8	1.7	0.4	4.5	0.045	0.89	0	1.2	3.8

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
BERG01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BERG02	0.093	0.051	0.15	1.2	1.2	1.8	0.58	0.74	1.2	0.17	1.9	0.073	0.55	0.02	0.83	1.7
BERG04	2.6	0.78	8.2	19	15	19	8	7.8	17	2.9	42	5.6	7.9	0.98	40	39
BERG05	0	0	0.0072	0.022	0.023	0.02	0	0.0084	0.019	0	0.031	0	0	0	0.026	0.05
BERG07	0.056	0.018	0.082	0.56	0.63	0.9	0.32	0.69	0.73	0.16	1.9	0.045	0.42	0	0.72	1.4
BERG08	0	0	0.0082	0.087	0.11	0.14	0.055	0.1	0.15	0	0.25	0	0.06	0	0.1	0.25
BERG10	0	0	0	0.019	0.027	0.024	0	0.019	0.02	0	0.031	0	0	0	0.015	0.034
BERG11	0	0.01	0.005	0.047	0.051	0.079	0.039	0.035	0.071	0.014	0.086	0	0.039	0	0.049	0.1
BERG12A	0	0	0	0.035	0.045	0.047	0.024	0.056	0.049	0	0.062	0	0.028	0	0.026	0.072
BERG12B	0	0	0	0.05	0.066	0.075	0.031	0.059	0.062	0	0.067	0	0.037	0	0.013	0.072
BERG12C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BERG13	0	0	0	0	0.018	0.024	0	0.022	0.02	0	0.029	0	0	0	0.013	0.029

Burlington County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
BURL01	0	0	0	0.022	0.03	0.041	0.013	0.021	0.035	0	0.054	0	0.015	0	0.024	0.05
BURL02A	0	0	0	0.015	0.024	0.039	0.017	0.021	0.03	0	0.047	0	0.011	0	0.018	0.034
BURL02B	0	0.0088	0.0054	0.1	0.18	0.41	0.12	0.16	0.23	0.03	0.3	0.0038	0.092	0.0032	0.12	0.22
BURL02C	0	0.0067	0	0.055	0.089	0.25	0.062	0.11	0.19	0.019	0.37	0	0.055	0	0.2	0.22
BURL03	0.025	0.0066	0.051	0.24	0.25	0.32	0.18	0.17	0.26	0.043	0.47	0.028	0.13	0.011	0.34	0.41
BURL04	0	0	0.0027	0.026	0.036	0.059	0.023	0.016	0.043	0	0.061	0	0.018	0	0.024	0.053
BURL05	0	0	0	0.036	0.048	0.058	0.033	0.023	0.042	0	0.057	0	0.026	0	0.023	0.056
BURL06	0	0	0.0032	0.057	0.061	0.1	0.045	0.042	0.077	0.012	0.13	0	0.037	0	0.043	0.094
BURL07	0	0.0059	0.006	0.1	0.15	0.29	0.12	0.11	0.18	0.027	0.31	0.0048	0.08	0	0.11	0.24
BURL08	0.013	0.02	0.02	0.28	0.35	0.59	0.23	0.38	0.42	0.065	0.65	0.0095	0.2	0	0.21	0.52
BURL10	0.015	0.17	0.14	1.7	2.1	4	1.4	2	2.3	0.42	5.3	0.024	1.2	0.051	0.67	3
BURL12	0.0041	0.0093	0.0089	0.12	0.15	0.16	0.11	0.1	0.16	0.017	0.2	0.0084	0.069	0.007	0.14	0.28

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
BURL01	0	0	0	0.0067	0	0.0089	0	0.0045	0.0049	0	0.0076	0	0	0	0.003	0.011
BURL02A	0	0	0	0.011	0.019	0.038	0.016	0.013	0.033	0	0.056	0	0.01	0	0.026	0.038
BURL02B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURL02C	0	0	0	0.0078	0.014	0.024	0	0.017	0.022	0	0.036	0	0.0067	0	0.016	0.023
BURL03	0	0	0.011	0.055	0.053	0.063	0.037	0.032	0.055	0	0.11	0	0.031	0	0.053	0.081
BURL04	0	0.0053	0.0041	0.065	0.075	0.11	0.054	0.06	0.1	0	0.13	0	0.045	0.0032	0.05	0.12
BURL05	0	0	0	0.0097	0.014	0.018	0.01	0.0071	0.015	0	0.019	0	0.0079	0	0.0063	0.019
BURL06	0	0	0	0.011	0.012	0.017	0	0.0042	0.013	0	0.017	0	0.004	0	0.0085	0.019
BURL07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BURL08	0	0	0	0.012	0.013	0.021	0.011	0.0073	0.014	0	0.02	0	0.01	0	0.0052	0.021
BURL10	0.0093	0.013	0.034	0.21	0.27	0.54	0.16	0.22	0.3	0.047	0.41	0.01	0.13	0.0074	0.15	0.33
BURL12	0.0083	0.014	0.009	0.14	0.18	0.18	0.12	0.11	0.19	0.031	0.24	0.021	0.077	0	0.25	0.38

Camden County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
CAMD01	0.025	0.027	0.072	0.72	0.98	1.5	0.57	0.66	0.92	0.13	1.3	0.029	0.47	0.0087	0.48	1.1
CAMD02	0	0	0.005	0.022	0.029	0.048	0.017	0.018	0.032	0	0.057	0	0.016	0	0.023	0.046
CAMD03	0	0	0	0.032	0.043	0.061	0.026	0.032	0.045	0	0.076	0	0.02	0	0.028	0.065
CAMD06	0.046	0	0.14	0.37	0.3	0.4	0.13	0.19	0.36	0.038	0.81	0.039	0.11	0.0054	0.59	0.57
CAMD07A	0.012	0.0054	0.023	0.16	0.19	0.3	0.11	0.13	0.2	0.023	0.34	0.011	0.093	0.0041	0.15	0.25
CAMD07B	0.0055	0.0062	0.02	0.18	0.18	0.33	0.11	0.14	0.22	0.031	0.37	0	0.078	0.0036	0.15	0.27
CAMD07C	0.014	0.0069	0.034	0.25	0.26	0.37	0.15	0.26	0.28	0.049	0.49	0.02	0.13	0.0066	0.24	0.39
CAMD08	0.0052	0	0.016	0.11	0.12	0.18	0.075	0.1	0.14	0.023	0.23	0.0078	0.067	0	0.09	0.17
CAMD11	0.0034	0	0.0086	0.09	0.088	0.12	0.058	0.072	0.11	0.019	0.17	0.005	0.052	0.0035	0.071	0.14
CAMD12	0	0	0.006	0.057	0.066	0.095	0.043	0.052	0.08	0	0.12	0.0037	0.036	0.0027	0.044	0.085
CAMD13	0	0	0	0.015	0.017	0.017	0.0094	0.014	0.02	0	0.029	0	0.009	0	0.016	0.028
CAMD14	0.015	0.0078	0.029	0.23	0.33	0.5	0.23	0.32	0.3	0.063	0.42	0.017	0.2	0	0.16	0.35

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
CAMD01	0	0	0	0.032	0.021	0.042	0.018	0.02	0.036	0	0.037	0	0.012	0	0.01	0.034
CAMD02	0.02	0	0.06	0.24	0.24	0.34	0.11	0.15	0.23	0.031	0.53	0.022	0.11	0	0.29	0.4
CAMD03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CAMD06	0	0	0	0	0	0	0	0	0	0	0.0056	0	0	0	0	0
CAMD07A	0.026	0.0081	0.067	0.26	0.25	0.39	0.14	0.21	0.27	0.044	0.6	0.053	0.12	0.025	0.47	0.44
CAMD07B	0.012	0.008	0.034	0.24	0.26	0.43	0.15	0.2	0.29	0.047	0.53	0.014	0.13	0.0066	0.22	0.41
CAMD07C	0.052	0.0081	0.15	0.48	0.44	0.68	0.26	0.35	0.5	0.068	1.3	0.081	0.21	0.013	0.83	0.84
CAMD08	0.0043	0	0.011	0.073	0.087	0.12	0.045	0.053	0.088	0	0.15	0.0059	0.045	0	0.069	0.13
CAMD11	0	0	0	0	0.005	0.0058	0	0	0	0	0.0073	0	0	0	0.0053	0.0086
CAMD12	0.0088	0	0.022	0.069	0.044	0.057	0.017	0.025	0.053	0	0.1	0.0081	0.018	0	0.081	0.082
CAMD13	0	0	0	0	0	0	0	0	0	0	0.0099	0	0	0	0.0068	0.0099
CAMD14	0	0	0.0053	0.032	0.034	0.04	0.018	0.019	0.034	0	0.057	0	0.017	0	0.024	0.049

Cape May County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
CAPE06A	0	0	0.0038	0.03	0.046	0.066	0.032	0.032	0.045	0	0.06	0	0.022	0	0.017	0.057
CAPE06B	0	0	0.0034	0.043	0.048	0.073	0.035	0.044	0.055	0	0.059	0	0.025	0	0.027	0.071
CAPE06C	0	0	0.003	0.03	0.049	0.071	0.021	0.043	0.053	0	0.061	0	0.02	0	0.019	0.06
CAPE11	0	0	0.0046	0.032	0.038	0.052	0.021	0.032	0.039	0	0.061	0	0.016	0	0.023	0.05

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
CAPE06A	0.21	0.32	0.33	2	1.7	1.8	1.3	1.1	2.7	0.38	3.9	0.59	0.82	0.19	5.5	5.4
CAPE06B	0	0.0021	0.0041	0.037	0.044	0.057	0.027	0.03	0.045	0	0.052	0	0.02	0	0.027	0.067
CAPE06C	0.036	0.041	0.041	0.43	0.52	0.65	0.33	0.37	0.72	0.078	0.65	0.045	0.22	0.014	0.58	1.1
CAPE11	0	0	0.0086	0.05	0.054	0.088	0.027	0.043	0.059	0	0.099	0	0.028	0	0.041	0.089

Cumberland County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
CUMB02A	0	0	0.0057	0.023	0.044	0.034	0.015	0.035	0.04	0	0.062	0	0.018	0	0.053	0.098
CUMB02B	0	0	0	0.022	0.028	0.018	0.015	0.029	0.037	0	0.051	0	0.013	0	0.048	0.075
CUMB02C	0	0	0	0.026	0.034	0.034	0	0.023	0.044	0	0.057	0	0.016	0.0083	0.047	0.074

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
CUMB02A	0	0	0	0	0.0072	0.0053	0	0.0039	0	0	0.0061	0	0	0	0.0049	0.0097
CUMB02B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CUMB02C	0	0	0	0	0	0	0	0	0	0	0.0064	0	0	0	0.0041	0

Essex County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
ESSE02	0.014	0.0065	0.049	0.24	0.22	0.32	0.12	0.16	0.29	0.04	0.54	0.026	0.13	0.0075	0.36	0.58
ESSE04	0.0048	0	0.012	0.11	0.11	0.18	0.066	0.074	0.14	0	0.23	0	0.058	0	0.13	0.28
ESSE05	0	0	0.0058	0.036	0.041	0.073	0	0.034	0.052	0	0.087	0	0.018	0	0.044	0.077
ESSE09	0.0059	0	0.017	0.1	0.11	0.17	0.055	0.088	0.14	0.018	0.22	0	0.06	0.0054	0.12	0.22
ESSE11	0.038	0.013	0.1	0.62	0.63	1	0.34	0.52	0.71	0.094	1.2	0.03	0.28	0.011	0.52	1.2
ESSE12	0.0043	0	0.012	0.12	0.13	0.21	0.06	0.086	0.15	0.019	0.19	0	0.061	0.0053	0.089	0.22
ESSE15	0	0	0.011	0.081	0.1	0.17	0.039	0.09	0.12	0	0.19	0	0.043	0	0.083	0.16
ESSE19	0.0078	0	0.028	0.23	0.22	0.4	0.13	0.13	0.27	0.036	0.45	0.01	0.11	0.0089	0.23	0.47
ESSE20A	0	0	0	0.01	0.011	0.015	0	0.01	0.013	0	0.022	0	0	0	0.0096	0.018
ESSE20B	0	0	0	0.029	0.033	0.05	0	0.021	0.036	0	0.061	0	0.013	0	0.028	0.053
ESSE20C	0	0	0.0073	0.054	0.058	0.075	0.026	0.051	0.066	0	0.12	0	0.028	0.0061	0.054	0.1
ESSE21	0	0	0.012	0.15	0.17	0.25	0.096	0.1	0.17	0.035	0.27	0	0.097	0	0.064	0.27

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
ESSE02	0	0	0	0	0	0	0	0	0	0	0.0069	0	0	0	0	0.0097
ESSE04	0	0	0	0	0	0.015	0	0.0051	0	0	0.019	0	0	0	0.012	0.021
ESSE05	0	0	0	0	0	0	0	0	0	0	0.0073	0	0	0	0.0038	0.0072
ESSE09	0	0	0	0	0	0	0	0	0	0	0.0092	0	0	0	0	0.01
ESSE11	0	0	0.0036	0.034	0.035	0.048	0.023	0.018	0.038	0	0.059	0	0.02	0	0.029	0.065
ESSE12	0	0	0	0.034	0.036	0.048	0.014	0.025	0.045	0	0.058	0	0.016	0	0.022	0.068
ESSE15	0	0	0	0.021	0.021	0.029	0	0.011	0.024	0	0.038	0	0	0	0.019	0.037
ESSE19	0	0	0	0	0	0	0	0	0	0	0.007	0	0	0	0	0.0093
ESSE20A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ESSE20B	0	0	0	0	0	0	0	0	0	0	0.0052	0	0	0	0	0.0061
ESSE20C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ESSE21	0	0	0.013	0.15	0.16	0.23	0.09	0.09	0.16	0.035	0.25	0	0.1	0	0.064	0.28

Gloucester County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
GLOU01	0	0	0	0.0096	0	0	0	0	0.012	0	0.016	0	0	0	0.0054	0.012
GLOU03	0	0	0	0.045	0.098	0.13	0.13	0.085	0.083	0	0.066	0	0.089	0	0.023	0.081
GLOU05	0	0	0	0.027	0.034	0.041	0.018	0.032	0.039	0	0.047	0	0.015	0	0.025	0.044
GLOU06	0	0	0	0.028	0.031	0.044	0.016	0.026	0.037	0	0.074	0	0.013	0	0.036	0.049
GLOU07	0	0	0	0.011	0.017	0.011	0	0.015	0.011	0	0.016	0	0	0	0.0076	0.014
GLOU08A	0.036	0	0.097	0.24	0.18	0.19	0.097	0.2	0.25	0.053	0.51	0.032	0.092	0.012	0.51	0.46
GLOU08B	0	0	0.0045	0.039	0.046	0.066	0.034	0.059	0.063	0.017	0.075	0	0.031	0	0.04	0.06
GLOU08C	0.015	0	0.032	0.094	0.088	0.11	0.042	0.078	0.11	0	0.16	0.016	0.049	0.0054	0.17	0.15
GLOU09	0	0	0.0099	0.061	0.069	0.087	0.042	0.075	0.1	0	0.14	0	0.039	0	0.065	0.14
GLOU10	0	0	0	0.037	0.041	0.05	0.03	0.051	0.051	0	0.077	0	0.028	0	0.028	0.054

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
GLOU01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOU03	0	0	0	0.0098	0.037	0.024	0.038	0.024	0.019	0	0	0	0.026	0	0	0.017
GLOU05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOU06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOU07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOU08A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOU08B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GLOU08C	0	0	0	0	0	0	0	0	0	0	0.0097	0	0	0	0.0057	0
GLOU09	0	0	0	0.0093	0	0	0	0.015	0.011	0	0.018	0	0	0	0	0.012
GLOU10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Hudson County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
HUDS01	0.012	0.015	0.024	0.21	0.17	0.39	0.11	0.21	0.21	0	0.37	0.0098	0.063	0	0.21	0.35
HUDS02	0.014	0.015	0.031	0.35	0.28	0.53	0.11	0.38	0.33	0.044	0.47	0.011	0.12	0.01	0.2	0.48
HUDS04	0.034	0.018	0.065	0.55	0.39	0.82	0.16	0.36	0.56	0.096	0.73	0.022	0.16	0.014	0.32	0.76
HUDS05	0.0085	0.023	0.035	0.19	0.27	0.47	0.16	0.38	0.33	0.025	0.55	0.012	0.11	0.007	0.25	0.37
HUDS06	0.011	0.035	0.084	0.38	0.45	0.73	0.13	0.48	0.47	0	0.8	0.015	0.11	0.0069	0.33	0.53
HUDS08A	0.035	0.0078	0.029	0.25	0.3	0.49	0.13	0.32	0.3	0.056	0.36	0.013	0.081	0	0.18	0.32
HUDS08B	0.014	0	0.014	0.083	0.11	0.15	0.03	0.12	0.11	0.013	0.16	0	0.031	0.0048	0.075	0.13
HUDS08C	0.028	0	0.028	0.18	0.18	0.25	0.1	0.21	0.23	0.028	0.32	0.011	0.062	0.0071	0.12	0.26
HUDS10	0.013	0.019	0.035	0.19	0.27	0.47	0.11	0.39	0.3	0.052	0.59	0.0097	0.1	0.0072	0.23	0.37
HUDS11	0.014	0.0091	0.029	0.24	0.29	0.53	0.15	0.3	0.36	0.066	0.52	0.016	0.11	0.0081	0.15	0.4
HUDS12	0.051	0.013	0.1	0.71	0.46	0.9	0.24	0.65	0.69	0.1	1.4	0.035	0.21	0.014	0.65	1.2
HUDS13	0.011	0.016	0.041	0.32	0.47	0.69	0.31	0.67	0.46	0.11	0.92	0.011	0.2	0	0.23	0.53

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
HUDS01	0.0047	0	0.0082	0.025	0.038	0.042	0.02	0.035	0.035	0	0.058	0.0048	0.016	0	0.046	0.063
HUDS02	0.036	0.024	0.1	0.72	0.61	1	0.3	0.72	0.65	0.1	1.1	0.033	0.18	0.021	0.59	0.94
HUDS04	0	0	0.006	0.045	0.048	0.052	0.026	0.052	0.051	0.014	0.076	0	0.022	0	0.027	0.08
HUDS05	0.012	0.014	0.055	0.29	0.26	0.32	0.066	0.31	0.29	0.024	0.7	0.0068	0.049	0.0094	0.27	0.5
HUDS06	0.014	0.04	0.074	0.32	0.44	0.52	0.12	0.5	0.37	0.05	0.45	0	0.083	0.013	0.24	0.41
HUDS08A	0.0028	0	0.0027	0.014	0.022	0.015	0	0.025	0.016	0	0.021	0	0	0	0.0084	0.02
HUDS08B	0	0	0	0.011	0.018	0.014	0	0.018	0.016	0	0.02	0	0.0096	0	0.007	0.02
HUDS08C	0	0	0	0.021	0.033	0.019	0.0089	0.025	0.023	0	0.038	0	0.0081	0	0.017	0.029
HUDS10	0	0	0	0	0	0	0	0	0.006	0	0.0053	0	0	0	0.0025	0.0069
HUDS11	0	0	0	0.0094	0	0.021	0	0.0051	0.012	0	0.015	0	0	0	0.0048	0.015
HUDS12	0.01	0	0.054	0.47	0.48	0.81	0.13	0.5	0.4	0.076	0.82	0.007	0.12	0.0092	0.23	0.72
HUDS13	0.047	0.021	0.19	0.67	0.71	1.2	0.27	1	0.82	0.11	2.1	0.038	0.22	0.013	0.78	1.1

Hunterdon County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
HUNT01	0.007	0.018	0.019	0.27	0.33	0.44	0.18	0.21	0.39	0.055	0.53	0.014	0.16	0	0.24	0.52
HUNT08A	0.004	0	0.013	0.093	0.13	0.21	0.1	0	0.12	0	0.17	0.0081	0.074	0	0.085	0.33
HUNT08B	0	0	0.0055	0.036	0.049	0.072	0.037	0.026	0.05	0	0.064	0	0.022	0	0.034	0.081
HUNT08C	0	0	0.0083	0.07	0.091	0.12	0.052	0.059	0.1	0	0.14	0.0053	0.041	0	0.085	0.15

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
HUNT01	0	0.007	0.0057	0.074	0.097	0.12	0.051	0.085	0.11	0	0.16	0.0058	0.045	0	0.073	0.15
HUNT08A	0	0	0	0.0064	0	0.0092	0	0.0067	0.0078	0	0.0093	0	0	0	0	0.0093
HUNT08B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HUNT08C	0	0	0	0	0	0	0	0	0	0	0.0045	0	0	0	0	0.0071

Mercer County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MERC01	0.015	0	0.023	0.2	0.23	0.27	0.14	0.22	0.26	0.06	0.52	0	0.16	0	0.21	0.53
MERC02	0	0	0	0.035	0.04	0.044	0	0.055	0.045	0	0.065	0	0	0	0.024	0.053
MERC03A	0.063	0.15	0.17	1.6	1.9	2.4	1.3	1.2	1.8	0.35	3	0.1	1	0	1.3	6
MERC03B	0.14	0.15	0.38	2	2	2.5	1.3	1.2	2.1	0.36	4.8	0.25	1	0.11	2.4	3.2
MERC03C	0.021	0.046	0.057	0.64	0.72	0.73	0.53	0.79	0.87	0.23	2.1	0.044	0.48	0.012	0.58	1.9
MERC04	0.15	0.18	0.21	1.8	1.8	2	1.2	1.3	2.4	0.27	5.6	0.26	0.9	0.066	2.8	4.3
MERC05	0.043	0.03	0.053	0.39	0.5	0.76	0.42	0.31	0.49	0.12	0.64	0.042	0.3	0	0.37	0.89
MERC06	0	0	0.0088	0.085	0.095	0.12	0.066	0.12	0.11	0	0.17	0	0.051	0	0.049	0.15

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MERC01	0	0	0	0.011	0.017	0.012	0	0.016	0.012	0	0.02	0	0	0	0	0.026
MERC02	0	0	0	0.032	0.04	0.043	0	0.044	0.044	0	0.059	0	0	0	0.028	0.058
MERC03A	0.015	0.032	0.04	0.39	0.45	0.62	0.26	0.29	0.5	0.074	0.57	0.031	0.21	0	0.33	0.7
MERC03B	0.12	0.14	0.39	2	2	2.6	1.2	1.2	2.1	0.4	5.7	0.23	1.1	0	1.8	3.4
MERC03C	0.0063	0.014	0.012	0.19	0.22	0.29	0.14	0.16	0.24	0.039	0.3	0.012	0.11	0	0.15	0.33
MERC04	0.013	0.0098	0.017	0.12	0.13	0.16	0.077	0.078	0.17	0.022	0.24	0.018	0.062	0	0.21	0.3
MERC05	0	0	0	0.011	0.011	0.012	0	0.0089	0.015	0	0.017	0	0	0	0	0.025
MERC06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Middlesex County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MIDD01	0.0044	0	0.013	0.068	0.072	0.11	0.035	0.056	0.091	0	0.12	0	0.037	0.0044	0.071	0.15
MIDD02	0.056	0.04	0.13	1.3	1.3	2.2	0.56	1.2	1.4	0.17	2.2	0.065	0.6	0.017	0.99	2.1
MIDD03	0	0	0	0.018	0.02	0.031	0.0094	0.014	0.026	0	0.036	0	0.01	0	0.02	0.04
MIDD04	0	0	0.0035	0.062	0.071	0.11	0.036	0.045	0.087	0	0.12	0	0.036	0.0036	0.045	0.14
MIDD06	0.0056	0.0037	0.013	0.1	0.13	0.21	0.057	0.12	0.16	0.017	0.24	0.0069	0.059	0.0079	0.13	0.24
MIDD08	0	0	0	0.035	0.047	0.063	0.024	0.042	0.056	0	0.073	0	0.024	0.0026	0.028	0.093
MIDD10	0.047	0	0.095	0.25	0.19	0.24	0.081	0.17	0.26	0.032	0.53	0.041	0.095	0.0061	0.47	0.52
MIDD12	0	0	0.011	0.11	0.13	0.19	0.059	0.096	0.14	0.02	0.21	0	0.066	0.0039	0.069	0.23
MIDD13A	0.0067	0.0028	0.018	0.12	0.13	0.16	0.078	0.08	0.14	0.024	0.24	0.0088	0.074	0.0031	0.11	0.26
MIDD13B	0.0027	0	0.0068	0.091	0.12	0.2	0.074	0.092	0.15	0.025	0.18	0	0.075	0.0044	0.055	0.2
MIDD13C	0	0	0.0076	0.1	0.12	0.19	0.068	0.1	0.14	0.022	0.19	0	0.072	0	0.059	0.22
MIDD15	0.011	0.0084	0.021	0.29	0.28	0.4	0.15	0.26	0.44	0.039	0.66	0.015	0.15	0.029	0.31	0.71

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MIDD01	0	0	0	0.0072	0	0	0	0	0.007	0	0.01	0	0	0	0.0045	0.012
MIDD02	0	0	0.007	0.072	0.082	0.11	0.062	0.057	0.098	0.018	0.14	0	0.059	0	0.052	0.16
MIDD03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIDD04	0	0	0	0.026	0.024	0.032	0.011	0.013	0.04	0	0.038	0	0.011	0.0048	0.029	0
MIDD06	0	0	0	0	0	0	0	0	0	0	0.004	0	0	0	0	0.0056
MIDD08	0	0	0	0.01	0.0093	0.015	0	0.0055	0.011	0	0.016	0	0	0	0.0069	0.019
MIDD10	0	0	0.011	0.039	0.035	0.045	0.016	0.022	0.048	0	0.068	0	0.017	0.0028	0.05	0.073
MIDD12	0	0	0	0.012	0.014	0.017	0	0.011	0.014	0	0.017	0	0	0	0	0.02
MIDD13A	0.0038	0.0049	0.013	0.12	0.15	0.21	0.083	0.11	0.17	0.027	0.23	0.0057	0.085	0.0051	0.094	0.24
MIDD13B	0.0043	0.0088	0.011	0.14	0.18	0.29	0.1	0.18	0.21	0.033	0.26	0.0065	0.11	0.0058	0.08	0.26
MIDD13C	0	0	0	0.046	0.051	0.07	0.023	0.035	0.057	0	0.082	0	0.026	0	0.024	0.093
MIDD15	0.006	0.0044	0.013	0.12	0.14	0.21	0.081	0.093	0.2	0.026	0.25	0.0091	0.082	0.036	0.15	0.28

Monmouth County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MONM02	0	0	0	0.0092	0.017	0.017	0	0	0.015	0	0.022	0	0	0	0.0075	0.014
MONM03	0	0	0	0.024	0.032	0.038	0	0.025	0.032	0	0.044	0	0.016	0	0.017	0.044
MONM04	0.011	0.027	0.054	0.39	0.4	0.54	0.24	0.43	0.48	0.11	1.4	0	0.27	0	0.35	1.1
MONM09	0	0	0.011	0.099	0.12	0.16	0.064	0.11	0.13	0.036	0.28	0	0.076	0	0.06	0.18
MONM12	0	0	0	0.015	0.017	0.028	0	0.02	0.021	0	0.044	0	0	0	0.014	0.028
MONM14	0	0	0.014	0.16	0.2	0.28	0.14	0.19	0.22	0.077	0.48	0	0.14	0	0.071	0.31
MONM15	0	0	0	0.031	0.027	0.045	0	0.032	0.039	0	0.063	0	0	0	0.022	0.049
MONM16	0.039	0	0.12	0.58	0.58	0.88	0.4	0.64	0.78	0.12	2.4	0.032	0.4	0	0.82	2.1
MONM18A	0	0	0	0.033	0.059	0.066	0	0.067	0.055	0	0.099	0	0	0	0.026	0.074
MONM18B	0	0	0	0.031	0.041	0.053	0.024	0.041	0.04	0.015	0.069	0	0.023	0	0.02	0.051
MONM18C	0.0027	0	0.0047	0.047	0.061	0.11	0.052	0.066	0.077	0	0.13	0	0.042	0	0.056	0.1
MONM19	0	0	0	0.042	0.045	0.052	0.052	0.076	0.071	0	0.12	0	0.045	0	0.025	0.11

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MONM02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONM03	0	0	0	0.015	0.024	0.022	0	0	0.019	0	0.03	0	0	0	0.01	0.029
MONM04	0	0	0	0.0087	0.014	0.019	0	0	0.011	0	0.017	0	0	0	0	0.01
MONM09	0	0	0	0.0072	0	0	0	0	0.0082	0	0.0092	0	0	0	0	0
MONM12	0	0	0	0	0	0.0077	0	0.0078	0	0	0.011	0	0	0	0	0.012
MONM14	0	0	0	0.056	0.065	0.068	0.034	0.073	0.063	0.021	0.087	0	0.034	0	0.022	0.085
MONM15	0	0	0	0.0088	0.018	0.013	0.0091	0.015	0.0086	0	0.018	0	0.009	0	0.0047	0.011
MONM16	0	0	0	0.014	0.016	0.017	0.0096	0.023	0.019	0	0.029	0	0.0085	0	0.0087	0.023
MONM18A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONM18B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONM18C	0.01	0.0086	0	0.087	0.15	0.23	0.13	0.25	0.24	0.046	0.75	0.013	0.15	0.017	0.37	0.46
MONM19	0	0.036	0.034	0.42	0.56	0.69	0.34	0.52	0.65	0.14	0.69	0.027	0.34	0	0.22	1.1

Morris County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MORR01	0	0	0	0.025	0.031	0.033	0	0.037	0.043	0	0.056	0	0	0	0.021	0.065
MORR03	0	0	0.0065	0.055	0.066	0.093	0.045	0.061	0.088	0	0.14	0	0.037	0	0.081	0.16
MORR04	0	0	0	0.055	0.054	0.063	0	0.074	0.07	0	0.13	0	0.025	0	0.06	0.15
MORR05A	0	0	0.012	0.099	0.14	0.13	0.093	0.16	0.15	0	0.27	0.0099	0.086	0	0.15	0.3
MORR05B	0.012	0	0.023	0.19	0.2	0.26	0.16	0.21	0.27	0.089	0.55	0.02	0.15	0	0.35	0.57
MORR05C	0	0	0.011	0.087	0.078	0.092	0.055	0.083	0.11	0.021	0.23	0	0.05	0	0.12	0.26
MORR08	0.027	0.014	0.024	0.16	0.19	0.22	0.14	0.18	0.27	0.075	0.55	0.043	0.14	0.0074	0.38	0.68
MORR10	0	0	0	0.027	0.031	0.042	0	0.037	0.041	0	0.062	0	0	0	0.028	0.059
MORR11	0	0	0	0.018	0.022	0.024	0	0.016	0.022	0	0.036	0	0	0	0.015	0.034
MORR15	0	0.0063	0	0.055	0.057	0.066	0.034	0.059	0.09	0	0.13	0	0.029	0	0.058	0.13
MORR16	0	0	0	0.069	0.086	0.096	0.082	0.096	0.1	0	0.17	0	0.068	0	0.07	0.2
MORR17	0	0	0	0.014	0.019	0.023	0	0.019	0.025	0	0.032	0	0	0	0.015	0.046

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
MORR01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MORR03	0	0	0	0	0.0078	0	0	0	0	0	0.0072	0	0	0	0	0.011
MORR04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MORR05A	0	0	0	0.018	0.021	0.019	0	0.026	0.022	0	0.03	0	0	0	0.014	0.041
MORR05B	0	0	0	0.021	0.023	0.033	0	0.023	0.034	0	0.054	0	0	0	0.032	0.07
MORR05C	0	0	0	0.011	0.02	0.011	0	0.016	0.016	0	0.023	0	0	0	0.014	0.039
MORR08	0	0	0	0.01	0.0094	0.0095	0	0.011	0.013	0	0.023	0	0	0	0.016	0.026
MORR10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MORR11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0039	0.011
MORR15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MORR16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MORR17	0	0	0	0	0	0	0	0	0	0	0.0078	0	0	0	0	0.011

Ocean County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
OCEA01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA02	0	0	0	0.015	0.024	0.025	0.013	0.023	0.022	0	0.051	0	0.013	0	0.02	0.038
OCEA03	0	0	0.0051	0.048	0.06	0.065	0.055	0.073	0.071	0	0.12	0	0.05	0	0.028	0.13
OCEA04A	0	0	0	0.027	0	0.04	0	0.033	0.041	0	0.08	0	0.02	0	0.034	0.071
OCEA04B	0	0	0	0.02	0.022	0.032	0	0.021	0.027	0	0.07	0	0	0	0.028	0.054
OCEA04C	0	0	0	0.013	0	0.019	0	0.016	0.016	0	0.038	0	0	0	0.016	0.035
OCEA05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA06	0	0	0	0.018	0.031	0.029	0.018	0.031	0.034	0	0.049	0	0.019	0	0.023	0.042
OCEA07	0	0	0.0081	0.092	0.11	0.16	0.084	0.12	0.13	0	0.27	0	0.085	0.0082	0.085	0.28
OCEA08	0	0	0	0.013	0.022	0.022	0	0.017	0.021	0	0.036	0	0	0	0.013	0.034
OCEA09	0.0067	0.012	0.021	0.19	0.21	0.3	0.17	0.22	0.26	0.087	0.61	0	0.13	0	0.16	0.54
OCEA10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
OCEA01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA03	0	0	0	0.016	0.021	0.045	0.017	0.026	0.036	0	0.051	0	0.022	0	0.013	0.058
OCEA04A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA04B	0	0	0	0	0	0	0	0	0	0	0.0083	0	0	0	0.0042	0.0069
OCEA04C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEA09	0	0	0.0034	0.032	0.045	0.046	0.038	0.047	0.046	0	0.095	0	0.035	0	0.024	0.1
OCEA10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Passaic County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
PASS01	0	0	0.0065	0.044	0.047	0.065	0.036	0.035	0.058	0	0.085	0	0.03	0	0.044	0.096
PASS02	0	0.0066	0.0041	0.045	0.067	0.098	0.053	0.051	0.072	0	0.1	0	0.038	0	0.063	0.098
PASS03	0	0.012	0.011	0.1	0.13	0.16	0.11	0.063	0.16	0	0.17	0.013	0.076	0	0.13	0.31
PASS04	0	0	0.0034	0.026	0.033	0.056	0.027	0.018	0.035	0	0.049	0	0.021	0	0.027	0.05
PASS06	0.26	0.037	0.78	4.5	3.9	5.8	1.6	3.1	4.8	0.54	8.3	0.26	1.4	0.19	5.1	9.4
PASS07A	0	0	0	0.027	0.031	0.049	0	0.023	0.04	0	0.051	0	0	0	0.028	0.06
PASS07B	0	0	0.0093	0.077	0.084	0.15	0.042	0.062	0.11	0	0.15	0	0.038	0.0089	0.097	0.19
PASS07C	0.0055	0	0.013	0.095	0.11	0.22	0.048	0.066	0.14	0	0.18	0	0.046	0.0051	0.11	0.21
PASS08	0	0	0.0057	0.045	0.05	0.087	0.049	0.059	0.06	0	0.06	0	0.031	0	0.02	0.093
PASS10	0.012	0.036	0.04	0.45	0.42	0.67	0.23	0.25	0.64	0.07	0.64	0.036	0.19	0.018	0.58	1.1
PASS14	0.012	0.0089	0.022	0.2	0.19	0.29	0.1	0.16	0.25	0.035	0.38	0.014	0.1	0.0066	0.21	0.37
PASS16	0	0	0.0086	0.076	0.098	0.17	0.051	0.071	0.12	0	0.17	0	0.05	0	0.079	0.15

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
PASS01	0	0	0	0.0079	0	0.0084	0	0.0042	0.0067	0	0.009	0	0	0	0	0.012
PASS02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASS03	0	0	0	0.0044	0	0	0	0	0.0037	0	0.0039	0	0	0	0.0031	0.0063
PASS04	0	0	0	0	0	0	0	0	0	0	0.0028	0	0	0	0	0
PASS06	0.039	0	0.13	0.47	0.43	0.64	0.22	0.23	0.44	0.07	0.75	0.039	0.2	0.015	0.56	0.85
PASS07A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASS07B	0	0	0	0	0	0	0	0	0	0	0.012	0	0	0	0.0078	0.016
PASS07C	0	0	0	0.014	0.012	0.015	0	0.0058	0.013	0	0.019	0	0	0	0.013	0.027
PASS08	0	0	0	0.014	0.015	0.027	0	0.0097	0	0	0.022	0	0	0	0.0094	0.026
PASS10	0.01	0.0064	0.02	0.11	0.1	0.12	0.049	0.069	0.12	0.016	0.17	0	0.044	0.013	0.13	0.22
PASS14	0	0	0	0.013	0.017	0.017	0	0.011	0.016	0	0.024	0	0	0	0.014	0.029
PASS16	0	0	0	0.01	0.013	0.019	0	0.0081	0.016	0	0.02	0	0	0	0.0092	0.022

Salem County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
SALE01A	0	0	0.0022	0.02	0.016	0.038	0.012	0.016	0.031	0	0.045	0	0.0084	0.029	0.019	0.032
SALE01B	0	0	0.0026	0.019	0.013	0.046	0	0.013	0.052	0	0.051	0	0	0.035	0.025	0.033
SALE01C	0	0	0.0034	0.015	0	0.038	0	0.0073	0.036	0	0.057	0	0	0.14	0.049	0.039
SALE04	0	0	0.0023	0.012	0.017	0.032	0	0.0085	0.024	0	0.03	0	0	0	0.014	0.024

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
SALE01A	0	0	0	0	0	0.0063	0	0.0059	0	0	0.0079	0	0	0.0074	0.0037	0.0059
SALE01B	0	0	0	0	0	0.013	0	0	0.0065	0	0.007	0	0	0	0.0042	0.0062
SALE01C	0	0	0.0027	0.018	0.037	0.062	0.049	0.033	0.033	0	0.016	0	0.036	0.016	0.0092	0.022
SALE04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Somerset County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
SOME02	0.18	0.091	0.55	3.4	3.6	4.3	2.4	2.6	3.6	0.63	11	0.24	2.1	0.055	4	9.2
SOME10	0.0057	0.011	0.016	0.27	0.28	0.52	0.16	0.2	0.29	0.03	0.53	0.0062	0.12	0	0.086	0.47
SOME11	0.014	0.0053	0.029	0.28	0.32	0.48	0.19	0.25	0.37	0.051	0.64	0.023	0.16	0	0.32	0.57
SOME13A	0.019	0.02	0.045	0.54	0.63	0.88	0.37	0.49	0.7	0.096	1.2	0.023	0.27	0.012	0.4	1.1
SOME13B	0.022	0.022	0.05	0.6	0.68	1.1	0.37	0.45	0.68	0.081	1.2	0.027	0.31	0.013	0.46	1.2
SOME13C	0.012	0.013	0.033	0.35	0.39	0.58	0.19	0.22	0.38	0.051	0.69	0.018	0.16	0.0073	0.25	0.62
SOME18	0	0	0.0067	0.11	0.12	0.21	0.081	0.073	0.14	0	0.22	0	0.059	0.0068	0.096	0.2
SOME19	0.016	0.0073	0.039	0.39	0.46	0.76	0.27	0.41	0.5	0.079	0.91	0.017	0.24	0.0086	0.3	0.7

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
SOME02	0.22	0.086	0.45	2.8	3.2	2.8	1.9	1.8	3.1	0.61	8.4	0.34	1.7	0.064	4.6	6
SOME10	0	0	0.012	0.11	0.12	0.17	0.088	0.065	0.12	0	0.2	0	0.058	0	0.074	0.19
SOME11	0.066	0.014	0.11	0.74	0.68	1	0.33	0.42	0.83	0.087	1.9	0.11	0.28	0.022	1.4	1.7
SOME13A	0	0	0.0044	0.059	0.062	0.075	0.039	0.045	0.067	0	0.1	0	0.032	0	0.037	0.11
SOME13B	0	0	0	0.017	0.018	0.019	0.011	0.016	0.017	0	0.029	0	0.011	0	0.011	0.027
SOME13C	0	0	0.0081	0.041	0.044	0.055	0.024	0.025	0.045	0	0.081	0.0057	0.022	0	0.043	0.078
SOME18	0	0	0	0.012	0.012	0.015	0.0069	0.01	0.011	0	0.016	0	0.0071	0	0.0059	0.018
SOME19	0	0	0.0052	0.047	0.05	0.06	0.031	0.048	0.059	0	0.1	0	0.027	0	0.036	0.088

Sussex County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
SUSS01	0	0	0	0.01	0	0.0087	0	0.0049	0.0058	0	0.0082	0	0	0	0	0.011
SUSS04A	0	0	0	0.016	0	0.023	0	0.011	0.021	0	0.028	0	0	0	0.017	0.029
SUSS04B	0	0	0	0.015	0.015	0.02	0	0.008	0.016	0	0.018	0	0	0	0.01	0.021
SUSS04C	0	0	0	0.015	0	0	0	0	0.023	0	0.031	0	0	0	0.016	0.029
SUSS05	0	0.0046	0.0063	0.082	0.1	0.18	0.058	0.072	0.11	0	0.17	0	0.055	0	0.068	0.15

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
SUSS01	0	0	0	0.0043	0	0	0	0	0.0035	0	0.0044	0	0	0	0.0028	0
SUSS04A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUSS04B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUSS04C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUSS05	0	0	0	0.016	0.016	0.02	0.012	0.014	0.015	0	0.024	0	0.012	0	0.0085	0.025

Union County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
UNIO01	0	0	0.014	0.1	0.11	0.18	0.054	0.076	0.13	0.016	0.23	0.0057	0.05	0	0.1	0.21
UNIO17	0	0	0.009	0.07	0.075	0.15	0.033	0.056	0.093	0	0.16	0	0.034	0.0054	0.068	0.14
UNIO18	0.02	0.032	0.065	0.7	0.72	1.6	0.43	0.73	0.84	0.12	1.3	0.031	0.4	0.019	0.55	1.3
UNIO19	0.0084	0	0.018	0.18	0.19	0.37	0.11	0.15	0.25	0.041	0.29	0.0061	0.094	0.005	0.15	0.33
UNIO20	0	0	0.0096	0.07	0.073	0.12	0.034	0.063	0.09	0	0.17	0	0.033	0	0.076	0.14
UNIO21	0.022	0.011	0.079	0.53	0.56	0.92	0.27	0.41	0.58	0.087	0.92	0.022	0.23	0.006	0.38	1
UNIO22A	0	0	0.0038	0.053	0.054	0.086	0.031	0.042	0.061	0	0.092	0	0.03	0	0.031	0.11
UNIO22B	0.0028	0	0.0093	0.089	0.088	0.13	0.045	0.075	0.11	0.013	0.16	0	0.044	0.0025	0.065	0.18
UNIO22C	0.003	0	0.0088	0.068	0.073	0.12	0.035	0.049	0.083	0	0.15	0	0.033	0	0.057	0.13
UNIO23	0	0	0.0066	0.042	0.053	0.081	0.019	0.045	0.065	0	0.11	0	0.022	0	0.061	0.089
UNIO25	0	0	0	0.041	0.043	0.08	0.023	0.029	0.053	0	0.099	0	0.023	0	0.042	0.078
UNIO26	0.018	0.01	0.076	0.49	0.46	0.71	0.25	0.41	0.54	0.084	0.88	0.022	0.2	0.029	0.56	1

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
UNIO01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNIO17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNIO18	0	0	0	0.012	0.013	0.02	0	0.0091	0.014	0	0.019	0	0	0	0.0096	0.025
UNIO19	0	0	0	0	0	0.011	0	0	0	0	0.011	0	0	0	0	0.014
UNIO20	0	0	0.0048	0.048	0.05	0.083	0.02	0.033	0.061	0	0.11	0	0.021	0	0.05	0.087
UNIO21	0.0041	0	0.011	0.11	0.11	0.16	0.054	0.086	0.13	0.017	0.21	0	0.053	0.0038	0.097	0.24
UNIO22A	0	0	0.0072	0.074	0.073	0.1	0.035	0.054	0.083	0	0.12	0	0.034	0	0.046	0.14
UNIO22B	0.0069	0.0054	0.063	0.97	0.77	1.2	0.3	0.66	0.87	0.11	1.4	0.011	0.3	0.013	0.18	1.4
UNIO22C	0	0	0.0044	0.043	0.046	0.065	0.02	0.037	0.049	0	0.075	0	0.02	0	0.028	0.078
UNIO23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNIO25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNIO26	0.014	0.0056	0.094	0.25	0.22	0.31	0.11	0.18	0.29	0.035	0.69	0.023	0.11	0.015	0.48	0.55

Warren County

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
WARR01A	0	0	0.0035	0.074	0.099	0.17	0.065	0.06	0.093	0	0.063	0	0.056	0	0.012	0.06
WARR01B	0	0	0.0024	0.052	0.079	0.12	0.059	0.083	0.067	0.018	0.056	0	0.047	0	0.012	0.057
WARR01C	0	0	0.0071	0.077	0.099	0.19	0.068	0.079	0.12	0.023	0.14	0	0.061	0	0.05	0.11
WARR03	0.011	0.013	0.025	0.28	0.28	0.42	0.15	0.17	0.33	0.048	0.45	0.013	0.13	0.0096	0.24	0.47
WARR05	0.0073	0.006	0.011	0.16	0.16	0.22	0.13	0.11	0.22	0.042	0.32	0.012	0.11	0	0.22	0.38

Subsurface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
WARR01A	0	0	0.0035	0.044	0.061	0.12	0.043	0.044	0.069	0	0.065	0	0.04	0	0.013	0.048
WARR01B	0	0	0	0.0078	0	0	0	0	0.0097	0	0.01	0	0	0	0.0047	0.011
WARR01C	0	0	0.0069	0.052	0.062	0.085	0.03	0.049	0.054	0	0.074	0	0.03	0	0.033	0.07
WARR03	0	0	0.0046	0.048	0.047	0.054	0.047	0.045	0.064	0	0.078	0	0.034	0.0037	0.04	0.088
WARR05	0	0	0	0.01	0.0069	0.012	0	0.0097	0.014	0	0.018	0	0	0	0.012	0.023

APPENDIX 4

Phase II: PAH Data

Phase II: PAH Data

analytical parameter	abbreviation
Acenaphthene	Ace
Acenaphthylene	Acy
Anthracene	A
Benzo(a)anthracene	BaA
Benzo(a)pyrene	BaP
Benzo(b)fluoranthene	BbFl
Benzo(g,h,i)perylene	BPer
Benzo(k)fluoranthene	BkFl
Chrysene	Chry
Dibenzo(a,h)anthracene	DahA
Fluoranthene	Fl
Fluorene	F
Indeno(1,2,3-cd)pyrene	IndP
Naphthalene	Naph
Phenanthrene	Phen
Pyrene	P

Asphalt Study
AS01

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
AS01-00	0	0	0	0	0	0	0	0	0.45	0	0.21	0	0	0	0	0.39
AS01-A1	0	0	0	0.11	0.13	0.13	0.11	0.13	0.15	0.024	0.22	0	0.084	0	0.11	0.29
AS01-A2	0	0	0	0.097	0.11	0.13	0.049	0.14	0.13	0	0.17	0	0.046	0	0.11	0.19
AS01-A3	0	0	0	0.12	0.12	0.13	0.044	0.15	0.17	0	0.19	0	0.04	0	0.11	0.21
AS01-B1	0	0	0	0.028	0.03	0.032	0.028	0.039	0.039	0	0.048	0	0	0	0.025	0.051
AS01-B2	0	0	0	0.036	0.04	0.046	0	0.046	0.047	0	0.061	0	0	0	0.032	0.068
AS01-B3	0	0	0	0.049	0.052	0.068	0	0.074	0.067	0	0.085	0	0	0	0.048	0.088
AS01-C1	0	0	0	0	0	0	0	0.021	0.022	0	0.024	0	0	0	0	0.025
AS01-C2	0	0	0	0.019	0.027	0	0	0.035	0.029	0	0.033	0	0	0	0	0.036
AS01-C3	0	0	0	0.03	0.035	0.031	0	0.035	0.038	0	0.048	0	0	0	0.028	0.05
AS01-D1	0	0	0	0	0	0	0	0.02	0.02	0	0.023	0	0	0	0	0.023
AS01-D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.018
AS01-D3	0	0	0	0	0	0	0	0.02	0.019	0	0.027	0	0	0	0	0.031
AS01-E1	0	0	0	0	0	0	0	0.017	0.018	0	0.026	0	0	0	0	0.026
AS01-E2	0	0	0	0.062	0.064	0.074	0	0.082	0.069	0	0.11	0	0	0	0.035	0.11
AS01-E3	0	0	0	0.022	0.027	0.032	0	0.034	0.029	0	0.054	0	0	0	0.037	0.054

Asphalt Study
AS02

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
AS02-00	0	0	0	0	0	0	0	0	0.27	0	0	0	0	0	0	0
AS02-A1	0	0.059	0.04	0.57	0.79	0.88	0.78	0.86	1.1	0.25	1.4	0	0.65	0	0.53	2
AS02-A2	0	0.027	0.045	0.56	0.73	0.64	0.56	0.81	0.85	0.18	1.3	0	0.51	0	0.46	1.7
AS02-A3	0	0.028	0.04	0.54	0.74	0.63	0.64	0.79	0.87	0.21	1.3	0	0.57	0	0.44	1.8
AS02-B1	0	0	0	0.065	0.19	0.19	0.11	0.21	0.11	0.036	0.14	0	0.11	0	0.046	0.17
AS02-B2	0	0	0	0.088	0.19	0.18	0.13	0.19	0.15	0.04	0.24	0	0.13	0	0.073	0.26
AS02-B3	0	0	0	0.082	0.15	0.14	0.13	0.15	0.13	0.04	0.22	0	0.11	0	0.07	0.29
AS02-C1	0	0	0	0.026	0.082	0.066	0.07	0.068	0.046	0.021	0.074	0	0.064	0	0.025	0.08
AS02-C2	0	0	0	0.025	0.059	0.05	0.052	0.051	0.044	0.017	0.072	0	0.048	0	0.023	0.075
AS02-C3	0	0	0	0.018	0.045	0.036	0.045	0.039	0.034	0.018	0.053	0	0.041	0	0	0.056
AS02-D1	0	0	0	0	0.034	0.028	0.045	0.03	0.026	0	0.043	0	0.037	0	0	0.042
AS02-D2	0	0	0	0	0.028	0	0.038	0.023	0.022	0	0.037	0	0.034	0	0	0.037
AS02-D3	0	0	0	0.022	0.037	0.036	0	0.039	0.039	0	0.062	0	0	0	0.021	0.064
AS02-E1	0	0	0	0	0	0	0	0.018	0.019	0	0.026	0	0	0	0	0.027
AS02-E2	0	0	0	0	0	0	0	0.018	0.02	0	0.025	0	0	0	0	0.028
AS02-E3	0	0	0	0	0	0	0	0.02	0.023	0	0.032	0	0	0	0	0.033

Asphalt Study
AS03

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
AS03-00	0	0	0	0	0	0	0	0	0.24	0	0.15	0	0	0	0	0.37
AS03-A1	0.024	0	0.036	0.19	0.19	0.23	0.11	0.22	0.24	0.039	0.43	0	0.097	0	0.2	0.39
AS03-A2	0	0	0.049	0.25	0.22	0.27	0.16	0.25	0.3	0.039	0.53	0.031	0.11	0	0.36	0.6
AS03-A3	0	0	0	0.18	0.19	0.27	0.15	0.23	0.24	0.034	0.43	0	0.12	0	0.2	0.42
AS03-B1	0	0	0	0.079	0.1	0.12	0.078	0.13	0.12	0.027	0.19	0	0.066	0	0.058	0.18
AS03-B2	0	0	0	0.066	0.084	0.1	0.089	0.11	0.1	0.029	0.17	0	0.061	0	0.062	0.18
AS03-B3	0	0	0	0.08	0.11	0.14	0.054	0.12	0.12	0	0.2	0	0.049	0	0.071	0.2
AS03-C1	0	0	0	0.029	0.04	0.042	0	0.045	0.043	0	0.072	0	0	0	0.024	0.071
AS03-C2	0	0	0	0.049	0.068	0.088	0.028	0.083	0.075	0	0.13	0	0	0	0.043	0.12
AS03-C3	0	0	0	0.04	0.05	0.072	0	0.061	0.06	0	0.1	0	0	0	0.034	0.095
AS03-D1	0	0	0	0.055	0.065	0.086	0	0.085	0.074	0	0.12	0	0	0	0.037	0.12
AS03-D2	0	0	0	0.032	0.046	0.056	0	0.05	0.049	0	0.076	0	0	0	0.026	0.077
AS03-D3	0	0	0	0.025	0.038	0.049	0	0.044	0.041	0	0.065	0	0	0	0.023	0.064
AS03-E1	0	0	0	0.043	0.062	0.076	0	0.074	0.065	0	0.099	0	0	0	0.037	0.1
AS03-E2	0	0	0	0.03	0.042	0.05	0	0.05	0.045	0	0.073	0	0	0	0.025	0.067
AS03-E3	0	0	0	0.044	0.062	0.083	0	0.074	0.068	0	0.12	0	0	0	0.04	0.11

Asphalt Study
AS04

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
AS04-00	0	0	0	0	0	0	0	0	0.43	0	0	0	0	0	0	0.25
AS04-A1	0	0	0	0	0	0	0	0.018	0	0	0	0	0	0	0	0.028
AS04-A2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-A3	0	0	0	0	0	0	0	0.02	0.019	0	0.025	0	0	0	0	0.028
AS04-B1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-B3	0	0	0	0	0	0	0	0.023	0.021	0	0.027	0	0	0	0	0.026
AS04-C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-C2	0	0	0	0.028	0.03	0	0	0.036	0.033	0	0.046	0	0	0	0	0.039
AS04-C3	0	0	0	0	0	0	0	0.016	0	0	0	0	0	0	0	0.018
AS04-D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-D3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-E1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-E2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AS04-E3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Asphalt Study
AS05

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
AS05-00	0	0	0	0	0	0	0	0	0.38	0	0	0	0	0	0	0
AS05-A1	0	0	0	0.02	0.027	0.028	0.0084	0.029	0.037	0	0.052	0	0.017	0	0.025	0.055
AS05-A2	0	0	0.004	0.03	0.042	0.052	0.039	0.053	0.057	0	0.093	0	0.031	0	0.039	0.069
AS05-A3	0	0	0.0041	0.036	0.046	0.056	0.045	0.061	0.059	0.018	0.092	0	0.035	0	0.043	0.086
AS05-B1	0	0	0	0.019	0.025	0.026	0.017	0.04	0.035	0	0.05	0	0.014	0	0.025	0.04
AS05-B2	0	0	0	0.014	0	0.024	0.011	0.023	0.02	0	0.038	0	0.0099	0	0.017	0.031
AS05-B3	0	0	0	0.012	0	0.018	0	0.017	0.023	0	0.033	0	0.0087	0	0.016	0.03
AS05-C1	0	0	0	0.0071	0	0	0	0	0.01	0	0.016	0	0	0	0.0075	0.015
AS05-C2	0	0	0.0024	0.019	0.032	0.036	0.032	0.034	0.035	0.012	0.055	0	0.027	0	0.024	0.046
AS05-C3	0	0	0	0.011	0	0	0	0.015	0.016	0	0.022	0	0	0	0.012	0.019
AS05-D1	0	0	0	0.017	0	0.027	0	0.027	0.024	0	0.038	0	0	0	0.019	0.028
AS05-D2	0	0	0	0.01	0	0	0	0.02	0.017	0	0.027	0	0	0	0.012	0.021
AS05-D3	0	0	0	0.015	0.024	0.027	0.014	0.024	0.027	0.0093	0.046	0	0.015	0	0.018	0.034
AS05-E1	0	0	0	0.014	0	0.028	0.021	0.026	0.025	0.013	0.04	0	0.018	0.0022	0.018	0.034
AS05-E2	0	0	0	0.01	0	0.016	0	0.016	0.018	0	0.023	0	0	0	0.012	0.02
AS05-E3	0	0	0	0.0097	0	0.018	0.013	0.023	0.016	0.0078	0.026	0	0.012	0	0.012	0.023

Railroad Study

Surface samples (mg/kg)

Sample ID	Ace	Acy	A	BaA	BaP	BbFl	BPer	BkFl	Chry	DahA	Fl	F	IndP	Naph	Phen	P
RR03-A	0	0.034	0.039	0.29	0.29	0.47	0.26	0.38	0.48	0.083	0.64	0	0.18	0.1	0.36	0.57
RR03-B	0.016	0.1	0.082	0.62	0.8	1.1	0.68	1.1	0.98	0.28	1.5	0.029	0.56	0.02	0.4	1.3
RR03-C	0	0	0	0.009	0.018	0.016	0	0.019	0.017	0	0.023	0	0	0	0.01	0.017
RR03-D	0	0	0	0	0	0	0	0	0	0	0.0052	0	0	0	0	0.0068
RR03-E	0	0	0	0	0	0	0	0	0.0083	0	0.011	0	0	0	0.0058	0.013
RR07-A	0	0.019	0.02	0.095	0.13	0.22	0.21	0.18	0.23	0.056	0.35	0	0.12	0.083	0.22	0.39
RR07-B	0	0.021	0.017	0.088	0.096	0.15	0.18	0.13	0.15	0	0.25	0	0.11	0.063	0.14	0.23
RR07-C	0	0	0.0075	0.054	0.094	0.13	0.1	0.12	0.099	0	0.14	0	0.094	0.0095	0.057	0.1
RR07-D	0.0048	0.012	0.02	0.13	0.17	0.24	0.14	0.21	0.18	0.043	0.38	0	0.11	0.02	0.16	0.27
RR07-E	0	0.011	0.014	0.12	0.18	0.24	0.15	0.21	0.2	0.046	0.34	0	0.13	0.0094	0.099	0.23
RR08-A	0	0.027	0.024	0.12	0.15	0.14	0.16	0.17	0.22	0.089	0.32	0	0.13	0.024	0.16	0.36
RR08-B	0	0	0.017	0.11	0.14	0.11	0.09	0.17	0.15	0.033	0.21	0	0.088	0.0077	0.1	0.23
RR08-C	0	0.0068	0.015	0.073	0.11	0.11	0.08	0.15	0.12	0.037	0.16	0	0.068	0	0.086	0.17
RR08-D	0	0	0.005	0.027	0.043	0.046	0.02	0.036	0.038	0	0.049	0	0.018	0	0.02	0.05
RR08-E	0.008	0	0.0073	0.053	0.047	0.064	0.033	0.084	0.076	0	0.11	0	0.029	0.008	0.08	0.084
RR10-A	0.012	0.068	0.04	0.4	0.47	0.59	0.5	0.59	0.68	0.23	1.2	0	0.4	0.069	0.34	1.4
RR10-B	0	0.066	0.074	0.53	0.52	0.65	0.45	0.72	0.77	0.18	1.1	0.019	0.42	0.034	0.37	1.2
RR10-C	0	0	0	0.034	0.042	0.051	0.034	0.038	0.054	0	0.071	0	0.031	0.01	0.046	0.068
RR10-D	0.0082	0.014	0.027	0.18	0.21	0.24	0.16	0.24	0.27	0.051	0.37	0	0.15	0.0083	0.17	0.35
RR10-E	0	0.065	0.058	0.53	0.54	1	0.45	0.76	0.81	0.16	1.2	0.0071	0.39	0.0098	0.36	0.99
RR21-A	0.041	0.061	0.063	0.52	0.47	0.77	0.51	0.65	0.91	0.23	2	0.041	0.45	0.061	0.64	1.8
RR21-B	0.16	0.097	0.33	1.9	1.9	2.4	1.5	1.8	2.4	0.76	6.2	0.11	1.4	0.057	2.5	3
RR21-C	0.087	0.099	0.33	2	2.1	2.3	1.6	2.4	2.4	0.76	6.5	0.12	1.4	0.036	2.5	2.4
RR21-D	0.02	0.038	0.07	0.39	0.41	0.49	0.36	0.45	0.54	0.1	1.3	0.03	0.31	0.041	0.44	1.1
RR21-E	0.014	0.063	0.043	0.45	0.54	0.52	0.45	0.68	0.57	0.19	1.1	0.017	0.43	0	0.29	0.99

APPENDIX 5

Phase I: Particle Size and Total Organic Carbon Data

Phase I: Particle Size and Total Organic Carbon Data

Analytical Parameter	units	ATLA 05	ATLA 07	ATLA 10	BERG 01	BERG 04	BERG 05	BERG 07	BERG 08	BERG 10	BERG 12	BURL 01	BURL 02	BURL 04	BURL 05	BURL 10
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	99.9	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	100	100	100	100	99.1	100	99.5	98.9	100	100	100	100	100	100	100
No.4 Sieve (4.75 mm)	%	99.9	100	100	99.4	96.2	99.8	95.9	98	99.1	99.6	100	99.7	100	100	100
No.8 Sieve (2.36 mm)	%	95.7	99.6	99.6	98.6	92.8	99.3	90.6	97.5	96.4	99	99.9	99.3	99.9	99.5	99.9
No.10 Sieve (2.00 mm)	%	93.6	99.4	99.1	98.2	92	99.2	89.1	97.4	92.2	98.9	99.4	99.1	99.9	98.9	99.9
No.16 Sieve (1.18 mm)	%	81.6	93.4	97.2	94.7	88.8	70.3	81.7	96.1	88.9	96	96.4	97.7	98.7	97.1	94.6
No.30 Sieve (0.60 mm)	%	62.9	71	85.6	81.1	74.1	59.6	64.9	83.4	79	83.7	84.9	91.5	94.3	88.8	78.3
No.50 Sieve (0.30 mm)	%	40	53	69.5	60.8	59.5	48.1	51.4	60	67.6	59.1	64.6	68	84.3	67.3	49.4
No.100 Sieve (0.15 mm)	%	14	29.7	53.9	47.6	44.1	40.6	42.3	35.1	50.9	37.1	39.4	21.9	65.7	42.1	33.9
No.200 Sieve (0.075 mm)	%	11.2	23.4	48.6	38	35	36.9	38.3	24.2	40.9	28	28.3	10.7	52.5	33.1	28.5
0.030 mm (Hydrometer)	%	9	17	41	32	22	26	19	16	20	18	14	8	38	27	20
0.005 mm (Hydrometer)	%	4	7	14	10	10	6.7	10	10	9	9.2	8	4	18	16	8
0.0015 mm (Hydrometer)	%	3	4.8	5.4	6	5	0	0	5	3	6	7.1	2	10	10	5.2
% Gravel	%	0.11	0.02	0	0.6	3.8	0.19	4.1	2	0.87	0.41	0.01	0.27	0.02	0	0
% Sand	%	88.7	76.6	51.5	61.4	61.2	62.9	57.7	73.8	58.2	71.6	71.7	89.1	47.5	66.9	71.5
% Silt, Clay, Colloids	%	11.2	23.4	48.6	38	35	36.9	38.3	24.2	40.9	28	28.3	10.7	52.5	33.1	28.5
Solids, Percent	%	90.4	87.6	76.3	81.6	77.8	65.7	39.4	85.6	82.3	84.4	94.9	93.6	82.6	88.1	87.5
Total Organic Carbon	mg/kg	14,300	31,000	24,000	17,500	30,000	114,000	311,000	19,100	21,700	22,400	11,500	9,870	14,500	23,200	73,300

Analytical Parameter	units	CAMD 01	CAMD 02	CAMD 08	CAMD 11	CAMD 13	CAMD 14	CAPE 11	CUMB 02	ESSE 02	ESSE 04	ESSE 09	ESSE 11	ESSE 19	ESSE 20	ESSE 21
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	99.8	100	99.7	100	100	100	100	100	100
0.375 Inch Sieve	%	100	100	100	100	100	100	99.7	99.6	99.1	99.4	100	99.7	99.9	98.3	100
No.4 Sieve (4.75 mm)	%	100	99.5	99.9	100	100	100	99.6	99.5	98.8	98.7	99.9	96.6	97.2	97.1	100
No.8 Sieve (2.36 mm)	%	99.6	95.5	99.5	100	99.7	99.3	99.5	99.1	98.4	96.2	99	94.9	92.1	92.5	99.8
No.10 Sieve (2.00 mm)	%	99.5	94.4	99.1	100	99.4	98.9	99.4	99	98.2	95.5	98.7	94.3	91.3	90.8	99.7
No.16 Sieve (1.18 mm)	%	93.8	84.4	97.4	98.7	95.2	96.1	96.1	90.3	88.6	91.9	95.2	93.2	85.1	86.8	98
No.30 Sieve (0.60 mm)	%	83.5	47.7	92.8	95.7	79.1	80.7	83.8	58.8	87	87.5	92	88.8	79	79.7	95.3
No.50 Sieve (0.30 mm)	%	69.9	30.9	84.3	66.6	41.4	46.7	50.7	35.8	83.6	82.2	86.7	78.4	69.6	68.5	90.7
No.100 Sieve (0.15 mm)	%	62.2	22.4	77.2	29.6	21	28.6	21.6	27.5	77.4	76.7	74.2	66.6	49.7	57.4	81.9
No.200 Sieve (0.075 mm)	%	58.8	18.5	69.1	19.7	15.8	21.1	14.6	26.1	72.1	72.1	61.5	58.4	37.3	48.9	70.6
0.030 mm (Hydrometer)	%	22	12	46	12	8	11	10	14	54	52	40	40	20	34	46
0.005 mm (Hydrometer)	%	11	6	22	6	3	6	2	5	26	18	24	20	8	18	22
0.0015 mm (Hydrometer)	%	7	3	14	5.4	2	3	1	1	20	9.9	16	9	5	9	16
% Gravel	%	0.01	0.48	0.06	0.02	0	0	0.4	0.48	1.2	1.3	0.09	3.4	2.8	2.9	0.05
% Sand	%	41.2	81	30.8	80.2	84.2	78.9	85	73.4	26.7	26.6	38.4	38.3	60	48.2	29.4
% Silt, Clay, Colloids	%	58.8	18.5	69.1	19.7	15.8	21.1	14.6	26.1	72.1	72.1	61.5	58.4	37.3	48.9	70.6
Solids, Percent	%	76.6	83.4	88.8	91.9	89.7	90.1	89.2	85.7	56.6	68.9	78.9	78.9	79.8	79.4	79
Total Organic Carbon	mg/kg	58,000	20,600	21,800	17,000	9,620	22,100	15,000	26,900	68,600	43,100	20,600	22,200	33,300	12,900	24,300

Analytical Parameter	units	GLOU 01	GLOU 03	GLOU 05	GLOU 07	HUDS 01	HUDS 04	HUDS 06	HUDS 10	HUDS 11	HUNT 01	HUNT 08	MERC 03	MERC 04	MERC 05	MERC 06
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	99.9	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	99.7	100	100	100	99.9	100	100	100	99.9	100	98.3	100	99.3	99.9	100
No.4 Sieve (4.75 mm)	%	98	100	100	100	98.8	100	97.7	94.4	99.6	100	98.1	97.6	95.5	97.5	99.9
No.8 Sieve (2.36 mm)	%	96.3	100	99.9	99.9	96.1	99.8	96	87.9	96.8	99.9	97.4	92.3	83.2	96.8	99.8
No.10 Sieve (2.00 mm)	%	95.9	99.9	99.9	99.7	95.6	99.7	95.5	87.1	95.6	99.9	97.1	91.2	80.6	96.6	99.5
No.16 Sieve (1.18 mm)	%	90.7	97.5	99.1	96.2	93.2	93.6	94.1	83.4	94.4	96.2	95.5	89	73.5	95.9	97.1
No.30 Sieve (0.60 mm)	%	79.2	81.3	90.3	75.6	89.7	84.4	87	76.7	88.9	92.3	94.5	84	63	86.1	82.7
No.50 Sieve (0.30 mm)	%	60.3	55.1	56.9	40.7	83.3	75.7	70.8	68.5	79.2	89	92.2	80.8	57.3	65.6	62.7
No.100 Sieve (0.15 mm)	%	38.7	36.5	29.2	24.1	70.4	65.5	47.4	60.2	67.6	86.6	86.1	76.4	53.4	49.8	46.1
No.200 Sieve (0.075 mm)	%	18.9	28.6	19.7	18.6	59.8	57.2	37.7	55	59	85.1	76.7	72.7	51.2	45.3	41.9
0.030 mm (Hydrometer)	%	11	20	14	12	30	32	20	34	33	81	52	57	28	34	38
0.005 mm (Hydrometer)	%	3.3	10	6	6	9	13	9	10	12	36	19	26	11	14	15
0.0015 mm (Hydrometer)	%	3.3	6	1	4	5	5.3	3	0	5	16	11	13	5	9.4	10
% Gravel	%	2	0.02	0	0.02	1.2	0	2.3	5.6	0.42	0.01	1.9	2.4	4.5	2.5	0.09
% Sand	%	79.2	71.4	80.3	81.4	39	42.8	60	39.4	40.6	14.9	21.4	24.9	44.4	52.2	58
% Silt, Clay, Colloids	%	18.9	28.6	19.7	18.6	59.8	57.2	37.7	55	59	85.1	76.7	72.7	51.2	45.3	41.9
Solids, Percent	%	76.6	91.2	88.7	92.3	79.5	80.5	81.2	70.8	79.8	70.3	76	73.1	77.8	75.7	74.1
Total Organic Carbon	mg/kg	30,400	14,100	17,800	6,070	24,600	32,700	26,500	58,200	59,000	33,900	23,100	26,600	32,600	26,500	31,800

Analytical Parameter	units	MIDD 01	MIDD 02	MIDD 03	MIDD 04	MIDD 06	MIDD 10	MIDD 12	MIDD 13	MIDD 15
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	90.8	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	76.4	96.8	92.1	100	100	97.9	100	99	100
No.4 Sieve (4.75 mm)	%	67.6	92.5	78.4	100	99.8	91.6	100	89.2	92.7
No.8 Sieve (2.36 mm)	%	55	81.7	66.3	100	96.1	86.4	99.9	74.6	79.3
No.10 Sieve (2.00 mm)	%	51.7	79.1	63.7	99.9	95	85	99.9	71.3	76.4
No.16 Sieve (1.18 mm)	%	48.2	76.3	59.2	84.4	87.3	79	97.2	67.5	74
No.30 Sieve (0.60 mm)	%	43.9	70.5	51.1	72.7	78.3	66	87.9	57.1	68.4
No.50 Sieve (0.30 mm)	%	38.9	61.8	41.7	53.9	68.5	50.5	74	46.8	60.8
No.100 Sieve (0.15 mm)	%	34.1	52.5	37.6	40.1	60.2	40.3	58.2	40.5	54.1
No.200 Sieve (0.075 mm)	%	30.8	46.1	36.1	36.8	54.3	35.3	50	37.6	51.2
0.030 mm (Hydrometer)	%	24	40	18	33	42	25	47	30	46
0.005 mm (Hydrometer)	%	11	18	6	11	16	10	20	18	20
0.0015 mm (Hydrometer)	%	5.1	9.8	0	3.4	5.8	2.8	12	10	7.9
% Gravel	%	32.4	7.5	21.6	0.01	0.24	8.4	0.03	10.8	7.3
% Sand	%	36.8	46.4	42.3	63.2	45.4	56.2	50	51.6	41.4
% Silt, Clay, Colloids	%	30.8	46.1	36.1	36.8	54.3	35.3	50	37.6	51.2
Solids, Percent	%	79.8	81.2	65.8	74.5	65	76.5	78.4	65.5	68.3
Total Organic Carbon	mg/kg	31,500	21,500	59,200	44,300	63,800	36,900	25,200	40,000	37,000

Analytical Parameter	units	MONM 02	MONM 03	MONM 09	MONM 12	MONM 14	MONM 16	MONM 18
3 Inch Sieve	%	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	99.8	100	100	100	100	100
0.375 Inch Sieve	%	100	98.9	99.8	100	100	100	100
No.4 Sieve (4.75 mm)	%	99.9	98.6	99.6	100	99.2	100	100
No.8 Sieve (2.36 mm)	%	96.8	97.3	99.3	99.9	98.5	100	98.6
No.10 Sieve (2.00 mm)	%	95.7	96.9	99	99.9	98.2	100	98.1
No.16 Sieve (1.18 mm)	%	90.9	93.3	91.4	97.9	94.6	95	94.4
No.30 Sieve (0.60 mm)	%	79.7	74.6	82.4	89.3	92.3	76.2	83.2
No.50 Sieve (0.30 mm)	%	63	42.8	64.3	70.3	81.4	53.6	49.2
No.100 Sieve (0.15 mm)	%	50.4	26.2	50.3	57	71.7	42.9	34.1
No.200 Sieve (0.075 mm)	%	44.6	22.2	44.4	51	67.8	40.3	21.5
0.030 mm (Hydrometer)	%	30	17	32	32	42	37	12
0.005 mm (Hydrometer)	%	14	9	16	14	14	17	4
0.0015 mm (Hydrometer)	%	7	7.1	10	10	8	12	1
% Gravel	%	0.12	1.4	0.44	0	0.79	0	0
% Sand	%	55.3	76.4	55.2	49	31.4	59.8	78.5
% Silt, Clay, Colloids	%	44.6	22.2	44.4	51	67.8	40.3	21.5
Solids, Percent	%	88.2	87.3	78.3	87.4	90.9	82.3	90.6
Total Organic Carbon	mg/kg	12,400	16,100	29,000	10,000	44,800	19,800	16,400

Analytical Parameter	units	MORR 01	MORR 03	MORR 04	MORR 05	MORR 08	MORR 10	MORR 11	MORR 16	MORR 17	OCEA 02	OCEA 03	OCEA 04	OCEA 07	OCEA 09	OCEA 10
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	86.9	100	100	100	100	100	99.6	100	100	100	100
0.375 Inch Sieve	%	100	99.3	97.7	99	81.8	98.9	96.2	100	100	100	99.6	100	100	100	100
No.4 Sieve (4.75 mm)	%	99.8	99.3	97.2	98	79	93.7	91.9	98.9	97.4	100	98.3	100	100	98.7	100
No.8 Sieve (2.36 mm)	%	99.3	97.5	94.9	96.6	73.9	86.2	88	93.3	88.5	99	95.6	99.9	96.5	88.1	99.7
No.10 Sieve (2.00 mm)	%	99.1	96.5	93.7	96	72.5	83.8	86.2	92	86.2	98.2	94.3	99.8	95.3	85.2	99.5
No.16 Sieve (1.18 mm)	%	94.6	94.6	70.2	93	65.3	77.5	81.7	86	80.7	92.6	85.2	96.4	86	64.9	94.1
No.30 Sieve (0.60 mm)	%	89.5	91.9	58.3	89.6	58	68	73.4	72.7	66	70.8	56.6	79.7	60.8	37.2	73.3
No.50 Sieve (0.30 mm)	%	82.4	86.2	44.6	84	50.4	55	65.5	61	51.7	35.7	31.2	32.5	39.7	21	23.7
No.100 Sieve (0.15 mm)	%	74.1	78.4	34.3	77.7	44.2	41.7	57.3	51.3	39.2	14.8	17.2	11.1	27.7	11.6	7.2
No.200 Sieve (0.075 mm)	%	66.3	73.7	27	72.5	41.1	33.3	51.6	45.2	30.7	9.3	13.4	7.4	21.8	8.4	4.9
0.030 mm (Hydrometer)	%	46	65	24	63	35	24	44	38	18	8	8	6	16	4	5
0.005 mm (Hydrometer)	%	18	34	14	26	10	12	14	18	8	6	5.3	3	7	0.86	3
0.0015 mm (Hydrometer)	%	10	19	0	12	0	7	0	0	0	3	1.1	1	3	0	2
% Gravel	%	0.25	0.74	2.8	2	21	6.3	8.1	1.1	2.6	0.01	1.8	0.04	0	1.3	0
% Sand	%	33.5	25.6	70.2	25.5	37.9	60.3	40.3	53.6	66.8	90.7	84.8	92.6	78.2	90.3	95.2
% Silt, Clay, Colloids	%	66.3	73.7	27	72.5	41.1	33.3	51.6	45.2	30.7	9.3	13.4	7.4	21.8	8.4	4.9
Solids, Percent	%	68.2	77.5	73.1	67	55.9	81.9	61	66.1	79.9	91.4	85.4	90.7	91.8	95.4	96.4
Total Organic Carbon	mg/kg	32,200	9,050	18,000	35,900	91,300	9,320	70,700	66,900	15,300	14,900	48,400	13,200	34,100	14,800	2,550

Analytical Parameter	units	PASS 01	PASS 03	PASS 07	PASS 14	PASS 16	SALE 04	SOME 02	SOME 10	SOME 13	SOME 18	SUSS 01	SUSS 04	SUSS 05
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	100	100	99.9	100	100	100	100	99.8	99.9	99.7	100	100	100
No.4 Sieve (4.75 mm)	%	100	99.6	99.8	100	99	99.8	100	97.3	99.7	97	100	99.6	100
No.8 Sieve (2.36 mm)	%	99.3	99.3	98.7	100	98.1	98.7	100	91.6	99.2	88.1	98.6	99	100
No.10 Sieve (2.00 mm)	%	98.9	99.2	98.4	100	97.7	97.6	100	90.4	99	85.8	98	98.9	100
No.16 Sieve (1.18 mm)	%	91.7	97.5	93.2	98.8	89.9	94.9	98.2	84.9	97.2	78.1	94.9	93.6	99.6
No.30 Sieve (0.60 mm)	%	82.3	91.6	80.4	95.9	82.9	91.1	96.1	80.7	96.2	68.5	90.1	90	97
No.50 Sieve (0.30 mm)	%	71.5	73.5	67.9	82.9	75.5	85.4	90.2	76.5	94	58.9	82.1	83.7	91.5
No.100 Sieve (0.15 mm)	%	59.7	52.2	57.7	71.3	68.2	81.4	79.8	72.4	90.1	52.3	69.5	75.1	79.1
No.200 Sieve (0.075 mm)	%	51	43.4	52.5	61.6	63.2	79.6	69.1	69.5	85.8	46	62.1	69.8	72.6
0.030 mm (Hydrometer)	%	22	25	30	33	43	64	45	60	58	38	37	54	44
0.005 mm (Hydrometer)	%	10	9	12	14	17	30	22	34	24	20	8	24	12
0.0015 mm (Hydrometer)	%	5	4	0	8	0	15	15	18	18	14	1	5.6	4
% Gravel	%	0	0.39	0.25	0	1.1	0.18	0	2.7	0.35	3	0.01	0.37	0
% Sand	%	49	56.2	47.3	38.4	35.8	20.2	30.9	27.8	13.9	51	37.9	29.8	27.4
% Silt, Clay, Colloids	%	51	43.4	52.5	61.6	63.2	79.6	69.1	69.5	85.8	46	62.1	69.8	72.6
Solids, Percent	%	89.3	77	64.6	72.5	64.8	82.2	77	80.1	73.7	82.2	75.9	61.9	72.2
Total Organic Carbon	mg/kg	12,000	35,300	74,300	29,200	74,500	18,400	29,800	18,300	26,100	20,600	17,800	33,900	23,000

Analytical Parameter	units	UNIO 01	UNIO 17	UNIO 18	UNIO 19	UNIO 20	UNIO 21	UNIO 23	UNIO 25	WARR 01	WARR 03	WARR 05
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	95.9	100	100	100	99.2	100	100	100	100	99.8	100
No.4 Sieve (4.75 mm)	%	95.1	100	99.8	99.8	97.3	99.6	99.9	99.4	100	99.7	100
No.8 Sieve (2.36 mm)	%	92.1	100	99.7	99.6	93.5	98.7	99.2	97.9	97.6	98.6	99.9
No.10 Sieve (2.00 mm)	%	90.8	100	99.6	99.3	91.7	98.5	99	97.6	95.9	98.3	99.9
No.16 Sieve (1.18 mm)	%	87.4	93.9	98.9	97.1	89	97.2	97.1	91.4	85.5	93.7	96.7
No.30 Sieve (0.60 mm)	%	81.6	86.9	95.1	93	84.1	90	89.3	81.6	70.7	89.9	89.4
No.50 Sieve (0.30 mm)	%	67.2	77.3	90.5	87.8	77.1	75.6	68.7	72.2	56.9	85.1	80.3
No.100 Sieve (0.15 mm)	%	51.6	66.2	85	80.5	66.4	61.7	49.5	64.7	45.4	77.2	71.2
No.200 Sieve (0.075 mm)	%	43.2	57.5	79.5	73.8	58.2	53.3	40.2	60.6	38.2	69.2	65.1
0.030 mm (Hydrometer)	%	32	54	59	52	48	40	34	47	20	31	44
0.005 mm (Hydrometer)	%	17	30	28	28	22	19	18	22	5	7	15
0.0015 mm (Hydrometer)	%	11	0	14	16	14	12	0	0	1	1	1.1
% Gravel	%	4.9	0	0.16	0.18	2.7	0.41	0.12	0.65	0	0.34	0.04
% Sand	%	51.9	42.5	20.3	26	39.1	46.3	59.7	38.7	61.8	30.5	34.9
% Silt, Clay, Colloids	%	43.2	57.5	79.5	73.8	58.2	53.3	40.2	60.6	38.2	69.2	65.1
Solids, Percent	%	71.2	63.3	73.5	76.3	74.2	77.8	64.5	64.2	78	65	73.5
Total Organic Carbon	mg/kg	26,300	55,600	44,000	35,100	32,300	25,800	48,000	118,000	21,400	44,500	20,500

APPENDIX 6

Phase II: Particle Size and Total Organic Carbon Data

Phase II: Particle Size and Total Organic Carbon Data

Asphalt Study
AS01

Analytical Parameter	units	AS01-A1	AS01-A2	AS01-A3	AS01-B1	AS01-B2	AS01-B3	AS01-C1	AS01-C2	AS01-C3	AS01-D1	AS01-D2	AS01-D3	AS01-E1	AS01-E2	AS01-E3
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	97.1	100	98.8	99	98.8	100	100	98.8	100	100	100	100	99.3	100	100
No.4 Sieve (4.75 mm)	%	94	95.9	90.2	98.9	98.8	99.2	99.9	98.6	99.9	100	99.2	99.6	99.2	99.5	98.4
No.8 Sieve (2.36 mm)	%	90.2	91.5	83.6	98.6	98.4	99.1	99.2	98.2	99.3	98.8	98.4	99.3	98.5	98.8	97.7
No.10 Sieve (2.00 mm)	%	89.1	90	82	98.4	98.3	99.1	98.9	98	99	98.6	98.1	99.2	98.4	98.6	97.5
No.16 Sieve (1.18 mm)	%	83.1	85	75.8	94.4	94.9	96.2	95	94.3	95.4	94.7	94.5	96.5	95.1	94.7	94.7
No.30 Sieve (0.60 mm)	%	70	71.1	61.6	71.4	75.7	77.8	73.4	69.6	74.5	72.1	73.4	78.8	74.5	75.5	76.8
No.50 Sieve (0.30 mm)	%	45.6	46.5	40.1	44.8	49.3	50.9	47.6	44.2	44.2	40.8	43.2	48.8	42.3	43	44.2
No.100 Sieve (0.15 mm)	%	29	29.9	25.2	22.4	23.4	24.2	23.2	21.2	24.4	17.5	20.1	21.7	19.5	19.2	19.9
No.200 Sieve (0.075 mm)	%	22.3	23.7	19.9	16	15.3	15.1	14.6	13.5	14.8	11.6	11.1	11.7	10.4	10.8	10.9
0.030 mm (Hydrometer)	%	19	18	18	12	12	11.3	12	10	10	10.9	10.8	11.2	10	9.4	8
0.005 mm (Hydrometer)	%	12	14	12	7	6	6	6	6	6	6	6	6	6	5.2	6
0.0015 mm (Hydrometer)	%	9	9	8	6	5.2	4	3	4	4	5	3	4	4.9	5.2	5
% Gravel	%	6	4.1	9.8	1.1	1.2	0.76	0.13	1.4	0.06	0	0.82	0.4	0.82	0.49	1.6
% Sand	%	71.7	72.2	70.3	83	83.6	84.1	85.3	85.1	85.1	88.4	88.1	87.9	88.8	88.7	87.5
% Silt, Clay, Colloids	%	22.3	23.7	20	16	15.3	15.1	14.6	13.5	14.8	11.6	11.1	11.7	10.4	10.8	10.9
Solids, Percent	%	89.1	88.1	92.1	80.1	93.5	92.2	96.3	79.7	93.2	94.1	91.5	80.1	92.8	93.9	74.9
Total Organic Carbon	mg/kg	17,500	16,600	19,800	17,000	16,300	22,200	6,610	7,770	6,090	5,930	7,950	5,020	6,030	8,680	8,240

Asphalt Study
AS02

Analytical Parameter	units	AS02-A1	AS02-A2	AS02-A3	AS02-B1	AS02-B2	AS02-B3	AS02-C1	AS02-C2	AS02-C3	AS02-D1	AS02-D2	AS02-D3	AS02-E1	AS02-E2	AS02-E3
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
No.4 Sieve (4.75 mm)	%	98.5	100	98.8	100	100	99.6	100	100	100	100	100	100	100	100	100
No.8 Sieve (2.36 mm)	%	97	99.8	98.6	99.9	99.8	99.3	100	99.9	99.2	99.2	99.9	100	100	100	99
No.10 Sieve (2.00 mm)	%	96.5	99.7	98.4	99.7	99.7	99.2	100	99.9	98.7	98.9	100	100	100	100	99
No.16 Sieve (1.18 mm)	%	93.4	98.1	95.9	96.6	97.4	96.4	99.1	99.3	94.9	96	97	98	98	98	97
No.30 Sieve (0.60 mm)	%	81.6	90.5	88.3	86.1	86.5	86	95.1	95.6	85.3	86.8	86	89	90	93	90
No.50 Sieve (0.30 mm)	%	57.3	66.6	65.2	65	61.8	64.9	75.9	78	63	63.9	61	64	68	74	64
No.100 Sieve (0.15 mm)	%	22.8	22.1	21.9	25.2	22.5	23	25.2	24.7	21.4	18.2	18	21	19	26	24
No.200 Sieve (0.075 mm)	%	10.8	9.3	9.3	11.3	11	10.1	9.4	8.9	10.1	9.7	8.1	9.4	8.9	8.4	10
0.030 mm (Hydrometer)	%	8	7	7	8	8	8	7	7	7	7	7	8	7	7	7
0.005 mm (Hydrometer)	%	4	3	3.6	4	4	3	4	4	5	5	4	4	4	3.6	4
0.0015 mm (Hydrometer)	%	3	2.6	3	2.6	2.6	2.6	2.7	3	3	4	3	3	3	3	3.5
% Gravel	%	1.6	0	1.2	0	0	0.42	0	0	0	0	0	0	0.08	0	0.33
% Sand	%	87.6	90.7	89.5	88.7	89	89.5	90.6	91.1	89.9	90.3	92	91	91	92	90
% Silt, Clay, Colloids	%	10.8	9.3	9.3	11.3	11	10.1	9.4	8.9	10.1	9.7	8.1	9.4	8.9	8.4	10
Solids, Percent	%	72.7	93.8	92	69.9	79.3	93.5	93.8	92.6	73.3	95.4	95	95.7	93.1	94.6	93.7
Total Organic Carbon	mg/kg	16,800	20,700	18,800	17,900	11,000	11,900	14,300	11,000	12,400	8,690	10,300	11,600	11,900	9,200	12,200

Asphalt Study
AS03

Analytical Parameter	units	AS03-A1	AS03-A2	AS03-A3	AS03-B1	AS03-B2	AS03-B3	AS03-C1	AS03-C2	AS03-C3	AS03-D1	AS03-D2	AS03-D3	AS03-E1	AS03-E2	AS03-E3
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	95.7	99.5	97.5	100	93.7	100	100	100	100	100	99.7	100	100	100	99.4
No.4 Sieve (4.75 mm)	%	95	95.3	93.1	99.4	87.4	98.3	100	100	100	98.7	99.2	96.1	100	97.9	99.4
No.8 Sieve (2.36 mm)	%	91.6	92.1	86.1	96.1	81.2	97	100	100	100	96.5	97.9	93.5	100	97.3	99.1
No.10 Sieve (2.00 mm)	%	90.5	91	83.9	94.9	79.3	96.3	100	100	100	95.4	97.5	92.7	100	96.9	99
No.16 Sieve (1.18 mm)	%	87.5	88	78.2	91.1	75.8	94.4	99.5	99.8	99.6	93.6	95.2	91	98	94.8	98.1
No.30 Sieve (0.60 mm)	%	78.3	79.4	64.4	72.7	67.2	87.8	95.9	96.7	95.7	86.9	87.6	82.4	92.6	86.2	93.6
No.50 Sieve (0.30 mm)	%	65.7	63	50.6	59.8	57.2	68	84.7	85.7	80.3	75.3	73.6	72.4	81.4	76.5	82.6
No.100 Sieve (0.15 mm)	%	55.1	53.9	39.8	52	49.9	54.5	69.5	68.3	67.5	64.4	64.4	62.2	72	67.5	73.7
No.200 Sieve (0.075 mm)	%	51.3	49.5	36.1	48.6	47	50.7	64.1	62	63.4	61	61.4	57.8	68.5	64.3	71.3
0.030 mm (Hydrometer)	%	46	45	32	44	46	46	56	52	54	56	50	48	64	56	62
0.005 mm (Hydrometer)	%	20	18	18	18	18	20	24	22	18	22	18	20	26	20	22
0.0015 mm (Hydrometer)	%	13	11	10	12	12	11.7	10	12.2	9.9	11.7	12	11	12	9.5	12.1
% Gravel	%	5	4.7	6.9	0.58	12.6	1.7	0	0	0	1.3	0.85	3.9	0	2.1	0.6
% Sand	%	43.7	45.8	57	50.8	40.5	47.7	35.9	38	36.6	37.7	37.7	38.2	31.5	33.6	28.1
% Silt, Clay, Colloids	%	51.3	49.5	36.1	48.6	47	50.7	64.1	62	63.4	61	61.4	57.8	68.5	64.3	71.3
Solids, Percent	%	80.8	81.2	80	84.9	80.3	80.8	73.7	75.9	78.3	76.1	80.2	79.9	77.4	76.6	78.5
Total Organic Carbon	mg/kg	21,400	24,700	22,900	18,700	22,000	27,900	27,400	26,800	29,500	17,500	15,700	16,700	22,200	22,200	23,200

Asphalt Study
AS04

Analytical Parameter	units	AS04-A1	AS04-A2	AS04-A3	AS04-B1	AS04-B2	AS04-B3	AS04-C1	AS04-C2	AS04-C3	AS04-D1	AS04-D2	AS04-D3	AS04-E1	AS04-E2	AS04-E3
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	94.3	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	96.6	98	94.3	100	100	77.3	96.7	100	95.5	100	100	100	100	100	100
No.4 Sieve (4.75 mm)	%	95.5	96.9	93.9	99.6	98.9	66.5	94.8	96.8	94.8	99.7	99.6	98.3	99.1	99.3	100
No.8 Sieve (2.36 mm)	%	94.4	95.7	93	99.1	98	60.5	93	94.2	93.4	98.5	98.5	97	98.5	99	100
No.10 Sieve (2.00 mm)	%	94.1	95.3	92.8	98.9	97.7	59	92.5	93.7	93	98	98.3	96.6	98.4	98.9	100
No.16 Sieve (1.18 mm)	%	90.8	90.4	86	96.1	93.7	55.4	88.4	89.4	88.6	94.7	95.3	93	96.4	97.7	97.5
No.30 Sieve (0.60 mm)	%	73.7	70.4	64.3	80.1	74.2	44.1	71.1	70.1	69.3	80.5	81.1	78.1	84.6	87.7	83.7
No.50 Sieve (0.30 mm)	%	42.7	33.2	29.2	46.8	39.6	22.5	38.8	37	32.8	48.5	47.2	43.3	49.4	54.7	38.8
No.100 Sieve (0.15 mm)	%	15.2	11.5	11.7	16	14.1	8.3	14.2	15	14.6	17.6	15.7	15.4	16.9	19.7	15.8
No.200 Sieve (0.075 mm)	%	8.8	8	8.2	9.7	9.6	4.5	8.6	9.7	10.4	12.2	9.7	9	12	12.3	12.4
0.030 mm (Hydrometer)	%	6	9	6	8	7	4	6.6	8	10	6	6.5	6	7	8	8
0.005 mm (Hydrometer)	%	4	6	4	4	4	2.5	4	6	8	3	4	3	4	4	3
0.0015 mm (Hydrometer)	%	2.9	5	2.8	3.1	3	1.9	2.8	4.8	4.8	2.6	2.5	2.5	2.5	2.2	2.5
% Gravel	%	4.6	3.1	6.1	0.42	1.1	33.5	5.2	3.2	5.2	0.35	0.39	1.7	0.94	0.71	0
% Sand	%	86.7	88.9	85.7	89.9	89.3	62	86.2	87.2	84.5	87.5	89.9	89.4	87.1	87	87.6
% Silt, Clay, Colloids	%	8.8	8	8.2	9.7	9.6	4.5	8.6	9.7	10.4	12.2	9.7	9	12	12.3	12.4
Solids, Percent	%	92.1	91.1	90.9	89.7	89.8	90.2	92.1	87.8	89.4	89.9	92.4	93.4	90.6	91.2	90.5
Total Organic Carbon	mg/kg	9,820	11,600	10,700	15,600	15,400	12,800	11,500	14,000	13,700	12,800	11,900	10,200	8,910	12,900	9,860

Asphalt Study
AS05

Analytical Parameter	units	AS05-A1	AS05-A2	AS05-A3	AS05-B1	AS05-B2	AS05-B3	AS05-C1	AS05-C2	AS05-C3	AS05-D1	AS05-D2	AS05-D3	AS05-E1	AS05-E2	AS05-E3
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
No.4 Sieve (4.75 mm)	%	100	100	100	98.7	100	100	100	100	100	100	100	100	100	100	100
No.8 Sieve (2.36 mm)	%	100	100	100	96.5	100	100	100	100	100	100	99.2	100	100	100	100
No.10 Sieve (2.00 mm)	%	100	100	100	95.4	100	100	100	100	100	100	98.8	100	100	100	100
No.16 Sieve (1.18 mm)	%	90.1	92.6	95.5	88.5	92	90.2	94	94.4	93.5	93.6	87.1	91.4	90.6	91.9	92.7
No.30 Sieve (0.60 mm)	%	78.2	82.7	86.6	80.6	84.8	79	85.4	85.3	87	81.8	75.5	78.9	82	76.4	82.7
No.50 Sieve (0.30 mm)	%	72.4	76.3	80.9	75.8	79.4	72.2	80.7	80.5	81.9	76.1	69.9	75	76.5	66.5	78
No.100 Sieve (0.15 mm)	%	67.5	71.1	75.9	71.9	75.6	68	76.4	77.7	78.1	72.8	66.5	72	71.7	62.2	74.2
No.200 Sieve (0.075 mm)	%	66.1	69.4	74.6	70.7	74.6	66.9	75.1	76.8	77	71.8	65.2	70.8	69.5	60.6	72.8
0.030 mm (Hydrometer)	%	56	69	72	64	68	66	75	76	72	71	65	70	69	60	72
0.005 mm (Hydrometer)	%	26	38	30	24	34	34	36	40	30	36	30	40	36	30	30
0.0015 mm (Hydrometer)	%	15	0	17	0	19.2	0	23.9	0	0	22.2	0	23.7	21.7	19	17.2
% Gravel	%	0	0	0	1.3	0	0	0	0	0	0	0	0	0	0	0
% Sand	%	33.9	30.6	25.5	28	25.4	33.1	24.9	23.2	23	28.2	34.8	29.2	30.5	39.4	27.2
% Silt, Clay, Colloids	%	66.1	69.4	74.6	70.7	74.6	66.9	75.1	76.8	77	71.8	65.2	70.8	69.5	60.6	72.8
Solids, Percent	%	80.1	83.1	81.9	83.3	84.2	87.1	74.2	83.1	87.4	85.4	85.5	87.5	87.4	86.9	85.5
Total Organic Carbon	mg/kg	32,600	72,200	33,500	50,100	35,500	25,400	24,000	49,200	18,700	27,300	26,700	37,400	22,500	30,900	32,700

Railroad Study

Analytical Parameter	units	RR03-A	RR03-B	RR03-C	RR03-D	RR03-E	RR07-A	RR07-B	RR07-C	RR07-D	RR07-E	RR08-A	RR08-B	RR08-C	RR08-D	RR08-E
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	100	100	100	100	100	96.6	100	100	99.1	100	100	100	100	100	100
No.4 Sieve (4.75 mm)	%	100	100	100	100	99.6	92.5	94	96.9	98	99.5	99.6	100	100	100	99.5
No.8 Sieve (2.36 mm)	%	99.2	99.8	99.9	100	99.4	88.3	90.4	95.7	96.9	99.3	98.8	99.8	100	100	99
No.10 Sieve (2.00 mm)	%	98.9	99.8	99.9	100	99.3	87.3	89.5	95.3	96.7	99.2	98.4	99.8	100	100	98.4
No.16 Sieve (1.18 mm)	%	98	99.1	98.6	99.4	98.9	83.9	84.3	92.9	94.7	98.1	97.7	99.6	99.9	99.7	97.6
No.30 Sieve (0.60 mm)	%	90.4	92	84.4	92.4	88.8	73	67.1	76.4	78.5	81.8	91.6	90.3	95	81.6	83
No.50 Sieve (0.30 mm)	%	62.6	59.1	49.9	51.3	49.8	51.6	40.9	50.8	54.2	49.3	55.8	53.8	56.2	46.7	35.1
No.100 Sieve (0.15 mm)	%	33.8	24.1	25.1	18.7	20.8	32.7	27.9	33.1	42.8	32.7	33.7	34	34.1	32.5	20.8
No.200 Sieve (0.075 mm)	%	22.7	12.4	15.9	9.4	9	19.8	21.6	23.4	38.7	26.6	28.2	29.6	28.9	29	18.4
0.030 mm (Hydrometer)	%	15	11	12	8	8	13	16	17	28	21	22	24	22	22	16
0.005 mm (Hydrometer)	%	8	8	8	6	6	7	8	8	10	8	11	9	9	9	8
0.0015 mm (Hydrometer)	%	4.5	5.6	5.5	5.1	3.1	4.9	0	7.5	7.5	5.5	0	0	5.5	5.5	5.3
% Gravel	%	0	0	0	0	0.37	7.5	6	3.1	2	0.48	0.4	0	0	0	0.49
% Sand	%	77.4	87.6	84.1	90.6	90.6	72.7	72.5	73.5	59.3	72.9	71.4	70.4	71.1	71	81.2
% Silt, Clay, Colloids	%	22.7	12.4	15.9	9.4	9	19.8	21.6	23.4	38.7	26.6	28.2	29.6	28.9	29	18.4
Solids, Percent	%	89.2	92.4	91.7	93.5	95.4	93.3	88.1	83.1	83.4	89.6	90.4	94.2	95.1	95	91.6
Total Organic Carbon	mg/kg	104,000	25,500	11,300	4,090	5,330	44,100	43,600	43,300	53,300	25,400	73,200	29,100	26,600	19,800	20,800

Railroad Study

Analytical Parameter	units	RR10-A	RR10-B	RR10-C	RR10-D	RR10-E	RR21-A	RR21-B	RR21-C	RR21-D	RR21-E
3 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100
1.5 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100
0.75 Inch Sieve	%	100	100	100	100	100	100	100	100	100	100
0.375 Inch Sieve	%	93.2	97.9	100	99.4	92.5	100	100	100	100	100
No.4 Sieve (4.75 mm)	%	86.9	97.2	97.1	96.8	82.6	98.5	97.2	95.8	97	98.2
No.8 Sieve (2.36 mm)	%	79.4	96.2	95.8	93	74.4	94.8	93.3	92.4	92.5	95.1
No.10 Sieve (2.00 mm)	%	77.5	95.9	95.6	91.7	73.7	93.6	92.4	91.5	91.6	94
No.16 Sieve (1.18 mm)	%	72.2	94.8	93.4	86	67.4	88.2	90.4	88.5	86.9	91.1
No.30 Sieve (0.60 mm)	%	61	80	77.6	70.1	54.8	77.2	78.5	77.3	78	82.8
No.50 Sieve (0.30 mm)	%	42.1	43.7	44.7	41.2	36.5	66	66.8	66	66.4	56.9
No.100 Sieve (0.15 mm)	%	27.2	26.7	26.7	23.4	22.2	54	53.5	51	53.9	30.1
No.200 Sieve (0.075 mm)	%	19.8	22	20.9	16.8	16.7	42.8	48.2	44	44.9	23.9
0.030 mm (Hydrometer)	%	16	18	16	15	13	28	38	33	32	18
0.005 mm (Hydrometer)	%	8	11	9	7	5	9	13	12	10	9
0.0015 mm (Hydrometer)	%	0	5.2	5.2	4.7	3.8	0	0	0	0	5
% Gravel	%	13.1	2.9	3	3.2	17.4	1.5	2.8	4.2	3	1.8
% Sand	%	67.1	75.1	76.1	80	65.9	55.7	49	51.9	52.1	74.3
% Silt, Clay, Colloids	%	19.8	22	20.9	16.8	16.7	42.8	48.2	44	44.9	23.9
Solids, Percent	%	70.6	88	90.6	91.7	91.7	91.6	82.6	82.5	82.7	90.3
Total Organic Carbon	mg/kg	252,000	45,400	25,500	23,100	17,900	78,500	118,000	116,000	119,000	12,100

APPENDIX 7

2010 Census Population Density

2010 Census Population Density

Sample ID	Municipality	County	2010 Population Density per Square Mile
ATLA02	Atlantic City	Atlantic	2,488
ATLA05	Northfield City	Atlantic	2,389
ATLA07	Somers Point City	Atlantic	2,172
ATLA09	Pleasantville City	Atlantic	2,789
ATLA10	Margate City	Atlantic	3,898
BERG01	Allendale Boro	Bergen	2,092
BERG02	Bergenfield Boro	Bergen	9,229
BERG04	Paramus Boro	Bergen	2,509
BERG05	Hackensack City	Bergen	9,910
BERG07	Park Ridge Boro	Bergen	3,300
BERG08	Englewood City	Bergen	5,495
BERG10	North Arlington Boro	Bergen	6,084
BERG11	Fair Lawn Boro	Bergen	6,230
BERG12	Wallington Boro	Bergen	10,899
BERG13	River Edge Boro	Bergen	6,032
BURL01	Maple Shade Twp	Burlington	5,008
BURL02	Pemberton Boro	Burlington	2,273
BURL03	Edgewater Park Twp	Burlington	2,883
BURL04	Burlington City	Burlington	2,631
BURL05	Bordentown City	Burlington	4,088
BURL06	Mount Holly Twp	Burlington	3,323
BURL07	Willingboro Twp	Burlington	3,900
BURL08	Riverside Twp	Burlington	4,956
BURL10	Riverton Boro	Burlington	2,895
BURL12	Beverly City	Burlington	3,391
CAMD01	Oaklyn Boro	Camden	5,769
CAMD02	Berlin Boro	Camden	2,102
CAMD03	Cherry Hill Twp	Camden	2,939
CAMD06	Gloucester Twp	Camden	2,776
CAMD07	Haddon Twp	Camden	5,215
CAMD08	Voorhees Twp	Camden	2,507
CAMD11	Camden City	Camden	7,394
CAMD12	Collingswood Boro	Camden	7,216
CAMD13	Haddonfield Boro	Camden	4,082
CAMD14	Runnemede Boro	Camden	4,032

Sample ID	Municipality	County	2010 Population Density per Square Mile
CAPE06	Wildwood Crest Boro	Cape May	2,209
CAPE11	Wildwood City	Cape May	3,227
CUMB02	Bridgeton City	Cumberland	3,906
ESSE02	Newark City	Essex	10,574
ESSE04	Bloomfield Twp	Essex	8,827
ESSE05	West Orange Twp	Essex	3,816
ESSE09	Irvington Twp	Essex	18,531
ESSE11	Nutley Twp	Essex	8,320
ESSE12	City Of Orange Twp	Essex	13,635
ESSE15	Montclair Twp	Essex	6,037
ESSE19	East Orange City	Essex	16,395
ESSE20	Verona Twp	Essex	4,761
ESSE21	South Orange Village Twp	Essex	5,704
GLOU01	Washington Twp	Gloucester	2,254
GLOU03	Woodbury City	Gloucester	4,845
GLOU05	National Park Boro	Gloucester	2,094
GLOU06	Pitman Boro	Gloucester	4,005
GLOU07	Swedesboro Boro	Gloucester	3,356
GLOU08	Wenonah Boro	Gloucester	2,278
GLOU09	Westville Boro	Gloucester	3,153
GLOU10	Woodbury Heights Boro	Gloucester	2,444
HUDS01	Bayonne City	Hudson	8,206
HUDS02	Jersey City	Hudson	15,611
HUDS04	Hoboken City	Hudson	40,654
HUDS05	Weehawken Twp	Hudson	15,891
HUDS06	Kearny Town	Hudson	3,996
HUDS08	North Bergen Twp	Hudson	11,510
HUDS10	Secaucus Town	Hudson	2,483
HUDS11	Harrison Town	Hudson	10,318
HUDS12	Union City	Hudson	51,918
HUDS13	West New York Town	Hudson	50,210
HUNT01	Flemington Boro	Hunterdon	4,281
HUNT08	Lambertville City	Hunterdon	3,202
MERC01	Trenton City	Mercer	10,317
MERC02	Ewing Twp	Mercer	2,302
MERC03	Hopewell Boro	Mercer	2,669
MERC04	Pennington Boro	Mercer	2,665

Sample ID	Municipality	County	2010 Population Density per Square Mile
MERC05	Hightstown Boro	Mercer	4,360
MERC06	Hamilton Twp	Mercer	2,199
MIDD01	Carteret Boro	Middlesex	5,076
MIDD02	Dunellen Boro	Middlesex	6,818
MIDD03	East Brunswick Twp	Middlesex	2,120
MIDD04	Edison Twp	Middlesex	3,263
MIDD06	Metuchen Boro	Middlesex	4,796
MIDD08	New Brunswick City	Middlesex	9,597
MIDD10	Perth Amboy City	Middlesex	9,829
MIDD12	South Plainfield Boro	Middlesex	2,811
MIDD13	South River Boro	Middlesex	5,482
MIDD15	Highland Park Boro	Middlesex	7,682
MONM02	Allentown Boro	Monmouth	2,997
MONM03	Atlantic Highlands Boro	Monmouth	3,565
MONM04	Asbury Park City	Monmouth	10,603
MONM09	Freehold Boro	Monmouth	6,245
MONM12	Manasquan Boro	Monmouth	3,756
MONM14	Matawan Boro	Monmouth	3,671
MONM15	Spring Lake Boro	Monmouth	2,036
MONM16	Shrewsbury Twp	Monmouth	12,678
MONM18	Neptune City Boro	Monmouth	5,471
MONM19	Keansburg Boro	Monmouth	8,351
MORR01	Boonton Town	Morris	3,366
MORR03	Chatham Boro	Morris	3,750
MORR04	Dover Town	Morris	6,675
MORR05	Madison Boro	Morris	3,755
MORR08	Morristown Town	Morris	6,137
MORR10	Parsippany-Troy Hills Twp	Morris	2,101
MORR11	Pequannock Twp	Morris	2,189
MORR15	Wharton Boro	Morris	3,076
MORR16	Netcong Boro	Morris	3,367
MORR17	Rockaway Boro	Morris	3,037
OCEA01	Beachwood Boro	Ocean	3,987
OCEA02	Brick Twp	Ocean	2,316
OCEA03	Lakehurst Boro	Ocean	2,708
OCEA04	Lakewood Twp	Ocean	3,700
OCEA05	Ocean Gate Boro	Ocean	3,724
OCEA06	Pine Beach Boro	Ocean	3,272

Sample ID	Municipality	County	2010 Population Density per Square Mile
OCEA07	Point Pleasant Beach Boro	Ocean	2,495
OCEA08	Point Pleasant Boro	Ocean	4,379
OCEA09	Beachwood Boro	Ocean	3,987
OCEA10	South Toms River Boro	Ocean	2,995
PASS01	Passaic City	Passaic	21,604
PASS02	Paterson City	Passaic	16,824
PASS03	Little Falls Twp	Passaic	5,029
PASS04	Woodland Park Boro	Passaic	3,850
PASS06	Hawthorne Boro	Passaic	5,593
PASS07	Prospect Park Boro	Passaic	12,750
PASS08	Totowa Boro	Passaic	2,655
PASS10	Clifton City	Passaic	7,361
PASS14	Pompton Lakes Boro	Passaic	3,557
PASS16	Wayne Twp	Passaic	2,175
SALE01	Penns Grove Boro	Salem	5,783
SALE04	Woodstown Boro	Salem	2,177
SOME02	North Plainfield Boro	Somerset	7,779
SOME10	Raritan Boro	Somerset	3,406
SOME11	Somerville Boro	Somerset	5,170
SOME13	Bound Brook Boro	Somerset	6,155
SOME18	Manville Boro	Somerset	4,239
SOME19	South Bound Brook Boro	Somerset	6,251
SUSS01	Hamburg Boro	Sussex	2,825
SUSS04	Newton Town	Sussex	2,366
SUSS05	Sussex Boro	Sussex	3,435
UNIO01	Cranford Twp	Union	4,646
UNIO17	Berkeley Heights Twp	Union	2,109
UNIO18	Clark Twp	Union	3,316
UNIO19	Elizabeth City	Union	8,984
UNIO20	Fanwood Boro	Union	5,502
UNIO21	Hillside Twp	Union	7,699
UNIO22	Linden City	Union	3,662
UNIO23	New Providence Boro	Union	3,289
UNIO25	Westfield Town	Union	4,498
UNIO26	Roselle Park Boro	Union	10,899
WARR01	Hackettstown Town	Warren	2,628
WARR03	Phillipsburg Town	Warren	4,489
WARR05	Washington Boro	Warren	3,296