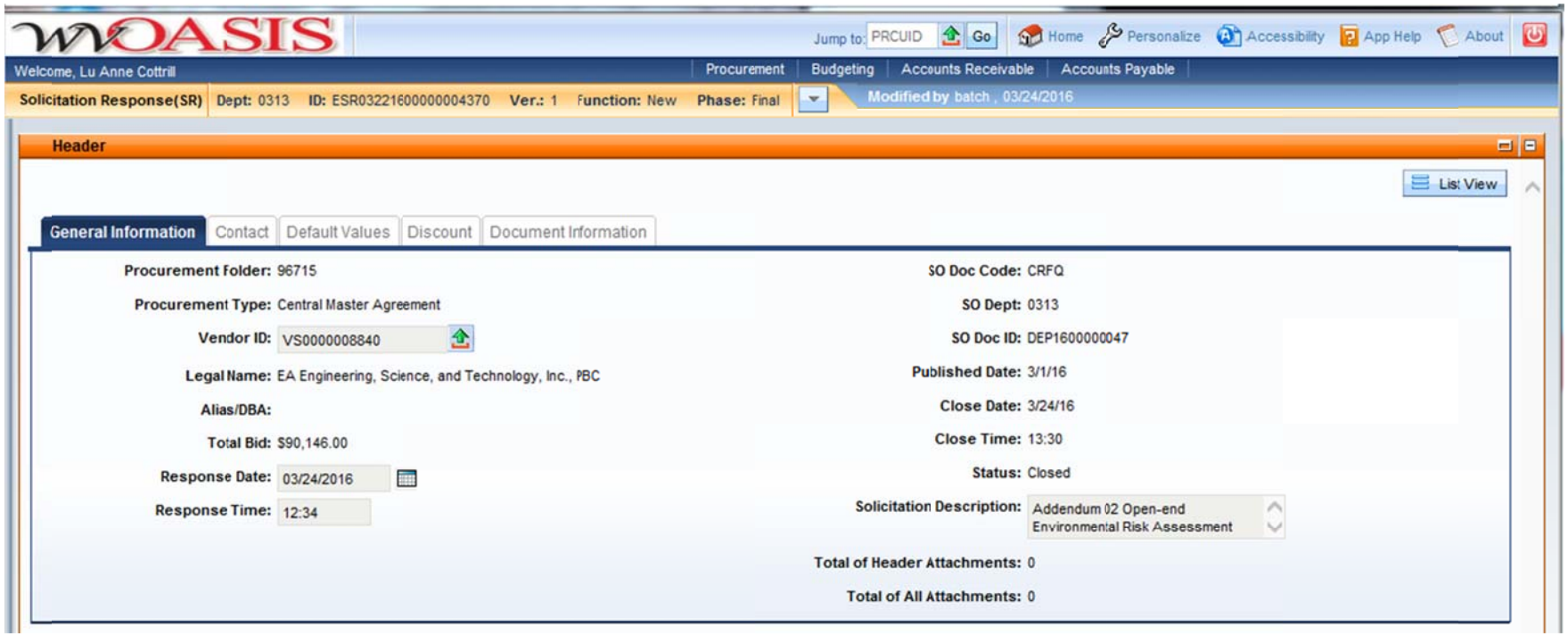
The following documentation is an electronically-submitted vendor response to an advertised solicitation from the *West Virginia Purchasing Bulletin* within the Vendor Self-Service portal at ***wvOASIS.gov***. As part of the State of West Virginia's procurement process, and to maintain the transparency of the bid-opening process, this documentation submitted online is publicly posted by the West Virginia Purchasing Division at ***WVPurchasing.gov*** with any other vendor responses to this solicitation submitted to the Purchasing Division in hard copy format.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Procurement
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Solicitation Response(SR) Dept: 0313 ID: ESR03221600000004370 Ver.: 1 Function: New Phase: Final
Modified by batch , 03/24/2016
Header
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General Information
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Document Information
Procurement Folder: 96715
Procurement Type: Central Master Agreement
Vendor ID: VS0000008840
Legal Name: EA Engineering, Science, and Technology, Inc., PBC
Alias/DBA:
Total Bid: $90,146.00
Response Date: 03/24/2016
Response Time: 12:34
SO Doc Code: CRFQ
SO Dept: 0313
SO Doc ID: DEP1600000047
Published Date: 3/1/16
Close Date: 3/24/16
Close Time: 13:30
Status: Closed
Solicitation Description: Addendum 02 Open-end Environmental Risk Assessment
Total of Header Attachments: 0
Total of All Attachments: 0

Purchasing Division
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Solicitation Response

Proc Folder : 96715

Solicitation Description : Addendum 02 Open-end Environmental Risk Assessment

Proc Type : Central Master Agreement

Date issued	Solicitation Closes	Solicitation No	Version
	2016-03-24 13:30:00	SR 0313 ESR03221600000004370	1

VENDOR

VS0000008840

EA Engineering, Science, and Technology, Inc., PBC

FOR INFORMATION CONTACT THE BUYER

Beth Collins

(304) 558-2157
beth.a.collins@wv.gov

Signature X **FEIN #** **DATE**

All offers subject to all terms and conditions contained in this solicitation

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Ln Total Or Contract Amount
1	Risk or hazard assessment	700.00000	HOUR	$128.780000	$90,146.00

Comm Code	Manufacturer	Specification	Model #
77101501			

Extended Description : Environmental Risk Assessor

EA Engineering, Science,
and Technology, Inc., PBC

225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031
Telephone: 410-584-7000
Fax: 410-771-1625
www.eaest.com

24 March 2016

Department of Administration, Purchasing Division
2019 Washington Street East
Charleston, West Virginia 25305-0130

Subject: **Proposal in Response to Solicitation No. CRFQ 0313 DEP1600000047**
Open-End Contract for an Environmental Risk Assessor

Dear Sirs and Mesdames:

EA Engineering, Science, and Technology, Inc., PBC (EA) is pleased to submit this proposal in response to Solicitation No. CRFQ 0313 DEP1600000047: Open-End Contract for Environmental Risk Assessor. Per the Request for Quotation, our proposal includes resumes and qualifications for environmental risk assessment personnel (Attachment A), pricing (Attachment B), and an example risk assessment document (Attachment C). EA is a registered Public Benefit Corporation with a stated goal of improving the environment and a demonstrated record of providing expert review and environmental services to public agencies at the state and federal level. We look forward to the chance to work with the state of West Virginia Department of Environmental Protection.

If you have any questions regarding this proposal, please do not hesitate to call me at (410)-584-7000.

Sincerely,

Jeffrey Boltz
Vice President
Water, Natural Resources, and Environment

Enclosure
cc: Michael Ciarlo, EA Project Manager

ATTACHMENT A

QUALIFICATIONS AND RESUMES

EA Engineering, Science, and Technology, Inc. PBC (EA) has over three decades of experience performing, reviewing, and providing expert technical support for environmental risk assessments on behalf of state and federal agencies. Our risk assessors draw from a broad base of experience and expertise, have access to in-house toxicological resources, and can draw from an extensive knowledge-base of West Virginia environmental resources. EA's key qualifications for this scope of work include:

Staff Expertise and Experience

- Combined experience performing over 300 human health and ecological risk assessments comprehensive of over 1,000 individual sites.
- Directly relevant experience supporting public agencies through review of third party risk assessment documents, including current roles supporting U.S. Environmental Protection Agency (USEPA) Regions 3 and 6 and the state of Delaware. EA is currently serving in a risk assessment or toxicology review capacity for public agencies on 10 separate projects.
- Experience with all aspects of risk assessment, from approach development, field investigation, chemical analysis and data management through risk modeling, report preparation, goal calculation, and development of risk management options.
- Expertise in assessing a wide range of chemicals stressors, including arsenic, lead, mercury, other metals, PCBs, PAHs, petroleum compounds, dioxins, mine waste, chlorinated solvents, wood-treating compounds, pesticides, consumer product ingredients, and military-specific compounds.
- In-depth understanding of risk assessment guidance under RCRA, CERCLA, NEPA, NRDA, West Virginia and other state frameworks, mining regulations, sediment and dredged material evaluation frameworks, and emerging contaminant assessment frameworks.
- Experience planning and performing investigations to support risk assessment, including sampling of soil, groundwater, sediment, water, building materials, and air; field collection of plant, fish, and wildlife tissue; laboratory bioaccumulation and toxicity testing; collection of population and community level measurements to evaluate impacts to wild populations.
- Experience and demonstrated success applying innovative assessment methods including passive samplers; specialized analyses of metal bioavailability; spatial modeling of wild populations; and advanced chemical fate and transport modeling.
- Risk communication expertise for a wide range of audiences, with over 300 risk-related presentations to community groups, the media, stakeholders, public officials, scientific organizations, property owners, regulators, and non-profit organizations. Experience includes expert testimony and over 40 publications or presentations in peer-reviewed scientific literature.

Technical Resources

- In-house toxicological laboratory staffed by experts in standard methods of aquatic and terrestrial toxicity and bioaccumulation testing, with past experience performing over 40 standard test methods.
- Formalized system of technical quality assurance with access to a company-wide expertise for review and analysis of documents.
- Checklists and SOPs developed by EA specifically for review of risk assessment documents for public agencies; these provide a tested and proven framework for evaluating the relevance, accuracy, precision, and overall defensibility of risk assessment data and documents that can be modified to meet the needs of the state of West Virginia.

- In-house databases of ecological and human health exposure and toxicity data developed from guidance and the scientific literature.

West Virginia Experience

- Over 20 years of experience investigating and characterizing the natural resources of West Virginia, including wetland delineations, threatened and endangered species surveys, fish and mussel surveys, and plant surveys, with EA personnel co-authoring the book *Fishes of West Virginia* (1995).
- Preparation of environmental assessment and resource report documents for the National Park Service in West Virginia which considered potential impacts on land use, recreation, cultural resources, and natural resources.
- Coordination with numerous state and federal agencies on projects in West Virginia, including WVDEP, WVDNR, USFWS, and USACE and interaction with West Virginia natural resources stakeholders and community groups.

Commitment to Public Benefit

- Established over 43 years ago, EA is a sustainable and stable company providing a consistent and continued resource for clients. EA has developed an outstanding reputation for technical expertise, responsive service, and judicious use of client resources. Today, we have over 450 employees located in 24 offices nationwide and provide a full range of environmental investigation, design, construction oversight and technical support services
- EA is a Public Benefit Corporation and has written goals for improving the quality of soil, sediment, water, and air; protecting natural resources; and restoring the environment into its corporate charter.
- EA has a long history of technical support for public sector clients, with specific success providing oversight in the fields of risk assessment and toxicology.

EA's risk-assessment qualifications are reflected in EA's risk assessment staff, who include:

- **Daniel Hinckley, Ph.D.** – Dr. Hinckley will serve as technical lead, providing expert review of documents and providing senior technical review of EA's work products. He brings to the project his extensive expertise in human health risk assessment, ecological risk assessment, and environmental chemistry. Dr. Hinckley has a Ph.D. in Chemistry from the University of South Carolina and 34 years' experience, and thus meets the requirements of the RFQ.
- **Michael Ciarlo** – Mr. Ciarlo will serve as EA's project manager and ecological risk assessment (ERA) specialist. He will be available to provide reviews requiring specific expertise in ecotoxicology and ERA; oversee preparation and submission of deliverables; oversee invoicing; oversee consistency with schedule, scope, and budget; and serve as primary point of contact for contracting and administrative purposes. Mr. Ciarlo has a Masters of Environmental Science from Johns Hopkins University and over 20 years' experience, and thus meets the requirements of the RFQ.
- **Cynthia Cheatwood** – Ms. Cheatwood will serve as human health risk assessment (HHRA) specialist. She will be available to provide reviews requiring specific expertise in toxicology and HHRA. Ms. Cheatwood has a Bachelor of Science in Civil Engineering from University of Maryland and 23 years' experience. Ms. Cheatwood would provide HHRA support.

Resumes for key staff are provided in the sections below followed by a copy of the diploma or transcript documenting their highest level of degree.

Daniel A. Hinckley, Ph.D.

Senior Scientist

Relevant Highlights

- ✓ Extensive human health and ecological risk assessment experience
- ✓ Environmental fate and transport
- ✓ Technical review

Years of Experience: 34

Education

Ph.D/Marine Chemistry, Chemical Oceanography/1989
M.S./Environmental Chemistry, Physical Chemistry/1985
B.S./Chemistry/1983

Dr. Hinckley has 34 years of multidisciplinary experience in human health and ecological risk assessment, environmental chemistry, marine chemistry, analytical chemistry, physical chemistry, environmental assessment, and project management. He specializes in human health and ecological risk assessments, environmental fate and transport assessment, environmental characterization, sample design, evaluations of water and sediment quality and quality assurance/quality control issues related to work plans, health and safety documents, and reports.

He has participated in more than 300 human health and ecological risk assessments. These risk assessments were performed for sites from Egypt to Guam, and have included not only standard types of receptors (bugs and bunnies to residents) but also specialized receptor risk assessments such as canine risk evaluations and probabilistic food-web risk assessments. The risk assessment process has changed significantly in the 20+ years that Dr. Hinckley has been performing them. Has been involved in these changes, and has worked with risk assessors in more than a dozen states and most U.S. Environmental Protection Agency (EPA) regions. Has performed Senior Technical Reviews and external reviews for many risk assessments, including those associated with EPA Regions 3 and 6, and the State of Delaware.

Remedial Action Contract 2; EPA Region 3; Program Chemist and Risk Assessor: Program chemist and risk assessor for this 10-year CERCLA program that includes all aspects of EPA Region 3 responsibilities. From 2012 to 2016, worked on select EPA Region 3 sites, including:

- North Penn 6, Pennsylvania assessing cumulative risks and meeting with EPA Region 3 Remedial Project Manager and risk assessor
- Hidden Lane Landfill, Maryland meeting with EPA risk assessors, and conducting a screening level ecological risk assessment
- Ryeland Road Arsenic Site, Pennsylvania assisting with chemical quality, sampling planning and design, and data interpretation
- Franklin Slag Groundwater Remedial Investigation, Philadelphia, PA, wrote an ecological risk assessment.

Remedial Action Contract; EPA Region 6; Program Chemist and Risk Assessor: Program chemist and risk assessor for this 10-year CERCLA program that includes all aspects of EPA Region 6 responsibilities. During 2012-2016, worked with the following EPA Region 6 sites:

- Iron King Mine, Arizona assessing data quality
- Devils Swamp, Louisiana, an oversight project reviewing Potentially Responsible Party screening level ecological risk assessments and other ecological risk documents
- R&H Oil/Tropicana Energy, Texas another oversight project reviewing Potentially Responsible Party screening level ecological risk assessment
- Donna Canal, Texas, assessment of polychlorinated biphenyl risks in the canal, assisted in sample design, reviewed QAPP, and assisted with ongoing chemical issues. Performed Senior Technical Review for both the human health and ecological risk assessments.
- EVR Wood, Texas, developed ecological conceptual site model and reviewed human health conceptual site model
- Falcon Refinery, Texas assisted in sample design and QAPP for conducting an ecological risk assessment. Screening level ecological risk assessment conducted on multiple Operable Units, culminating in determining the need for a baseline ecological risk assessment at one of the Operable Units while the others were found to have acceptable risks.
- Bandera Road, Texas, assisted in sample design and production of a QAPP, conducted an ecological risk assessment, and reviewed the human health risk assessment
- Brine Services, Texas, conducted an ecological risk assessment

- Van der Horst, Texas, conducted an ecological risk assessment, reviewed the human health risk assessment, and participated in the Record of Decision.
- Arkwood Superfund Site, Arkansas, for this Potentially Responsible Party oversight project performed senior technical review of a QAPP to collect "split" incremental samples for the analysis of dioxin congeners at trace levels. Interacted with EPA scientists, managers, and laboratories to assure that the incremental samples were collected, processed, and analyzed appropriately
- McMillan Ring Superfund Site, Arkansas, developed a conceptual site model, and directed an ecological risk assessment for this oil-contamination site.

Seaford Power Plant, Delaware; Delaware Department of Natural Resources and Conservation; Risk Assessor: Performed a screening level ecological risk assessment for the power plant discharge and provided oversight for streamlined human health risk assessment to support state clean-up programs. Limited risk was found in sediment immediately adjacent to the power plant cooling water discharge. Communicated with the client and stakeholders about risk results.

Background Polycyclic Aromatic Hydrocarbon Study; **Delaware Department of Natural Resources and Environmental Control; Chemist:** Assisted in the evaluation of polycyclic aromatic hydrocarbon data collected from various parks in Delaware. Delaware Department of Natural Resources and Environmental Control desired to produce a background data set for polycyclic aromatic hydrocarbons that could be used by the State as reference conditions for these ubiquitous chemicals. Confounding factors, such as the presence of asphalt roads and parking lots, were found to create data management and statistical problems.

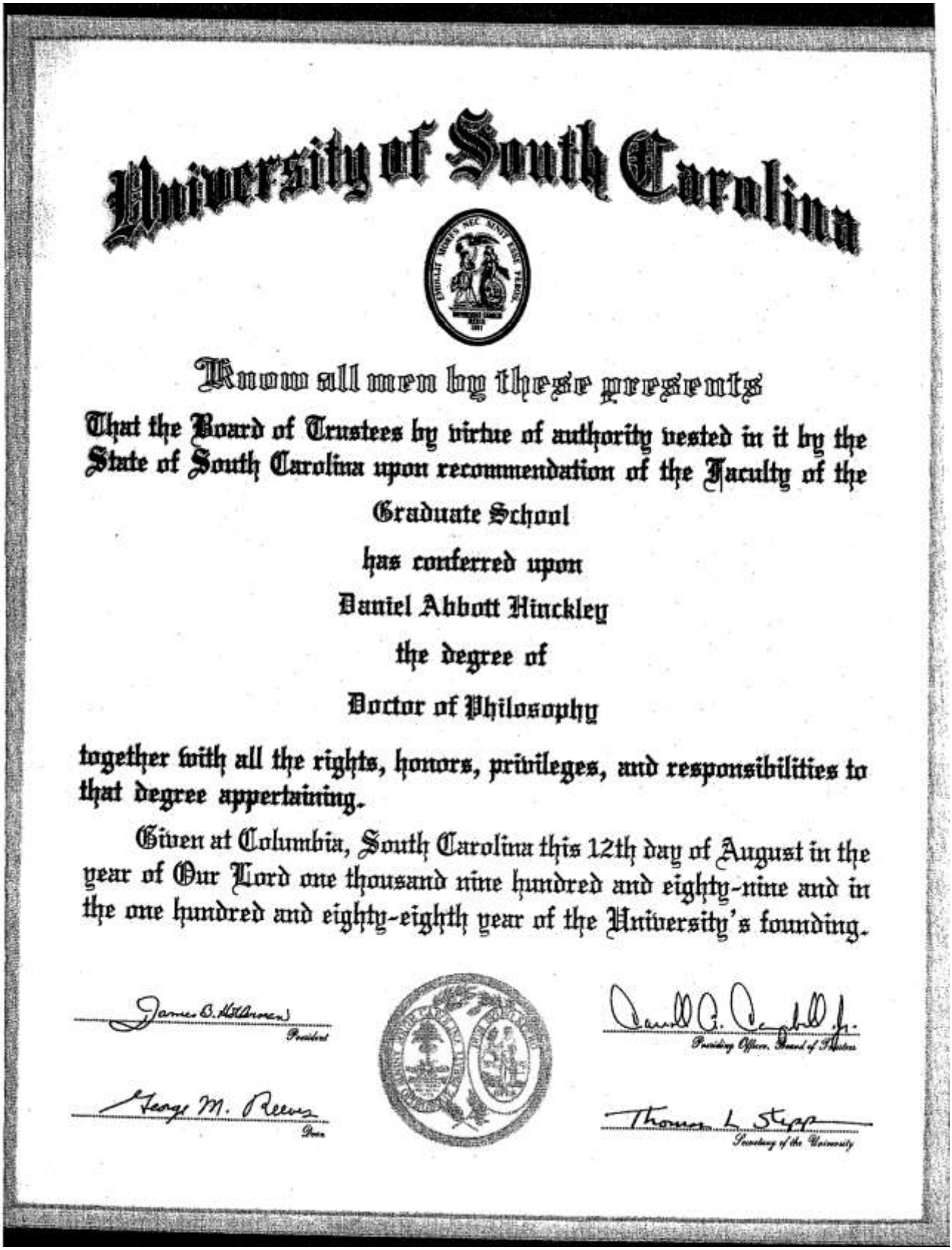
Ommelanden Remedial Investigation; Delaware Department of Natural Resources and Conservation; Ecological Risk Assessor: Conducted an ecological risk assessment for a trap and skeet facility operated by the Delaware Department of Natural Resources and Environmental Control. Performed exposure and bioaccumulation modeling of multiple environmental media. Site was found to have relatively high levels of lead, posing risk to numerous ecological receptors.

Sparrows Point; Sparrows Point Environmental Trust; Baltimore Senior Technical Review: Performed senior technical review for Work Plans and Human and Ecological Risk Assessments Plans, and the QAPP for this Baltimore sediment site. Project was performed using CERCLA guidance under the purview of consent-decree funded investigation. Provided key inputs to aspects of a complex risk assessment that coupled models of contaminant transport from groundwater into surface water with hydrodynamic models to estimate aquatic life and human health exposures. Provided input on incorporation of bioaccumulation factors into risk models for recreational and commercial fisherman and to wildlife.

Alliant Techsystems; Eileen Mahoney Associates; Project Chemist and Ecological Risk Assessor: The Alliant Techsystems site is located in New Jersey, and is a site that was utilized for the testing of large solid and liquid rockets associated with the space program. The site was closed in the 1970s with the initiation of the space shuttle program, and has been left alone since that time. As a result of site activities propellants, metals (e.g., beryllium), and other organic chemicals were released to the environment. Provided an ecological risk assessment which has been approved by EPA Region 2.

Kemess North Gold Mine, British Columbia, Canada; Klohn Crippen; Project Manager: The Kemess Mine, located in the northern Rocky Mountains, wanted to expand its operations which would have involved turning an alpine lake into a tailings treatment facility. Assisted Kemess Mine to determine if such an action would have a significant effect on native mammals, including moose and beaver. Attended a multi-day stakeholders meeting with First Nations on their reservation to present these assessments. Ultimately, the committee investigating this request determined that, while long-term negative impacts were expected to be low, turned down the request due to significant First Nation concerns and border-line life-time of the mining capacity for the facility.

Knolls Atomic Power Laboratory Site S1C; Knolls Atomic Power Laboratory; Eileen Mahoney Associates; Project Manager/Ecological Risk Assessor: The Knolls Atomic Power Laboratory S1C site, located in Windsor Connecticut, was the site of a testing Naval nuclear reactor. Subsequent to completion of an environmental assessment, the nuclear reactor was removed, and the entire site dismantled. EPA had expressed concern regarding the adjacent Goodwin Pond, and potential impacts to ecological receptors from treated waste and runoff from the site in the past. Based on the ecological risk assessment, it was found that there was little likelihood that ecological receptors at the site or in Goodwin Pond were at risk. In 2007, the site was formally turned over for unconditional redevelopment by the Navy, the first Navy nuclear site ever released for residential redevelopment.



University of South Carolina

Know all men by these presents

That the Board of Trustees by virtue of authority vested in it by the State of South Carolina upon recommendation of the Faculty of the

Graduate School

has conferred upon

Daniel Abbott Hinckley

the degree of

Doctor of Philosophy

together with all the rights, honors, privileges, and responsibilities to that degree appertaining.

Given at Columbia, South Carolina this 12th day of August in the year of Our Lord one thousand nine hundred and eighty-nine and in the one hundred and eighty-eighth year of the University's founding.

James B. Holderman
President

Daniel G. Campbell Jr.
Presiding Officer, Board of Trustees

George M. Reeves
Dean

Thomas L. Stepp
Secretary of the University

Michael C. Ciarlo
Risk Assessor/Project Manager

Relevant Highlights

- ✓ Extensive ecological risk assessment experience
- ✓ Project Manager

Years of Experience: 20

Education

M.S./Environmental Science/2000
B.S./Biology/1995

Mr. Ciarlo has 20 years of experience in the fields of risk assessment, remediation, environmental assessment, and environmental science. As a project manager, he has led successful investigation, assessment, and remediation of complex sites requiring use of soil, groundwater, and sediment remediation technologies to address risks from metals, PCBs, pesticides, PAHs, solvents, and military compounds.

As lead risk assessor for numerous projects, Mr. Ciarlo is an expert in standard ecological risk assessment practice and has successfully completed assessments under numerous regulatory frameworks, including those for remediation of hazardous waste sites and management of dredged material. He has performed and overseen all aspects of ecological risk assessment, from planning field investigations to using wildlife exposure models, developing toxicological benchmarks, and presenting results in reports and meetings.

Donna Reservoir and Canal Superfund Site, Donna, Hidalgo County, Texas; U.S. Environmental Protection Agency Region 3; Ecological Risk Assessor—Lead development of a complex ecological risk assessment for a canal and reservoir system where irrigation structures were suspected as a source of polychlorinated biphenyls to fish tissue. Evaluated exposure pathways for fate and transport via suspended sediment and bioaccumulation, including transfer of polychlorinated biphenyls into game fish, agricultural fields, and agricultural products. Aided in development of a complex sampling plan to determine source of polychlorinated biphenyls, including use of passive samplers to determine relative contributions of sediment and water to bioaccumulation of polychlorinated biphenyls in mollusks and fish. Lead completion of a high profile risk assessment, which included biota-sediment accumulation factors - to guide remediation. Provided inputs to the feasibility study.

Other Edgewood Areas, Aberdeen Proving Ground, Maryland; Environmental Chemical Corporation; Lead Ecological Risk Assessor: EA is subcontractor to Environmental Chemical Corporation under an overall performance based acquisition contract to the U.S. Army Corps of Engineers–Baltimore District. Leading ecological risk assessment for five investigation areas each containing disposal sites in areas of terrestrial and aquatic habitats (Gun Club Creek, Swaderick-Watson Creek, Coopers Creek, Boone Creek, and Maxwell Point) within the Other Edgewood Areas. Potential source areas include small arms ranges, burning trenches, disposal trenches, training areas, aerial spray grids, and test facilities. Completed risk assessments for all five sites and negotiated or negotiating finalization; developed risk-based clean-up goals in support of feasibility study. Prepared interactive GIS presentations for regulators allowing sample-by-sample as well as watershed-wide examination of chemical concentrations.

Coke Point Offshore Environments, Sparrows Point, Maryland; Maryland Environmental Service; Risk Assessment Task Manager: Task Manager responsible for oversight of a high profile ecological risk assessment and human health risk assessment of sediments in a heavily contaminated urban estuary. Evaluated relative risk from a single source compared to influence of ongoing sources/elevated background concentrations. Conducted an ecological risk assessment for wildlife and important fisheries species. Planned and oversaw collection of fish and crab tissue as well as conduct of laboratory bioaccumulation tests. Performed extensive coordination with regulators to address public health and risk communication concerns. Presented risk assessment results to elected officials, community groups, the media, and stakeholders. Developed a strategy and standalone studies for risk management and risk reduction to inform decisions regarding construction of corrective measures. Currently supporting regulatory and property transfer negotiations with technical expertise regarding risk results.

Chevron Questa Mine Site, Questa, New Mexico; U.S. Environmental Protection Agency; Toxicologist: Reviewed work plans and resulting reports for collection of data on physical properties of 10,000,000 cubic yards of proposed cover material. Provided technical input regarding studies to determine methods of re-vegetating waste rock, including special considerations regarding molybdenum toxicity and potential mobilization. Reviewed results of greenhouse studies, risk models, bioavailability analyses, and toxicity tests and provided input regarding bioavailability and bioaccumulation as factors in site restoration.

R&H Oil/Tropicana Energy Site, San Antonio, Texas; U.S. Environmental Protection Agency Region 6; Toxicologist: Senior Technical Reviewer for comments on Potentially Responsible Party ecological risk assessment on behalf of the U.S. Environmental Protection Agency to ensure risk assessment was completed in accordance with applicable agency guidance, directives, and procedures.

Gulfco Marine Maintenance Superfund Site, Freeport, Texas; U.S. Environmental Protection Agency Region 6; Senior Technical Reviewer: Senior Technical Reviewer responsible for providing reviews for the U.S. Environmental Protection Agency of work plans and risk assessment documents submitted the U.S. Environmental Protection Agency. Site consists of tidal wetlands which potentially received inputs from marine maintenance activities.

Devil's Swamp Lake Superfund Site, Baton Rouge, Louisiana; U.S. Environmental Protection Agency Region 6; Senior Technical Reviewer: Senior Technical Reviewer responsible for providing reviews for the U.S. Environmental Protection Agency of work plans and risk assessment documents. Site consists of a man-made lake which potentially received inputs of polychlorinated biphenyls to sediment.

Old Esco Manufacturing Superfund Site, Greenville, Texas; U.S. Environmental Protection Agency Region 6; Senior Technical Reviewer: Senior Technical Reviewer responsible for providing reviews for the U.S. Environmental Protection Agency of work plans and risk assessment documents. Site consists of a lake which potentially received inputs of polychlorinated biphenyls to sediment.

Iron King Mine and Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona; U.S. Environmental Protection Agency Region 6; Lead Ecological Risk Assessor: Conducting ecological risk assessment of an over 300-acre mining and smelting site where principal contaminants are arsenic and lead in mine tailings and associated drainages. Compiled species lists and habitat information for surrounding chaparral habitats and prepared an exposure pathway analysis for terrestrial and aquatic ecological exposure pathways in this semi-arid environment. Developed sampling design for sediment and surface water sampling and prepared statements of work for habitat surveys. Currently preparing to perform ecological risk assessment for the site examining eleven receptors, including mammals, birds, reptiles, and fish.

Texarkana Wood Preserving Superfund Site, Texarkana, Texas; U.S. Environmental Protection Agency Region 6; Lead Ecological Risk Assessor: Conducted ecological risk assessment of terrestrial environments at a 20+-acre wood preserving site contaminated with creosote related compounds. Prepared a conceptual model and ecological risk assessment which evaluated plants, invertebrates, birds, and mammals. Provided value added assessment results to the client through a risk management appendix which evaluated the effectiveness of planned remedial actions in eliminating ecological risks. Coordinated with the U.S. Environmental Protection Agency and state of Texas points of contact to ensure risk assessment complied with all appropriate guidance.

Savannah Harbor Expansion Project, Savannah, Georgia; U.S. Army Corps of Engineers-Savannah District; Risk Assessor: Completed ecological and human health risk assessment report evaluating Savannah River dredged materials containing high cadmium levels. Fully utilized dredged material management guidance and methods to effectively evaluate risks to plants, fish, and wildlife in river and in placement site uplands and wetlands. Evaluated risks to human health for fish consumption. Worked closely with the client to provide a risk assessment that addresses specific mitigation and dredged material needs and identifies conclusions for adaptive management. Utilized sequential extraction procedures for metals as an innovative approach to predicting metal bioavailability in dredged material post-placement.

St. Georges Bridge, Newcastle County, Delaware; U.S. Army Corps of Engineers-Philadelphia District; Ecological Risk Assessor: Completed ecological risk assessment report for federal lands impacted by aerial deposition of lead paint chips below the St. Georges Bridge. Planned and coordinated field data collection and prepared a thorough risk assessment including wildlife food web modeling and incorporation of Delaware ecological standards. Streamlined the risk assessment process by incorporating literature data concerning lead bioavailability and paint chip composition; this produced cost savings and early completion of the risk assessment process.

JOHNS HOPKINS UNIVERSITY - BALTIMORE, MARYLAND 21218

SCHOOL OF ARTS & SCIENCES
ADVANCED ACADEMIC PROGRAMS

DATE OF BIRTH	01/17/XX
SOCIAL SECURITY NUMBER	[redacted]
DATE OF ADMISSION	02/08/99
MAJOR FIELD OF STUDY	ENVIRON SCI
CLASSIFICATION	DEGREE CANDIDATE
ADVISER	
DATE PRINTED	3/17/06
PAGE	1 OF 1

PREVIOUS EDUCATION
DUKE UNIV Durham NC 2770 (1995 BS)

DEGREE AND DATE CONFERRED
XXXXXXXXXXXXXXXXXXXX
MSESP 05/23/02

STUDENT'S NAME AND PERMANENT ADDRESS
MICHAEL CHRISTOPHER CIARLO
2402 CHETWOOD CIR #302
TIMONIUM, MARYLAND 21093

SCH	OPT	CRS NUM	COURSE TITLE	GRDE
	SPRING 1998-99		AS 31 245-ENVIRON SCI	
	ADV: GUNNARSSON, BJORN			
AS	420	608	OCEAN & ATMOS PROCESSES	A
	SUMMER 1999		AS 31 245-ENVIRON SCI	
AS	420	625	CHESAPEAKE ECOL/ECOSYS	A
	FALL 1999-00		AS 31 245-ENVIRON SCI	
	ADV: GUNNARSSON, BJORN			
AS	420	601	EARTH RES/WASTE PROD	A
	SPRING 1999-00		AS 31 245-ENVIRON SCI	
	ADV: GUNNARSSON, BJORN			
AS	420	651	RISK ASSESSMENT & MGMT	A
	FALL 2000-01		AS 31 245-ENVIRON SCI	
	ADV: GUNNARSSON, BJORN			
AS	420	604	HYDROLOGY/WATER RESOURCE	A
AS	420	620	SOILS/ECOSYSTEMS	A
	SPRING 2000-01		AS 31 245-ENVIRON SCI	
	ADV: GUNNARSSON, BJORN			
AS	420	636	REMOTE SENSING	A
	FALL 2001-02		AS 31 245-ENVIRON SCI	
	ADV: ELBERT, DAVID C.			
AS	420	646	TRANSPORTATION POLICY	A-
AS	420	656	IMPACT ASSESSMENT	A
	SPRING 2001-02		AS 31 245-ENVIRON SCI	
	ADV: ELBERT, DAVID C.			
AS	420	635	CHEMICAL ECOLOGY	A

F529 Rev 04/03

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TO VERIFY: TRANSLUCENT GLOBE ICONS MUST BE VISIBLE WHEN HELD TOWARD A LIGHT SOURCE

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Hedy A. Schaedel, Registrar

Cynthia L. Cheatwood
Human Health Risk Assessor

Relevant Highlights

✓ Extensive human health risk assessment experience

Years of Experience: 23

Education

M.S.P.H/anticipated 2016

B.S./Civil Engineering/1993

Ms. Cheatwood is an environmental engineer with 23 years of experience who specializes in human health risk assessment and environmental site assessments. Her duties have included project management, fate and transport modeling, toxicology, statistical analysis, and remedial design.

As the primary risk assessor for numerous projects, Ms. Cheatwood is familiar with standard human health risk assessment practice and has successfully completed over 200 risk assessments under various regulatory frameworks, including federal, state, and local agencies. She has performed and overseen all aspects of a risk assessment, from determining appropriate sample plans, maintaining databases of chemical data, to using exposure models.

Arkwood, Inc. Superfund Site, Omaha, Arkansas; EPA Region 6; Senior Risk Assessor: Former wood-treating site that underwent remedial actions under CERCLA in late 1990s. Site was re-evaluated under Five-Year Review due to the presence of dioxin as a contaminant of concern at the site and revised toxicity values for dioxin set forth by the EPA in 2012. Senior risk assessor responsible for oversight and review of the Potential Responsible Party sampling, analysis, and risk assessment of dioxin levels remaining at the site.

MacMillan Ring Superfund Site, Norphlet, Arkansas; EPA Region 6; Senior Risk Assessor: Senior risk assessor for this former oil refinery located in a rural area of Arkansas. Adjacent to the site is a public school and local ballfields. Evaluated soil, groundwater, surface water, and sediment for potential human health risk concerns. The risk assessment also involved the assessment of uptake of chemicals from soil to home-grown produce and uptake from surface water to fish. The primary chemicals of concern included total petroleum hydrocarbons and other fuel/oil related chemicals.

Donna Reservoirs and Canal System Superfund Site, Hidalgo, Texas; EPA Region 6; Senior Risk Assessor: Senior risk assessor for this currently used canal and reservoir system that has historical releases of polychlorinated biphenyls. The canal and reservoirs are used for both agricultural irrigation and public water supply. The canal is a popular local fishing area that has known concentrations of polychlorinated biphenyls in fish and other organism within the canal. Performed human health risk assessment for use of the local agricultural fields and the canal system for recreational uses. Primary exposure pathways were ingestion of fish from the canal system. Also determined sediment remedial goals that would result in polychlorinated biphenyls levels in fish that are not harmful to the local population.

Military Munitions Response Program; U.S. Army; Senior Risk Assessor: Served as human health risk assessor for the Military Munitions Response Program, assisting in sample design, participation in meetings with clients and conducting risk assessments for appropriate sites. To date, three sites have been included in this role: Moody Air Force Base, Georgia; Alpena Combat Readiness Training Center, Michigan; and Arnold Air Force Base, Tennessee. Each site is evaluated separately to determine if a full baseline human health risk assessment is needed or a streamlined human health risk assessment. The use of a streamlined human health risk assessment saves the client time and money in evaluating potential health concerns and reuse of the site.

Marsh Run Park, New Cumberland, Pennsylvania; U.S. Army Corps of Engineers–Baltimore District; Senior Risk Assessor: The Marsh Run Park was a former Army Depot that had undergone remedial actions in the early 2000s. The site required a Five-Year Review in accordance with CERCLA to evaluate the effectiveness of the remedy and previous remedial investigation/feasibility studies that were performed in 1990. Evaluated the original Human Health Risk Assessment for the Five-Year Review and recommended additional actions based upon deficiencies found in the original Human Health Risk Assessment. Completed a revised Human Health Risk Assessment to account for chemicals not evaluated in the original Human Health Risk Assessment. In addition, the revised Human Health Risk Assessment took into account the planned use of the site as recreational fields in evaluating whether additional actions were warranted at the site. Also prepared Fact Sheets and participated in public meetings to inform the local community about the site, potential health concerns, and final use.

Hidden Lane Landfill, Sterling, Virginia; EPA Region 3; Senior Risk Assessor: Evaluated and performed a human health risk assessment of groundwater, indoor air, surface water, and sediment contamination from a closed, unlined landfill. The complex hydrogeology at the site warranted a detailed risk assessment of different aquifers at the site and dividing potential receptors into varying exposure areas. The site was further complicated by contamination in adjacent, residential wells which also were evaluated to determine potential concerns to residents who live adjacent to the landfill.

Ryeland Road Arsenic Site, Womelsdorf, Pennsylvania; EPA Region 3; Senior Risk Assessor: Evaluated and performed a human health risk assessment for this site that was a former industrial operation that disposed of arsenic containing wastes on the ground. Soil cleanup has occurred at the site; however, arsenic contamination still exists in groundwater, surface water, and sediment near the site. Evaluated whether arsenic in groundwater was a concern and if cleanup of arsenic waste left at the site was still needed.

Eielson Air Force Base, Fairbanks, Alaska; Air Force Center for Engineering and Environment; Senior Risk Assessor: Evaluated and performed risk assessment of groundwater, soil, indoor air, surface water, and sediment contamination at a various sites across Eielson. Sites include polychlorinated biphenyl contamination within a stream that potentially affects local fish population and groundwater contaminated with volatile organic compounds. Evaluated concerns for local residents, recreational users, and site workers exposure. Also performed Five-Year Review of previous risk assessments for various groundwater operable units at Eielson to evaluate if changes in risk assessment methodology, toxicity values, and exposure parameters affect the protectiveness of selected remedies.

Sandy Beach Road Groundwater Plume Site, Pelican Bay, Texas; EPA Region 6; Senior Risk Assessor: Evaluated and performed risk assessment of groundwater, soil, indoor air, and ambient air contamination at an illegal dumping Superfund Site. The site is located within a residential community, and adjacent to a park and commercial businesses. The primary concern is a groundwater contamination plume that has affected a number of residential groundwater wells and local town water supply wells. Evaluated concerns for local residents, recreational users, and site workers exposure. The risk assessment provided justification for groundwater treatment system.

Iron King Mine and Humboldt Smelter Superfund Site, Dewey-Humboldt, Arizona; U.S. Environmental Protection Agency Region 6; Environmental Engineer: Performed risk assessment of offsite migration of arsenic and lead in mine tailings and associated drainages from an over 300-acre mining and smelting site for potential human receptors. Performed multiple risk assessments for various contact and exposure areas for a major smelter and refinery. Evaluated risks from arsenic using speciation data to assess bioavailability.

Harper Thiel, Inc., Wilmington, Delaware; Delaware Department of Natural Resources and Environmental Control; Environmental Engineer: Reviewed a previous risk assessment performed at the Harper Thiel Site, a former chrome plating plant. Contaminants of concern at the site included polychlorinated biphenyls, chromium, and lead. Determined that additional exposure pathways should be evaluated based upon the contaminants at the site. Also determined cleanup goals based upon the results of the revised risk assessment. Based upon the cleanup goals, prepared a feasibility study to determine the best alternative for remedial actions at the site. Prepared cost estimates, volumes of contamination, construction specifications, and final remedial alternatives. Cost estimate and remediation were complicated by the presence of hazardous waste in soils and within the buildings. Determined what would be considered hazardous and non-hazardous, including building foundations and flooring.

Former Lake Ontario Ordnance Work, Lewiston, New York; U.S. Army Corps of Engineers; Human Health Risk Assessor/Project Manager for Human Health Risk Assessment: Project Task Manager responsible for all aspects of human health risk assessment, including budget, risk calculation, and report production. Human Health Risk Assessment including nine separate areas with seven receptors per area. Main contaminants of concern included polychlorinated biphenyls, volatile organic compounds, polycyclic aromatic hydrocarbons, and arsenic. In addition to soil, surface water, sediment, and groundwater analysis, the risk assessment also analyzed the consumption of deer meat, plants, and vegetables. The human health risk assessment also included an indoor air risk assessment and the potential risks associated with groundwater inhalation from outdoor air. Evaluated underground pipelines for exposure to the contents and seepage into the surrounding soils. Participated in public meetings and presentation of risk assessment results and implications to community and project stakeholders. Prepared a Risk Management Decision Document that integrated results from multiple RI reports and risk assessments to determine the appropriate path forward for various areas of the site based upon results of the risk assessments. Also calculated cleanup goals for each area based upon results of the risk assessment.

University of Maryland
at College Park

In recognition of the successful completion of the requisite course of study and on nomination of the Faculty of the

College of Engineering

by virtue of authority granted by charter of the State of Maryland hereby confers upon

Cynthia Lee Pyles

the degree of

Bachelor of Science in Civil Engineering

with all the honors, rights, and privileges thereunto appertaining.

In witness whereof this Diploma, signed by the authorized officers of the University and sealed with the corporate seal of the University, is granted.

Given at College Park on the twentieth day of May in the year nineteen hundred ninety-three

UNIVERSITY OF MARYLAND
COLLEGE PARK

Chairperson of the Board of Regents

Chancellor

W E Kirwan

ATTACHMENT B

UNIT COSTS

In accordance with the RFQ, EA is unit costs per labor hour. Per the RFQ instructions, costs are on a labor hour basis for any labor hours expended. Rates are built to be inclusive of non-labor costs including travel expenses (i.e. vehicle usage, per diem, etc.) and materials (i.e. reproduction). It is assumed that travel will not require late notice purchase of airfare, purchase of equipment, or purchase of supplies other than those associated with reproduction and shipping. Unit rates were estimated on the basis of a two year period of performance. Per the RFQ, rates were applied to the estimated 700 hour maximum. Unit rates and estimated cost are presented in Exhibit B-1 below.

EXHIBIT B-1
UNIT COST AND TOTAL COST FOR RISK ASSESSOR SUPPORT

Line Item	Line Item Description	Quantity	Unit Issue	Unit Price	Total Price
1	Risk or hazard assessment	700	Hour	$128.78	$90,146.00

ATTACHMENT C

SAMPLE DOCUMENT

Per the RFQ, EA is providing a sample document that demonstrates the type and quality of risk assessment technical support services EA has provided in the past. The Facility Evaluation Report for Seaford Power Plant represents EA's past work performing human health (Chapter 5) and ecological risk assessments (Chapter 6) on behalf of Delaware Department of Natural Resources and Environmental Control. The document was submitted within the client's requested timeframe for completion following receipt of comments. Given the size of the document, it is provided electronically under a separate cover page below.

SAMPLE DOCUMENT

FACILITY EVALUATION REPORT FOR SEAFORD POWER PLANT

EA Engineering, Science,
and Technology, Inc., PBC

FINAL
FACILITY EVALUATION REPORT

SEAFORD POWER PLANT (DE-1031)
200 SOUTH PINE STREET
SEAFORD, SUSSEX COUNTY, DELAWARE

Delaware Department of
Natural Resources and Environmental Control

October 2015

FINAL
Facility Evaluation
Seaford Power Plant (DE-1031)
200 South Pine Street
Seaford, Delaware

Prepared for

Delaware Department of Natural Resources and Environmental Control
Site Investigation and Restoration Section
391 Lukens Drive
New Castle, Delaware 19720

Prepared by

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, Maryland 21031
(410) 584-7000

October 2015
Version: FINAL
EA Project No. 1482609

EXECUTIVE SUMMARY

EA Engineering, Science, and Technology, Inc., PBC (EA) has completed this facility evaluation (FE) at the former Seaford Power Plant (Site) located along the Nanticoke River in the City of Seaford, Sussex County, Delaware. The purpose of this FE is to determine the impacts to surface soil, subsurface soil, surface water, sediment, and groundwater due to historical uses of the Site. This FE was completed in accordance with Delaware Department of Natural Resources and Environmental Control (DNREC) – Site Investigation and Restoration Section (SIRS) requirements and with DNREC-SIRS oversight.

The Site is approximately 1.86 acres in size and is bounded on the south by the Nanticoke River with approximately 0.8 acres currently occupied by the former Seaford Power Plant building footprint. The remaining acreage is divided between asphalt parking lots and roadways, active and former electrical substations, grass landscaping, and a concrete walkway along the Nanticoke River ("The Riverwalk").

The FE included the following:

- A ground penetrating radar (GPR) survey was conducted across the Site to identify remaining cooling water intake and discharge pipelines between the Nanticoke River and the former power plant. The GPR survey also identified existing subsurface utilities and verified the location of two removed historic underground storage tanks (USTs).

- Twenty-two direct push soil borings were advanced throughout the Site to characterize and describe the subsurface soil conditions. A combination of 30 surface and subsurface soil samples were collected from the soil borings and screened at the DNREC-SIRS New Castle laboratory in Delaware for benzene, toluene, ethylbenzene, and xylene (BTEX), total petroleum hydrocarbons-diesel range organics (TPH-DRO), polycyclic aromatic hydrocarbons (PAHs), pesticides, metals, and polychlorinated biphenyls (PCBs). Based on the screening results, certain samples were selected for confirmatory laboratory analysis at Test America in New Jersey. An additional subset of samples was selected for full laboratory analysis of the above constituents at Test America.

- Two sludge samples were collected from stormwater inlets and screened at the DNREC-SIRS New Castle laboratory for BTEX, TPH-DRO, PAHs, pesticides, PCBs, and metals. Based on the screening results, the two samples were analyzed for confirmatory laboratory analysis by Test America.

- Three groundwater monitoring wells were installed, developed, and sampled, along with two existing groundwater monitoring wells. Samples were collected and analyzed by Test America for methyl tert-butyl ether (MTBE), BTEX, TPH-DRO, PAHs, total metals, and dissolved metals.

- Two wastewater samples were collected from a pair of clean-out drains associated with the remaining cooling water intake and discharge pipelines. The samples were analyzed by Test America for MTBE, BTEX, PAHs, and metals.

- Five surface water samples were collected from the Nanticoke River and analyzed by Test America for BTEX, MTBE, TPH-DRO, PAHs, total metals, and dissolved metals.

- Ten sediment samples were collected from the Nanticoke River and screened at the DNREC-SIRS New Castle laboratory for BTEX, MTBE, TPH-DRO, PAHs, PCBs, and metals. Based on the screening results, certain samples were selected for confirmatory laboratory analysis at Test America. An additional subset of samples was selected for full laboratory analysis of the above constituents at Test America.

- One sub-slab soil vapor sample was collected from beneath the interior floor of the main power plant and analyzed by Test America for the full suite of volatile organic compounds (VOCs).

- A human health risk assessment and an ecological risk screening assessment were conducted for the terrestrial and aquatic samples, respectively.

The GPR survey confirmed the presence of five existing cooling water intake and discharge pipelines between the southern edge of the power plant and the Nanticoke River. Surface and subsurface soil sample results from this area exceeded the January 2015 DNREC soil screening criteria for TPH-DRO, arsenic, and benzo(a)pyrene. Surface soil samples collected from north of the power plant (adjacent to the former above ground storage tank [AST] secondary containment pit), and west of the existing operational substation exceeded the DNREC soil screening criteria for benzo(a)pyrene. One subsurface soil sample from south of the abandoned substation exceeded the DNREC soil screening criteria for 2-methylnaphthalene and arsenic.

The sludge sample collected north of the power plant exceeded the DNREC soil screening criteria for benzo(a)pyrene, while the sludge sample collected south of the power plant exceeded the criteria for 2-methylnaphthalene, benzo(b)fluoranthene, cadmium, and lead.

Groundwater samples collected from south of the power plant exceeded the DNREC groundwater screening criteria for total arsenic, iron, manganese, and lead; dissolved arsenic, manganese, and iron; and TPH-DRO.

Surface water samples from the Nanticoke River were found to exceed the DNREC Ecological Surface Fresh Water Screening Criteria for total aluminum, barium, and iron; and dissolved aluminum, barium, and iron.

Sediment samples collected immediately adjacent to the southern Site boundary exceeded the DNREC Ecological Sediment Fresh Screening Criteria for 2-methylnaphthalene, acenaphthene, benzo(a)pyrene, benzo(a)anthracene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, indeno(1,2,3-c, d)pyrene, dibenz(a,h)anthracene, phenanthrene, pyrene, lead, and zinc. Three

sediment samples from mid-river exceeded the screening criteria for 2-methlnaphthalene, acenaphthene, anthracene, benzo(k)fluoranthene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene, benzo(a)anthracene, benzo(a)pyrene, chrysene, indeno(1,2,3-c,d)pyrene, and cyanide. Two sediment samples collected along the southern bank of the Nanticoke River exceeded the screening criteria for 2-methylnaphthalene, acenaphthene, benzo(a)anthracene, chysene, cobalt, copper, fluorene, iron, manganese, nickel, phenanthrene, pyrene, and zinc.

The two wastewater samples collected from the cooling water intake and discharge clean-outs exceeded the DNREC groundwater screening criteria for total arsenic, iron, lead, manganese; and dissolved arsenic, iron, and manganese.

The sub-slab soil vapor sample exceeded DNREC Sub-Slab Gas and Soil Gas Screening Criteria for benzene and chloroform.

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LIST OF ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
µg	Micrograms
µg/L	Micrograms per liter
µg/m^3	Micrograms per cubic meters
95%UCL	95^{th} percentile upper confidence limit on the mean
ABS	Dermal Absorption Factor
ADI	Average daily intake
AF	Adherence Factor
AST	Aboveground Storage Tank
ATEC	ATEC Environmental Consultants
ATSDR	Agency for Toxic Substance and Disease Registry
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
bgs	Below ground surface
BRAPF	Baseline Risk Assessment and Problem Formulation
BTEX	Benzene, toluene, ethylene, and xylene
CalEPA	California Environmental Protection Agency
CFR	Code of Federal Regulations
CHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
cm^2	Square centimeter
COC	Contaminant of concern
COPC	Chemicals of potential concern
CSM	Conceptual site model
days/year	Days per year
DNREC	Department of Natural Resources and Environmental Control
DPT	Direct-Push Technology
EA	EA Engineering, Science, and Technology, Inc., PBC
EC	Exposure concentration
EcoSSL	Ecological Soil Screening Level
EFH	Exposure Factors Handbook
EPA	U.S. Environmental Protection Agency
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
FE	Facility Evaluation
FI	Food Ingestion
FS	Feasibility Study
ft	Feet(foot)

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

GIABS	Gastrointestinal Dermal Absorption Factor
GPR	Ground Penetrating Radar
HHRA	Human Health Risk Assessment
HI	Hazard index
HMW	High-molecular weight
HQ	Hazard quotient
HSCA	Hazardous Substance Control Act
in.	Inch(es)
IRIS	Integrated Risk Information System
IUR	Inhalation unit risk
kg	Kilograms
kg/kg-day	Kilograms soil per kilogram body weight per day
kg/mg	Kilograms per milligram
LADI	Lifetime Average Daily Intake
LMW	Low-molecular weight
LOAEL	Lowest Observed Adverse Effects Level
MDL	Method Detection Limit
MF	Modifying factor
mg	Milligrams
mg/kg-bw/day	Milligrams of chemical per kilogram of body weight per day
mg/cm^2	Milligrams per square centimeter
mg/L	Milligrams per liter
mg/m^3	Milligrams per cubic meter
mg/day	Milligrams per day
mg/kg	Milligrams per kilogram
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MTBE	Methyl-tert-butyl ethyl
No.	Number
NOAEL	No-observed-adverse-effect-level
NRC	National Research Council
ORNL	Oak Ridge National Laboratory
OSWER	Office of Solid Waste and Emergency Response
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PEC	Probable Effects Concentration
PEL	Probable Effects Level
PID	Photoionization Detector
ppm	Parts per million
QA	Quality Assurance
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RAIS	Risk Assessment Information System
RCRA	Resource Conservation and Recovery Act
RfC	Reference concentration
RfD	Reference dose
RI	Remedial Investigation
SF	Slope factor
SIRS	Site Investigation and Restoration Section
Site	Former Seaford Power Plant Site
SL	Screening level
SLERA	Screening-Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SPP	Seaford Power Plant Building
SQL	Sample quantitation level
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TEC	Threshold Effects Concentration
TPH	Total Petroleum Hydrocarbons
TPH-DRO	Total Petroleum Hydrocarbons-Diesel Range Organics
TRV	Toxicity Reference Value
UCLM	Upper confidence limit of the mean
UF	Uncertainty factor
UST	Underground Storage Tank
VOC	Volatile Organic Compound

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1. INTRODUCTION

EA Engineering, Science, and Technology, Inc., PBC (EA), under Contract Number (No.) NAT-10374 to the Delaware Department of Natural Resources and Environmental Control (DNREC)–Site Investigation and Restoration Section (SIRS), has been tasked to investigate the presence of, if any, total petroleum hydrocarbons (TPH)–diesel range organics (TPH-DRO); benzene, toluene, ethylbenzene, and xylene (BTEX); fuel oxygenates (e.g., methyl tertiary butyl ether [MTBE]); polycyclic aromatic hydrocarbons (PAHs); Target Analyte List (TAL) metals; and TAL/Target Compound List (TCL) pesticides and polychlorinated biphenyls (PCBs) as part of a facility evaluation (FE) at the former Seaford Power Plant (DE-1031) (the Site) in Seaford, Delaware. This FE was originally tasked as a Remedial Investigation (RI) and EA revised the document to an FE per DNREC-SIRS direction on 21 September 2015.

This FE has been prepared for DNREC-SIRS in accordance with the Delaware Hazardous Substance Control Act (HSCA), October 1994 and the Delaware Regulations Governing Hazardous Substance Cleanup, September 1996, Amended August 2012. The FE summarizes the methodology of the well installation activities and the results of the soil, groundwater, surface water, sediment, and soil vapor sampling. This FE report also includes a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA).

1.1 PURPOSE AND ORGANIZATION OF REPORT

The purpose of this FE is to potentially determine the presence of, if any, contaminants of concern (COCs) at the Site based on historical site usage.

This report is divided into the following chapters:

- ***Chapter 1, Introduction***—Outlines the purpose and organization of the report, presents background information, identifies the COCs, and summarizes the previous investigation and current site conditions.

- ***Chapter 2, Physical Characteristics—***Provides an overview of the operational history, geology, hydrogeology, surface water hydrogeology, meteorology, demography, and land use at the Site as well as an overview of Site ecology.

- ***Chapter 3, Facility Evaluation***—Summarizes the methodology of the well installation activities and the soil, groundwater, surface water, sediment, and soil vapor sampling performed. This chapter includes the boring logs, well construction logs, and completion reports.

- ***Chapter 4, Nature and Extent of Contamination***—Identifies the extent of onsite and offsite soil, groundwater, surface water, sediment, and soil vapor contamination.

- ***Chapter 5, Human Health Risk Assessment***—Discusses the methodology of and details the results and conclusions of the HHRA in reference to the COCs detected in the terrestrial and aquatic sampling media.

- ***Chapter 6, Ecological Risk Assessment***—Discusses the methodology of and details the results and conclusions of the ERA in reference to the COCs detected in the aquatic sampling media.

- ***Chapter 7, Summary and Conclusions***—Summarizes the results of the FE and presents its conclusions.

- ***Chapter 8, References***—Includes references used in preparation of this FE.

1.2 FACILITY BACKGROUND

The Seaford Power Plant building (SPP) is located at 200 South Pine Street in Seaford, Sussex County, Delaware. The Site is located along the north side of Nanticoke River off of North Front Street (Figure 1-1). The Site is approximately 1.86 acres in size and is listed in Sussex County as Tax Parcel No. 431-5.00 291.

1.2.1 Facility Description

The Site is bounded to the north and west by private and commercial properties, to the east by alternate Route 13 (North Front Street), and to the south by the Nanticoke River. The specific date of construction of the power plant is unknown. The Site operated as a power plant from the early 1930s to approximately 2000. There is a Riverwalk and floating dock located along the northern bank of the Nanticoke River. The central coordinates for the Site are latitude 38 degrees 38 feet (ft) 26.78 inches (in.) north by longitude 75 degrees 36 ft 35.64 in. west. The elevation at the Site ranges from 10-20 ft above mean sea level. Based on a review of a United States Geological Survey (2015) topographic map, the Site is located in a relatively flat area, with surface water drainage primarily toward the south toward the Nanticoke River.

1.2.2 Previous Investigations

Based on information provided from DNREC from a report by Atlantic Hydrologic, dated December 1993, indicated that TPH in soil was present at levels up to 3,871 parts per million (ppm) within 10 ft of the former underground storage tank (UST) location and up to 603 ppm beyond 10 ft (the original document was not received by EA). One additional soil sample was collected in April 1994 and analyzed for BTEX and naphthalene; no detections of BTEX or naphthalene were reported. The exact location of the soil sample is unknown. In April 1994, DNREC issued a no further action decision for the former UST location as per correspondence with DNREC.

In the 1994 timeframe, the City of Seaford planned to expand the western portion of the power plant. Prior to construction, soil and groundwater samples were collected to characterize potential impacts from former USTs and existing aboveground storage tanks (ASTs) at the Site.

Former USTs included in the investigation include a 1,000-gallon gasoline UST, a 1,000-gallon diesel UST, and one 275-gallon gasoline UST. All three tanks were located in the parking area north of the (currently) abandoned substation. The 1,000-gallon USTs were used by the City of Seaford until 1979 when the tanks were removed by Gallo Tanks. It is unknown if the 1,000-gallon USTs were filled in-place or removed, or otherwise abandoned. The 275-gallon gasoline UST was removed in January 1993 by an unknown contractor. Soil in the vicinity of the removed UST was reported to contain up to 310 ppm TPH; however, BTEX were not detected. The exact depth of the soil samples is unknown. There was no record of soil excavation and disposal as part of the UST removal. DNREC sent a modified hydrogeologic investigation letter dated November 1994 to the City of Seaford in response to the leaking UST.

The investigation also included a 25,000-gallon fuel oil AST, a 150,000-gallon fuel oil AST, and a 500-gallon lubricating oil AST, located north of the power plant, inside a concrete secondary containment pad on Water Street. There were plans to relocate these ASTs to the adjacent Burton Brothers site north of the power plant, but no records indicate that this plan was realized. The Limited Phase II Environmental Site Assessment Report (ATEC Environmental Consultants [ATEC] 1994) indicated that soil was impacted by TPH, BTEX, and naphthalene in samples collected from 5 ft below ground surface (bgs). A sample collected from one well (MW-1) indicated the presence of TPH in groundwater.

To facilitate the relocation of the ASTs, a Focused Phase II Environmental Site Assessment dated May 1994 was conducted on the Burton Brothers site north of the power plant. A leaking UST of unknown content and size was reported at the Burton Brothers site. Soil was screened using a photoionization detector (PID) from three soil borings at several intervals down to 40 ft bgs. The interval with the highest PID reading or visual impact from each boring was submitted for laboratory analysis of TPH. TPH was detected in one soil sample with a reported concentration of 16 ppm from a depth of 2.5-4 ft bgs.

A RI was proposed by ATEC that would characterize the power plant area, transformer storage area, and the area of the two fuel oil ASTs. At the request of the site owner and with DNREC approval, ATEC conducted an RI in December 1995 that focused on the western portion of the Site in the area of the proposed expansion of the power plant and on the northern portion of the Site in the area of the proposed AST relocation. During the focused RI, one monitoring well (MW-2 [29 ft]) and three temporary well points (TP-1 [25 ft], TP-2 [16 ft], and TP-3 [16 ft]) were installed. Two rounds of groundwater samples were collected from MW-2 and submitted for analysis of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and Resource Conservation and Recovery Act (RCRA) metals.

Groundwater samples collected from TP-2 and TP-3 were submitted for analysis of VOCs and TPH. Soil samples collected from the temporary point installations were submitted for analysis of VOCs, SVOCs, and RCRA metals. Three additional soil borings were installed and samples were collected at 2-ft intervals. Soil samples were submitted for analysis of VOCs and SVOCs. One piezometer (P-2 [16 ft]) was installed and an aquifer pump test was performed on MW-2 to evaluate dewatering at the Site. PAHs, arsenic, and benzene were reported at levels exceeding U.S. Environmental Protection Agency (EPA) risk-based concentrations in surface soil.

Benzene, barium, ethylbenzene, and total xylenes were reported at levels exceeding EPA risk-based concentrations in subsurface soil. Benzene and chloroform were reported at levels exceeding EPA tapwater risk-based concentrations in groundwater.

An interim removal action was conducted in the western area of the Site in January 1997 by an unknown contractor. The top 2 ft of soil was removed from within the proposed building expansion area and disposed of offsite. During excavation activities, a subsurface stormwater pipe was encountered and removed. However, during the removal of the stormwater pipe, approximately 100 gallons of petroleum-impacted groundwater was released into the Nanticoke River causing a sheen of approximately 40 × 70 ft on the river surface. The sheen dissipated within 1 hour and a DNREC emergency response team determined that no further action was required. Inspection of the stormwater pipe indicated that the pipe contained gaps at connection fittings that allowed contaminated groundwater to discharge to the Nanticoke River. Closure of the stormwater pipe mitigated the impacts to groundwater from that pipe. However, additional concrete pipes located on the Site likely have the same structural deficiencies. No additional investigation of the concrete pipes was performed as part of the interim removal action.

2. PHYSICAL CHARACTERISTICS

2.1 OPERATIONAL HISTORY

The SPP operated as an oil fired power plant from the early 1930s through approximately 2000. Prior to 1979, the SPP housed emergency dispatch personnel for the local Police Department, as well as two 1,000-gallon USTs (diesel and gasoline) for fueling City of Seaford vehicles. The Police Department relocated to new facilities in 1979 when the tanks were decommissioned. The City of Seaford expanded the western portion of the power plant in 1994 and relocated two ASTs to the neighboring Burton Brothers property in 1995. The SPP continued producing electricity until the early 2000s when the plant was decommissioned and the electrical generators and equipment were removed.

The Site is currently unoccupied and is still under ownership by the City of Seaford. A City of Seaford maintenance garage occupies the eastern site boundary, while an active electrical substation occupies the western site boundary.

2.2 GEOLOGY

The Site lies within the Atlantic Coastal Plain Physiographic Province characterized by gently rolling hills and plains. The underlying geologic formation is the Quaternary-age Lynch Heights Formation consisting of light gray to brown to light yellowish brown, medium to fine sand with discontinuous beds of coarse sand, gravel, silt, fine to very fine sand, and organic-rich clayey silt to silty sand. Vertical sequences are variable, but generally consist of a lower medium to coarse sand, a middle interbedded clayey silt and fine to medium sand, and an upper medium sand fining upward to a fine sand to fine sandy silt. Small-scale cross-bedding within the sands is common. Some of the interbedded clayey silts and silty sands are burrowed. Sands are quartzose and slightly feldspathic, and typically micaceous where very fine to fine grained. The unit is up to 50 ft thick to the east and thins to the west.

The 1974 U.S. Department of Agriculture Soil Conservation Service soil survey of Sussex County, Delaware determined that the site is comprised of Evesboro loamy sand with a slope between 0 and 2%. The Evesboro consists primarily of excessively drained soils that have rapidly permeable subsoil of sand to sandy loam.

Soil encountered within the Site during direct push activities consisted of a combination of well and poorly sorted sand with trace layers of silty sand and/or gravel as well as sporadic 1 ft layers of clay. Layers of quartz pebbles were encountered as well.

2.3 HYDROGEOLOGY

The groundwater elevations are approximately 8.5 ft bgs on the southern portion of the Site, adjacent to the Nanticoke River bulkhead, and approximately 14 ft bgs on the northern portion of the Site. The local groundwater flow direction is to the south-southeast towards the Nanticoke River.

The local shallow groundwater flow direction beneath the site ultimately discharges to the Nanticoke River, adjacent to the south of the Site (Figure 2-1). A bulkhead wall runs along the riverbank which may contribute to groundwater mounding where the shallow water table intersects the wall.

The unconfined Columbia Aquifer underlays the Site and is inferred to be a maximum of approximately 100 ft thick (Johnston 1973). The Columbia Aquifer in the area includes the Nanticoke River Group with a range of aquifer transmissivity from 6,000 to 80,000 gallons per day per ft and an average hydraulic conductivity of 90 ft per day.

No domestic wells or production wells are located within a ½-mile radius of the Site as all residences and businesses are serviced by a public water system (DNREC Division of Water Public Record Request).

2.4 SURFACE WATER HYDROGEOLOGY

The Site is relatively flat with a 5-10 ft wall along the south side of the Site that drops off to the Nanticoke River. Surface water flows primarily south towards the Nanticoke River. The flow of the Nanticoke River is towards the west along the Site. The Site is located within a flood zone based on the currently available 2005 Sussex County and Incorporated Areas Flood Insurance Rate Map (Federal Emergency Management Agency 2005).

The Site is located in Zone AE and Zone X based on the currently available 2005 Flood Insurance Rate Map. Zone AE is classified as the special flood hazard area subject to inundation by the 1% annual chance flood (100-year flood), also known as the base flood. The base flood elevation is the water surface elevation of the 1% annual chance flood. Zone X is classified as areas of 0.2% annual chance flood, area of 1% annual chance flood with average depths of less than 1 ft or with drainage areas less than 1 square mile, and areas protected by levees from 1% annual chance for flood.

2.5 METEOROLOGY

Seaford, Delaware climate is warm during the summer, when temperatures tend to be in the 80s degrees Fahrenheit (°F), and cold during the winter, when temperatures tend to be in the 20s°F.

The warmest month of the year is July, with an average maximum temperature of 87°F, while the coldest month of the year is January, with an average minimum temperature of 25.40°F.

Temperature variations between night and day tend to be moderate during summer, with a difference that can reach 23°F, and fairly limited during winter, with an average difference of 20°F.

The annual average precipitation at Seaford is 43.7 in. Rainfall is fairly evenly distributed throughout the year. The wettest month of the year is June, with an average rainfall of 4.61 in.

2.6 DEMOGRAPHY AND LAND USE

The Site is located in Seaford, Delaware, which is the largest city fully within Sussex County with a population of approximately 6,928 people and approximately 3,001 housing units according to the currently available 2010 United States Census (United States Census 2010). The city is located along the Nanticoke River in Sussex County. US Route 13 is the main north-south thoroughfare within city limits, with Delaware Route 20 being the main east-west highway.

Information provided by the Seaford, Delaware City website indicates that the Nanticoke Indians and their ancestors have lived along the Nanticoke River for over 6,000 years. The land in current western and southern Sussex County was first settled as part of Maryland, and Seaford was part of Dorchester County in the Province of Maryland. The first record of any settlement in the area around Seaford was in 1672. Despite development in the area, the Nanticoke River was the main highway until 1720 when roads began to be recorded as developed. The primary industry of the area was agriculture, particularly tobacco, and plantations were the main style of living. In 1925, the poultry industry became the main industry in Seaford, and the nature of farming changed from truck crops to grains and corn for chicken feed. The Site itself is a former Power Plant that was decommissioned in 2005.

2.7 ECOLOGY

The Site includes a decommissioned Power Plant with paved and grassy open areas, a Riverwalk, and a floating dock. No wetlands are known in the area of the Site (http://www.dnrec.delaware.gov/Admin/DelawareWetlands/Pages/Wetlands-Maps.aspx). In addition, the DNREC Division of Fish and Wildlife has been contacted and confirmed that no known threatened or endangered species are present at the site (DNREC 2015 a) (Appendix J).

3. FACILITY EVALUATION

The general sampling strategy and approach for the site inspection are summarized below. Field activities completed during the FE were performed in accordance with the DNREC regulations, operating procedures, and guidance documents as outlined in the 2015 DNREC approved FE Work Plan (EA 2015a).

3.1 DATA QUALITY OBJECTIVES

The overall data quality objective for the project was to provide data of known and documented quality to characterize current conditions at the Site. The goal of this investigation was to obtain site-wide soil, groundwater, wastewater, and sludge characterization data and surface water and sediment characterization data from the offsite Nanticoke River to support remedial efforts. The definitive quality of the data is assured by using: 1) standard operating procedures (SOPs) and quality control (QC) processes during sample and data collection; 2) documented control and traceability of reference standards, calibrations, and instrument performance; and 3) acceptable performance of field and laboratory QC procedures.

3.2 SAMPLING NOMENCLATURE

Sampling naming conventions for the surface soil samples included the site name, surface sample, and location. For example, the designation “SPP-SS-01” indicates:

SPP = Seaford Power Plant
SS = Surface Sample
01 = Location 01

Sampling naming conventions for the subsurface soil samples included the site name, sampling method, location of sample, and depth interval. For example, the designation “SPP-DPT-01-3-4” indicates:

SPP = Seaford Power Plant
DPT = Direct-push technology sampling
01 = Location 01
3-4 = 3-4 ft bgs

Sampling naming conventions for the groundwater samples included the site name, sampling media, and location of sample. For example, the designation “SPP-GW-01” indicates:

SPP = Seaford Power Plant
GW = Groundwater
01 = Location 01

Sampling naming conventions for the surface water samples included the site name, sampling media, and location of sample. For example, the designation "SPP-SW-01" indicates:

SPP = Seaford Power Plant
SW = Surface Water
01 = Location 01

Sampling naming conventions for the sediment samples included the site name, sampling media, and location of sample. For example, the designation "SPP-SD-01" indicates:

SPP = Seaford Power Plant
SD = Sediment
01 = Location 01

Sampling naming conventions for the sludge samples included the site name, sampling media, and location of sample. For example, the designation "SPP-SL-01" indicates:

SPP = Seaford Power Plant
SL = Sludge
01 = Location 01

Sampling naming conventions for the wastewater samples included the site name, sampling media, and location of sample. For example, the designation "SPP-WW-01" indicates:

SPP = Seaford Power Plant
WW = Wastewater
01 = Location 01

Sampling naming conventions for the wastewater samples included the site name, sampling media, and location of sample. For example, the designation "SPP-IA-01" indicates:

SPP = Seaford Power Plant
IA = Indoor Air
01 = Location 01

3.3 SCOPE OF INVESTIGATION

EA was tasked to investigate the presence of, if any, TPH–DRO; BTEX; fuel oxygenates (e.g., MTBE); PAHs; TAL metals; and TAL/TCL pesticides and PCBs at the Site based on historical site usage. The following boring locations were completed (Figures 3-1 and 3-2):

- SPP-01 and SPP-02 to evaluate the area downgradient of the former 25,000-gallon and 150,000-gallon fuel oil ASTs and 500-gallon lubricating oil AST.

- SPP-03 and SPP-04 to characterize the surface conditions at the western edge of the Site.

- SPP-05 and SPP-06 to characterize the subsurface conditions in the south-southeast edge of the Site.

- SPP-07 through SPP-11 to characterize the subsurface soil in the vicinity of the existing cooling water intake/discharge pipelines and the abandoned pipe vaults.

- SPP-12 to characterize subsurface soil south of the former transformer area.

- SPP-13 and SPP-14 to characterize soil from upgradient of the former power plant building.

Visually impacted soils observed were delineated to determine the lateral and vertical extent of impact.

Additional groundwater monitoring wells were installed as shown on Figure 3-3 to provide background data (SPP-GW-03), a location of known soil impact (SPP-GW-04), and to determine the potential migration of contaminated groundwater to the southeast (SPP-GW-05). Previously existing groundwater monitoring wells were located in the area of known impact (SPP-GW-02) and to determine the potential migration of contaminated groundwater to the southwest (SPP-GW-01).

Surface water and sediment samples were collected from the Nanticoke River to determine the potential for contamination from the SPP to the river. Surface water samples were collected from upstream to downstream along the center of the Nanticoke River as shown on Figure 3-4. The following sediment samples locations were completed (Figure 3-5):

- SPP-SD-01, SPP-SD-02, and SPP-SD-06 thorough SPP-SD-10 were collected to assess impacts to river-bottom sediment from potential releases from the Site.

- Sediment sample SPP-SD-05 was a background sample collected upstream of the Site.

- Samples SPP-SD-03 and SPP-SD-04 were collected from the southern bank of the Nanticoke River to determine if releases potentially originating from the southerly fuel dispensing terminal have impacted sediment in the river; these samples are also being used for background purposes.

Two sludge samples were collected from selected stormwater manholes, and two wastewater samples were collected from the discharge pipes to determine the presence of contamination in the piping (Figure 3-6). Additionally, a soil gas vapor sample was collected inside the SPP.

A photographic log of the current Site conditions is located in Appendix A.

3.4 INVESTIGATION METHODS

3.4.1 Soil

3.4.1.1 Surface Soil

Fourteen locations (SPP-DPT-01, SPP-DPT-02, SPP-DPT-03, SPP-DPT-04, SPP-DPT-05, SPP-DPT-06, SPP-DPT-07, SPP-DPT-08, SPP-DPT-09, SPP-DPT-10, SPP-DPT-11, SPP-DPT-12, SPP-DPT-13, and SPP-DPT-14) were identified for collection of surface soil samples based on site observations and former tank/pipeline locations (Figures 3-1 and 3-2). The soil investigation was conducted utilizing a track-mounted Geoprobe® 6620 rig using a licensed Delaware drilling company (Northeast Probe®). Surface soil samples were collected using direct-push technology (DPT) using 4-ft core lengths with acetate liners, with a composite sample collected from the surface interval (0-1 ft bgs) at each location.

Soil lithology was recorded on the boring log, including Munsell soil color, odors or observed soil staining, and presence of native versus fill material. Boring logs are provided in Appendix B. The soil was field screened visually and with a PID for the presence of VOCs prior to being placed in the laboratory provided sample container. Soil samples (screening) were transported to the DNREC-SIRS New Castle laboratory under strict chain-of-custody procedure. Screening of samples was performed at DNREC-SIRS New Castle laboratory. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

3.4.1.2 Sub-Surface Soil

In addition to the surface soil samples, 14 sub-surface soil samples were collected using DPT from the same locations (SPP-DPT-01, SPP-DPT-02, SPP-DPT-03, SPP-DPT-04, SPP-DPT-05, SPP-DPT-06, SPP-DPT-07, SPP-DPT-08, SPP-DPT-09, SPP-DPT-10, SPP-DPT-11, SPP-DPT-12, SPP-DPT-13, and SPP-DPT-14). An additional five delineation sub-surface soil samples were collected due to subsurface impact identified via PID or visual observations in a borehole. Delineation of impacted areas were investigated until no impact was observed and no PID readings above background conditions were encountered.

The DPT borings were continuously advanced to 10 ft bgs or refusal, whichever was encountered first, using 4-ft core lengths with acetate liners. After each 4-ft interval the core was extracted and logged. The soil cores were field screened visually and with a PID, with the results recorded on the boring logs. Soil lithology was recorded on the boring log, including depth to water (if encountered), Munsell soil color, odors or observed soil staining, and presence of native versus fill material. Boring logs are provided in Appendix B.

A subsurface soil sample was collected from 19 soil borings at the depth interval with the highest PID reading or visual impact by compositing a 1-ft interval in a disposable plastic bag. Samples were then placed in laboratory provided containers. If no PID readings above background

conditions were identified, the bottom 1 ft of the soil boring was sampled or the smear zone at the top of the water table, if encountered.

Soil samples (screening) were transported to the DNREC-SIRS New Castle laboratory under strict chain-of-custody procedure. Screening of samples was performed at DNREC-SIRS New Castle laboratory. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

3.4.2 Monitoring Well Installation and Groundwater Samples

Based on soil core field screening results as discussed in Section 3.1, three locations were selected for installation of 1-in. pre-packed monitoring wells (Figure 3-3). Wells installed as part of the current FE were installed with a 5-ft screen set at the screened intervals presented below.

Well Construction Data

Well ID	Construction Date	Total Well Depth ft bgs	Screened Interval ft bgs	Depth to Water ft Top of Casing
SPP-GW-01	Unknown	12.53	7.5-12.5	3.2
SPP-GW-02	Unknown	9.78	0-9.8	2.9
SPP-GW-03	3/9/2015	7.84	2.8-7.8	2.52
SPP-GW-04	3/5/2015	7.82	2.8-7.8	3.03
SPP-GW-05	3/5/2015	8.75	4.8-8.8	3.6

Following installation of SPP-GW-03, SPP-GW-04, and SPP-GW-05, the wells were completed with a steel flush mount cover and concrete pad. Following completion of the well pad, the pre-packed wells were allowed to sit for a minimum of 24 hours prior to development and sampling.

Since the existing monitoring wells had not been sampled recently, the wells were purged and surged until stabilization was achieved prior to initiating low-flow sampling procedures.

Five groundwater samples were collected from monitoring wells at the Site. Total and dissolved metals were collected for each groundwater and wastewater sample, with the exception of SPP-WW-02. Due to a lab error, the filtered sample of SPP-WW-02 was not analyzed. Dissolved metals were field filtered with a dedicated 0.45-micron inline filter attached to the end of the sampling tubing. Groundwater samples were collected from two existing site wells (SPP-GW-01 and SPP-GW-02) and three pre-pack wells installed during field activities (Figure 3-3). Copies of the well purge and sampling records, and the well construction logs are provided in Appendices C and D.

Prior to sampling, the depth to groundwater and total well depth were collected from each well. Groundwater samples were collected using low-flow sampling procedures with a peristaltic pump and disposable polyethylene tubing. During groundwater sampling, water quality parameters were recorded in 5-minute intervals using a YSI 6200 (or equivalent) water quality meter equipped with an inline flow-through cell. Samples were collected in laboratory-provided

containers and transported to the DNREC-SIRS New Castle laboratory for analysis under strict chain-of-custody procedure. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

3.4.3 Surface Water Samples

Five surface water samples were collected from a depth interval of 0-1 ft beneath the surface from the Nanticoke River in the vicinity of the Site (Figure 3-4). Surface water samples were collocated with five of the sediment samples. The surface water samples were collected using a dedicated, clean sample jar to transfer water into the appropriate, laboratory-provided sample containers. The filtered surface water samples were filtered using a peristaltic pump with an attached 0.45-micron filter.

Surface water samples were collected 28 January 2015 with the following tidal schedule:

		High Tide (time)	High Tide (Height)	Low Tide (time)	Low Tide (Height)
Wed, Jan 28	**Tide Set One**	10:54 AM	2.49 ft	04:35 AM	-0.36 ft
	Tide Set Two	11:10 PM	2.10 ft	05:23 PM	-0.03 ft

SPP-SW-03 and SPP-SW-04 were collected during the incoming tidal cycle, and SPP-SW-01, SPP-SW-02, and SPP-SW-05 were collected during the outgoing tidal cycle. Surface water samples were collected around the high tide.

Samples were collected in laboratory-provided containers and transported to the DNREC-SIRS New Castle laboratory for analysis under strict chain-of-custody procedure. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

3.4.4 Sediment Samples

Ten sediment samples were collected from the Nanticoke River in the vicinity of the Site (Figure 3-5). Sediment samples were collected using a Ponar grab and placed in laboratory provided sample containers. Decontamination of the Ponar grab was performed between each sampling locations.

Sediment samples were also collected 28 January 2015 in accordance with the tidal schedule in Section 3.4.3. SPP-SD-07 was collected during the incoming tidal cycle, and the remaining sediment samples were collected during the outgoing tidal cycle. SPP-SD-05, SPP-SD-06, SPP-SD-07, and SPP-SD-08 were collected around the high tide (between 1030 and 1205). SPP-SD-01, SPP-SD-02, and SPP-SD-03 were collected around the low tide (between 1515 and 1610). SPP-SD-04, SPP-SD-09, and SPP-SD-10 were collected between high and low tide (between 1310 and 1450).

Sediment samples (screening) were transported to the DNREC-SIRS New Castle laboratory under strict chain-of-custody procedure. Screening of samples was performed at DNREC-SIRS New Castle laboratory. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

3.4.5 Sub-Slab Soil Vapor Samples

One sub-slab soil vapor sample was collected from beneath the concrete floor of the SPP using a laboratory provided 1-liter Summa canister (Figure 3-6). A hammer drill was used to create a 1-in. hole in the concrete floor in the approximate center of SPP, extending 1-in. below the concrete slab. Probe tubing was inserted into the hole, and the annular space was sealed with putty. The tubing was then attached to the summa canister. A tracer helium gas was used as an indicator to evaluate whether the sample was influenced by surface air intrusion. The valve was then opened on the summa canister to allow flow for a period of 8 hours, upon which the valve was closed, the pressure gauge and time was recorded, and the sampled was packed up. The sample was transported to Test America in Edison, New Jersey.

3.4.6 Sludge and Wastewater Samples

Prior to the initiation of intrusive field activities, EA conducted an onsite visual inspection of accessible Site sumps and intake and/or discharge pipes to/from the Nanticoke River. Locations of sludge and wastewater samples were determined in coordination with DNREC based upon the results of the visual inspection. During the inspection, accessible sludge pits or sumps were opened and visually inspected for the presence of visible waste and/or staining. For pits or sumps with standing water, an interface probe was used to gauge the thickness of water and any product. In addition, a PID was used for screening of the ambient air inside of the pit or sump.

Two sludge and two wastewater samples were collected from accessible intakes, outfalls, and/or sumps (Figure 3-6). Samples were collected from locations where the lines “daylight” (no excavation) and were collected during the outgoing or low tide conditions of the Nanticoke River.

Wastewater samples were collected following the Standard Operating Procedures for Groundwater referenced in the RI Work Plan (EA 2015a). Prior to sampling the wastewater samples, the depth to water was collected from both locations. Wastewater samples were collected using low-flow sampling procedures with a peristaltic pump and disposable polyethylene tubing. During groundwater sampling, water quality parameters were recorded in 5-minute intervals using a YSI 6200 (or equivalent) water quality meter equipped with an inline flow-through cell. Well purge and sampling records are provided in Appendix C.

Wastewater samples were collected in laboratory-provided containers and transported to the DNREC-SIRS New Castle laboratory for analysis under strict chain-of-custody procedure. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

Sludge samples (screening) were transported to the DNREC-SIRS New Castle laboratory under strict chain-of-custody procedure. Screening of samples was performed at DNREC-SIRS New Castle laboratory. The Test America laboratory courier picked up the samples for laboratory analysis from the New Castle, Delaware office for shipment to the Edison, New Jersey Test America laboratory under strict chain-of-custody procedure.

3.4.7 Ground Penetrating Radar Investigation

Miss Utility was contacted to mark and locate underground utilities. As an additional precaution, a private utility locator was used to provide additional clearance of boring locations and identify subsurface utilities or obstructions. The utility locator utilized ground penetrating radar (GPR), electromagnetic, and pipe locating instruments to locate subsurface utilities (Figure 3-7). In addition to identifying existing utilities, the GPR was used to confirm the presence/absence of a two USTs, north of the abandoned substation. The tanks were removed in approximately 1979; however, DNREC has no record of abandonment. The GPR survey did not identify any subsurface anomalies indicative of USTs in the subsurface.

3.5 CHAIN-OF-CUSTODY

Chain-of-custody forms were completed for samples submitted to Test America. At the direction of DNREC, chain-of-custody forms were not required for samples submitted for screening purposes to the DNREC-SIRS New Castle laboratory; however, copies of the chain-of-custody forms for the samples sent to Test America were supplied to SIRS with the screening samples. Chain-of-custody forms were initiated by the sampler at the time samples were collected.

EA relinquished samples/coolers to the DNREC-SIRS New Castle laboratory. After removal of the samples for screening purposes by DNREC personnel, the Test America courier picked up and transported the samples/coolers to Edison, New Jersey under strict chain-of-custody.

Upon receipt and opening of the coolers by Test America, the laboratory sample custodian measured and recorded the temperature inside the coolers, which did not exceed 4 degrees Celsius.

3.6 ANALYTICAL REQUIREMENTS

Soil, groundwater, surface water, sediment, wastewater, sludge, and sub-slab soil vapor samples were collected as part of this FE. Soil, sediment, and sludge samples were screened by the DNREC-SIRS New Castle laboratory for BTEX/MTBE, TPH-DRO, pesticides, PCBs, PAHs, and metals to determine which samples would be submitted to the Test America. Groundwater, surface water, wastewater and selected soil, sediment, and sludge samples were analyzed for BTEX/MTBE, pesticides, PCBs, PAHs, and metals at Test America. The soil vapor sample was sent to Test America for analysis of TPH-DRO.

Quality assurance (QA)/QC samples were collected in accordance with the DNREC SOP for Chemical Analytical Programs Manual (DNREC 2010). The following QA/QC sample types were collected:

- ***Field Duplicates*** – Field duplicate samples are a second aliquot of a field sample that is measured and processed with the analysis batch in exactly the same manner as the rest of the field samples. Field duplicates are used as a QC check of the laboratory. Field duplicates were collected at a ratio of 1 per every 10 discrete samples per day.

- ***Field Blanks*** – Field blanks are used to detect contamination that may occur in the process of collecting or transporting samples. A matrix similar to that being collected and known to be free of the COC or chemicals of potential concern (COPCs) may be used as field blank material. Field blanks are prepared onsite by the persons who collect the samples. One field blank was collected per day of sample collection.

- ***Trip Blanks*** – Trip blanks are routinely used to monitor for cross-contamination between samples during transport. One trip blank was collected for every shipment of coolers/samples for VOC analysis per field day of sample collection.

- ***Rinsate/Equipment Blanks*** – The purpose of the rinsate/equipment blanks is to check the effectiveness of the decontamination process. One rinsate/equipment blank sample was collected per day of sampling during use of the Ponar dredge, which was used for sediment sampling.

- ***Matrix Spike (MS)/Matrix Spike Duplicates (MSD)*** – MS/MSD samples are used to monitor recovery of selected target compounds that are spiked ("fortified") within the samples to evaluate the overall performance of the analytical method. MS/MSD samples consist of additional aliquots of a field sample, and were collected at a ratio of 1 per every 20 discrete samples per day.

In addition to samples collected, the following QA/QC samples were collected and analyzed:

- Six field duplicates were collected: three soil duplicates analyzed for BTEX/TPH-DRO, one soil duplicate analyzed for PAHs, one groundwater duplicate analyzed for the full suite listed in Section 3.6 and, one surface water duplicated analyzed for the full suite listed in Section 3.6.

- Four MS/MSD samples were collected for each media (soil, sediment, groundwater, and surface water) and analyzed for the full suite of analytes listed in Section 3.6.

- Four field blanks were collected: one field blank was analyzed for cyanide, BTEX/MTBE, PAH, TPH-DRO, and pesticides, and three field blanks were analyzed for TAL Metals, cyanide, BTEX/MTBE, PAH, and TPH-DRO.

- Four trip blanks were collected for each sampling event and analyzed for BTEX.

- One equipment blank was collected during sediment sampling on the Ponar grab and analyzed for PAHs, TAL metals, and PCBs.

- Duplicate samples were collected at a rate of 1 per 10 samples, and MS/MSD samples were collected at a rate of 1 per 20 samples.

3.7 EQUIPMENT DECONTAMINATION

The Ponar dredge was cleaned prior to the initiation of field activities, between each sample location, and at the end of field activities. Decontamination procedures consisted of the following:

- Scrub the Ponar dredge to remove gross (visible) contamination using a brush, deionized water, and non-phosphate laboratory detergent.

- Rinse off detergent with deionized water.

- Rinse Ponar dredge with reagent grade alcohol.

- Rinse Ponar dredge with high performance liquid chromatography-grade water.

- Allow Ponar dredge to air dry.

Used decontamination solutions were allowed to drain to the ground surface.

3.8 PERSONAL PROTECTIVE EQUIPMENT

Level D personal protective equipment was used for field operations, which included:

- Steel-toe, steel-shank safety boots/shoes
- Hard hat that meets American National Standards Institute Standard Z89.1 1986
- Chemical-resistant gloves when conducting sampling
- Safety glasses.

3.9 INVESTIGATIVE-DERIVED WASTE MANAGEMENT

Used personal protective equipment that could not be decontaminated (i.e., chemical resistant gloves) was placed in plastic trash bags and disposed as municipal waste. In addition, used DPT plastic liners were placed in plastic trash bags and disposed as municipal waste. Two drums of investigation-derived waste were generated during groundwater monitoring well development and sampling. The drums are currently staged inside the SPP awaiting final determination on disposal method.

4. NATURE AND EXTENT OF CONTAMINATION

This chapter discusses the results of the field investigation and approach used for evaluating laboratory analytical results for samples collected as part of this FE.

FE activities were performed in accordance with DNREC-approved Final RI Work Plan and Final Site Safety and Health Plan (EA 2015a and 2015b). Field activities were performed from January through March 2015.

4.1 APPROCH TO EVALUATION OF SAMPLING RESULTS

Data collected through this FE have been compared to the DNREC Screening Criteria (2015c) to further refine the nature and extent of contamination at the Site. This section discusses the approach used for evaluating laboratory analytical results for samples collected from the Site. Data evaluation involves (1) identifying analytes present in each media, (2) evaluating data quality and usability, (3) selecting FE comparison criteria for the identification of COPCs and COCs, and (4) determining instances when exceptions to this approach are necessary.

4.1.1 Positive Identification of Analytes and Data Usability

Data were generated for this FE via the analysis of soil, groundwater, surface water, sediment, sludge, wastewater, and soil vapor samples collected as described in Section 3.6. Soil, sediment, and sludge samples collected were screened at the DNREC-SIRS New Castle laboratory for BTEX/MTBE, TPH-DRO, pesticides, PCBs, PAHs, and metals. The DNREC-SIRS New Castle laboratory screening results were utilized to determine which samples collected were sent for additional confirmatory analysis. With respect to the COPCs, if the DNREC-SIRS New Castle laboratory screening results indicated a potential for these analytes to be present in a specific sample, then confirmatory analysis for those certain COPCs was performed by Test America: a) BTEX/MTBE, b) PAHs, c) pesticides, d) PCBs, e) TPH-DRO, and f) metals. Groundwater, surface water, wastewater, and an additional subset of selected soil/sludge/sediment samples were analyzed for full laboratory analysis of the above constituents at Test America.

Samples submitted to Test America were analyzed using current EPA methodology (Section 4.2), and full QA/QC documentation was provided by the laboratory. Full laboratory reports are provided on compact disc (Appendix E). The laboratories identified compounds as being present in the analyzed media if the measured concentration was above the Method Detection Limit (MDL).

4.1.2 Data Quality and Usability

Data qualifiers were assigned by Test America based on internal QA/QC procedures. Data qualifiers are defined below:

J = Analyte present. Result is less than the reporting limit but greater than or equal to the method of detection limit and the concentration is an approximate value.

U = Not detected. Indicates the analyte was analyzed for but not detected.

F1 = MS and/or MSD Recovery exceeds the control limits.

Data quantitatively evaluated in the FE are summarized in Tables 4-1 through 4-8. These tables report all analytes that were detected at least once, each sample's detected concentration or the MDL for non-detects, and highlight those detected concentrations that exceed the DNREC Screening Criteria (2015c).

4.2 SURFACE SOIL SAMPLE RESULTS

Fourteen samples were initially screened for BTEX/MTBE, TPH-DRO, pesticides, PCBs, PAHs, and metals at the DNREC-SIRS New Castle laboratory. The DNREC-SIRS New Castle laboratory screening results as well as the laboratory confirmation results are provided in Appendices E and F.

Based on the screening results, the following samples were submitted to the DNREC HSCA-certified laboratory Test America for confirmatory laboratory analysis to confirm the initial screening results:

- Eight samples were submitted for PAH analysis via EPA Method 8270
- Two samples were submitted for BTEX/MTBE analysis via EPA Method 8260
- Five samples were submitted for TPH-DRO analysis via EPA Method 8015
- Three samples were submitted for pesticide analysis via EPA Method 8081
- Two samples were submitted for arsenic analysis via EPA Method 6010C
- Three samples were submitted for PCB analysis via EPA Method 680.

Tables 4-1 through 4-4 summarize the confirmatory sample results from the direct-push sampling event. Additionally, BTEX/MTBE and arsenic were reported at concentrations below the screening criteria.

4.2.1 Polycyclic Aromatic Hydrocarbon Results

Benzo(a)pyrene was reported above the screening criteria in samples SPP-SS-03 and SPP-SS-13 as shown on Figure 4-1.

4.2.2 Volatile Organic Compounds and Diesel Range Organics Results

BTEX/MTBE samples were reported at concentrations below the screening criteria.

TPH-DRO was reported above the applicable criteria at location SPP-SS-07. In summary, the surface soil immediately south of the SPP as shown in Figure 4-2, was found to be impacted with TPH-DRO. This impact can be attributed to former site operations in association with the cooling water intake/discharge pipes. TPH-DRO contaminants likely have migrated through subsurface bedding material surrounding the cooling water intake/discharge pipes.

4.2.3 Pesticide Results

No results above the MDL were reported for pesticides.

4.2.4 Arsenic Results

Arsenic was reported at concentrations below the screening criteria.

4.2.5 Polychlorinated Biphenyl Results

No results above the MDL were reported for PCBs.

4.3 SUB-SURFACE SOIL SAMPLE RESULTS

Nineteen samples were initially screened for BTEX/MTBE, TPH-DRO, pesticides, PCBs, PAHs, and metals at the DNREC–SIRS New Castle laboratory. The DNREC–SIRS New Castle laboratory screening results as well as the laboratory confirmation results are provided in Appendices E and F.

Based on the screening results, the following samples were submitted to the DNREC HSCA-certified laboratory Test America for confirmatory laboratory analysis to confirm the initial screening results:

- Eleven samples were submitted for PAH analysis via EPA Method 8270
- Two samples were submitted for cyanide analysis via EPA Method 9012B
- Fifteen samples were submitted for BTEX/MTBE analysis via EPA Method 8260
- Thirteen samples were submitted for TPH- DRO analysis via EPA Method 8015
- Two samples were submitted for pesticide analysis via EPA Method 8081
- Two samples were submitted for mercury analysis via EPA Method 7071A
- Two samples was submitted for TAL metals analysis via EPA Method 6010C
- Two samples were submitted for arsenic analysis via EPA Method 6010C
- Two samples were submitted for PCB analysis via EPA Method 680.

Tables 4-1 through 4-4 summarize the confirmatory sample results from the DPT sampling event.

Visual impact and/or elevated PID readings were noted at the subsurface at locations SPP-01, SPP-02, SPP-07, SPP-08, SPP-08a, SPP-08b, SPP-09, SPP-09a, SPP-09b, SPP-09c, SPP-10, SPP-11, SPP-12, and SPP-12a.

4.3.1 Polycyclic Aromatic Hydrocarbon Results

2-methylnaphthalene was reported above the screening criteria in samples SPP-DPT-12-4-5. Benzo(a)pyrene was reported above the screening criteria at samples SPP-DPT-10-5-6 and

SPP-DPT-11-5-6 (Figures 4-1 and 4-2). The PAH impact to SPP-DPT-12-4-5 is attributed to former site operations due to location and visual impact observed during field screening.

4.3.2 Cyanide Results

No results above the MDL were reported for cyanide.

4.3.3 Volatile Organic Compounds and Diesel Range Organics Results

TPH-DRO was reported above the screening criteria in samples SPP-DPT-0-5-6, SPP-DPT-08-4-5, SPP-DPT-08a-8-9, SPP-DPT-08b-7-8, SPP-DPT-09c-2-3, SPP-DPT-10-5-6, and SPP-DPT-11-5-6. Benzene and TPH-DRO were reported above the screening criteria in the duplicate sample of location SPP-DPT-12-4-5. The impacted DPT locations and their exceedances are illustrated on Figures 4-1 and 4-2.

In summary, the subsurface soils south of the SPP as shown in Figure 4-2, were found to be impacted with TPH-DRO and the area south of the abandoned substation was found to be impacted with benzene. This impact can be attributed to former site operations in association with the cooling water intake/discharge pipes and the abandoned substation. TPH-DRO contaminants likely have migrated through subsurface bedding material surrounding the cooling water intake/discharge pipes.

4.3.4 Pesticide Results

No results above the MDL were reported for pesticides.

4.3.5 Metals Results

Arsenic was reported above the screening criteria in samples SPP-DPT-11 from 5 to 6 ft bgs and SPP-DPT-12 from 4 to 5 ft bgs. SPP-DPT-11 is located south of the SPP along the Riverwalk, and SPP-DPT-12 is located south of the abandoned substation as shown on Figures 4-1 and 4-2.

4.3.6 Polychlorinated Biphenyl Results

No results above the MDL were reported for PCBs, with the exception of a low detection of nonachlorobiphenyl at SPP-DPT-05-3-4.

4.4 GROUNDWATER RESULTS

Table 4-5 summarizes the groundwater results in comparison to the screening criteria (DNREC-SIRS Screening Level Table for Groundwater, January 2015). Samples from each of the five monitoring wells were analyzed for BTEX/MTBE per EPA Method 8260B, PAHs by EPA Method 8270C, TPH-DRO by EPA Method 8015 (samples SPP-GW-03, SPP-GW-04, and SPP-GW-05 only), total and dissolved TAL metals and mercury by EPA Method 6020A, and cyanide by EPA Method 9012B at the request of DNREC-SIRS as shown on Table 4-5.

Figure 4-3 summarizes the concentrations reported above the screening criteria in the groundwater. BTEX/MTBE and PAHs were not reported above the screening criteria in the five groundwater sampling wells.

4.4.1 Volatile Organic Compounds and Diesel Range Organics Results

TPH-DRO was above the applicable criteria in SPP-GW-05, located south of the SPP (Figure 4-3). BTEX/MTBE were not reported above the screening criteria in the five groundwater sampling wells.

4.4.2 Polycyclic Aromatic Hydrocarbon Results

PAHs were not reported above the screening criteria in the five groundwater sampling wells.

4.4.2.1 Metal Results

Four of the five groundwater wells were impacted with dissolved and total metals as shown on Table 4-5 and Figure 4-3. The background well (SPP-GW-03) detections were below applicable criteria.

Dissolved and total arsenic was reported above screening criteria in SPP-GW-01, SPP-GW-04, and SPP-GW-05, with the highest concentrations recorded at SPP-GW-05. Dissolved and total iron was reported above screening criteria in SPP-GW-01, SPP-GW-02, and SPP-GW-05, with the highest concentrations recorded at SPP-GW-05. SPP-GW-04 reported only total iron above screening criteria at the second highest concentration. Dissolved and total manganese was reported above screening criteria in SPP-GW-01, SPP-GW-02, SPP-GW-04, and SPP-GW-05, with the highest concentrations reported at SPP-GW-05. Total lead was reported above screening criteria in SPP-GW-04.

4.5 SURFACE WATER RESULTS

Table 4-6 summarizes the surface water results in comparison to the screening criteria (DNREC-SIRS Ecological Fresh Surface Water Screening Criteria, January 2015). Samples were analyzed for PAHs by EPA Method 8270C, BTEX/MTBE per EPA Method 8260B, TPH-DRO by EPA Method 8015, total and dissolved TAL metals and mercury by EPA Method 6020A, and cyanide by EPA Method 9012B at the request of DNREC-SIRS as shown on Table 4-6.

Figure 4-4 summarizes the concentrations detected above the applicable criteria in the surface water.

4.5.1 Polycyclic Aromatic Hydrocarbon Results

PAHs were not reported above the screening criteria in the surface water samples.

4.5.2 Volatile Organic Compounds and Diesel Range Organics Results

BTEX/MTBE and TPH-DRO were not reported above the screening criteria in the surface water samples

4.5.3 Metals Results

Total and dissolved aluminum was reported above screening criteria in the five surface water samples. Total barium and aluminum was above applicable criteria in the five surface water samples, and total iron was reported above screening criteria in two of the surface water samples.

4.6 SEDIMENT RESULTS

Ten samples were initially screened for BTEX/MTBE, TPH-DRO, pesticides, PCBs, PAHs, and metals at the DNREC–SIRS New Castle laboratory. The DNREC–SIRS New Castle laboratory screening results as well as the laboratory confirmation results are provided in Appendices E and F.

Based on the screening results, the 10 sediment samples were submitted to the DNREC HSCA-certified laboratory Test America for confirmatory laboratory analysis to confirm the initial screening results for TAL metals, TPH-DRO, BTEX/MTBE, PAHs with phthalates, and aroclors.

Visual impact (visible sheen) was observed at SPP-SD-01 along the north bank of the Nanticoke River. Table 4-7 summarizes the confirmatory sample results from the sediment sampling event.

4.6.1 Metals Results

SPP-SD-03, located on the south bank of the Nanticoke River, reported levels of cobalt, copper, iron, manganese, nickel, and zinc above the screening criteria. SPP-SD-01, located on the north bank of the Nanticoke River, reported levels of lead and zinc above the screening criteria. Additionally, cyanide was reported in SPP-SD-08 above screening criteria.

4.6.2 Volatile Organic Compounds and Diesel Range Organics Results

No results above the MDL were reported for BTEX/MTBE. TPH-DRO was reported at levels ranging from 24 to 790 milligrams per kilogram (mg/kg), with SPP-SD-10 reporting the highest concentration. Figure 4-5 illustrates the locations above the screening criteria.

4.6.3 Polycyclic Aromatic Hydrocarbon Results

Indeno(1,2,3-cd)pyrene was reported above screening criteria in SPP-SD-01, SPP-SD-02, SPP-SD-04, SPP-SD-09, and SPP-SD-10. Acenaphthene, benzo(a)anthracene, chrysene, and pyrene were reported above screening criteria in SPP-SD-01, SPP-SD-02, SPP-SD-03, and SPP-SD-10. 2-methylnaphthalene, fluorine, and phenanthrene were reported above screening criteria in SPP-SD-01, SPP-SD-03, and SPP-SD-10. Anthracene, benzo(a)pyrene, and

benzo(k)fluoranthene were reported above screening criteria in SPP-SD-01 and SPP-SD-10. Fluoranthene was reported above screening criteria in SPP-SD-01, SPP-SD-02, and SPP-SD-10. Dibenz(a,h)anthracene was reported above screening criteria in SPP-SD-02 and SPP-SD-10. Naphthalene was reported above screening criteria in SPP-SD-10.

Additionally, SPP-SD-06 reported levels of benzo(a)anthracene, benzo(a)pyrene, chrysene, indeno(1,2,3-cd)pyrene, and pyrene above screening criteria.

In summary, the three samples along the north and south banks of the Nanticoke River, and the sample furthest downstream reported the greatest PAH impact. Sample SPP-SD-06, located immediately downstream of the bridge, also reported a PAH impact.

4.6.4 Polychlorinated Biphenyl Results

No results above the MDL were reported for PCBs, with the exception of a low detection of trichlorobiphenyl at SPP-SD-01.

4.7 SUB-SLAB SOIL VAPOR RESULTS

Table 4-8 summarizes the soil gas vapor results in comparison to the applicable criteria (DNREC Sub-Slab Gas and Soil Gas Screening Criteria, January 2015).

Benzene and chloroform were reported above the screening criteria in SPP-IA-01 as shown on Figure 4-6.

4.8 SLUDGE RESULTS

Two sludge samples were initially screened for BTEX/MTBE, TPH-DRO, pesticides, PCBs, PAHs, and metals at the DNREC–SIRS New Castle laboratory. The DNREC–SIRS New Castle laboratory screening results as well as the laboratory confirmation results are provided in Appendices E and F.

Based on the screening results, one sludge sample (SPP-SL-01) was submitted to the DNREC HSCA-certified laboratory Test America for confirmatory laboratory analysis to confirm the initial screening results for arsenic, lead, PAHs, and TPH-DRO. SPP-SL-02 was submitted to Test America for confirmatory analysis to confirm the initial screening results for cadmium, arsenic, mercury, lead, cyanide, BTEX/MTBE, TPH-DRO, and PAHs.

Tables 4-1 through 4-4, and Figure 4-6 summarize the confirmatory sample results from the sludge sampling. Sludge samples were compared to the DNREC Soil Screening Criteria, January 2015.

4.8.1 Metals Results

SPP-SL-01 reported levels of arsenic and lead, below screening criteria. For SPP-SL-02, cadmium and lead were reported above screening criteria.

Total arsenic, iron, lead, and manganese were reported above screening criteria for SPP-WW-01. Dissolved arsenic, iron, and manganese were reported above screening criteria for SPP-WW-01. Total antimony, arsenic, and iron were reported above screening criteria for SPP-WW-02.

4.8.2 Volatile Organic Compounds and Diesel Range Organics Results

SPP-SL-01 reported levels of TPH-DRO below screening criteria. For SPP-SL-02, BTEX/MTBE and TPH-DRO were reported below the screening criteria.

BTEX/MTBE were reported below screening criteria for the wastewater samples.

4.8.3 Polycyclic Aromatic Hydrocarbons Results

Benzo(a)pyrene was reported above the screening criteria for PAHs in SPP-SL-01. For SPP-SL-02, 2-methylnaphthalene and benzo(b)fluoranthene were reported above screening criteria.

PAHs were reported below screening criteria for the wastewater samples.

4.9 WASTEWATER RESULTS

Two wastewater samples were collected from accessible areas of the intake/discharge piping. The laboratory confirmation results are provided in Appendix F.

Table 4-5 summarizes the wastewater results in comparison to the screening criteria (DNREC-SIRS Screening Level Table for Groundwater, January 2015). Figure 4-6 summarizes the sample results from the wastewater sampling.

4.9.1 Metals Results

Total beryllium, chromium, cobalt, nickel, selenium, silver, and zinc were reported above screening criteria for SPP-WW-01. Dissolved beryllium, cobalt, nickel, selenium, and zinc were reported above screening criteria for SPP-WW-01. Total antimony, arsenic, and iron were reported above screening criteria for SPP-WW-02.

4.9.2 Volatile Organic Compounds and Diesel Range Organics Results

BTEX/MTBE were reported below screening criteria for the wastewater samples.

4.9.3 Polycyclic Aromatic Hydrocarbons Results

PAHs were reported below screening criteria for the wastewater samples.

5. LIMITED HUMAN HEALTH RISK ASSESSMENT

As part of the FE, sample results were evaluated to determine if there are potential concerns for human contact to site media that may have been affected by past activities. To determine potential human health concerns, a HHRA was performed. The HHRA is a systematic, scientific characterization of the nature and magnitude of potential health risks to humans who may be exposed to chemicals present within the investigation area. The HHRA is an integral part of the RI process included in the National Contingency Plan (40 Code of Federal Regulations [CFR] 300.43) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S. Code 9605); specifically the HHRA follows the methodology and guidance as recommended by the EPA (1989) and DNREC (2015b).

The HHRA evaluates the potential sources of contamination and routes of migration based on current and potential future site uses. The results are based upon exposure pathways that are occurring or are reasonably likely to occur in the future. The HHRA is a baseline evaluation that assumes no remedial actions or other means of exposure reduction (e.g., land use controls). The HHRA evaluates the reasonable maximum exposure that has the potential to occur within the investigation area. As a result, the results are considered potential and should be used as a guideline in making risk management decisions.

5.1 HHRA OBJECTIVES AND APPROACH

The overall objective of this HHRA is to evaluate potential human health risk under current and potential future conditions. Specifically, the HHRA:

- Outlines the regulatory basis and guidance for conducting the HHRA
- Develops a conceptual site model (CSM) that characterizes relevant contaminant pathways and receptors of concern
- Outlines the methods for determining COPC for the HHRA
- Calculates potential carcinogenic and non-carcinogenic risk to receptors of concern (e.g., any human contact at the site under present or future scenarios)
- Identifies areas or media that pose no unacceptable risks to human health and require no further action
- Determines COPC that contribute significantly to overall site risks, which will be used to in risk management decisions for the Site.

The HHRA approach follows the risk assessment methodology and guidance as recommended by the EPA (1989) and DNREC (2015b). Following EPA guidance (1989), the HHRA methodology involves a four-step process: data evaluation and hazard assessment, exposure

assessment, toxicity assessment, and risk characterization. The following guidance documents were used for the overall risk assessment approach within this HHRA:

- Risk Assessment Guidance for Superfund (RAGS), *Volume I: Human Health Evaluation Manual (Part A) (Interim Final),* EPA/540/1-89/002 (EPA 1989)

- RAGS, Volume I: Human Health Evaluation Manual Supplemental Guidance – "Standard Default Exposure Factors" (Interim Final), Publication 9285.6-03 (EPA 1991a)

- RAGS, Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). EPA/540/R-92/003. December. (EPA 1991b)

- *Guidelines for Data Usability in Risk Assessment (Part A).* Office of Solid Waste and Emergency Response (OSWER), Publication OSWER9285.7-09A (EPA 1992)

- RAGS, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments). Office of Emergency and Remedial Response (EPA 2002a)

- *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER 9285.7-53. Office of Emergency and Remedial Response (EPA 2003a)

- RAGS, *Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment)* Final, EPA/540/R/99/005, OSWER 9285.7-02EP, Office of Superfund Remediation and Technology Innovation, July (EPA 2004)

- *Guidelines for Carcinogen Risk Assessment*. Risk Assessment Forum. EPA/630/P-03/001F (EPA 2005a)

- Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part F: Supplemental Guidance for Inhalation Risk Assessment) Final. Office of Superfund Remediation and Technology Innovation, EPA-540-R-070-002 (EPA 2009a)

- *Exposure Factors Handbook, 2011 Edition*. EPA/600/R-090/052F (EPA 2011)

- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. OSWER Directive 9200.1-120. February (EPA 2014)

- *Remediation Standards Guidance under the Delaware Hazardous Substance Cleanup Act*. Revised December 1999 (DNREC 1999)

- *Human Health Risk Assessment Guidance,* Section 9.0 of HSCA, SIRS (DNREC 2015b).

5.2 EXPOSURE SETTING

The SPP is located at 200 South Pine Street in Seaford, Sussex County, Delaware, along the north side of Nanticoke River off of North Front Street (Figure 1-1). The Site is bounded to the north and west by private and commercial properties, to the east by alternate Route 13 (North Front Street), and to the south by the Nanticoke River. The SPP is approximately 1.86 acres. The site consists of a power plant (decommissioned in 2005), associated utilities, and buildings. A majority of the site is currently covered with asphalt. A Riverwalk runs along the southern boundary of the site, beginning west of North Front Street and paralleling the Nanticoke River.

Depth to the water table is approximately 3 ft bgs (ATEC 1994). Local groundwater flow direction has not been established for the Site; groundwater is assumed to flow to the south toward the Nanticoke River. The Site is relatively flat with a 5-10 ft wall along the south side of the Site that drops off to the Nanticoke River. Surface water flows primarily south towards the Nanticoke River. The flow of the Nanticoke River is towards the west along the Site. The Site is located within a flood zone based on the currently available 2005 Sussex County and Incorporated Areas Flood Insurance Rate Map (Federal Emergency Management Agency 2005).

Future use for the Site has not been determined. Based upon the site location along the river, the presence of the Riverwalk, and the close proximity of other recreational sites, future site use is likely recreational. There are no land use restrictions for the Site. However, the location of the Site within the flood zone would result in some restrictions.

5.2.1 Conceptual Site Model

Based upon the exposure setting and current and future land uses, a CSM was developed to identify all complete, potentially complete, or incomplete exposure pathways under both current and reasonably anticipated future land uses. An exposure pathway is the course a chemical or physical agent takes from a source to a receptor. The CSM, Figure 5-1, presents the potential sources of contamination, routes of migration, and receptors evaluated. Pathways begin from potential source areas and progress through the environment via various fate and transport processes to potential human receptors. The pathways may also include a release mechanism (i.e., migration) and a transport medium (i.e., air) if the point of exposure is not at the same location as the source. A completed exposure pathway requires the following four components:

- A source and mechanism of chemical release to the environment
- An environmental transport medium for the released chemical
- A point of potential human contact with the contaminated medium
- A human exposure route at the point of exposure.

All four components must exist for an exposure pathway to be complete and for exposure to occur. Incomplete exposure pathways do not result in actual human exposure and are not included in the HHRA.

5.2.1.1 Source Areas

Primary source areas included USTs, ASTs, and the power plant. Former USTs include a 1,000-gallon gasoline UST, a 1,000-gallon diesel UST, and a 275-gallon gasoline UST. All three tanks were located in the parking area north of the (currently) abandoned substation. The 1,000-gallon USTs were used by the City of Seaford until 1979 when the tanks were removed by Gallo Tanks. It is unknown if the 1,000-gallon USTs were filled in-place or removed, or otherwise abandoned. The 275-gallon gasoline UST was removed in January 1993 by an unknown consultant. Soil in the vicinity of the removed UST was reported to contain up to 310 ppm TPH; however, BTEX were not detected. The exact depth of the soil samples is unknown. There was no record of soil excavation and disposal as part of the UST removal. A GPR survey was conducted across the Site to identify remaining cooling water intake and discharge pipelines between the Nanticoke River and the former power plant. The GPR survey confirmed the presence of five existing cooling water intake and discharge pipelines between the southern edge of the power plant and the Nanticoke River. The GPR survey also identified existing subsurface utilities and verified the location of two removed historic USTs.

The Site also included a 25,000-gallon fuel oil AST, a 150,000-gallon fuel oil AST, and a 500-gallon lubricating oil AST, located north of the power plant, inside a concrete secondary containment pad on Water Street. The Limited Phase II Environmental Site Assessment Report (ATEC 1994) indicated that soil below the ASTs was impacted by TPH, BTEX, and naphthalene in samples collected from 5 ft bgs. A sample collected from one well indicated the presence of TPH in groundwater.

5.2.1.2 Media of Concern

Based upon past site activities and previous investigations, the media of concern include soil, surface water and sediment within the Nanticoke River, and groundwater. The likely migration pathway from the Site to the Nanticoke River is via subsurface cooling water intake/discharge pipes and the associated bedding/fill material from the southern edge of SPP to the river.

5.2.1.3 Exposure Units

Figures 4-1 through 4-6 present the sample locations collected as part of the FE. Soil samples were collected throughout the site. Soil boring locations SPP-01 and SPP-02 were collected to evaluate the area downgradient of the former 25,000-gallon and 150,000-gallon fuel oil ASTs and 500-gallon lubricating oil AST. SPP-03 and SPP-04 were collected to characterize the surface conditions at the western edge of the Site. SPP-05 and SPP-06 were collected to characterize the subsurface conditions in the south-southeast edge of the Site. SPP-07 through SPP-11 were collected to characterize the subsurface soil in the vicinity of the existing cooling water intake/discharge pipelines and the abandoned pipe vaults. SPP-12 was sampled to characterize subsurface soil south of the former transformer area, while SPP-13 and SPP-14 were collected to characterize soil from upgradient of the former power plant building. Based upon the area of the site (1.86 acres) and potential future use, the entire site is considered one exposure unit for soil.

Surface water and sediment samples were collected from the Nanticoke River to determine the potential for contamination from the SPP to the river. Surface water samples were collected from upstream to downstream along the center of the Nanticoke River. Sediment samples SPP-SD-01, SPP-SD-02, and SPP-SD-06 thorough SPP-SD-10 were collected to assess impacts to river-bottom sediment from potential releases from the Site. Sediment sample SPP-SD-05 was a background sample to be collected upstream of the Site. Samples SPP-SD-03 and SPP-SD-04 were collected from the southern bank of the Nanticoke River to determine if releases potentially originating from a southerly fuel dispensing terminal not associated with the SPP have impacted sediment in the river; these samples are also being used for background purposes. Based upon expected human exposures to sediment in the Nanticoke River, only samples results from sediment locations SPP-SD-01 and SPP-SD-02 were considered available for human contact because these sediment sample locations are along the riverbank of the Nanticoke River. All other sediment sample locations were located in deeper portions of the Nanticoke River in which human receptors are not expected to contact. All surface water sample locations were evaluated in the HHRA.

In addition, two sludge samples and two wastewater samples were collected from the discharge pipes that discharge to the Nanticoke River. These samples were evaluated along with the surface water and sediment sample results due to their direct discharge to the river. Therefore, all surface water samples in the Nanticoke River and wastewater samples within the piping were considered an exposure unit for surface water. The exposure unit for sediment included only those sediment sample locations along the Nanticoke riverbank and sludge samples within the piping. The sludge within the pipelines would only be exposed in instances of excavation or removal from the subsurface.

5.2.1.4 Receptors of Concern

Within the exposure assessment, EPA (1989) and DNREC (2015b) guidance require that plausible exposure under both current and future land use be evaluated in the HHRA. Accordingly, potential receptors are identified for both current and future use. The HHRA evaluates the risk to a range of onsite human receptor populations that are either currently or reasonably anticipated to be exposed to site-related constituents based upon current land use, adjacent land use, and reasonably anticipated future land use.

Currently, the site is not in use. Current receptors only include workers who maintain the site and members of the public traversing the Riverwalk. Future use for the site has not been determined. The site could be used for recreational uses, commercial/industrial uses, or unrestricted uses. As a result, future receptors include commercial workers, outdoor workers, and recreational users. A composite worker is also a possibility at the site. A composite worker is a worker who may work within the site buildings and also perform shallow digging or other subsurface activities at the site. Excavation/construction workers are also expected at the site based on the potential for removal and construction of site structures or utilities. Residents are not expected as future users of the site. However, the resident is evaluated to determine if an unrestricted site use is a possibility for the Site.

Typically, recreational users, commercial workers, and composite workers are not expected to contact soil at depths (i.e., greater than 1 or 2 ft bgs). Because the future use of the site is not known and buildings at the site may be removed in the future, it is expected that subsurface soil at the site may be brought to the surface and mixed with surface soil. As a result, all receptors are assumed to contact both surface and subsurface soil.

For the quantitative evaluation of potential risks, only the resident, adolescent recreational user, composite worker, and indoor (commercial) worker were evaluated based upon expected rates of contact. These receptors also evaluate a range of ages for receptors from child to adult. The resident is expected to have the highest rates of contact and represents an unrestricted site use. A resident also evaluates an adult and a child age range. Recreational users at the site could range from child to adult. Actual site contact for a child recreational user is expected to be minimal. An adolescent recreational user represents an age range that would have high contact with the site and is a high probability for the Site. For the worker scenario, the composite worker represents a worker with the highest contact to site media.

5.2.1.5 Complete Exposure Pathways

Based upon the CSM, complete exposure pathways exist for exposure to all impacted site media. For all potential receptors, the following complete exposure pathways were identified:

- Ingestion of, dermal contact with, and inhalation of particulates from soil
- Ingestion of and dermal contact with sediment
- Ingestion of and dermal contact with surface water.

5.3 HHRA METHODOLOGY

5.3.1 Data Evaluation and Hazard Assessment

In the data evaluation and hazard assessment, all soil, sediment, and surface water samples collected for the FE investigation were compiled and reviewed. The Site environmental data were analyzed for data quality and compared to risk-based screening values. The comparison to risk-based screening values allows the HHRA to focus on analytes that may contribute significantly to overall Site risks. Analytes that are below risk-based screening values do not require further evaluation. Chapter 3 contains a detailed discussion of sampling that occurred within the SPP, including the number of samples collected for each media.

5.3.2 Data Quality Evaluation

Data quality is evaluated through the use of analytical qualifiers. The inclusion or exclusion of data within the HHRA on the basis of analytical qualifiers was performed in accordance with EPA guidance (EPA 1989 and 1992). Analytical qualifiers were applied by the analytical laboratory. The following procedures were followed if qualifiers were present:

- Analytical results bearing the "U" qualifier (indicating that the analyte was not detected at the given reporting limit) were retained in the data set and considered non-detects at the given reporting limit.

- Analytical results bearing the "J" qualifier (indicating that the reported value was estimated because the analyte was detected at a concentration below the reporting limit or for other reasons) were retained at the reported concentration.

- Analytical results bearing the "D" qualifier (indicating that the analytes were analyzed at a secondary dilution factor) were retained at the reported concentration.

- Analytical results bearing the "F1" qualifier (indicating that the MS and/or MSD recovery exceeded control limits) were retained at the reported concentration.

For duplicate samples collected from the same sample location on the same date, the following guidelines were employed to select the appropriate sample measurement:

- If both samples show that the analyte was present, the maximum concentration of the two detected concentrations was retained for analysis.

- If both samples were not detected, the maximum of the two non-detect reporting limits were retained for analysis.

- If only one sample indicated that the analyte was present, it was retained for analysis and the non-detect value was discarded.

Laboratory QC samples, spikes, and blanks were not included in the HHRA. If a given analyte was not detected in any sample in an environmental medium, the analyte was not considered further.

5.3.3 Risk-Based Screening

After the data quality evaluation, detected analytes are subject to a risk-based screening to determine COPCs. Risk-based screening was conducted by comparing maximum detected analyte concentrations to risk-based screening concentrations. Any analyte in any medium, in which the maximum measured concentration exceeded the risk-based screening concentration was retained as a COPC. The DNREC Screening Levels (SLs) (DNREC 2015c) were used as the Applicable or Relevant and Appropriate Requirements screening concentrations for the determination of COPCs.

For soil, sludge, and sediment, the DNREC SLs for soil were used as the risk-based screening criteria (DNREC 2015c). For surface water and wastewater, site-specific screening levels were determined through the use of the Risk Assessment Information System (RAIS). Exposure parameters for a recreational user were taken from DNREC guidance (2015b) and input into the RAIS preliminary remediation goal calculator. The site-specific surface water screening criteria

assumed ingestion of and dermal contact with surface water for 75 days per year for 2 hours per day. Dermal contact assumes full body contact through swimming. Outputs from the RAIS calculator are provided in Appendix G. The more conservative of the two receptors were used as screening concentrations for the surface water and wastewater media.

Note sediment and surface water were screened separate from wastewater and sludge to ensure that the combination of these media was appropriate as an exposure unit.

5.3.4 Analytes Exceeding Risk-Based Screening Levels

The occurrence, distribution, and selection of COPCs are represented in medium-specific tables following the RAGS D format (EPA 2002a). Tables 5-1 through 5-6 present the risk-based screening results. The tables present the minimum and maximum detected concentrations, the location of the maximum detected concentrations, as well as the frequency of detection for each chemical detected. Analytes that exceed screening criteria are highlighted and presented in bold type.

The following COPCs were identified in surface soil (Table 5-1): benzo(a)pyrene and TPH-DRO.

The following COPCs were identified in subsurface soil (Table 5-2): arsenic, benzo(a)pyrene, 2-methylnaphthalene, benzene, and TPH-DRO.

No COPCs were identified in surface water (Table 5-3).

The following COPCs were identified in sediment (Table 5-4): cobalt, benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene.

The following COPCs were identified in sludge (Table 5-5): cadmium, lead, benzo(a)pyrene, and benzo(b)fluoranthene.

The following COPC was identified in wastewater (Table 5-6): arsenic.

It is noted that the COPCs within surface soil are similar to subsurface soil, even though more COPCs were determined in subsurface soil. Due to the potential construction across the site and the level of analytes detected in both surface soil and subsurface soil, these two datasets were combined to represent potential soil contact for all receptors across the site.

No COPCs were determined in surface water, and only arsenic was determined as a COPC in wastewater. Arsenic was not detected in surface water samples. Due to the low number of detects for arsenic in water (only two detects), arsenic in wastewater was evaluated qualitatively in the Section 5.7.3, Uncertainty Section.

5.4 EXPOSURE ASSESSMENT

In the exposure assessment, the human population, or groups of individuals potentially exposed to Site media (i.e., potential human receptors) are identified. Pathways applicable to potential receptors at the site are identified from the many potential pathways of exposure. The CSM, Figure 5-1, presents the potential receptors identified for the Site, as well as complete exposure pathways.

Based upon the complete exposure pathways, the COPC in Site media are converted into systemic doses, taking into account rates of contact (e.g., ingestion rates) and absorption rates of different COPCs. The magnitude, frequency, and duration of these exposures are then integrated to obtain estimates of daily doses over a specified period of time (e.g., lifetime, activity-specific duration).

5.4.1 Exposure Point Concentration

For soil and sediment, site receptors are assumed to contact these media randomly over an exposure time, so COPC concentrations are represented by a conservative estimate of the average concentration of the COPCs within the area of investigation. The COPC concentrations are represented by the 95th percentile upper confidence limit on the mean (95%UCL), which represents a conservative estimate of the average concentration. The 95%UCL represents the concentration of a COPC in media that a potential receptor is expected to contact over a designated exposure period. The 95%UCL is used because assuming long-term contact with the maximum concentration is not reasonable (EPA 1989). While the ProUCL manual notes that a sufficient sample size is generally 10 samples, ProUCL will calculate statistics on sample sizes less than 10. The ProUCL outputs only note that the sample size is small (i.e., <10) but does not detail that the results should not be used. For COPCs with a low number of detects (i.e., less than 4) (EPA 2013), the maximum detected concentration was used as the exposure point concentration (EPC) in order to determine the most conservative impact (EPA 1989).

The 95%UCL was determined through the EPA ProUCL program version 5.0.00 (EPA 2013). The EPA ProUCL program determines the distribution, sample size, variance, and 95%UCL of the COPC data set (EPA 2013). Tables 5-7 and 5-8 present the EPCs selected for soil and sediment. Appendix G presents the outputs from the ProUCL program.

5.4.2 Exposure Intake Equations

The next step in the exposure assessment is to estimate COPC intake or exposure for each complete exposure pathway considered in the HHRA. In the exposure assessment, two different measures of intake are provided, depending on the nature of the effect being evaluated. When evaluating longer-term (i.e., chronic) exposures to chemicals that produce adverse non-carcinogenic effects, intakes are averaged over the period of exposure (i.e., the averaging time) (EPA 1989). This measure of intake is referred to as the average daily intake (ADI) and is a less than lifetime exposure. For chemicals that produce carcinogenic effects, intakes are averaged over an entire lifetime and are referred to as the lifetime ADI (EPA 1989). Detailed equations for determining intake are provided on Tables 5-9 through 5-16. Most exposure

parameters used to estimate intakes are based on default assumptions described in EPA (1989, 1991a, 1991b, 2004, 2009a, 2011, and 2014) and DNREC (2015b) guidance documents.

Intake for the incidental ingestion of soil and sediment was estimated using the following equation:

$$(L)ADI = \frac{EPC \; x \; IR \; x \; EF \; x \; ED \; x \; CF}{BW \; x \; AT}$$

where:

(L)ADI	=	(Lifetime) Average daily intake (mg/kg-day)
EPC	=	Concentration of a COPC in soil or sediment (mg/kg)
CR	=	Ingestion Rate (milligrams per day [mg/day])
EF	=	Exposure frequency (days per year [days/year])
ED	=	Exposure duration (years)
CF	=	Conversion Factor (10^{-6} kilograms per milligrams [kg/mg])
BW	=	Body weight (kilogram [kg])
AT	=	Averaging time (days) For non-carcinogens, AT = ED × 365 days/year For carcinogens, AT = 70 years × 365 days/year

Exposure associated with dermal contact with soil and sediment was estimated based upon the following equation:

$$(L)ADI = \frac{EPC \; x \; SA \; x \; AF \; x \; ABS \; x \; EF \; x \; ED \; x \; CF}{BW \; x \; AT}$$

where:

(L)ADI	=	(Lifetime) Average daily intake (mg/kg-day)
EPC	=	Concentration of a COPC in soil (mg/kg)
SA	=	Surface Area for Contact (square centimeter [cm^2])
AF	=	Skin adherence factor (milligrams per square centimeter [mg/cm^2]-event)
ABS	=	Absorption factor (dimensionless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
CF	=	Conversion Factor (10^{-6} kg/mg)
AT	=	Averaging time (days) For non-carcinogens, AT = ED × 365 days/year For carcinogens, AT = 70 years × 365 days/year

For inhalation, exposure concentrations (ECs) were calculated. ECs are time-weighted average concentrations from contaminant concentrations in air, adjusted based on the characteristics of the exposure scenario being evaluated.

$$EC = \frac{EPC \; x \; ET \; x \; EF \; x \; ED \; x \; CF_1}{AT \; x \; CF_2}$$

where

EC	=	Exposure Concentration (milligrams per cubic meter [mg/m^3])
EPC	=	Concentration of a COPC in air (mg/m^3) EPC (for residential exposure) = VOC COPC concentration in air, COPC concentration in ground water (milligram per liter [mg/L]) × K
K	=	Andelman Volatilization Factor (0.5 liters per cubic meter)
ET	=	Exposure Time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
AT	=	Averaging time (days) For non-carcinogens, AT = ED × 365 days/year For carcinogens, AT = 70 years × 365 days/year
CF_1	=	Conversion Factor (10^3 micrograms per milligram) (for carcinogenic intakes only).
CF_2	=	Conversion Factor (24 hours per day).

5.4.3 Selection of Exposure Parameters

All exposure factor values used in estimating intakes were developed based on current EPA guidance and best professional judgment for the site. Tables 5-9 through 5-16 present the exposure parameters. The following guidance documents were used in defining exposure parameters for estimating intakes for exposure pathways evaluated:

- *Risk Assessment Guidance for Superfund Volume I Human Health Evaluation Manual Part A*, December 1989 (EPA 1989)

- *Memorandum: Risk Assessment Guidance for Superfund Volume I-Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"*. Publication 9285.6-03, March 25, 1991 (EPA 1991a)

- *Exposure Factors Handbook: 2011 Edition*. EPA/600/R-09/052F, September 2011 (EPA 2011)

- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment, Final Guidance*. OSWER 9285.7-02EP, July 2004 (EPA 2004)

- *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Part F, Supplemental Guidance for Inhalation Risk Assessment.* Final. OSWER 9285.7-82, January 2009 (EPA 2009a)

- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors*. OSWER 9200.1-120. February 2014 (EPA 2014)

- Regional Screening Levels for Superfund Sites, User's Guide. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm. (EPA 2015a)

- *Human Health Risk Assessment Guidance,* Section 9.0 of HSCA, SIRS (DNREC 2015b).

Two age groups were considered for the residential scenario: adult and child. The resident child represents the age range from birth to 6 years of age (EPA 1989). Although adults are typically assumed at an age range of greater than 16 years of age, the resident adult is evaluated for a long-term exposure typical of residents (EPA 1991b). Residents are typically assumed to have a duration of 26 years, so the resident adult spans the age range from 7 to 20 years beyond childhood (EPA 1991a). This health-protective approach is set forth by the EPA to account for the higher daily rates of soil ingestion in children (EPA 1991b).

5.4.3.1 Soil Exposure Parameters

Resident Adult and Child

Exposure parameters for the resident exposure to soil are presented on Tables 5-9 and 5-10. Complete soil exposure pathways for the resident include incidental ingestion, dermal contact with, and inhalation of particulates from soil. The resident adult was assumed to weigh 80 kg and be exposed for a 20-year duration at a frequency of 350 days/year (EPA 2011 and 2014; DNREC 2015b). This frequency assumes two weeks are spent away from the residence per year. The resident child was assumed to weigh 15 kg and be exposed for 6 years at a frequency of 350 days/year (EPA 1989, 2014, and 2015a; DNREC 2015b). The resident adult was assumed to ingest 100 milligrams (mg) of soil per day, and the resident child is assumed to consume 200 mg/day (EPA 2015a). For dermal contact, soil exposures are limited to unclothed body parts. For the resident adult, the recommended surface area is 6,032 cm^2 based upon contact with the head, hands, forearms, lower legs, and feet (EPA 2014). For the resident child, the skin surface area available for contact is 2,373 cm^2, based on the mean surface area for the head, hands, forearms, lower legs, and feet (EPA 2015a).

Recreational User

Exposure parameters for the recreational user exposure to soil are presented on Table 5-11. Complete soil exposure pathways for the recreational user include incidental ingestion, dermal contact with, and inhalation of particulates from soil while visiting the site. The recreational user is assumed an adolescent from 6 to 16 years of age. It is assumed that the recreational user will visit the Site for 75 days/year based upon DNREC guidance (2015b). Specific soil ingestion rates for recreational users playing sports activities are not available, but the total soil ingestion rate used for the 6- to 16-year age range and adult is 100 mg/day (EPA 2015a), which takes into account both indoor and outdoor activities. Because the recreational user may have high contact with the area, it is conservatively assumed that 100% of the daily fraction of soil ingested is from the site.

For dermal contact with soil, the recreational user skin surface area available during dermal contact is estimated. For the adolescent recreational user, from Table 7-17 of EPA 2011 Exposure Factors Handbook (EFH), which identifies the percentage of exposed skin surface available during warm weather activities for 5- to 17-year olds in organized team sports as 29% (EPA 2011). The percentage of exposed skin is multiplied by the skin surface area from Table 7-9 of EPA 2011 EFH (EPA 2011). The total skin surface area for a 6- to 16-year old is estimated as the average of two age ranges presented in Table 7-9 of EPA 2011 EFH that notes a total skin surface area of 10,500 cm^2 for ages 6 to <11 years of age and 15,700 cm^2 for ages 11 to <16 years of age for males and females combined. The adherence factor (AF) for soil to skin is 0.4 mg/cm^2 based upon a range presented in the EPA 2011 EFH for a child playing in dry soil. For inhalation exposures, the recreational user is assumed to spend 1 hour at the site each time they visit (DNREC 2015b).

Composite Worker

Exposure parameters for the worker exposure to soil are presented on Table 5-12. Complete soil exposure pathways for the composite worker include incidental ingestion, dermal contact with, and inhalation of particulates from soil. The duration of exposure to the Site is assumed for 25 years (DNREC 2015b). The frequency of soil contact was estimated at 5 days per week for 50 weeks for a total of 250 days (EPA 1991a and DNREC 2015b). A composite worker represents a worker who works within the site buildings and may also contact soil through digging. As a result, the soil ingestion rate was assumed at a higher rate similar to a construction worker at approximately 330 mg/day (EPA 2002a). It is expected that workers would wear work clothing (i.e., short-sleeved shirt, long pants, and boots) that limits the exposed skin surface areas to the head, hands, and forearms. The recommended skin surface area for the worker is 3,527 cm^2, based on the mean surface area for males and females 21 years of age or greater (EPA 2015a).

Indoor Worker

Exposure parameters for the indoor worker exposure to soil are presented on Table 5-13. Complete soil exposure pathways for the indoor worker include incidental ingestion, dermal contact with, and inhalation of particulates from soil. The duration of exposure to the Site is assumed for 25 years (DNREC 2015b). The frequency of soil contact was estimated at 5 days per week for 50 weeks for a total of 250 days (EPA 1991a and DNREC 2015b). An indoor worker represents a worker who works within the site buildings and has limited contact with soil. As a result, the soil ingestion rate is relatively low at 50 mg/day (EPA 2015a). It is expected that workers would wear work clothing (i.e., short-sleeved shirt, long pants, and boots) that limits the exposed skin surface areas to the head, hands, and forearms. The recommended skin surface area for the worker is 3,527 cm^2, based on the mean surface area for males and females 21 years of age or greater (EPA 2015a).

5.4.3.2 Sediment Exposure Parameters

Residents and Recreational Users

Exposure parameters for the resident exposure to sediment are presented on Tables 5-14 and 5-15. Exposure parameters for the recreational user exposure to sediment are presented on Table 5-16. Complete exposure pathways for sediment include incidental ingestion of and dermal contact with. Due to the wet conditions of sediment, inhalation of particulates from wind is not expected. Exposure to sediments within the Nanticoke River is expected to be similar for the resident and the recreational user. Ingestion of sediment was assumed at half the rate of soil. For exposure frequency, the number of days at the Site for a recreational user (i.e., 75 days/year) was assumed for both the resident and recreational user exposure to sediments (DNREC 2015b). Dermal contact with sediment for both the resident and recreational users is assumed similar to soil. To determine the sediment ingestion rate, half of the soil ingestion rates were used.

Composite Worker

Exposure parameters for the worker exposure to sediment are presented on Table 5-17. Complete exposure pathways for sediment include incidental ingestion of and dermal contact with. Due to the wet conditions of sediment, inhalation of particulates from wind is not expected. Similar to the resident and recreational user, the exposure parameters for the worker exposure to sediment are similar to soil. However, the exposure frequency was reduced to 52 days/year to account for reduced exposures to sediment in comparison to soil.

5.5 TOXICITY ASSESSMENT

The toxicity assessment considers the types of potential adverse health effects associated with exposures to COPCs, the relationship between the magnitude of exposure and potential adverse effects, and related uncertainties, such as the weight of evidence of a particular COPC's carcinogenicity in humans. EPA guidance (EPA 1989) specifies that the assessment be accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether studies claim that exposure to a COPC may cause the incidence of an adverse effect. EPA specifies the dose-response assessment, which involves: 1) EPA's quantitative evaluation of the existing toxicity information, and 2) EPA's characterization of the relationship between the dose of the COPC administered or received, and the incidence of potentially adverse health effects in the exposed population. From this quantitative dose-response relationship, specific toxicity values are derived by EPA that can be used to estimate the incidence of potentially adverse effects occurring in humans at different exposure levels (EPA 1989).

Toxicity values are selected in keeping with appropriate exposure duration and EPA guidance (EPA 1989 and 2003a). Tier 1 values are found using the Integrated Risk Information System (IRIS) (EPA 2015b) for established, current values. When toxicity values are not available from IRIS, Tier 2 values are then examined.

Tier 2 values are EPA's Provisional Peer Reviewed Toxicity Values, which are developed by the Office of Research and Development, the National Center for Environmental Assessment, and the Superfund Health Risk Technical Support Center on a chemical-specific basis when requested by the Superfund program.

Tier 3, other toxicity values, are considered when Tier 1 or Tier 2 toxicity values are not available. These toxicity values are taken from additional EPA and non-EPA sources and are chosen based on the most current and best peer-reviewed source available. The California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment Cancer Potency Values (CalEPA 2009), the CalEPA Reference Exposure Limits (CalEPA 2015), and the Agency for Toxic Substance and Disease Registry (ATSDR) Minimal Risk Levels (ATSDR 2014) are the Tier 3 sources utilized for this HHRA.

5.5.1 Toxicity Assessment for Non-Carcinogens

The methodology used by EPA for deriving non-cancer reference values for non-carcinogens and site-specific considerations for modifying or using these concentrations are discussed in detail in EPA guidance (EPA 2015b). Non-carcinogens are typically judged to have a threshold daily dose below which deleterious or harmful effects are unlikely to occur. This concentration is called the no-observed-adverse-effect-level (NOAEL), and may be derived from either animal laboratory experiments or human epidemiology investigations (usually workplace studies). In developing a toxicity value or human NOAEL for non-carcinogens [i.e., a reference dose (RfD)], the regulatory approach is to (1) identify the critical toxic effect associated with chemical exposure (i.e., the most sensitive adverse effect), (2) identify the threshold dose in either an animal or human study, and (3) modify this dose to account for interspecies variability (where appropriate), differences in individual sensitivity (within-species variability), and other uncertainty factors (UFs).

UFs are intended to account for specific types of uncertainty inherent in extrapolation from the available data. The UFs are generally 10-fold, default factors used in operationally deriving the RfD and reference concentration (RfC) from experimental data. UFs less than 10 can be used. A UF of 3 can be used in place of one-half power ($10^{0.5}$) when appropriate. The UFs are intended to account for (1) variation in susceptibility among the members of the human population (i.e., inter-individual or intraspecies variability), (2) uncertainty in extrapolating animal data to humans (i.e., interspecies uncertainty), (3) uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure), (4) uncertainty in extrapolating from a lowest-observed-adverse-effect-level rather than from a NOAEL, and (5) uncertainty associated with extrapolation when the database is incomplete. The maximum UF for the derivation of the RfC is 3,000. The theoretical maximum UF for the derivation of the RfD is 10,000. However, the total uncertainty factors applied to an RfD is generally limited to 3,000.

The use of these factors is a conservative approach for protection of human health and is likely to overestimate the toxic potency associated with chemical exposure. The RfDs and RfCs provided in this HHRA take into account the associated uncertainty factors identified by EPA. To

calculate the RfD/RfC, the appropriate NOAEL is divided by the product of all the applicable UFs and the modifying factor (MF).

This is expressed as:

$$RfD/RfC = NOAEL / (UF_1 \times UF_2 \ldots \times MF)$$

The resulting RfD is expressed in units of mg of chemical per kg of body weight per day (mg/kg-bw/day). The RfC is expressed in units of mg/m^3. Table 5-18 presents the oral/dermal non-carcinogenic RfDs for COPC, and Table 5-19 presents the inhalation RfCs for site COPCs.

5.5.2 Toxicity Assessment for Carcinogenicity

Unlike non-carcinogens, carcinogens are generally assumed to have no threshold. There is presumed to be no level of exposure below which carcinogenic effects will not manifest themselves. This "non-threshold" concept supports the idea that there are small, finite probabilities of inducing a carcinogenic response associated with every level of exposure to a potential carcinogen. EPA uses a two-part evaluation for carcinogenic effects. This evaluation includes the assignment of a weight-of-evidence classification and the quantification of a cancer toxic potency concentration. Quantification is expressed as a slope factor (SF) or an inhalation unit risk (IUR), which reflects the dose-response data for the carcinogenic endpoint(s) (EPA 2015b).

The SF and the IUR are the upper 95^{th} percentile confidence limit of the probability of response per unit daily intake of a chemical over a lifetime. Typically, the SF and IUR are used to estimate the upper-bound lifetime probability of a person developing cancer from exposure to a given concentration of a carcinogen. SFs and IURs are generally based on experimental animal data, unless suitable epidemiological studies are available. Because of the difficulty in detecting and measuring carcinogenic endpoints at low exposure concentrations, SFs and IURs are typically developed by using a model to fit the available high-dose, experimental animal data, and then extrapolating downward to the low-dose range to which humans are typically exposed. EPA recommends the linear multistage model to derive an SF and IUR. The model is conservative and provides an upper bound estimate of excess lifetime cancer risk.

EPA has also established five recommended standard hazard descriptors:

- "*Carcinogenic to Humans*"
- "*Likely to Be Carcinogenic to Humans*"
- "*Suggestive Evidence of Carcinogenic Potential*"
- "*Inadequate Information to Assess Carcinogenic Potential*"
- "*Not Likely to Be Carcinogenic to Humans*" (EPA 2005a).

The weight-of-evidence classification is based on a thorough scientific examination of the body of available data.

Because the revised cancer guidelines (EPA 2005a) are not yet incorporated into many of the IRIS chemical profiles, the weight-of-evidence classifications defined by the EPA (EPA 1986a and 1989) and shown in the toxicity profiles on the IRIS system will still be used when interpreting carcinogenic toxicity of COPC. The weight-of-evidence classification system assigns a letter or alphanumeric (A through E) to each potential carcinogen that reflects an assessment of its potential to be a human carcinogen (EPA 1986a). The weight-of-evidence classification that will be used in the HHRA is defined as follows:

- Group A: Known human carcinogen
- Group B: Probable human carcinogen
- Group B1: Limited evidence of carcinogenicity in humans
- Group B2: Sufficient evidence in animals, but inadequate evidence in humans
- Group C: Possible human carcinogen (limited evidence of carcinogenicity in animals in the absence of human data)
- Group D: Human carcinogenicity not classifiable because of lack of data
- Group E: Evidence of non-carcinogenicity in humans (no evidence in at least two adequate animal tests in different species or in both epidemiological and animal studies).

Table 5-20 presents the oral/dermal carcinogenic SFs for COPCs, and Table 5-21 presents the inhalation IURs for site COPCs.

COPCs that are determined to have sufficient weight-of-evidence for carcinogenic endpoints are also assessed for mutagenic modes of action. The mutagenic mode of action is assessed with a linear approach (EPA 2005a). COPCs identified as mutagenic have sensitivity pertaining to cancer risks associated with early-life exposures. To account for the early-life exposure and the mutagenic mode of action, the cancer potency estimates are adjusted. EPA recommends, for mutagenic chemicals, when no chemical-specific data exist, a default approach using estimates from chronic studies (i.e., cancer slope factors) with appropriate modifications to address the potential for differential risk of early-life stage exposure (EPA 2005b and 2005c). A modification for early-life stage exposure to mutagenic COPCs is required because available studies indicate higher cancer risks resulting from a given exposure occurring early in life when compared with the same amount of exposure during adulthood (EPA 2005b). For this HHRA, the carcinogenic intakes for COPCs identified with a mutagenic mode of action (i.e., PAHs) are modified for the following (EPA 2005c):

- For exposures before 2 years of age (i.e., spanning a 2-year time interval from the first day of birth up until a child's second birthday), a 10-fold adjustment.

- For exposures between 2 and <16 years of age (i.e., spanning a 14-year time interval from a child's second birthday up until their sixteenth birthday), a 3-fold adjustment.

- For exposures after turning 16 years of age, no adjustment.

For this HHRA, the adolescent site user and resident adult and child are within the age range that requires adjustment for a mutagenic mode of action. As noted in Section 5.4.3, two age groups are considered for the residential scenario, an adult and a child. The age group for the child is assumed at 0 to 6 years. The resident adult is evaluated from an age range of 7 to 26 years old (EPA 1991b). Although adults are typically assumed at an age range of greater than 16 years of age, the resident adult is evaluated for a long-term exposure typical of residents (EPA 1991b). Residents are typically assumed at a duration of 26 years, so the resident adult spans that 7 to 26 years beyond childhood (EPA 1991a). Therefore, both the resident child and the resident adult require an adjustment for potential mutagenic modes of action.

5.5.3 Modifications for Dermal Contact

While the toxicity assessment for dermal contact is based on the oral toxicity and intake assessment methodology, two significant modifications are applied. The dermal dose is adjusted to reflect absorption through the skin surface. Additionally, toxicity values specific to dermal exposures are not available. Table 5-22 presents the inputs used for dermal exposures.

Adjustment of the oral toxicity values (oral RfDs or SFs) is used to represent dermal toxicity. This adjustment accounts for the difference between the daily intake dose through dermal contact as opposed to ingestion. Most toxicity values are based on the actual administered dose and must be corrected for the percent of chemical-specific absorption that occurs across the gastrointestinal tract prior to use in dermal contact risk assessment (EPA 1989 and 2004). EPA recommends utilizing oral absorption efficiency factors in converting oral toxicity values to dermal toxicity values (EPA 2004). This adjustment accounts for the absorption efficiency in the "critical study," which is utilized in determining the RfD and SF. Where oral absorption in the critical study is essentially complete (i.e., 100%), the absorbed dose is equivalent to the administered dose, and no adjustment of oral toxicity values is necessary when evaluating dermal exposures. When gastrointestinal absorption of a chemical in the critical study is poor (e.g., 1%), the absorbed dose is much smaller than the administered dose, and toxicity values for dermal exposure are adjusted to account for the difference in the absorbed dose relative to the administered dose. To account for the differences between the administered (oral) and the absorbed (dermal) dose, RfDs and SFs are modified by the gastrointestinal dermal absorption factor (GIABS). The chemical-specific parameters utilized in assessing dermal exposure, GIABS and dermal absorption factor (ABS) are selected from the EPA dermal guidance (EPA 2004).

Dermal contact rates are also evaluated based upon a chemical's ability to be absorbed through the skin surface. This absorption rate is dependent upon the medium evaluated. For soil, EPA has identified an ABS that is chemical-specific. The ABS value reflects the desorption of a chemical from soil and the absorption of the chemical across the skin and into the blood stream. Recommended values are presented that take into account ranges of values that result from

different soil types, loading rates, chemical concentrations, and other conditions. ABS values for sediment are not available. The EPA recommends the use of the soil ABS values to account for dermal exposures to sediment (EPA 2004).

5.6 RISK CHARACTERIZATION

In risk characterization, the calculated chemical intakes and toxicity values are used to quantitatively estimate both carcinogenic and non-carcinogenic risks. Risks are calculated for each potential receptor.

5.6.1 Hazard Index for Non-Carcinogenic Effects

The potential human health risks associated with exposures to non-carcinogenic COPC are calculated by comparing the ADI with the chemical-specific RfD, as per EPA Guidance (EPA 1989). A hazard quotient (HQ) is derived for each COPC, as shown in the equation below:

$$HQ = \frac{EC}{RfC} \qquad or$$

$$HQ = \frac{ADI}{RfD}$$

where:

HQ	=	Hazard Quotient; ratio of average daily intake level to acceptable daily intake level (unitless)
EC	=	Exposure Concentration (micrograms per cubic meters [$\mu g/m^3$])
ADI	=	Calculated non-carcinogenic average daily intake (mg/kg-day)
RfD	=	Reference dose (mg/kg-day)
RfC	=	Reference concentration (mg/m^3)

If the average daily dose exceeds the RfD or RfC, the HQ will exceed a ratio of one (1.0) and there may be concern that potential adverse systemic health effects will be observed in the exposed populations. If the ADI does not exceed the RfD or the RfC, the HQ will not exceed 1.0 and there will be no concern that potential adverse systemic health effects will be observed in the exposed populations. In general, the greater the value of the HQ above 1.0, the greater the level of concern. However, the HQ does not represent a statistical probability that an adverse health effect will occur.

For consideration of exposures to more than one chemical causing systemic toxicity via several different pathways, the individual HQs are summed to provide an overall hazard index (HI). If the HI is less than 1.0, then no adverse health effects are likely to be associated with exposures at the site. However, if the total HI is greater than 1.0, separate endpoint-specific HIs may be calculated based on toxic endpoint of concern or target organ (e.g., HQs for neurotoxins are summed separately from HQs for renal toxins). Only if an endpoint-specific HI is greater than 1.0 is there reason for concern about potential health effects for that endpoint.

5.6.2 Carcinogenic Risks

Carcinogenic risk is calculated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The numerical estimate of excess lifetime cancer risk is calculated by multiplying the lifetime ADI by the risk per unit dose (the SF).

This is shown in the following equation:

$$Risk = LADI \times SF \quad \text{or}$$
$$Risk = EC \times IUR$$

where:

Risk	=	Unitless probability of an exposed individual developing cancer
LADI	=	Lifetime cancer average daily intake (mg/kg-day)
SF	=	Cancer slope factor $(mg/kg\text{-}day)^{-1}$
EC	=	Exposure Concentration $(\mu g/m^3)$
IUR	=	Inhalation Unit Risk $(\mu g/m^3)^{-1}$

Because the SF and the IUR are the statistical 95th percent upper-bound confidence limit on the dose-response slope, this method provides a conservative, upper-bound estimate of risk.

It should be noted that the interpretation of the significance of the cancer risk estimate is based on the appropriate public policy. EPA in the National Contingency Plan (40 CFR Part 300) (EPA 1990) states that:

> "*...For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}.*"

5.6.3 Special Chemicals: Lead

Lead, identified as a COPC in sludge, is classified as a B2-probable human carcinogen. However, the EPA has not published a SF or IUR for quantifying carcinogenic risks. Additionally, the EPA has not set forth a threshold value for lead to develop an RfD. As a result, blood-lead levels are the indicator of excess lead exposure in humans. For comparison of risk purposes, modeled blood level results are compared to the established cutoff value or acceptable blood-lead threshold of 10 micrograms (µg) lead/deciliter for children. This is the level that the EPA and Center for Disease Control have considered presents a risk to children's health. Lead is only considered a COPC in sludge, which was evaluated with sediment samples. The EPA has not set forth a blood-lead model to evaluate lead concentrations in sediment. As a result, the average concentration of lead was compared to the DNREC SL of 400 mg/kg, which is protective of children.

5.6.4 Risk Characterization Results

The tables present the calculations for non-carcinogenic hazards and carcinogenic risks and estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects. Calculations are presented by receptor in Tables 5-23 through 5-27. Table 5-28 presents the calculation for particulate concentrations.

Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects are presented in Tables 5-29 through 5-32. If cumulative non-carcinogenic hazards are greater than 1.0, a breakdown by target organ is provided.

5.6.4.1 Residents

Residents were evaluated for exposure to soil and sediments. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for the resident are presented in Table 5-29.

Non-Carcinogenic Results

The total non-carcinogenic HI for adult resident is 0.1, which is below the acceptable threshold of 1 (Table 5-29). The non-carcinogenic HI for exposure to soil is 1 and for exposure to sediment is 0.02.

The total non-carcinogenic HI for child resident is 1, which is equal to the acceptable threshold of 1 (Table 5-29). The non-carcinogenic HI for exposure to soil is 0.1 and for exposure to sediment is 0.2.

Carcinogenic Results

Carcinogenic risks for the resident adult and child were combined to represent the incremental lifetime carcinogenic risks for exposure to the Site. The cumulative carcinogenic risk for the lifetime resident is 5×10^{-5}, which is above the DNREC acceptable level of 10^{-5} (Table 5-29). The carcinogenic risk for exposure to soil is 4×10^{-5} and for exposure to sediment is 6×10^{-6}. Arsenic and benzo(a)pyrene in soil are the only COPCs with a carcinogenic risks above 10^{-5}. Benzo(a)pyrene in sediment is the only COPC with carcinogenic risks above 10^{-6}. Arsenic contributes approximately 70% of the carcinogenic risks.

5.6.4.1 Adolescent Recreational User

The recreational user was evaluated for exposure to soil and sediments. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for the resident are presented in Table 5-30.

Non-Carcinogenic Results

The total non-carcinogenic HI for the commercial worker is 0.1, which is below the acceptable threshold of 1 (Table 5-30). The non-carcinogenic HI for exposure to soil is 0.08 and for exposure to sediment is 0.03.

Carcinogenic Results

The carcinogenic risk for the commercial worker is 4×10^{-6}, which is below the DNREC acceptable level of 10^{-5} (Table 5-30). Arsenic in soil is the only COPC with carcinogenic risks greater than 10^{-6}. The carcinogenic risk for exposure to soil is 3×10^{-6} and for exposure to sediment is 2×10^{-6}.

5.6.4.2 Composite Worker

The composite worker was evaluated for exposure to soil and sediments. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for the resident are presented in Table 5-31.

Non-Carcinogenic Results

The total non-carcinogenic HI for the composite worker is 0.3, which is below the acceptable threshold of 1 (Table 5-31). The non-carcinogenic HI for exposure to soil is 0.3 and for exposure to sediment is 0.01.

Carcinogenic Results

The carcinogenic risk for the composite worker is 2×10^{-5}, which is above the DNREC acceptable level of 10^{-5} (Table 5-31). The carcinogenic risk for exposure to soil is 2×10^{-5} and for exposure to sediment is 3×10^{-7}. Arsenic in soil is the only COPC with carcinogenic risks greater than 10^{-5}. Arsenic contributes to over 80% of the carcinogenic risks.

5.6.4.1 Indoor Worker

The indoor worker was evaluated for exposure to soil only. Estimates of cumulative risks across all pathways for non-carcinogenic and carcinogenic effects for the resident are presented in Table 5-32.

Non-Carcinogenic Results

The total non-carcinogenic HI for the indoor worker is 0.06, which is below the acceptable threshold of 1 (Table 5-32).

Carcinogenic Results

The carcinogenic risk for the indoor worker is 4×10^{-6}, which is below the DNREC acceptable level of 10^{-5} (Table 5-32). Arsenic in soil is the only COPC with carcinogenic risks greater than 10^{-6}. Arsenic contributes to over 87% of the carcinogenic risks.

5.6.4.2 Lead

Lead was considered a COPC in sludge based upon a maximum detected concentration of 1,200 mg/kg at sample location SPP-SL-02. Lead results for the other sludge sample, SPP-SL-01, was only 158 mg/kg. The highest detection of lead within the sediment samples collected in the Nanticoke River, along the riverbank or within the river, was 73.3 mg/kg. This reveals that the detection of lead within sludge is an isolated exceedance. Additionally, sediment within the Nanticoke River, which received discharge from the Site, does not reveal any impacts from lead. As a result, lead is not a concern at the Site.

5.7 RISK ASSESSMENT UNCERTAINTY

There are numerous uncertainties involved in the HHRA process. These are discussed briefly in the following sections.

5.7.1 Uncertainties Analysis of Exposure Assessment

An analysis of uncertainties is an important aspect of the exposure assessment. It provides the risk assessor and reviewer with information relevant to the individual uncertainties associated with exposure factor assumptions and their potential impact on the final assessment. Conservative assumptions are made about exposure to these media that may result in an overestimate of potential health risks. Sample locations for soil were biased near former source areas (i.e., USTs, ASTs, etc.) to determine potential impacts. However, the biased nature of these locations may over-estimate potential chemical concentrations for a receptor's exposure to the entire site. Additionally, only sediment samples along the riverbank were evaluated in the HHRA. These locations were placed just downgradient from locations were on-site piping discharge into the Nanticoke River. The evaluation of these locations and sludge/sediment within the piping itself may over-estimate potential chemical concentrations within sediment.

5.7.2 Uncertainties of Toxicity Assessment

There are numerous uncertainties associated with the toxicity assessment. These are generally due to the unavailability of data to thoroughly calculate the toxicity of COPCs. These uncertainties are described in more detail in the following sections.

5.7.2.1 Uncertainties Associated With Non-Carcinogenic Effects

Interspecies Extrapolation
Most toxicological information is developed through experiments with laboratory animals. Regulatory agencies rely on experimental animal data to assess the hazards of chemical

exposures to humans. Interspecies differences in chemical absorption, metabolism, excretion, and toxic response are not well understood; therefore, conservative assumptions are applied to animal data when extrapolating to humans. These assumptions probably result in an overestimation of toxicity.

Intraspecies Extrapolation
Differences in individual human susceptibilities to the effects of chemical exposures may be caused by such variables as genetic factors (e.g., glucose-6-phosphate dehydrogenase deficiency), lifestyle (e.g., cigarette smoking and alcohol consumption), age, hormonal status (e.g., pregnancy), and disease. To take into account the diversity of human populations and their differing susceptibilities to chemically induced injury or disease, a safety factor is used. EPA uses a factor between 1 and 10. This uncertainty may lead to overestimates of human health effects at given doses.

Exposure Routes
When available, experimental data are derived from a route of exposure that is different from the actual route of exposure that is of interest, route-to-route extrapolation must be performed before the risk can be assessed. Several criteria must be satisfied before route-to-route extrapolation can be undertaken. The most critical assumption is that a chemical injures the same organ(s) regardless of route, even though the injury can vary in degree. Another assumption is that the behavior of a substance in the body is similar by all routes of contact. This may not be the case when, for example, materials absorbed via the gastrointestinal tract pass through the liver prior to reaching the systemic circulation, whereas by inhalation the same chemical will reach other organs before the liver. However, when data are limited, these extrapolations are made and may result in overestimates of human toxicity.

5.7.2.2 Uncertainties Associated With Carcinogenic Effects

Interspecies Extrapolation
Most toxicological information for carcinogenic assessments is derived from experiments with laboratory animals. There is uncertainty about whether animal carcinogens are also carcinogenic in humans. While many chemical substances are carcinogenic in one or more animal species, only a very small number of chemical substances are known to be human carcinogens. The fact that some chemicals are carcinogenic in some animal species, but not in others raise the possibility that not all animal carcinogens are human carcinogens. Regulatory agencies assume that humans are as sensitive to carcinogens as the most sensitive animal species. This policy decision, designed to prevent underestimation of risk, introduces the potential to overestimate carcinogenic risk.

High-Dose to Low-Dose Extrapolation
Typical cancer bioassays provide limited low-dose data on responses in experimental animals for chemicals being assessed for carcinogenic or chronic effects. The usual dose regime involves three dose groups per assay. The first dose group is given the highest dose that can be tolerated, the second is exposed to one-half that dose, and the third group is unexposed (control group) (National Research Council [NRC] 1983). Because this dosing method does not reflect how animals would react to much lower doses of a chemical, a dose-response assessment normally

requires extrapolation from high to low doses using mathematical modeling that incorporates to varying degrees information about physiologic processes in the body (NRC 1983).

A central problem with the low-dose extrapolation models is that they often fit the range of data from animal bioassays equally well, and it is not possible to determine their validity based on goodness of fit. Several models may fit experimental data equally well, but all may not be equally plausible biologically. The dose-response curves derived from different models diverge substantially in the dose range of interest (NRC 1983). Therefore, low-dose extrapolation is more than a curve-fitting process, and considerations of biological plausibility of the models must be taken into account before choosing the best model for a particular set of data.

5.7.3 Uncertainties in Risk Characterization

Uncertainties in the risk characterization can stem from the inherent uncertainties in the data evaluation, the exposure assessment process, including any modeling of exposure point concentrations in secondary media from primary media, and the toxicity assessment process. The individual uncertainties in these respective processes were addressed in the previous sections.

Wastewater within the on-site piping was not evaluated quantitatively in the HHRA. Arsenic was the only COPC determined for wastewater based upon a comparison to the DNREC surface water SLs. The arsenic SL is 2.8 micrograms per liter (µg/L) based upon a carcinogenic endpoint. The maximum detected concentration of arsenic in wastewater was 5 µg/L. The maximum detected concentration of arsenic in wastewater is only 2 times higher than the SL, which is based upon a carcinogenic endpoint of 10^{-6}. As a result, the level of arsenic in wastewater would not be a concern for potential receptor exposure.

5.8 CONCLUSIONS

Based upon current and potential future use of the Site, complete exposure pathways exist for commercial workers, outdoor workers, and recreational users. A composite worker is also a possibility at the site. A composite worker is a worker who may work within the site buildings and also perform shallow digging or other subsurface activities at the site.

Excavation/construction workers are also expected at the site based on the potential for removal and construction of site structures or utilities. Residents are not expected as future users of the site. However, the resident is evaluated to determine if an unrestricted site use is a possibility for the Site.

For the quantitative evaluation of potential risks, only the resident, adolescent recreational user, composite worker, and indoor worker were evaluated based upon expected rates of contact. These receptors also evaluate a range of ages for receptors from child to adult. The resident is expected to have the highest rates of contact and represents an unrestricted site use. A resident also evaluates an adult and a child age range. Recreational users at the site could range from child to adult. Actual site contact for a child recreational user is expected to be minimal. An adolescent recreational user represents an age range that would have high contact with the site

and is a high probability for the Site. For the worker scenario, the composite worker represents a worker with the highest contact to site media. The following table presents a summary of the HHRA results for each of the receptors evaluated quantitatively:

Summary of HHRA Results

Receptor	HHRA Results			COPC Contributing Significantly to Results
Child Resident[1]	**Media**	**Carcinogenic Risks**	**Non-Carcinogenic Hazards**	
	Soil	4×10^{-5}	1	NA
	Sediment	6×10^{-6}	0.2	Arsenic
	Total	**5×10^{-5}**	**1**	
Adult Resident[1]	Soil	4×10^{-5}	0.1	NA
	Sediment	6×10^{-6}	0.02	Arsenic
	Total	**5×10^{-5}**	**0.1**	
Adolescent Recreational User	Soil	2×10^{-6}	0.08	NA
	Sediment	2×10^{-6}	0.03	NA
	Total	**4×10^{-6}**	**0.1**	
Composite Worker	Soil	2×10^{-5}	0.03	Arsenic
	Sediment	3×10^{-7}	0.01	NA
	Total	**2×10^{-5}**	**0.3**	
Commercial Worker	Soil	4×10^{-6}	0.06	NA
	Total	**4×10^{-6}**	**0.06**	

1 Carcinogenic risks for the resident adult and child are combined and presented as a total lifetime cumulative carcinogenic risk.
NA = Not Applicable.

The HHRA results reveal potential cumulative carcinogenic risks for the lifetime resident and worker above the DNREC acceptable level of 10^{-5}. Arsenic in soil is the only COPC that has carcinogenic risks greater than 10^{-5}. Arsenic contributes to over 80% of the carcinogenic risks. Two sample locations in subsurface soil exceeded the DNREC SL of 11 mg/kg. For non-carcinogenic hazards, none of the receptors evaluated had a concern.

6. ECOLOGICAL RISK ASSESSMENT

This Chapter presents the screening level ecological risk assessment (SLERA) conducted by EA for SPP. The purpose of this assessment is to characterize and quantify potential environmental impacts from residual chemicals in soil, sediment, and surface water from site activities. The assessment was conducted in accordance with EPA guidance for the RI/Feasibility Study (FS) process; specifically the SLERA was conducted in accordance with the process for ERAs outlined in the document *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997a), other relevant EPA guidance, and DNREC *Regulations Governing Hazardous Substance Cleanup* (DNREC 2012) and updated *Screening Level Tables* (DNREC 2015c and 2014a).

The ERA process outlined in EPA guidance includes eight steps (EPA 1997a and 1998), and this document presents the first three steps of the ERA process (Figure 6-1). Steps 1 and 2 represent the SLERA. The SLERA uses highly precautionary assumptions regarding exposure and toxicity to develop a CSM and identify COPCs. The CSM (Figure 6-2) defines complete and significant exposure pathways and identifies assessment and measurement endpoints. The screening level evaluation typically relies on chemical analytical data.

Step 3 of the SLERA process is the baseline risk assessment problem formulation (BRAPF). The BRAPF draws from the risk evaluation performed in the SLERA to identify COPCs, exposure pathways, assessment endpoints, and risk questions requiring further consideration. The BRAPF often includes refinement of the screening level risk calculations through use of more realistic or more relevant exposure and toxicity data. The goal of the BRAPF is to provide a clear definition of the ecological risk problems for the site. This problem formulation forms the basis for either further assessment or, in cases where sufficient data are available, risk management if necessary.

In the case of the Site, a SLERA and BRAPF refinement of risk calculations were performed. Section 6.1 discusses the data used in the SLERA and presents measurement endpoints for the screening level risk evaluation. Section 6.2 presents the CSM and assessment endpoints. Section 6.3 presents the SLERA results and conclusions.

Section 6.4 presents the refined risk assessment and methodology and discusses the data and measurement endpoints used. The refined toxicity assessment is defined in Section 6.5 and the refined risk calculation is defined in Section 6.6. Results from the BRAPF for each source area are presented in Section 6.6. The results for all measurement endpoints are combined in a qualitative weight of evidence approach to provide a preliminary risk characterization for each assessment endpoint. Uncertainties associated with the risk assessment are presented in Section 6.7, and results of the risk characterization are considered together in developing the conclusions for the Site; which are presented in Section 6.7.

6.1 SUMMARY OF DATA USED IN THE SLERA

The data evaluated in this SLERA include surface water sample results (dissolved metals only) and the results of 10 sediment samples submitted for analysis (Table 6-1 and Figure 6-3). Although surface soil samples were collected and submitted for analysis, surface soil results were not evaluated in this SLERA as the exposure pathway is incomplete due to a lack of suitable habitat as discussed in the CSM (Section 6.2). A sediment sample (SPP-SD-05) and surface water sample (SPP-SW-01) were collected upstream of the identified source areas, and their results are considered representative of background conditions. Background data are evaluated in the BRAPF to aid in risk management decisions.

6.1.1 Data Reduction and Summary Statistics

This section describes the approach that was followed to evaluate the available analytical data in each medium of concern (i.e. sediment and surface water). The following list summarizes the approach:

- Analytical results with an "R" qualifier (indicating that the data were rejected during the validation process) were not used in the SLERA and BRAPF. No data were rejected in this dataset.

- Analytical results with a "U" or "UJ" qualifier indicate that the analyte was not detected at the sample quantitation level (SQL). These data were considered non-detects and were retained in the data set. In the calculation of the 95 percent upper confidence limits of the mean (UCLMs), each non-detect was assigned a numerical value of its SQL.

- Analytical results with a "J" qualifier indicate that the reported values were estimated because the analyte was detected at a concentration below the SQL or for other reasons. These data were considered detections and were retained in the data set at the measured concentration.

The following EPA guidance (1989) was used in determining the representative concentration for a location:

1. The maximum concentration of a pair of duplicate or split samples (taken from the same location on the same date) was used if both parent and duplicate were detected.

2. The maximum non-detect concentration was used if both parent and duplicate were non-detects.

3. The detected value was used if either parent or duplicate were detected and the other non-detected were used to represent the concentration for that location.

Due to sample coverage and study design, there are a number of uncertainties associated with the chemical analytical data. Uncertainties associated with the data used in the SLERA are discussed in Section 6.7.

6.2 ECOLOGICAL CONCEPTUAL SITE MODEL

As part of the CSM, potential sources of chemicals and exposure pathways are characterized for the site (Figure 6-2). The model illustrates the pathways through which receptors may be exposed to sources of COPCs. Sources and exposure pathways are discussed in the following sub-sections.

6.2.1 Ecological Setting

The Site includes a decommissioned power plant with paved and grassy open areas, a Riverwalk, and a floating dock (Figure 6-3). The Site is primarily (approximately 80%) impervious area, with paved parking lot and walking path, as well as the footprint of the building. The remaining terrestrial habitat is mowed grass. A 5- to 10-ft wall along the south side of the Site drops off to the Nanticoke River. The stretch of the river that borders the Site has been dredged to a depth of approximately 16 to 17 ft. No wetlands are known in the area of the investigation. After evaluating the Site against the DNREC Initial Ecological Evaluation Screening Questions, it was determined that further ecological evaluation was required (Appendix I).

6.2.1.1 Threatened and Endangered Species

An important consideration in forming an ecological conceptual model is the presence of endangered, threatened, and rare plant and animal species onsite. DNREC Division of Fish and Wildlife has been contacted and it has been determined that no threatened or endangered species have been observed in the area of investigation (Appendix J).

6.2.1.2 Identification of Potential Receptors

Aquatic and benthic (sediment-dwelling) organisms; amphibians and reptiles; and piscivorous (fish consuming) birds and mammals have been identified as potential receptors for contaminants in sediment and surface water at SSP. Terrestrial plants, soil invertebrates, and terrestrial (non-piscivorous) birds and mammals were considered as potential receptors for soil contaminants, but not evaluated because the lack of suitable upland habitat renders the exposure pathway incomplete (Figure 6-2).

Consequently, potential receptors evaluated in the SLERA for the Site are aquatic and benthic organisms; reptiles and amphibians; and piscivorous wildlife. Potential ecological receptors are shown in the CSM (Figure 6-2).

6.2.1.3 Potential Source Areas

As shown in Figure 6-3, two potential source areas have been identified. Potential Source Area 1 represents potential discharge to the Nanticoke River from SPP, and includes sediment samples located in the river near the Site (SPP-SD-01, SPP-SD-02, and SPP-SD-06 through SPP-SD-10). Potential Source Area 2 is a fuel dispensing terminal located across the Nanticoke River and includes sediment sample locations SPP-SD-03 and SPP-SD-04. The two source areas (sediment sample results) were evaluated separately to determine if there was a difference in risks from the two sources. Surface water samples (SPP-SW-02 through SPP-SW-05) collected from the middle of the Nanticoke River were evaluated as a group, along with sediment samples from Source Area 1 and sediment samples from Source Area 2. The two sources identified are the most likely contributors to the contaminants found in the surface water samples; however, an unknown possible upstream source may exist but has not been identified. Sediment sample SSP-SD-05 and surface water sample SSP-SW-01 (Figure 6-3) represent the upstream background sample location.

6.2.2 Fate, Transport, and Media of Concern

A number of fate and transport pathways are expected to influence the transfer of elevated concentrations of COPCs between environmental media in the Site. Runoff and erosion can transport chemicals into sediment or surface water. Similarly, sediment containing chemicals may be eroded and deposited farther downstream. Chemicals carried in surface waters from source areas have the potential to adsorb onto sediment or soil particles. Chemicals may also desorb from the sediment where they are released back into the surface waters. These processes concern ecological receptors in that they allow chemicals from low quality habitats to be redistributed to high quality habitats utilized by wildlife and plants. Bioaccumulation is also a relevant transport pathway. Plants and animals that come in contact with contamination in sediment or surface water may uptake chemicals. Dependent upon the chemical and the organism, these chemicals may accumulate in tissue.

It is important to note that all of the transport pathways discussed above are dependent upon factors that influence the forms of chemicals in environmental media and their bioavailability. This is especially important for metals. Metals are present in nature in a wide range of chemical forms. Soluble forms of some metals are highly mobile in sediment and water, facilitating higher transport rates and making them more bioavailable. Many of the mineral forms of metals found in naturally occurring rocks and soils are relatively insoluble and are not readily taken up by wildlife. Changes in the chemistry of sediment or water may make metals more or less soluble, and thus determine their ultimate mobility and bioavailability.

Based on the above discussion of potential habitats, sources, and fate and transport, sediment and surface water are considered the primary media of concern (Figure 6-2)

6.2.3 Identification of Exposure Pathways

Based on the ecological setting and media of concern, ecological receptors potentially present in the Site include aquatic and benthic organisms, and piscivorous wildlife (Figure 6-2). Media of concern and ecological receptors are evaluated to determine potential exposure routes linking the two, and to determine which pathways are complete and significant. The sub-sections below identify the major routes of exposure and their applicability to each of these receptor groups.

6.2.3.1 Aquatic and Benthic Organisms

Aquatic plants may absorb chemicals from sediment and surface water via their roots or osmosis. Aquatic and benthic animals may be exposed to chemicals in sediment and surface water through direct contact as well as absorption through the skin and gills. Direct exposure to these media is considered a complete and significant pathway for plants and aquatic and benthic organisms, and therefore relevant for the assessment of Site sediment and water exposures.

6.2.3.2 Wildlife (Reptiles, Amphibians, Birds, and Mammals)

The most significant exposure route for wildlife is ingestion of chemicals in contaminated media (EPA 2003b). Wildlife may ingest chemicals in environmental media by drinking surface water or by incidentally ingesting sediment while grooming or foraging. Chemicals may bioaccumulate in the tissue of food plants and animals. Therefore, wildlife may also ingest chemicals through plants and animals that they consume as food. Ingestion of chemicals in sediment, surface water, and/or food is considered a complete and potentially significant exposure pathway for wildlife at the Site.

Wildlife may be exposed to chemicals in air, soil, sediment, or water via direct contact during foraging or burrowing. With the exception of reptiles and amphibians, most wildlife have protective outer coverings such as fur, feathers, or scales that prevent or limit the dermal absorption of chemicals from environmental media (U.S. Army Center for Health Promotion and Preventative Medicine [CHPPM] 2004). EPA guidance identifies that, in most cases, dermal exposures are likely to be less significant than exposures through ingestion and their evaluation involves considerable uncertainty (EPA 2003b and CHPPM 2004). Consequently this exposure route is considered complete but relatively insignificant for wildlife, with the exception of reptiles and amphibians.

In summary, ingestion of chemicals in sediment, surface water, and food are considered complete and significant exposure pathways for assessment in the SLERA.

6.2.4 Selection of Representative Receptors

Ecological receptors potentially present at the site include wildlife (reptiles, amphibians, and piscivorous birds and mammals), and aquatic and benthic organisms. Selection of representative receptor species is based primarily on several factors: 1) the likelihood of a species to use the site and the area immediately surrounding the site, 2) the potential for exposure to site-related

contaminants based on the feeding habits and life history of the organisms/guild represented by the receptor species, 3) the availability of life history and exposure information for the selected receptor species, and 4) the availability of toxicity information for the representative receptor species. Potential representative receptors were evaluated based on these criteria and based on the applicability of available toxicity benchmarks to plants, soil invertebrates, wildlife, and aquatic and benthic organisms. The receptors of concern (and representative receptor species) included in this ERA are:

- Benthic and aquatic organisms (multiple species)
- Amphibians and reptiles (multiple species)
- Piscivorous birds (great blue heron)
- Piscivorous mammals (river otter).

6.2.4.1 Aquatic and Benthic Organisms

No specific aquatic species are selected for evaluation; instead, the assessment evaluates the potential for adverse effects to aquatic plant and animal populations. Potential risks to aquatic organisms are evaluated in the SLERA for the Site by comparing the chemical concentrations measured in surface water with available toxicity data from the scientific literature.

As with aquatic organisms exposed to surface water, the toxicity data being used in the SLERA were designed to evaluate the potential for adverse effects to benthic organism populations exposed to sediment; no individual species were selected for evaluation. The assessment evaluates the potential for adverse effects to the overall benthic populations. Potential risks to benthic organisms are evaluated in the SLERA for Source Areas 1 and 2 by comparing concentrations of the COPCs identified in sediment to applicable toxicity values.

6.2.4.2 Amphibians and Reptiles

The assessment of risks to amphibians and reptiles is limited by the lack of sufficient literature-based exposure and toxicity information. Also, there are currently no assessment methods for evaluating these receptors. The Site includes habitat that may potentially support amphibian and reptile populations. Because potential risks to these receptors cannot be quantitatively dismissed, the amphibian and reptile receptor endpoints will be carried forward through the SLERA and discussed in the uncertainty assessment (Section 6.7).

6.2.4.3 Aquatic Organism-Eating Terrestrial Wildlife

The great blue heron (*Ardea herodias*) was selected as the avian receptor species for evaluating potential adverse effects to birds from the ingestion of aquatic prey at the Site. A large portion of the great blue heron diet is comprised of fish and larger aquatic invertebrates. Great blue herons are known to live along freshwater rivers, such as the Nanticoke River; however, they feed in shallow waters and nest in dense colonies near foraging habitat (EPA 1993). The Nanticoke River near the Site is not shallow and great blue herons would not likely forage at the

Site, but the risks to great blue herons (piscivorous birds) were assessed as a conservative measure.

The North American river otter (*Lutra canadensis*) was selected as the mammalian receptor species for evaluating potential adverse effects to mammals from the ingestion of fish and aquatic invertebrates. The North American river otter is almost exclusively aquatic (preferring flowing water habitats) and is piscivorous, feeding primarily on fish. "Because of its piscivorous diet and high trophic level, the river otter is a noteworthy indicator of bioaccumulative pollution in aquatic ecosystems" (EPA 1993). According to *Paddle the Nanticoke*—a website promoting travel in and around the Nanticoke River and administered by the Nanticoke Watershed Alliance and the DNREC Division of Parks and Recreation—river otters are known to inhabit the Nanticoke River. Due to the nature that the river otter is a clear piscivore and is known to live in the range of the Site, the river otter was chosen as the mammalian receptor. Although the Nanticoke River near the Site had been heavily developed and river otters are unlikely to forage in the area, the risks to river otters (piscivorous mammals) were assessed as a conservative measure.

In addition to the ingestion of chemicals in food items, the inadvertent ingestion of chemicals in sediment and consumption of chemicals in surface water were evaluated for the above species.

6.3 SLERA RESULTS

Maximum exposure estimates were compared to media-specific risk-based screening-levels (Table 6-2). The results of this risk calculation are used to identify COPCs. When the screening level is greater than the maximum concentration, the potential for adverse effects is considered unlikely. Because of the conservative nature of the SLERA, chemicals with maximum concentrations less than the screening level can be removed from further examination. If the maximum concentration is equal to or greater than the screening level, or if a media-specific screening criterion is not available, the chemical is retained as a COPC and examined further. Inclusion of a chemical as a COPC does not necessarily indicate that it poses risks; it indicates that the chemical cannot be definitively eliminated from further consideration. Although detected in sediment and surface water, essential nutrients—calcium, magnesium, sodium, and potassium—are not included in the list of COPCs.

6.3.1 Source Area 1

Sediment, see Table 6-3

The following chemicals exceed the sediment screening value and are retained as COPCs:

Metals
- Lead
- Zinc

PAHs
- Total PAHs (as a surrogate for all individual PAHs)

Inorganics
- Cyanide

The following chemicals are retained as COPCs due to lack of a sediment screening value:

- Aluminum
- Barium
- Beryllium
- Vanadium
- TPH-DRO

The 95 percent UCLM (calculated using ProUCL version 5.0) EPCs for these COPCs are shown in Table 6-4. An output table from ProUCL is attached as an appendix (Appendix H).

6.3.2 Source Area 2

Sediment, see Table 6-5

The following chemicals exceed the sediment screening value and are retained as COPCs:

Metals

- Cobalt
- Copper
- Iron
- Manganese
- Mercury
- Nickel
- Zinc

PAHs

- Total PAHs (as a surrogate for all individual PAHs)

The following chemicals are retained as COPCs due to lack of a sediment screening value:

- Aluminum
- Barium
- Beryllium
- Vanadium

The 95 percent UCLM EPCs for these COPCs could not be calculated due to insufficient sample quantity. The maximum detected concentration was used as the UCLM EPC, as shown in Table 6-6.

6.3.3 Source Areas 1 and 2

Surface Water, see Table 6-7

The following chemicals exceed the surface water screening value and are retained as COPCs:

- Aluminum (dissolved)

- Barium (dissolved)
- Iron (dissolved)

The 95 percent UCLM EPCs for these COPCs could not be calculated due to insufficient sample quantity. The maximum detected concentration was used as the UCLM EPC, as shown in Table 6-8.

6.3.4 SLERA Conclusions

Chemicals not detected in any onsite samples are considered not to be present at the Site. However, there is some uncertainty in dismissing these non-detected chemicals from further consideration because a chemical could theoretically be present at a concentration less than the reporting limit or detection limit, but greater than the screening level concentration. Risks from these non-detected chemicals cannot be determined, therefore, the assessment of risk from these non-detected chemicals remains an uncertainty in this ERA, as discussed in Section 6.7.

The SLERA concludes that there are COPCs in sediment at both source areas as well as the Site's surface water that require further evaluation. The results of the SLERA represent maximum estimates of risk, and are not necessarily representative of population-wide risks. Step 3 of the ERA (the BRAPF) will include a refinement of risk estimates using more site-specific assumptions and information. Uncertainties associated with the SLERA are discussed in Section 6.7.

6.4 ECOLOGICAL RISK ASSESSMENT REFINEMENT

The third step in the eight-step ERA process is required only for compounds for which the SLERA (Steps 1 and 2) indicates a need for further ecological risk evaluation. Consistent with ERA guidance (EPA 1997a), highly conservative assumptions were used in the SLERA to provide an upper bound estimate of risk to ecological resources. Such an approach meets with the objectives of the SLERA, which are to screen out all chemicals that do not have the potential to adversely affect ecological resources, and to maintain chemicals that have potential to cause risks. These conservative assumptions are expected to over-estimate actual levels of risk to most ecological receptors. Consequently, some chemicals that pose negligible risk may be retained as COPCs at the outset of Step 3. The objective of the BRAPF is to determine the scope and goals of the baseline ERA by considering the results of the SLERA with additional site-specific information and alternate, more realistic assumptions in the estimates of risk. The results of this evaluation build upon the risk results presented in the SLERA, and are intended to assist in making scientific management decisions about the need for further investigation.

6.4.1 Refined Assessment and Measurement Endpoints

The following refined assessment endpoints were defined to reflect the potential impacts of the complete and significant exposure pathways discussed above:

1. Protection of benthic invertebrate communities to ensure that COPCs in sediment do not have unacceptable adverse effects on survival, growth, and reproduction of key invertebrate species, which may result in adverse effects to the community structure (i.e., diversity or biomass).

2. Protection of aquatic organism communities to ensure that COPCs in surface water do not have unacceptable adverse effects on survival, growth, and reproduction of key aquatic species, which may result in adverse effects to the community structure (i.e., diversity or biomass).

3. Protection of piscivorous wildlife to ensure that COPCs that have bioaccumulated in prey tissue do not have unacceptable adverse effects on survival, growth, and reproduction of representative receptor species.

4. Protection of reptiles and amphibians to ensure that COPCs in sediment and surface water do not have unacceptable adverse effects on survival, growth, and reproduction of key species.

Because assessment endpoints are often defined in terms of ecological characteristics that are difficult to measure (e.g., the health of a population or community), measurement endpoints are selected to provide a quantifiable means of characterizing risks. Measurement endpoints are quantifiable ecological characteristics that are related to each assessment endpoint (EPA 1989). The following refined measurement endpoints were defined to draw inferences regarding the refined assessment endpoints.

1. Protection of Benthic Invertebrate Communities—

    - The measurement of maximum COPC concentrations in sediment and the calculation of 95 percent UCLM COPC concentrations in sediment provide the means, when compared to relevant (based on acute or low effects levels) receptor-specific benchmarks, for drawing inferences regarding the first assessment endpoint.

2. Protection of Aquatic Organism Communities—

    - The measurement of maximum COPC concentrations in surface water and the calculation of 95 percent UCLM COPC concentrations in surface water provide the means, when compared to relevant (based on acute or chronic levels) receptor-specific benchmarks, for drawing inferences regarding the second assessment endpoint.

3. Protection of Piscivorous Wildlife—

    - The measurement of maximum COPC concentrations in surface water and sediment, and the calculation of 95 percent UCLM COPC concentrations in surface water and sediment provide the means to model wildlife doses. The modeled wildlife doses can

be compared to relevant (based on acute or low effects levels) receptor-specific benchmarks, to draw inferences regarding the third assessment endpoint.

4. Protection of Reptiles and Amphibians—

   - The assessment of risks to amphibians and reptiles is limited by the lack of sufficient literature-based exposure and toxicity information. Also, there are currently no assessment methods for evaluating these receptors.

6.4.1.1 Aquatic and Benthic Organisms

Potential risks to aquatic and benthic organisms were evaluated by comparing EPCs in surface water and sediment to toxicity reference values (TRVs) for these media. TRVs represent the threshold above which effects are expected and below which either no effect or a low effect is expected. Conservative benchmarks were selected to ensure that all chemicals that may pose a risk have been accurately identified. Comparisons were initially made using maximum EPCs as a precautionary screen. Comparisons were then refined using mean and point-by-point concentrations as EPCs. As defined in EPA guidance (EPA 1997a), the ratio of a chemical's concentration to its TRV is called a HQ. HQs greater than or equal to 1 indicate a potential for unacceptable risk, while HQs less than 1 indicate no potential for unacceptable risk. Results of comparisons are interpreted in light of the anticipated environmental chemistry of site media and spatial relationships which may affect comparison results and relevance.

Exposure estimates were not developed for amphibians or reptiles, because a quantitative measurement endpoint for this ecological resource cannot be identified. Literature and database resources were examined for exposure and toxicity information that could be used to quantitatively evaluate risks to amphibians and reptiles. Despite searches of the EPA ECOTOX database, Canadian-based Reptile and Amphibian Toxicology Literature database, and other literature sources, inadequate data are available for a quantitative evaluation. Therefore, the potentials for risks to amphibians and reptiles are maintained as an uncertainty throughout this ERA (see Section 6.7).

6.4.1.2 Wildlife

For wildlife, measurement endpoints are based on the results of food web models that predict the dose of chemicals ingested by wildlife. These doses are compared to TRVs for wildlife. The first measurement endpoint evaluated is a comparison of doses based on maximum EPCs to no-effects TRVs. Refinement of the models is conducted using 95 percent UCLM EPCs. As discussed previously, HQs greater than or equal to 1 indicate a potential for unacceptable risk while HQs less than 1 indicate no potential for unacceptable risk. Results of comparisons are interpreted in light of factors that include the anticipated environmental chemistry of site media and spatial relationships which may affect comparison results and relevance. A more detailed presentation of measurement endpoints is provided in Table 6-9.

6.4.1.3 Refined Exposure Assessment

Many of the measurement endpoints identified in Section 6.2 rely on exposure estimation using chemical analytical data. In some cases, chemical concentrations are used as the exposure estimate and measured or 95 percent UCLM concentrations are identified as EPCs for comparison to benchmarks. In other cases, chemical concentrations are the EPC inputs for food web models that estimate exposures as ingested doses. The exposure assessment identifies the models and input parameters that were used in benchmark comparisons and food web dose modeling. These parameters include identification of exposure point concentrations, food web model assumptions, and literature-based uptake factors. These are discussed on a receptor-by-receptor basis.

6.4.1.4 Exposure Point Concentrations

EPCs are the COPC concentrations that a receptor is assumed to be exposed to within an exposure area (e.g., Operable Units). Two separate EPCs were used in the ERA. The initial measurement endpoint for each receptor consists of a screening level comparison of the maximum case scenario exposure estimate to no-effects benchmarks. Therefore, the maximum concentrations detected in onsite media were used as the EPC in exposure estimation. The maximum EPC is a realistic estimate of hot-spot exposures to organisms that may spend their entire lives in a small area. However, use of the maximum EPCs for assessment of some organisms is conservative and is likely to over-estimate risks because it assumes that individual organisms spend 100% of their time inhabiting and feeding from the most contaminated sample location at the site.

Additional measurement endpoints were evaluated based on 95 percent UCLM concentrations found in onsite media. The 95 percent UCLM is a more realistic and yet still conservative value for consideration of the site-wide populations and exposures for mobile receptors because it assumes an average exposure across the site. The 95 percent UCLM concentration of a chemical within a given sample data grouping was calculated with the EPA statistical software package ProUCL version 5.0, following EPA guidance (EPA 2002b and 2013). ProUCL was used for calculating the 95 percent UCLMs in this risk assessment as this program allows the user to calculate distribution-specific UCLMs, as well as UCLMs for data that do not exhibit a specific distribution. If the calculated 95 percent UCLM exceeded the maximum detected concentration, then the maximum concentration was used as the EPC; as was the case for total PAHs in Source Area 1. Where the 95 percent UCLM could not be calculated because of low-detection frequencies, the maximum was used in its stead. Due to insufficient sample quantities, maximum chemical concentrations in surface water samples (four locations) and sediment samples in Source Area 2 (two locations total) were used in place of calculated UCLM concentrations. These substitutions create uncertainties which are discussed further in Section 6.7; however, it is consistent with the methods utilized in ProUCL version 5.0.

6.4.2 Exposure Modeling for Lower Trophic Level Wildlife

The measurement endpoints for aquatic and benthic organisms include comparison of EPCs to TRVs protective of exposures to environmental media. Literature-based toxicity reference values for sediment and freshwater, with their respective sources, are provided in Tables 6-18 and 6-19.

Aquatic and Benthic Organisms—Chemical concentrations detected in the sediment samples were used to evaluate the potential for adverse effects to benthic organisms. Data were compared to literature-based toxicity values for benthic organisms. The maximum detected concentrations of chemicals within the source areas (sediment) were used in the evaluation of sediment contamination in accordance with EPA guidance (EPA 1997a). Although use of the maximum concentration is conservative, it is relevant in the evaluation of potential adverse effects to aquatic and benthic organisms. If a chemical was not detected at concentrations exceeding the available toxicity value, it was concluded that the chemical is not likely to adversely affect benthic organisms in that area. The mean sediment concentration at Source Area 1 was also evaluated as an indicator of risks.

Chemical concentrations measured in surface water samples were used to evaluate the potential for adverse effects to aquatic life. Data from the waterbody (Nanticoke River) were compared to literature-based toxicity values for aquatic life. The maximum concentrations of chemicals were used to evaluate the potential for adverse effects to aquatic life from the presence of chemicals in surface water.

6.4.3 Exposure Modeling for Higer Trophic Level Wildlife

Food web dose modeling was used to derive the dose-based exposure estimates for wildlife. This section presents the methods used to quantify the potential exposure of wildlife to chemicals via the ingestion of food, surface water, and sediment. The methods are based on equations presented in EPA (1993) and Sample et al. (1996). The equations and exposure parameters discussed are consistent with EPA (1997b) guidance and standard risk assessment practice.

Chemicals in the exposure media for each receptor were evaluated in the exposure models. Concentrations of these chemicals within other media to which a receptor could be exposed were then also considered for evaluation, whether or not they were COPCs within that media. By using such an approach, concentrations of chemicals within surface water which were not COPCs in surface water, but were COPCs in sediment, were included in the model. Table 6-10 provides uptake factors for fish used in the exposure models. Table 6-11 provides a summary of exposure parameters for the avian and mammalian representative receptor species identified for evaluation. Food web dose models are presented in Tables 6-12 through 6-15 for Source Area 1 and Tables 6-16 and 6-17 for Source Area 2.

It should be noted that, in general, conservative assumptions were used in the food web models. The objective of the models is to provide an upper bound risk estimate. Accordingly, in almost all cases, actual risks are likely to be overestimated by the models. Uncertainties associated with conservative assumptions and other exposure estimation factors are discussed in Section 6.7.

Two separate EPCs were used in food web dose modeling. The initial measurement endpoint for the bird and mammal receptors consists of a screening level comparison of the maximum case scenario exposure estimate to no-effects benchmarks. Therefore, the maximum concentration detected in onsite media was used as the EPC in exposure estimation for this endpoint. Use of the maximum is highly conservative and is likely to over-estimate risks because it assumes that that wildlife spend 100% of their time inhabiting and feeding from the most contaminated sample location at the site.

Therefore, food web modeling for the other wildlife measurement endpoints was based on the 95 percent UCLM concentration in the exposure media. The 95 percent UCLM is a more realistic value for consideration of the site-wide population, because it assumes an average exposure across the site. As previously discussed, the 95 percent UCLM concentration of a chemical within a given sample data grouping was calculated as the 95 percent UCLM derived by the EPA statistical software package ProUCL version 5.0. Where the 95 percent UCLM could not be calculated because of low detection frequencies, the maximum was used in its stead. The maximum was used in place of the calculated 95 percent UCLM for total PAHs (sediment) in Source Area 1, all chemicals detected in surface water samples, and all chemicals detected in sediment in Source Area 2. Use of the maximum is conservative and produces an exposure estimate that is biased high. This creates uncertainties that are discussed further in Section 6.7; however, it is consistent with the methods utilized in ProUCL version 5.0.

6.4.3.1 Ingestion of Chemicals from Abiotic Media

Wildlife may ingest soil, surface water, and sediment while foraging or grooming. Therefore, food web models account for incidental ingestion of soil, surface water, and sediment.

The following equation was used to calculate the dose of chemical wildlife would obtain from the ingestion of sediment ($Dose_{sediment}$, mg/kg):

$$Dose_{sediment} = Sediment * C_{sediment}$$

where:

$Dose_{sediment}$ = amount of chemical ingested per day from sediment (mg/kg-day)
Sediment = Sediment/soil ingestion rate (kilograms soil per kilogram body weight per day [kg/kg-day])
C_{soil} = chemical concentration in sediment (mg/kg)

Percent sediment ingestion values taken from the scientific literature for the piscivorous wildlife species of concern were multiplied by the food ingestion (FI) rates for these species to estimate ingestion rates. Sample and Suter (1994) do not provide a value for the soil/sediment consumption rate for piscivorous organisms; which they assume to negligible. To be conservative, a sediment consumption rate of 2% was used for the piscivorous wildlife. A summary of the percent sediment ingestion rates and food ingestion rates taken from the scientific literature is presented in Table 6-11.

Exposures to surface water were calculated in a manner similar to those in soil by multiplying the daily drinking water ingestion rate by the concentrations of chemicals in surface water. The following equation was used to calculate the upper bound dose of chemical that terrestrial wildlife could obtain from the ingestion of surface water:

$$Dose_{sw} = WI * C_{sw}$$

Where:

$Dose_{sw}$ = amount of chemical ingested per day from surface water (mg/kg-bw/day)
WI = surface water ingestion rate (liters per kilogram of body weight per day)
C_{sw} = maximum chemical concentration in surface water (mg/L)

6.4.3.2 Ingestion of Chemicals from Food

Food item concentrations were developed using Bioaccumulation Factors (BAFs)/ Bioconcentration Factors (BCFs). In general, values were selected from defensible, compilation- and consensus-based sources or sources which include validation models (i.e., EPA 1985a, 1985b, 1985c, 1986a, 1987a, 1987b, 1999, 2003c, 2009b) instead of values from single studies. First preference was given to regression equations derived from paired field- or laboratory-based measurements. Second preference was given to ratio-derived BAFs developed based on paired data of tissue concentrations compared to media concentrations, unless validation studies showed these to be preferable to regressions. Examples of regression and ratio BAF development can be found in Sample et al. (1998). Third preference was given to modeled equilibrium partitioning-derived BAFs based on physical or chemical characteristics. If no values could be identified, a BAF or BCF of 1 was selected.

The following equation was used to calculate the dose of chemicals that a wildlife species could obtain from the ingestion of food ($Dose_{food/prey}$, mg/kg-day):

$$Dose_{food/prey} = FI * C_{food/prey}$$

where:

FI = food ingestion rate (kg/kg-day)
$C_{food/prey}$ = estimated maximum concentration of chemical in food (mg/kg)

A summary of the FI rate used in the SLERA for the wildlife species selected for evaluation is presented in Table 6-11. The following section discusses the equations used to estimate chemical concentrations within each food group ($C_{plant/invert/prey}$).

6.4.3.3 EPCs in Aquatic Organisms

Fish were selected as representatives of the potential for chemicals to accumulate from surface water into aquatic food items. In the SLERA, fish were used as model prey items to evaluate the potential for adverse effects to piscivorous birds (as represented by great blue herons) and piscivorous mammals (river otter), because they are important dietary components for these

species. Literature-based water-to-fish uptake factors or bioaccumulation equations were used to estimate concentrations of COPCs in fish tissue using the following equation:

$$C_{fish} = C_{water} * UPF$$

Where:

C_{water} = maximum concentration of COPC in water (mg/L)
UPF = uptake factor for chemicals in fish (unit less)

The maximum concentrations of COPCs in surface water detected at each site were used as the C_{water} value in the equation. UPFs and log K_{ow}s for organic chemicals, and their literature-based sources and specific species used are provided in Table 6-10. Selected bioconcentration and bioaccumulation factors for fish used in developing UPFs are conservative and are designed to be protective of all fish species. Values were selected from defensible, compilation- and consensus-based sources or sources which include validation models instead of values from single studies. In the absence of a literature-based bioaccumulation model or uptake factor for a COPC, an accumulation factor of 1 was used to estimate chemical concentrations in fish. Use of this default accumulation factor is expected to provide a conservative estimate of accumulation for most chemicals and is expected to overestimate accumulation for non-bioaccumulative compounds.

6.4.3.4 Total Chemical Ingestion

The total dietary exposure doses ($Dose_{total}$, mg/kg bw-d) for piscivorous birds (great blue heron) and mammals (river otter) for the evaluated COPCs were determined using the following equation.

$$Dose_{total} = Dose_{food} + Dose_{sediment} + Dose_{water}$$

where:

$Dose_{food}$ = amount of chemical ingested per day from food (prey or plants) (mg/kg-bw/day)
$Dose_{sediment}$ = amount of chemical ingested per day from sediment (mg/kg-bw/day)
$Dose_{water}$ = amount of chemical ingested per day from water (mg/kg-bw/day)

The total dietary intakes are compared to dietary toxicity values to determine if adverse effects are likely to occur to piscivorous wildlife from the ingestion of COPCs in food, sediment, and surface water.

6.5 REFINED TOXICITY ASSESSMENT

This section derives toxicity values for use in evaluating exposure estimates for each representative receptor selected for evaluation. The TRVs represent concentrations or doses of the chemicals that are protective of the ecological receptors being evaluated. TRVs are compared to EPCs or estimated doses to evaluate each chemical's potential for adverse effects on the receptor in question. The following sections summarize TRVs for each indicator species or community identified for evaluation.

6.5.1 Overview of Bioavailability and Toxicity

The toxicity of chemicals is related to their bioavailability. Organic compounds may form complexes or compounds that bind them to soil and make them chemically inaccessible to ecological receptors. Alternatively, these elements and compounds may be present in forms that are easily dissolved and absorbed, or in forms that tend to bind to biological tissues. It is these forms of easily absorbed chemicals that are most toxic. Most TRVs are based on forms of chemicals that are readily bioavailable.

6.5.1.1 Metals

For metals, bioavailability is governed largely by formation of metallic compounds, binding to the sediment matrix, and speciation. The compounds and bonds formed by metals are determined by reduction and oxidation reactions, by the dominant pH in soil and sediment, and by the presence of organic carbon. These factors affect different metals in different ways. Acidity increases the bioavailability of many cationic compounds; such as cadmium, chromium, copper, lead, silver, and zinc, which may become soluble at pH below 5. Some metals, such as aluminum, may also form complexes with iron oxides and hydroxides; which makes these metals less bioavailable and less mobile. The effect of acidity on other metals is complex. For example, arsenic may form compounds that are less bioavailable under acidic conditions; however, it may also become more bioavailable if arsenic bound to iron hydroxide compounds is released (Bodek et al. 1988).

Redox conditions and pH also determine the speciation of metals. Some metals may exist in different valence states or chemical forms that demonstrate different toxicity and bioavailability. For example, arsenic can be found in nature as As III or As V, with higher toxicity and mobility typically exhibited by As III (EPA 2005b). Site specific pH (6.88 pH units) and dissolved oxygen (15.1 mg/L) values tell us that the surface water is not anoxic and is within an acceptable pH range. Such conditions thus do not favor increased bioavailability of metals; however the effect cannot be quantified.

Hardness affects the bioavailabilty and subsequent toxicity of the metals cadmium, chromium, copper, lead, nickel, silver, and zinc. Hardness at the site (24.7 mg/L) was used to determine site-specific screening criteria for the hardness dependent metals (Tables 6-2 and 6-7).

6.5.1.2 Organic Compounds

For organic compounds, the primary factors determining persistence, mobility, and fate are: 1) degradation, 2) volatilization, and 3) binding to soil/sediment. PAHs may degrade over time, resulting in lower concentrations.

Volatilization can also affect SVOCs (particularly low molecular weight [LMW] PAHs). Concentrations of these chemicals may decrease in soil, sediment, and surface water over time due to transfer to and dispersion in the air. Volatilization may be an important factor in

eliminating them from soil and sediment. Expected contributions of these chemicals to air pathways are insignificant.

Perhaps the most important factor affecting fate of organic compounds in sediment is their affinity for binding to fine grained soils and organic matter. Many organic compounds, including PAHs, are hydrophobic and will bind tightly to these soil/sediment particles. This decreases the mobility of these compounds, preventing them from dissolving in the water column. However, while the hydrophobicity of these organic compounds may decrease solubility, it may also increase their uptake into the tissues of biota and the potential for bioaccumulation. Hydrophobic compounds may bioaccumulate and biomagnify in fats and lipids within fish, invertebrates, or wildlife (EPA 2000).

6.5.2 TRVs

6.5.2.1 Organism TRVs for Exposure to Soil and Sediment

Several sources of toxicity data were used to identify the potential for chemicals in sediment to cause adverse effects to benthic communities (Table 6-18). Wherever possible, Threshold Effects Concentrations (TECs), or Threshold Effects Levels, and Probable Effects Concentrations (PECs), or Probable Effects Levels (PELs), from MacDonald et al. (2000) were utilized as chronic and acute TRVs, respectively, to determine whether chemicals in the sediments are likely to impact benthic organisms. In the absence of the above TRVs, the following values were used: TECs and PECs from Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Persuad et al. 1993) for chronic and acute TRVs, and Target and Intervention Values from the Dutch Ministry Standards (Ministry of Housing, Spatial Planning, and Environment 1994 and Dutch Ministry of the Environment 2000).

6.5.2.2 Aquatic Organism TRVs for Exposure to Surface Water

National Ambient Water Quality Criteria developed by EPA (EPA 2012) for the protection of aquatic life were used to assess potential impacts to aquatic species from chemicals in surface water. Freshwater chronic and acute criterion from the Delaware Surface Water Quality Standards (2014b) were used as TRVs to evaluate the potential for adverse effects to aquatic life from chemicals measured in the surface water samples (Table 6-19). When a Water Quality Standard criterion was not available for a particular chemical, the Tier II value from Suter and Tsao (1996) was used as the TRV.

The sediment and surface water screening levels represent both freshwater and marine environments, and they were derived from the EPA Region III Biological Technical Assistance Group Screening Benchmarks

For metals in surface water that are hardness dependent, site-specific hardness (average of 317 mg/L) was used to calculate the appropriate chronic and acute TRVs. Hardness dependent

TRVs were recalculated with the Criterion Continuous Concentration formula (DNREC 2014b) using the mean hardness measurement.

6.5.2.3 Wildlife TRVs

Chemicals identified as having the potential to adversely affect wildlife species were evaluated using dose-based toxicological benchmarks. Two types of benchmarks were used; each corresponding to a different level of ecological impacts for birds (Table 6-20) and mammals (Table 6-21). Modeled doses were first compared to dose-based NOAELs. NOAELs are doses that have been shown to cause no adverse impacts in test species. The NOAELs used in this ERA were derived from studies by Hill (1979), Sanchez et al. (1991), EPA Ecological Soil Screening Levels (EcoSSLs) (EPA 2005a-e and 2007a-e), and by Oak Ridge National Laboratory (ORNL) (Sample et al. 1996). The ORNL NOAELs were generally derived based upon measurements of survival, growth, or reproduction in the laboratory. Values from EPA EcoSSLs were derived through statistical analyses of results from multiple toxicological studies with multiple endpoints. Because NOAELs are conservative and highly protective, they were used as TRVs in this ERA.

The second set of benchmarks utilized was Lowest Observed Adverse Effects Levels (LOAELs). These are doses at which a very low level of adverse effect was observed on individual test organisms. The severity of effects considered 'low level' varies based on the study from which LOAELs are derived; in general, they correspond to minor changes in growth or reproduction. LOAELs are useful because there is considerable uncertainty associated with NOAELs. Because NOAELs are associated with no effects in a test study, it is uncertain whether they are close to or far below the threshold value at which effects would first be observed. LOAELs thus serve to bound the range of NOAELs, and the threshold of toxic-effects is considered to lie between the NOAEL and the LOAEL. Therefore, LOAELS were also utilized as TRVs. In some cases, LOAELs were available from studies by ORNL (Sample et al. 1996). When LOAELs were not available from this source or exceeded more reliable NOAELs from EPA EcoSSL sources, the data provided in EPA EcoSSL documents was used to derive LOAELs. In all cases, the geometric mean of the bounded LOAELs for growth and reproduction was calculated; this approach is similar to that used for derivation of many EcoSSL NOAELs.

In general, chemical exposures and toxicity were evaluated on a chemical-by-chemical basis; however, combined effects were evaluated for PAHs. EPA studies show that the PAHs can be grouped into high-molecular weight (HMW) and LMW groups and concentrations summed for comparison to benchmarks (EPA 2007e). Toxicity evaluation using summed PAH concentrations is performed for benthic and aquatic organisms, birds, and mammals throughout the ERA.

TRVs could not be found for certain chemicals due to a lack of available information in the scientific literature. The uncertainty associated with the lack of TRVs is discussed in Section 6.7.

6.6 REFINED RISK CALCULATION

To calculate a refined estimate of risks, refined estimates of exposure are compared to receptor-specific TRVs. Risk calculation is performed by dividing EPCs by TRVs. As defined in EPA guidance (EPA 1997b), the ratio of a chemical's concentration to its TRV is called an HQ. HQs greater than or equal to 1 indicate a potential for unacceptable risk, while HQs less than 1 indicate no potential for unacceptable risk. Results of comparisons are interpreted in light of factors that include the anticipated environmental chemistry of site media and spatial relationships that may affect comparison results and relevance.

6.6.1 Refined Risk Characterization

The purpose of the risk characterization is to draw conclusions regarding the potential for risks to each assessment endpoint/representative receptor. This is done using a qualitative weight of evidence approach in which results for each measurement endpoint are considered as lines of evidence. In general, lines of evidence that provide results based on site-specific data applicable at the population level are given the greatest weight. Per EPA guidance (EPA 1997b), the focus of the ERA is to protect the ecological values at the site-wide population or community level except where threatened or endangered species are concerned.

6.6.2 Comparisons to Receptor-Based TRVs

Receptor-specific COPCs for the Site were identified through the comparison of receptor-specific exposure estimates to TRVs. As presented in Section 6.5, TRVs are derived from literature-based NOAELs. The comparison of the two values results in the HQ. Consistent with ERA guidance (EPA 1997b), the models used to quantify the potential exposure to higher trophic level organisms were designed to estimate an upper bound potential for adverse effects to the selected representative receptor species. Therefore, exceedance of a TRV indicates the potential for adverse effects, but does not indicate that an adverse effect is occurring from the chemical (Tannenbaum et al. 2003).

The refinement of the risk calculation compares exposure estimates of the COPCs identified in the first phase to TRVs for each representative receptor species. For benthic and aquatic organisms, the maximum detected chemical concentrations in sediment or surface water are used as exposure estimates. Chemicals with exposure estimates that equal or exceed their TRVs are maintained as COPCs for that receptor, as are chemicals that do not have TRVs.

LOAELs are a valuable indicator of risk because they provide a bound to NOAELs. Exceeding a NOAEL-based TRV does not necessarily indicate a risk, because NOAELs, by definition, correspond to no effects and may not be the highest concentration at which no effects occur. LOAELs provide a clear indication of potential effects and a potential for risk; therefore, comparisons to LOAEL-based TRVs provide an important tool for ERA. Comparisons, where possible, focus on 95 percent UCLM case scenario exposure estimates because they are the most relevant estimates for wildlife populations.

It is important to note that the quality of the TRV can influence the HQ. With metals, for instance, one must consider the bioavailable form of the metal from which the TRV is generated and the bioavailable/toxic form of the metal that is most likely present onsite. Additionally, other literature TRVs are available and may generate different HQs. Uncertainties associated with the selection and use of TRVs is discussed in Section 6.7.

TRVs are not available for all COPCs; therefore, there is uncertainty associated with the lack of toxicity information for some COPCs. Chemicals that lacked TRVs or had exposure estimates that equaled or exceeded TRVs were considered COPCs (with the exception of essential nutrients). Those chemicals that had exposure estimates below TRVs (HQs <1.0) were removed from further consideration.

6.6.2.1.1 Background Data

Background data specific to the project are used as comparison criteria as part of a weight of evidence approach to inform risk management. Background data are presented in Tables 6-22 through 6-24. Comparisons to background are discussed as a factor relevant to risk characterization for each receptor.

6.6.3 Step 3: Refinement and Problem Formulation

6.6.3.1 Aquatic Organisms

The CSM identifies protection of aquatic organism survival, growth, and reproduction from impacts of COPCs in surface water as an assessment endpoint. The following measurement endpoints were evaluated as indicators of risk to aquatic organisms:

- Comparison of maximum chemical concentrations to benchmarks protective of aquatic organisms including
  - Comparison using maximum EPCs
  - Comparison of 95 percent UCLM EPCs

- Comparison of the chemical concentrations to background values including
  - Comparison using maximum EPCs.
  - Comparison using 95 percent UCLM EPCs.

Comparison of maximum concentrations to benchmarks is typically given the most weight in the weight-of-evidence approach because it is the most precautionary indicator of risks at specific locations (i.e., hotspots). Comparison of 95 percent UCLM concentrations to benchmarks is given the second most weight as an indicator of population-wide risks with the understanding that results must be interpreted in light of spatial distribution; however, the 95 percent UCLM concentration for chemicals detected in surface water could not be calculated and the maximum concentrations were used in their stead. Comparisons using 95 percent UCLM concentrations in surface water are the same as comparisons made using maximum concentrations (Table 6-25).

Measurement Endpoint 1: Screening-level Comparison of Maximum Surface Water Concentrations to TRVs Protective of Aquatic Organisms

When maximum EPCs of COPCs in surface water were compared to literature-based chronic TRVs protective of aquatic organisms, concentrations of two metals (aluminum and barium) exceeded TRVs protective of aquatic organisms and had an HQ greater than or equal to 1.0 (Table 6-25). Results for this measurement endpoint indicate that there is a potential for risk from these chemicals, although this measurement endpoint is highly precautionary because it assumes maximum exposure. When the maximum EPCs of COPCs in surface water compared to literature-based acute TRVs protective of aquatic organisms, no metals concentrations exceeded.

Measurement Endpoint 2: Screening-level Comparison of 95 Percent UCLM Surface Water Concentrations to TRVs Protective of Aquatic Organisms

Results for the screening-level comparison of 95 percent UCLMs for the three surface water COPCs (aluminum, barium, and iron) are the same as the results of the screening-level comparison of maximum surface water concentrations to TRVs (Table 6-25).

Measurement Endpoint 3: Comparison of Maximum Surface Water Concentrations to Background

The third measurement endpoint evaluated was the comparison of maximum chemical concentrations in surface water to background (Tables 6-22 and 6-25). The maximum concentrations of aluminum (190 µg/L) and barium (104 µg/L) exceeded background concentrations (102 µg/L and 101 µg/L, respectively), but were similar. The background concentrations of aluminum and barium also exceeded the screening criteria (87 µg/L and 4 µg/L, respectively). The maximum concentration of iron in surface water (364 µg/L) exceeded the screening criteria (300 µg/L), as well as the background concentration (280 µg/L), which did not exceed the screening criteria.

6.6.3.2 Benthic Invertebrates

The CSM identifies protection of benthic invertebrate survival, growth, and reproduction from impacts of COPCs in sediment as an assessment endpoint. The following measurement endpoints were evaluated as indicators of risk to benthic invertebrates:

- Comparison of the chemical concentrations to benchmarks protective of benthic invertebrates including
  - Comparison using maximum EPCs
  - Comparison of 95 percent UCLM EPCs.

- Comparison of the chemical concentrations to background values including
  - Comparison using maximum EPCs.
  - Comparison using 95 percent UCLM EPCs.

Comparison of maximum concentrations to benchmarks is typically given the most weight in the weight-of-evidence approach because it is the most precautionary indicator of risks at specific locations (i.e., hotspots). Comparison of 95 percent UCLM concentrations to benchmarks is given the second most weight as an indicator of population-wide risks with the understanding that results must be interpreted in light of spatial distribution/frequency of detection. The 95 percent UCLM concentration for chemicals detected in sediment samples from Source Area 2 could not be calculated and the maximum concentrations were used in their stead. Comparisons using 95 percent UCLM concentrations in sediment for Source Area 2 are the same as comparisons made using maximum concentrations (Table 6-26).

6.6.3.2.1 Source Area 1

Measurement Endpoint 1: Screening-level Comparison of Maximum Sediment Concentrations to TRVs Protective of Benthic Organisms

When maximum EPCs of COPCs were compared to TRVs, lead, zinc, and total PAHs exceeded TRVs protective of benthic organisms. There is no TRV available for aluminum, barium, beryllium, vanadium, or TPH-DRO, so the risks to benthic invertebrates could not be determined (Table 6-26). When maximum EPCs of COPCs were compared to LOAEL-based TRVs, total PAHs exceeded, with an HQ of 1.44.

Measurement Endpoint 2: Screening-level Comparison of 95 Percent UCLM Sediment Concentrations to TRVs Protective of Benthic Organisms

The 95 percent UCLM EPC was calculated for lead, zinc, and total PAHs. However, the 95 percent UCLM EPC for total PAHs was above the maximum EPC, and the maximum EPC was used in-place of the calculated 95 percent UCLM EPC for total PAHs, per EPA guidance. When the 95 percent UCLM EPCs in sediment were compared to literature-based benchmarks protective of benthic invertebrates, lead and total PAHs exceeded the TRVs with HQs of 1.21 and 20.376, respectively. When the 95 percent UCLM EPCs in sediment were compared to LOAEL-based TRVs, total PAH limits were exceeded (Table 6-26).

Measurement Endpoint 3: Comparison of Maximum Sediment Concentrations to Background

The third measurement endpoint evaluated was the comparison of maximum chemical concentrations in sediment to background. None of the chemicals detected in the background sample exceeded their respective screening criteria. Of the identified COPCs, maximum concentrations of aluminum, barium, beryllium, cyanide, lead, vanadium, zinc, total PAHs, and TPH-DRO exceed background (Tables 6-22 and 6-26). Cyanide, PAHs, and TPH-DRO were detected in Source Area 1, but not in the background sample. The maximum concentration of

aluminum (6,240 mg/kg) in sediment at Source Area 1 is 9.7 times the background concentration (642 mg/kg). The maximum concentration of barium (192 mg/kg) in sediment at Source Area 1 is 7.8 times the background concentration (24.6 mg/kg). The maximum concentration of lead (73.3 mg/kg) in sediment at Source Area 1 is 12 times the background concentration (6.1 mg/kg). The maximum concentration of vanadium (12.7 mg/kg) in sediment at Source Area 1 is 3.6 times the background concentration (3.5 mg/kg). The maximum concentrations of beryllium and zinc in sediment at Source Area 1 are 2.7 and 3.4 times the background concentrations, respectively.

6.6.3.2.2 Source Area 2

Measurement Endpoint 1: Screening-level Comparison of Maximum Sediment Concentrations to TRVs Protective of Benthic Organisms

When maximum EPCs of COPCs were compared to TRVs, copper, iron, manganese, mercury, nickel, zinc, and total PAHs exceeded TRVs protective of benthic organisms. There is no TRV available for aluminum, barium, beryllium, cobalt, or vanadium, so the risks to benthic invertebrates could not be determined. When maximum EPCs of COPCs were compared to LOAEL-based TRVs, none of the concentrations exceeded the TRVs (Table 6-27).

Measurement Endpoint 2: Screening-level Comparison of 95 Percent UCLM Sediment Concentrations to TRVs Protective of Benthic Organisms

The results of the screening-level comparison of 95 percent UCLM EPCs for sediment in Source Area 2 to TRVs protective of benthic organisms are the same as the results of the screening-level comparison made using maximum sediment concentrations (Table 6-27).

Measurement Endpoint 3: Comparison of Maximum Sediment Concentrations to Background

The third measurement endpoint evaluated was the comparison of maximum chemical concentrations in sediment to background. Of the identified COPCs, maximum concentrations of aluminum, barium, beryllium, cobalt, copper, iron, manganese, mercury, nickel, vanadium, zinc, and total PAHs exceed background (Tables 6-22 and 6-27). Mercury and PAHs were detected in Source Area 2, but not in the background sample. The maximum concentration of aluminum (13,600 mg/kg) in sediment at Source Area 2 is 21 times the background concentration (642 mg/kg). The maximum concentration of barium (429 mg/kg) in sediment at Source Area 2 is 17 times the background concentration (24.6 mg/kg). Maximum concentrations of cobalt (92.8 mg/kg) and nickel (35.6 mg/kg) are 11 times background concentrations (8.1 mg/kg and 3 mg/kg, respectively). The maximum concentration of copper in sediments in Source Area 2 (31.9 mg/kg) is nine times the background concentration (3.4 mg/kg). Maximum concentrations of vanadium, zinc, beryllium, and manganese are seven times that of background concentrations. The maximum concentration of iron (28,800 mg/kg) in sediments in Source Area 2 is two times the background concentration (12,500 mg/kg).

6.6.3.3 Avian Wildlife

The CSM identifies protection of the survival, growth, and reproduction of birds from impacts of COPCs in sediment and food as an assessment endpoint. The following measurement endpoints were evaluated as indicators of risk to birds:

- Screening level comparison of maximum case scenario doses ingested through the food web to NOAEL and LOAEL based benchmarks protective of birds
- Comparison of 95 percent UCLM case scenario doses ingested through the food web to NOAEL and LOAEL based benchmarks protective of birds
- Comparison of maximum case scenario doses to background doses.

The 95 percent UCLM concentration for chemicals detected in surface water and Source Area 2 sediments could not be calculated, and the maximum concentrations were used in their stead. Comparisons using 95 percent UCLM concentrations in surface water and Source Area 2 sediments are the same as comparisons made using maximum concentrations.

Currently, there are no identified NOAEL- and LOAEL-based TRVs for total PAHs; however, total LMW PAHs and HMW PAHs have avian NOAEL- and LOAEL-based TRVs and were evaluated in place of total PAHs.

6.6.3.3.1 Source Area 1

Measurement Endpoint 1: Comparison of Maximum Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Piscivorous Birds
The HQ for each chemical is calculated based on the comparison of the dose from maximum concentrations in sediment to the NOAEL and the LOAEL.

Dose modeling and comparisons to NOAELs and LOAELs using maximum EPCs were made for aluminum, barium, lead, vanadium, zinc, total LMW PAHs, and total HMW PAHs. None of the maximum case scenario HQs equaled or exceeded 1.0 for piscivorous birds (Table 6-28). Beryllium, cyanide, iron, and TPH-DRO cannot be evaluated in this measurement endpoint due to lack of avian NOAEL- and LOAEL-based TRVs.

Measurement Endpoint 2: Comparison of 95 Percent UCLM Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Birds
Dose modeling and comparisons to NOAELs and LOAELs using 95 percent UCLM EPCs were made for aluminum, barium, lead, vanadium, zinc, total LMW PAHs, and total HMW PAHs. None of the 95 percent UCLM case scenario HQs equaled or exceeded 1.0 for piscivorous birds (Table 6-29). Beryllium, cyanide, iron, and TPH-DRO cannot be evaluated in this measurement endpoint due to lack of avian NOAEL- and LOAEL-based TRVs.

Measurement Endpoint 3: Comparison of Maximum Case Scenario Modeled Doses to Background Doses

The third measurement endpoint compared maximum case scenario doses to background case scenario doses (Tables 6-23 and 6-28). Maximum case scenario doses for beryllium, iron, and zinc exceed, but are similar to, background case scenario doses. Cyanide, total LMW PAHs, total HMW PAHs, and TPH-DRO were detected in Source Area 1, but not in the background sample. The maximum case scenario modeled dose for lead (0.066 mg/kg-bw/day) is 12 times the background case scenario dose for lead (0.005 mg/kg-bw/day). The maximum case scenario modeled dose for aluminum (5.648 mg/kg-bw/day) is nine times the background case scenario dose for aluminum (0.595 mg/kg-bw/day). The maximum case scenario modeled doses for barium (0.196 mg/kg-bw/day) and vanadium (0.011 mg/kg-bw/day) are four times and three times the respective background case scenario doses (0.045 mg/kg-bw/day and 0.003 mg/kg-bw/day, respectively).

6.6.3.3.2 Source Area 2

Measurement Endpoint 1: Comparison of Maximum Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Piscivorous Birds

The HQ for each chemical is calculated based on the comparison of the dose from maximum concentrations in sediment to the NOAEL and the LOAEL.

Dose modeling and comparisons to NOAELs and LOAELs using maximum EPCs were made for aluminum, barium, cobalt, copper, manganese, mercury, nickel, vanadium, zinc, total LMW PAHs, and total HMW PAHs. None of the maximum case scenario HQs equaled or exceeded 1.0 for piscivorous birds (Table 6-30). Beryllium, cyanide, and iron cannot be evaluated in this measurement endpoint due to lack of avian NOAEL- and LOAEL-based TRVs.

Measurement Endpoint 2: Comparison of 95 Percent UCLM Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Birds

The 95 percent UCLM EPCs for sediment in Source Area 2 equal the maximum concentration EPCs. Therefore, the results of the measurement endpoint 2 comparison are the same as the results of the comparison made under measurement endpoint 1 (Table 6-30).

Measurement Endpoint 3: Comparison of Maximum Case Scenario Modeled Doses to Piscivorous Birds to Background Doses to Piscivorous Birds

The third measurement endpoint compared maximum case scenario doses to piscivorous birds to background case scenario doses to piscivorous birds in Source Area 2 (Tables 6-23 and 6-30). Maximum case scenario doses for iron and manganese exceed, but are similar to, background case scenario doses. Total LMW PAHs, total HMW PAHs, and mercury were detected in Source Area 2, but not in the background sample. The maximum case scenario modeled doses for aluminum (12.272 mg/kg-bw/day) and copper (0.077 mg/kg-bw/day) are 20 times their respective background case scenario doses (0.595 mg/kg-bw/day and 0.003 mg/kg-bw/day, respectively). The maximum case scenario modeled dose for barium (0.410 mg/kg-bw/day) and cobalt (0.084 mg/kg-bw/day) are nine times their respective background case scenario doses (0.045 mg/kg-bw/day and 0.008 mg/kg-bw/day, respectively). The maximum case scenario

modeled doses for beryllium, nickel, vanadium, and zinc are between five and seven times their respective background case scenario doses.

6.6.3.4 Mammalian Wildlife

The conceptual model for the site identifies protection of the survival, growth, and reproduction of mammals from impacts of COPCs in sediment and food as an assessment endpoint. The conceptual model identified representative receptors from predator (piscivores) feeding guild for assessment. The following measurement endpoints were evaluated as indicators of risk to mammals:

- Screening level comparison of maximum case scenario doses ingested through the food web to NOAEL- and LOAEL-based benchmarks protective of mammals

- Comparison of 95 percent UCLM case scenario doses ingested through the food web to NOAEL- and LOAEL-based benchmarks protective of mammals.

Comparison of 95 percent UCLM concentrations to benchmarks is given the second most weight as an indicator of population-wide risks with the understanding that results must be interpreted in light of spatial distribution; however, the 95 percent UCLM concentration for chemicals detected in surface water and Source Area 2 sediment could not be calculated and the maximum concentrations were used in their stead. Comparisons using 95 percent UCLM concentrations in surface water are the same as comparisons made using maximum concentrations (Table 6-31).

Currently, there are no identified NOAEL- and LOAEL-based TRVs for total PAHs; however, total LMW PAHs and HMW PAHs have mammalian NOAEL- and LOAEL-based TRVs and were evaluated in place of total PAHs.

6.6.3.4.1 Source Area 1

Measurement Endpoint 1: Comparison of Maximum Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Mammals

For this measurement endpoint, the HQ for each chemical is calculated based on the comparison of the dose from maximum concentrations in sediment and surface water to the NOAEL- and LOAEL-based TRVs. Dose modeling and comparisons to NOAEL-based literature TRVs using maximum EPCs identified one chemical (aluminum) for piscivorous mammals as having an HQ equaling or exceeding 1.0 (Table 6-31). No chemicals detected in Source Area 1 had an HQ equaling or exceeding 1.0 when dose modeling and comparisons to LOAEL-based literature TRVs were made using maximum EPCs.

Iron and TPH-DRO cannot be evaluated in this measurement endpoint due to lack of mammalian NOAEL- and LOAEL-based TRVs.

Measurement Endpoint 2: Comparison of 95 Percent UCLM Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Mammals

For this measurement endpoint, the HQ for each chemical is calculated based on the comparison of the dose from 95 percent UCLM concentrations in sediment and water to the NOAEL- and LOAEL-based TRVs. One chemical (aluminum) had a calculated 95 percent UCLM that exceeded NOAEL-based TRVs for piscivorous mammals. No chemicals had a calculated 95 percent UCLM that exceeded LOAEL-based TRVs for piscivorous mammals (Table 6-32).

Iron and TPH-DRO cannot be evaluated in this measurement endpoint due to lack of mammalian NOAEL- and LOAEL-based TRVs.

Measurement Endpoint 3: Comparison of Maximum Case Scenario Modeled Doses for Mammals to Background Doses for Mammals

The third measurement endpoint compared maximum case scenario doses to background case scenario doses (Tables 6-24 and 6-31). Maximum case scenario doses for beryllium, iron, and zinc exceed, but are similar to, background case scenario doses. Cyanide, total LMW PAHs, total HMW PAHs, and TPH-DRO were detected in Source Area 1, but not in the background sample. The maximum case scenario modeled dose for lead (0.070 mg/kg-bw/day) is 12 times the background case scenario dose for lead (0.006 mg/kg-bw/day). The maximum case scenario modeled dose for aluminum (6.030 mg/kg-bw/day) is nine times the background case scenario dose for aluminum (0.638 mg/kg-bw/day). The maximum case scenario modeled dose for barium (0.213 mg/kg-bw/day) and vanadium (0.012 mg/kg-bw/day) are four times and three times the respective background case scenario doses (0.051 mg/kg-bw/day and 0.003 mg/kg-bw/day, respectively).

6.6.3.4.2 Source Area 2

Measurement Endpoint 1: Comparison of Maximum Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Mammals

For this measurement endpoint, the HQ for each chemical is calculated based on the comparison of the dose from maximum concentrations in sediment and surface water to the NOAEL- and LOAEL-based TRVs. Dose modeling and comparisons to NOAEL-based literature TRVs using maximum EPCs identified one chemical (aluminum) for piscivorous mammals as having an HQ equaling or exceeding 1.0 (Table 6-33). No chemicals detected in Source Area 2 had an HQ equaling or exceeding 1.0 when dose modeling and comparisons to LOAEL-based literature TRVs were made using maximum EPCs.

Iron cannot be evaluated in this measurement endpoint due to lack of mammalian NOAEL- and LOAEL-based TRVs.

Measurement Endpoint 2: Comparison of 95 Percent UCLM Case Scenario Modeled Doses to NOAEL and LOAEL Benchmarks Protective of Mammals

For this measurement endpoint, the HQ for each chemical is calculated based on the comparison of the dose from 95 percent UCLM concentrations in sediment and water to the NOAEL- and LOAEL-based TRVs. The 95 percent UCLM EPCs in Source Area 2 are equal the maximum EPCs in Sources Area 2, and the results of the measurement endpoint 2 comparison are the same as the results of the measurement endpoint 1 comparison (Table 6-33).

Measurement Endpoint 3: Comparison of Maximum Case Scenario Modeled Doses to Piscivorous Mammals to Background Doses to Piscivorous Mammals

The third measurement endpoint compared maximum case scenario doses to piscivorous mammals to background case scenario doses to piscivorous mammals (Tables 6-24 and 6-33). Maximum case scenario doses for iron and manganese exceed, but are similar to, background case scenario doses. Total LMW PAHs, total HMW PAHs, and mercury were detected in Source Area 2, but not in the background sample. The maximum case scenario modeled dose for aluminum (13.096 mg/kg-bw/day) and copper (0.082 mg/kg-bw/day) are 20 times their respective background case scenario doses (0.638 mg/kg-bw/day and 0.003 mg/kg-bw/day, respectively). The maximum case scenario modeled dose for barium (0.440 mg/kg-bw/day) and cobalt (0.090 mg/kg-bw/day) are 8 and 10 times their respective background case scenario doses (0.051 mg/kg-bw/day and 0.008 mg/kg-bw/day, respectively). The maximum case scenario modeled doses for beryllium, nickel, vanadium, and zinc are between five and seven times their respective background case scenario doses.

6.6.3.5 Risk Characterization Results

6.6.3.5.1 Aquatic Organisms

When maximum concentrations and 95 percent UCLM EPCs are compared to TRVs protective of aquatic organisms, aluminum and barium are in exceedance.

Aluminum

With concentrations ranging from 102 to 190 µg/L, all five surface water samples had an aluminum concentration that exceeded the chronic TRV protective of aquatic organisms (87 µg/L). The background sample SPP-SW-01, located upriver of the site, had the lowest aluminum concentration in surface water (102 µg/L), but still exceeded the TRV. The maximum EPC exceeds the TRV (87 µg/L), with an HQ of 2.18. Aluminum also has an HQ greater than 1.0 (2.08 µg/L) when the 95 percent UCLM is compared to the aquatic organism chronic TRV, but not when compared to the acute TRV. The chronic TRV is based on a striped bass toxicity test, which is a species not expected to be found in the Nanticoke River, and the EPA notes that they are aware of many high-quality water bodies with concentrations higher than 87 µg/L. Because the acute TRV is not exceeded, the similarity of Source Areas 1 and 2 with the upstream reference, and the uncertainty associated with the toxicity value, the finding of the SLERA is that aluminum unlikely to pose risks to aquatic organism populations at the site.

Barium
With concentrations ranging from 101 to 104 µg/L, all five surface water samples had a barium concentration that exceeded the chronic, but not the acute TRV protective of aquatic organisms. The maximum concentration exceeds the chronic TRV with an HQ of 26. The 95 percent UCLM EPC for barium also exceeds the chronic TRV protective of aquatic organisms, with an HQ of 25.8. The 95 percent UCLM EPC for barium does not exceed the acute TRV (110 µg/L). The concentration of barium found in the background sample is similar to the maximum detected concentration. Finally, the chronic barium water quality value of 3.9 µg/L is a Tier II value calculated using Great Lakes methodology, and is not based on a comprehensive toxicological database. Because the acute TRV is not exceeded, site concentrations are similar to upstream concentrations, and the source of the chronic TRV is not strong, the finding of the SLERA is that barium is unlikely to pose risks to aquatic organism populations at the site.

6.6.3.5.2 Benthic Invertebrates in Source Area 1

When maximum sediment EPCs in Source Area 1 are compared to TRVs protective of benthic invertebrates, lead, zinc, and total PAHs have HQs greater than 1.0.

Lead
Lead was detected in all seven sediment samples in Source Area 1. Only the maximum detected concentration (73.3 mg/kg at SPP-SD-01) exceeded the TRV protective of benthic organisms. Location SPP-SD-01 is located near the SPP, closest to the plant's cooling water intake/discharge pipes and pipe vaults. It is also located immediately downstream of a potential discharge point. The HQ was less than 1.0 when the 95 percent UCLM EPC for lead was compared to the LOAEL-based TRV (128 mg/kg). Although the 95 percent UCLM EPC for lead in Source Area 1, and the lead concentration in the sediment sample taken at SPP-SD-01 exceed the chronic TRV protective of benthic invertebrates, lead concentration results from the remaining six locations in Source Area 1 do not; lead is unlikely to pose a risk to benthic invertebrate populations in Source Area 1.

Zinc
Zinc was detected in all seven sediment samples in Source Area 1. Only the maximum detected concentration (125 mg/kg at SPP-SD-01) exceeded the chronic TRV protective of benthic organisms. Location SPP-SD-01 is located near the SPP, closest to the plant's cooling water intake/discharge pipes and pipe vaults. It is also located immediately downstream of the potential discharge point. The HQ was less than 1 when the 95 percent UCLM EPC for zinc was compared to the LOAEL-based TRV (459 mg/kg). Although the zinc concentration in the sediment sample taken at SPP-SD-01 exceeds the chronic TRV protective of benthic invertebrates, zinc concentration results from the remaining locations do not exceed; zinc is unlikely to pose a risk to benthic invertebrate populations in Source Area 1.

Total PAHs
Total PAHs was calculated for all seven locations in Source Area 1. Four locations (SPP-SD-01, SPP-SD-02, SPP-SD-06, and SPP-SD-10) had total PAHs concentrations that exceed the chronic TRV protective of benthic invertebrates (1.61). Total PAHs concentrations at locations

SPP-SD-02 (2.152 mg/kg) and SPP-SD-06 (1.753 mg/kg) exceeded the chronic TRV just slightly. Total PAHs concentrations at SPP-SD-01 (32.806 mg/kg) and SPP-SD-10 (17.837 mg/kg) exceeded the chronic TRV, with HQs of 20.4 and 11.1, respectively. Only location SPP-SD-01 exceeded the PEL of 32.8 mg/kg, with a concentration essentially the same as the PEL. Location SPP-SD-01 is located near the SPP, closest to the plant's cooling water intake/discharge pipes and pipe vaults. It is also located immediately downstream of the potential discharge point. Location SPP-SD-10 is southwest of sampling locations SPP-SD-01 through SPP-SD-09, and is down river, in the direction of flow, from Source Area 2. When the maximum EPC for total PAHs is compared to the LOAEL-based TRV, the HQ is greater than 1.0 (1.44). Because only a single sample (SPP-SD-01) was found at essentially the PEL, and most samples are well below this concentration total PAHs are unlikely to pose a risk to benthic invertebrate populations in Source Area 1.

6.6.3.5.3 Benthic Invertebrates in Source Area 2

When maximum sediment EPCs in Source Area 2 are compared to TRVs protective of benthic invertebrates, copper, iron, manganese, mercury, nickel, zinc, and total PAHs have HQs greater than 1.0. No maximum EPCs exceed the LOAEL-based TRVs.

Copper

Copper was detected in both sediment samples in Source Area 2, but only one location (31.9 mg/kg at SPP-SD-03) had a concentration that exceeded the TRV protective of benthic invertebrates (31.6 mg/kg). No concentrations exceeded the LOAEL. When the maximum EPC is compared to the TRV, the HQ is 1.01. Sampling location SPP-SD-03 is located along the shore, closest to the fuel dispensing facility. It is unlikely that copper poses a risk to the benthic invertebrate populations in Source Area 2, and it is important to note that copper was not found to be an issue at Source Area 1.

Iron

Iron was detected in both sediment samples in Source Area 2, but only one location (28,800 mg/kg at SPP-SD-03) had a concentration that exceeded the TRV protective of benthic invertebrates (20,000 mg/kg). When the maximum EPC is compared to the TRV, the HQ is 1.44. When compared to the LOAEL the HQ was less than 1. Sampling location SPP-SD-03 is located along the shore closest to the fuel dispensing facility. It is unlikely that iron poses a risk to the benthic invertebrate populations in Source Area 2, and as noted for copper, iron was not identified as an issue at Source Area 1.

Manganese

Manganese was detected in both sediment samples in Source Area 2, but only one location (618 mg/kg at SPP-SD-03) had a concentration that exceeded the TRV protective of benthic invertebrates (460 mg/kg). When the maximum EPC is compared to the TRV, the NOAEL HQ is 1.34 and the LOAEL HQ is less than 1. Sampling location SPP-SD-03 is located along the shore closest to the fuel dispensing facility. It is unlikely manganese poses a risk to the benthic invertebrate populations in Source Area 2 and was not identified as a problem at Source Area 1.

Mercury
Mercury was detected in both sediment samples in Source Area 2. The maximum EPC for mercury in Source Area 2 was 0.18 mg/kg (sampling location SPP-SD-03), which is equal to the TRV protective of benthic invertebrates (HQ is 1.0). Sampling location SPP-SD-03 is located along the shore closest to the fuel dispensing facility. It is unlikely that mercury poses a risk to the benthic invertebrate populations in Source Area 2 and was not identified as a problem at Source Area 1.

Nickel
Nickel was detected in both sediment samples in Source Area 2, but only one location (35.6 mg/kg at SPP-SD-03) had a concentration that exceeded the TRV protective of benthic invertebrates (22.7 mg/kg). When the maximum EPC for nickel is compared to the TRV, the NOAEL HQ is 1.57 and the LOAEL is less than 1. Sampling location SPP-SD-03 is located along the shore closest to the fuel dispensing facility. Nickel is unlikely to pose a risk to the benthic invertebrate populations in Source Area 2 and was not found to be an issue at Source Area 1.

Zinc
Zinc was detected in both sediment samples in Source Area 2, but only one location (260 mg/kg at SPP-SD-03) had a concentration that exceeded the TRV protective of benthic invertebrates (121 mg/kg). When the maximum EPC for zinc in sediment is compared to the TRV, the NOAEL HQ is 2.15 and the LOAEL HQ is less than 1. Sampling location SPP-SD-03 is located along the shore closest to the fuel dispensing facility. Zinc is unlikely to pose a risk to the benthic invertebrate populations in Source Area 2 and was not found to be an issue at Source Area 1.

Total PAHs
Total PAHs was calculated for both sediment samples in Source Area 2. Total PAHs concentrations exceeded the TRV protective of benthic invertebrates (1.61 mg/kg) at one location (2.255 mg/kg at SPP-SD-03). When the maximum EPC for total PAHs is compared to the NOAEL TRV, the HQ is 1.4 and the LOAEL TRV is less than 1. Sampling location SPP-SD-03 is located along the shore closest to the fuel dispensing facility. It is unlikely that total PAHs poses a risk to the benthic invertebrate populations in Source Area 2.

6.6.3.5.4 Avian Wildlife in Source Area 1

When either maximum EPCs or 95 percent UCLM EPCs are compared to NOAEL- and LOAEL-based TRVs protective of birds, no chemicals detected in Source Area 1 exceed for piscivorous birds. There are no avian NOAEL- or LOAEL-based TRVs for beryllium, cyanide, iron, or TPH-DRO. Aluminum, barium, lead, vanadium, zinc, total LMW PAHs, and total HMW PAHs do not pose risks to piscivorous bird populations in Source Area 1.

6.6.3.5.5 Avian Wildlife in Source Area 2

When either maximum EPCs or 95 percent UCLM EPCs are compared to NOAEL- and LOAEL-based TRVs protective of birds, no chemicals detected in Source Area 2 exceed for piscivorous birds. There are no avian NOAEL- or LOAEL-based TRVs for beryllium, cyanide, or iron. Aluminum, barium, cobalt, copper, manganese, mercury, nickel, vanadium, zinc, total LMW PAHs, and total HMW PAHs do not pose risks to piscivorous bird populations in Source Area 2.

6.6.3.5.6 Mammalian Wildlife in Source Area 1

In Source Area 1, only aluminum had an HQ equal to or exceeding 1.0 in both the comparison of maximum case scenario modeled doses and the comparison of 95 percent UCLM case scenario modeled doses to NOAEL-based TRVs. No chemicals had an HQ equal to or exceeding 1.0 in either the comparison of maximum case scenario modeled doses or the comparison of 95 percent UCLM case scenario modeled doses to LOAEL-based TRVs. Iron and TPH-DRO cannot be evaluated in this measurement endpoint due to lack of mammalian NOAEL- and LOAEL-based TRVs. Aluminum likely poses a risk to piscivorous mammals at the site, though there is uncertainty involved.

6.6.3.5.7 Mammalian Wildlife in Source Area 2

In Source Area 2, only aluminum had an HQ equal to or exceeding 1.0 in the comparison of maximum case scenario modeled doses to NOAEL-based TRVs. No chemicals had an HQ equal to or exceeding 1.0 in the comparison of maximum case scenario modeled doses to LOAEL-based TRVs. Iron cannot be evaluated in this measurement endpoint due to lack of mammalian NOAEL- and LOAEL-based TRVs. There is not enough sample data to determine if aluminum poses a risk to piscivorous mammalian wildlife in Source Area 2.

6.7 UNCERTAINTY EVALUATION

This ERA for the Site incorporates a number of uncertainties associated with the estimates of ecological risk. As directed in the ERA guidance (EPA 1997b), a conservative approach was utilized in the ERA to ensure that chemicals eliminated from consideration do not pose risks to ecological receptors. Accordingly, the risks are likely to be overestimated. The main areas of uncertainty associated with the ERA are grouped under the following categories, each of which is discussed in the following subsections:

- Environmental Sampling and Analysis
- Analysis of Chemical Data
- Analysis of Estimated Exposure and Toxicity Data
- Assessment of Risks.

6.7.1 Environmental Sampling and Analysis

Of the potential uncertainties associated with the environmental sampling at the Site, the sample design is likely to have the greatest impact on the evaluation of risks to ecological resources. There is always a possibility that the study design could miss samples where chemicals are present. The limited sample data for Source Area 2 (two sediment samples), also creates uncertainties in identifying nature and extent of contamination.

In an effort to address the uncertainties just discussed, and in accordance with the conservative nature of SLERAs, samples were biased to areas of likely contamination in an effort to characterize the areas that were most impacted from historic activities. With the exception of fixed or limited mobility receptors (e.g., vegetation and benthic invertebrates), ecological receptors are unlikely to utilize only those areas of highest contamination, and are more likely to forage over a larger area that includes areas of contamination as well as less contaminated outlying areas.

6.7.2 Analysis of Chemical Data

The maximum concentration of a pair of duplicate or split samples (taken from the same location on the same date) was used to represent the concentration for that location. Selecting the maximum concentration of a chemical detected in duplicate samples for use in the ERAs is a conservative measure and may overestimate risks. The 95 percent UCLM was used as an upper estimate of mean exposures. This exposure scenario is conservative and may also overestimate ecological risks presented in this report.

Chemicals that are not detected in any onsite samples are considered not to be present at the site, because based on the analytical tools and capabilities at the time of investigation, there is no evidence indicating that these chemicals are present. Risks from these non-detected chemicals cannot be determined; therefore, the assessment of risk from these non-detected chemicals remains an uncertainty in this ERA.

6.7.3 Analysis of Estimated Exposure and Toxicity Data

The estimation of receptor exposure to COPCs is a major source of uncertainty in this ERA. Generally, the models used to estimate exposures from sediment and prey were created to represent a worst-case scenario of possible risks to the receptor groups, and thus, many conservative assumptions were incorporated into the models.

Risks to piscivorous birds and mammals were evaluated, in spite of a lack of appropriate habitat for either receptor. In the food web modeling, piscivorous birds and mammals were also assumed to consume only fish, when in reality their diet likely includes a variety of organisms in addition to their primary diet of fish. The bioaccumulation of a chemical in a prey organism was estimated from the maximum detected concentration in surface water. Also, a BAF of 1.0 was used to estimate chemical concentrations in prey (i.e., fish) for which literature-based BAFs were not available. This accumulation factor is expected to provide a conservative estimate of

accumulation for all chemicals that are not bioaccumulative. Additionally, for the SLERA the models assume that receptors are exposed to the maximum detected concentration of chemicals over their entire foraging range. This approach is consistent with the objectives of the screening-level assessment, which is to estimate a worst-case scenario under which risks would not be underestimated. It is expected, however, that such a conservative scenario would overestimate risk.

In addition, there is uncertainty associated with the lack of formal literature-based TRVs for certain chemicals. TRVs could not be established or derived for some chemicals because adequate toxicity information could not be found in the scientific literature. Given the absence of methods for estimating risks from exposure to chemicals with no appropriate TRVs, it is not possible to estimate the uncertainty associated with the limitation. It is not possible to indicate if the impacts result in an underestimate or overestimate of potential ecological risks. Presumably, either scenario is possible. Consequently, risks to ecological receptors resulting from exposure to these chemicals without TRVs cannot be quantitatively assessed

There is also uncertainty associated with toxicological evaluation of essential nutrients; these include calcium, magnesium, potassium, and sodium. These chemicals are necessary for metabolic processes in organisms and, thus, are considered essential nutrients for wildlife. At naturally occurring concentrations, receptors are able to regulate uptake and metabolism of these elements. However, as with all chemicals, it is possible that nutrients may produce toxic effects at very highly elevated concentrations. These four chemicals do not have screening level concentrations or TRVs. As these metals are essential nutrients, adverse effects to organisms can occur if concentrations are either too low (causing deficiency symptoms) or too high (causing toxic symptoms). However, organisms can adapt to different levels of these metals, although there is little information available regarding concentrations at which adverse effects of either type may be observed. Because screening-level concentrations and TRVs are not available for the essential nutrients, it is not possible to quantitatively assess the potential for risks to ecological receptors from them.

6.7.4 Assessment of Risks

There are uncertainties associated with the assessment of risks in the ERA for the Site. One apparent uncertainty results from the extrapolation of assumptions about the potential for adverse effects from individual organisms to populations. The intent of this ERA, as set forth in the assessment endpoints, is to ultimately evaluate risks to populations. Few methods are available to extrapolate the potential for adverse effects from the individual level to the population level. It is generally assumed that if there is no potential for direct adverse effects to individual organisms then it is also unlikely for there to be the potential for direct adverse effects to populations. Similarly, it is assumed that if there is the potential for adverse effects to individual organisms there is also the potential for adverse effects to populations. However, it is conservative to assume that potential damage at the individual level will impact the populations in the surrounding ecosystem.

This uncertainty is one of several limitations associated with the use of HQs to determine the potential for risk to ecological receptors. While the HQ is a standard tool in ERAs set forth in EPA guidance (EPA 1997b), an article in the scientific literature points out a number of limitations to the use of this method (Tannenbaum et al. 2003). The use of the HQ identifies a potential for risk as opposed to an actual risk, because the HQ result is not a probability. Because the HQ identifies whether a dose or concentrations exceeds a benchmark, it is not a linear or scalable metric. Also, the HQ cannot be used to quantitatively extrapolate between individual and population level effects. Because HQs are based on NOAELs and on the most sensitive species in a media, HQs are often exceeded by concentrations normally found in the environment. All of these limitations should be considered before using HQ-based estimates of the potential for risk to draw conclusions or make decisions based on assessment results.

Another important uncertainty is the limited ability of risk assessment to assess combined and synergistic effects of chemicals. At the site, ecological receptors are exposed to a chemical mixture; however, comparison of individual chemicals to TRVs does not capture the potential for combined effects. Combined and synergistic effects are usually assessed by performing bioassays. As such, risk assessment conclusions have conservatively identified the potential for synergistic effects, and recommended in certain cases the consideration in risk management of all detected chemicals.

In addition, the assessment of risks was primarily based on the comparison of estimated doses to toxicity values from the literature. There are many uncertainties associated with these evaluation tools and thus, with the assessment of risks based upon them.

6.8 CONCLUSIONS

A conceptual model was developed for the site based on review of site conditions and available data. This model identified that the site provides aquatic habitats, but marginal terrestrial habitat. Based on the conceptual model, assessment endpoints were selected to represent the most sensitive of ecological receptors within the site's ecological community. The assessment endpoints included the survival, growth, and reproduction of aquatic organisms, benthic invertebrates, and piscivorous mammals and birds. Four surface water samples were evaluated together as being representative of the site. Sediment samples were grouped into Source Areas by proximity to likely source areas: Source Area 1 (SPP) – samples SPP-SD-01, SPP-SD-02, and SPP-SD-06 through SPP-SD-10; and Source Area 2 (fuel dispensing terminal south of the SPP) – samples SPP-SD-03 and SPP-SD-04.

Assessment endpoints were defined to reflect the potential impacts of complete and significant exposure pathways discussed above and to aid in identifying representative receptor species. These endpoints included the viability of the aquatic organism community, the viability of the terrestrial and aquatic community as resources for wildlife, and the viability of the terrestrial and aquatic wildlife community. Measurement endpoints were selected to provide a quantifiable means of characterizing risks. The measurement endpoints for aquatic organisms and benthic invertebrates included an initial comparison of maximum concentrations to media-specific screening criteria to identify potential COPCs. Maximum and 95 percent UCLM EPCs were

then compared to receptor specific benchmarks (sediment TRVs [chronic toxicity] and LOAELs [acute toxicity] for benthic organisms and acute and chronic TRVs for aquatic organisms). The benchmarks selected are highly precautionary and thus provide a conservative assessment of site risks.

For higher trophic level wildlife, maximum concentrations were initially compared to media-specific screening criteria to identify potential COPCs. Additional measurement endpoints were based on the results of food web models that predict the dose of chemicals ingested by wildlife. These doses were compared to benchmarks. The first measurement endpoint evaluated was a screening level comparison of maximum case scenario doses to no-effects benchmarks. Additional measurement endpoints included comparison of 95 percent UCLM case scenario doses to no-effects and low-effects benchmarks.

To test the measurement endpoints, both site-specific and literature-based information was used to develop exposure and toxicity data and assumptions for use in estimating risks. These tools were used in the data evaluation to test each measurement endpoint as a line of evidence. Lines of evidence were combined in a qualitative weight-of-evidence discussion to determine the potential for risks.

Based on all lines of evidence no risks to populations of aquatic receptors, including aquatic and benthic organisms and piscivorous mammals and birds, were found.

7. SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The GPR survey determined that five subsurface pipes remain in-situ between the southern wall of the SPP and daylight through the bulkhead along the northern bank of the Nanticoke River (Figure 3-7).

TPH-DRO, 2-methylnaphthalene, benzo(a)pyrene, and arsenic contamination is predominantly located in the subsurface from 2 to 9 ft bgs in the area of the cooling water discharge/intake pipes. The contamination extends approximately 230 ft parallel to the Nanticoke River from boring location SPP-DPT-12 to SPP-09c and from the southern edge of the SPP to the Nanticoke River bulkhead (Figure 4-2). Arsenic, lead, manganese, iron, and TPH-DRO above the applicable criteria were also found in groundwater samples collected from monitoring wells SPP-GW-01, SPP-GW-02, and SPP-GW-04 in this same area (Figure 4-3).

Benzo(a) pyrene is also present in two surface soil samples (SPP-SS-03 and SPP-SS-13) collected west of the existing substation, and north of the SPP, respectively.

Sludge sample SPP-SL-01 has an elevated concentration of benzo(a)pyrene and is associated with a stormwater inlet receiving runoff from north of the Site (High Street and North Pine Street). Sludge sample SPP-SL-02 was collected from a stormwater inlet that collects run-off from inlets along North Front Street and had elevated concentrations of PAHs, cadmium, and lead (Figure 4-6). Both inlets were visually observed to be structurally intact, indicating the contaminant source is likely from offsite or breaches along the stormwater pipes allowing infiltration of impacted Site groundwater.

Surface water samples collected along the mid-river axis of the Nanticoke River had elevated total and dissolved metals impacts (aluminum, barium, and iron). The concentrations in SPP-SW-02 through SPP-SW-05 were consistent with the upstream concentrations in the background sample SPP-SW-01 (Figure 4-4), indicating the metals are either naturally occurring or from an upstream source (not related to the Site).

Two sediment samples (SPP-SD-01 and SPP-SD-02) located adjacent to the cooling water intake/discharge pipe outfalls in the Nanticoke River bulkhead had elevated PAH, lead, and zinc concentrations above the applicable DNREC criteria (Figure 4-5). Based on the observed subsurface soil and groundwater contamination observed in the area surrounding the pipelines, contaminants are were likely transported either, 1) through the pipes during the Site's historical operation, or 2) have seeped through the panels of the bulkhead and settled in the bottom sediments. Based on the RI findings, the exact mode of deposition of the contaminants cannot be determined. Three sediment locations along the mid-stream axis of the Nanticoke River (SPP-SD-06, SPP-SD-08, and SPP-SD-09) had elevated concentrations of PAHs and cyanide. The exact mode of deposition cannot be determined from the FE data; however, it is likely the contaminants were transported to the middle river locations from the Site.

Sediment samples SPP-SD-03, SPP-SD-04, and SPP-SD-10 had elevated concentrations of several PAHs similar to the samples SPP-SD-01 and SPP-SD-2, as well as, elevated metals concentrations not observed in the north bank sediment (Figure 4-5). The lack of PAH and metals impact mid-river, indicated the PAHs and metals observed along the south bank are likely due to source associated with the fuel storage area located across the river from the Site.

The results of the HHRA, which included all media except groundwater, indicates that for a lifetime resident and worker, arsenic in soil has a carcinogenic risk greater than 10^{-5}. No receptors evaluated were at risk from a non-carcinogenic hazard.

The ERA for aquatic and benthic receptors indicates that based on the current Site conditions, terrestrial receptors were not evaluated in the FE. Analysis of the results from the surface water and sediment samples from Area 1 and Area 2 (Figure 6-3) indicate no risk exists to populations or aquatic and benthic organisms, or piscivorous mammals and birds.

7.2 CONCLUSIONS

The extent of soil impacts, both surface and subsurface, from historical electricity generating operations at the Site has been adequately characterized. TPH-DRO, PAH, and metals contamination is present in the area adjacent to the cooling water intake/discharge pipeline between the southern edge of the SPP and Nanticoke River bulkhead. The contaminants, likely from fuel and lubricant leaked into pits in the interior of the SPP have migrated towards the river through either structural breaks in the piping, or through preferential subsurface pathways in the bedding material surrounding the pipe. Subsurface contaminants flow via groundwater towards the south, and the Nanticoke River, where they likely mound against the bulkhead. Hydrostatic pressure then forces contaminants either between the bulkhead panels or through mechanical breaks in the panels into the Nanticoke River.

The impacted groundwater is believed to be confined to the upper Columbia Aquifer, however, no deep groundwater monitoring wells or bedrock wells were installed as part of this FE.

Soil samples collected from north, west, and east of the SPP do not indicate contamination from the Site has impacted these areas of the Site nor migrated off-site in those directions. Low level PAH impacts in SPP-SS-03 and SPP-SS-13 are likely due to non-point source contaminants not associated with historical Site operations.

Sediment samples indicate PAH and metals impacts in the Nanticoke River (SPP-SD-01 and SPP-SD-02) have originated from the Site. The contaminants are concentrated in the location where the cooling water intake/discharge pipes penetrate the Nanticoke River bulkhead. This indicates contaminants are either migrated through the existing pipes or along contaminant impacted soil and groundwater that is in contact with the bulkhead.

Additionally, contamination along the southern bank of the Nanticoke River (SPP-SD-03, SPP-SD-04, and SPP-SD-10) indicates a potential source of sediment impacts from current or historical use of the property opposite the SPP.

The conclusions of the HHRA indicate a carcinogenic risk for arsenic in Site soil for lifetime residents and workers. The residents evaluated include both adults and children representing unrestricted Site use. A Site worker is defined as a worker who may work within the Site buildings and also perform digging or other subsurface activities at the Site.

For the two Site investigation areas defined for the ERA, no risks to aquatic, benthic, mammals, or birds was found at the Site. Future disturbance of the sediment via dredging or construction may cause increases in contaminant levels, however, no such activities are planned for the near future.

Based on the results presented in this FE, EA proposes the following to further delineate the Site contaminants:

- Installation of deeper monitoring wells to assess the vertical distribution of contaminants in the groundwater throughout the Columbia Aquifer.

- Conduct an extended diurnal study to assess the impact of tidal fluctuations on the hydrostatic pressure exerted on the Nanticoke River bulkhead.

The above is proposed prior to moving forward to the FS phase or included in future redevelopment plans for the Site.

In addition, although not attributed to the Site, further delineation of contaminants in sediments that may be occurring from a potential source area along the southern bank of the Nanticoke River could be performed.

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Figures

Legend

Site Boundary

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

Project Number: 1482609

Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 1-1
Site Location Map

Document Path: L:\GIS\Data\Northeast\Delaware\Seaford\PP\MXD\June 2015\Figure 1-1 - Site Location Map.mxd

Legend

- Groundwater Flow Direction
- Groundwater Elevation Contours (5 foot interval)
- Site Boundary
- Groundwater Monitoring Wells

2.09 Groundwater Monitoring Well Elevation (feet)

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

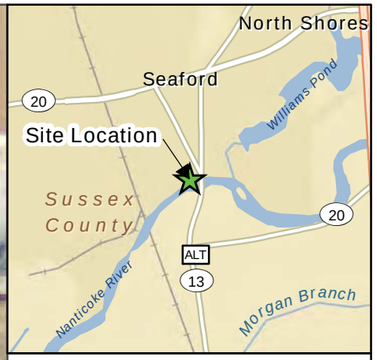
Project Number: 1482609

Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 2-1
Groundwater
Elevation Contours

Document Path: L:\GISData\Northeast\Delaware\Seaford\PP\MXD\June 2015\Figure 2-1 Groundwater Elevation Contours.mxd



Legend

- Site Boundary
- Soil Boring Location

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

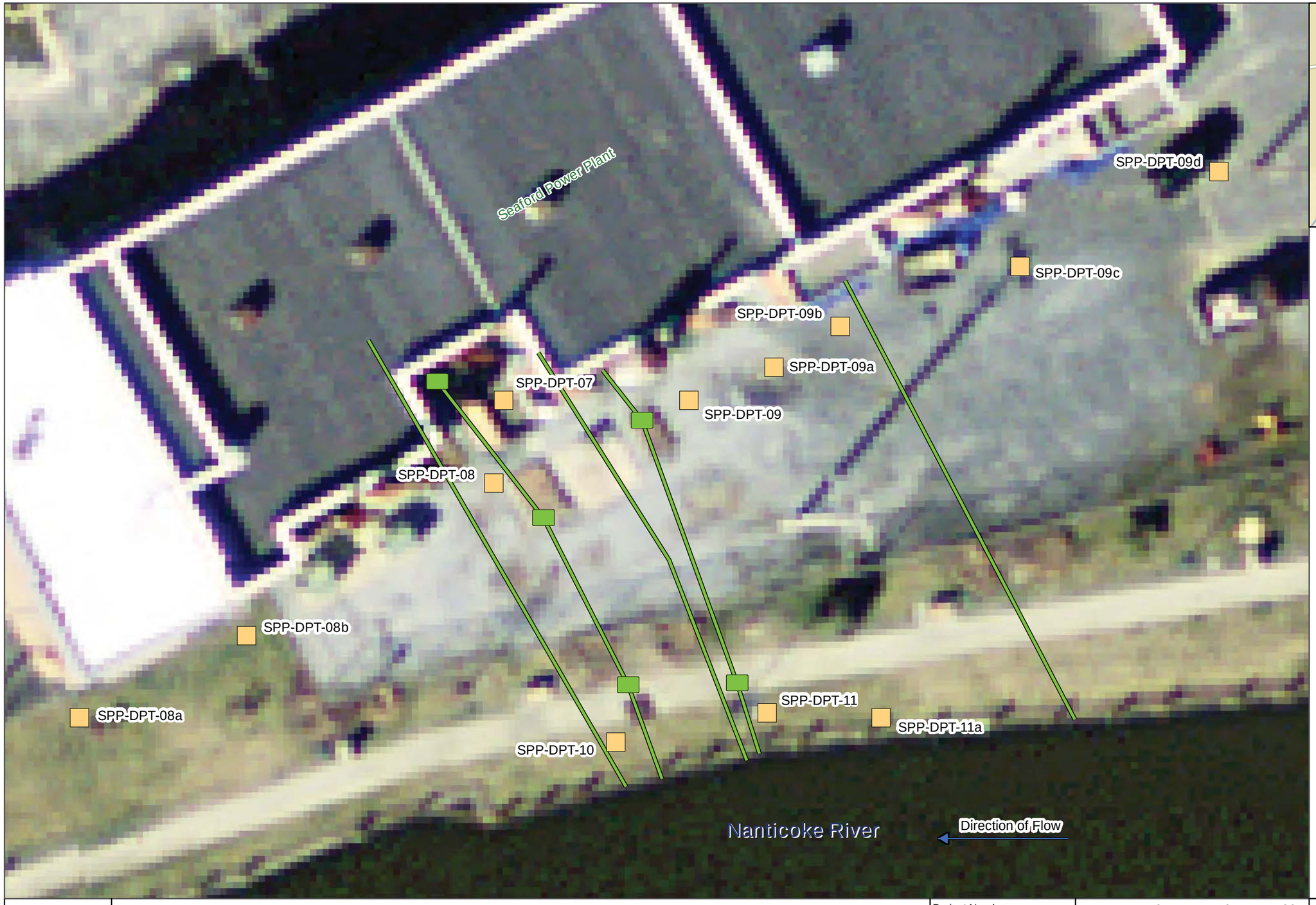
Project Number: 1482609

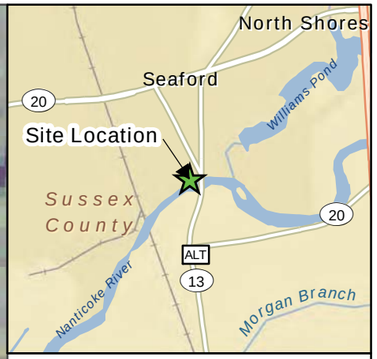
Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 3-1
Soil Boring
Sampling Locations

Document Path: L:\GISData\Northeast\Delaware\SeafordPP\MXD\June 2015\Figure 3-1 - SB Sampling Locations.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Vault
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Soil Boring Location

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

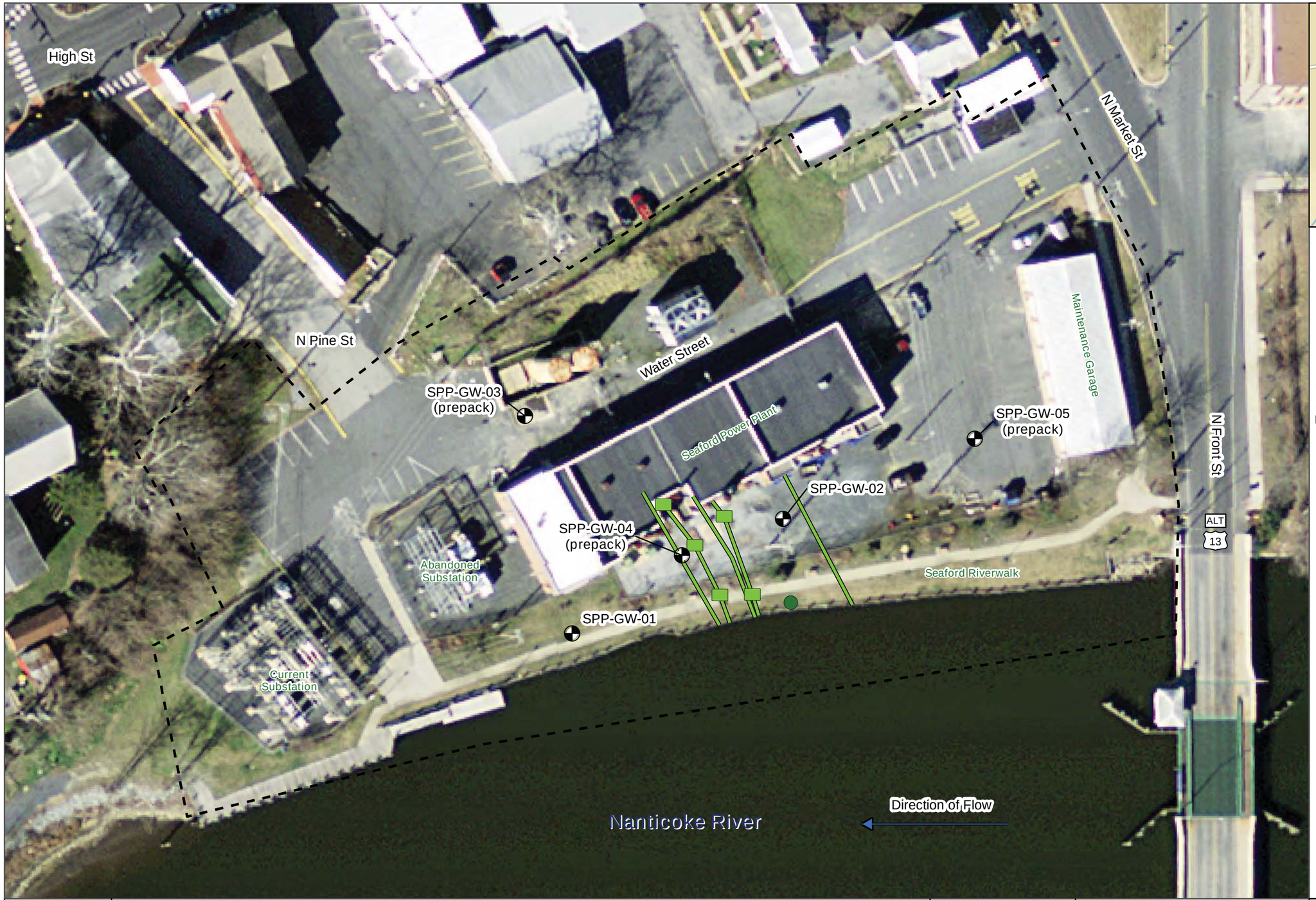
Project Number: 1482609

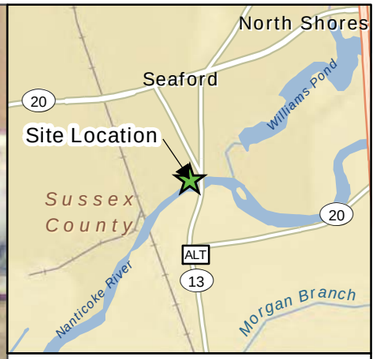
Date: June 2015

0 10 20
Feet
1 inch = 15 feet

Figure 3-2
Soil Boring Sampling Locations
Discharge Piping Area

Document Path: L:\GIS\Data\Northeast\Delaware\Seaford\PPT\MXD\June 2015\Figure 3-2 - Discharge Piping Area.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Groundwater Sample Locations

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

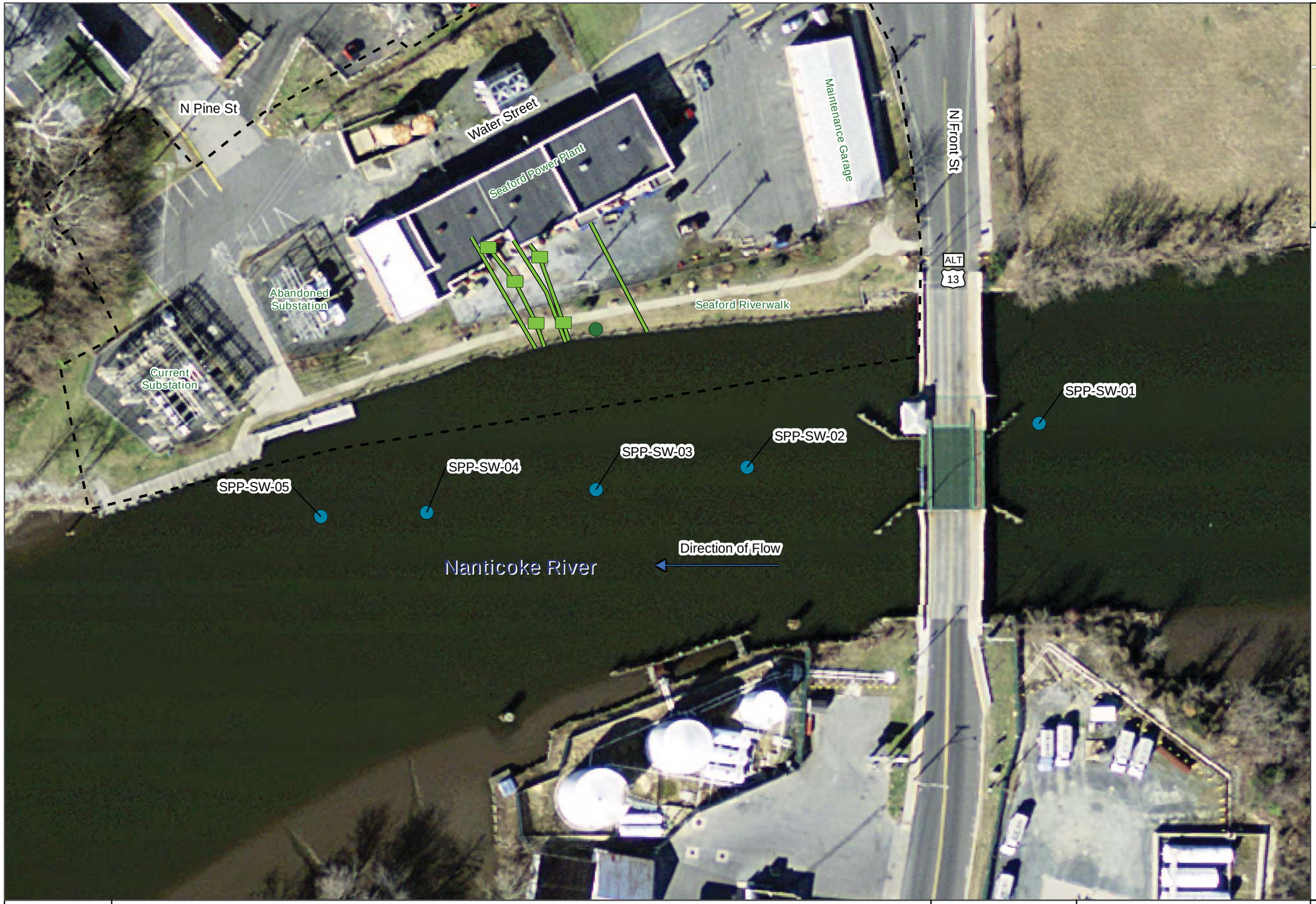
Project Number: 1482609

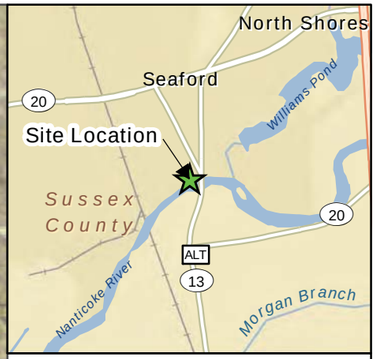
Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 3-3
Groundwater
Sampling Locations

Document Path: L:\GIS\Data\Northeast\Delaware\Seaford\PP\MXD\June 2015\Figure 3-3 - GW Sampling Locations.mxd





Legend

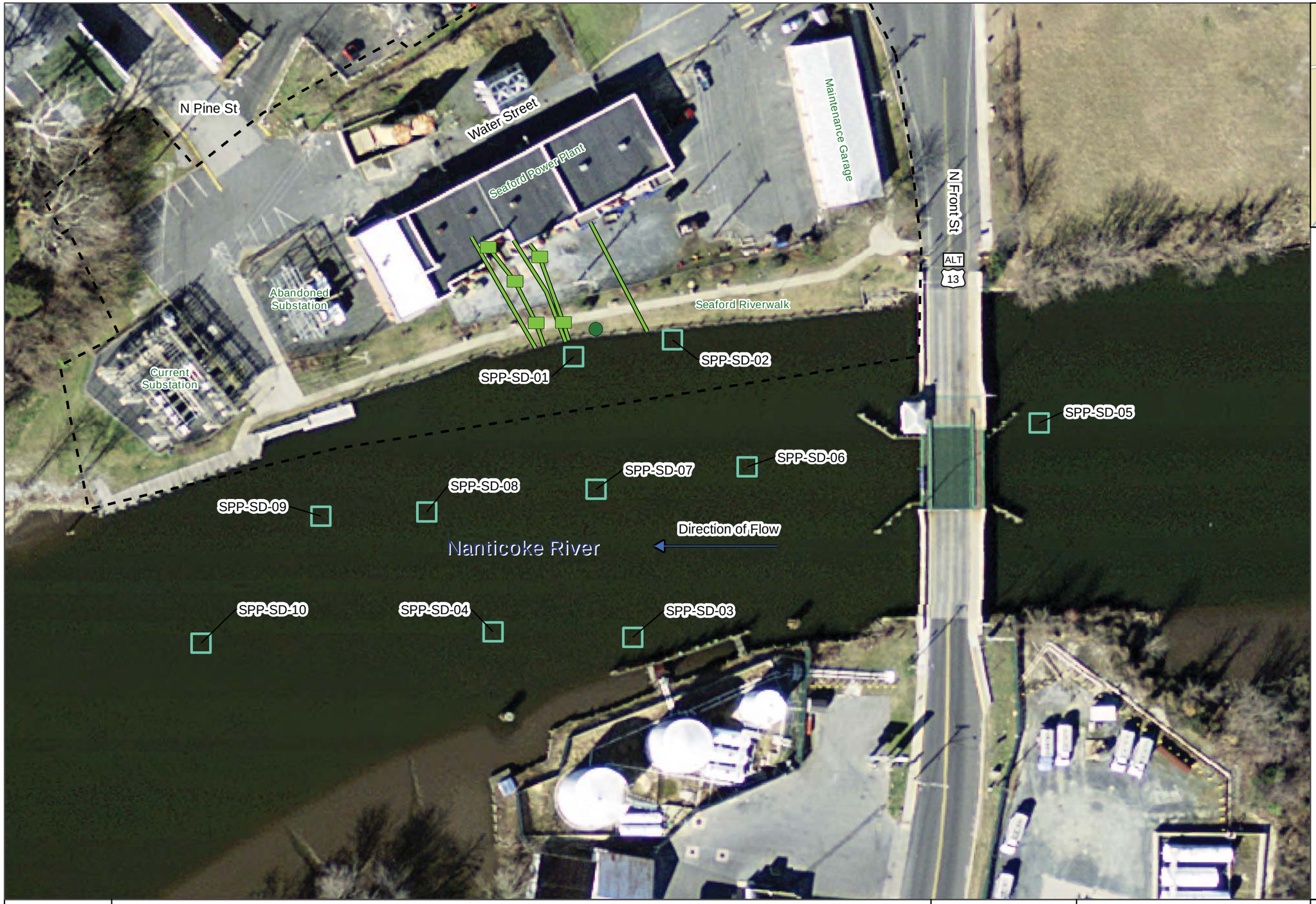
Utility Locations

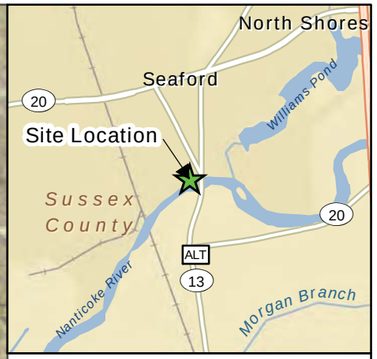
- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Surface Water Sample Location

Aerial Photograph Source:
USGS, 2012

EA	Seaford Power Plant Seaford, Delaware DNREC-SIRS Project DE-1031	Project Number: 1482609 Date: June 2015	0 25 50 Feet 1 inch = 60 feet	Figure 3-4 Surface Water Sampling Locations

Document Path: L:\GIS Data\Northeast\Delaware\Seaford\PPMXD\June 2015\Figure 3-4 - Surface Water Sampling Locations.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Sediment Sample Location

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

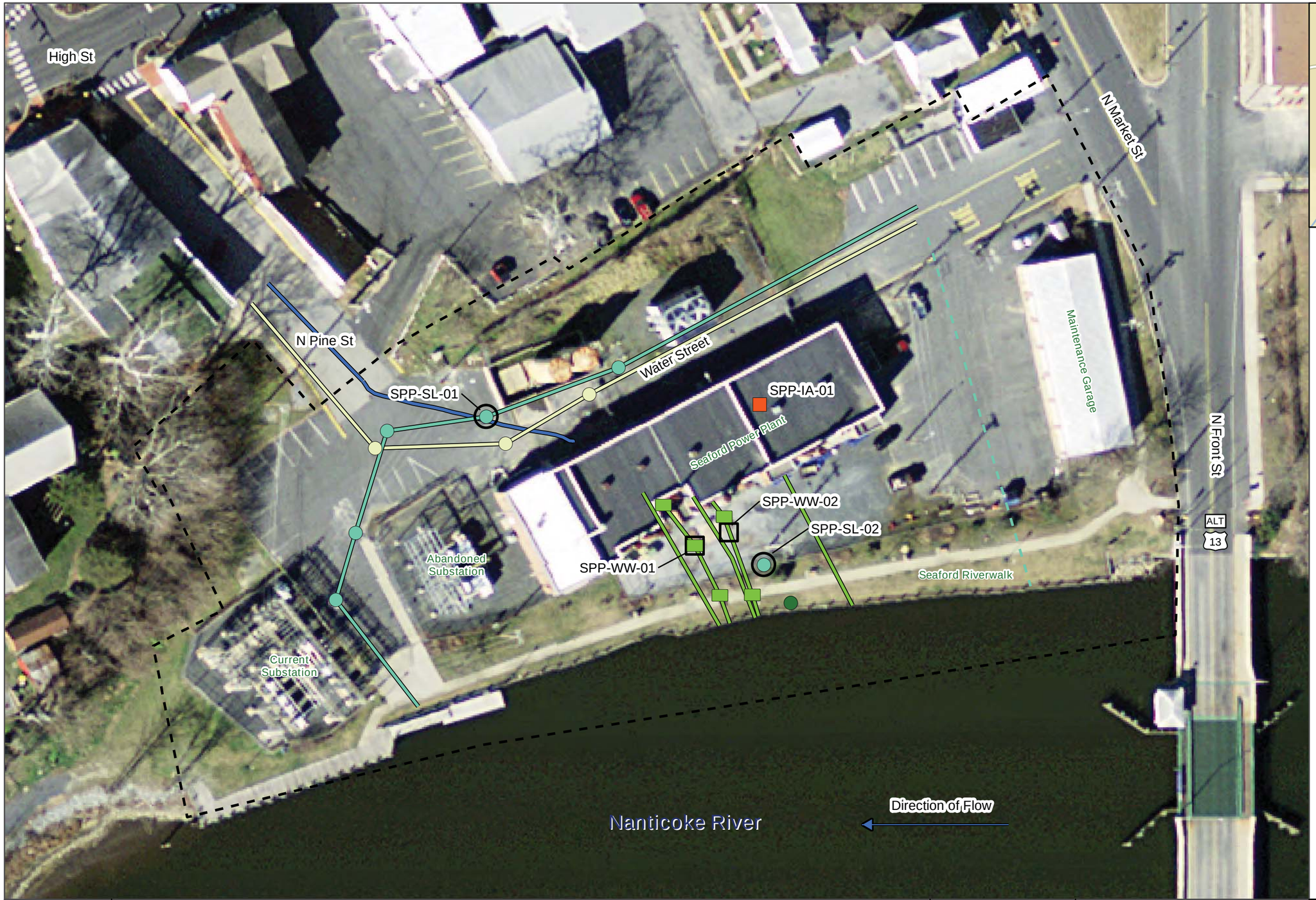
Project Number: 1482609

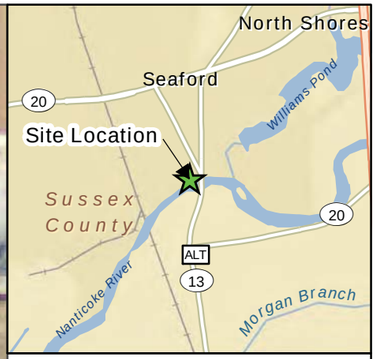
Date: June 2015

0 25 50
Feet
1 inch = 60 feet

Figure 3-5
Sediment
Sampling Locations

Document Path: L:\GIS\Data\Northeast\Delaware\Seaford\PPMXD\June 2015\Figure 3-5 - Sediment Sampling Locations.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Sanitary Sewer
- Stormwater Manhole
- Water
- Cooling Water Intake/Discharge Pipe
- Sanitary Sewer Line
- Stormwater Line
- Stormwater Line (Approximate)
- Site Boundary
- Wastewater Sampling Locations
- Sludge Sampling Locations
- Sub-Slab Soil Vapor

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

Project Number: 1482609

Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 3-6
Sludge/Wastewater and Sub-Slab Soil Vapor Sampling Locations

Document Path: L:\GISData\Northeast\Delaware\Seaford\PPMXD\June 2015\Figure 3-6 - Sludge_Waste Sampling Locations.mxd

Legend

- Electric
- Gas/Petroleum Pipe Line
- Sewer/Drainage
- Unknown
- Water
- GPR Survey Extent for UST
- Concrete Anomaly Observed in Field

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

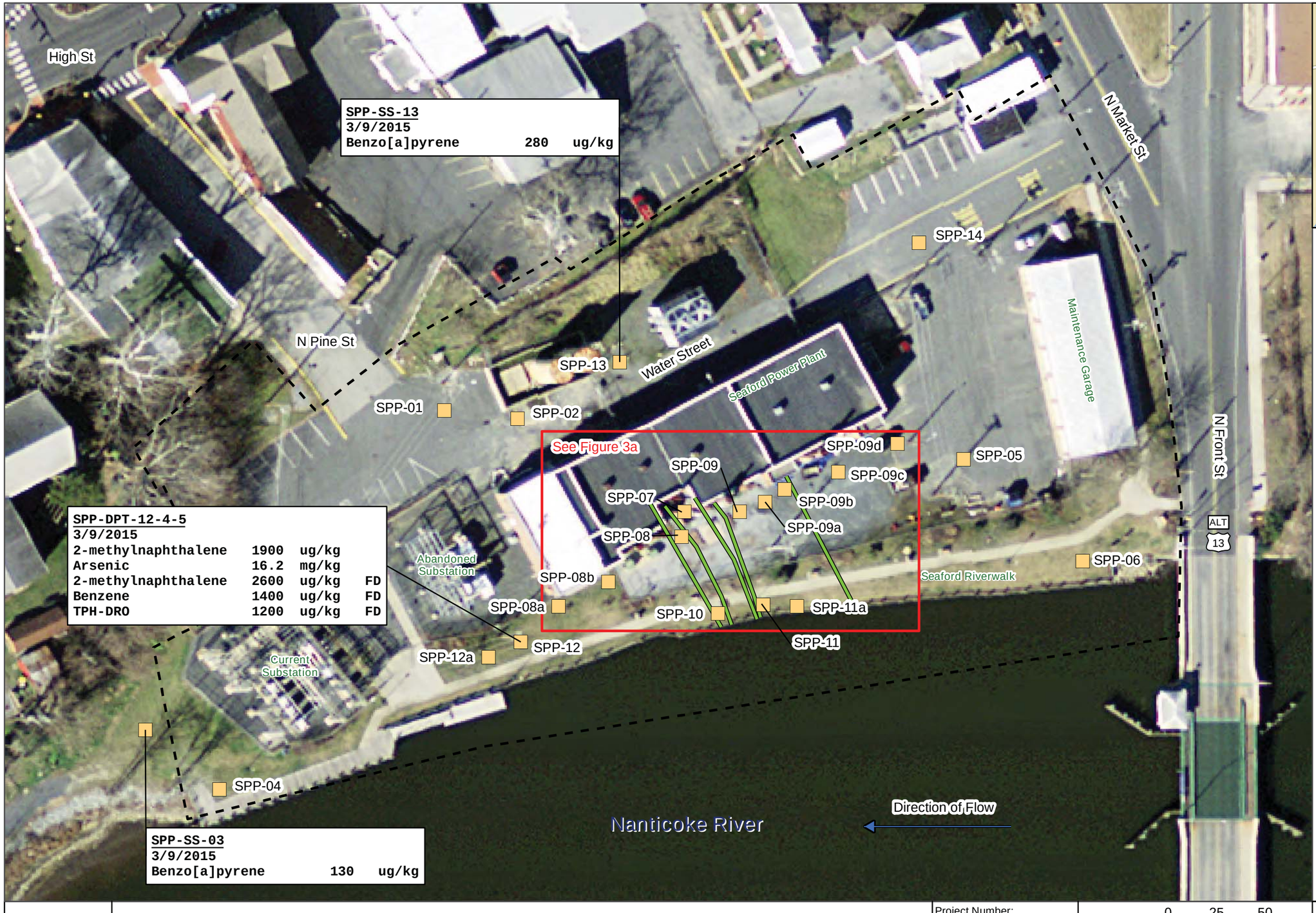
Project Number: 1482609

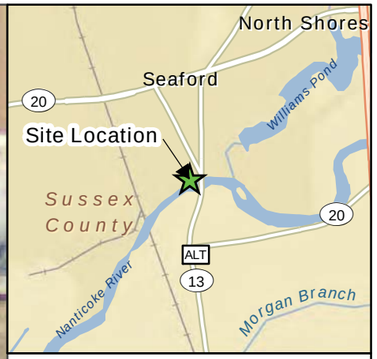
Date: June 2015

0 25 50
Feet
1 inch = 40 feet

Figure 3-7
GPR Survey

Document Path: L:\GISData\Northeast\Delaware\SeafordPP\MXD\June 2015\Figure 3-7 - GPR Survey.mxd





Legend

- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Soil Boring Location

DNREC Soil Screening Criteria dated January 2015

2-methylnaphthalene	1000 ug/kg
Arsenic	11 mg/kg
Benzo(a)pyrene	90 ug/kg
Benzene	1200 ug/kg
Diesel Range Organics:	1000 mg/kg

ug/kg - micrograms per kilogram
mg/kg - millagrams per kilogram
FD - Field Duplicate

SS - Surface Sample Location
DPT - Sub Surface Sample Location

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

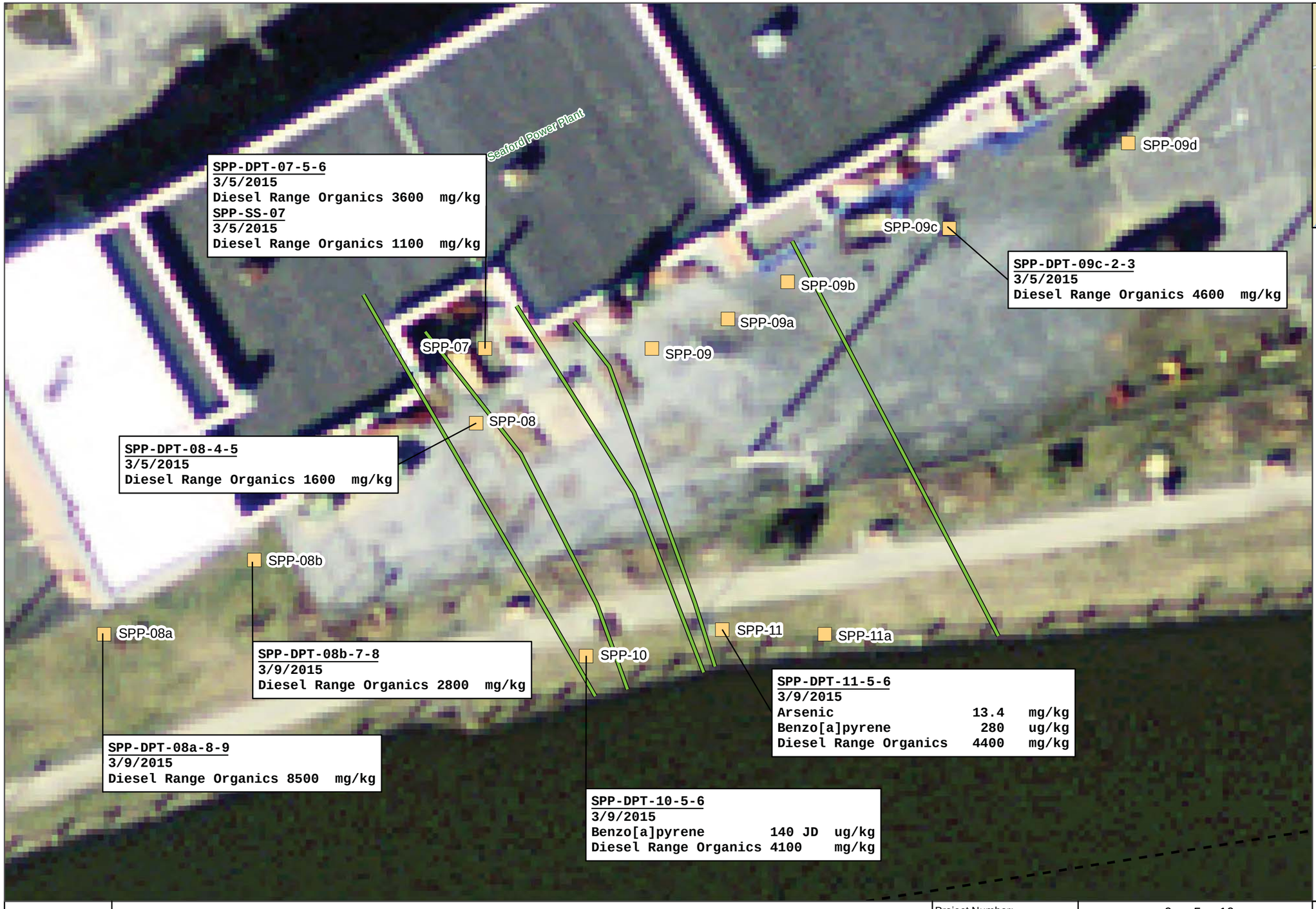
Project Number: 1482609

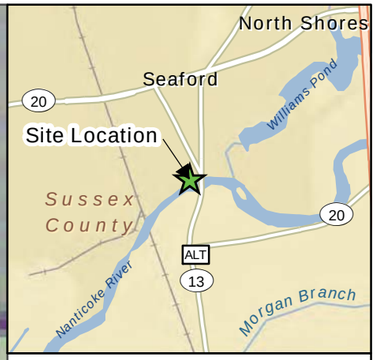
Date: July 2015

0 25 50
Feet
1 inch = 50 feet

Figure 4-1
Soil Samples
Exceeding DNREC Criteria

Document Path: L:\GIS\Data\Northeast\Delaware\SeafordPP\MXD\June 2015\Figure 4-1 - Soil Sampling Results.mxd





Legend

- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Soil Boring Location

DNREC Soil Screening Criteria dated January 2015

Arsenic	11 mg/kg
Benzo(a)pyrene	90 ug/kg
Diesel Range Organics	1000 mg/kg

ug/kg - micrograms per kilogram
mg/kg - millagrams per kilogram
JD - Analyte present. Reported value may not be accurate or precise

SS - Surface Sample Location
DPT - Sub Surface Sample Location

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

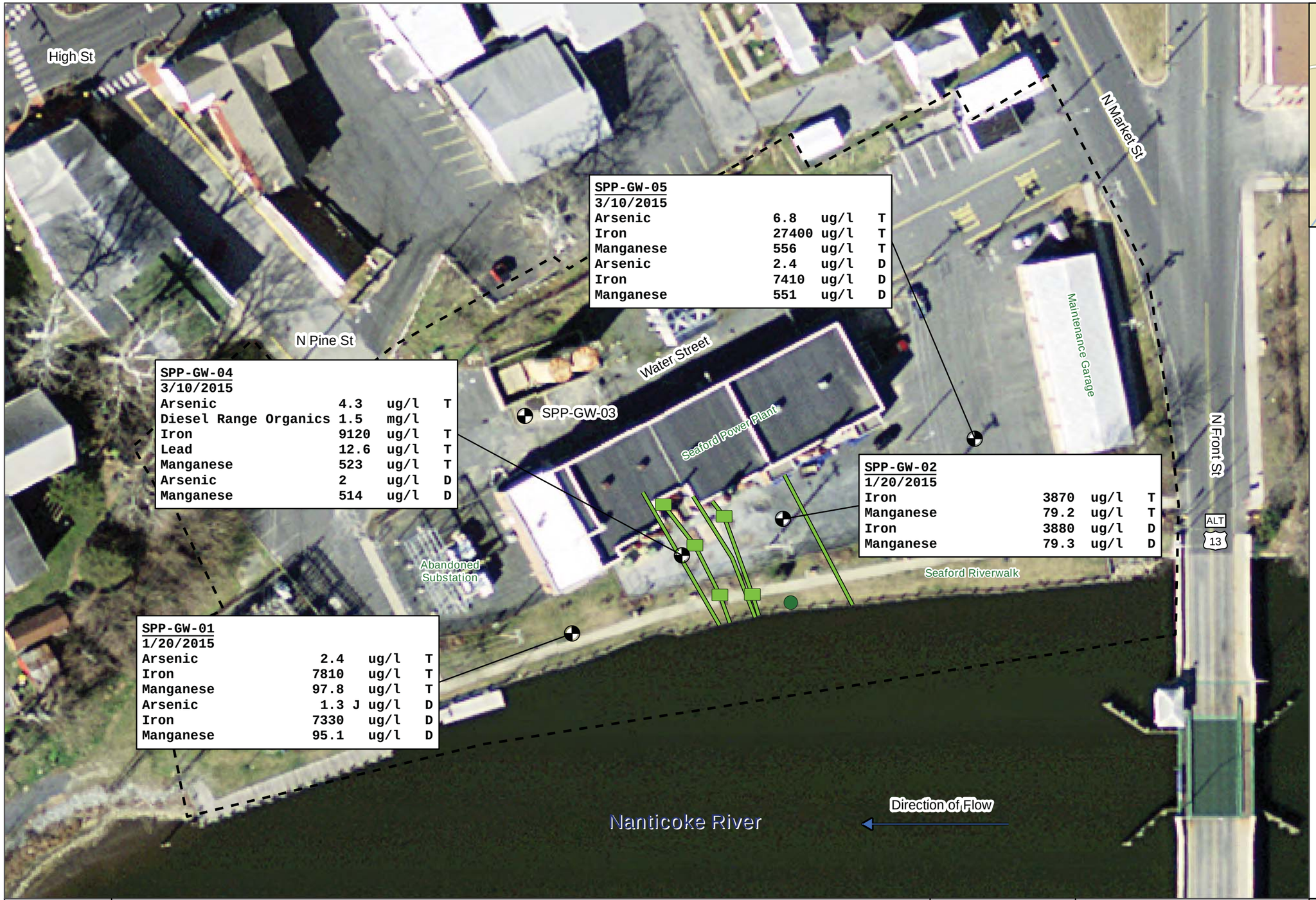
Project Number: 1482609

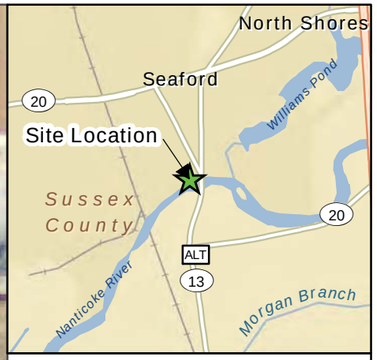
Date: June 2015

0 5 10
Feet
1 inch = 20 feet

Figure 4-2
Soil Samples
Exceeding DNREC Criteria
(Cooling Water Intake)

Document Path: L:\GISData\Northeast\Delaware\SeafordPP\MXD\June 2015\Figure 4-2 - Soil Sampling Results.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Groundwater Sample Locations

DNREC Groundwater Screening Criteria dated January 2015

Arsenic	0.052 ug/l
Iron	1400 ug/l
Manganese	43 ug/l
Diesel Range Organics	0.2 mg/l

ug/l - micrograms per liter
mg/l - millagrams per liter

T - Total
D - Dissolved

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

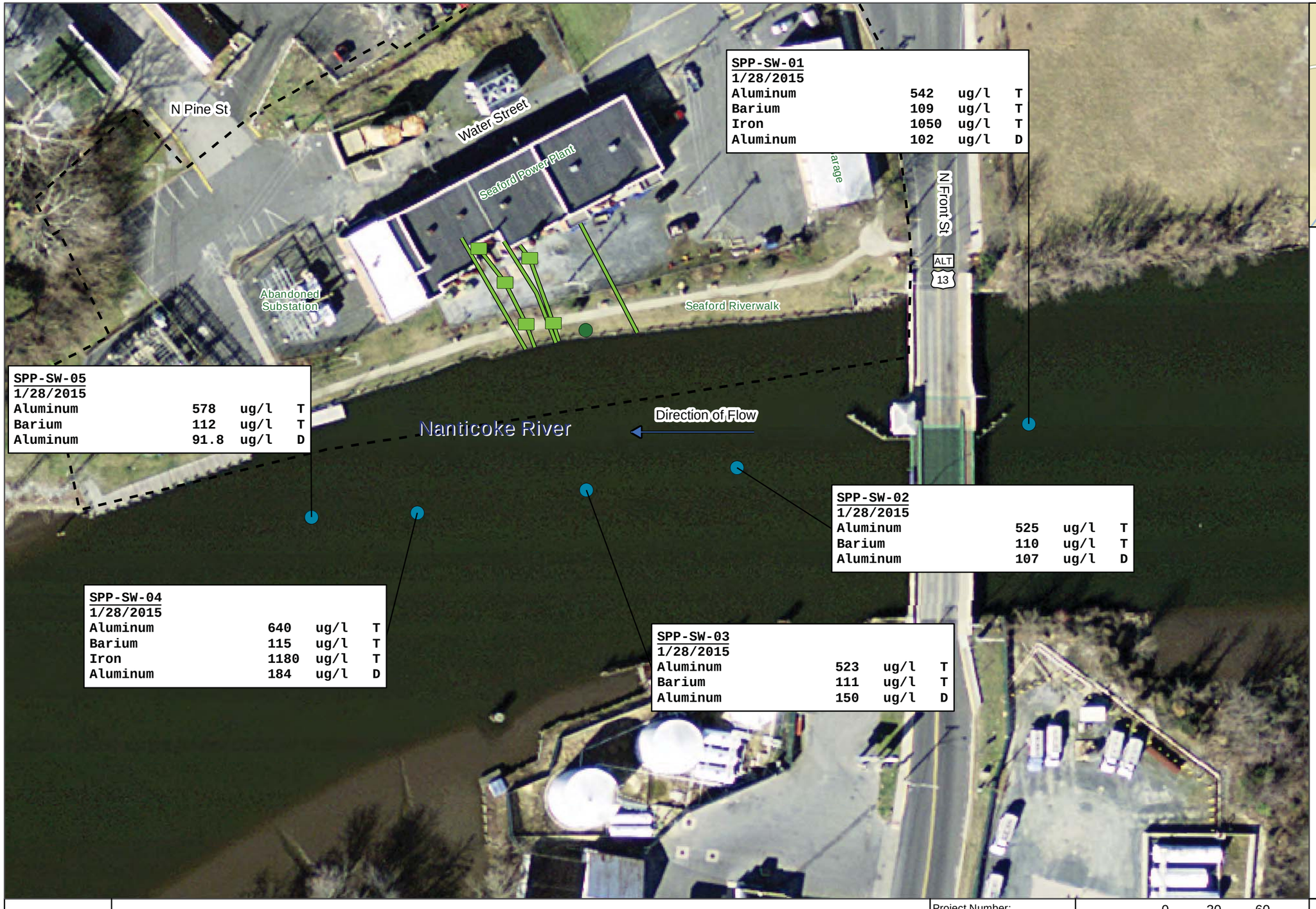
Project Number: 1482609

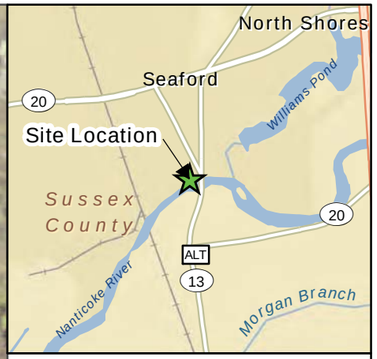
Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 4-3
Groundwater Samples
Exceeding DNREC Criteria

Document Path: L:\GIS Data\Northeast\Delaware\Seaford\PPMXD\June 2015\Figure 4-3 - Groundwater Sampling Results.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Surface Water Sample Location

DNREC Ecological Fresh Surface Water Screening Criteria dated January 2015

Aluminum	87 ug/l
Barium	109 ug/l
Iron	1050 ug/l

ug/l - micrograms per liter

T - Total
D - Dissolved

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

Project Number: 1482609

Date: June 2015

0 30 60
Feet
1 inch = 60 feet

Figure 4-4
Surface Water Samples
Exceeding DNREC Criteria

Document Path: L:\GIS\Data\Northeast\Delaware\Seaford\PP\MXD\June 2015\Figure 4-4 - Surface Water Sampling Results.mxd

SPP-SD-01
1/28/2015

2-methylnaphthalene	160 J	ug/kg
Acenaphthene	970 J	ug/kg
Anthracene	820 J	ug/kg
Benzo[a]anthracene	1100	ug/kg
Benzo[a]pyrene	430	ug/kg
Benzo[k]fluoranthene	310	ug/kg
Chrysene	1500	ug/kg
Fluoranthene	8700	ug/kg
Fluorene	1300 J	ug/kg
Indeno[1,2,3-c,d]pyrene	290	ug/kg
Lead	73.3	mg/kg
Phenanthrene	11000	ug/kg
Pyrene	4800	ug/kg
Zinc	125	mg/kg

SPP-SD-02
1/28/2015

Acenaphthene	26 J	ug/kg
Benzo[a]anthracene	130	ug/kg
Chrysene	200 J	ug/kg
Dibenz[a,h]anthracene	34 J	ug/kg
Fluoranthene	430	ug/kg
Indeno[1,2,3-c,d]pyrene	130	ug/kg
Pyrene	290 J	ug/kg

SPP-SD-06
1/28/2015

Benzo[a]anthracene	180	ug/kg
Benzo[a]pyrene	160	ug/kg
Chrysene	200 J	ug/kg
Indeno[1,2,3-c,d]pyrene	140	ug/kg
Pyrene	250 J	ug/kg

SPP-SD-08
1/28/2015

Cyanide	0.13	mg/kg

SPP-SD-09
1/28/2015

Indeno[1,2,3-c,d]pyrene	110	ug/kg

SPP-SD-04
1/28/2015

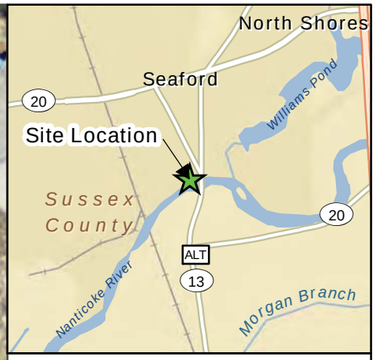
Indeno[1,2,3-c,d]pyrene	76 J	ug/kg

SPP-SD-10
1/28/2015

2-methylnaphthalene	78 J	ug/kg
Acenaphthene	400 J	ug/kg
Anthracene	460 J	ug/kg
Benzo[a]anthracene	1200	ug/kg
Benzo[a]pyrene	1200	ug/kg
Benzo[k]fluoranthene	560	ug/kg
Chrysene	1300	ug/kg
Dibenz[a,h]anthracene	210	ug/kg
Fluoranthene	2700	ug/kg
Fluorene	310 J	ug/kg
Indeno[1,2,3-c,d]pyrene	1100	ug/kg
Naphthalene	280 J	ug/kg
Phenanthrene	2700	ug/kg
Pyrene	2600	ug/kg

SPP-SD-03
1/28/2015

2-methylnaphthalene	40 J	ug/kg
Acenaphthene	97 J	ug/kg
Benzo[a]anthracene	170	ug/kg
Chrysene	230 J	ug/kg
Cobalt	92.8	mg/kg
Copper	31.9	mg/kg
Fluorene	120 J	ug/kg
Iron	28800	mg/kg
Manganese	618	mg/kg
Nickel	35.6	mg/kg
Phenanthrene	380 J	ug/kg
Pyrene	400 J	ug/kg
Zinc	260	mg/kg



Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Cooling Water Intake/Discharge Pipe
- Site Boundary
- Sediment Sample Location

DNREC Ecological Sediment Fresh Screening Criteria dated January 2015

Colbat	50 mg/kg
Copper	31.6 mg/kg
Cyanide	0.1 mg/kg
Iron	20000 mg/kg
Lead	35.8 mg/kg
Manganese	460 mg/kg
Mercury	0.18 mg/kg
Zinc	121 mg/kg
2-methylnaphthalene	20.2 ug/kg
Acenaphthene	6.7 ug/kg
Anthracene	57.2 ug/kg
Benzo[a]anthracene	1100 ug/kg
Benzo[a]pyrene	150 ug/kg
Benzo[k]fluoranthene	310 ug/kg
Chrysene	166 ug/kg
Dibenz[a,h]anthracene	33 ug/kg
Fluoranthene	423 ug/kg
Fluorene	77.4 ug/kg
Indeno[1,2,3-c,d]pyrene	17 ug/kg
Naphthalene	176 ug/kg
Phenanthrene	204 ug/kg
Pyrene	195 ug/kg

ug/l - micrograms per liter

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

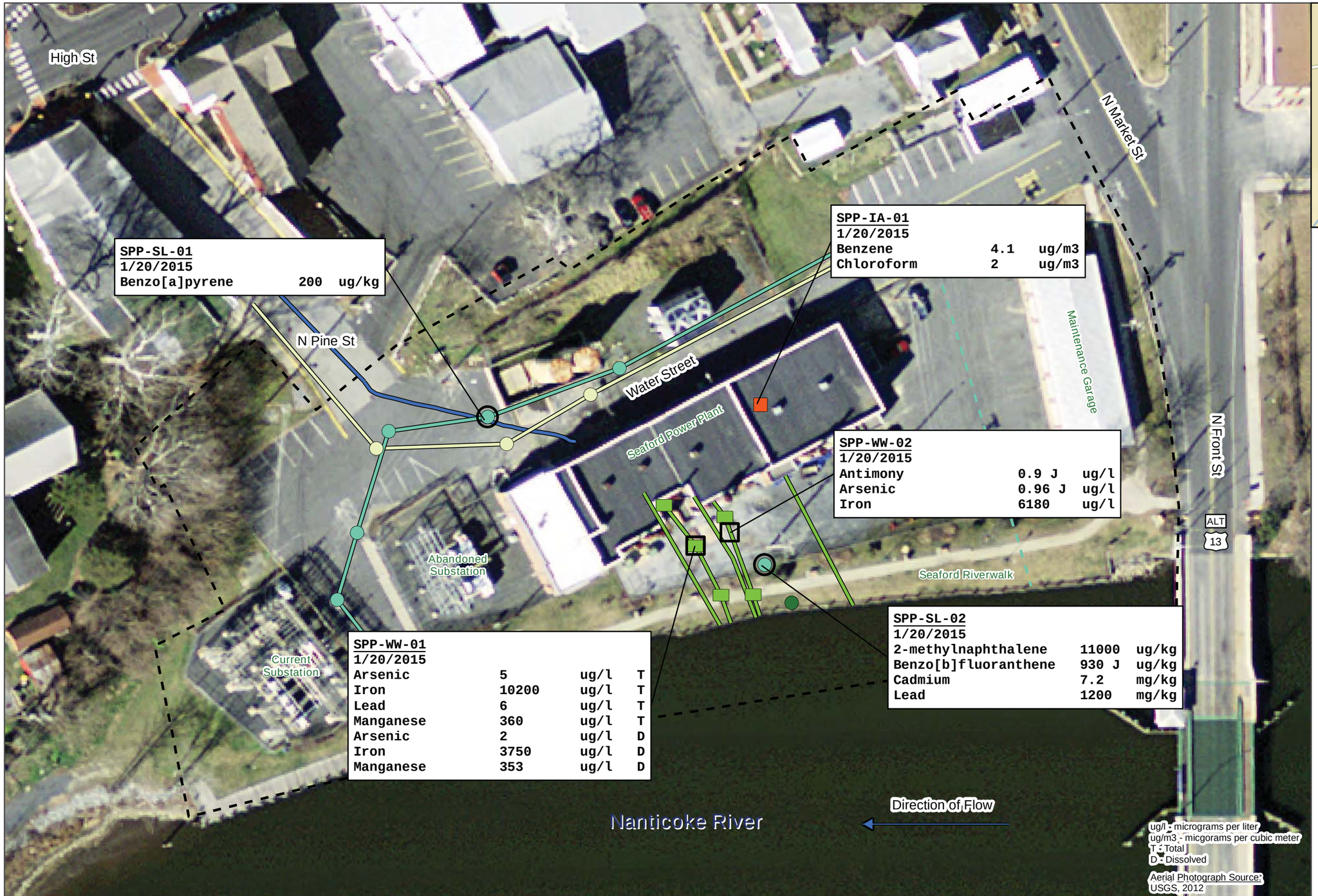
Project Number: 1482609

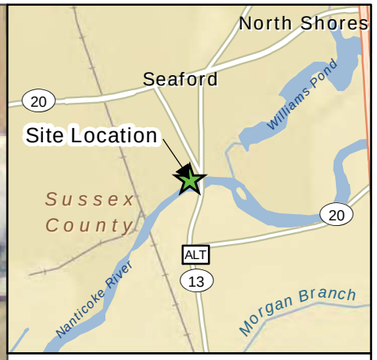
Date: June 2015

0 50 100
Feet
1 inch = 90 feet

Figure 4-5
Sediment Samples Exceeding DNREC Criteria

Document Path: L:\GIS Data\Northeast\Delaware\Seaford\PPMXD\June 2015\Figure 4-5 - Sediment Sampling Results.mxd





Legend

Utility Locations

- Cooling Water Intake/Discharge Pipe Valut
- Potential Discharge Point
- Sanitary Sewer
- Stormwater Manhole
- Water
- Cooling Water Intake/Discharge Pipe
- Sanitary Sewer Line
- Stormwater Line
- Stormwater Line (Approximate)
- Site Boundary
- Wastewater/Sludge Sampling Locations
- Sub-Slab Soil Vapor Sampling Locations
- Indoor Air Quality Sample Location

DNREC Soil Screening Criteria dated January 2015

2-methylnaphthalene	0.052 ug/l
Benzo[b]fluoranthene	900 ug/kg
Cadmium	7 mg/kg
Lead	400 mg/kg

DNREC Groundwater Screening Criteria dated January 2015

Arsenic	0.052 ug/l
Iron	1400 ug/l
Manganese	43 ug/l

DNREC Sub-Slab Gas and Soil Gas Screening Criteria dated January 2015

Benzene	3.6 ug/m3
Chloroform	1.2 ug/m3

Seaford Power Plant

Seaford, Delaware
DNREC-SIRS Project DE-1031

Project Number: 1482609

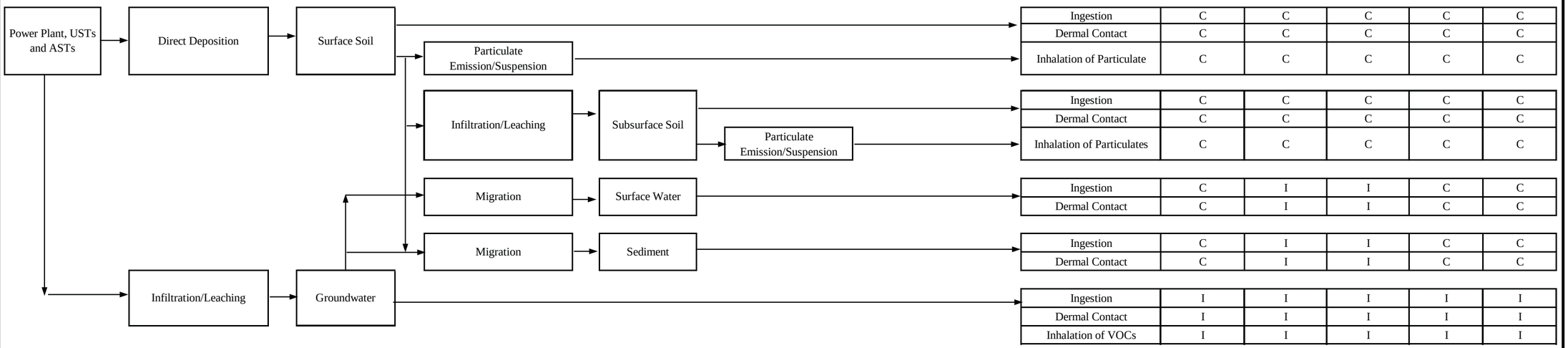
Date: June 2015

0 25 50
Feet
1 inch = 50 feet

Figure 4-6
Wastewater/Sludge and Sub-Slab Soil Vapor Samples Exceeding DNREC Criteria

Document Path: L:\GIS Data\Northeast\Delaware\Seaford\PPMXD\June 2015\Figure 4-6 - Wastewater_Sludge and Indoor Air Samples.mxd

FIGURE 5-1
HUMAN HEALTH CONCEPTUAL SITE MODEL
SEAFORD POWER PLANT
SEAFORD, DELAWARE



PRIMARY SOURCE	PRIMARY RELEASE MECHANISM	SECONDARY SOURCE	SECONDARY RELEASE MECHANISM	TERTIARY SOURCE	TERTIARY RELEASE MECHANISM	EXPOSURE ROUTE	POTENTIAL RECEPTORS				
							Residents (Adult and Child)	Excavation Workers	Commercial Worker	Composite Worker	Recreational User
Power Plant, USTs and ASTs	Direct Deposition	Surface Soil				Ingestion	C	C	C	C	C
						Dermal Contact	C	C	C	C	C
			Particulate Emission/Suspension			Inhalation of Particulate	C	C	C	C	C
			Infiltration/Leaching	Subsurface Soil		Ingestion	C	C	C	C	C
						Dermal Contact	C	C	C	C	C
					Particulate Emission/Suspension	Inhalation of Particulates	C	C	C	C	C
			Migration	Surface Water		Ingestion	C	I	I	C	C
						Dermal Contact	C	I	I	C	C
			Migration	Sediment		Ingestion	C	I	I	C	C
						Dermal Contact	C	I	I	C	C
	Infiltration/Leaching	Groundwater				Ingestion	I	I	I	I	I
						Dermal Contact	I	I	I	I	I
						Inhalation of VOCs	I	I	I	I	I

LEGEND

I Incomplete or negligible exposure pathway

C Potentially complete exposure pathway

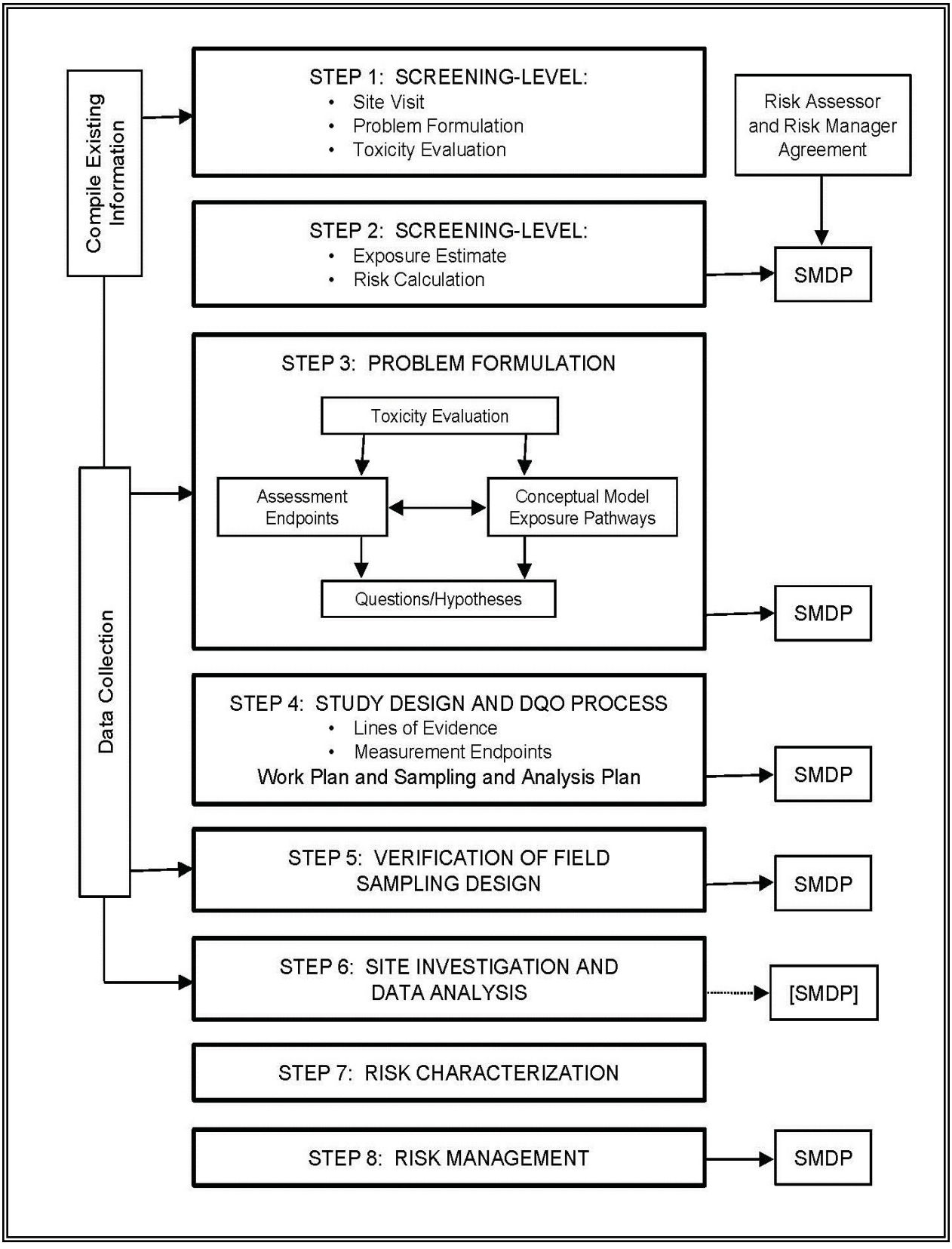


Figure 6-1. Eight-step Ecological Risk Assessment Process for Superfund (from EPA 1997).

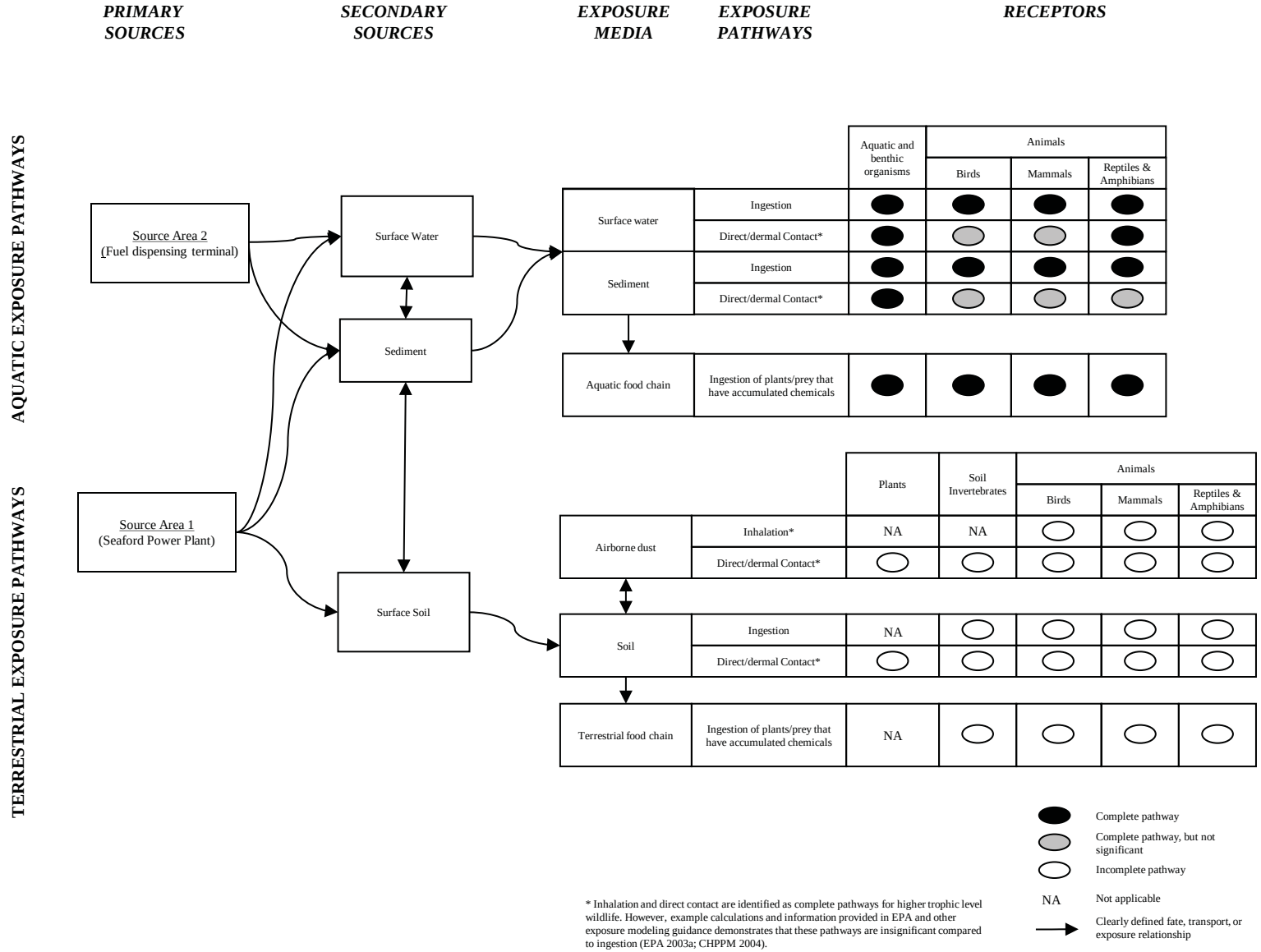
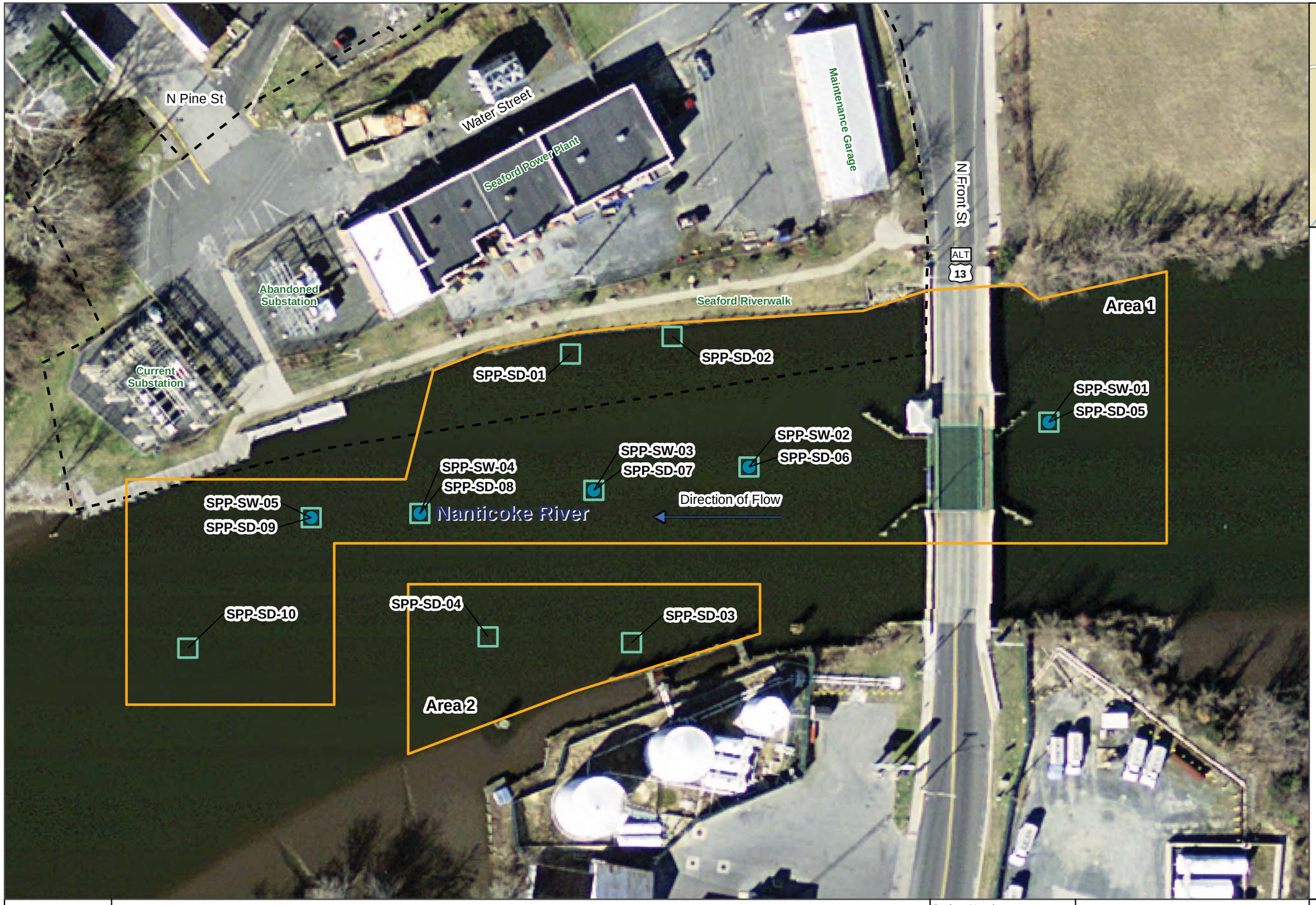


Figure 6-2. Ecological Conceptual Site Model for Seaford Power Plant Investigation Area



Legend

- Site Boundary
- Risk Assessment Investigation Area
- Sediment Sample Location
- Surface Water Sample Location

Aerial Photograph Source:
USGS, 2012

Seaford Power Plant
Seaford, Delaware
DNREC-SIRS Project DE-1031

Project Number: 1482609

Date: June 2015

0 25 50
Feet
1 inch = 58 feet

Figure 6-3
Seaford Power Plant
Investigation Area Overview

Document Path: L:\GIS\Data\Northeast\Delaware\Seaford\PPI\MXD\June 2015\Figure 6-3 - Seaford Power Plant Investigation Area Overview.mxd

Tables

Table 4-1: Surface Soil, Subsurface Soil, and Sludge Sample Results (BTEX, DRO, PAH)

		Location	SPP-DPT-01	SPP-DPT-02	SPP-DPT-03	SPP-DPT-03	SPP-DPT-04	SPP-DPT-04	SPP-DPT-05	SPP-DPT-06	SPP-DPT-06	SPP-DPT-07
		Sample Name	SPP-DPT-01-5-6	SPP-DPT-02-3-4	SPP-SS-03	SPP-DPT-03-3-4	SPP-SS-04	SPP-DPT-04-1-2	SPP-DPT-05-3-4	SPP-SS-06	SPP-DPT-06-4-5	SPP-SS-07
		Parent Sample ID										
		Date Sampled	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/5/2015	3/9/2015	3/9/2015	3/5/2015
		Sample Interval	5 - 6 ft	3 - 4 ft	0 - 0.5 ft	3 - 4 ft	0 - 0.5 ft	1 - 2 ft	3 - 4 ft	0 - 0.5 ft	4 - 5 ft	0 - 0.5 ft
Analyte	**DNREC Soil**	**Unit**										
BTEX												
Benzene	1200	ug/kg	-	< 96 U	-	-	-	-	< 120 U	-	-	< 130 U
Butyl alcohol, tert-	NS	ug/kg	-	< 960 U	-	-	-	-	< 1200 U	-	-	< 1300 U
Ethylbenzene	5800	ug/kg	-	< 96 U	-	-	-	-	< 120 U	-	-	< 130 U
Methyl tert-butyl ether	47000	ug/kg	-	< 96 U	-	-	-	-	< 120 U	-	-	< 130 U
Toluene	490000	ug/kg	-	< 96 U	-	-	-	-	< 120 U	-	-	< 130 U
Xylenes, Total	58000	ug/kg	-	< 190 U	-	-	-	-	< 230 U	-	-	< 250 U
Diesel Range Organics												
Diesel Range Organics	1000	mg/kg	-	9.8	-	-	-	-	16	-	-	**1100**
Polycyclic aromatic hydrocarbons (PAHs)												
2-chloronaphthalene	630000	ug/kg	< 380 U	< 370 U	< 360 U	< 360 U	< 390 U	< 400 U	< 410 U	< 370 U	< 410 U	-
2-methylnaphthalene	1000	ug/kg	< 380 U	< 370 U	15 J	8.1 J	< 390 U	< 400 U	< 410 U	12 J	26 J	-
Acenaphthene	270000	ug/kg	< 380 U	< 370 U	9.1 J	< 360 U	< 390 U	< 400 U	< 410 U	< 370 U	< 410 U	-
Acenaphthylene	NS	ug/kg	< 380 U	< 370 U	16 J	< 360 U	< 390 U	< 400 U	< 410 U	< 370 U	< 410 U	-
Anthracene	1000000	ug/kg	< 380 U	< 370 U	< 360 U	< 360 U	< 390 U	< 400 U	< 410 U	< 370 U	< 410 U	-
Benzo[a]anthracene	900	ug/kg	< 38 U	< 37 U	110	30 J	36 J	< 40 U	< 41 U	< 37 U	< 41 U	-
Benzo[a]pyrene	90	ug/kg	< 38 U	< 37 U	**130**	41	36 J	< 40 U	< 41 U	12 J	16 J	-
Benzo[b]fluoranthene	900	ug/kg	< 38 U	< 37 U	180	51	72	< 40 U	< 41 U	26 J	32 J	-
Benzo[g,h,i]perylene	NS	ug/kg	< 380 U	< 370 U	110 J	49 J	33 J	< 400 U	< 410 U	< 370 U	< 410 U	-
Benzo[k]fluoranthene	9000	ug/kg	< 38 U	< 37 U	74	< 36 U	20 J	< 40 U	< 41 U	< 37 U	< 41 U	-
Chrysene	87000	ug/kg	< 380 U	< 370 U	110 J	31 J	50 J	< 400 U	< 410 U	17 J	30 J	-
Dibenz[a,h]anthracene	90	ug/kg	< 38 U	< 37 U	30 J	< 36 U	< 39 U	< 40 U	< 41 U	< 37 U	< 41 U	-
Fluoranthene	310000	ug/kg	< 380 U	11 J	140 J	36 J	59 J	< 400 U	< 410 U	23 J	36 J	-
Fluorene	300000	ug/kg	< 380 U	< 370 U	< 360 U	< 360 U	< 390 U	< 400 U	< 410 U	< 370 U	< 410 U	-
Indeno[1,2,3-c,d]pyrene	900	ug/kg	< 38 U	< 37 U	150	54	40	< 40 U	< 41 U	< 37 U	< 41 U	-
Naphthalene	5000	ug/kg	< 380 U	< 370 U	17 J	11 J	< 390 U	< 400 U	22 J	< 370 U	32 J	-
Phenanthrene	1000000	ug/kg	< 380 U	< 370 U	44 J	24 J	15 J	< 400 U	14 J	16 J	40 J	-
Pyrene	230000	ug/kg	< 380 U	< 370 U	120 J	35 J	57 J	< 400 U	< 410 U	23 J	35 J	-

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 2015.
- = Not analyzed.
* = Duplicate recovery exceeds control limits.
J = Analyte present. Reported value may not be accurate or precise.
mg/kg = Milligrams per kilogram.
F1 = MS and/or MSD Recovery exceeds the control limits
NS = No screening criteria.
ug/kg = Micrograms per kilogram.
U = Indicates the analyte was analyzed for but not detected.
Bold and shaded values exceed the screening criteria.

Table 4-1: Surface Soil, Subsurface Soil, and Sludge Sample Results (BTEX, DRO, PAH)

		Location	SPP-DPT-07	SPP-DPT-08	SPP-DPT-08	SPP-DPT-08	SPP-DPT-08	SPP-DPT-08	SPP-DPT-09	SPP-DPT-09	SPP-DPT-09	SPP-DPT-09
		Sample Name	SPP-DPT-07-5-6	SPP-SS-08	Dup-02 3/5/15	SPP-DPT-08-4-5	SPP-DPT-08a-8-9	SPP-DPT-08b-7-8	SPP-SS-09	SPP-SS-09	SPP-DPT-09c-2-3	SPP-DPT-09-4-5
		Parent Sample ID			SPP-SS-08							
		Date Sampled	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/9/2015	3/9/2015	3/5/2015	3/9/2015	3/5/2015	3/5/2015
		Sample Interval	5 - 6 ft	0 - 0.5 ft	0 - 0.5 ft	4 - 5 ft	8 - 9 ft	7 - 8 ft	0 - 0.5 ft	0 - 0.5 ft	2 - 3 ft	4 - 5 ft
Analyte	**DNREC Soil**	**Unit**										
BTEX												
Benzene	1200	ug/kg	< 87 U	< 99 U	< 84 U	< 99 U	< 100 U	< 87 U	-	-	63 J	< 93 U
Butyl alcohol, tert-	NS	ug/kg	< 870 U	< 990 U	< 840 U	< 990 U	< 1000 U	< 870 U	-	-	< 1100 U	< 930 U
Ethylbenzene	5800	ug/kg	< 87 U	< 99 U	< 84 U	< 99 U	< 100 U	< 87 U	-	-	190	< 93 U
Methyl tert-butyl ether	47000	ug/kg	< 87 U	< 99 U	< 84 U	< 99 U	< 100 U	< 87 U	-	-	< 110 U	< 93 U
Toluene	490000	ug/kg	< 87 U	< 99 U	< 84 U	< 99 U	< 100 U	< 87 U	-	-	60 J	< 93 U
Xylenes, Total	58000	ug/kg	< 170 U	30 J	< 170 U	< 200 U	45 J	< 170 U	-	-	450	< 190 U
Diesel Range Organics												
Diesel Range Organics	1000	mg/kg	**3600**	280	490	**1600**	**8500**	**2800**	24	120	**4600**	580 F1
Polycyclic aromatic hydrocarbons (PAHs)												
2-chloronaphthalene	630000	ug/kg	-	-	-	-	< 8100 U	< 400 U	< 380 U	-	-	-
2-methylnaphthalene	1000	ug/kg	-	-	-	-	< 8100 U	< 400 U	13 J	-	-	-
Acenaphthene	270000	ug/kg	-	-	-	-	2600 JD	720	< 380 U	-	-	-
Acenaphthylene	NS	ug/kg	-	-	-	-	1100 JD	< 400 U	< 380 U	-	-	-
Anthracene	1000000	ug/kg	-	-	-	-	1100 JD	220 J	< 380 U	-	-	-
Benzo[a]anthracene	900	ug/kg	-	-	-	-	< 810 U	< 40 U	39	-	-	-
Benzo[a]pyrene	90	ug/kg	-	-	-	-	< 810 U	< 40 U	40	-	-	-
Benzo[b]fluoranthene	900	ug/kg	-	-	-	-	< 810 U	< 40 U	57	-	-	-
Benzo[g,h,i]perylene	NS	ug/kg	-	-	-	-	< 8100 U	< 400 U	55 J	-	-	-
Benzo[k]fluoranthene	9000	ug/kg	-	-	-	-	< 810 U	< 40 U	< 38 U	-	-	-
Chrysene	87000	ug/kg	-	-	-	-	< 8100 U	26 J	43 J	-	-	-
Dibenz[a,h]anthracene	90	ug/kg	-	-	-	-	< 810 U	< 40 U	< 38 U	-	-	-
Fluoranthene	310000	ug/kg	-	-	-	-	1200 JD	140 J	59 J	-	-	-
Fluorene	300000	ug/kg	-	-	-	-	7100 JD	1800	< 380 U	-	-	-
Indeno[1,2,3-c,d]pyrene	900	ug/kg	-	-	-	-	< 810 U	< 40 U	48	-	-	-
Naphthalene	5000	ug/kg	-	-	-	-	< 8100 U	< 400 U	30 J	-	-	-
Phenanthrene	1000000	ug/kg	-	-	-	-	12000 D	2700	40 J	-	-	-
Pyrene	230000	ug/kg	-	-	-	-	1300 JD	130 J	46 J	-	-	-

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 20
- = Not analyzed.
* = Duplicate recovery exceeds control limits.
J = Analyte present. Reported value may not be accurate or precis
mg/kg = Milligrams per kilogram.
F1 = MS and/or MSD Recovery exceeds the control limits
NS = No screening criteria.
ug/kg = Micrograms per kilogram.
U = Indicates the analyte was analyzed for but not detected.
Bold and shaded values exceed the screening criteria.

Table 4-1: Surface Soil, Subsurface Soil, and Sludge Sample Results (BTEX, DRO, PAH)

		Location	SPP-DPT-09	SPP-DPT-09	SPP-DPT-09	SPP-DPT-10	SPP-DPT-10	SPP-DPT-11	SPP-DPT-11	SPP-DPT-12	SPP-DPT-12	SPP-DPT-12
		Sample Name	Dup-01 3/5/15	SPP-DPT-09a-6-7	SPP-DPT-09b-6-7	SPP-DPT-10-5-6	SPP-SS-10	SPP-SS-11	SPP-DPT-11-5-6	SPP-SS-12	SPP-DPT-12-4-5	Dup-03 3/9/15
		Parent Sample ID	SPP-DPT-09-4-5									SPP-DPT-12-4-5
		Date Sampled	3/5/2015	3/5/2015	3/5/2015	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/9/2015	3/9/2015
		Sample Interval	4 - 5 ft	6 - 7 ft	6 - 7 ft	5 - 6 ft	0 - 0.5 ft	0 - 0.5 ft	5 - 6 ft	0 - 0.5 ft	4 - 5 ft	4 - 5 ft
Analyte	**DNREC Soil**	**Unit**										
BTEX												
Benzene	1200	ug/kg	< 96 U	< 97 U	< 110 U	< 96 U	-	-	< 120 U	-	1100	**1400**
Butyl alcohol, tert-	NS	ug/kg	< 960 U	< 970 U	< 1100 U	< 960 U	-	-	< 1200 U	-	< 840 U	< 890 U
Ethylbenzene	5800	ug/kg	< 96 U	< 97 U	< 110 U	< 96 U	-	-	< 120 U	-	1100	1100
Methyl tert-butyl ether	47000	ug/kg	< 96 U	< 97 U	< 110 U	< 96 U	-	-	< 120 U	-	< 84 U	< 89 U
Toluene	490000	ug/kg	< 96 U	< 97 U	< 110 U	< 96 U	-	-	< 120 U	-	400	510
Xylenes, Total	58000	ug/kg	< 190 U	< 190 U	< 230 U	< 190 U	-	-	36 J	-	1700	2000
Diesel Range Organics												
Diesel Range Organics	1000	mg/kg	510	650	990	**4100**	49	-	**4400**	-	510 F1	**1200**
Polycyclic aromatic hydrocarbons (PAHs)												
2-chloronaphthalene	630000	ug/kg	-	-	-	< 4100 U	< 380 U	< 370 U	< 920 U	< 430 U	< 390 U	< 400 U
2-methylnaphthalene	1000	ug/kg	-	-	-	< 4100 U	120 J	13 J	800 J	19 J	**1900**	**2600**
Acenaphthene	270000	ug/kg	-	-	-	2100 JD	< 380 U	< 370 U	620 J	< 430 U	390	440
Acenaphthylene	NS	ug/kg	-	-	-	730 JD	11 J	< 370 U	220 J	< 430 U	130 J	130 J
Anthracene	1000000	ug/kg	-	-	-	< 4100 U	< 380 U	< 370 U	530 J	< 430 U	140 J	160 J
Benzo[a]anthracene	900	ug/kg	-	-	-	< 410 U	32 J	< 37 U	480	< 43 U	48	55
Benzo[a]pyrene	90	ug/kg	-	-	-	**140 JD**	50	23 J	**280**	43	15 J	16 J
Benzo[b]fluoranthene	900	ug/kg	-	-	-	220 JD	95	46	440	54	29 J	33 J
Benzo[g,h,i]perylene	NS	ug/kg	-	-	-	< 4100 U	51 J	< 370 U	140 J	52 J	< 390 U	< 400 U
Benzo[k]fluoranthene	9000	ug/kg	-	-	-	< 410 U	33 J	18 J	< 92 U	< 43 U	< 39 U	< 40 U
Chrysene	87000	ug/kg	-	-	-	220 JD	48 J	31 J	440 J	53 J	40 J	49 J
Dibenz[a,h]anthracene	90	ug/kg	-	-	-	< 410 U	< 38 U	< 37 U	< 92 U	< 43 U	< 39 U	< 40 U
Fluoranthene	310000	ug/kg	-	-	-	930 JD	45 J	29 J	1300	38 J	280 J	320 J
Fluorene	300000	ug/kg	-	-	-	4700 D	< 380 U	< 370 U	1200	< 430 U	700	770
Indeno[1,2,3-c,d]pyrene	900	ug/kg	-	-	-	< 410 U	60	< 37 U	170	51	< 39 U	< 40 U
Naphthalene	5000	ug/kg	-	-	-	< 4100 U	49 J	< 370 U	260 J	39 J	< 390 U	< 400 U
Phenanthrene	1000000	ug/kg	-	-	-	8200 D	41 J	14 J	1700	21 J	1100	1300
Pyrene	230000	ug/kg	-	-	-	1400 JD	45 J	49 J	1100	47 J	180 J	200 J

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 20
- = Not analyzed.
* = Duplicate recovery exceeds control limits.
J = Analyte present. Reported value may not be accurate or precis
mg/kg = Milligrams per kilogram.
F1 = MS and/or MSD Recovery exceeds the control limits
NS = No screening criteria.
ug/kg = Micrograms per kilogram.
U = Indicates the analyte was analyzed for but not detected.
Bold and shaded values exceed the screening criteria.

Table 4-1: Surface Soil, Subsurface Soil, and Sludge Sample Results (BTEX, DRO, PAH)

		Location	SPP-DPT-13	SPP-DPT-13	SPP-DPT-14	SPP-SL-01	SPP-SL-02
		Sample Name	SPP-SS-13	SPP-DPT-13-5-6	SPP-DPT-14-7-8	SPP-SL-01	SPP-SL-02
		Parent Sample ID					
		Date Sampled	3/9/2015	3/9/2015	3/9/2015	1/20/2015	1/20/2015
		Sample Interval	0 - 0.5 ft	5 - 6 ft	7 - 8 ft	-	-
Analyte	**DNREC Soil**	**Unit**					
BTEX							
Benzene	1200	ug/kg	-	< 93 U	< 94 U	-	< 150 U
Butyl alcohol, tert-	NS	ug/kg	-	< 930 U	< 940 U	-	< 1500 U
Ethylbenzene	5800	ug/kg	-	< 93 U	< 94 U	-	35 J
Methyl tert-butyl ether	47000	ug/kg	-	< 93 U	< 94 U	-	< 150 U
Toluene	490000	ug/kg	-	< 93 U	< 94 U	-	73 J
Xylenes, Total	58000	ug/kg	-	< 190 U	< 190 U	-	120 J
Diesel Range Organics							
Diesel Range Organics	1000	mg/kg	-	-	-	410	370
Polycyclic aromatic hydrocarbons (PAHs)							
2-chloronaphthalene	630000	ug/kg	< 370 U	-	-	< 440 U	< 11000 U
2-methylnaphthalene	1000	ug/kg	9.9 J	-	-	25 J*	**11000**
Acenaphthene	270000	ug/kg	9.3 J	-	-	< 440 U	670 J
Acenaphthylene	NS	ug/kg	17 J	-	-	110 J*	< 11000 U
Anthracene	1000000	ug/kg	38 J	-	-	82 J	< 11000 U
Benzo[a]anthracene	900	ug/kg	270	-	-	180	< 1100 U
Benzo[a]pyrene	90	ug/kg	**280**	-	-	**200 ***	< 1100 U
Benzo[b]fluoranthene	900	ug/kg	420	-	-	340 *	**930 J***
Benzo[g,h,i]perylene	NS	ug/kg	230 J	-	-	180 J	< 11000 U
Benzo[k]fluoranthene	9000	ug/kg	130	-	-	130	< 1100 U
Chrysene	87000	ug/kg	290 J	-	-	320 J	680 J
Dibenz[a,h]anthracene	90	ug/kg	71	-	-	< 44 U	< 1100 U
Fluoranthene	310000	ug/kg	450	-	-	380 J	1900 J
Fluorene	300000	ug/kg	11 J	-	-	< 440 U	2300 J
Indeno[1,2,3-c,d]pyrene	900	ug/kg	290	-	-	140	< 1100 U
Naphthalene	5000	ug/kg	16 J	-	-	31 J*	< 11000 U
Phenanthrene	1000000	ug/kg	190 J	-	-	170 J	4300 J
Pyrene	230000	ug/kg	380	-	-	220 J	3300 J

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 20
- = Not analyzed.
* = Duplicate recovery exceeds control limits.
J = Analyte present. Reported value may not be accurate or precis
mg/kg = Milligrams per kilogram.
F1 = MS and/or MSD Recovery exceeds the control limits
NS = No screening criteria.
ug/kg = Micrograms per kilogram.
U = Indicates the analyte was analyzed for but not detected.
Bold and shaded values exceed the screening criteria.

Table 4-2: Surface Soil, Subsurface Soil, and Sludge Sample Results (Metals)

		Location	SPP-DPT-02	SPP-DPT-05	SPP-DPT-07	SPP-DPT-08	SPP-DPT-09	SPP-DPT-11	SPP-DPT-12	SPP-SL-01	SPP-SL-02
		Sample Name	SPP-DPT-02-3-4	SPP-DPT-05-3-4	SPP-SS-07	SPP-SS-08	SPP-DPT-09c-2-3	SPP-DPT-11-5-6	SPP-DPT-12-4-5	SPP-SL-01	SPP-SL-02
		Parent Sample ID									
		Date Sampled	3/9/2015	3/5/2015	3/5/2015	3/5/2015	3/5/2015	3/9/2015	3/9/2015	1/20/2015	1/20/2015
		Sample Interval	3 - 4 ft	3 - 4 ft	0 - 0.5 ft	0 - 0.5 ft	2 - 3 ft	5 - 6 ft	4 - 5 ft	-	-
Analyte	**DNREC Soil**	**Unit**									
Inorganics											
Aluminum	51200	mg/kg	4490	8590	-	-	-	-	-	-	-
Antimony	3.1	mg/kg	< 4.4 U	< 3.4 U	-	-	-	-	-	-	-
Arsenic	11	mg/kg	< 3.3 U	3	4.8	3.4	-	**13.4**	**16.2**	< 3.5 U	4.1 J
Barium	1500	mg/kg	11.3 J	17.6 J	-	-	-	-	-	-	-
Beryllium	16	mg/kg	< 0.44 U	< 0.34 U	-	-	-	-	-	-	-
Cadmium	7	mg/kg	< 0.87 U	< 0.69 U	-	-	-	-	-	-	**7.2**
Calcium	NS	mg/kg	27900	1990	-	-	-	-	-	-	-
Chromium	214	mg/kg	7.5	9.7	-	-	-	-	-	-	-
Cobalt	34	mg/kg	< 10.9 U	< 8.6 U	-	-	-	-	-	-	-
Copper	310	mg/kg	2.7 J	4.2 J	-	-	-	-	-	-	-
Cyanide	2.1	mg/kg	0.2	0.18	-	-	-	-	-	-	< 0.17 U
Iron	74767	mg/kg	2560	12700	-	-	-	-	-	-	-
Lead	400	mg/kg	6.4	11.4	-	-	-	-	-	158	**1200**
Magnesium	NS	mg/kg	376 J	289 J	-	-	-	-	-	-	-
Manganese	2100	mg/kg	24.9	38	-	-	-	-	-	-	-
Mercury	0.94	mg/kg	0.057	0.046	-	-	0.06	0.19	-	-	0.083
Nickel	150	mg/kg	2 J	1.9 J	-	-	-	-	-	-	-
Potassium	NS	mg/kg	181 J	534 J	-	-	-	-	-	-	-
Selenium	39	mg/kg	< 4.4 U	< 3.4 U	-	-	-	-	-	-	-
Silver	39	mg/kg	< 2.2 U	< 1.7 U	-	-	-	-	-	-	-
Sodium	NS	mg/kg	200 J	< 860 U	-	-	-	-	-	-	-
Thallium	0.078	mg/kg	< 4.4 U	< 3.4 U	-	-	-	-	-	-	-
Vanadium	134	mg/kg	10.8 J	12.2	-	-	-	-	-	-	-
Zinc	2300	mg/kg	7.6	6	-	-	-	-	-	-	-

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 2015.
- = Not analyzed.
J = Analyte present. Reported value may not be accurate or precise.
NS = No screening criteria.
mg/kg = Milligrams per kilogram.
U = Indicates the analyte was analyzed for but not detected.
Bold and shaded values exceed the screening criteria.

Table 4-3: Surface Soil and Subsurface Soil Sample Results (PCBs)

		Location	SPP-DPT-02	SPP-DPT-05	SPP-DPT-06	SPP-DPT-11	SPP-DPT-12
		Sample Name	SPP-DPT-02-3-4	SPP-DPT-05-3-4	SPP-SS-06	SPP-SS-11	SPP-SS-12
		Parent Sample ID					
		Date Sampled	3/9/2015	3/5/2015	3/9/2015	3/9/2015	3/9/2015
		Sample Interval	3 - 4 ft	3 - 4 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft
Analyte	**DNREC Soil**	**Unit**					
Polychlorinated biphenyls (PCBs)							
Decachlorobiphenyl	NS	ug/kg	< 19 U	< 21 U	< 19 U	< 19 U	< 110 U
Dichlorobiphenyl, Total	NS	ug/kg	< 3.7 U	< 4.1 U	< 3.7 U	< 3.7 U	< 22 U
Heptachlorobiphenyls, Total	NS	ug/kg	< 11 U	< 12 U	< 11 U	< 11 U	< 65 U
Hexachlorobiphenyls, Total	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.4 U	< 7.5 U	< 44 U
Monochlorobiphenyl, Total	NS	ug/kg	< 3.7 U	< 4.1 U	< 3.7 U	< 3.7 U	< 22 U
Nonachlorobiphenyl, Total	NS	ug/kg	< 19 U	13 J*	< 19 UF1	< 19 U	< 110 U
Octachlorobiphenyl, Total	NS	ug/kg	< 11 U	< 12 U	< 11 U	< 11 U	< 65 U
Pentachlorobiphenyls, Total	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.4 U	< 7.5 U	< 44 U
Tetrachlorobiphenyl, Total	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.4 U	< 7.5 U	< 44 U
Trichlorobiphenyl, Total	NS	ug/kg	< 3.7 U	< 4.1 U	< 3.7 U	< 3.7 U	< 22 U

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 2015.
NS = No screening criteria.
* = Duplicate recovery exceeds control limits.
F1 = MS and/or MSD recovery exceeds control limits.
J = Analyte present. Reported value may not be accurate or precise.
U = Indicates the analyte was analyzed for but not detected.
ug/kg = Micrograms per kilogram.
Bold and shaded values exceed the screening criteria.

Table 4-4: Surface Soil and Subsurface Soil Sample Results (Pesticides)

		Location	SPP-DPT-02	SPP-DPT-05	SPP-DPT-06	SPP-DPT-11	SPP-DPT-12
		Sample Name	SPP-DPT-02-3-4	SPP-DPT-05-3-4	SPP-SS-06	SPP-SS-11	SPP-SS-12
		Parent Sample ID					
		Date Sampled	3/9/2015	3/5/2015	3/9/2015	3/9/2015	3/9/2015
		Sample Interval	3 - 4 ft	3 - 4 ft	0 - 0.5 ft	0 - 0.5 ft	0 - 0.5 ft
Analyte	**DNREC Soil**	**Unit**					
Pesticides							
4,4-DDD	2200	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
4,4-DDE	1600	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
4,4-DDT	1900	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Aldrin	31	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
alpha-BHC	85	ug/kg	< 2.3 U	< 2.5 U	< 2.3 U	< 2.2 U	< 2.6 U
alpha-Chlordane	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Beta-BHC	300	ug/kg	< 2.3 U	< 2.5 U	< 2.3 U	< 2.2 U	< 2.6 U
Chlordane, Technical	1800	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
delta-BHC	NS	ug/kg	< 2.3 U	< 2.5 U	< 2.3 U	< 2.2 U	< 2.6 U
Dieldrin	33	ug/kg	< 2.3 U	< 2.5 U	< 2.3 U	< 2.2 U	< 2.6 U
Endosulfan I	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Endosulfan II	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Endosulfan sulfate	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Endrin	1800	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Endrin aldehyde	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Endrin ketone	NS	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Gamma-BHC (Lindane)	560	ug/kg	< 2.3 U	< 2.5 U	< 2.3 U	< 2.2 U	< 2.6 U
Heptachlor	120	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Heptachlor epoxide	59	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Methoxychlor	31000	ug/kg	< 7.5 U	< 8.3 U	< 7.5 U	< 7.5 U	< 8.8 U
Toxaphene	480	ug/kg	< 75 U	< 83 U	< 75 U	< 75 U	< 88 U

Notes:
DNREC Soil = DNREC Soil Screening Criteria, dated Januray 2015.
NS = No screening criteria.
U = Indicates the analyte was analyzed for but not detected.
ug/kg = Micrograms per kilogram.
Bold and shaded values exceed the screening criteria.

Table 4-5: Groundwater and Wastewater Sample Results

Location			SPP-GW-01	SPP-GW-01	SPP-GW-01	SPP-GW-01	SPP-GW-02	SPP-GW-02	SPP-GW-03	SPP-GW-03	SPP-GW-04	SPP-GW-04	SPP-GW-05	SPP-GW-05	SPP-WW-01	SPP-WW-01	SPP-WW-02
Sample Name			SPP-GW-01	Dup-01-GW	SPP-GW-01-F	Dup-01-GW-F	SPP-GW-02	SPP-GW-02-F	SPP-GW-03	SPP-GW-03-F	SPP-GW-04	SPP-GW-04-F	SPP-GW-05	SPP-GW-05-F	SPP-WW-01	SPP-WW-01-F	SPP-WW-02
Parent Sample ID				SPP-GW-01		SPP-GW-01-F											
Date Sampled			1/20/2015	1/20/2015	1/20/2015	1/20/2015	1/20/2015	1/20/2015	3/10/2015	3/10/2015	3/10/2015	3/10/2015	3/10/2015	3/10/2015	1/20/2015	SPP-WW-02	1/20/2015
Analyte	**DNREC Groundwater**	**Unit**															
Inorganics																	
Aluminum	2000	ug/l	332	372	< 40 U	< 40 U	< 40 U	< 40 U	1210	< 40 U	1260	< 40 U	1330	< 40 U	360	353	498
Antimony	0.78	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 4 U	< 4 U	**0.9 J**
Arsenic	0.052	ug/l	**2.4**	**2.5**	**1.3 J**	**1.5 J**	< 2 U	< 2 U	< 2 U	< 2 U	**4.3**	**2**	**6.8**	**2.4**	< 2 U	< 2 U	**0.96 J**
Barium	380	ug/l	102	104	96.9	106	93.4	88.1	55	54.8	143	110	293	245	< 4 U	< 4 U	9.3
Beryllium	2.5	ug/l	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	**5720**	**5930**	< 0.8 U
Cadmium	0.92	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 4 U	< 4 U	< 2 U
Calcium	NS	ug/l	30800	32200	30600	30900	30600	29900	28900	30300	101000	107000	144000	149000	193	< 40 U	10400
Chromium	10	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	3.7 J	< 4 U	2.1 J	< 4 U	2.2 J	< 4 U	**40.3**	< 4 U	< 4 U
Cobalt	0.6	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	**83800**	**85500**	< 4 U
Copper	80	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	3 J	< 4 U	6.5	< 4 U	2.9 J	< 4 U	< 4 U	< 4 U	15.1
Cyanide	0.00015	mg/l	< 0.01 U	< 0.01 U	-	-	< 0.01 U	-	< 0.01 U	-	< 0.01 U	-	< 0.01 U	-	< 0.01 U	-	< 0.01 U
Iron	1400	ug/l	**7810**	**8120**	**7330**	**7350**	**3870**	**3880**	726	412	**9120**	1060	**27400**	**7410**	6	< 1.2 U	**6180**
Lead	5	ug/l	1.7	2	< 1.2 U	< 1.2 U	< 1.2 U	< 1.2 U	0.86 J	< 1.2 U	**12.6**	< 1.2 U	4.3	< 1.2 U	< 2 U	< 2 U	3.8
Magnesium	NS	ug/l	4860	5000	4930	4940	4250	4260	5280	5320	5750	5980	12700	12700	< 2 U	< 2 U	2010
Manganese	43	ug/l	**97.8**	**101**	**95.1**	**96.3**	**79.2**	**79.3**	19.6	18.2	**523**	**514**	**556**	**551**	< 10 U	< 10 U	37.9
Mercury	0.063	ug/l	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U
Nickel	39	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	2.4 J	1.9 J	< 4 U	2 J	< 4 U	< 4 U	**12700**	**13100**	< 4 U
Potassium	NS	ug/l	7000	7190	6360	6370	6050	5360	5550	5820	9760	10700	9710	10200	5	2	369
Selenium	10	ug/l	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	3.5 J	3.8 J	< 10 U	< 10 U	< 10 U	< 10 U	**10200**	**3750**	< 10 U
Silver	9.4	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	**15 J**	< 16 U	< 2 U
Sodium	NS	ug/l	16700	17000	17600	17600	7420	7590	19100	20700	22400	23200	22400	22300	104	88.6	2070
Thallium	0.02	ug/l	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U
Vanadium	8.6	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	2.3 J	1.9 J	5.2	2 J	3 J	< 4 U	2.7 J	< 4 U	< 0.8 U	< 0.8 U	< 4 U
Zinc	600	ug/l	8.5 J	8.7 J	< 16 U	< 16 U	22.6	23	10.3 J	< 16 U	39.4	< 16 U	7.7 J	< 16 U	**14100**	**15400**	41.5
Diesel Range Organics																	
Diesel Range Organics	0.2	mg/l							< 0.12 U		**1.5**		0.12				
BTEX																	
Benzene	0.45	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		0.11 J		< 1 U
Butyl alcohol, tert-	NS	ug/l							< 10 U		< 10 U		< 10 U				
Ethylbenzene	1.5	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Methyl tert-butyl ether	10	ug/l	0.14 J	< 1 U			< 1 U		< 1 U		0.44 J		0.14 J		< 1 U		< 1 U
Toluene	110	ug/l	0.27 J	0.24 J			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Xylenes, Total		ug/l	< 2 U	< 2 U			< 2 U		< 2 U		< 2 U		< 2 U		0.64 J		< 2 U
Polycyclic aromatic hydrocarbons (PAHs)																	
2-chloronaphthalene	75	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		< 10 U
2-methylnaphthalene	3.6	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		< 10 U
Acenaphthene	53	ug/l	1.3 J	2 J			6.6 J		< 10 U		< 10 U		< 10 U		1.7 J		< 10 U
Acenaphthylene	NS	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		< 10 U
Anthracene	180	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		< 10 U
Benzo[a]anthracene	0.034	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Benzo[a]pyrene	0.0034	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Benzo[b]fluoranthene	0.034	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Benzo[g,h,i]perylene	NS	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		< 10 U
Benzo[k]fluoranthene	0.34	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Chrysene	3.4	ug/l	< 2 U	< 2 U			< 2 U		< 2 U		< 2 U		< 2 U		< 2 U		< 2 U
Dibenz[a,h]anthracene	0.0034	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Fluoranthene	80	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		1.1 J
Fluorene	29	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		2.6 J		< 10 U
Indeno[1,2,3-c,d]pyrene	0.034	ug/l	< 1 U	< 1 U			< 1 U		< 1 U		< 1 U		< 1 U		< 1 U		< 1 U
Naphthalene	0.17	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		< 10 U
Phenanthrene	12	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		1.2 J		< 10 U		1.3 J		< 10 U
Pyrene	12	ug/l	< 10 U	< 10 U			< 10 U		< 10 U		< 10 U		< 10 U		< 10 U		2.1 J

Notes:
NS = No screening criteria.
DNREC Groundwater = DNREC Groundwater Screening Criteria, dated Januray 2015.
U = Indicates the analyte was analyzed for but not detected.
J = Analyte present. Reported value may not be accurate or precise.
ug/l = Micrograms per liter.
mg/l = Milligrams per liter.
Bold and shaded values exceed the screening criteria.

Table 4-6: Surface Water Sample Results

Location			SPP-SD-05/SW-01	SPP-SD-05/SW-01	SPP-SD-06/SW-02	SPP-SD-06/SW-02	SPP-SD-07/SW-03	SPP-SD-07/SW-03	SPP-SD-07/SW-03	SPP-SD-07/SW-03	SPP-SD-08/SW-04	SPP-SD-08/SW-04	SPP-SD-09/SW-05	SPP-SD-09/SW-05
Sample Name			SPP-SW-01	SPP-SW-01-F	SPP-SW-02	SPP-SW-02-F	SPP-SW-03	DUP-SW-01 1/28/15	SPP-SW-03-F	DUP-SW-01-F 1/28/15	SPP-SW-04	SPP-SW-04-F	SPP-SW-05	SPP-SW-05-F
Parent Sample ID								SPP-SW-03		SPP-SW-03-F				
Date Sampled			1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015
Analyte	**DNREC Surface Water**	**Unit**												
Inorganics														
Aluminum	87	ug/l	**542**	**102**	**525**	**107**	**523**	**582**	**150**	**190**	**640**	**184**	**578**	**91.8**
Antimony	30	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U
Arsenic	5	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U
Barium	4	ug/l	**109**	**101**	**110**	**101**	**111**	**115**	**101**	**101**	**115**	**104**	**112**	**102**
Beryllium	0.66	ug/l	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U
Cadmium	0.25	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U
Calcium	NS	ug/l	6020	5640	5980	5560	6030	6060	5400	5750	6150	5830	6300	5610
Chromium	85	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U
Cobalt	23	ug/l	6.3	5	6	5.1	6.5	6.3	5.3	5.4	6.5	5.4	5.9	5.3
Copper	9	ug/l	3.3 J	< 4 U	3.3 J	< 4 U	3.2 J	< 4 U	< 4 U	< 4 U	3.3 J	2.3 J	4.2	< 4 U
Cyanide	0.005	mg/l	< 0.01 U	-	< 0.01 U	-	< 0.01 U	< 0.01 U	-	-	< 0.01 U	-	< 0.01 U	-
Iron	300	ug/l	**1050**	280	**999**	290	**1000**	**1000**	**364**	**363**	**1180**	**352**	**970**	270
Lead	2.5	ug/l	0.97 J	< 1.2 U	0.73 J	< 1.2 U	0.75 J	0.65 J	< 1.2 U	< 1.2 U	1.1 J	< 1.2 U	0.64 J	< 1.2 U
Magnesium	NS	ug/l	2320	2340	2290	2300	2350	2340	2280	2460	2370	2470	2400	2340
Manganese	120	ug/l	58.2	46.6	57.7	45.9	56.5	56.5	45.8	44.1	61.9	46.4	56.5	46.5
Mercury	0.026	ug/l	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U	< 0.2 U
Nickel	52	ug/l	2.7 J	2.2 J	2.8 J	2.5 J	2.8 J	2.8 J	2.4 J	2.5 J	3 J	2.3 J	2.8 J	2.1 J
Potassium	NS	ug/l	2830	2610	2860	2610	2910	2920	2540	2650	2890	2680	2900	2600
Selenium	1	ug/l	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U	< 10 U
Silver	3.2	ug/l	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U	< 2 U
Sodium	NS	ug/l	8120	8100	8010	8000	8100	8110	7770	8010	8140	8090	8160	8100
Thallium	0.8	ug/l	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U	< 0.8 U
Vanadium	20	ug/l	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U	< 4 U
Zinc	120	ug/l	20.4	16.1	21.4	16.5	22.4	18.6	16.3	18.4	22.8	17.9	21.1	16.3
BTEX														
Benzene	370	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Butyl alcohol, tert-	NS	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Ethylbenzene	90	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Methyl tert-butyl ether	11070	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Toluene	2	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Xylenes, Total	13	ug/l	< 2 U	-	< 2 U	-	< 2 U	< 2 U	-	-	< 2 U	-	< 2 U	-
Diesel Range Organics														
Diesel Range Organics	NS	mg/l	< 0.12 U	-	< 0.12 U	-	< 0.12 U	< 0.12 U	-	-	< 0.12 U	-	< 0.12 U	-
Polycyclic aromatic hydrocarbons (PAHs)														
2-chloronaphthalene	NS	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
2-methylnaphthalene	4.7	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Acenaphthene	5.8	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Acenaphthylene	NS	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Anthracene	0.012	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Benzo[a]anthracene	0.018	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Benzo[a]pyrene	0.015	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Benzo[b]fluoranthene	NS	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Benzo[g,h,i]perylene	NS	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Benzo[k]fluoranthene	NS	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Chrysene	NS	ug/l	< 2 U	-	< 2 U	-	< 2 U	< 2 U	-	-	< 2 U	-	< 2 U	-
Dibenz[a,h]anthracene	NS	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Fluoranthene	0.04	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Fluorene	3	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Indeno[1,2,3-c,d]pyrene	NS	ug/l	< 1 U	-	< 1 U	-	< 1 U	< 1 U	-	-	< 1 U	-	< 1 U	-
Naphthalene	1.1	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Phenanthrene	0.4	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-
Pyrene	0.025	ug/l	< 10 U	-	< 10 U	-	< 10 U	< 10 U	-	-	< 10 U	-	< 10 U	-

Notes:
DNREC Surface Water = DNREC Ecological Fresh Surfae Water Screening Criteria, dated Januray 2015.
- = Not analyzed.
J = Analyte present. Reported value may not be accurate or precise.
NS = No screening criteria.
U = Indicates the analyte was analyzed for but not detected.
ug/l = Micrograms per liter.

Table 4-7: Sediment Sample Results

		Location ID	SPP-SD-01	SPP-SD-02	SPP-SD-03	SPP-SD-04	SPP-SD-05/SW-01	SPP-SD-06/SW-02	SPP-SD-07/SW-03	SPP-SD-08/SW-04	SPP-SD-09/SW-05	SPP-SD-10
		Sample Name	SPP-SD-01	SPP-SD-02	SPP-SD-03	SPP-SD-04	SPP-SD-05	SPP-SD-06	SPP-SD-07	SPP-SD-08	SPP-SD-09	SPP-SD-10
		Parent Sample ID										
		Sample Date	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015	1/28/2015
		Sample Interval	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Analyte	**DNREC Sediment**	**Unit**										
Polychlorinated biphenyls (PCBs)												
Decachlorobiphenyl	NS	ug/kg	< 39 U	< 22 U	< 68 U	< 27 U	< 23 U	< 22 U	< 22 U	< 22 U	< 21 U	< 25 U
Dichlorobiphenyl, Total	NS	ug/kg	< 7.5 U	< 4.3 U	< 13 U	< 5.2 U	< 4.4 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.1 U	< 4.9 U
Heptachlorobiphenyls, Total	NS	ug/kg	< 23 U	< 13 U	< 40 U	< 16 U	< 13 U	< 13 U	< 13 U	< 13 U	< 13 U	< 15 U
Hexachlorobiphenyls, Total	NS	ug/kg	< 15 U	< 8.8 U	< 27 U	< 11 U	< 9 U	< 8.8 U	< 8.7 U	< 8.6 U	< 8.4 U	< 9.9 U
Monochlorobiphenyl, Total	NS	ug/kg	< 7.5 U	< 4.3 U	< 13 U	< 5.2 U	< 4.4 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.1 U	< 4.9 U
Nonachlorobipheny, Total	NS	ug/kg	< 39 U	< 22 U	< 68 U	< 27 U	< 23 U	< 22 U	< 22 U	< 22 U	< 21 U	< 25 U
Octachlorobiphenyl, Total	NS	ug/kg	< 23 U	< 13 U	< 40 U	< 16 U	< 13 U	< 13 U	< 13 U	< 13 U	< 13 U	< 15 U
Pentachlorobiphenyls, Total	NS	ug/kg	< 15 U	< 8.8 U	< 27 U	< 11 U	< 9 U	< 8.8 U	< 8.7 U	< 8.6 U	< 8.4 U	< 9.9 U
Polychlorinated Biphenyls	59.8	ug/kg	< 190 U	< 110 U	< 340 U	< 130 U	< 110 U	< 110 U	< 110 U	< 110 U	< 110 U	< 120 U
Tetrachlorobiphenyl, Total	NS	ug/kg	< 15 U	< 8.8 U	< 27 U	< 11 U	< 9 U	< 8.8 U	< 8.7 U	< 8.6 U	< 8.4 U	< 9.9 U
Trichlorobiphenyl, Total	NS	ug/kg	4.5 J	< 4.3 U	< 13 U	< 5.2 U	< 4.4 U	< 4.3 U	< 4.3 U	< 4.3 U	< 4.1 U	< 4.9 U
Inorganics												
Aluminum	NS	mg/kg	6240	2810	13600	2200	642	1230	612	1050	1020	1300
Antimony	2	mg/kg	< 7 U	< 4.1 U	< 14.5 U	< 4.5 U	< 3.9 U	< 4 U	< 3.5 U	< 3.8 U	< 3.9 U	< 4.1 U
Arsenic	9.8	mg/kg	3.8 J	< 3.1 U	8.7 J	2 J	1.8 J	1 J	< 2.7 U	1.3 J	0.82 J	1.3 J
Barium	NS	mg/kg	192	26.5 J	429	101	24.6 J	30.8 J	14.2 J	22.5 J	27.8 J	40.4 J
Beryllium	NS	mg/kg	1.2	< 0.41 U	3.2	0.67	0.44	0.41	0.24 J	0.44	0.43	0.55
Cadmium	0.99	mg/kg	< 1.4 U	< 0.83 U	< 2.9 U	< 0.91 U	< 0.78 U	< 0.81 U	< 0.71 U	< 0.77 U	< 0.78 U	< 0.82 U
Calcium	NS	mg/kg	2250	317 J	2350 J	533 J	109 J	286 J	127 J	163 J	201 J	391 J
Chromium	43.4	mg/kg	10.2	3	22.7	4.7	4.8	7.2	3.3	3.2	2	3
Cobalt	50	mg/kg	34.4	4.8 J	**92.8**	16.3	8.1 J	6.9 J	10.5	14.7	5.5 J	8.2 J
Copper	31.6	mg/kg	12.7	3.3 J	**31.9**	9.1	3.4 J	8.5	2.2 J	2.1 J	1.9 J	3.2 J
Cyanide	0.1	mg/kg	< 0.24 U	< 0.13 U	< 0.41 U	< 0.15 U	< 0.14 U	< 0.12 U	< 0.12 U	**0.13**	< 0.13 U	< 0.14 U
Iron	20000	mg/kg	15900	3340	**28800**	7040	12500	3830	2900	4030	3360	4620
Lead	35.8	mg/kg	**73.3**	6.7	34.3	11.3	6.1	12.7	5.5	11.2	8.1	13.4
Magnesium	NS	mg/kg	1030 J	219 J	1880 J	253 J	155 J	107 J	< 884 U	96.5 J	126 J	162 J
Manganese	460	mg/kg	434	51	**618**	100	78.3	61.6	129	157	64	91.1
Mercury	0.18	mg/kg	0.095	< 0.022 U	0.18	0.03	< 0.023 U	< 0.022 U	< 0.021 U	< 0.021 U	< 0.021 U	< 0.025 U
Nickel	22.7	mg/kg	14.5	2.5 J	**35.6**	6.6 J	3 J	3.5 J	1.6 J	2.4 J	2.2 J	3.4 J
Potassium	NS	mg/kg	531 J	99 J	1070 J	133 J	< 978 U	75.9 J	31.4 J	76.6 J	58.6 J	79.2 J
Selenium	2	mg/kg	< 7 U	< 4.1 U	< 14.5 U	< 4.5 U	< 3.9 U	< 4 U	< 3.5 U	< 3.8 U	< 3.9 U	< 4.1 U
Silver	1.0	mg/kg	< 3.5 U	< 2.1 U	< 7.2 U	< 2.3 U	< 2 U	< 2 U	< 1.8 U	< 1.9 U	< 2 U	< 2 U
Sodium	NS	mg/kg	< 1740 U	< 1040 U	< 3620 U	< 1130 U	< 978 U	< 1010 U	< 884 U	< 961 U	< 977 U	< 1020 U
Thallium	NS	mg/kg	< 7 U	< 4.1 U	< 14.5 U	< 4.5 U	< 3.9 U	< 4 U	< 3.5 U	< 3.8 U	< 3.9 U	< 4.1 U
Vanadium	NS	mg/kg	12.7 J	3.8 J	26.9 J	4.3 J	3.5 J	3.5 J	2.5 J	3.6 J	3.2 J	4.1 J
Zinc	121	mg/kg	**125**	16.2	**260**	49.1	36.5	36.2	12.9	17.2	14.7	23
BTEX												
Benzene	NS	ug/kg	< 280 U	< 130 U	< 600 U	< 210 U	< 130 U	< 130 U	< 110 U	< 97 U	< 100 U	< 150 U
Butyl alcohol, tert-	NS	ug/kg	< 2800 U	< 1300 U	< 6000 U	< 2100 U	< 1300 U	< 1300 U	< 1100 U	< 970 U	< 1000 U	< 1500 U
Ethylbenzene	1100	ug/kg	< 280 U	< 130 U	< 600 U	< 210 U	< 130 U	< 130 U	< 110 U	< 97 U	< 100 U	< 150 U
Methyl tert-butyl ether	NS	ug/kg	< 280 U	< 130 U	< 600 U	< 210 U	< 130 U	< 130 U	< 110 U	< 97 U	< 100 U	< 150 U
Toluene	NS	ug/kg	< 280 U	< 130 U	< 600 U	< 210 U	< 130 U	< 130 U	< 110 U	< 97 U	< 100 U	< 150 U
Xylenes, Total	NS	ug/kg	< 560 U	< 250 U	< 1200 U	< 410 U	< 270 U	< 250 U	< 230 U	< 190 U	< 210 U	< 300 U
Diesel Range Organics												
Diesel Range Organics	NS	mg/kg	24	< 11 U	< 35 U	< 14 U	< 12 U	< 11 U	83	50	69	790
Polycyclic aromatic hydrocarbons (PAHs)												
2-chloronaphthalene	NS	ug/kg	< 1500 U	< 430 U	< 1300 U	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	< 490 U
2-methylnaphthalene	20.2	ug/kg	**160 J**	18 J	**40 J**	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	**78 J**
Acenaphthene	6.7	ug/kg	**970 J**	**26 J**	**97 J**	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	**400 J**
Acenaphthylene	NS	ug/kg	96 J	13 J	< 1300 U	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	89 J
Anthracene	57.2	ug/kg	**820 J**	51 J	< 1300 U	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	**460 J**
Benzo[a]anthracene	108	ug/kg	**1100**	**130**	**170**	95 J	< 44 U	**180**	< 43 U	< 86 U	74 J	**1200**
Benzo[a]pyrene	150	ug/kg	**430**	110	95 J	84 J	< 44 U	**160**	< 43 U	< 86 U	81 J	**1200**
Benzo[b]fluoranthene	NS	ug/kg	940	260	200	140	< 44 U	200	18 J	48 J	140	1700
Benzo[g,h,i]perylene	NS	ug/kg	230 J	110 J	< 1300 U	73 J	< 440 U	110 J	< 430 U	< 860 U	96 J	950
Benzo[k]fluoranthene	240	ug/kg	**310**	91	86 J	54 J	< 44 U	63 J	< 43 U	< 86 U	42 J	**560**
Chrysene	166	ug/kg	**1500**	**200 J**	**230 J**	160 J	< 440 U	**200 J**	13 J	26 J	70 J	**1300**
Dibenz[a,h]anthracene	33	ug/kg	< 150 U	**34 J**	< 130 U	< 100 U	< 44 U	< 87 U	< 43 U	< 86 U	< 84 U	**210**
Fluoranthene	423	ug/kg	**8700**	**430**	400 J	190 J	< 440 U	290 J	21 J	44 J	120 J	**2700**
Fluorene	77.4	ug/kg	**1300 J**	29 J	**120 J**	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	**310 J**
Indeno[1,2,3-c,d]pyrene	17	ug/kg	**290**	**130**	< 130 U	**76 J**	< 44 U	**140**	< 43 U	< 86 U	**110**	**1100**
Naphthalene	176	ug/kg	160 J	30 J	37 J	< 1000 U	< 440 U	< 870 U	< 430 U	< 860 U	< 840 U	**280 J**
Phenanthrene	204	ug/kg	**11000**	200 J	**380 J**	140 J	< 440 U	160 J	< 430 U	32 J	41 J	**2700**
Pyrene	195	ug/kg	**4800**	**290 J**	**400 J**	150 J	< 440 U	**250 J**	< 430 U	< 860 U	89 J	**2600**

Notes:
DNREC Sediment = DNREC Ecological Sediment Fresh Screening Criteria, dated Januray 2015.
J = Analyte present. Reported value may not be accurate or precise.
mg/kg = Milligrams per kilogram.
NS = No screening criteria.
ug/kg = Micrograms per kilogram.
U = Indicates the analyte was analyzed for but not detected.
Bold and shaded values exceed the screening criteria.

Table 4-8: Sub-Slab Soil Vapor Sample Results

		Location	SPP-IA-01
		Sample Name	SPP-IA-01
		Parent Sample ID	
		Date Sampled	1/20/2015
Analyte	**DNREC Soil Gas**	**Unit**	
Volatile Organic Compounds			
1,1,1-trichloroethane	5200	ug/m3	< 1.1 U
1,1,2,2-tetrachloroethane	0.48	ug/m3	< 1.4 U
1,1,2-Trichloro-1,2,2-trifluoroethane	31000	ug/m3	0.54 J
1,1,2-trichloroethane	0.21	ug/m3	< 1.1 U
1,1-dichloroethane	18	ug/m3	< 0.81 U
1,1-dichloroethene	210	ug/m3	< 0.79 U
1,2,4-trichlorobenzene	2.1	ug/m3	< 3.7 U
1,2,4-trimethylbenzene	7.3	ug/m3	6.8
1,2-dibromoethane	0.047	ug/m3	< 1.5 U
1,2-dichlorobenzene	210	ug/m3	< 1.2 U
1,2-dichloroethane	1.1	ug/m3	< 0.81 U
1,2-dichloroethene	NS	ug/m3	< 0.79 U
1,2-dichloropropane	2.8	ug/m3	< 0.92 U
1,2-Dichlorotetrafluoroethane	NS	ug/m3	< 1.4 U
1,3,5-trimethylbenzene	NS	ug/m3	1.8
1,3-butadiene	0.94	ug/m3	0.22 J
1,3-dichlorobenzene	NS	ug/m3	< 1.2 U
1,4-dichlorobenzene	2.6	ug/m3	0.13 J
1,4-dioxane	NS	ug/m3	< 18 U
2,2,4-Trimethylpentane	NS	ug/m3	13
2-butanone	5200	ug/m3	1.8
2-chlorotoluene	NS	ug/m3	< 1 U
2-hexanone	31	ug/m3	< 2 U
3-Chloropropene	4.7	ug/m3	< 1.6 U
4-Ethyltoluene	NS	ug/m3	2
4-Isopropyltoluene	NS	ug/m3	< 1.1 U
4-methyl-2-pentanone	3100	ug/m3	< 2 U
Acetone	32000	ug/m3	12
Benzene	3.6	ug/m3	**4.1**
Benzyl Chloride	0.57	ug/m3	< 1 U
Bromodichloromethane	0.76	ug/m3	< 1.3 U
Bromoform	NS	ug/m3	< 2.1 U
Bromomethane	5.2	ug/m3	< 0.78 U
Butane	NS	ug/m3	7.5
Butyl alcohol, tert-	NS	ug/m3	< 15 U
Carbon disulfide	730	ug/m3	1.6
Carbon tetrachloride	4.7	ug/m3	< 1.3 U
Chlorobenzene	52	ug/m3	< 0.92 U
Chlorodifluoromethane	52000	ug/m3	0.67 J
Chloroethane	10000	ug/m3	< 1.3 U
Chloroform	1.2	ug/m3	**2**
Chloromethane	94	ug/m3	0.32 J
cis-1,2-dichloroethene	NS	ug/m3	< 0.79 U
cis-1,3-dichloropropene	NS	ug/m3	< 0.91 U
Cyclohexane	6300	ug/m3	0.98
Dibromochloromethane	1	ug/m3	< 1.7 U
Dichlorodifluoromethane	100	ug/m3	2.8
Ethylbenzene	11	ug/m3	4.1
Hexachloro-1,3-butadiene	NS	ug/m3	< 2.1 U
Hexane	730	ug/m3	10
Isopropyl Alcohol	NS	ug/m3	12
Isopropylbenzene	420	ug/m3	0.38 J
M,P-Xylene	NS	ug/m3	15
Methyl Methacrylate	730	ug/m3	< 2 U
Methyl tert-butyl ether	110	ug/m3	0.26 J
Methylene Chloride	630	ug/m3	6
Naphthalene	0.83	ug/m3	< 2.6 U
n-Butylbenzene	NS	ug/m3	< 1.1 U
n-Heptane	NS	ug/m3	6.6
N-propylbenzene	1000	ug/m3	1.2
o-Xylene	100	ug/m3	5.5
Sec-butylbenzene	NS	ug/m3	< 1.1 U
Styrene	1000	ug/m3	0.2 J
Tert-butylbenzene	NS	ug/m3	< 1.1 U
Tetrachloroethene	42	ug/m3	4
Tetrahydrofuran	2100	ug/m3	< 15 U
Toluene	5200	ug/m3	15
trans-1,2-dichloroethene	63	ug/m3	< 0.79 U
trans-1,3-dichloropropene	NS	ug/m3	< 0.91 U
Trichloroethene	2.1	ug/m3	< 1.1 U
Trichlorofluoromethane	730	ug/m3	1.1 J
Vinyl Bromide	0.88	ug/m3	< 0.87 U
Vinyl chloride	1.7	ug/m3	< 0.51 U
Xylenes, Total	100	ug/m3	20

Notes:
DNREC Soil Gas= DNREC Sub-Slab Gas and Soil Gas Screening Criteria, dated Januray 2015.
NS = No screening criteria.
J = Analyte present. Reported value may not be accurate or precise.
U = Indicates the analyte was analyzed for but not detected.
ug/m3 = Micrograms per cubic meter.
Bold and shaded values exceed the screening criteria.

TABLE 5-1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SEAFORD POWER PLANT (DE-1031) - SURFACE SOIL
SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Medium: Surface soil
Exposure Medium: Surface soil
Exposure Point: Seaford Power Plant

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Inorganics																	
7440-38-2	Arsenic	3.4		4.8		mg/kg	SPP-SS-07	2/2	2.5 - 2.6	4.8	NA	11	B	NA	NA	No	BSL
Polycyclic aromatic hydrocarbons (PAHs)																	
91-57-6	2-methylnaphthalene	0.0099	J	0.12	J	mg/kg	SPP-SS-10	7/9	0.36 - 0.43	0.12	NA	1	U	NA	NA	No	BSL
83-32-9	Acenaphthene	0.0091	J	0.0093	J	mg/kg	SPP-SS-13	2/9	0.36 - 0.43	0.0093	NA	270	U	NA	NA	No	BSL
208-96-8	Acenaphthylene	0.011	J	0.017	J	mg/kg	SPP-SS-13	3/9	0.36 - 0.43	0.017	NA	270	U	NA	NA	No	BSL
120-12-7	Anthracene	0.038	J	0.038	J	mg/kg	SPP-SS-13	1/9	0.36 - 0.43	0.038	NA	1000	U	NA	NA	No	BSL
56-55-3	Benzo[a]anthracene	0.032	J	0.27		mg/kg	SPP-SS-13	5/9	0.036 - 0.043	0.27	NA	0.9	U	NA	NA	No	BSL
50-32-8	**Benzo[a]pyrene**	**0.012**	**J**	**0.28**		**mg/kg**	**SPP-SS-13**	**8/9**	**0.036 - 0.043**	**0.28**	**NA**	**0.09**	**U**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	Benzo[b]fluoranthene	0.026	J	0.42		mg/kg	SPP-SS-13	8/9	0.036 - 0.043	0.42	NA	0.9	U	NA	NA	No	BSL
191-24-2	Benzo[g,h,i]perylene	0.033	J	0.23	J	mg/kg	SPP-SS-13	6/9	0.36 - 0.43	0.23	NA	230	U	NA	NA	No	BSL
207-08-9	Benzo[k]fluoranthene	0.018	J	0.13		mg/kg	SPP-SS-13	5/9	0.036 - 0.043	0.13	NA	9	U	NA	NA	No	BSL
218-01-9	Chrysene	0.017	J	0.29	J	mg/kg	SPP-SS-13	8/9	0.36 - 0.43	0.29	NA	87	U	NA	NA	No	BSL
53-70-3	Dibenz[a,h]anthracene	0.03	J	0.071		mg/kg	SPP-SS-13	2/9	0.036 - 0.043	0.071	NA	0.09	U	NA	NA	No	BSL
206-44-0	Fluoranthene	0.023	J	0.45		mg/kg	SPP-SS-13	8/9	0.36 - 0.43	0.45	NA	310	U	NA	NA	No	BSL
86-73-7	Fluorene	0.011	J	0.011	J	mg/kg	SPP-SS-13	1/9	0.36 - 0.43	0.011	NA	300	U	NA	NA	No	BSL
193-39-5	Indeno[1,2,3-c,d]pyrene	0.04		0.29		mg/kg	SPP-SS-13	6/9	0.036 - 0.043	0.29	NA	0.9	U	NA	NA	No	BSL
91-20-3	Naphthalene	0.016	J	0.049	J	mg/kg	SPP-SS-10	5/9	0.36 - 0.43	0.049	NA	5	U	NA	NA	No	BSL
85-01-8	Phenanthrene	0.014	J	0.19	J	mg/kg	SPP-SS-13	8/9	0.36 - 0.43	0.19	NA	1000	U	NA	NA	No	BSL
129-00-0	Pyrene	0.023	J	0.38		mg/kg	SPP-SS-13	8/9	0.36 - 0.43	0.38	NA	230	U	NA	NA	No	BSL
Total Petroleum Hydrocarbons																	
DRO	**Diesel Range Organics**	**49**		**1100**		**mg/kg**	**SPP-SS-07**	**4/4**	**10 - 250**	**1100**	**NA**	**1000**		**NA**	**NA**	**Yes**	**ASL**
Volatile Organic Compounds																	
XYLENES	Xylenes, Total	0.03	J	0.03	J	mg/kg	SPP-SS-08	1/2	0.2 - 0.25	0.03	NA	58	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) DNREC Site Investigation and Restoration Section (SIRS) Hazardous Substance Control Act (HSCA) Screening Level, dated Januray 2015.
(5) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
mg/kg = milligrams per kilogram
B = DNREC Background Threshold Value
U = DNREC 1999 Uniform Risk-Based Remediation Standard
Data Qualifiers: J = Value is estimated.

TABLE 5-2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SEAFORD POWER PLANT (DE-1031) - SUBSURFACE SOIL
SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Medium: Subsurface soil
Exposure Medium: Subsurface soil
Exposure Point: Seaford Power Plant

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Inorganics																	
7429-90-5	Aluminum	4490		8590		mg/kg	SPP-DPT-05-3-4	2/2	34.4 - 43.7	8590	NA	51200	B	NA	NA	No	BSL
7440-38-2	**Arsenic**	**3**		**16.2**		**mg/kg**	**SPP-DPT-12-4-5**	**3/4**	**2.6 - 3.9**	**16.2**	**NA**	**11**	**B**	**NA**	**NA**	**Yes**	**ASL**
7440-39-3	Barium	11.3	J	17.6	J	mg/kg	SPP-DPT-05-3-4	2/2	34.4 - 43.7	17.6	NA	1500	N	NA	NA	No	BSL
7440-70-2	Calcium	1990		27900		mg/kg	SPP-DPT-02-3-4	2/2	860 - 1090	27900	NA	NSL		NA	NA	No	NUT
7440-47-3	Chromium	7.5		9.7		mg/kg	SPP-DPT-05-3-4	2/2	1.7 - 2.2	9.7	NA	214	B	NA	NA	No	BSL
7440-50-8	Copper	2.7	J	4.2	J	mg/kg	SPP-DPT-05-3-4	2/2	4.3 - 5.5	4.2	NA	310	N	NA	NA	No	BSL
57-12-5	Cyanide	0.18		0.2		mg/kg	SPP-DPT-02-3-4	2/2	0.11 - 0.13	0.2	NA	2.1	N	NA	NA	No	BSL
7439-89-6	Iron	2560		12700		mg/kg	SPP-DPT-05-3-4	2/2	25.8 - 32.8	12700	NA	74767	B	NA	NA	No	BSL
7439-92-1	Lead	6.4		11.4		mg/kg	SPP-DPT-05-3-4	2/2	1.7 - 2.2	11.4	NA	400		NA	NA	No	BSL
7439-95-4	Magnesium	289	J	376	J	mg/kg	SPP-DPT-02-3-4	2/2	860 - 1090	376	NA	NSL		NA	NA	No	NUT
7439-96-5	Manganese	24.9		38		mg/kg	SPP-DPT-05-3-4	2/2	2.6 - 3.3	38	NA	2100	B	NA	NA	No	BSL
7439-97-6	Mercury	0.046		0.19		mg/kg	SPP-DPT-11-5-6	4/4	0.018 - 0.023	0.19	NA	0.94	N	NA	NA	No	BSL
7440-02-0	Nickel	1.9	J	2	J	mg/kg	SPP-DPT-02-3-4	2/2	6.9 - 8.7	2	NA	150	N	NA	NA	No	BSL
7440-09-7	Potassium	181	J	534	J	mg/kg	SPP-DPT-05-3-4	2/2	860 - 1090	534	NA	NSL		NA	NA	No	NUT
7440-23-5	Sodium	200	J	200	J	mg/kg	SPP-DPT-02-3-4	1/2	860 - 1090	200	NA	NSL		NA	NA	No	NUT
7440-62-2	Vanadium	10.8	J	12.2		mg/kg	SPP-DPT-05-3-4	2/2	8.6 - 10.9	12.2	NA	134	B	NA	NA	No	BSL
7440-66-6	Zinc	6		7.6		mg/kg	SPP-DPT-02-3-4	2/2	5.2 - 6.6	7.6	NA	2300	N	NA	NA	No	BSL
Polycyclic aromatic hydrocarbons (PAHs)																	
91-57-6	**2-methylnaphthalene**	**0.0081**	**J**	**2.6**		**mg/kg**	**SPP-DPT-12-4-5**	**4/10**	**0.36 - 8.1**	**2.6**	**NA**	**1**	**U**	**NA**	**NA**	**Yes**	**ASL**
83-32-9	Acenaphthene	0.44		2.6	JD	mg/kg	SPP-DPT-08a-8-9	5/10	0.36 - 8.1	2.6	NA	270	U	NA	NA	No	BSL
208-96-8	Acenaphthylene	0.13	J	1.1	JD	mg/kg	SPP-DPT-08a-8-9	4/10	0.36 - 8.1	1.1	NA	270	U	NA	NA	No	BSL
120-12-7	Anthracene	0.16	J	1.1	JD	mg/kg	SPP-DPT-08a-8-9	4/10	0.36 - 8.1	1.1	NA	1000	U	NA	NA	No	BSL
56-55-3	Benzo[a]anthracene	0.03	J	0.48		mg/kg	SPP-DPT-11-5-6	3/10	0.036 - 0.81	0.48	NA	0.9	U	NA	NA	No	BSL
50-32-8	**Benzo[a]pyrene**	**0.016**	**J**	**0.28**		**mg/kg**	**SPP-DPT-11-5-6**	**5/10**	**0.036 - 0.81**	**0.28**	**NA**	**0.09**	**U**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	Benzo[b]fluoranthene	0.032	J	0.44		mg/kg	SPP-DPT-11-5-6	5/10	0.036 - 0.81	0.44	NA	0.9	U	NA	NA	No	BSL
191-24-2	Benzo[g,h,i]perylene	0.049	J	0.14	J	mg/kg	SPP-DPT-11-5-6	2/10	0.36 - 8.1	0.14	NA	230	U	NA	NA	No	BSL
218-01-9	Chrysene	0.026	J	0.44	J	mg/kg	SPP-DPT-11-5-6	6/10	0.36 - 8.1	0.44	NA	87	U	NA	NA	No	BSL
206-44-0	Fluoranthene	0.011	J	1.3		mg/kg	SPP-DPT-11-5-6	8/10	0.36 - 8.1	1.3	NA	310	U	NA	NA	No	BSL
86-73-7	Fluorene	0.77		7.1	JD	mg/kg	SPP-DPT-08a-8-9	5/10	0.36 - 8.1	7.1	NA	300	U	NA	NA	No	BSL
193-39-5	Indeno[1,2,3-c,d]pyrene	0.054		0.17		mg/kg	SPP-DPT-11-5-6	2/10	0.036 - 0.81	0.17	NA	0.9	U	NA	NA	No	BSL
91-20-3	Naphthalene	0.011	J	0.26	J	mg/kg	SPP-DPT-11-5-6	4/10	0.36 - 8.1	0.26	NA	5	U	NA	NA	No	BSL
85-01-8	Phenanthrene	0.014	J	12	D	mg/kg	SPP-DPT-08a-8-9	8/10	0.36 - 8.1	12	NA	1000	U	NA	NA	No	BSL
129-00-0	Pyrene	0.035	J	1.4	JD	mg/kg	SPP-DPT-10-5-6	7/10	0.36 - 8.1	1.4	NA	230	U	NA	NA	No	BSL
Total Petroleum Hydrocarbons																	
DRO	**Diesel Range Organics**	**9.8**		**8500**		**mg/kg**	**SPP-DPT-08a-8-9**	**13/13**	**9.8 - 610**	**8500**	**NA**	**1000**		**NA**	**NA**	**Yes**	**ASL**
Volatile Organic Compounds																	
71-43-2	**Benzene**	**0.063**	**J**	**1.4**		**mg/kg**	**SPP-DPT-12-4-5**	**2/15**	**0.087 - 0.12**	**1.4**	**NA**	**1.2**	**C**	**NA**	**NA**	**Yes**	**ASL**
100-41-4	Ethylbenzene	0.19		1.1		mg/kg	SPP-DPT-12-4-5	2/15	0.087 - 0.12	1.1	NA	5.8	C	NA	NA	No	BSL
108-88-3	Toluene	0.06	J	0.51		mg/kg	SPP-DPT-12-4-5	2/15	0.087 - 0.12	0.51	NA	490	N	NA	NA	No	BSL
XYLENES	Xylenes, Total	0.036	J	2		mg/kg	SPP-DPT-12-4-5	4/15	0.17 - 0.25	2	NA	58	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) DNREC Site Investigation and Restoration Section (SIRS) Hazardous Substance Control Act (HSCA) Screening Level, dated Januray 2015.
(5) Rationale Codes

Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
mg/kg = milligrams per kilogram
B = DNREC Background Threshold Value
U = DNREC 1999 Uniform Risk-Based Remediation Standard

Data Qualifiers: J = Value is estimated.
JD = Estimated value is diluted.

TABLE 5-3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SEAFORD POWER PLANT (DE-1031) - SURFACE WATER
SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Medium: Surface water
Exposure Medium: Surface water
Exposure Point: Seaford Power Plant

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Inorganics-TOTAL																	
7429-90-5	Aluminum	523		640		ug/L	SPP-SW-04	5/5	40 - 40	640	NA	64700	N	NA	NA	No	BSL
7440-39-3	Barium	109		115		ug/L	SPP-SW-04	5/5	4 - 4	115	NA	5170	N	NA	NA	No	BSL
7440-70-2	Calcium	5980		6300		ug/L	SPP-SW-05	5/5	200 - 200	6300	NA	NSL		NA	NA	No	NUT
7440-48-4	Cobalt	5.9		6.5		ug/L	SPP-SW-03 / SPP-SW-04	5/5	4 - 4	6.5	NA	20.8	N	NA	NA	No	BSL
7440-50-8	Copper	3.2	J	4.2		ug/L	SPP-SW-05	5/5	4 - 4	4.2	NA	2590	N	NA	NA	No	BSL
7439-89-6	Iron	970		1180		ug/L	SPP-SW-04	5/5	120 - 120	1180	NA	45300	N	NA	NA	No	BSL
7439-92-1	Lead	0.64	J	1.1	J	ug/L	SPP-SW-04	5/5	1.2 - 1.2	1.1	NA	15		NA	NA	No	BSL
7439-95-4	Magnesium	2290		2400		ug/L	SPP-SW-05	5/5	200 - 200	2400	NA	NSL		NA	NA	No	NUT
7439-96-5	Manganese	56.5		61.9		ug/L	SPP-SW-04	5/5	8 - 8	61.9	NA	418	N	NA	NA	No	BSL
7440-02-0	Nickel	2.7	J	3	J	ug/L	SPP-SW-04	5/5	4 - 4	3	NA	891	N	NA	NA	No	BSL
7440-09-7	Potassium	2830		2910		ug/L	SPP-SW-03	5/5	200 - 200	2910	NA	NSL		NA	NA	No	NUT
7440-23-5	Sodium	8010		8160		ug/L	SPP-SW-05	5/5	200 - 200	8160	NA	NSL		NA	NA	No	NUT
7440-66-6	Zinc	20.4		22.8		ug/L	SPP-SW-04	5/5	16 - 16	22.8	NA	20300	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) Site-specific screening levels determined for surface water based upon a recreator scenario as identified in DNREC Site Investigation and Restoration Section (SIRS) Hazardous Substance Control Act (HSCA) risk assessment guidance, dated April 2015.
(5) Rationale Codes

Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions: C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
ug/L = micrograms per liter

Data Qualifiers: J = Value is estimated.

TABLE 5-4
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SEAFORD POWER PLANT (DE-1031) - SEDIMENT - RESIDENTIAL
SEAFORD, DELAWARE

Scenario Timeframe: Current/Future-Residential
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Seaford Power Plant

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Inorganics																	
7429-90-5	Aluminum	2810		6240		mg/kg	SPP-SD-01	2/2	41.4 - 69.6	6240	NA	51200	B	NA	NA	No	BSL
7440-38-2	Arsenic	3.8	J	3.8	J	mg/kg	SPP-SD-01	1/2	3.1 - 5.2	3.8	NA	11	B	NA	NA	No	BSL
7440-39-3	Barium	26.5	J	192		mg/kg	SPP-SD-01	2/2	41.4 - 69.6	192	NA	1500	N	NA	NA	No	BSL
7440-41-7	Beryllium	1.2		1.2		mg/kg	SPP-SD-01	1/2	0.41 - 0.7	1.2	NA	16	N	NA	NA	No	BSL
7440-70-2	Calcium	317	J	2250		mg/kg	SPP-SD-01	2/2	1040 - 1740	2250	NA	NSL		NA	NA	No	NUT
7440-47-3	Chromium	3		10.2		mg/kg	SPP-SD-01	2/2	2.1 - 3.5	10.2	NA	214	B	NA	NA	No	BSL
7440-48-4	**Cobalt**	**4.8**	**J**	**34.4**		**mg/kg**	**SPP-SD-01**	**2/2**	**10.4 - 17.4**	**34.4**	**NA**	**34**	**B**	**NA**	**NA**	**Yes**	**ASL**
7440-50-8	Copper	3.3	J	12.7		mg/kg	SPP-SD-01	2/2	5.2 - 8.7	12.7	NA	310	N	NA	NA	No	BSL
7439-89-6	Iron	3340		15900		mg/kg	SPP-SD-01	2/2	31.1 - 52.2	15900	NA	74767	B	NA	NA	No	BSL
7439-92-1	Lead	6.7		73.3		mg/kg	SPP-SD-01	2/2	2.1 - 3.5	73.3	NA	400		NA	NA	No	BSL
7439-95-4	Magnesium	219	J	1030	J	mg/kg	SPP-SD-01	2/2	1040 - 1740	1030	NA	NSL		NA	NA	No	NUT
7439-96-5	Manganese	51		434		mg/kg	SPP-SD-01	2/2	3.1 - 5.2	434	NA	2100	B	NA	NA	No	BSL
7439-97-6	Mercury	0.095		0.095		mg/kg	SPP-SD-01	1/2	0.022 - 0.039	0.095	NA	0.78	N	NA	NA	No	BSL
7440-02-0	Nickel	2.5	J	14.5		mg/kg	SPP-SD-01	2/2	8.3 - 13.9	14.5	NA	150	N	NA	NA	No	BSL
7440-09-7	Potassium	99	J	531	J	mg/kg	SPP-SD-01	2/2	1040 - 1740	531	NA	NSL		NA	NA	No	NUT
7440-62-2	Vanadium	3.8	J	12.7	J	mg/kg	SPP-SD-01	2/2	10.4 - 17.4	12.7	NA	134	B	NA	NA	No	BSL
7440-66-6	Zinc	16.2		125		mg/kg	SPP-SD-01	2/2	6.2 - 10.4	125	NA	2300	N	NA	NA	No	BSL
Polycyclic aromatic hydrocarbons (PAHs)																	
91-57-6	2-methylnaphthalene	0.018	J	0.16	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	0.16	NA	1	U	NA	NA	No	BSL
83-32-9	Acenaphthene	0.026	J	0.97	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	0.97	NA	270	U	NA	NA	No	BSL
208-96-8	Acenaphthylene	0.013	J	0.096	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	0.096	NA	270	U	NA	NA	No	BSL
120-12-7	Anthracene	0.051	J	0.82	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	0.82	NA	1000	U	NA	NA	No	BSL
56-55-3	**Benzo[a]anthracene**	**0.13**		**1.1**		**mg/kg**	**SPP-SD-01**	**2/2**	**0.043 - 0.15**	**1.1**	**NA**	**0.9**	**U**	**NA**	**NA**	**Yes**	**ASL**
50-32-8	**Benzo[a]pyrene**	**0.11**		**0.43**		**mg/kg**	**SPP-SD-01**	**2/2**	**0.043 - 0.15**	**0.43**	**NA**	**0.09**	**U**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	**Benzo[b]fluoranthene**	**0.26**		**0.94**		**mg/kg**	**SPP-SD-01**	**2/2**	**0.043 - 0.15**	**0.94**	**NA**	**0.9**	**U**	**NA**	**NA**	**Yes**	**ASL**
191-24-2	Benzo[g,h,i]perylene	0.11	J	0.23	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	0.23	NA	230	U	NA	NA	No	BSL
207-08-9	Benzo[k]fluoranthene	0.091		0.31		mg/kg	SPP-SD-01	2/2	0.043 - 0.15	0.31	NA	9	U	NA	NA	No	BSL
218-01-9	Chrysene	0.2	J	1.5		mg/kg	SPP-SD-01	2/2	0.43 - 1.5	1.5	NA	87	U	NA	NA	No	BSL
53-70-3	Dibenz[a,h]anthracene	0.034	J	0.034	J	mg/kg	SPP-SD-02	1/2	0.043 - 0.15	0.034	NA	0.09	U	NA	NA	No	BSL
206-44-0	Fluoranthene	0.43		8.7		mg/kg	SPP-SD-01	2/2	0.43 - 1.5	8.7	NA	310	U	NA	NA	No	BSL
86-73-7	Fluorene	0.029	J	1.3	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	1.3	NA	300	U	NA	NA	No	BSL
193-39-5	Indeno[1,2,3-c,d]pyrene	0.13		0.29		mg/kg	SPP-SD-01	2/2	0.043 - 0.15	0.29	NA	0.9	U	NA	NA	No	BSL
91-20-3	Naphthalene	0.03	J	0.16	J	mg/kg	SPP-SD-01	2/2	0.43 - 1.5	0.16	NA	5	U	NA	NA	No	BSL
85-01-8	Phenanthrene	0.2	J	11		mg/kg	SPP-SD-01	2/2	0.43 - 1.5	11	NA	1000	U	NA	NA	No	BSL
129-00-0	Pyrene	0.29	J	4.8		mg/kg	SPP-SD-01	2/2	0.43 - 1.5	4.8	NA	230	U	NA	NA	No	BSL
Total Petroleum Hydrocarbons																	
DRO	Diesel Range Organics	24		24		mg/kg	SPP-SD-01	1/2	11 - 20	24	NA	1000		NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) DNREC Site Investigation and Restoration Section (SIRS) Hazardous Substance Control Act (HSCA) Screening Level, dated Januray 2015.
(5) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
mg/kg = milligrams per kilogram
B = DNREC Background Threshold Value
U = DNREC 1999 Uniform Risk-Based Remediation Standard
Data Qualifiers: J = Value is estimated.

TABLE 5-5
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SEAFORD POWER PLANT (DE-1031) - SLUDGE
SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Medium: Sludge
Exposure Medium: Sludge
Exposure Point: Seaford Power Plant

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Inorganics																	
7440-38-2	Arsenic	4.1	J	4.1	J	mg/kg	SPP-SL-02	1/2	3.5 - 4.9	4.1	NA	11	B	NA	NA	No	BSL
7440-43-9	**Cadmium**	**7.2**		**7.2**		**mg/kg**	**SPP-SL-02**	**1/1**	**1.3 - 1.3**	**7.2**	**NA**	**7**	**N**	**NA**	**NA**	**Yes**	**ASL**
7439-92-1	**Lead**	**158**		**1200**		**mg/kg**	**SPP-SL-02**	**2/2**	**2.3 - 3.2**	**1200**	**NA**	**400**		**NA**	**NA**	**Yes**	**ASL**
7439-97-6	Mercury	0.083		0.083		mg/kg	SPP-SL-02	1/1	0.029 - 0.029	0.083	NA	0.78	N	NA	NA	No	BSL
Polycyclic aromatic hydrocarbons (PAHs)																	
91-57-6	2-methylnaphthalene	0.025	J*	11		mg/kg	SPP-SL-02	2/2	0.44 - 11	11	NA	1	U	NA	NA	No	BSL
83-32-9	Acenaphthene	0.67	J	0.67	J	mg/kg	SPP-SL-02	1/2	0.44 - 11	0.67	NA	270	U	NA	NA	No	BSL
208-96-8	Acenaphthylene	0.11	J*	0.11	J*	mg/kg	SPP-SL-01	1/2	0.44 - 11	0.11	NA	270	U	NA	NA	No	BSL
120-12-7	Anthracene	0.082	J	0.082	J	mg/kg	SPP-SL-01	1/2	0.44 - 11	0.082	NA	1000	U	NA	NA	No	BSL
56-55-3	Benzo[a]anthracene	0.18		0.18		mg/kg	SPP-SL-01	1/2	0.044 - 1.1	0.18	NA	0.9	U	NA	NA	No	BSL
50-32-8	**Benzo[a]pyrene**	**0.2**	*****	**0.2**	*****	**mg/kg**	**SPP-SL-01**	**1/2**	**0.044 - 1.1**	**0.2**	**NA**	**0.09**	**U**	**NA**	**NA**	**Yes**	**ASL**
205-99-2	**Benzo[b]fluoranthene**	**0.34**	*****	**0.93**	**J***	**mg/kg**	**SPP-SL-02**	**2/2**	**0.044 - 1.1**	**0.93**	**NA**	**0.9**	**U**	**NA**	**NA**	**Yes**	**ASL**
191-24-2	Benzo[g,h,i]perylene	0.18	J	0.18	J	mg/kg	SPP-SL-01	1/2	0.44 - 11	0.18	NA	230	U	NA	NA	No	BSL
207-08-9	Benzo[k]fluoranthene	0.13		0.13		mg/kg	SPP-SL-01	1/2	0.044 - 1.1	0.13	NA	9	U	NA	NA	No	BSL
218-01-9	Chrysene	0.32	J	0.68	J	mg/kg	SPP-SL-02	2/2	0.44 - 11	0.68	NA	87	U	NA	NA	No	BSL
206-44-0	Fluoranthene	0.38	J	1.9	J	mg/kg	SPP-SL-02	2/2	0.44 - 11	1.9	NA	310	U	NA	NA	No	BSL
86-73-7	Fluorene	2.3	J	2.3	J	mg/kg	SPP-SL-02	1/2	0.44 - 11	2.3	NA	300	U	NA	NA	No	BSL
193-39-5	Indeno[1,2,3-c,d]pyrene	0.14		0.14		mg/kg	SPP-SL-01	1/2	0.044 - 1.1	0.14	NA	0.9	U	NA	NA	No	BSL
91-20-3	Naphthalene	0.031	J*	0.031	J*	mg/kg	SPP-SL-01	1/2	0.44 - 11	0.031	NA	5	U	NA	NA	No	BSL
85-01-8	Phenanthrene	0.17	J	4.3	J	mg/kg	SPP-SL-02	2/2	0.44 - 11	4.3	NA	1000	U	NA	NA	No	BSL
129-00-0	Pyrene	0.22	J	3.3	J	mg/kg	SPP-SL-02	2/2	0.44 - 11	3.3	NA	230	U	NA	NA	No	BSL
Total Petroleum Hydrocarbons																	
DRO	Diesel Range Organics	370		410		mg/kg	SPP-SL-01	2/2	12 - 15	410	NA	1000		NA	NA	No	BSL
Volatile Organic Compounds																	
100-41-4	Ethylbenzene	0.035	J	0.035	J	mg/kg	SPP-SL-02	1/1	0.15 - 0.15	0.035	NA	5.8	C	NA	NA	No	BSL
108-88-3	Toluene	0.073	J	0.073	J	mg/kg	SPP-SL-02	1/1	0.15 - 0.15	0.073	NA	490	N	NA	NA	No	BSL
XYLENES	Xylenes, Total	0.12	J	0.12	J	mg/kg	SPP-SL-02	1/1	0.3 - 0.3	0.12	NA	58	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) DNREC Site Investigation and Restoration Section (SIRS) Hazardous Substance Control Act (HSCA) Screening Level, dated Januray 2015.
(5) Rationale Codes
Selection Reason: ASL = Above Screening Toxicity Level
Deletion Reason: BSL = Below Screening Toxicity Level
NSL = No Screening Level
NUT = Essential Nutrient

Definitions:
C = Carcinogenic
COPC = Chemical of Potential Concern
N = Non-Carcinogenic
NA = Not Applicable
mg/kg = milligrams per kilogram
B = DNREC Background Threshold Value
U = DNREC 1999 Uniform Risk-Based Remediation Standard
Data Qualifiers: J = Value is estimated.

TABLE 5-6
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
SEAFORD POWER PLANT (DE-1031) - WASTEWATER
SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Medium: Wastewater
Exposure Medium: Wastewater
Exposure Point: Seaford Power Plant

CAS Number	Chemical	Minimum (1) Concentration	Minimum Qualifier	Maximum (1) Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration (2) Used for Screening	Background (3) Value	Screening (4) Toxicity Value		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for (5) Contaminant Deletion or Selection
Inorganics-Total																	
7429-90-5	Aluminum	193		498		ug/L	SPP-WW-02	2/2	4.00E+01 - 4.00E+01	498	NA	64700	N	NA	NA	No	BSL
7440-36-0	Antimony	0.9	J	0.9	J	ug/L	SPP-WW-02	1/2	2.00E+00 - 2.00E+00	0.9	NA	15.8	N	NA	NA	No	BSL
7440-38-2	**Arsenic**	**0.96**	**J**	**5**		**ug/L**	**SPP-WW-01**	**2/2**	**2.00E+00 - 2.00E+00**	**5**	**NA**	**2.8**	**C**	**NA**	**NA**	**Yes**	**ASL**
7440-39-3	Barium	9.3		104		ug/L	SPP-WW-01	2/2	4.00E+00 - 4.00E+00	104	NA	5170	N	NA	NA	No	BSL
7440-70-2	Calcium	10400		83800		ug/L	SPP-WW-01	2/2	2.00E+02 - 2.00E+02	83800	NA	NSL		NA	NA	No	NUT
7440-50-8	Copper	15.1		40.3		ug/L	SPP-WW-01	2/2	4.00E+00 - 4.00E+00	40.3	NA	2590	N	NA	NA	No	BSL
7439-89-6	Iron	6180		10200		ug/L	SPP-WW-01	2/2	1.20E+02 - 1.20E+02	10200	NA	45300	N	NA	NA	No	BSL
7439-92-1	Lead	3.8		6		ug/L	SPP-WW-01	2/2	1.20E+00 - 1.20E+00	6	NA	15		NA	NA	No	BSL
7439-95-4	Magnesium	2010		5720		ug/L	SPP-WW-01	2/2	2.00E+02 - 2.00E+02	5720	NA	NSL		NA	NA	No	NUT
7439-96-5	Manganese	37.9		360		ug/L	SPP-WW-01	2/2	8.00E+00 - 8.00E+00	360	NA	418	N	NA	NA	No	BSL
7440-09-7	Potassium	369		12700		ug/L	SPP-WW-01	2/2	2.00E+02 - 2.00E+02	12700	NA	NSL		NA	NA	No	NUT
7440-23-5	Sodium	2070		14100		ug/L	SPP-WW-01	2/2	2.00E+02 - 2.00E+02	14100	NA	NSL		NA	NA	No	NUT
7440-66-6	Zinc	15	J	41.5		ug/L	SPP-WW-02	2/2	1.60E+01 - 1.60E+01	41.5	NA	20300	N	NA	NA	No	BSL
Polycyclic aromatic hydrocarbons (PAHs)																	
83-32-9	Acenaphthene	1.7	J	1.7	J	ug/L	SPP-WW-01	1/2	1.00E+01 - 1.00E+01	1.7	NA	215	N	NA	NA	No	BSL
206-44-0	Fluoranthene	1.1	J	1.1	J	ug/L	SPP-WW-02	1/2	1.00E+01 - 1.00E+01	1.1	NA	2920	N	NA	NA	No	BSL
86-73-7	Fluorene	2.6	J	2.6	J	ug/L	SPP-WW-01	1/2	1.00E+01 - 1.00E+01	2.6	NA	108	N	NA	NA	No	BSL
85-01-8	Phenanthrene	1.3	J	1.3	J	ug/L	SPP-WW-01	1/2	1.00E+01 - 1.00E+01	1.3	NA	36	N	NA	NA	No	BSL
129-00-0	Pyrene	2.1	J	2.1	J	ug/L	SPP-WW-02	1/2	1.00E+01 - 1.00E+01	2.1	NA	36	N	NA	NA	No	BSL
Volatile Organic Compounds																	
71-43-2	Benzene	0.11	J	0.11	J	ug/L	SPP-WW-01	1/2	1.00E+00 - 1.00E+00	0.11	NA	17.4	C	NA	NA	No	BSL
XYLENES	Xylenes, Total	0.64	J	0.64	J	ug/L	SPP-WW-01	1/2	2.00E+00 - 2.00E+00	0.64	NA	1540	N	NA	NA	No	BSL

(1) Minimum/maximum detected concentration.
(2) Maximum concentration used as screening value.
(3) Background values are not included as part of the COPC selection process.
(4) Site-specific screening levels determined for surface water based upon a recreator scenario as identified in DNREC Site Investigation and Restoration Section (SIRS) Hazardous Substance Control Act (HSCA) risk assessment guidance, dated April 2015.
(5) Rationale Codes — Selection Reason: ASL = Above Screening Toxicity Level; Deletion Reason: BSL = Below Screening Toxicity Level, NSL = No Screening Level, NUT = Essential Nutrient

Definitions: C = Carcinogenic; COPC = Chemical of Potential Concern; N = Non-Carcinogenic; NA = Not Applicable; ug/L = micrograms per liter

Data Qualifiers: J = Value is estimated.

TABLE 5-7
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
SEAFORD POWER PLANT (DE-1031) - TOTAL SOIL
SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Total Soil
Exposure Point: Seaford Power Plant

Chemical of Potential Concern	Units	Mean of Detected Concentrations	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
Arsenic	mg/kg	8.2	12.3	16.2		mg/kg	12.3	95%UCLM-KMt	ProUCL
PAHs									
2-Methylnaphthalene	mg/kg	0.33	1.80	2.6		mg/kg	1.80	95%UCLM-KMC	ProUCL
Benzo(a)pyrene	mg/kg	0.085	0.20	0.28		mg/kg	0.20	95%UCLM-KMC	ProUCL
TOTAL PETROLEUM HYDROCARBONS									
Diesel Range Organics	mg/kg	2,047	4,255	8,500		mg/kg	4,255	95%UCLM-Adjusted Gamma	ProUCL
VOLATILE ORGANICS									
Benzene	mg/kg	0.73	NA	1.4		mg/kg	1.4	Maximum	Low#Detects

Note: Statistics calculated by the EPA program ProUCL.
95%Adjusted Gamme UCL indicates that the 95 percent upper confidence limit on the mean is based on the adjusted gamma distribution.
95%UCLM-KMC indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) Chebyshev test.
95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.
NA = Not Applicable
LOW #DETECTS indicates low number of detects so maximum detected concentration used as EPC.

TABLE 5-8
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
SEAFORD POWER PLANT (DE-1031) - SEDIMENT/SLUDGE
SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Sediment/Sludge
Exposure Medium: Sediment/Sludge
Exposure Point: Seaford Power Plant

Chemical of Potential Concern	Units	Mean of Detected Concentrations	95% UCL	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
INORGANICS									
Cadmium	mg/kg	7.2	NA	7.2		mg/kg	7.2	Maximum	Low #Detects
Cobalt	mg/kg	19.6	NA	34.4		mg/kg	34.4	Maximum	Low #Detects
Lead	mg/kg	360	NA	1,200		mg/kg	360	Mean	EPA 1994
PAHs									
Benz(a)anthracene	mg/kg	0.47	0.98	1.1		mg/kg	0.98	95%UCLM-KMt	ProUCL
Benzo(a)pyrene	mg/kg	0.25	0.47	0.43		mg/kg	0.43	Maximum	95%UCL>Max
Benzo(b)fluoranthene	mg/kg	0.62	1.05	0.94		mg/kg	0.94	Maximum	95%UCL>Max

Note: Statistics calculated by the EPA program ProUCL.
95%UCLM-Student's indicates that the 95 percent upper confidence limit on the mean is based on the student's t-test.
95%UCLM-KMt indicates that the 95 percent upper confidence limit on the mean is based on the non-parametric Kaplan-Meier (KM) student's t-test.
NA = Not Applicable
LOW #DETECTS indicates number of detects <3.

TABLE 5-9
VALUES USED FOR RESIDENT ADULT DAILY SOIL INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil, Air
Exposure Point: Power Plant
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	Chronic Daily Intake (CDI) (mg/kg/day) =
	CR	Ingestion Rate	mg/day	100	EPA 2015a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	350	DNREC 2015a	
	ED-NC	Exposure Duration - Noncancer	yr	20	EPA 2014	
	ED-C	Exposure Duration-Cancer	yr	20	EPA 2014	
	BW	Body Weight	kg	80	EPA 2014	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	7,300	EPA 1989	CS x EF x ([(ED$_{6-16}$ x CR x 3) + (ED$_{16-30}$ x CR x 1)]/BW) x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	6,032	EPA 2015a	CS x SA x AF x ABS x EF x ED x CF / (BW x AT
	AF	Adherence Factor	mg/cm^2	0.07	EPA 2004 (1)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004 (2)	
	EF	Exposure Frequency	event/yr	350	DNREC 2015a	
	ED-NC	Exposure Duration - Noncancer	yr	20	EPA 2014	
	ED-C	Exposure Duration - Cancer	yr	20	EPA 2014	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	BW	Body Weight	kg	80	EPA 2014	CS x EF x ABS x ([(ED$_{6-16}$ x SA x AF x 3) + (ED$_{16-30}$ x SA x AF x 1)]/BW) x CF / (AT)
	AT-NC	Averaging time - Noncancer	days	7,300	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (mg/m^3) =
	ET	Exposure Time	hours	24	EPA 2009	CA x CF$_1$ x ET x EF x ED / AT x CF$_2$
	CF$_1$	Conversion Factor	µg/mg	1,000	EPA 2009	
	EF	Exposure Frequency	day/yr	350	DNREC 2015a	
	ED-NC	Exposure Duration - Noncancer	yr	20	EPA 2014	Note: CF$_1$ is only used in determining carcinogenic exposure concentrations
	ED-C	Exposure Duration - Cancer	yr	20	EPA 2014	
	CF$_2$	Conversion Factor	hr/day	24	EPA 2009	Mutagenic Exposure Concentration (µg/m^3 or mg/m^3) =
	AT-NC	Averaging time - Noncancer	days	7,300	EPA 1989	CA x ET x EF x [(ED$_{6-16}$ x 3) + (ED$_{16-30}$ x 1)] x CF$_1$ / (AT x CF$_2$)
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	

(1) Taken from Exhibit 3-5 of EPA 2004.
(2) Taken from Exhibit 3-4 of EPA 2004.

kg = kilogram
hr/day = hours per day
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
µg/m^3 = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency

TABLE 5-10
VALUES USED FOR RESIDENT CHILD DAILY SOIL INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil, Air
Exposure Point: Power Plant
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	200	EPA 2015a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	350	DNREC 2015a	
	ED	Exposure Duration	yr	6	DNREC 2015a	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	BW	Body Weight	kg	15	EPA 2014	CS x EF x [[(ED_{0-2} x CR x 10) + (ED_{2-6} x CR x 3)]/BW) x CF / (AT)
	AT-NC	Averaging time - Noncancer	days	2,190	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	2,373	EPA 2015a	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.2	EPA 2004 (1)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004 (2)	
	EF	Exposure Frequency	event/yr	350	DNREC 2015a	
	ED	Exposure Duration	yr	6	DNREC 2015a	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	BW	Body Weight	kg	15	EPA 2014	CS x EF x ABS x [[(ED_{0-2} x SA x AF x 10) + (ED_{2-6} x SA x AF x 3)]/BW) x CF / (AT)
	AT-NC	Averaging time - Noncancer	days	2,190	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (mg/m^3) =
	ET	Exposure Time	hours	24	DNREC 2015	CA x CF_1 x ET x EF x ED / AT x CF_2
	CF_1	Conversion Factor	µg/mg	1,000	EPA 2009	Note: CF_1 is only used in determining carcinogenic exposure concentrations
	EF	Exposure Frequency	day/yr	350	EPA 1991a,b	
	ED	Exposure Duration	yr	6	EPA 1991a,b	Mutagenic Exposure Concentration ($\mu g/m^3$ or mg/m^3) =
	CF_2	Conversion Factor	hr/day	24	EPA 2009	CA x ET x CF_1 x EF x [(ED_{0-2} x 10) + (ED_{2-6} x 3)] / (AT x CF_2)
	AT-NC	Averaging time - Noncancer	days	2,190	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	

(1) Taken from Exhibit 3-5 of EPA 2004.
(2) Taken from Exhibit 3-4 of EPA 2004.

DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-11
VALUES USED FOR ADOLESCENT RECREATIONAL USER DAILY SURFACE SOIL INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Soil, Air
Exposure Point: Power Plant
Receptor Population: Recreational User
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	100	EPA 2011	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	75	DNREC 2015a	
	ED	Exposure Duration	yr	10	BPJ (1)	
	BW	Body Weight	kg	45	EPA 2011	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	3,650	EPA 1989	CS x EF x [(ED_{8-16} x CR x 3)/BW] x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,800	EPA 2011 (2)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.4	EPA 2011	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004	
	EF	Exposure Frequency	event/yr	75	DNREC 2015a	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	ED	Exposure Duration	yr	10	BPJ (1)	CS x EF x ABS x [(ED_{8-16} x SA x AF x 3)/BW] x CF / (AT)
	BW	Body Weight	kg	45	EPA 2011	
	AT-NC	Averaging time - Noncancer	days	3,650	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (mg/m^3) =
	ET	Exposure Time	hours	1	DNREC 2015a	CA x CF_1 x ET x EF x ED / AT x CF_2
	CF_1	Conversion Factor	µg/mg	1,000	EPA 2009	Note: CF_1 is only used in determining carcinogenic exposure concentrations
	EF	Exposure Frequency	day/yr	75	DNREC 2015a	
	ED	Exposure Duration	yr	10	BPJ (1)	
	CF_2	Conversion Factor	hr/day	24	EPA 2009	Mutagenic Exposure Concentration (µg/m^3 or mg/m^3) =
	AT-NC	Averaging time - Noncancer	days	3,650	EPA 1989	CA x ET x CF x EF x [(ED_{8-16} x 3)] / (AT x CF_2)
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	

(1) Assumes an age range of 6 to 16 years of age.

(2) Skin surface area is taken from Table 7-17 and Table 7-9 of 2011 EFH. Table 7-17 notes 29% of exposed skin surface available for 5 to 17 year old during outdoor activities. Table 7-9 presents the total skin surface area for 6 to <11 years of age and 11 to <16 years of age for male and female combined.

DNREC = Delware Department of Natural Resources and Environmental Conservation
BPJ = Best Professional Judgment
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
µg/m^3 = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-12
VALUES USED FOR MAINTENANCE WORKER DAILY SURFACE SOIL INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Current
Medium: Soil
Exposure Medium: Surface Soil, Air
Exposure Point: Power Plant
Receptor Population: Composite Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	330	EPA 2002a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	250	DNREC 2015	
	ED	Exposure Duration	yr	25	DNREC 2015	
	BW	Body Weight	kg	80	EPA 2014	
	AT-NC	Averaging time - Noncancer	days	9,125	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0.E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,527	EPA 2015a	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.3	EPA 2004 (1)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004 (2)	
	EF	Exposure Frequency	event/yr	250	DNREC 2015	
	ED	Exposure Duration	yr	25	DNREC 2015	
	BW	Body Weight	kg	80	EPA 2014	
	AT-NC	Averaging time - Noncancer	days	9,125	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.E-06	EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m^3 or mg/m^3) =
	ET	Exposure Time	hours	8	DNREC 2015	CA x CF_1 x ET x EF x ED / AT x CF_2
	CF_1	Conversion Factor	ug/mg	1,000	EPA 2009	
	EF	Exposure Frequency	day/yr	250	DNREC 2015	
	ED	Exposure Duration	yr	25	DNREC 2015	Note: CF_1 is only used in determining carcinogenic
	CF_2	Conversion Factor	hr/day	24	EPA 2009	exposure concentrations
	AT-NC	Averaging time - Noncancer	days	365	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	

(1) Taken from Exhibit 3-5 of EPA 2004.
(2) Taken from Exhibit 3-4 of EPA 2004.

DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-13
VALUES USED FOR COMMERCIAL WORKER DAILY SOIL INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Soil
Exposure Medium: Soil, Air
Exposure Point: Power Plant
Receptor Population: Composite Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	EPA 2015a	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	250	DNREC 2015	
	ED	Exposure Duration	yr	25	DNREC 2015	
	BW	Body Weight	kg	80	EPA 2014	
	AT-NC	Averaging time - Noncancer	days	9,125	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Soil	mg/kg	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,527	EPA 2015a	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.12	EPA 2015a	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004 (1)	
	EF	Exposure Frequency	event/yr	250	DNREC 2015	
	ED	Exposure Duration	yr	25	DNREC 2015	
	BW	Body Weight	kg	80	EPA 2014	
	AT-NC	Averaging time - Noncancer	days	9,125	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Inhalation	CA	Chemical Concentration in Air	mg/m^3	Chemical-Specific	Chemical-Specific	Exposure Concentration (ug/m^3 or mg/m^3) =
	ET	Exposure Time	hours	8	DNREC 2015	CA x CF_1 x ET x EF x ED / AT x CF_2
	CF_1	Conversion Factor	ug/mg	1,000	EPA 2009	
	EF	Exposure Frequency	day/yr	250	DNREC 2015	
	ED	Exposure Duration	yr	25	DNREC 2015	Note: CF_1 is only used in determining carcinogenic exposure concentrations
	CF_2	Conversion Factor	hr/day	24	EPA 2009	
	AT-NC	Averaging time - Noncancer	days	365	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	

(1) Taken from Exhibit 3-4 of USEPA 2004.

BPJ = Best Professional Judgment
USEPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-14
VALUES USED FOR RESIDENT ADULT DAILY SEDIMENT INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Nanticoke River Riverbank
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	BPJ (1)	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	75	DNREC 2015a	
	ED-NC	Exposure Duration - Noncancer	yr	20	EPA 2014	
	ED-C	Exposure Duration - Cancer	yr	20	EPA 2014	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	BW	Body Weight	kg	80	EPA 2014	CS x EF x ([(ED$_{6-16}$ x CR x 3) + (ED$_{16-30}$ x CR x 1)]/BW) x CF / (AT)
	AT-NC	Averaging time - Noncancer	days	7,300	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	6,032	EPA 2014 (2)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.07	EPA 2004	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004	
	EF	Exposure Frequency	event/yr	75	DNREC 2015a	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	ED-NC	Exposure Duration - Noncancer	yr	20	EPA 2014	CS x EF x ABS x ([(ED$_{6-16}$ x SA x AF x 3) + (ED$_{16-30}$ x SA x AF x 1)]/BW) x CF / (AT)
	ED-C	Exposure Duration - Cancer	yr	20	EPA 2014	
	BW	Body Weight	kg	80	EPA 2014	
	AT-NC	Averaging time - Noncancer	days	7,300	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	

(1) The incidental sediment ingestion rate is assumed to be half that of soil.
(2) Primary contact with sediment is expected to be minimal. Therefore, exposed skin surface area is similar to soil, which includes head, hands, forearms, and lower legs.

DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
µg/m^3 = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-15
VALUES USED FOR RESIDENT CHILD DAILY SEDIMENT INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Nanticoke River Riverbank
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	100	BPJ (1)	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	75	DNREC 2015a	
	ED	Exposure Duration	yr	6	EPA 2014	
	BW	Body Weight	kg	15	EPA 2014	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	2,190	EPA 1989	CS x EF x ([(ED$_{0-2}$ x CR x 10) + (ED$_{2-6}$ x CR x 3)]/BW) x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	2,373	EPA 2015a (2)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.3	EPA 2004	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004	
	EF	Exposure Frequency	event/yr	75	DNREC 2015a	
	ED	Exposure Duration	yr	6	EPA 2014	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	BW	Body Weight	kg	15	EPA 2014	CS x EF x ABS x ([(ED$_{0-2}$ x SA x AF x 10) + (ED$_{2-6}$ x SA x AF x 3)]/BW) x CF / (AT)
	AT-NC	Averaging time - Noncancer	days	2,190	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	

(1) The incidental sediment ingestion rate is assumed to be half that of soil.
(2) Primary contact with sediment is expected to be minimal. Therefore, exposed skin surface area is similar to soil, which includes head, hands, forearms, and lower legs.

DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
µg/m^3 = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-16
VALUES USED FOR ADOLESCENT RECREATIONAL USER DAILY SEDIMENT INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Current
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Nanticoke River Riverbank
Receptor Population: Recreational User
Receptor Age: Adolescent

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	BPJ (1)	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	75	DNREC 2015a	
	ED-C	Exposure Duration	yr	10	BPJ (2)	
	BW	Body Weight	kg	45	EPA 2011	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	AT-NC	Averaging time - Noncancer	days	3,650	EPA 1989	CS x EF x $[(ED_{8\text{-}16} \text{ x CR x } 3)/BW]$ x CF / (AT)
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,800	EPA 2011 (3)	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.4	EPA 2004 (4)	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004	
	EF	Exposure Frequency	event/yr	75	DNREC 2015a	Mutagenic Chronic Daily Intake (MCDI) (mg/kg/day) =
	ED-C	Exposure Duration	yr	10	BPJ (2)	CS x EF x ABS x $[(ED_{8\text{-}16} \text{ x SA x AF x } 3)/BW]$ x CF / (AT)
	BW	Body Weight	kg	45	EPA 2011	
	AT-NC	Averaging time - Noncancer	days	3,650	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	

(1) The incidental soil ingestion rate is assumed to be half that of a resident.
(2) The exposure frequency is based on best professional judgment, assuming that the trespasser would visit the site approximately 2 days/week for 6 months of the year. The exposure duration is based on the age range evaluated (6 - 16 years of age).
(3) Taken from Table 7-2 of EPA 2011, equal to the average of two age ranges: 6 to <11 years and 11 to <16 years. Assuming head, hands, forearms, lower legs, and feet are exposed.
(4) Assumes similar soil adherence to resident child.

DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-17
VALUES USED FOR MAINTENANCE WORKER DAILY SEDIMENT INTAKE EQUATIONS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Current
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Nanticoke River Riverbank
Receptor Population: Composite Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/Reference	Intake Equation / Model Name
Ingestion	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	CR	Ingestion Rate	mg/day	50	BPJ	CS x CR x EF x ED x CF / (BW x AT)
	EF	Exposure Frequency	day/yr	52	BPJ (1)	
	ED-C	Exposure Duration	yr	25	DNREC 2015a	
	BW	Body Weight	kg	80	EPA 2014	
	AT-NC	Averaging time - Noncancer	days	9,125	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	
Dermal	CS	Chemical Concentration in Sediment	Chemical-Specific	Chemical-Specific	Chemical-Specific	CDI (mg/kg/day) =
	SA	Surface Area for Contact	cm^2/event	3,527	EPA 2015a	CS x SA x AF x ABS x EF x ED x CF / (BW x AT)
	AF	Adherence Factor	mg/cm^2	0.20	EPA 2004	
	ABS	Dermal Absorption Fraction	unitless	Chemical-Specific	EPA 2004	
	EF	Exposure Frequency	event/yr	52	BPJ (1)	
	ED-C	Exposure Duration	yr	25	DNREC 2015a	
	BW	Body Weight	kg	80	DNREC 2015a	
	AT-NC	Averaging time - Noncancer	days	9,125	EPA 1989	
	AT-C	Averaging Time - Cancer	days	25,550	EPA 1989	
	CF	Conversion Factor	kg/mg	1.0E-06	EPA 1989	

(1) The worker is assumed to contact sediment one day week for an entire year (52 weeks).

DNREC = Delware Department of Natural Resources and Environmental Conservation
EPA = United States Environmental Protection Agency
CDI = chronic daily intake
mg/kg = milligrams per kilogram
kg/mg = kiograms per miligram
mg/cm^2 = milligrams per square centimeter
mg/day = milligrams per day
day/yr = days per year
RME = Reasonable Maximum Exposure
mg/m^3 = milligram per cubic meter
$\mu g/m^3$ = micrograms per cubic meter
cm^2 /event = square centimeters per event
µg/mg = microgram per milligram
kg = kilogram
hr/day = hours per day

TABLE 5-18
NON-CANCER TOXICITY DATA - ORAL/DERMAL
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value (mg/kg-day)	Oral to Dermal Adjustment Factor (GI ABS) (1)	Adjusted Dermal RfD (2) (mg/kg-day)	Primary Target Organ	Combined Uncertainty/ Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (mm/dd/yy)
Inorganics								
ARSENIC	Chronic	3.0E-04	1	3.0E-04	Skin	3/1	IRIS	5/28/2015
CADMIUM	Chronic	1.0E-03	0.025	2.5E-05	Kidneys	10/1	IRIS	5/28/2015
COBALT	Chronic	3.0E-04	1	3.0E-04	Thyroid	3000/1	PPRTV	8/25/2008
PAHs								
BENZ(A)ANTHRACENE	NA	NA	1	NA	NA	NA/NA	IRIS	5/28/2015
BENZO(B)FLUORANTHENE	NA	NA	1	NA	NA	NA/NA	IRIS	5/28/2015
BENZO(A)PYRENE	NA	NA	1	NA	NA	NA/NA	IRIS	5/28/2015
2-METHYLNAPHTHALENE	Chronic	4.0E-03	1	4.0E-03	Lungs	1000/1	IRIS	5/28/2015
Semivolatiles								
DIESEL RANGE ORGANICS	Chronic	1.0E-01	1	1.0E-01	NA		DNREC	1/31/2015
Volatiles								
BENZENE	Chronic	4.0E-03	1	4.0E-03	Immune System	300/1	IRIS	5/28/2015

NA = Not Applicable
RfD = Reference Dose
GI ABS = Gastrointestional absorption
mg/kg-day = milligram per kilogram - day
(1) Taken from USEPA 2004 Guidance.
(2) Dermal toxicological values adjusted from oral values using USEPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). RfDs are multiplied by the GI ABS.
(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
PPRTV - Provisional Peer Reviewed Toxicity Value
DNREC - Delaware Department of Natural Resource and Environmental Control

TABLE 5-19
NON-CANCER TOXICITY DATA - INHALATION
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation (RfC) (mg/m^3)	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC Target Organ	Dates (1) (mm/dd/yy)
Inorganics						
ARSENIC	Chronic	1.5E-05	Cardiovascular System	30/1	CalEPA	5/28/2015
CADMIUM	Chronic	1.0E-05	Kidneys	9/1	ATSDR	12/1/2014
COBALT	Chronic	6.0E-06	Cardiovascular System	300/1	PPRTV	8/25/2008
PAHs						
BENZ(A)ANTHRACENE	NA	NA	NA	NA	IRIS	5/28/2015
BENZO(B)FLUORANTHENE	NA	NA	NA	NA	IRIS	5/28/2015
BENZO(A)PYRENE	NA	NA	NA	NA	IRIS	5/28/2015
2-METHYLNAPHTHALENE	NA	NA	NA	NA	IRIS	5/28/2015
Semivolatiles						
DIESEL RANGE ORGANICS	Chronic	2.0E-01	NA	NA	DNREC	1/31/2015
Volatiles						
BENZENE	Chronic	3.0E-02	Immune System	300/1	IRIS	5/28/2015

NA = Not Applicable
RfC = Reference Concentration
mg/m^3 = milligrams per cubic meter
(1) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
ATSDR - Agency for Toxic Substances and Disease Registry, Minimal Risk Levels
PPRTV - Provisional Peer Reviewed Toxicity Value
CAL EPA - California Environmental Protection Agency
DNREC - Delaware Department of Natural Resource and Environmental Control

TABLE 5-20
CANCER TOXICITY DATA - ORAL/DERMAL
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral Absorption Efficiency for Dermal (GI ABS)[1]	Absorbed Cancer Slope Factor for Dermal [2]	Units	Weight of Evidence/Cancer Guideline Description	Mutagenic	Source	Date [3] (mm/dd/yy)
Inorganics								
ARSENIC	1.5	1	1.50E+00	per (mg/kg-day)	A		IRIS	5/28/2015
CADMIUM	NA	0.025	NA	per (mg/kg-day)	B1		IRIS	5/28/2015
COBALT	NA	1	NA	per (mg/kg-day)	NA		PPRTV	8/25/2008
PAHs								
BENZ(A)ANTHRACENE	0.73	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	5/28/2015
BENZO(B)FLUORANTHENE	0.73	1	7.30E-01	per (mg/kg-day)	B2	M	IRIS	5/28/2015
BENZO(A)PYRENE	7.3	1	7.30E+00	per (mg/kg-day)	B2	M	IRIS	5/28/2015
2-METHYLNAPHTHALENE	NA	1	NA	per (mg/kg-day)	NA		IRIS	5/28/2015
Semivolatiles								
DIESEL RANGE ORGANICS	NA	1	NA	per (mg/kg-day)	NA		DNREC	1/31/2015
Volatiles								
BENZENE	0.055	1	5.50E-02	per (mg/kg-day)	A		IRIS	5/28/2015

NA = Not Applicable

(1) Taken from USEPA 2004 Guidance.

(2) Dermal Toxicological values adjusted from oral values using USEPA 2004 recommended chemical-specific gastrointestinal absorption factors (GI ABS). CSFs are divided by the GI ABS.

(3) IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.
HEAST - Health Effects Assessment Summary Tables. For HEAST values, the date of HEAST is provided.
EPA-NCEA - National Center for Environmental Assessment. For EPA-NCEA values, the date of the article provided by EPA-NCEA is provided.
PPRTV - Provisional Peer Reviewed Toxicity Value
CAL EPA - California Environmental Protection Agency
DNREC - Delaware Department of Natural Resource and Environmental Control

Weight of Evidence:
A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 5-21
CANCER TOXICITY DATA - INHALATION
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Chemical of Potential Concern	Unit Risk		Weight of Evidence/Cancer Guideline Description	Mutagenic	Unit Risk - Inhalation CSF	
	Value	Units			Source	Date [(1)]
Inorganics						
ARSENIC	4.3E-03	per (ug/m^3)	A		IRIS	5/28/2015
CADMIUM	1.8E-03	per (ug/m^3)	B1		IRIS	5/28/2015
COBALT	9.0E-03	per (ug/m^3)	B2		PPRTV	8/25/2008
PAHs						
BENZ(A)ANTHRACENE	1.1E-04	per (ug/m^3)	B2	M	CalEPA	5/1/2009
BENZO(B)FLUORANTHENE	1.1E-04	per (ug/m^3)	B2	M	CalEPA	5/1/2009
BENZO(A)PYRENE	1.1E-03	per (ug/m^3)	B2	M	CalEPA	5/1/2009
2-METHYLNAPHTHALENE	NA	per (ug/m^3)	NA		IRIS	5/28/2015
Semivolatiles						
DIESEL RANGE ORGANICS	NA	per (ug/m^3)	NA		DNREC	1/31/2015
Volatiles						
BENZENE	7.8E-06	per (ug/m^3)	A		IRIS	5/28/2015

NA = Not Applicable

ug/m^3 = micrograms per cubic meter

(1)IRIS - Integrated Risk Information System. For IRIS values, the date IRIS was searched is provided.

HEAST - Health Effects Assessment Summary Tables. For HEAST values, the date of HEAST is provided.
EPA-NCEA - National Center for Environmental Assessment. For EPA-NCEA values, the
PPRTV - Provisional Peer Reviewed Toxicity Value
CAL EPA - California Environmental Protection Agency
DNREC - Delaware Department of Natural Resource and Environmental Control

Weight of Evidence: A - Human carcinogen
B1 - Probable human carcinogen - indicate that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 5-22
CHEMICAL-SPECIFIC PARAMETERS
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Chemical of Potential Concern	Absorption Factor	Reference	GI ABS	Reference
Inorganics				
ARSENIC	0.03	U.S. EPA, 2004	1	U.S. EPA, 2004
CADMIUM	0.001	U.S. EPA, 2004	0.025	U.S. EPA, 2004
COBALT	NA	U.S. EPA, 2004	1	U.S. EPA, 2004
PAHs				
BENZ(A)ANTHRACENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
BENZO(B)FLUORANTHENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
BENZO(A)PYRENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
2-METHYLNAPHTHALENE	0.13	U.S. EPA, 2004	1	U.S. EPA, 2004
Semivolatiles				
DIESEL RANGE ORGANICS	0.1	U.S. EPA, 2004	1	U.S. EPA, 2004
Volatiles				
BENZENE	NA	U.S. EPA, 2004	1	U.S. EPA, 2004

NA = Data not available.
GI ABS = Gastrointestional Absorption factors
U.S. EPA, 2004 = U.S. Environmental Protection Agency, 2004. *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* Final Guidance.

TABLE 5-23

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment	Sediment	Riverbank	Ingestion	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	2.64E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	9.25E-07	(mg/kg-day)	1.00E-03	(mg/kg-day)	9.2E-04
				COBALT	3.44E+01	(mg/kg)	1.26E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	4.42E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.5E-02
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	6.47E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.7E-08	1.26E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	6.21E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.5E-08	1.21E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	2.84E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.1E-07	5.52E-08	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**3.0E-07**					**1.6E-02**
			Dermal[1]	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	2.23E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	7.81E-09	(mg/kg-day)	2.50E-05	(mg/kg-day)	3.1E-04
				COBALT	3.44E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	7.11E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	5.2E-08	1.38E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	6.82E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	5.0E-08	1.33E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	3.12E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.3E-07	6.06E-08	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**3.3E-07**					**3.1E-04**
		Exposure Point Total									**6.3E-07**					**1.6E-02**
	Exposure Medium Total										**6.3E-07**					**1.6E-02**
Sediment Total											**6.3E-07**					**1.6E-02**
Soil	Soil	Power Plant	Ingestion	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	4.21E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	6.3E-06	1.47E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	4.9E-02
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	1.23E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	9.0E-07	2.40E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	6.16E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.16E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	5.4E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	1.46E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	5.10E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	5.1E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	4.79E-07	(mg/kg-day)	5.50E-02	per (mg/kg-day)	2.6E-08	1.68E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	4.2E-04
			Exp. Route Total								**7.2E-06**					**1.0E-01**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	5.34E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	8.0E-07	1.87E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	6.2E-03
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	6.77E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	4.9E-07	1.32E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	3.38E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.18E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	3.0E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	6.15E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	2.15E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	2.2E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	NA	(mg/kg-day)	5.50E-02	per (mg/kg-day)	--	NA	(mg/kg-day)	4.00E-03	(mg/kg-day)	--
			Exp. Route Total								**1.3E-06**					**2.8E-02**
		Exposure Point Total									**8.5E-06**					**1.3E-01**
	Exposure Medium Total										**8.5E-06**					**1.3E-01**
Soil	Air	Power Plant	Inhalation	**Inorganics**												
				ARSENIC	9.04E-09	(mg/m^3)	2.48E-06	(ug/m^3)	4.30E-03	per (ug/m^3)	1.1E-08	8.67E-09	(mg/m^3)	1.50E-05	(mg/m^3)	5.8E-04
				PAHs												
				BENZO(A)PYRENE	1.47E-10	(mg/m^3)	7.25E-08	(ug/m^3)	1.10E-03	per (ug/m^3)	8.0E-11	1.41E-10	(mg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.32E-09	(mg/m^3)	3.63E-07	(ug/m^3)	NA	per (ug/m^3)	--	1.27E-09	(mg/m^3)	NA	(mg/m^3)	--
				Semivolatiles												
				DIESEL RANGE ORGANICS	3.13E-06	(mg/m^3)	8.57E-04	(ug/m^3)	NA	per (ug/m^3)	--	3.00E-06	(mg/m^3)	2.00E-01	(mg/m^3)	1.5E-05
				Volatiles												
				BENZENE	1.03E-09	(mg/m^3)	2.82E-07	(ug/m^3)	7.80E-06	per (ug/m^3)	2.2E-12	9.87E-10	(mg/m^3)	3.00E-02	(mg/m^3)	3.3E-08
			Exp. Route Total								**1.1E-08**					**5.9E-04**
		Exposure Point Total									**1.1E-08**					**5.9E-04**
	Exposure Medium Total										**1.1E-08**					**5.9E-04**
Soil Total											**8.5E-06**					**1.3E-01**
										Total of Receptor Risks Across All Media	**9.2E-06**				Total of Receptor Hazards Across All Media		**0.1**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 4-5.3.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 5-24
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment	Sediment	Riverbank	Ingestion	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	8.45E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	9.86E-06	(mg/kg-day)	1.00E-03	(mg/kg-day)	9.9E-03
				COBALT	3.44E+01	(mg/kg)	4.04E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	4.71E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.6E-01
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	6.10E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.5E-07	1.34E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	5.85E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.3E-07	1.29E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	2.68E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.0E-06	5.89E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**2.8E-06**					**1.7E-01**
			Dermal[1]	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	6.02E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	7.02E-08	(mg/kg-day)	2.50E-05	(mg/kg-day)	2.8E-03
				COBALT	3.44E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	5.64E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.1E-07	1.24E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	5.41E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	4.0E-07	1.19E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	2.48E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.8E-06	5.45E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**2.6E-06**					**2.8E-03**
		Exposure Point Total									**5.4E-06**					**1.7E-01**
	Exposure Medium Total										**5.4E-06**					**1.7E-01**
Sediment Total											**5.4E-06**					**1.7E-01**
Soil	Soil	Power Plant	Ingestion	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	1.35E-05	(mg/kg-day)	1.50E+00	per (mg/kg-day)	2.0E-05	1.57E-04	(mg/kg-day)	3.00E-04	(mg/kg-day)	5.2E-01
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	1.16E-06	(mg/kg-day)	7.30E+00	per (mg/kg-day)	8.5E-06	2.56E-06	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	1.97E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	2.30E-05	(mg/kg-day)	4.00E-03	(mg/kg-day)	5.8E-03
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	4.66E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	5.44E-02	(mg/kg-day)	1.00E-01	(mg/kg-day)	5.4E-01
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	1.53E-06	(mg/kg-day)	5.50E-02	per (mg/kg-day)	8.4E-08	1.79E-05	(mg/kg-day)	4.00E-03	(mg/kg-day)	4.5E-03
			Exp. Route Total								**2.9E-05**					**1.1E+00**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	9.60E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	1.4E-06	1.12E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	3.7E-02
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	3.58E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.6E-06	7.89E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	6.09E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	7.10E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.8E-03
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	1.11E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.29E-02	(mg/kg-day)	1.00E-01	(mg/kg-day)	1.3E-01
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	NA	(mg/kg-day)	5.50E-02	per (mg/kg-day)	--	NA	(mg/kg-day)	4.00E-03	(mg/kg-day)	--
			Exp. Route Total								**4.1E-06**					**1.7E-01**
		Exposure Point Total									**3.3E-05**					**1.2E+00**
	Exposure Medium Total										**3.3E-05**					**1.2E+00**
Soil	Air	Power Plant	Inhalation	**Inorganics**												
				ARSENIC	9.04E-09	(mg/m^3)	7.43E-07	(ug/m^3)	4.30E-03	per (ug/m^3)	3.2E-09	8.67E-09	(mg/m^3)	1.50E-05	(mg/m^3)	5.8E-04
				PAHs												
				BENZO(A)PYRENE	1.47E-10	(mg/m^3)	6.41E-08	(ug/m^3)	1.10E-03	per (ug/m^3)	7.0E-11	1.41E-10	(mg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.32E-09	(mg/m^3)	1.09E-07	(ug/m^3)	NA	per (ug/m^3)	--	1.27E-09	(mg/m^3)	NA	(mg/m^3)	--
				Semivolatiles												
				DIESEL RANGE ORGANICS	3.13E-06	(mg/m^3)	2.57E-04	(ug/m^3)	NA	per (ug/m^3)	--	3.00E-06	(mg/m^3)	2.00E-01	(mg/m^3)	1.5E-05
				Volatiles												
				BENZENE	1.03E-09	(mg/m^3)	8.46E-08	(ug/m^3)	7.80E-06	per (ug/m^3)	6.6E-13	9.87E-10	(mg/m^3)	3.00E-02	(mg/m^3)	3.3E-08
			Exp. Route Total								**3.3E-09**					**5.9E-04**
		Exposure Point Total									**3.3E-09**					**5.9E-04**
	Exposure Medium Total										**3.3E-09**					**5.9E-04**
Soil Total											**3.3E-05**					**1.2E+00**
										Total of Receptor Risks Across All Media	**3.8E-05**				Total of Receptor Hazards Across All Media		**1**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 4-5.3.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 5-25
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment	Sediment	Riverbank	Ingestion	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	2.35E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.64E-06	(mg/kg-day)	1.00E-03	(mg/kg-day)	1.6E-03
				COBALT	3.44E+01	(mg/kg)	1.12E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	7.85E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	2.6E-02
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	9.59E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	7.0E-08	2.24E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	9.20E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	6.7E-08	2.15E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	4.21E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	3.1E-07	9.82E-08	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**4.4E-07**					**2.8E-02**
			Dermal[1]	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	7.14E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	5.00E-08	(mg/kg-day)	2.50E-05	(mg/kg-day)	2.0E-03
				COBALT	3.44E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	3.79E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.8E-07	8.84E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	3.63E-07	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.7E-07	8.48E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	1.28E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	9.3E-07	2.98E-07	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**1.5E-06**					**2.0E-03**
		Exposure Point Total									**1.9E-06**					**3.0E-02**
	Exposure Medium Total										**1.9E-06**					**3.0E-02**
Sediment Total											**1.9E-06**					**3.0E-02**
Soil	Soil	Power Plant	Ingestion	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	8.02E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	1.2E-06	5.62E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.9E-02
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	3.91E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.9E-07	9.13E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	1.17E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	8.22E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	2.1E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	2.78E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	1.94E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	1.9E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	9.13E-08	(mg/kg-day)	5.50E-02	per (mg/kg-day)	5.0E-09	6.39E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.6E-04
			Exp. Route Total								**1.5E-06**					**3.9E-02**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	3.66E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	5.5E-07	2.56E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	8.5E-03
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	5.95E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	4.3E-07	1.39E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	2.32E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	1.62E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	4.1E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	4.22E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	2.95E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	3.0E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	NA	(mg/kg-day)	5.50E-02	per (mg/kg-day)	--	NA	(mg/kg-day)	4.00E-03	(mg/kg-day)	--
			Exp. Route Total								**9.8E-07**					**3.8E-02**
		Exposure Point Total									**2.5E-06**					**7.7E-02**
	Exposure Medium Total										**2.5E-06**					**7.7E-02**
Soil	Air	Power Plant	Inhalation	**Inorganics**												
				ARSENIC	9.04E-09	(mg/m^3)	1.11E-08	(ug/m^3)	4.30E-03	per (ug/m^3)	4.8E-11	7.74E-11	(mg/m^3)	1.50E-05	(mg/m^3)	5.2E-06
				PAHs												
				BENZO(A)PYRENE	1.47E-10	(mg/m^3)	5.40E-10	(ug/m^3)	1.10E-03	per (ug/m^3)	5.9E-13	1.26E-12	(mg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.32E-09	(mg/m^3)	1.62E-09	(ug/m^3)	NA	per (ug/m^3)	--	1.13E-11	(mg/m^3)	NA	(mg/m^3)	--
				Semivolatiles												
				DIESEL RANGE ORGANICS	3.13E-06	(mg/m^3)	3.83E-06	(ug/m^3)	NA	per (ug/m^3)	--	2.68E-08	(mg/m^3)	2.00E-01	(mg/m^3)	1.3E-07
				Volatiles												
				BENZENE	1.03E-09	(mg/m^3)	1.26E-09	(ug/m^3)	7.80E-06	per (ug/m^3)	9.8E-15	8.81E-12	(mg/m^3)	3.00E-02	(mg/m^3)	2.9E-10
			Exp. Route Total								**4.8E-11**					**5.3E-06**
		Exposure Point Total									**4.8E-11**					**5.3E-06**
	Exposure Medium Total										**4.8E-11**					**5.3E-06**
Soil Total											**2.5E-06**					**7.7E-02**
										Total of Receptor Risks Across All Media	**4.4E-06**			Total of Receptor Hazards Across All Media		**0.11**

TABLE 5-26

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Current/Future
Receptor Population: Composite Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Sediment	Sediment	Riverbank	Ingestion	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	2.29E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	6.41E-07	(mg/kg-day)	1.00E-03	(mg/kg-day)	6.4E-04
				COBALT	3.44E+01	(mg/kg)	1.09E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	3.06E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.0E-02
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	3.12E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.3E-08	8.73E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	2.99E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	2.2E-08	8.37E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	1.37E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.0E-07	3.83E-08	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**1.4E-07**					**1.1E-02**
			Dermal[1]	**Inorganics**												
				CADMIUM	7.20E+00	(mg/kg)	1.24E-09	(mg/kg-day)	NA	per (mg/kg-day)	--	9.04E-09	(mg/kg-day)	2.50E-05	(mg/kg-day)	3.6E-04
				COBALT	3.44E+01	(mg/kg)	NA	(mg/kg-day)	NA	per (mg/kg-day)	--	NA	(mg/kg-day)	3.00E-04	(mg/kg-day)	--
				PAHs												
				BENZ(A)ANTHRACENE	9.80E-01	(mg/kg)	2.20E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.6E-08	1.60E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(B)FLUORANTHENE	9.40E-01	(mg/kg)	2.11E-08	(mg/kg-day)	7.30E-01	per (mg/kg-day)	1.5E-08	1.54E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				BENZO(A)PYRENE	4.30E-01	(mg/kg)	9.65E-09	(mg/kg-day)	7.30E+00	per (mg/kg-day)	7.0E-08	7.02E-08	(mg/kg-day)	NA	(mg/kg-day)	--
			Exp. Route Total								**1.0E-07**					**3.6E-04**
		Exposure Point Total									**2.5E-07**					**1.1E-02**
	Exposure Medium Total										**2.5E-07**					**1.1E-02**
Sediment Total											**2.5E-07**					**1.1E-02**
Soil	Soil	Power Plant	Ingestion	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	1.24E-05	(mg/kg-day)	1.50E+00	per (mg/kg-day)	1.9E-05	3.48E-05	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.2E-01
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	2.02E-07	(mg/kg-day)	7.30E+00	per (mg/kg-day)	1.5E-06	5.65E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	1.82E-06	(mg/kg-day)	NA	per (mg/kg-day)	--	5.09E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.3E-03
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	4.29E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	1.20E-02	(mg/kg-day)	1.00E-01	(mg/kg-day)	1.2E-01
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	1.41E-06	(mg/kg-day)	5.50E-02	per (mg/kg-day)	7.8E-08	3.96E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	9.9E-04
			Exp. Route Total								**2.0E-05**					**2.4E-01**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	1.19E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	1.8E-06	3.34E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.1E-02
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	8.41E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	6.1E-07	2.36E-07	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	7.57E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	2.12E-06	(mg/kg-day)	4.00E-03	(mg/kg-day)	5.3E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	1.38E-03	(mg/kg-day)	NA	per (mg/kg-day)	--	3.85E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	3.9E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	NA	(mg/kg-day)	5.50E-02	per (mg/kg-day)	--	NA	(mg/kg-day)	4.00E-03	(mg/kg-day)	--
			Exp. Route Total								**2.4E-06**					**5.0E-02**
		Exposure Point Total									**2.3E-05**					**2.9E-01**
	Exposure Medium Total										**2.3E-05**					**2.9E-01**
	Air	Power Plant	Inhalation	**Inorganics**												
				ARSENIC	9.04E-09	(mg/m^3)	7.37E-07	(mg/kg-day)	4.30E-03	per (mg/kg-day)	3.2E-09	5.16E-08	(mg/kg-day)	1.50E-05	(mg/kg-day)	3.4E-03
				PAHs												
				BENZO(A)PYRENE	1.47E-10	(mg/m^3)	1.20E-08	(mg/kg-day)	1.10E-03	per (mg/kg-day)	1.3E-11	8.39E-10	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.32E-09	(mg/m^3)	1.08E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	7.55E-09	(mg/kg-day)	NA	(mg/kg-day)	--
				Semivolatiles												
				DIESEL RANGE ORGANICS	3.13E-06	(mg/m^3)	2.55E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	1.79E-05	(mg/kg-day)	2.00E-01	(mg/kg-day)	8.9E-05
				Volatiles												
				BENZENE	1.03E-09	(mg/m^3)	8.39E-08	(mg/kg-day)	7.80E-06	per (mg/kg-day)	6.5E-13	5.88E-09	(mg/kg-day)	3.00E-02	(mg/kg-day)	2.0E-07
			Exp. Route Total								**3.2E-09**					**3.5E-03**
		Exposure Point Total									**3.2E-09**					**3.5E-03**
	Exposure Medium Total										**3.2E-09**					**3.5E-03**
Soil Total											**2.3E-05**					**2.9E-01**
										Total of Receptor Risks Across All Media	**2.3E-05**				Total of Receptor Hazards Across All Media		**0.3**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 4-5.3.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 5-27

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Soil	Soil	Power Plant	Ingestion	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	1.88E-06	(mg/kg-day)	1.50E+00	per (mg/kg-day)	2.8E-06	5.27E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	1.8E-02
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	3.06E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.2E-07	8.56E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	2.75E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	7.71E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.9E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	6.51E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	1.82E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	1.8E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	2.14E-07	(mg/kg-day)	5.50E-02	per (mg/kg-day)	1.2E-08	5.99E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	1.5E-04
			Exp. Route Total								**3.1E-06**					**3.6E-02**
			Dermal[1]	**Inorganics**												
				ARSENIC	1.23E+01	(mg/kg)	4.78E-07	(mg/kg-day)	1.50E+00	per (mg/kg-day)	7.2E-07	1.34E-06	(mg/kg-day)	3.00E-04	(mg/kg-day)	4.5E-03
				PAHs												
				BENZO(A)PYRENE	2.00E-01	(mg/kg)	3.36E-08	(mg/kg-day)	7.30E+00	per (mg/kg-day)	2.5E-07	9.42E-08	(mg/kg-day)	NA	(mg/kg-day)	--
				2-METHYLNAPHTHALENE	1.80E+00	(mg/kg)	3.03E-07	(mg/kg-day)	NA	per (mg/kg-day)	--	8.48E-07	(mg/kg-day)	4.00E-03	(mg/kg-day)	2.1E-04
				Semivolatiles												
				DIESEL RANGE ORGANICS	4.26E+03	(mg/kg)	5.51E-04	(mg/kg-day)	NA	per (mg/kg-day)	--	1.54E-03	(mg/kg-day)	1.00E-01	(mg/kg-day)	1.5E-02
				Volatiles												
				BENZENE	1.40E+00	(mg/kg)	NA	(mg/kg-day)	5.50E-02	per (mg/kg-day)	--	NA	(mg/kg-day)	4.00E-03	(mg/kg-day)	--
			Exp. Route Total								**9.6E-07**					**2.0E-02**
		Exposure Point Total									**4.0E-06**					**5.6E-02**
	Exposure Medium Total										**4.0E-06**					**5.6E-02**
	Air	Power Plant	Inhalation	**Inorganics**												
				ARSENIC	9.04E-09	(mg/m^3)	7.37E-07	(ug/m^3)	4.30E-03	per (ug/m^3)	3.2E-09	5.16E-08	(mg/m^3)	1.50E-05	(mg/m^3)	3.4E-03
				PAHs												
				BENZO(A)PYRENE	1.47E-10	(mg/m^3)	1.20E-08	(ug/m^3)	1.10E-03	per (ug/m^3)	1.3E-11	8.39E-10	(mg/m^3)	NA	(mg/m^3)	--
				2-METHYLNAPHTHALENE	1.32E-09	(mg/m^3)	1.08E-07	(ug/m^3)	NA	per (ug/m^3)	--	7.55E-09	(mg/m^3)	NA	(mg/m^3)	--
				Semivolatiles												
				DIESEL RANGE ORGANICS	3.13E-06	(mg/m^3)	2.55E-04	(ug/m^3)	NA	per (ug/m^3)	--	1.79E-05	(mg/m^3)	2.00E-01	(mg/m^3)	8.9E-05
				Volatiles												
				BENZENE	1.03E-09	(mg/m^3)	8.39E-08	(ug/m^3)	7.80E-06	per (ug/m^3)	6.5E-13	5.88E-09	(mg/m^3)	3.00E-02	(mg/m^3)	2.0E-07
			Exp. Route Total								**3.2E-09**					**3.5E-03**
		Exposure Point Total									**3.2E-09**					**3.5E-03**
	Exposure Medium Total										**3.2E-09**					**3.5E-03**
Soil Total											**4.0E-06**					**6.0E-02**
										Total of Receptor Risks Across All Media	**4.0E-06**			Total of Receptor Hazards Across All Media		**0.06**

1) Dermal intake value is "NA" due to no published dermal absorption fraction for COPC. Please see USEPA 2004 guidance and Table 4-5.3.
EPC = Exposure Point Concentration
CSF = Cancer Slope Factor
RfD = Reference Dose
RfC = Reference Concentration

TABLE 5-28

CALCULATIONS OF AIR CONCENTRATIONS DUE TO DUST ENTRAINMENT FROM SOIL

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Model Equations:

Particulate Emmision Factor	PEF = Q/C x [(3,600 s/h)/(.36 x (1- V) x (Um/Ut)^3 x F(x))] =	1.36E+09 m^3/kg
Air Concentration	Cair = Csoil/PEF	

Model Constants:				
	Q/C	9.08E+01	g/m^2-s per kg/m^3	Inverse Mean Concentration at Center of 0.05 square, U.S. EPA 2015a
	V	5.00E-01	unitless	Default, U.S. EPA 2015a
	Um	4.69E+00	m/s	Mean annual wind speed, U.S. EPA 2015a
	Ut	1.13E+01	m/s	Equivalent threshold value of windspeed at 7 m, U.S. EPA 2015a
	F(x)	1.94E-01	unitless	Default, U.S. EPA 2015a

Reference for the model: USEPA Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response. U.S. EPA, 1996.

Chemical	**Csoil** RME EPC mg/kg	**Cair** RME EPC mg/m^3
Inorganics		
ARSENIC	1.23E+01	9.04E-09
PAHs		
BENZO(A)PYRENE	2.00E-01	1.47E-10
2-METHYLNAPHTHALENE	1.80E+00	1.32E-09
Semivolatiles		
DIESEL RANGE ORGANICS	4.26E+03	3.13E-06
Volatiles		
BENZENE	1.40E+00	1.03E-09

TABLE 5-29

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Location: Seaford Power Plant
Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child and Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Soil	Power Plant	**Inorganics**					**Inorganics**					
	Child		ARSENIC	2.0E-05	1.4E-06	3.2E-09	2.2E-05	ARSENIC	Skin	5.2E-01	3.7E-02	5.8E-04	5.6E-01
			PAHs					**PAHs**					
			BENZO(A)PYRENE	8.5E-06	2.6E-06	7.0E-11	1.1E-05	BENZO(A)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	5.8E-03	1.8E-03	--	7.5E-03
			Semivolatiles					**Semivolatiles**					
			DIESEL RANGE ORGANICS	--	--	--	NA	DIESEL RANGE ORGANICS	NA	5.4E-01	1.3E-01	1.5E-05	6.7E-01
			Volatiles					**Volatiles**					
			BENZENE	8.4E-08	--	6.6E-13	8.4E-08	BENZENE	Immune System	4.5E-03	--	3.3E-08	4.5E-03
			(Total for Child)	2.9E-05	4.1E-06	3.3E-09	3.3E-05		(Total for Child)	1.1E+00	1.7E-01	5.9E-04	1.2E+00
Soil	Soil	Power Plant	**Inorganics**					**Inorganics**					
	Adult		ARSENIC	6.3E-06	8.0E-07	1.1E-08	7.1E-06	ARSENIC	Skin	4.9E-02	6.2E-03	5.8E-04	5.6E-02
			PAHs					**PAHs**					
			BENZO(A)PYRENE	9.0E-07	4.9E-07	8.0E-11	1.4E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	5.4E-04	3.0E-04	--	8.4E-04
			Semivolatiles					**Semivolatiles**					
			DIESEL RANGE ORGANICS	--	--	--	NA	DIESEL RANGE ORGANICS	NA	5.1E-02	2.2E-02	1.5E-05	7.3E-02
			Volatiles					**Volatiles**					
			BENZENE	2.6E-08	--	2.2E-12	2.6E-08	BENZENE	Immune System	4.2E-04	--	3.3E-08	4.2E-04
			(Total for Adult)	7.2E-06	1.3E-06	1.1E-08	8.5E-06		(Total for Adult)	1.0E-01	2.8E-02	5.9E-04	1.3E-01
Soil	Soil	Power Plant	**Inorganics**										
	Adult + Child		ARSENIC	2.7E-05	2.2E-06	1.4E-08	2.9E-05						
			PAHs										
			BENZO(A)PYRENE	9.4E-06	3.1E-06	1.5E-10	1.2E-05						
			2-METHYLNAPHTHALENE	NA	NA	NA	NA						
			Semivolatiles										
			DIESEL RANGE ORGANICS	NA	NA	NA	NA						
			Volatiles										
			BENZENE	1.1E-07	NA	2.9E-12	1.1E-07						
			(Total for Child + Adult)	3.6E-05	5.3E-06	1.4E-08	4.1E-05					**Total Hazard Index Across Soil (Child)**	**1.2E+00**
					Total Risk Across Soil		**4.1E-05**					**Total Hazard Index Across Soil (Adult)**	**1.3E-01**

TABLE 5-30

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Location: Seaford Power Plant
Scenario Timeframe: Current/Future
Receptor Population: Trespasser
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Soil	Power Plant	**Inorganics**					**Inorganics**					
			ARSENIC	1.2E-06	5.5E-07	4.8E-11	1.8E-06	ARSENIC	Skin	1.9E-02	8.5E-03	5.2E-06	2.7E-02
			PAHs					**PAHs**					
			BENZO(A)PYRENE	2.9E-07	4.3E-07	5.9E-13	7.2E-07	BENZO(A)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	2.1E-04	4.1E-04	--	6.1E-04
			Semivolatiles					**Semivolatiles**					
			DIESEL RANGE ORGANICS	--	--	--	NA	DIESEL RANGE ORGANICS	NA	1.9E-02	3.0E-02	1.3E-07	4.9E-02
			Volatiles					**Volatiles**					
			BENZENE	5.0E-09	--	9.8E-15	5.0E-09	BENZENE	Immune System	1.6E-04	--	2.9E-10	1.6E-04
			(Total)	1.5E-06	9.8E-07	4.8E-11	2.5E-06		(Total)	3.9E-02	3.8E-02	5.3E-06	7.7E-02
						Total Risk Across Soil	**2.5E-06**					**Total Hazard Index Across Soil**	**7.7E-02**
Sediment	Sediment	Riverbank	**Inorganics**					**Inorganics**					
			CADMIUM	--	--	--	NA	CADMIUM	Kidneys	1.6E-03	2.0E-03	--	3.6E-03
			COBALT	--	--	--	NA	COBALT	Thyroid	2.6E-02	--	--	2.6E-02
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	7.0E-08	2.8E-07	--	3.5E-07	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	6.7E-08	2.7E-07	--	3.3E-07	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	3.1E-07	9.3E-07	--	1.2E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			(Total)	4.4E-07	1.5E-06	---	1.9E-06		(Total)	2.8E-02	2.0E-03	---	3.0E-02
							Total Risk Across Sediment	**1.9E-06**					**Total Hazard Index Across Sediment**	**3.0E-02**
							Total Risk Across All Media and All Exposure Routes	**4E-06**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.1**

-- = No risks calculated for this exposure pathway.

TABLE 5-31

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

AREA 2

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Location: Seaford Power Plant
Scenario Timeframe: Current/Future
Receptor Population: Composite Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Soil	Power Plant	**Inorganics**					**Inorganics**					
			ARSENIC	1.9E-05	1.8E-06	3.2E-09	2.0E-05	ARSENIC	Skin	1.2E-01	1.1E-02	3.4E-03	1.3E-01
			PAHs					**PAHs**					
			BENZO(A)PYRENE	1.5E-06	6.1E-07	1.3E-11	2.1E-06	BENZO(A)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	1.3E-03	5.3E-04	--	1.8E-03
			Semivolatiles					**Semivolatiles**					
			DIESEL RANGE ORGANICS	--	--	--	NA	DIESEL RANGE ORGANICS	NA	1.2E-01	3.9E-02	8.9E-05	1.6E-01
			Volatiles					**Volatiles**					
			BENZENE	7.8E-08	--	6.5E-13	7.8E-08	BENZENE	Immune System	9.9E-04	--	2.0E-07	9.9E-04
			(Total)	2.0E-05	2.4E-06	3.2E-09	2.3E-05		(Total)	2.4E-01	5.0E-02	3.5E-03	2.9E-01
						Total Risk Across Soil	**2.3E-05**					**Total Hazard Index Across Soil**	**2.9E-01**
Sediment	Sediment	Riverbank	**Inorganics**					**Inorganics**					
			CADMIUM	--	--	--	NA	CADMIUM	Kidneys	6.4E-04	3.6E-04	--	1.0E-03
			COBALT	--	--	--	NA	COBALT	Thyroid	1.0E-02	--	--	1.0E-02
			PAHs					**PAHs**					
			BENZ(A)ANTHRACENE	2.3E-08	1.6E-08	--	3.9E-08	BENZ(A)ANTHRACENE	NA	--	--	--	NA
			BENZO(B)FLUORANTHENE	2.2E-08	1.5E-08	--	3.7E-08	BENZO(B)FLUORANTHENE	NA	--	--	--	NA
			BENZO(A)PYRENE	1.0E-07	7.0E-08	--	1.7E-07	BENZO(A)PYRENE	NA	--	--	--	NA
			(Total)	1.4E-07	1.0E-07	---	2.5E-07		(Total)	1.1E-02	3.6E-04	---	1.1E-02
						Total Risk Across Sediment	**2.5E-07**					**Total Hazard Index Across Sediment**	**1.1E-02**
						Total Risk Across All Media and All Exposure Routes	**2E-05**					**Total Hazard Index Across All Media and All Exposure Routes**	**0.3**

-- = No risks calculated for this exposure pathway.

TABLE 5-32

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

SEAFORD POWER PLANT - SEAFORD, DELAWARE

Location: Swaderick-Watson Investigation Area
Scenario Timeframe: Future
Receptor Population: Commercial Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Dermal	Inhalation	Exposure Routes Total		Primary Target Organ	Ingestion	Dermal	Inhalation	Exposure Routes Total
Soil	Soil	Power Plant	**Inorganics**					**Inorganics**					
			ARSENIC	2.8E-06	7.2E-07	3.2E-09	3.5E-06	ARSENIC	Skin	1.8E-02	4.5E-03	3.4E-03	2.5E-02
			PAHs					**PAHs**					
			BENZO(A)PYRENE	2.2E-07	2.5E-07	1.3E-11	4.7E-07	BENZO(A)PYRENE	NA	--	--	--	NA
			2-METHYLNAPHTHALENE	--	--	--	NA	2-METHYLNAPHTHALENE	Lungs	1.9E-04	2.1E-04	--	4.0E-04
			Semivolatiles					**Semivolatiles**					
			DIESEL RANGE ORGANICS	--	--	--	NA	DIESEL RANGE ORGANICS	NA	1.8E-02	1.5E-02	8.9E-05	3.4E-02
			Volatiles					**Volatiles**					
			BENZENE	1.2E-08	--	6.5E-13	1.2E-08	BENZENE	Immune System	1.5E-04	--	2.0E-07	1.5E-04
			(Total)	3.1E-06	9.6E-07	3.2E-09	4.0E-06		(Total)	3.6E-02	2.0E-02	3.5E-03	6.0E-02
					Total Risk Across Soil		**4.0E-06**				**Total Hazard Index Across Soil**		**6.0E-02**
			Total Risk Across All Media and All Exposure Routes				**4E-06**		**Total Hazard Index Across All Media and All Exposure Routes**				**0.06**

NA = Not applicable due to no toxicity values.

-- = No risks calculated for this exposure pathway.

Table 6-1

Samples Used in the Ecological Risk Assessment

Media	Source Area	Sample Date	Sample ID
Sediment	1	28-Jan-15	SPP-SD-01
	1	28-Jan-15	SPP-SD-02
	2	28-Jan-15	SPP-SD-03
	2	28-Jan-15	SPP-SD-04
	Upstream	28-Jan-15	SPP-SD-05
	1	28-Jan-15	SPP-SD-06
	1	28-Jan-15	SPP-SD-07
	1	28-Jan-15	SPP-SD-08
	1	28-Jan-15	SPP-SD-09
	1	28-Jan-15	SPP-SD-10
Surface Water	Upstream	28-Jan-15	SPP-SW-01
	1 and 2	28-Jan-15	SPP-SW-02
	1 and 2	28-Jan-15	SPP-SW-03
	1 and 2	28-Jan-15	SPP-SW-04
	1 and 2	28-Jan-15	SPP-SW-05

Table 6-2

Ecological Screening Benchmarks

Chemical	Sediment Criteria (mg/kg)	Source	Surface Water Criteria (µg/L)	Source
Metals				
Aluminum	NA	---	87	DNREC-SIRS 2015
Arsenic	9.8	DNREC-SIRS 2015	5	DNREC-SIRS 2015
Barium	NA	---	4	DNREC-SIRS 2015
Beryllium	NA	---	0.66	DNREC-SIRS 2015
Calcium	NA	---	116000	EPA Region 3 2006a
Chromium	43.4	DNREC-SIRS 2015	23.81[a]	DNREC-SIRS 2015
Cobalt	50	DNREC-SIRS 2015	23	DNREC-SIRS 2015
Copper	31.6	DNREC-SIRS 2015	2.74[a]	DNREC-SIRS 2015
Cyanide	0.1	DNREC-SIRS 2015	5	DNREC-SIRS 2015
Iron	20000	DNREC-SIRS 2015	300	DNREC-SIRS 2015
Lead	35.8	DNREC-SIRS 2015	0.54[a]	DNREC-SIRS 2015
Magnesium	NA	---	82000	EPA Region 3 2006a
Manganese	460	DNREC-SIRS 2015	120	DNREC-SIRS 2015
Mercury	0.18	DNREC-SIRS 2015	0.026	DNREC-SIRS 2015
Nickel	22.7	DNREC-SIRS 2015	16.1[a]	DNREC-SIRS 2015
Potassium	NA	---	53000	EPA Region 3 2006a
Sodium	NA	---	680000	EPA Region 3 2006a
Vanadium	NA	---	ND	---
Zinc	121	DNREC-SIRS 2015	36.5[a]	DNREC-SIRS 2015
Polychlorinated Biphenyls (PCBs)				
Trichlorobiphenyl, total	0.0598	EPA Region 3 2006b	ND	---
Polycyclic Aromatic Hyrdrocarbons (PAHs)				
2-Methylnaphthalene	0.0202	DNREC-SIRS 2015	ND	---
Acenaphthene	0.0067	DNREC-SIRS 2015	ND	---
Acenaphthylene	0.0059	EPA Region 3 2006b	ND	---
Anthracene	0.0572	DNREC-SIRS 2015	ND	---
Benzo(a)anthracene	0.108	DNREC-SIRS 2015	ND	---
Benzo(a)pyrene	0.15	DNREC-SIRS 2015	ND	---
Benzo(b)fluoranthene	0.0272	EPA Region 3 2006b	ND	---
Benzo(g,h,i)perylene	0.17	EPA Region 3 2006b	ND	---
Benzo(k)fluoranthene	0.24	DNREC-SIRS 2015	ND	---
Chrysene	0.166	DNREC-SIRS 2015	ND	---
Dibenzo(a,h)anthracene	0.033	DNREC-SIRS 2015	ND	---
Fluoranthene	0.423	DNREC-SIRS 2015	ND	---
Fluorene	0.0774	DNREC-SIRS 2015	ND	---
Indeno(1,2,3-c,d)pyrene	0.017	DNREC-SIRS 2015	ND	---
Naphthalene	0.176	DNREC-SIRS 2015	ND	---
Phenanthrene	0.204	DNREC-SIRS 2015	ND	---
Pyrene	0.195	DNREC-SIRS 2015	ND	---
Total PAHs	1.61	EPA Region 3 2006b	ND	---
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	---	ND	---

Sources

For sediment and surface water criteria:

- EPA Region III BTAG Ecological Screening Benchmarks. Accessed at http://www.epa.gov/reg3hscd/risk/eco/btag/sbv/fwsed/screenbench.htm and http://www.epa.gov/reg3hscd/risk/eco/btag/sbv/fw/screenbench.htm.

-DNREC Site Investigation & Restoration Section (SIRS) Screening Levels, effective January 2015. Accessed at http://www.dnrec.delaware.gov/dwhs/SIRB/Documents/Screening%20Level%20Table.pdf

Notes:

a = The bioavailabilty of chromium, copper, lead, nickel, and zinc is hardness-dependent. Surface water hardness at the SPP Site is 24.7 mg/L. Surface water criteria selected for these metals are based on a hardness of 25 mg/L.

NA = Screening Value not available
ND = Analyte not detected
Sediment and surface water criteria listed for Trichlorobiphenyl is Total PCBs

Sediment criteria listed for Total PAHs is the consensus-based threshold effect concentration from MacDonald et. al. 2000
Surface water criteria for acenaphthylene is value for acenaphthene.
Surface water criteria for cadmium, copper, lead, nickel, and zinc based on hardness of 100.
Surface water criteria for chromium is for total chromium and is based on hardness of 100.

mg/kg: miligram per kilogram
µg/L: microgram per liter
DNREC: Delaware Department of Natural Resources and Environmental Control

Table 6-3
Maximum Sediment Detection Comparisons to Screening Levels
for Seaford Power Plant Source Area 1

Analyte	Sediment				
	Frequency	Maximum (mg/kg)	Location of the Maximum	Screening Criteria (mg/kg)	Selection of Chemicals of Potential Concern
Metals					
Aluminum	**7/7**	**6240**	**SPP-SD-01**	**NA**	**YES**
Arsenic	5/7	3.8	SPP-SD-01	9.8	NO
Barium	**7/7**	**192**	**SPP-SD-01**	**NA**	**YES**
Beryllium	**6/7**	**1.2**	**SPP-SD-01**	**NA**	**YES**
Calcium	7/7	2250	SPP-SD-01	NA	NO, Esn. Nut.
Chromium	7/7	10.2	SPP-SD-01	43.4	NO
Cobalt	7/7	34.4	SPP-SD-01	50	NO
Copper	7/7	12.7	SPP-SD-01	31.6	NO
Cyanide	**1/7**	**0.13**	**SPP-SD-08**	**0.1**	**YES**
Iron	7/7	15900	SPP-SD-01	20000	NO
Lead	**7/7**	**73.3**	**SPP-SD-01**	**35.8**	**YES**
Magnesium	6/7	1030	SPP-SD-01	NA	NO, Esn. Nut.
Manganese	7/7	434	SPP-SD-01	460	NO
Mercury	1/7	0.095	SPP-SD-01	0.18	NO
Nickel	7/7	14.5	SPP-SD-01	22.7	NO
Potassium	7/7	531	SPP-SD-01	NA	NO, Esn. Nut.
Vanadium	**7/7**	**12.7**	**SPP-SD-01**	**NA**	**YES**
Zinc	**7/7**	**125**	**SPP-SD-01**	**121**	**YES**
PCBs					
Trichlorobiphenyl (Total TrCB)	1/7	0.0045	SPP-SD-01	0.0598	NO
PAHs					
2-Methylnaphthalene	**3/7**	**0.16**	**SPP-SD-01**	**0.0202**	**YES**
Acenaphthene	**3/7**	**0.97**	**SPP-SD-01**	**0.0067**	**YES**
Acenaphthylene	**3/7**	**0.096**	**SPP-SD-01**	**0.0059**	**YES**
Anthracene	**3/7**	**0.82**	**SPP-SD-01**	**0.0572**	**YES**
Benzo(a)Anthracene	**5/7**	**1.2**	**SPP-SD-10**	**0.108**	**YES**
Benzo(a)Pyrene	**5/7**	**1.2**	**SPP-SD-10**	**0.15**	**YES**
Benzo(b)Fluoranthene	**7/7**	**1.7**	**SPP-SD-10**	**0.0272**	**YES**
Benzo(g,h,i)Perylene	**5/7**	**0.95**	**SPP-SD-10**	**0.17**	**YES**
Benzo(k)Fluoranthene	**5/7**	**0.56**	**SPP-SD-10**	**0.24**	**YES**
Chrysene	**7/7**	**1.5**	**SPP-SD-01**	**0.166**	**YES**
Dibenzo(a,h)Anthracene	**2/7**	**0.21**	**SPP-SD-10**	**0.033**	**YES**
Fluoranthene	**7/7**	**8.7**	**SPP-SD-01**	**0.423**	**YES**
Fluorene	**3/7**	**1.3**	**SPP-SD-01**	**0.0774**	**YES**
Indeno(1,2,3-Cd)Pyrene	**5/7**	**1.1**	**SPP-SD-10**	**0.017**	**YES**
Naphthalene	**3/7**	**0.28**	**SPP-SD-10**	**0.176**	**YES**
Phenanthrene	**6/7**	**11**	**SPP-SD-01**	**0.204**	**YES**
Pyrene	**5/7**	**4.8**	**SPP-SD-01**	**0.195**	**YES**
Total LMW PAHs	**6/7**	**14.506**	**SPP-SD-01**	**0.076**	**YES**
Total HMW PAHs	**7/7**	**15**	**SPP-SD-01**	**0.19**	**YES**
Total PAHs	**7/7**	**32.806**	**SPP-SD-01**	**1.61**	**YES**
Total Petroleum Hydrocarbons					
Diesel Range Organics	**5/7**	**790**	**SPP-SD-10**	**NA**	**YES**

NA: Screening value not available
Esn. Nut.: Essential nutrient
mg/kg: miligram per kilogram
µg/L: microgram per liter

Table 6-4
Frequency of Detection and Exposure Point Concentrations
for Seaford Power Plant Source Area 1

Analyte	Sediment		
	Frequency	Maximum (mg/kg)	95% UCL Mean (mg/kg)
Metals			
Aluminum	7/7	6240	4089
Arsenic	NO COPC	NO COPC	NO COPC
Barium	7/7	192	107.6
Beryllium	6/7	1.2	0.753
Cyanide	1/7	0.13	0.13
Iron	7/7	15900	13090
Lead	7/7	73.3	40.14
Vanadium	7/7	12.7	10.59
Zinc	7/7	125	74.98
PAHs			
2-Methylnaphthalene	3/7	0.16	*use total PAHs
Acenaphthene	3/7	0.97	*use total PAHs
Acenaphthylene	3/7	0.096	*use total PAHs
Anthracene	3/7	0.82	*use total PAHs
Benzo(a)Anthracene	5/7	1.2	*use total PAHs
Benzo(a)Pyrene	5/7	1.2	*use total PAHs
Benzo(b)Fluoranthene	7/7	1.7	*use total PAHs
Benzo(g,h,i)Perylene	5/7	0.95	*use total PAHs
Benzo(k)Fluoranthene	5/7	0.56	*use total PAHs
Chrysene	7/7	1.5	*use total PAHs
Dibenzo(a,h)Anthracene	2/7	0.21	*use total PAHs
Fluoranthene	7/7	8.7	*use total PAHs
Fluorene	3/7	1.3	*use total PAHs
Indeno(1,2,3-Cd)Pyrene	5/7	1.1	*use total PAHs
Naphthalene	3/7	0.28	*use total PAHs
Phenanthrene	6/7	11	*use total PAHs
Pyrene	5/7	4.8	*use total PAHs
Total LMW PAHs	6/7	14.506	7.982
Total HMW PAHs	7/7	15	15
Total PAHs	7/7	32.806	32.806
Total Petroleum Hydrocarbons			
Diesel Range Organics	5/7	790	841.8

HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
mg/kg: miligram per kilogram
COPC: Chemical of potential concern
UCL: Upper confidence level
*Use 95% UCL mean value for total PAHs in lieu of 95% UCL mean values for individual PAHs

Table 6-5
Maximum Sediment Detection Comparisons to Screening Levels
for Seaford Power Plant Source Area 2

Analyte	Sediment				
	Frequency	Maximum (mg/kg)	Location of the Maximum	Screening Criteria (mg/kg)	Selection of Chemicals of Potential Concern
Metals					
Aluminum	**2/2**	**13600**	**SPP-SD-03**	**NA**	**YES**
Arsenic	2/2	8.7	SPP-SD-03	9.8	NO
Barium	**2/2**	**429**	**SPP-SD-03**	**NA**	**YES**
Beryllium	**2/2**	**3.2**	**SPP-SD-03**	**NA**	**YES**
Calcium	2/2	2350	SPP-SD-03	NA	NO, Esn. Nut.
Chromium	2/2	22.7	SPP-SD-03	43.4	NO
Cobalt	**2/2**	**92.8**	**SPP-SD-03**	**50**	**YES**
Copper	**2/2**	**31.9**	**SPP-SD-03**	**31.6**	**YES**
Iron	**2/2**	**28800**	**SPP-SD-03**	**20000**	**YES**
Lead	2/2	34.4	SPP-SD-03	35.8	NO
Magnesium	2/2	1880	SPP-SD-03	NA	NO, Esn. Nut.
Manganese	**2/2**	**618**	**SPP-SD-03**	**460**	**YES**
Mercury	**2/2**	**0.18**	**SPP-SD-03**	**0.18**	**YES**
Nickel	**2/2**	**35.6**	**SPP-SD-03**	**22.7**	**YES**
Potassium	2/2	1070	SPP-SD-03	NA	NO, Esn. Nut.
Vanadium	**2/2**	**26.9**	**SPP-SD-03**	**NA**	**YES**
Zinc	**2/2**	**260**	**SPP-SD-03**	**121**	**YES**
PAHs					
2-Methylnaphthalene	**1/2**	**0.04**	**SPP-SD-03**	**0.0202**	**YES**
Acenaphthene	**1/2**	**0.097**	**SPP-SD-03**	**0.0067**	**YES**
Benzo(a)Anthracene	**2/2**	**0.17**	**SPP-SD-03**	**0.108**	**YES**
Benzo(a)Pyrene	2/2	0.095	SPP-SD-03	0.15	NO
Benzo(b)Fluoranthene	**2/2**	**0.2**	**SPP-SD-03**	**0.0272**	**YES**
Benzo(g,h,i)Perylene	1/2	0.073	SPP-SD-04	0.17	NO
Benzo(k)Fluoranthene	2/2	0.086	SPP-SD-03	0.24	NO
Chrysene	**2/2**	**0.23**	**SPP-SD-03**	**0.166**	**YES**
Fluoranthene	2/2	0.4	SPP-SD-03	0.423	NO
Fluorene	**1/2**	**0.12**	**SPP-SD-03**	**0.0774**	**YES**
Indeno(1,2,3-Cd)Pyrene	**1/2**	**0.076**	**SPP-SD-04**	**0.017**	**YES**
Naphthalene	1/2	0.037	SPP-SD-03	0.176	NO
Phenanthrene	**2/2**	**0.38**	**SPP-SD-03**	**0.204**	**YES**
Pyrene	**2/2**	**0.4**	**SPP-SD-03**	**0.195**	**YES**
Total LMW PAHs	**2/2**	**0.674**	**SPP-SD-03**	**0.076**	**YES**
Total HMW PAHs	**2/2**	**1.03**	**SPP-SD-03**	**0.19**	**YES**
Total PAHs	**2/2**	**2.255**	**SPP-SD-03**	**1.61**	**YES**

NA: Screening Value Not Available
mg/kg: miligram per kilogram
µg/L: microgram per liter

UCL: Upper confidence level
Esn. Nut.: Essential nutrient

Table 6-6
Frequency of Detection and Exposure Point Concentrations
for Seaford Power Plant Source Area 2

Analyte	Sediment		
	Frequency	Maximum (mg/kg)	95% UCL Mean (mg/kg)
Metals			
Aluminum	2/2	13600	13600
Arsenic	NO COPC	NO COPC	NO COPC
Barium	2/2	429	429
Beryllium	2/2	3.2	3.2
Calcium	NO COPC	NO COPC	NO COPC
Chromium	NO COPC	NO COPC	NO COPC
Cobalt	2/2	92.8	92.8
Copper	2/2	31.9	31.9
Cyanide	NO COPC	NO COPC	NO COPC
Iron	2/2	28800	28800
Lead	NO COPC	NO COPC	NO COPC
Magnesium	NO COPC	NO COPC	NO COPC
Manganese	2/2	618	618
Mercury	2/2	0.18	0.18
Nickel	2/2	35.6	35.6
Potassium	NO COPC	NO COPC	NO COPC
Vanadium	2/2	26.9	26.9
Zinc	2/2	260	260
PAHs			
2-Methylnaphthalene	1/2	0.04	*use total PAHs
Acenaphthene	1/2	0.097	*use total PAHs
Benzo(a)Anthracene	2/2	0.17	*use total PAHs
Benzo(a)Pyrene	NO COPC	NO COPC	NO COPC
Benzo(b)Fluoranthene	2/2	0.2	*use total PAHs
Benzo(g,h,i)Perylene	NO COPC	NO COPC	NO COPC
Benzo(k)Fluoranthene	NO COPC	NO COPC	NO COPC
Chrysene	2/2	0.23	*use total PAHs
Fluoranthene	NO COPC	NO COPC	NO COPC
Fluorene	1/2	0.12	*use total PAHs
Indeno(1,2,3-Cd)Pyrene	1/2	0.076	*use total PAHs
Naphthalene	NO COPC	NO COPC	NO COPC
Phenanthrene	2/2	0.38	*use total PAHs
Pyrene	2/2	0.4	*use total PAHs
Total LMW PAHs	2/2	0.674	0.674
Total HMW PAHs	2/2	1.03	1.03
Total PAHs	2/2	2.255	2.255

*Use 95% UCL mean value for total PAHs in lieu of 95% UCL mean values for individual PAHs
mg/kg: miligram per kilogram
µg/L: microgram per liter
COPC: Chemical of potential concern
UCL: Upper confidence level
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

Table 6-7
Maximum Surface Water Detection Comparisons to Screening Levels
for Seaford Power Plant Source Areas 1 and 2

Analyte	Surface Water (Dissolved)				
	Frequency	Maximum (µg/L)	Location of Maximum	Screening Criteria (µg/L)	Selection of Chemicals of Potential Concern
Metals					
Aluminum	4/4	190	SPP-SW-03-F	87	**YES**
Arsenic	0/4	---	---	---	NO
Barium	4/4	104	SPP-SW-04-F	4	**YES**
Beryllium	0/4	---	---	---	YES
Calcium	4/4	5830	SPP-SW-04-F	116000	YES
Chromium	0/4	---	---	---	NO
Cobalt	4/4	5.4	SPP-SW-03-F / SPP-SW-04-F	23	NO
Copper	1/4	2.3	SPP-SW-04-F	2.74[a]	YES
Cyanide	0/4	---	---	---	NO
Iron	4/4	364	SPP-SW-03-F	300	**YES**
Lead	0/4	---	---	---	NO
Magnesium	4/4	2470	SPP-SW-04-F	82000	YES
Manganese	4/4	46.5	SPP-SW-05-F	120	YES
Mercury	0/4	---	---	---	NO
Nickel	4/4	2.5	SPP-SW-02-F / SPP-SW-03-F	16.1[a]	YES
Potassium	4/4	2680	SPP-SW-04-F	53000	YES
Sodium	5/5	8100	SPP-SW-05-F / SPP-SW-01-F	680000	YES
Vanadium	0/4	---	---	---	NO
Zinc	4/4	18.4	SPP-SW-03-F	36.5[a]	YES
PCBs					
Trichlorobiphenyl (Total TrCB)	0/4	---	---	---	NO
PAHs					
2-Methylnaphthalene	0/4	---	---	---	NO
Acenaphthene	0/4	---	---	---	NO
Acenaphthylene	0/4	---	---	---	NO
Anthracene	0/4	---	---	---	NO
Benzo(a)Anthracene	0/4	---	---	---	NO
Benzo(a)Pyrene	0/4	---	---	---	NO
Benzo(b)Fluoranthene	0/4	---	---	---	NO
Benzo(g,h,i)Perylene	0/4	---	---	---	NO
Benzo(k)Fluoranthene	0/4	---	---	---	NO
Chrysene	0/4	---	---	---	NO
Dibenzo(a,h)Anthracene	0/4	---	---	---	NO
Fluoranthene	0/4	---	---	---	NO
Fluorene	0/4	---	---	---	NO
Indeno(1,2,3-Cd)Pyrene	0/4	---	---	---	NO
Naphthalene	0/4	---	---	---	NO
Phenanthrene	0/4	---	---	---	NO
Pyrene	0/4	---	---	---	NO
Total LMW PAHs	0/4	---	---	---	NO
Total HMW PAHs	0/4	---	---	---	NO
Total PAHs	0/4	---	---	---	NO
Total Petroleum Hydrocarbons					
Diesel Range Organics	0/4	---	---	---	NO

Notes:

a = The bioavailabilty of copper, nickel, and zinc is hardness-dependent. Surface water hardness at the SPP Site is 24.7 mg/L. Surface water criteria selected for these metals are based on a hardness of 25 mg/L.

Esn. Nut.: Essential nutrient

mg/kg: miligram per kilogram

µg/L: microgram per liter

Table 6-8
Frequency of Detection and Exposure Point Concentrations
for Seaford Power Plant Source Areas 1 and 2

Analyte	Surface Water (Dissolved)		
	Frequency	Maximum (µg/L)	95% UCL Mean (µg/kg)
Metals			
Aluminum	4/4	190	190
Arsenic	NO COPC	NO COPC	NO COPC
Barium	4/4	104	104
Beryllium	0/4	---	---
Calcium	4/4	5830	5830
Chromium	NO COPC	NO COPC	NO COPC
Cobalt	NO COPC	NO COPC	NO COPC
Copper	1/4	2.3	2.3
Cyanide	NO COPC	NO COPC	NO COPC
Iron	4/4	364	364
Lead	NO COPC	NO COPC	NO COPC
Magnesium	4/4	2470	2470
Manganese	4/4	46.5	46.5
Mercury	NO COPC	NO COPC	NO COPC
Nickel	4/4	2.5	2.5
Potassium	4/4	2680	2680
Sodium	5/5	8100	8100
Vanadium	NO COPC	NO COPC	NO COPC
Zinc	4/4	18.4	18.4
PCBs			
Trichlorobiphenyl (Total TrCB)	NO COPC	NO COPC	NO COPC
PAHs			
2-Methylnaphthalene	NO COPC	NO COPC	NO COPC
Acenaphthene	NO COPC	NO COPC	NO COPC
Acenaphthylene	NO COPC	NO COPC	NO COPC
Anthracene	NO COPC	NO COPC	NO COPC
Benzo(a)Anthracene	NO COPC	NO COPC	NO COPC
Benzo(a)Pyrene	NO COPC	NO COPC	NO COPC
Benzo(b)Fluoranthene	NO COPC	NO COPC	NO COPC
Benzo(g,h,i)Perylene	NO COPC	NO COPC	NO COPC
Benzo(k)Fluoranthene	NO COPC	NO COPC	NO COPC
Chrysene	NO COPC	NO COPC	NO COPC
Dibenzo(a,h)Anthracene	NO COPC	NO COPC	NO COPC
Fluoranthene	NO COPC	NO COPC	NO COPC
Fluorene	NO COPC	NO COPC	NO COPC
Indeno(1,2,3-Cd)Pyrene	NO COPC	NO COPC	NO COPC
Naphthalene	NO COPC	NO COPC	NO COPC
Phenanthrene	NO COPC	NO COPC	NO COPC
Pyrene	NO COPC	NO COPC	NO COPC
Total LMW PAHs	NO COPC	NO COPC	NO COPC
Total HMW PAHs	NO COPC	NO COPC	NO COPC
Total PAHs	NO COPC	NO COPC	NO COPC
Total Petroleum Hydrocarbons			
Diesel Range Organics	NO COPC	NO COPC	NO COPC

µg/L: microgram per liter
COPC: Chemical of potential concern
UCL: Upper confidence level
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

Table 6-9
Measurement Endpoints for Ecological Risk Assessment

Assessment Endpoint	Measurement Endpoint	On Site-Measurements/Exposure Point Concentrations (EPC)	Evaluation Method	Risk Indicators
Protection of aquatic organisms exposed to COPCs in sediment and surface water from adverse survival, growth and reproductive effects	Initial screening	• Sediment and surface water concentrations measured at site in past and more recent sampling	• Direct comparison to the Region III ecological screening values to define COPCs	• Chemicals defined as COPCs indicate the potential for risk
	Comparison of sediment and surface water concentrations to benchmarks	• Sediment and surface water concentrations measured at site in past and more recent sampling - SLERA: Maximum Concentrations - Refined BRAPF: Mean Concentrations	• Compare maximum, mean, and individual sediment concentrations against benthic TRVs (consensus based benchmarks from literature-based studies) • Compare maximum, mean, and individual surface water concentrations against aquatic TRVs (consensus based benchmarks from literature-based studies)	• Exceedence of benchmarks indicates potential for risks • Exceedence of benchmarks and background indicates a more certain potential for risks
Protection of aquatic-feeding birds and mammals, to ensure that ingestion of COPCs in sediment, surface water, and food do not have adverse impacts on survival, growth, and reproduction	Initial screening	• Sediment and surface water concentrations measured at site in past and more recent sampling	• Direct comparison to the DNREC-SIRS, Eco-SSL, or Region IV ecological screening values to define COPCs	• Chemicals defined as COPCs indicate the potential for risk
	Comparison of modeled food web doses to benchmarks	• Sediment and surface water concentrations measured at site in past and more recent sampling - SLERA: Maximum Concentrations - Refined SLERA & BRAPF: Mean Concentrations • Aquatic food item tissue concentrations modeled using literature-based equations - SLERA: Maximum Concentrations - Refined SLERA & BRAPF: Mean Concentrations • Ingested dose based on literature-based exposure factors and uptake equations - SLERA: Maximum Dose - Refined SLERA & BRAPF: Mean Dose	• Calculate maximum case scenario doses using food web models and compare to no-effects benchmarks • Calculate mean case scenario doses and compare to no- and low-effects benchmarks • Mammal and bird dose-based benchmarks from 1) EPA Eco-SSL 2) ORNL benchmarks (Sample et al., 1998) 3) Additional literatue-based sources as relevant	• Exceedence of benchmarks indicates a potential for risks • Exceedence of low-effects benchmarks indicates a more certain potential for risks
Protection of reptiles and amphibians to ensure that ingestion of COPCs in surface soil, sediment, surface water, and food do not have unacceptable impacts on survival, growth, and reproduction	Comparison of modeled food web doses to benchmarks	• EPCs evaluated for other receptors	• Evaluate whether other wildlife receptors are at risk and consider results as surrogate for reptiles and amphibians.	• Risks from COPCs to other receptors indicate that there may be a risk to reptiles and amphibians from the same COPCs

BRAPF: Baseline Risk Assessment Problem Formulation
COPC: Chemical of Potential Concern
Eco-SSL: Ecological Soil Screening Levels
ORNL: Oak Ridge National Laboratory
SLERA: Screening Level Ecological Risk Assessment
TRVs: Toxicity reference values
EPA: U.S. Environmental Protection Agency

Table 6-10
Uptake Models Relating Concentrations in Surface Water to Concentrations in Fish

Chemical	Food Item (Fish) Uptake		
	Uptake Model[A, B, C]	BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Source
Metals			
Aluminum	Uptake Factor	2.700	From Table C-5 - EPA 1999
Arsenic	Uptake Factor	4.000	Based on bluegill in Table 5 - EPA 1985a
Barium	Uptake Factor	4.000	BCF from ORNL 2009
Beryllium	Uptake Factor	62.000	From Table C-5 - EPA 1999
Calcium	Uptake Factor	1.000	Default
Chromium	Uptake Factor	200.000	BCF from ORNL 2009
Cobalt	Uptake Factor	1.000	Default
Copper	Uptake Factor	464.000	Based on fathead minnow in Table 5 - EPA 2003b
Cyanide	Uptake Factor	1.000	Default
Iron	Uptake Factor	1.000	Default
Lead	Uptake Factor	45.000	Based on bluegill in Table 5 - EPA 1985b
Magnesium	Uptake Factor	1.000	Default
Manganese	Uptake Factor	400.000	BCF from ORNL 2009
Mercury	Uptake Factor	1800.000	Based on rainbow trout in Table 5 - EPA 1985c
Nickel	Uptake Factor	27.000	Based on rainbow trout/fathead minnow in Table 5 - EPA 1986
Potassium	Uptake Factor	1.000	Default
Sodium	Uptake Factor	1.000	Default
Vanadium	Uptake Factor	1.000	Default
Zinc	Uptake Factor	13.000	Based on mummichog in Table 5 - EPA 1987b
PAHs			
2-Methylnaphthalene	Uptake Factor	186.209	Regression from BCFWIN Program
Acenaphthene	Uptake Factor	179.200	Regression from BCFWIN Program
Acenaphthylene	Uptake Factor	213.796	Regression from BCFWIN Program
Anthracene	Uptake Factor	537.032	Regression from BCFWIN Program
Benzo(a)Anthracene	Uptake Factor	5495.409	Regression from BCFWIN Program
Benzo(a)Pyrene	Uptake Factor	10471.290	Regression from BCFWIN Program
Benzo(b)Fluoranthene	Uptake Factor	5623.413	Regression from BCFWIN Program
Benzo(g,h,i)Perylene	Uptake Factor	25703.960	Regression from BCFWIN Program
Benzo(k)Fluoranthene	Uptake Factor	10000.000	Regression from BCFWIN Program
Chrysene	Uptake Factor	5888.437	Regression from BCFWIN Program
Dibenzo(a,h)Anthracene	Uptake Factor	21877.620	Regression from BCFWIN Program
Fluoranthene	Uptake Factor	1862.087	Regression from BCFWIN Program
Fluorene	Uptake Factor	266.100	Regression from BCFWIN Program
Indeno(1,2,3-Cd)Pyrene	Uptake Factor	28840.320	Regression from BCFWIN Program
Naphthalene	Uptake Factor	69.183	Regression from BCFWIN Program
Phenanthrene	Uptake Factor	537.032	Regression from BCFWIN Program
Pyrene	Uptake Factor	1148.154	Regression from BCFWIN Program
Total LMW PAHs	Uptake Factor	14301.725	Average of BCFs of individual PAHs
Total HMW PAHs	Uptake Factor	14301.725	Average of BCFs of individual PAHs
Total PAHs	Uptake Factor	14301.725	Average of BCFs of individual PAHs
Total Petroleum Hydrocarbons			
Diesel Range Organics	Uptake Factor	1.000	Default

A - Equation types:
Uptake Factor:
B - EPA 2009, Uptake factor for organics derived using the BCF Win/BCFBAF Program from USEPA
http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm
C - Uptake factor for inorganics from the following sources:
ORNL 2009
EPA 1999, Table C-5
EPA 1988, Table 5 (bluegill)
EPA 1985a, Table 5
EPA 1985b, Table 5
EPA 1985c, Table 5
mg/L dry wt: miligram per liter dry weight
NA: Uptake Model not available
mg/kg dry wt: miligram per kilogram of dry weight
UF: Uptake Factor
BCF: Bioconcentration Factor
BAF: Bioaccumulation Factor
EPA - U.S. Environmental Protection Agency
* BCFs of individual PAHS determined through regression from BCFWIN Program

Table 6-11
Wildlife Exposure Factors for the Ecological Risk Assessment

Exposure Parameter	Value	Units	Notes
GREAT BLUE HERON			
Body Weight	2.229	kg	CHPPM 2004
Food Ingestion Rate	0.045	kg dry wt./kg-day	Converted assuming 75% prey moisture (CHPPM 2004)
Food Ingestion Rate	0.18	kg wet wt./kg-day	CHPPM 2004
Incidental Sediment Ingestion Rate	2.00%	% of total mass of diet	Sample and Suter (1994) says sediment in diet is negligible. Assuming value of 2% to be conservative
Water Ingestion Rate	0.045	L/kg-day	CHPPM 2004
RIVER OTTER			
Body Weight	7.99	kg	EPA 1993, average of reported adult weights
Food Ingestion Rate	0.048	kg dry wt./kg-day	EPA 1993, calculated using the presented allometric equation for food ingestion
Food Ingestion Rate	0.19	kg wet wt./kg-day	Converted assuming 75% prey moisture (CHPPM 2004)
Incidental Sediment Ingestion Rate	2.00%	% of total mass of diet	Assuming value of 2% to be conservative. Sample and Suter (1994) says value is negligible for other organisms with high percentage of fish in diet
Water Ingestion Rate	0.081	L/kg-day	EPA 1993, average of male and female rate

kg: kilogram
g dry wt./kg-day: gram of dry weight food per kilogram of body weight per day
g wet wt./kg-day: gram of wet weight food per kilogram of body weight per day
kg dry wt./kg-day: kilogram of dry weight food per kilogram of body weight per day
kg wet wt./kg-day: kilogram of wet weight food per kilogram of body weight per day
dry wt.: dry weight
L/kg-day: liter of water per kilogram of body weight per day
EPA: U.S. Environmental Protection Agency
CHPPM: U.S. Army Center for Health Promotion and Preventative Medicine

Table 6-12
Wildlife Exposure Modeling of Maximum Doses to Piscivorous Birds (Great Blue Heron) from Media for Seaford Power Plant Source Area 1

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.00E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.50E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	4.50E-02	L/kg-day

Chemical	Maximum Sediment Concentration (mg/kg dry wt.)	Maximum Water Concentration - Source Areas 1 & 2 (mg/L)	Food Item (Fish) Uptake		Maximum Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Maximum Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	6240	0.19	2.7	0.51	5.62	0.02	0.01	5.65
Barium	192	0.104	4	0.42	0.17	0.02	0.00	0.20
Beryllium	1.2	0	62	0	0.001	0	0	0.001
Cyanide	0.13	0	1	0	0.0001	0	0	0.0001
Iron	15900	0.364	1	0.36	14.31	0.02	0.02	14.34
Lead	73.3	0	45	0	0.07	0	0	0.07
Vanadium	12.7	0	1	0	0.01	0	0	0.01
Zinc	125	0.0184	13	0.24	0.11	0.01	0.00	0.12
PAHs								
Total LMW PAHs	14.506	0	14301.7	0	0.01	0	0	0.01
Total HMW PAHs	15	0	14301.7	0	0.01	0	0	0.01
Total Petroleum Hydrocarbons								
Diesel Range Organics	790	0	1	0	0.71	0	0	0.71

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

Table 6-13
Wildlife Exposure Modeling of 95% UCL Mean Doses to Piscivorous Birds (Great Blue Heron) from Media for Seaford Power Plant Source Area 1

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.00E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.50E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	4.50E-02	L/kg-day

Chemical	95% UCL Mean Sediment Concentration (mg/kg dry wt.)	95% UCL Mean Water Concentration - Source Areas 1 & 2 (mg/L)	Food Item (Fish) Uptake		95% UCL Mean Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	95% UCL Mean Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	4089	0.19	2.7	0.51	3.68	0.02	0.01	3.71
Barium	107.6	0.104	4	0.42	0.10	0.02	0.005	0.12
Beryllium	0.753	0	62	0	0.0007	0	0	0.0007
Cyanide	0.13	0	1	0	0.0001	0	0	0.0001
Iron	13090	0.364	1	0.36	11.78	0.02	0.02	11.81
Lead	40.14	0	45	0	0.04	0	0	0.04
Vanadium	10.59	0	1	0	0.01	0	0	0.01
Zinc	74.98	0.0184	13	0.24	0.07	0.01	0.001	0.08
PAHs								
Total LMW PAHs	7.982	0	14301.725	0	0.01	0	0	0.01
Total HMW PAHs	15	0	14301.725	0	0.01	0	0	0.01
Total PAHs	32.806	0	14301.725	0	0.03	0	0	0.03
Total Petroleum Hydrocarbons								
Diesel Range Organics	841.8	0	1	0	0.76	0	0	0.76

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
UCL: Upper confidence level

Table 6-14
Wildlife Exposure Modeling of Maximum Doses to Piscivorous Mammals (River Otter) from Media for Seaford Power Plant Source Area 1

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.60E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.80E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	8.10E-02	L/kg-day

Chemical	Maximum Sediment Concentration (mg/kg dry wt.)	Maximum Water Concentration - Source Areas 1 & 2 (mg/L)	Food Item (Fish) Uptake		Maximum Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Maximum Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	6240	0.19	2.7	0.51	5.99	0.02	0.02	6.03
Barium	192	0.104	4	0.42	0.18	0.02	0.01	0.21
Beryllium	1.2	0	62	0	0.001	0	0	0.001152
Cyanide	0.13	0	1	0	0.0001	0	0	0.0001248
Iron	15900	0.364	1	0.36	15.26	0.02	0.03	15.31
Lead	73.3	0	45	0	0.07	0	0	0.07
Vanadium	12.7	0	1	0	0.01	0	0	0.01
Zinc	125	0.0184	13	0.24	0.12	0.01	0.001	0.13
PAHs								
Total LMW PAHs	14.506	0	14301.725	0	0.01	0	0	0.01
Total HMW PAHs	15	0	14301.725	0	0.01	0	0	0.01
Total PAHs	32.806	0	14301.725	0	0.03	0	0	0.03
Total Petroleum Hydrocarbons								
Diesel Range Organics	790	0	1	0	0.76	0	0	0.76

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

Table 6-15
Wildlife Exposure Modeling of 95% UCL Mean Doses to Piscivorous Mammals (River Otter) from Media for Seaford Power Plant Source Area 1

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.60E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.80E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	8.10E-02	L/kg-day

Chemical	95% UCL Mean Sediment Concentration (mg/kg dry wt.)	95% UCL Mean Water Concentration - Source Areas 1 & 2 (mg/L)	Food Item (Fish) Uptake		95% UCL Mean Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	95% UCL Mean Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	4089	0.19	2.7	0.51	3.93	0.02	0.02	3.97
Barium	107.6	0.104	4	0.42	0.10	0.02	0.01	0.13
Beryllium	0.753	0	62	0	0.001	0	0	0.001
Cyanide	0.13	0	1	0	0.0001	0	0	0.0001
Iron	13090	0.364	1	0.36	12.57	0.02	0.03	12.61
Lead	40.14	0	45	0	0.04	0	0	0.04
Vanadium	10.59	0	1	0	0.01	0	0	0.01
Zinc	74.98	0.0184	13	0.24	0.07	0.01	0.00	0.08
PAHs								
Total LMW PAHs	7.982	0	14301.725	0	0.01	0	0	0.01
Total HMW PAHs	15	0	14301.725	0	0.01	0	0	0.01
Total Petroleum Hydrocarbons								
Diesel Range Organics	841.8	0	1	0	0.81	0	0	0.81

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
UCL: Upper confidence level

Table 6-16
Wildlife Exposure Modeling of Maximum Doses to Piscivorous Birds (Great Blue Heron) from Media for Seaford Power Plant Source Area 2

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.00E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.50E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	4.50E-02	L/kg-day

Chemical	Maximum Sediment Concentration (mg/kg dry wt.)	Maximum Water Concentration - Source Areas 1 & 2 (mg/L)	Food Item (Fish) Uptake		Maximum Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Maximum Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	13600	0.19	2.7	0.51	12.24	0.02	0.009	12.27
Barium	429	0.104	4	0.42	0.39	0.02	0.005	0.41
Beryllium	3.2	0	62	0	0.003	0	0	0.003
Cobalt	92.8	0.0054	1	0.005	0.08	0.0002	0.0002	0.08
Copper	31.9	0.0023	464	1.07	0.03	0.05	0.0001	0.08
Iron	28800	0.364	1	0.36	25.92	0.02	0.02	25.95
Manganese	618	0.0466	400	18.64	0.56	0.84	0.002	1.40
Mercury	0.18	0	1800	0	0.0002	0	0	0.0002
Nickel	35.6	0.0025	27	0.07	0.03	0.003	0.0001125	0.04
Vanadium	26.9	0	1	0	0.02	0	0	0.02
Zinc	260	0.0184	13	0.24	0.23	0.01	0.001	0.25
PAHs								
Total LMW PAHs	0.674	0	14301.725	0	0.001	0	0	0.001
Total HMW PAHs	1.03	0	14301.725	0	0.001	0	0	0.001

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

Table 6-17
Wildlife Exposure Modeling of Maximum Doses to Piscivorous Mammals (River Otter) from Media for Seaford Power Plant Source Area 2

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.60E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.80E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	8.10E-02	L/kg-day

Chemical	Maximum Sediment Concentration (mg/kg dry wt.)	Maximum Water Concentration - Source Areas 1 & 2 (mg/L)	Food Item (Fish) Uptake		Maximum Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Maximum Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	13600	0.19	2.7	0.51	13.06	0.02	0.02	13.10
Barium	429	0.104	4	0.42	0.41	0.02	0.008	0.44
Beryllium	3.2	0	62	0	0.003	0	0	0.003
Cobalt	92.8	0.0054	1	0.005	0.09	0.0003	0.0004	0.09
Copper	31.9	0.0023	464	1.07	0.03	0.05	0.0001863	0.08
Iron	28800	0.364	1	0.36	27.65	0.02	0.03	27.69
Manganese	618	0.0466	400	18.64	0.59	0.89	0.004	1.49
Mercury	0.18	0	1800	0	0.0002	0	0	0.0002
Nickel	35.6	0.0025	27	0.07	0.03	0.003	0.0002	0.04
Vanadium	26.9	0	1	0	0.03	0	0	0.03
Zinc	260	0.0184	13	0.24	0.25	0.01	0.0014904	0.26
PAHs								
Total LMW PAHs	0.674	0	14301.725	0	0.0006	0	0	0.0006
Total HMW PAHs	1.03	0	14301.725	0	0.0010	0	0	0.001

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

Table 6-18
Sediment Toxicity Reference Values for Benthic Organism Exposures

Chemical	Sediment TRV (mg/kg dry wt.)	Sediment LOAEL-based TRV (mg/kg dry wt.)	Source
Metals			
Aluminum	NA	NA	---
Barium	NA	NA	---
Beryllium	NA	NA	---
Cobalt	NA	NA	---
Copper	31.6	149	Values are TEC and PEC from MacDonald et al. 2000
Cyanide	1	20	Target Value and Intervention Value from Dutch Ministry Standards (MHSPE 1994, RIVM 2000)
Iron	20000	40000	Values are TEC and PEC from Persaud 1993
Lead	35.8	128	Values are TEC and PEC from MacDonald et al. 2000
Manganese	460	NA	Value is TEL from MacDonald et al. 1996
Mercury	0.18	1.06	Values are TEC and PEC from MacDonald et al. 2000
Nickel	22.7	48.6	Values are TEC and PEC from MacDonald et al. 2000
Vanadium	NA	NA	---
Zinc	121	459	Values are TEC and PEC from MacDonald et al. 2000
PAHs			
Total PAHs	1.61	22.8	Values are TEC and PEC from MacDonald et al. 2000
Total Petroleum Hydrocarbons			
Diesel Range Organics	NA	NA	---

NA = TRV not available
mg/kg dry wt: miligram per kilogram of dry weight
TEC: Threshold Effect Concentration
TEL: Threshold Effect Level
PEC: Probable Effect Concentration
PEL: Probable Effect Level
LEL: Lowest Effect Level
LOAEL: Lowest Observed Adverse Effect Level

Table 6-19
Surface Water Toxicity Reference Values for Aquatic Organism Exposures

Chemical	Chronic TRV (ug/L)	Acute TRV (ug/L)	Source for Surface Water TRVs
Metals			
Aluminum	87	750	DNREC 7401 Surface Water Quality Standards (2014)
Barium	4	110	Tier II value from Suter and Tsao 1996
Iron	1000	NA	DNREC 7401 Surface Water Quality Standards (2014)

DNREC: Delaware Department of Natural Resources and Environmental Control
NA = TRV not available
µg/L: micrograms per liter
TRV: Toxicity Reference Values

Table 6-20
Dose-based Toxicity Reference Values for Birds

Chemical	Avian NOAEL (mg/kg-bw day)	Avian NOAEL Source and Notes	Avian LOAEL (mg/kg-bw day)	Avian LOAEL Source and Notes
Metals				
Aluminum	109.7	Sample et al. 1996	NA	---
Barium	20.8	Sample et al. 1996	41.7	Sample et al. 1996
Beryllium	NA	---	NA	---
Cobalt	7.61	EPA 2005c	26.7	Derived from Data in EPA 2005c
Copper	4.05	EPA 2007b	61.7	Sample et al. 1996
Cyanide	NA	---	NA	---
Iron	NA	---	NA	---
Lead	1.63	EPA 2005d	11.3	Sample et al. 1996
Manganese	997	Sample et al. 1996	NA	---
Mercury	0.45	Sample et al. 1996	0.9	Sample et al. 1996
Nickel	77.4	Sample et al. 1996	107	Sample et al. 1996
Vanadium	0.344	EPA 2005e	0.688	Hill 1979 (study from Eco-SSL used to derive NOAEL)
Zinc	66.1	EPA 2007e	131	Sample et al. 1996
PAHs				
Total LMW PAHs	3.37	Sample et al. 1996	33.7	Sample et al. 1996
Total HMW PAHs	3.37	Sample et al. 1996	33.7	Sample et al. 1996
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	---	NA	---

NA = TRV not available
mg/kg dry wt: miligram per kilogram of dry weight
EPA: U.S. Environmental Protection Agency
Eco-SSL: Ecological Soil Screening Levels
NOAEL: No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level

Table 6-21
Dose-based Toxicity Reference Values for Mammals

Chemical	Mammalian NOAEL (mg/kg-bw day)	Mammalian NOAEL Source and Notes	Mammalian LOAEL (mg/kg-bw day)	Mammalian LOAEL Source and Notes
Metals				
Aluminum	1.93	Sample et al. 1996	19.3	Sample et al. 1996
Barium	51.8	EPA 2005a	436	Derived from Data in EPA 2005a
Beryllium	0.532	EPA 2005b	NA	---
Cobalt	7.33	EPA 2005c	118	Derived from Data in EPA 2005c
Copper	5.6	EPA 2007b	15.4	Sample et al. 1996
Cyanide	68.7	Sample et al. 1996	NA	---
Iron	NA	---	NA	---
Lead	4.7	EPA 2005d	80	Sample et al. 1996
Manganese	51.5	EPA 2007c	284	Sample et al. 1996
Mercury	13.2	Sample et al. 1996	NA	---
Nickel	1.7	EPA 2007d	80	Sample et al. 1996
Vanadium	4.16	EPA 2005e	8.31	Sanchez et al. 1991 (study from Eco-SSL used to derive NOAEL)
Zinc	75.4	EPA 2007e	320	Sample et al. 1996
PAHs				
Total LMW PAHs	65.6	EPA 2007f	434	Derived from data in EPA 2007f
Total HMW PAHs	0.615	EPA 2007f	3.07	Derived from data in EPA 2007f
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	---	NA	---

NA = TRV not available
mg/kg dry wt: miligram per kilogram of dry weight
EPA: U.S. Environmental Protection Agency
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
Eco-SSL: Ecological Soil Screening Levels
NOAEL: No Observed Adverse Effect Level
LOAEL: Lowest Observed Adverse Effect Level

Table 6-22
Background Sediment and Surface Water Detection Comparisons to Screening Levels for Seaford Power Plant

Analyte	Results for Sediment Sample SPP-SD-05 (Background)		Results for Surface Water Sample SPP-SW-01 (Background)	
	Detected Value (mg/kg)	Screening Criteria (mg/kg)	Detected Value (µg/L)	Screening Criteria (µg/L)
Metals				
Aluminum	642.000	NA	102.000	87.000
Arsenic	1.800	9.800	ND	---
Barium	24.600	NA	101.000	4.000
Beryllium	0.440	NA	ND	---
Calcium	109.000	NA	5640.000	116000.000
Chromium	4.800	43.400	ND	---
Cobalt	8.100	50.000	5.000	23.000
Copper	3.400	31.600	ND	9.000
Iron	12500.000	20000.000	280.000	300.000
Lead	6.100	35.800	ND	---
Magnesium	155.000	NA	2340.000	82000.000
Manganese	78.300	460.000	46.600	120.000
Mercury	ND	0.180	---	---
Nickel	3.000	22.700	2.200	52.000
Potassium	ND	NA	2610.000	53000.000
Sodium	ND	NA	8100.000	680000.000
Vanadium	3.500	NA	ND	---
Zinc	36.500	121.000	16.100	120.000

NA: Screening Value Not Available
ND: Not detected
mg/kg: miligram per kilogram
µg/L: microgram per liter

Table 6-23
Wildlife Exposure Modeling of Background Doses to Piscivorous Birds (Great Blue Heron) from Media for Seaford Power Plant

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.00E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.50E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	4.50E-02	L/kg-day

Chemical	Sediment Concentration at SPP-SD-05 (mg/kg dry wt.)	Surface Water Concentration at SPP-SW-01 (mg/L)	Food Item (Fish) Uptake		Bakcground Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Background Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	642.000	0.102	2.700	0.275	0.578	0.012	0.005	0.595
Arsenic	1.800	ND	4.000	0.000	0.002	0.000	0.000	0.002
Barium	24.600	0.101	4.000	0.404	0.022	0.018	0.005	0.045
Beryllium	0.440	ND	62.000	0.000	0.000	0.000	0.000	0.000
Calcium	109.000	5.640	1.000	5.640	0.098	0.254	0.254	0.606
Chromium	4.800	ND	200.000	0.000	0.004	0.000	0.000	0.004
Cobalt	8.100	0.005	1.000	0.005	0.007	0.000	0.000	0.008
Copper	3.400	ND	464.000	0.000	0.003	0.000	0.000	0.003
Iron	12500.000	0.280	1.000	0.280	11.250	0.013	0.013	11.275
Lead	6.100	0.000	45.000	0.000	0.005	0.000	0.000	0.005
Magnesium	155.000	2.340	1.000	2.340	0.140	0.105	0.105	0.350
Manganese	78.300	0.047	400.000	18.640	0.070	0.839	0.002	0.911
Mercury	ND	0.000	1800.000	0.000	0.000	0.000	0.000	0.000
Nickel	3.000	0.002	27.000	0.059	0.003	0.003	0.000	0.005
Potassium	ND	2.610	1.000	2.610	0.000	0.117	0.117	0.235
Sodium	ND	8.100	1.000	8.100	0.000	0.365	0.365	0.729
Vanadium	3.500	ND	1.000	0.000	0.003	0.000	0.000	0.003
Zinc	36.500	0.016	13.000	0.209	0.033	0.009	0.001	0.043

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
ND: Not detected

Table 6-24
Wildlife Exposure Modeling of Bakcground Doses to Piscivorous Mammals (River Otter) from Media for Seaford Power Plant

Exposure Parameters

Sediment Ingestion Rate (kg dry wt./kg bw-day):	9.60E-04	kg/kg-day
Food Ingestion Rate (kg dry wt./kg bw-day):	4.80E-02	kg/kg-day
Water Ingestion Rate (L/kg bw-day):	8.10E-02	L/kg-day

Chemical	Sediment Concentration at SPP-SD-05 (mg/kg dry wt.)	Surface Water Concentration at SPP-SW-01 (mg/L)	Food Item (Fish) Uptake		Background Case Scenario Doses			
			BAF/Equation (mg/L dry wt. to mg/kg dry wt.)	Background Food Item Tissue Concentration (mg/L dry wt.)	Dose from Sediment (mg/kg bw-day)	Dose from Food (mg/kg bw-day)	Dose from Water (mg/kg bw-day)	Total Dose (mg/kg bw-day)
Metals								
Aluminum	642.000	0.102	2.700	0.275	0.616	0.013	0.008	0.638
Arsenic	1.800	ND	4.000	0.000	0.002	0.000	0.000	0.002
Barium	24.600	0.101	4.000	0.404	0.024	0.019	0.008	0.051
Beryllium	0.440	ND	62.000	0.000	0.000	0.000	0.000	0.000
Calcium	109.000	5.640	1.000	5.640	0.105	0.271	0.457	0.832
Chromium	4.800	ND	200.000	0.000	0.005	0.000	0.000	0.005
Cobalt	8.100	0.005	1.000	0.005	0.008	0.000	0.000	0.008
Copper	3.400	ND	464.000	0.000	0.003	0.000	0.000	0.003
Iron	12500.000	0.280	1.000	0.280	12.000	0.013	0.023	12.036
Lead	6.100	ND	45.000	0.000	0.006	0.000	0.000	0.006
Magnesium	155.000	2.340	1.000	2.340	0.149	0.112	0.190	0.451
Manganese	78.300	0.047	400.000	18.640	0.075	0.895	0.004	0.974
Nickel	3.000	0.002	27.000	0.059	0.003	0.003	0.000	0.006
Potassium	ND	2.610	1.000	2.610	0.000	0.125	0.211	0.337
Sodium	ND	8.100	1.000	8.100	0.000	0.389	0.656	1.045
Vanadium	3.500	ND	1.000	0.000	0.003	0.000	0.000	0.003
Zinc	36.500	0.016	13.000	0.209	0.035	0.010	0.001	0.046

mg/kg bw-day: miligram of food per kilogram of body weight per day
kg: kilogram
L/kg bw-day: liters per kilogram of body weight per day
mg/kg dry wt.: miligram per kilogram of dry weight
mg/L: miligram per liter
ND: Not detected

Table 6-25
Comparison of EPCs in Surface Water to Aquatic Organism Toxicity Reference Values
for Seaford Power Plant Source Areas 1 and 2

Chemical	Chronic TRV (µg/L)	Acute TRV (µg/L)	Dissolved Concentrations			
			Frequency of Detection	Maximum EPC (µg/L)	HQ for Maximum EPC Compared to Chronic TRV	HQ for Maximum EPC Compared to Acute TRV
Metals						
Aluminum	87	750	4/4	190	**2.18**	0.25
Barium	4	110	4/4	104	**26**	0.95
Iron	1000	NA	4/4	364	0.36	--

µg/L: microgram per liter
UCL: Upper confidence level
EPC: Exposure point concentrations
HQ: Hazard Quotient
LOAEL: Low Observed Adverse Effect Levels
TRV: Toxicity Reference Value

Table 6-26

Comparison of EPCs in Sediment to Benthic Organism Toxicity Reference Values

for Seaford Power Plant Source Area 1

Chemical	Sediment Toxicity Reference Value (mg/kg)	Frequency of Detection	Maximum Exposure Point Concentration (mg/kg dry wt)	Hazard Quotient for Maximum EPC	95% UCL Mean Exposure Point Concentration (mg/kg dry wt)	Hazard Quotient for 95% UCL Mean EPC	LOAEL-based TRV (mg/kg)	Hazard Quotient for Maximum Compared to LOAEL-based TRV	Hazard Quotient for 95% UCL Mean Compared to LOAEL-based TRV
Metals									
Aluminum	NA	7/7	6240	--	4089	--	NA	--	--
Barium	NA	7/7	192	--	107.6	--	NA	--	--
Beryllium	NA	6/7	1.2	--	0.753	--	NA	--	--
Cyanide	1	1/7	0.13	0.13	0.13	0.13	20	0.01	0.01
Lead	35.8	7/7	73.3	**2.05**	40.14	**1.12**	128	0.57	0.31
Vanadium	NA	7/7	12.7	--	10.59	--	NA	--	--
Zinc	121	7/7	125	**1.03**	74.98	0.62	459	0.27	0.16
PAHs									
Total PAHs	1.61	7/7	32.806	**20.38**	32.806	**20.38**	22.8	**1.44**	**1.44**
Total Petroleum Hydrocarbons									
Diesel Range Organics	NA	5/7	790	--	841.8	--	NA	--	--

mg/kg: miligram per kilogram
UCL: Upper confidence level
EPC: Exposure point concentrations
mg/kg dry wt: miligram per kilogram of dry weight
LOAEL: Low Observed Adverse Effect Levels
TRV: Toxicity Reference Value

Table 6-27

Comparison of EPCs in Sediment to Benthic Organisms Toxicity Reference Values

for Seaford Power Plant Source Area 2

Chemical	Sediment Toxicity Reference Value (mg/kg)	Frequency of Detection	Maximum Exposure Point Concentration (mg/kg dry wt)	Hazard Quotient for Maximum EPC	LOAEL-based TRV (mg/kg)	Hazard Quotient for Maximum EPC Compared to LOAEL-based TRV
Metals						
Aluminum	NA	2/2	13600	--	NA	--
Barium	NA	2/2	429	--	NA	--
Beryllium	NA	2/2	3.2	--	NA	--
Cobalt	NA	2/2	92.8	--	NA	--
Copper	31.6	2/2	31.9	**1.01**	149	0.21
Iron	20000	2/2	28800	**1.44**	40000	0.72
Manganese	460	2/2	618	**1.34**	NA	--
Mercury	0.18	2/2	0.18	**1.00**	1.06	0.17
Nickel	22.7	2/2	35.6	**1.57**	48.6	0.73
Vanadium	NA	2/2	26.9	--	NA	--
Zinc	121	2/2	260	**2.15**	459	0.57
PAHs						
Total PAHs	1.61	2/2	2.255	**1.40**	22.8	0.10

mg/kg: miligram per kilogram
UCL: Upper confidence level
EPC: Exposure point concentrations
mg/kg dry wt: miligram per kilogram of dry weight
LOAEL: Low Observed Adverse Effect Levels
TRV: Toxicity Reference Value

Table 6-28
Maximum Modeled Doses to Birds Compared to Avian Toxicity Reference Values
for Seaford Power Plant Source Area 1

Chemical	Avian TRVs (mg/kg-bw day)		Maximum Case Scenario HQs Based on Comparison of Doses to NOAELs	Maximum Case Scenario HQs Based on Comparison of Doses to LOAELs
	NOAEL	LOAEL	Piscivorous Birds	Piscivorous Birds
Metals				
Aluminum	110	NA	0.05	--
Barium	20.8	41.7	0.01	0.005
Beryllium	NA	NA	--	--
Cyanide	NA	NA	--	--
Iron	NA	NA	--	--
Lead	1.63	11.3	0.04	0.006
Vanadium	0.344	0.688	0.03	0.017
Zinc	66.1	131	0.002	0.001
PAHs				
Total LMW PAHs	3.37	33.7	0.004	0.0004
Total HMW PAHs	3.37	33.7	0.004	0.0004
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	NA	--	--

TRV: Toxicity Reference Value
mg/kg-bw day: miligram of food per kilogram of body weight per day
NOAEL: No Observed Adverse Effect Levels
LOAEL: Low Observed Adverse Effect Levels
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon

Table 6-29
95% UCL Mean Modeled Doses to Birds Compared to Avian Toxicity Reference Values for Seaford Power Plan Source Area 1

Chemical	Avian TRVs (mg/kg-bw day)		95% UCL Mean Case Scenario HQs Based on Comparison of Doses to NOAELs	95% UCL Mean Case Scenario HQs Based on Comparison of Doses to LOAELs
	NOAEL	LOAEL	Piscivorous Birds	Piscivorous Birds
Metals				
Aluminum	110	NA	0.034	--
Barium	20.8	41.7	0.006	0.003
Beryllium	NA	NA	--	--
Cyanide	NA	NA	--	--
Iron	NA	NA	--	--
Lead	1.63	11.3	0.022	0.003
Vanadium	0.344	0.688	0.028	0.014
Zinc	66.1	131	0.001	0.001
PAHs				
Total LMW PAHs	3.37	33.7	0.002	0.0002
Total HMW PAHs	3.37	33.7	0.004	0.0004
Total PAHs	NA	NA	--	--
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	NA	--	--

TRV: Toxicity Reference Value
mg/kg-bw day: miligram of food per kilogram of body weight per day
UCL: Upper confidence level
HQ: Hazard Quotient
NOAEL: No Observed Adverse Effect Levels
LOAEL: Low Observed Adverse Effect Levels
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon

Table 6-30
Maximum Modeled Doses to Birds Compared to Avian Toxicity Reference Values for Seaford Power Plant Source Area 2

Chemical	Avian TRVs (mg/kg-bw/day)		Maximum Case Scenario HQs Based on Comparison of Doses to NOAELs	Maximum Case Scenario HQs Based on Comparison of Doses to LOAELs
	NOAEL	LOAEL	Piscivorous Birds	Piscivorous Birds
Metals				
Aluminum	109.7	NA	0.11	--
Barium	20.8	41.7	0.02	0.01
Beryllium	NA	NA	--	--
Cobalt	7.61	26.7	0.01	0.003
Copper	4.05	61.7	0.02	0.001
Iron	NA	NA	--	--
Manganese	997	NA	0.001	--
Mercury	0.45	0.9	0.0004	0.0002
Nickel	77.4	107	0.0005	0.0003
Vanadium	0.344	0.688	0.07	0.04
Zinc	66.1	131	0.004	0.002
PAHs				
Total LMW PAHs	3.37	33.7	0.0002	0.00002
Total HMW PAHs	3.37	33.7	0.0003	0.00003

TRV: Toxicity Reference Value

mg/kg-bw/day: miligram of food per kilogram of body weight per day

NOAEL: No Observed Adverse Effect Levels

LOAEL: Low Observed Adverse Effect Levels

LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon

HMW PAH: High molecular weight polynuclear aromatic hydrocarbon

COPC: Chemical of Potential Concern

Table 6-31
Maximum Modeled Doses to Mammals Compared to Mammalian Toxicity Reference Values for Seaford Power Plan Source Area 1

Chemical	Mammalian TRVs (mg/kg bw day)		Maximum Case Scenario HQs Based on Comparison of Doses to NOAELs	Maximum Case Scenario HQs Based on Comparison of Doses to LOAELs
	NOAEL	LOAEL	Piscivorous Mammals	Piscivorous Mammals
Metals				
Aluminum	1.93	19.3	**3.12**	0.31
Barium	51.8	436	0.004	0.0005
Beryllium	0.532	NA	0.002	--
Cyanide	68.7	NA	0.000002	--
Iron	NA	NA	--	--
Lead	4.7	80	0.01	0.001
Vanadium	4.16	8.31	0.003	0.001
Zinc	75.4	320	0.002	0.0004
PAHs				
Total LMW PAHs	65.6	434	0.0002	0.00003
Total HMW PAHs	0.615	3.07	0.02	0.005
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	NA	--	--

TRV: Toxicity Reference Value
mg/kg-bw day: miligram of food per kilogram of body weight per day
NOAEL: No Observed Adverse Effect Levels
LOAEL: Low Observed Adverse Effect Levels
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon

Table 6-32
95% UCL Mean Modeled Doses to Mammals Compared to Mammalian Toxicity Reference Values for Seaford Power Plant Source Area 1

Chemical	Mammalian TRVs (mg/kg-bw day)		95% UCL Mean Case Scenario HQs Based on Comparison of Doses to NOAELs	95% UCL Mean Case Scenario HQs Based on Comparison of Doses to LOAELs
	NOAEL	LOAEL	Piscivorous Mammals	Piscivorous Mammals
Metals				
Aluminum	1.93	19.3	**2.05**	0.21
Barium	51.8	436	0.003	0.0003
Beryllium	0.532	NA	0.001	--
Cyanide	68.7	NA	0.000002	--
Iron	NA	NA	--	--
Lead	4.7	80	0.01	0.0005
Vanadium	4.16	8.31	0.002	0.001
Zinc	75.4	320	0.001	0.0003
PAHs				
Total LMW PAHs	65.6	434	0.0001	0.00002
Total HMW PAHs	0.615	3.07	0.02	0.005
Total Petroleum Hydrocarbons				
Diesel Range Organics	NA	NA	--	--

TRV: Toxicity Reference Value
mg/kg-bw day: miligram of food per kilogram of body weight per day
UCL: Upper confidence level
HQ: Hazard Quotient
NOAEL: No Observed Adverse Effect Levels
LOAEL: Low Observed Adverse Effect Levels
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon

Table 6-33
Maximum Modeled Doses to Mammals Compared to Mammalian Toxicity Reference Values
Seaford Power Plant Source Area 2

Chemical	Mammalian TRVs (mg/kg-bw day)		Maximum Case Scenario HQs Based on Comparison of Doses to NOAELs	Maximum Case Scenario HQs Based on Comparison of Doses to LOAELs
	NOAEL	LOAEL	Piscivorous Mammals	Piscivorous Mammals
Metals				
Aluminum	1.93	19.3	**6.79**	0.68
Barium	51.8	436	0.01	0.001
Beryllium	0.532	NA	0.01	--
Cobalt	7.33	118	0.01	0.001
Copper	5.6	15.4	0.01	0.01
Iron	NA	NA	--	--
Manganese	51.5	284	0.03	0.01
Mercury	13.2	NA	0.00001	--
Nickel	1.7	80	0.02	0.0005
Vanadium	4.16	8.31	0.01	0.003
Zinc	75.4	320	0.003	0.001
PAHs				
Total LMW PAHs	65.6	434	0.00001	0.000001
Total HMW PAHs	0.615	3.07	0.002	0.0003

TRV: Toxicity Reference Value
mg/kg-bw day: miligram of food per kilogram of body weight per day
NOAEL: No Observed Adverse Effect Levels
LOAEL: Low Observed Adverse Effect Levels
LMW PAH: Low molecular weight polynuclear aromatic hydrocarbon
HMW PAH: High molecular weight polynuclear aromatic hydrocarbon
COPC: Chemical of Potential Concern

Appendix A

Photograph Log

EA Engineering, Science, and Technology, Inc.

Photographic Record

Former Seaford Power Plant (DE-1031)
200 South Pine Street
Seaford, Delaware

View looking west of private utility markout performed

View looking east of sediment/surface water sampling performed on the Nanticoke River

Soil sampling performed by direct-push technologies

Oil sheen present on the Nanticoke River

SPP-05 located west of the maintenance garage

SPP-04 located on southwest of the current substation

EA Engineering, Science, and Technology, Inc.

Photographic Record

Former Seaford Power Plant (DE-1031)
200 South Pine Street
Seaford, Delaware

SPP-03 located west of the current substation

SPP-02 located on the western end of Water Street

SPP-08 located south of the Seaford Power Plant

SPP-07 located south of the Seaford Power Plant

SPP-01 located northwest of Seaford Power Plant

SPP-13 located adjacent to the cooling towers

EA Engineering, Science, and Technology, Inc.

Photographic Record

Former Seaford Power Plant (DE-1031)
200 South Pine Street
Seaford, Delaware

SPP-12 located south of the abandoned substation

SPP-10 located adjacent to SPP-11 along the riverwalk

SPP-14 located on the east end of Water Street

Soil cores collected south of the Seaford Power Plant with oily contamination

Soil core collected from SPP-12 with oily contamination

Representative well installation

Appendix B

Soil Boring Logs

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-01	
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 12	
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1	
				Drilling	
Water Level				Start	Finish
Time	-			3/9/2015 10:30	3/9/2015 10:45
Date					
Reference					

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: center of turnaround

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Pavement
	36"		0.0	1	30"	GW	Firm, Dry, very dark gray, asphalt, sandy clay, shell, brick, GRAVEL fill - (GW) (2.5Y 3/1)
			0.0	2			
			0.0	3	6"	SP	Dense, moist, dark grayish brown, c. SAND - (SP) (2.5Y 4/2)
			-	4	-	-	
	38"		0.0	5	4"	SW	ense, moist, v. dk. gray, clayey SAND w/petro odor/stain? - (SW) (2.5Y 3/
					14"	SP	Dense, wet, gray, c. SAND - (SP) (2.5Y 6/1)
			0.0	6	14"	SP	Dense, wet, pale brown, c. SAND w/ trace gravel - (SP) (2.5Y 7/3)
		H2O Table	0.0	7	8"	SP	Dense, wet, pale brown, c. SAND - (SP) (2.5Y 7/3)
			-	8	-	-	
	48"		0.0	9	6"	SP	Dense, wet, light gray, c. SAND - (SP) (2.5Y 7/2)
			0.0	10	16"	SP	Dense wet, pale brown, c. SAND - (SP) (2.5Y 7/3)
			0.0	11	20"	SP	Soft, wet, pale brown, f. SAND, trace silt to clay - (SW) (2.5Y 7/3)
			0.0	12	6"	SP	Soft, wet, pale brown, m.-f. SAND, trace silt - (SW) (2.5Y 7/3)

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-02	
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 11	
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1	
				Drilling	
Water Level				Start	Finish
Time	-			3/9/2015 10:00	3/9/2015 10:15
Date					
Reference					

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: Adjacent to asphalt patch

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Pavement
	34"		0.8	1	10"	GP	Firm, dry, black asphalt GRAVEL - (GP) (5Y 2.5/1)
			0.3	2	12"	SP	Dense, dry, black gravelly c. SAND - (SP) (5Y 2.5/1)
			8.2	3	8"	SP	Dense, moist, olive gray, c. SAND w/o odor - (SP) (5Y 4/2)
					6"	SW	Soft, moist, light olive brown, clayey c-m. SAND, trace gravel w/o odor - (SW) (2.5Y 5/4
			-	4	-	-	
	38"	H2O Table	0.2	5	16"	SP	Soft, wet, light yellowish brown, c. SAND with qtz pebble lenses - (SP) (2.5Y 6/4)
			0.1	6	24"	SP	Dense, wet, pale yellow, m. SAND - (SP) (5Y 7/4)
			0.0	7			
			1.9	8		SP	Dense, wet, light gray, c. SAND - (SP) (5Y 7/1)
	48"		5.4	9	48"	SP	Dense, wet, white, m-f. SAND - (SP) (5Y 8/1)
			9.6	10			
			5.1	11			
			5.0	12			

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-03
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 14
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 11:30
Time	-			Finish: 3/9/2015 11:45
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: Western-most boring loc.

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Grass/Gravel
	32"		0	1	4"	SM	Dense, moist, dark brown, organic-rich c. SAND - (SM) (7.5YR 3/3)
					6"	SP	Dense, moist, yellowish brown, c. SAND - (SP) (10YR 5/6)
			0	2	4"	SW	Soft, moist, grayish brown, m-f. SAND, trace silt-clay - (SW) (2.5Y 5/2)
					2"	GW	Loose, moist, dark gray, mix of c. SAND and shell fragments - (SP) (5Y
			0	3	16"	SM	Dense, moist,very dark gray, silty c-m. SAND - (SM) (5Y 2.5/1)
			-	4	-	-	
					-		
	32"	H2O Table	0	5	12"	SP	Soft, wet, olive, c. SAND - (SP) (5Y 4/4)
			0	6	2"	SM	Soft, moist, dark olive gray, silty f. SAND, trace clay - (SM) (5Y 2.5/2)
					6"	SP	Dense, wet, black, c. SAND w/ qtz pebbles - (SP) (Gley 1-2.5/N)
			0	7	6"	SM	Soft, wet, black silty f. SAND, trace clay & marshy - (SM) (Gley 1-2.5N)
					4"	SP	Dense, wet, olive brown, c. SAND w/ qtz pebbles - (SP) (2.5Y 4/4)
			-	8	-	-	
					-		
	48"		0	9	12"	SP	Dense, wet, light yellowish brown, c. SAND - (SP) (2.5Y 6/4)
			0	10	18"	SP	Dense, wet, light yellowish brown, c. SAND w/ qtz pebble lenses - (SP) (2.5Y 6/3)
			0	11	18"		Dense,wet, light yelllowish brown, m-f. SAND - (SP) (2.5Y 6/3)
			0	12			

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-04
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 13
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 11:00
Time	-			Finish: 3/9/2015 11:15
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: corner of boat ramp

Surface Conditions: grass

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	30"		0.0	1	8"	SM	Soft, moist, very dark brown organic-rich c. SAND (SM) (7.5YR 4/2)
			0.0	2	8"	SP	Soft, very moist, brown, c. SAND - (SP) (7.5YR 5/3)
		H2O Table	0.0	3	12"	SM	Soft, wet, olive gray, silty m-f. SAND, trace clay - (SM) (5Y 5/2)
			-	4	2"	SP	Soft, wet, olive gray m-f. SAND - (SP) (5Y 5/2)
					-	-	
					-		
	48"		0.0	5	24"	SP	Soft, wet, olive gray m-f. SAND - (SP) (5Y 5/2)
			0.0	6			
			0.0	7	14"	SP	Soft, wet, dark greenish gray m-f. SAND - (SP) (Gley 1-4/10Y)
			0.0	8	12"	SP	Soft, wet, olive gray m-f. SAND - (SP) (5Y 5/2)
	26"		0.0	9	8"	SM	Soft, wet, gray, silty f. SAND - (SM) (5Y 5/1)
					8"	SM	Soft, wet, greenish black, silty c. SAND w/ marshy organics - (SW) (Gley 1-2.5/10GY)
			0.0	10	2"	SP	Dense, wet, greenish black, c. SAND w/ qtz pebbles - (SP) (Gley 1-2.5/5G
			-		8"	SW	Soft, wet, greenish black, silty c. SAND, trace gravel - (SW) (Gley 1-2.5/5GY)
				11	-	-	
			-		-		
				12	-		

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-05
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 8
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: near dumpsters

				Start	Finish
Water Level					
Time	-			3/5/2015 14:00	3/5/2015 14:15
Date					
Reference					

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Paved
			0.3	1	10"	SW	Dense, slightly moist, very dark gray, c-m. SAND w/gravel - (SW) (2.5Y 3/1)
	48"		0.3	2	28"	SW	Dense, slightly moist, very dark gray, c-m. SAND w/ slag bits and gravel - (SW) (2.5Y 3/1)
			0.3	3			
			0.3	4	10"	CL	Soft, moist, pale olive, sandy CLAY, trace decomposing wood and fat clay - (CL) (5Y 6/3)
			0.3	5	17"	SP	Soft, wet, gray, c. SAND - (SP) (Gley 1-6/N)
	40"	H2O Table	0.3	6	23"	SW	V. soft, wet, gray, c-m-f. SAND, trace clay - (SW) (Gley 1-6/N)
			0.3	7			
			0.3	8	-	-	
			-				
			0.3	9	28"	SP	Dense, wet, gray, c. SAND w/ qtz pebble lenses - (SP) (Gley 1-6/N)
	46"		0.3	10			
			0.3	11	18"	SW	Dense, wet, olive dark gray, clayey c. SAND - (SW) (5Y 3/2)
			0.3	12			

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-06
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 22
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 15:15
Time	-			Finish: 3/9/2015 15:30
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: corner of bulkhead 6' NW of orig. loc.

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Grass
	26"		0.0	1	6"	SM	Soft, moist, very dary grayish brown, organic c. SAND - (SM) (10YR 3/2)
			0.0	2	20"	SP	Dense, moist to wet, olive yellow, c-m. SAND - (SP) (2.5Y 6/6)
			-	3	-	-	
			-	4	-		
	32"		0.0	5	8"	SP	Dense, moist, olive gray, m. SAND, trace clay - (SP) (5Y 4/2)
					3"	CL	Soft, wet, light olive gray, low placticity, silty CLAY - (CL) (5Y 6/2)
		H2O Table	0.0	6	8"	SP	Soft, wet, very dark gray, c. SAND - (SP) (Gley 1-3/N)
					3"	CL	Dense, wet, very dark gray, low plasticity, silty CLAY - (CL) (Gley 1/3/N)
			0.0	7	8"	SP	Soft, very wet, black, c. SAND, no odor - (SP) (Gley 1-2.5/N)
			-	8	2"	CL	Soft, moist,dark greenish gray, med plasticity CLAY, trace silt - (CH) (Gley 1-4/10Y)
	0"			9		-	Refusal @ 8' - Wood clogging core, same reason for original offset.
				10			
				11			
				12			

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-07
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 2
Sampling Method: 4 foot length, Double Tube Cores, Acetate Liner			Sheet 1 of 1
			Drilling
Water Level			Start: 3/5/2015 10:00 / Finish: 3/5/2015 10:30
Time	-		
Date			
Reference			

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: Closest to wall, fenced in

Surface Conditions: Gravel

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	30"		1.6	1	10"	SM	Soft, moist, dark reddish-brown, organic-rich c. SAND - (SM) (5YR 3/2)
			3.2	2	14"	SC	Soft, moist, dark reddish brown, clayey m-c. SAND with a petroleum odor and sheen - (SC) (5YR 2.5/2)
			2.2	3	6"	CH	Medium stiff, moist, very dark grey, high plasticity, CLAY, trace f. sand with a petroleum odor - (CH) (Gley 1-3/N)
			-	4	-		
	40"		2.5	5	3"		
					8"	SP	Dense, moist, greenish-gray, c. SAND with a petroleum odor - (SP) (Gley 1-5/10Y)
			30.1	6	29"	SM	Soft, wet, gray, silty c. SAND, trace m-f sand to clay with petroleum odor - (SM) (Gley 1-6.5/N)
		H2O Table	5.6	7			
			24.1	8	-		
	40"		0	9	16"	CL	Soft, wet, light gray, low plasticity, silty CLAY with decomposing wood and petroleum odor (CL) (2.5Y 7/2)
			3.3	10	8"	SP	Dense, wet, gray, c. SAND with petroleum odor - (SP) (Gley 1-5/N)
			3.7	11	8"	CL	Soft, wet, gray, low plasticity, f. sandy CLAY, trace c. sand and qtz pebbles with petroleum odor - (CL) (2.5Y 5/1)
			5.2	12	8"	SP	Dense, wet, gray, c. SAND with petroleum odor - (SP) (2.5Y 5/1)

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-08
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 3
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: closest to transformers

				Start	Finish
Water Level					
Time	-			3/5/2015 10:45	3/5/2015 11:15
Date					
Reference					

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Gravel
	32"		2.4	1	8"	SM	Soft, moist, dark reddish-brown, organic-rich c. SAND - (SM) (5YR 3/2)
			5.7		10"	SC	Soft, moist, light olive brown, clayey m-c. SAND with petroleum odor - (SC) (2.5Y 5/4)
			6.3	2	8"	SC	Soft, moist, black, clayey m-c. SAND with petroleum staining, sheen, and odor - (SC) (Gley 1-2.5/N)
			32.2	3	6"	SC	Soft, moist, greenish black, clayey m-c. SAND with petroleum sheen, and odor - (SC) (Gley 1-2.5/10Y)
			-	4	-		
	24"		37.4	5	3"	SC	Soft, wet, dark olive gray, m. SAND with petroleum odor - (SC) (5Y 3/2)
		H2O Table	12.1		12"	CL	Soft, wet, olive gray, m. sandy CLAY with petro odor - (CL) (5Y 5/2)
			18.4	6	6"	SP	Dense, wet, gray, m. SAND with petroleum odor - (SP) (5Y 6/1)
			14.3	7	3"	-	-
			-		-		
			-	8			
	0"		-	9		-	
			-	10			
			-	11			
			-	12			

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-08a
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 18
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling
Water Level			Start: 3/9/2015 13:15 / Finish: 3/9/2015 13:30
Time	-		
Date			
Reference			

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: outside corner of fence

Surface Conditions: Grass

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	30"		0.0	1	4"	SM	Dense, moist, v. dark grayish brown, organic rich c. SAND - (SM) (2.5Y 3/2
			0.0	2	16"	SP	Dense, moist, yellow, m. SAND - (SP) (2.5Y 7/6)
			0.0	3	8"	SP	Soft, wet, yellow, c. SAND - (SP) (2.5Y 7/6)
					2"	GP	Dense, angular, well sorted 10mm limestone GRAVEL - (GP)
			-	4	-	-	
	27"		0.0	5	6"	SP	Soft, wet, black, c. SAND with petroleum staining/sheen - (SP) (5Y 2.5/1)
			35.2		10"	SW	Soft, wet, c-m. SAND, trace silt to clay, with petroleum staining/sheen - (SW) (Gley 1-2.5/1)
			60.4				
		H2O Table	65.7	6	11"	SW	Soft, wet, gray, m. SAND with decomposing wood fragments, trace clay to silt with petro sheen and odor- (SP) (Gley 1-5/N)
			-	7		-	
			-	8	-		
	40"		215	9	10"	SP	Dense, wet, very dark greenish gray, c. SAND with petro sheen and odor - (SP) (Gley 1-3/10Y)
		H2O Table ?	94.1	10	10"	SP	Dense wet, very dark greenish gray, m. SAND with petro sheen and odor - (SP) (Gley 1-3/10Y)
			35.6	11	20"	SP	Dense, wet, very dark greenish gray, c. SAND with petro sheen and odor - (SP) (Gley 1-3/10Y)
			0.0				
			-	12	-	-	

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-08b
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 17
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling
Water Level			Start: 3/9/2015 12:45 / Finish: 3/9/2015 13:00
Time	-		
Date			
Reference			

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc:

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Grass
	30"		0.0	1	4"	SM	Soft, moist, v. dark grayish brown, organic rich c. SAND - (SM) (10YR 3/2)
			0.0	2	16"	SP	Dense, moist, dark olive brown, c. SAND, petro sheen toward bottom - (SP) (2.5Y 3/3)
			312	3	12"	SP	Soft, moist, bluish black, c. SAND, petro sheen and odor - (SP) (Gley 2-2.5/5BP
			-	4	-	-	
	27"	H2O Table	0.0?	5	6"	SP	Soft, wet, green black, c. SAND, trace clay w/sheen - (SP) (Gley 1-2.5/10Y
					3"	CL	Dense, moist, black, c. sandy CLAY with sheen - (CL) (Gley 1-2.5/N)
			109	6	18"	SW	Soft, wet, gray, clayey c. SAND with sheen to 6" down - (SW) (Gley 1-6/N)
			0.0?				
			-	7	-	-	
			-	8	-		
	0"		-	9	-	-	
			-	10	-		
			-	11	-		
			-	12	-		

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc:

Job. No.	Client:	Location:
1482609	DNREC	SPP-DPT-09

Drilling Method:	Boring No.
Geoprobe - Direct Push Technology	1
Sampling Method:	Sheet 1 of 1
4 foot length, Double Tube Cores	
	Drilling

				Start	Finish
Water Level					
Time	-			3/5/2015 09:15	3/5/2015 09:45
Date					
Reference					

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Gravel
			0.0		6"	SM	Soft, moist, brown, organic-rich c. SAND - (SM) (7.5YR 5/2)
			6..5	1	6"	SP	Soft, moist, black, m. SAND with petroleum sheen and odor - (SP) (10YR
			19.2		6"	SM	Soft, moist, black, silty f. SAND with petro sheen and odor - (SM) (5Y 2.5/
	18"		-	2	-	-	
			-		-		
				3	-		
			-		-		
				4	-		
			34.2		9"	MH	Soft, moist, dark gray, clayey SILT, trace f-m. sand with petro odor - (MH) (Gley 1-4/N)
			6.5	5			
		H2O Table	7.1		11"	SW	Soft, wet, gray, c. SAND, trace qtz pebbles with petroleum odor (SW) (5Y 5/1)
	20"		-	6			
			-		-	-	
				7	-		
			-		-		
				8	-		
			1.1	9	11"	SW	Soft, wet, very dark gray, c. SAND, trace clay and qtz pebbles with petroleum odor - (SW) (Gley 1-3/N)
			3.4	10	11"	SW	Soft, wet, gray, clayey m. SAND with petroleum odor - (SW) (Gley 1-6/N)
	44"		2.3	11	11"	SW	Soft, wet, very dark gray, c. SAND, trace clay and qtz pebbles with petroleum odor - (SW) (Gley 1-3/N)
			1.9	12	11"	SP	Dense, wet, greenish gray, c, SAND with petroleum odor - (SP) (Gley 1-5/5GY)

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORING

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-09a
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 4
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: 10' E of SPP-DPT-09

				Start	Finish
Water Level					
Time	-			3/5/2015 11:30	3/5/2015 11:45
Date					
Reference					

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Gravel
			0.1	1	6"	SM	Dense, dry, very dark gray, organic-rich c. SAND - (SM) (5YR 3/1)
					6"	SP	Dense, moist, dark gray, m. SAND - (SP) (10YR 4/1)
	32"		1.1	2	12"	SW	Dense, moist, dark gray, f-m. SAND - (SP) (2.5Y 4/4)
			1.3	3	3"	SP	Soft, moist, very dark gray, c. Sand, trace glass - (SP) (2.5Y 3/1)
					2"	CH	Soft, moist, light gray, fat CLAY - (CH) (Gley1-7/N)
			-	4	3"	CL	Soft, wet, greenish gray, m. sandy CLAY - (CL) (Gley 1-5/5GY)
					-		
			7.5	5	10"	CH	Soft, moist, greenish gray, high plasticity, fat CLAY with petroleum odor - (CH) (Gley 1-5/5GY)
		H2O Table	27.2	6	6"	SP	Soft, wet, greenish gray, c. SAND with petro odor - (SP) (Gley 1-5/5GY)
	40"		15.7		3"	CH	Firm, moist, greenish gray, high plasticity, fat CLAY - (CH) (Gley 1-5/5GY)
			49.4		8"	SW	Soft, wet, greenish gray, m-f. SAND, trace clay - (SW) (Gley 1-6/10Y)
			3.2	7	13"	CL	Soft, wet, greenish gray, m. sandy CLAY - (CL) (Gley 1-5/N)
			-	8	-	-	
			0.1	9	10"	SW	Soft, wet, dark gray, m-f. SAND, trace clay - (SW) (5Y 4/1)
			0.1	10	30"	SP	Soft, wet, dark gray, c. SAND - (SP) (5Y 4/1)
	40"		0.1	11			
			-	12	-	-	
					-		

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-09b
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 5
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: 12' E of SPP-DPT-09a

				Start	Finish
Water Level					
Time	-			3/5/2015 12:00	3/5/2015 12:15
Date					
Reference					

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Gravel
			4.2	1	14"	SM	Dense, moist, very dark gray, organic rich c. SAND - (SM) (10YR 3/1)
			11.4		6"	SP	Dense, moist, very dark gray, gravelly c. SAND with petro odor - (SP) (10YR 3/1)
	20"			2	-	-	
			-		-		
				3	-		
			-		-		
				4	-		
			10.3	5	24"	SW	Dense, moist-wet, greenish black, c-m. SAND, trace clay with petro odor - (SW) (Gley 1-2.5/10Y)
		H2O Table	12.1	6			
	40"		14.4		6"	SP	Dense, wet, greenish black, c. SAND, trace qtz pebble with petro odor - (SP) (Gley 1-2.5/10Y)
			6.7	7	12"	SW	
			-	8		-	Very soft, very wet, greenish gray, c-m-f. SAND with petro odor - (SW) (Gley 1-6/N)
				9			REFUSAL @ 8' bgs
				10			
				11			
				12			

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-09c
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 6
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: 10' E of SPP-DPT-09b

				Start	Finish
Water Level					
Time	-			3/5/2015 12:30	3/5/2015 12:45
Date					
Reference					

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Gravel
	40"		1.2	1	8"	SM	Dense, moist, very dark gray, organic-rich c. SAND - (SM) (10YR 3/1)
			2.3		14"	SP	Dense, moist, very dark gray, gravelly c. SAND - (SP) (10YR 3/1)
			22.3	2	14"	SP	Soft, moist, black, m. SAND with petro stain, sheen, and odor - (SP) (10YR 2/1)
			7.4	3	14"	CL	Soft, moist, olive gray, m-f. sandy CLAY with petro odor - (CL) (5Y 5/2)
			-	4		-	
	48"		12.4	5	6"	SW	Soft, moist, greenish gray, clayey c. SAND w/ petro odor - (SW) (Gley 1-6/
					6"	CL	Soft, wet, light greenish gray, c. sandy CLAY w/ odor - (CL) (Gley 1-7/10Y
		H2O Table	10.1	6	14"	SW	V. soft, wet, light gray, c-m-f. SAND with petro odor - (SW) (Gley 1-7/N)
			2.5	7	8"	SW	Soft, wet, light greenish gray, c. SAND, trace qtz pebbles and clay with petro odor - (SW) (Gley 1-7/10Y)
			1.5	8	8"	SW	V. soft, wet, light gray, c-m-f. SAND with petro odor - (SW) (Gley 1-7/N)
					6"	CL	Soft, wet, light greenish gray, c. sandy CLAY - (CL) (Gley 1-7/10Y)
	48"		1.1	9	24"	SW	Dense, wet, greenish gray, c-m. SAND, trace clay - (SW) (Gley 1-5/10Y)
			0.3	10			
			0.3	11	24"	SP	Dense, wet, olive gray, c. SAND - (SP) (5Y 5/2)
			0.3	12			

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC		Location: SPP-DPT-09d
Drilling Method: Geoprobe - Direct Push Technology			Boring No. 7
Sampling Method: 4 foot length, Double Tube Cores			Sheet 1 of 1
			Drilling

				Start	Finish
Water Level					
Time	-			3/5/2015 13:15	3/5/2015 13:30
Date					
Reference					

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: 80' E of SPP-DPT-09
edge of pavement 13' S of building corner

Surface Conditions: Gravel

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
			0.3		4"	SM	Dense, dry, dark gray, organic-rich c. SAND - (SM) (5YR 4/1)
			0.3	1	16"	SW	Dense, slightly moist, black, c-m. SAND, trace clay - (SW) (5YR 2.5/1)
				2			
	36"		0.3				
			0.2	3	16"	ML	Dense, slightly moist, gray, SILT, trace f. sand and clay - (ML) (5Y 6/1)
			-	4		-	
			0.3		6"	SP	Dense, moist, dark gray, c. SAND - (SP) (Gley 1-4/N)
			0.2	5	14"	SW	V. soft, wet, light gray, c-m-f. SAND - (SW) (Gley 1-7/N)
		H2O Table					
	48"		0.3	6	10"	SW	Soft, wet, olive, c-m. SAND, trace clay - (SW) (5Y 5/3)
				7			
			0.3		18"	SP	Dense, wet, olive gray, c. SAND - (SP) (5Y 5/2)
				8			
			0.4	9			
			0.3				
	48"			10	48"	SP	Dense, wet, olive gray, c. SAND with qtz pebble lenses - (SP) (5Y 5/2)
			0.3	11			
			0.3				
				12			

Notes:
No PID readings above background (0.3ppm), petroleoum staining, sheen, or odors. SPP-DPT-09 Delineation Compl
Refusal at 2-3' bgs in between SPP-DPT-09c and SPP-DPT-09d. Vibrations indicate large area slab extending to
from close to building to fenceline and from 09c east to near edge of paved lot.

Logged by: Jesse Drummond Date: 03/05/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-10	
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 19	
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1	
				Drilling	
Water Level				Start	Finish
Time	-			3/9/2015 13:45	3/9/2015 14:00
Date					
Reference					

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: along bulkead: W-center

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Grass
					6"	SM	Loose, moist, very dark gray, organic-rich c. SAND - (SM) (10YR 3/1)
			0.0	1	4"	SP	Soft, moist, dark brown, c. SAND - (SP) (10YR 3/3)
	34"		0.0	2	12"	SP	Soft, moist, olive brown, c. SAND - (SP) (2.5Y 4/4)
			0.0	3	12"	SP	Soft, wet, light yellowish brown, c-m. SAND with petro odor toward bottom (SP) (2.5Y 6/4)
		H2O Table	-	4	-	-	
					-		
			0.0	5	8"	SP	Soft, wet, greenish gray, m. SAND with petro odor- (SP) (Gley 1-5/10Y)
			0.0	6	10"	SP	Soft, wet, very dark greenish gray, c. SAND, trace clay with petro odor - (SP) (Gley 1-3/10GY)
	18"		-	7	-	-	
			-	8	-		
					-		
			0.0	9	6"	SP	Soft, wet, greenish gray, c-m. SAND - (SP) (Gley 1-5/10Y)
					8"	SW	Soft, wet, v. dk. grn. gray, c-m. SAND w/shell frags petro sheen/odor- (SW) (Gley 1-3/10Y)
			0.0	10	5"	SP	Dense, wet, v. dk. grn. gray, c. SAND w/ qtz pbl and petro odor - (SP) (Gley 1-3/10Y)
	44"		0.0	11	25"	CL	Soft, wet, greenish gray, low plasticity, silty CLAY with sand, no petro odor - (CL) (Gley 1-5/5GY)
			0.0	12			

Note: possible malfunction with PID, started acting erratic after heavy impacts on earlier borings. Recalibrations didn't help.

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-11	
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 20	
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1	
				Drilling	
Water Level				Start	Finish
Time	-			3/9/2015 14:15	3/9/2015 14:30
Date					
Reference					

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: along bulkhead: E-center

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Grass
			0.0	1	6"	SP	Dense, moist, very dark grayish brown, organic c. SAND - (SM) (10YR 3/2
					10"	SP	Dense, moist, light olive brown, c. SAND - (SP) (2.5Y 5/6)
	34"		0.0	2	8"	SP	Dense, wet, black, c. SAND, trace clay with petro odor - (SP) (5Y 2.5/1)
		H2O Table	0.0	3	8"	SP	Soft, wet, black, c. SAND with petro sheen and odor - (SP) (Gley 1-2.5/N
			-	4			
			46	5	9"	SP	Dense, wet, black, clayey c. SAND - (SC) (Gley 1-2.5/N)
	9"			6			
				7			
				8			
				9			
	0			10			
				11			
				12			

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-11a	
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 21	
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1	
				Drilling	
Water Level				Start	Finish
Time	-			3/9/2015 14:45	3/9/2015 15:00
Date					
Reference					

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: along bulkhead 20' E of DPT-11

Surface Conditions: Grass

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	28"		0.0	1	4"	SM	Soft, moist, v. dk. grayish brown, organic-rich c. SAND - (SM) (10YR 3/2)
					12"	SP	Soft, moist, light yellowish brown, c. SAND - (SP) (2.5Y 6/4)
			0.0	2	8"	SW	Soft, wet, very dark gray, c-m. SAND with qtz pebbles and shell fragments, no odor - (SW) (2.5Y 3/1)
		H2O Table	0.0	3	2"	SP	Soft, wet, very dark gray, c. SAND, trace clay - (SP) (Gley 1-3/N)
			0.0		2"	**SP**	Dense, wet, greenish gray, c. SAND with qtz pebble - (SP) (Gley 1-5/10Y)
				4	-		
	36"		0.0	5	4"	SP	Dense, wet, black, m. SAND - (SP) (Gley 1 2.5/N)
					2"	SP	Soft, wet, dark greenish gray, c. SAND, trace clay - (SP) (Gley 1-4/10Y)
			0.0	6	8"	SP	Soft, wet, dark greenish gray, c. SAND, w/slight sheen - (SP) (Gley 1-4/10
			0.0	7	18"	CL	Soft, wet, very dark greenish gray, med plasticity m. sandy CLAY with yellow wood plank (soft but not decomposed) - (CL) (Gley 1-3/10Y)
			-		-		
				8	-		
	44"		0.0	9	18"	CL	Soft, wet, very dark greenish gray, med plasticity m. sandy CLAY with yellow wood plank (soft but not decomposed) - (CL) (Gley 1-3/10Y)
			0.0	10	18"	SM	Soft, wet, very dark greenish gray, marshy silty c-m. SAND - (SM) (Gley 1-3/10Y)
			0.0	11			
			0.0	12	8"	SP	Dense, wet, Very dark greenish gray, c. SAND - (SP) (Gley 1-3/10Y

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc.

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LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-12
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 16
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 12:15
Time	-			Finish: 3/9/2015 12:30
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: 15' East of original DPT-12 just past concrete platform

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	Surface Conditions: Grass
					6"	SM	Soft, moist, dark brown, organic-rich c-m. SAND - (SM) (7.5YR 3/3)
			0.0	1	6"	SP	Soft, moist, dark brown, m. SAND - (SP) (10YR 3/3)
					4"	SW	Dense, moist, dark gray, m-f. SAND, trace silt - (SW) (5Y 4/1)
			0.0	2	4"	SP	Soft, moist, very dark gray, c. SAND w/petro sheen and odor - (SP)
	36"				6"	CL	Dense, moist, olive, high plasticity silty CLAY w/ odor - (CL) (5Y 4/3)
			1450	3	10"	SW	Soft, very moist, greenish black, c. SAND with clay lenses and heavy petroleum sheen, staining, odor - (SW) (Gley 1-2.5/5G_/1)
			2261				
			-	4	-	-	
			2560		14"	SP	Very soft, wet, black, c-m. SAND with heavy petroleum sheen, staining, odor & product - (SP) (Gley 1-2.5/N)
			1500	5			
					14"	CL	Soft, very moist, black, c-m sandy CLAY with heavy petroleum sheen, staining, and odor - (CL) (Gley1-2.5/N)
	36"		1194	6			
					8"	SP	Very soft, wet, dark gray, c. SAND with heavy petro sheen, staining, odor, & product - (SP) (Gley 1-4/N)
			1063	7			
			-		-	-	
				8	-		
			0.0		4"	SP	Soft, wet, dark gray, m. SAND, no petro indications - (SP) (Gley 1-4/N)
				9	10"	SW	Dense, wet, dark gray, c-m. SAND with basal qtz pebbles, no petro - (SW) (Gley 1-4/N)
			0.0	10			
	46"		0.0	11	32"	SP	Dense, wet, olive gray, m. SAND, no petro indications - (SP) (5Y 5/2)
			0.0	12			

Note: Not clear where the water table was due to nature of 4-8' interval recovery and presence of product. I estimate it to begin at 5' bgs with poor recovery in 5-6' interval due to presence of product.

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-12a
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 15
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 12:00
Time	-			Finish: 3/9/2015 12:05
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: outside fence in front of abandoned substation

Surface Conditions: Grass

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	30"		0.0	1	6"	SM	Soft, moist, dark brow, organic-rich c. SAND - (SM) (10YR 3/3)
					8"	SP	Dense, dry, yellow, c. SAND - (SP) (5Y 6/7)
			0.0	2	2"	GP	Dense, angular, well sorted 10mm limestone GRAVEL - (GP)
					14"	SW	Dense, moist, dark greenish gray, m-f. SAND, trace silt with light petro odor - (SW) (Gley 1-4/10Y)
			0.0	3	-	-	
			-	4	-		
					-		
	20"		0.0	5	14"	SW	Soft, moist, very dark gray, c-m-f. SAND, trace silt to clay - (SW) (2.5Y 3/1
			0.0	6	6"	CL	Soft, moist, gray, m. sandy CLAY - (CL) (Gley 1-5/N)
					-	-	
			-	7	-	-	Refusal @ 6' bgs
					-		
			-	8	-		

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-13
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 10
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 09:30
Time	-			Finish: 3/9/2015 09:45
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: W of cooling tower

Surface Conditions: gravel/grass

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	32"		0.0	1	10"	GW	Loose, moist, brown, c. sandy GRAVEL fill, trace clay - (GW) (10YR 5/3)
			0.0	2	6"	CL	Soft, moist, lt. brownish gray, c-m. sandy CLAY - (CL) (10YR 6/2)
					12"	SP	Dense, moist, white, c. SAND - (SP) (5Y 8/1)
			0.0	3	4"	SP	Dense, Very moist, strong brown, c. SAND - (SP) (7.5YR 5/8)
			-	4		-	
	42"		0.0	5	10"	SP	Dense, Very moist, strong brown, c. SAND - (SP) (7.5YR 5/8)
			0.0	6	4"	CL	Soft, moist, light greenish gray, m-f. sandy CLAY - (CL) (Gley 1-8/10Y)
		H2O Table			10	SW	Soft, wet, light greenish gray, c-m-f. SAND - (SW) (Gley 1-8/10)
			0.0	7	18	SP	Dense, wet, light greenish gray, c. SAND, trace qtz pebble - (SP) (Gley 1-8/10/Y)
			0.0	8			
	46"		0.0	9	18	SP	Dense, wet, white, f. SAND - (SP) (5Y8/1)
			0.0	10	6"	SP	Dense, wet, white, c. SAND with qtz pebble lenses - (SP) (5Y 8/1)
			0.0	11	10"	SP	Dense, wet, white, m. SAND - (SP) (5Y 8/1)
			0.0	12	12"	SP	Dense, wet, white, m. SAND, trace clay - (SP) (5Y 8/1)

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

EA Engineering, Science, and Technology, Inc., PBC

LOG OF SOIL/ROCK BORIN

Job. No. 1482609	Client: DNREC			Location: SPP-DPT-14
Drilling Method: Geoprobe - Direct Push Technology				Boring No. 9
Sampling Method: 4 foot length, Double Tube Cores				Sheet 1 of 1
				Drilling
Water Level				Start: 3/9/2015 09:00
Time	-			Finish: 3/9/2015 09:15
Date				
Reference				

Coordinates:
Surface Elevation:
Casing Below Surface:
Reference Elevation:
Reference Desc: Adjacent to gated entrance

Surface Conditions: Paved

Sample Type	Inches Drvn/In. Recvrd	H2O Table	PID ppm	Depth in Feet		USCS Log	
	38"		1.2	1	13"	GP	Firm, dry, black, asphalt with GRAVEL - (GP) (5Y 2.5/1)
			1.1	2	20"	CH	Soft, moist, light olive brown, high plasticity fat CLAY, trace silt - (CH) (2.5Y 5/3)
			0.2				
			0.3	3	5"	SP	Soft, very moist, light gray, c. SAND - (SP) (5Y 7/1)
			-		-	-	
				4	-		
	24"	H2O Table ?		5	24"	SW	Soft, wet, light gray, c-m. SAND with lenses of qtz pebble - (SW) (5Y7/1)
				6			
					-	-	
				7	-		
					-		
				8	-		
	40"	H2O Table		9	40"	SP	Dense, wet, light gray, c-m. SAND - (SP) (2.5Y 7/2)
				10			
				11			
				12	-	-	

Logged by: Jesse Drummond Date: 03/09/2015

Drilling Contractor: NEPROBE Driller: Rob Mcallister

Appendix C

Groundwater and Wastewater Purge Logs

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-GW-01 SAMPLE NO. SEE COMMENTS

WELL/SITE DESCRIPTION BOARDWALK

DATE 1/20/15 TIME 1100 AIR TEMP. 32°F

WELL DEPTH 12.53 TOC (ft) CASING HEIGHT -0.2 BGS (ft)

WATER DEPTH 3.20 TOC (ft) WELL DIAMETER 2 (in)

WATER COL. HEIGHT 9.33 (ft) SANDPACK DIAM. UNKNOWN ~~in~~

EQUIVALENT VOLUME OF STANDING WATER 1.52 (gal) (L)

PUMP RATE 0.4 LPM (gpm) (LPM)

PUMP TIME DEVELOP 15 MINS @ 1 GPM. LOW-FLOW PURGE 60 MINS @ 0.4 LPM min

WELL WENT DRY? ( ) Yes (X) No ~~PUMP TIME~~ ~~min~~

~~VOL. REMOVED~~ ~~(gal) (L)~~ RECOVERY TIME 40 (min)

PURGE AGAIN? ( ) Yes (X) No ~~TOTAL VOL. REMOVED~~ ~~(gal) (L)~~

Date	Time	Volume Removed Unit: L	pH SU	Cond. uS/cm	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC	Pump Rate mL/m
1-20-15	1110	2.5	6.28	272	12.81	-3.6	47.6	1.77	3.43	500
	1115	4.5	6.15	269	12.83	-3.9	34.4	1.34	3.40	400
	1120	6.5	6.11	273	12.77	-8.2	41.3	0.79	3.42	400
	1125	8.5	6.11	269	12.89	-8.1	25.9	0.62	3.43	400
	1130	10.5	6.10	270	12.86	-8.8	22.8	0.50	3.43	400
	1135	12.5	6.11	267	12.91	-9.3	16.3	0.42	3.44	400
	1140	14.5	6.11	273	12.85	-11.5	28.2	0.35	3.44	400
	1145	16.5	6.13	272	12.98	-11.5	18.3	0.30	3.45	400
	1150	18.5	6.13	271	12.93	-11.7	20.8	0.25	3.45	400
	1155	20.5	6.13	272	12.91	-11.8	19.7	0.22	3.45	400
	1200	22.5	6.13	272	12.90	-11.8	15.3	0.20	3.45	400

COMMENTS SAMPLE TIME 1215 - SPP-GW-01

SPP-GW-01 PARENT OF DUP 01-GW

SPP-GW-01-F PARENT OF DUP 01-GW-F (FILTERED - DISSOLVED METALS)

SIGNATURE

EA Engineering, Science, and Technology, Inc.

Development

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-GW-02 SAMPLE NO. _____

WELL/SITE DESCRIPTION South of Seaford Power Plant

DATE 1/20/15 TIME 0945 AIR TEMP. 40s

WELL DEPTH 9.78 ft CASING HEIGHT flush ft

WATER DEPTH 2.90 ft WELL DIAMETER 4 in

WATER COL. HEIGHT 6.88 ft SANDPACK DIAM. _____ in

EQUIVALENT VOLUME OF STANDING WATER 6.88 (0.653) = 4.49 = 17 (gal) (L)

PUMP RATE 3.0 - 1.5 (gpm) (LPM)

PUMP TIME 35 min

WELL WENT DRY? ( ) Yes (✓) No PUMP TIME 35 min

VOL. REMOVED 15 (gal) (L) RECOVERY TIME — min

PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED 15 (gal) (L)

Date	Time	Volume Removed Unit: L	pH -	Cond. µS/cm³	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC	Pump Rate
1/20/15	0950	3.0	7.15	113	10.07	12.2	340.5	9.70	4.7	3.0
	0955	6.0	7.28	115	10.90	93.1	249.1	6.54	7.2	3.0
	1000	7.5	7.20	118	12.12	42.4	164.1	3.03	7.4	1.5
	1005	9.0	7.09	121	12.56	10.9	212.5	1.86	8.0	
	1010	10.5	7.02	126 ~~130~~	13.57	-5.4	107.0	1.28	8.05	
	1015	12.0	6.97	130	13.92	-13.7	65.6	1.09	8.05	
	1020	13.5	6.93	136	14.21	-25.6	47.3	0.75	7.9	
✓	1025	15.0	6.90	145	14.33	-35.6	35.2	0.64	7.72	✓

COMMENTS dialed backflow due to poor recharge and did not want well to go dry

well development

SIGNATURE _____

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID STP-GW-02 SAMPLE NO.

WELL/SITE DESCRIPTION south of Seafood Power Plant

DATE 1/20/15 TIME 1035 AIR TEMP. 40s

WELL DEPTH 9.78 ft CASING HEIGHT flush ft
WATER DEPTH 2.90 ft WELL DIAMETER 4 in
WATER COL. HEIGHT 6.88 ft SANDPACK DIAM. ___ in
EQUIVALENT VOLUME OF STANDING WATER 17 (gal) (L)
PUMP RATE 0.75 (gpm) (LPM)
PUMP TIME 16 min
WELL WENT DRY? ( ) Yes (✓) No PUMP TIME 16 min
VOL. REMOVED 3.75 (gal) (L) RECOVERY TIME - min
PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED 3.75 (gal) (L)

Date	Time	Volume Removed Unit: L	pH —	Cond. µS/cm³	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC	Pump Rate LPM
1/20/15	1040	0.75	6.94	165	13.52	-5.7	49.8	2.58	6.20	0.75
↓	1044	1.5	6.85	170	13.70	-16.5	38.6	1.49	6.28	↓
	1048	2.25	6.83	174	13.77	-20.3	34.9	1.39	6.30	
	1052	3.0	6.83	178	13.77	-21.8	32.9	1.27	6.31	
↓	1056	3.75	6.83	183	13.77	-21.9	31.7	1.21	6.31	↓

COMMENTS

SIGNATURE

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-GW-03 SAMPLE NO. _____

WELL/SITE DESCRIPTION NW of Seaford Power Plant

DATE 3/10/15 TIME 1530 AIR TEMP. 50s rainy

WELL DEPTH @a 7.84 ft CASING HEIGHT flush ft

WATER DEPTH 2.52 ft WELL DIAMETER 0.75 in

WATER COL. HEIGHT 5.32 ft SANDPACK DIAM. _____ in

EQUIVALENT VOLUME OF STANDING WATER 0.12 gal = 0.45 (gal) (L)

PUMP RATE 0.5 LPM (gpm) (LPM)

PUMP TIME 60 ✓ min

WELL WENT DRY? ( ) Yes (✓) No PUMP TIME 60 min

VOL. REMOVED 32.5 (gal) (L) RECOVERY TIME — min

PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED 32.5 (gal) (L)

Date	Time	Volume Removed Unit: L	pH	Cond. mS/cm	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC*	Pump Rate LPM
3/10/15	1530	0.5	7.82	3166	4.80	-84.8	202.3	8.14	—	0.5
	1554	2.5	7.34	317	4.75	-63.8	188.9	8.43	—	
	1558	4.5	7.26	298	4.72	-55.6	414.4	8.84	—	
	1602	6.5	7.07	292	4.77	-43.4	120.7	9.13	—	
	1606	8.5	6.91	290	4.77	-33.3	87.1	9.09	—	
	1610	10.5	6.77	289	4.77	-27.4	107.3	9.03	—	
	1614	12.5	6.71	288	4.72	-24.3	60.2	8.98	—	
	1618	14.5	6.64	288	4.72	-20.1	75.7	8.94	—	
	1622	16.5	6.49	283	4.74	-11.6	80.7	9.26	—	
	1626	18.5	6.46	286	4.80	-7.5	111.0	12.00	—	
	1630	20.5	6.39	288	4.70	-7.0	124.0	10.49	—	
	1634	22.5	6.30	285	4.68	-2.9	125.6	9.06	—	
	1638	24.5	6.28	284	4.69	-2.1	94.4	8.91	—	

COMMENTS whitish turbidity @ first. Cleared up.

*couldn't measure w/ tubing in well

SIGNATURE _____

EA Engineering, Science, and Technology, Inc.

2 of 2

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-GW-03 SAMPLE NO. _____

WELL/SITE DESCRIPTION NW of Seaford Power Plant

DATE 3/4/05 TIME _____ AIR TEMP. _____

WELL DEPTH _____ ft CASING HEIGHT _____ ft

WATER DEPTH _____ ft WELL DIAMETER _____ in

WATER COL. HEIGHT _____ ft SANDPACK DIAM. _____ in

EQUIVALENT VOLUME OF STANDING WATER _____ (gal) (L)

PUMP RATE _____ (gpm) (LPM)

PUMP TIME _____ min

WELL WENT DRY? ( ) Yes ( ) No PUMP TIME _____ min

VOL. REMOVED _____ (gal) (L) RECOVERY TIME _____ min

PURGE AGAIN? ( )Yes ( ) No TOTAL VOL. REMOVED _____ (gal) (L)

Date	Time	Volume Removed Unit: L	pH —	Cond. mS/L	Temp. °C	ORP mV	Turb. NTU	DO	Depth to Water from TOC*	Pump Rate LPM
3/4/05	1642	26.5	6.22	283	4.68	-0.1	120.6	8.85	—	0.5
	1646	28.5	6.18	283	4.69	1.7	125.1	8.81	—	
	1650	30.5	6.13	283	4.69	3.7	128.1	8.79	—	
	1654	32.5	6.06	283	4.69	5.9	115.0	8.79	—	

COMMENTS _____

SIGNATURE _____

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-GW-04 SAMPLE NO. —

WELL/SITE DESCRIPTION South of Seaford Power Plant by discharge lines

DATE 3/10/15 TIME 0845 AIR TEMP. 50s rainy

WELL DEPTH 7.82 ft CASING HEIGHT flush ft

WATER DEPTH 3.03 ft WELL DIAMETER ~~1~~ ~~0.75~~ 0.75 in

WATER COL. HEIGHT 4.79 ft SANDPACK DIAM. — in

EQUIVALENT VOLUME OF STANDING WATER 0.11 gal = 0.42 (gal) (L)

PUMP RATE 0.25 L per 20 min. (gpm) (LPM)

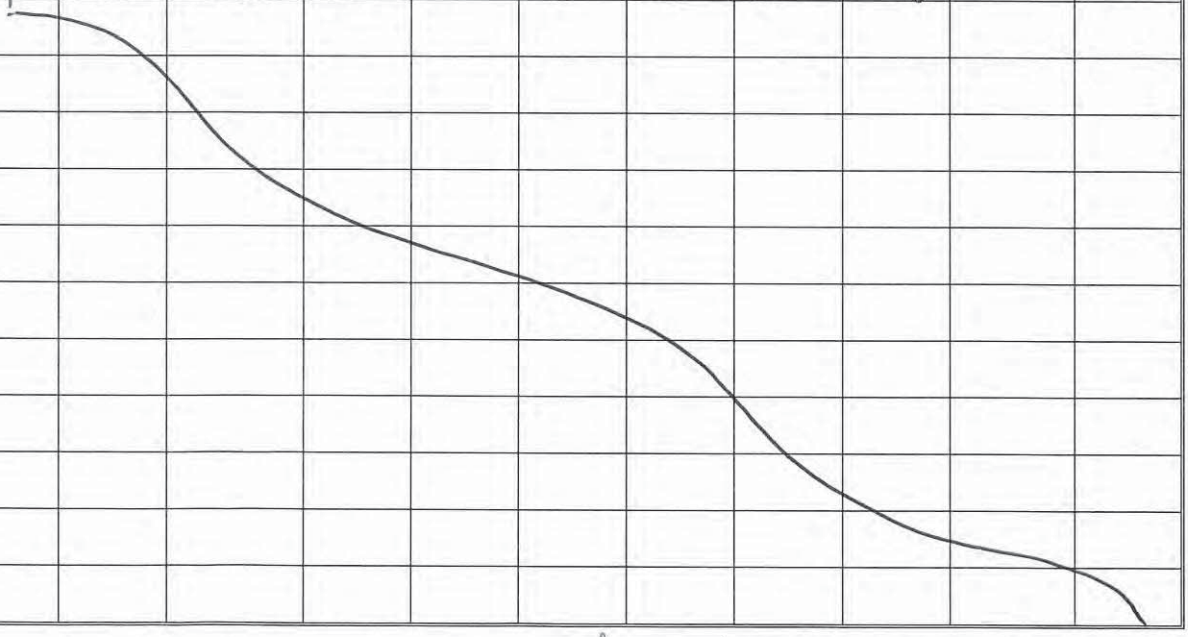
PUMP TIME — min

WELL WENT DRY? ( ) Yes (✓) No PUMP TIME — min

VOL. REMOVED — (gal) (L) RECOVERY TIME — min

PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED — (gal) (L)

Date	Time	Volume Removed Unit: L	pH -	Cond. ms/cm	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC *	Pump Rate NA
3/10/5	0900	—	7.64	547	3.61	-62.6	1640	8.15	—	NA
1	0910	0.25	7.62	247	4.56	-44.5	519	13.58	—	NA



COMMENTS Well barely pumping. Did not develop due to low volume of water output. Odor and stained tubing yellow

*couldn't measure w/ tubing in well

SIGNATURE

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-GW-05 SAMPLE NO. _____

WELL/SITE DESCRIPTION Southeast of Seaford Power Plant by dumpster

DATE 3/10/15 TIME 1400 AIR TEMP. 50s rainy

WELL DEPTH 8.75 ft CASING HEIGHT flush ft

WATER DEPTH 3.60 ft WELL DIAMETER 0.75 in

WATER COL. HEIGHT 5.95 ft SANDPACK DIAM. _____ in

EQUIVALENT VOLUME OF STANDING WATER 0.14 gal. = 0.53 (gal) (L)

PUMP RATE 0.5 LPM (gpm) (LPM)

PUMP TIME 46 min

WELL WENT DRY? ( ) Yes (✓) No PUMP TIME 46 min

VOL. REMOVED 24.5 (gal) (L) RECOVERY TIME _____ min

PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED 24.5 (gal) (L)

Date	Time	Volume Removed Unit: L	pH —	Cond. mS/cm	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC	Pump Rate LPM
3/10/15	1426	0.5	8.88	1078	6.04	-114.6	159.5	7.00	—	0.5
	1430	2.5	8.70	1022	6.41	-111.1	120.0	14.82	—	
	1434	4.5	8.64	996	6.38	-109.3	60.3	17.38	—	
	1438	6.5	8.50	986	6.44	-108.1	64.6	18.22	—	
	1442	8.5	8.45	978	6.37	-110.4	43.2	14.88	—	
	1446	10.5	8.36	964	6.32	-111.0	45.6	14.29	—	
	1450	12.5	8.31	956	6.35	-112.0	45.8	14.62	—	
	1452	14.5	8.28	949	6.31	-112.5	42.1	14.74	—	
	1456	16.5	8.23	941	6.34	-112.6	43.4	14.51	—	
	1500	18.5	8.14	928	6.28	-110.1	48.7	14.90	—	
	1504	20.5	8.09	922	6.31	-109.4	47.6	14.56	—	
	1508	22.5	8.07	914	6.28	-110.5	43.8	13.63	—	
	1512	24.5	8.06	908	6.31	-111.7	40.9	13.32	—	

COMMENTS Very dark greyish black turbidity. Cleared up in ~10-15 min.

*Couldn't measure w/ tubing in well

SIGNATURE _____

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-WW-01 SAMPLE NO. _____

WELL/SITE DESCRIPTION West discharge pipe/cleanout

DATE 1/20/15 TIME 1230 AIR TEMP. 40s

WELL DEPTH 6.05 ft CASING HEIGHT - ft

WATER DEPTH 4.55 ft WELL DIAMETER - in

WATER COL. HEIGHT 1.5 ft SANDPACK DIAM. _____ in

EQUIVALENT VOLUME OF STANDING WATER _____ (gal) (L)

PUMP RATE 0.75 (gpm) (LPM)

PUMP TIME - min

WELL WENT DRY? ( ) Yes (✓) No PUMP TIME - min

VOL. REMOVED N/A (gal) (L) RECOVERY TIME - min

PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED - (gal) (L)

Date	Time	Volume Removed Unit: L	pH -	Cond. uS/cm3	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC	Pump Rate LPM
1/20/15	1245	-	7.18	480	11.49	-62.1	324.7	1.18	-	0.75
↓	1303	-	7.31	475	10.98	-76.8	55.7	1.74	-	1

COMMENTS Sampled at 1250; slight sheen, slight odor; 0.2 ppm

Good recharge, did not go dry

SIGNATURE _____

EA Engineering, Science, and Technology, Inc.

WELL PURGING AND SAMPLING RECORD

WELL ID SPP-WW-02 SAMPLE NO. _____

WELL/SITE DESCRIPTION east discharge pipe/cleanout

DATE 1/20/15 TIME 1150 AIR TEMP. 40s

WELL DEPTH 5.45 ft CASING HEIGHT – ft

WATER DEPTH 2.40 ft WELL DIAMETER – in

WATER COL. HEIGHT 3.05 ft SANDPACK DIAM. – in

EQUIVALENT VOLUME OF STANDING WATER _____ (gal) (L)

PUMP RATE 0.75 (gpm) (LPM)

PUMP TIME – min

WELL WENT DRY? ( ) Yes (✓) No PUMP TIME – min

VOL. REMOVED – (gal) (L) RECOVERY TIME – min

PURGE AGAIN? ( ) Yes (✓) No TOTAL VOL. REMOVED – (gal) (L)

Date	Time	Volume Removed Unit:	pH –	Cond. µS/cm³	Temp. °C	ORP mV	Turb. NTU	DO mg/L	Depth to Water from TOC	Pump Rate LPM
1/20/15	1155	–	7.34	.74	11.45	-73.3	297.1	0.85	–	0.75
"	1220	–	7.07	.61	9.97	-3.3	27.5	1.83	–	"

COMMENTS 0.2ppm Sampled @1200
odor, oily sheen
Good recharge, did not go dry

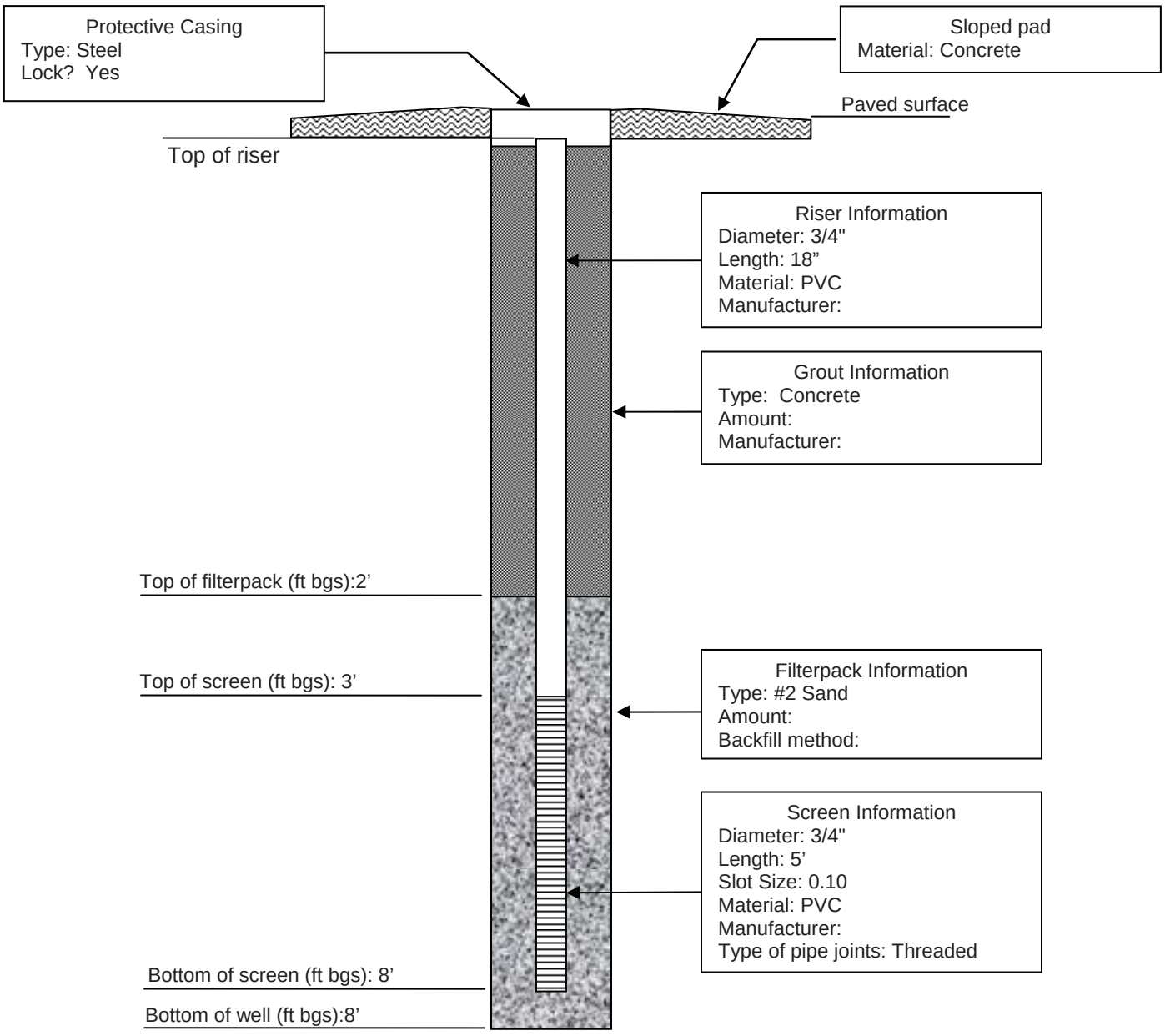
SIGNATURE

Appendix D

Well Construction Logs

RECORD OF MONITORING WELL CONSTRUCTION
(FLUSH MOUNT)

EA Engineering, Science, and Technology, Inc., PBC	Monitoring Well/Soil Boring ID No.: SPP-GW-03
Project Title/ Project No.: Seaford Power Plant 1482609	Date/Time Installed: 3/9/2015 Time Finished: 16:30
Location: 200 South Pine St., Seaford, DE	Depth to Water: EST 4' BGS
Site Geologist: Jesse Drummond (EA)	Drilling Method: Geoprobe-DPT

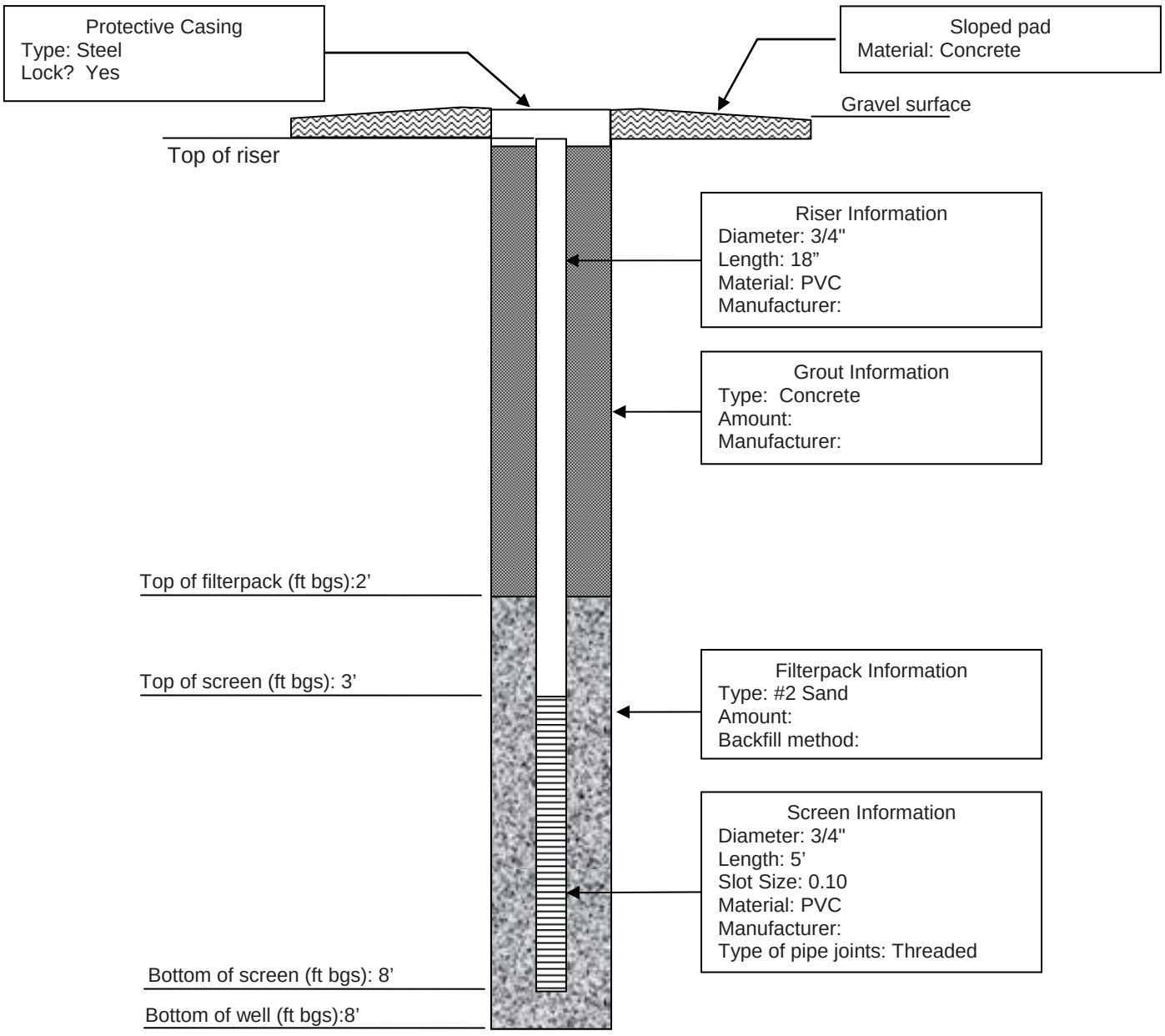


Note: All features not to scale

ags – Above Ground Surface
bgs – Below Ground Surface

RECORD OF MONITORING WELL CONSTRUCTION
(FLUSH MOUNT)

EA Engineering, Science, and Technology, Inc., PBC	Monitoring Well/Soil Boring ID No.: SPP-GW-04
Project Title/ Project No.: Seaford Power Plant 1482609	Date/Time Installed: 3/5/2015 Time Finished: 15:15
Location: 200 South Pine St., Seaford, DE	Depth to Water: EST 4.5' BGS
Site Geologist: Jesse Drummond (EA)	Drilling Method: Geoprobe-DPT

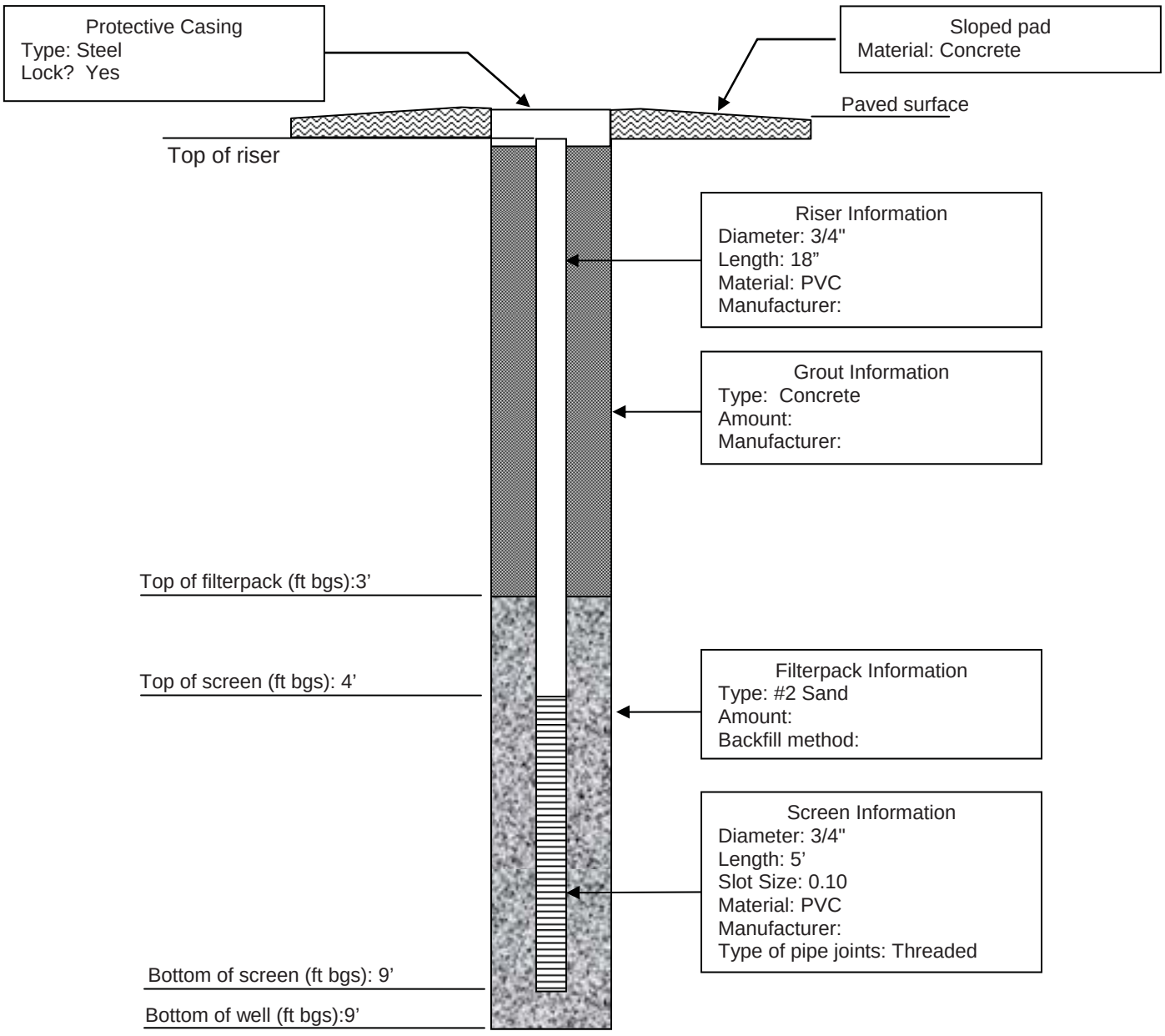


Note: All features not to scale

ags – Above Ground Surface
bgs – Below Ground Surface

RECORD OF MONITORING WELL CONSTRUCTION
(FLUSH MOUNT)

EA Engineering, Science, and Technology, Inc., PBC	Monitoring Well/Soil Boring ID No.: SPP-GW-05
Project Title/ Project No.: Seaford Power Plant 1482609	Date/Time Installed: 3/5/2015 Time Finished: 16:00
Location: 200 South Pine St., Seaford, DE	Depth to Water: EST 4.5' BGS
Site Geologist: Jesse Drummond (EA)	Drilling Method: Geoprobe-DPT



Note: All features not to scale

ags – Above Ground Surface
bgs – Below Ground Surface

Appendix E

DNREC-SIRS New Castle Laboratory Screening Results

Sample Name	VOC's	Analyte Result
SL-1	Low GRO	
SL-2	GRO	

:\RMS\Templates\FieldScreeningAnalysisSummary.xls

Purchasing Divison
2019 Washington Street East
Post Office Box 50130
Charleston, WV 25305-0130

State of West Virginia
Request for Quotation
10 — Consulting

Proc Folder: 96715

Doc Description: Addendum 02 Open-end Environmental Risk Assessment

Proc Type: Central Master Agreement

Date Issued	Solicitation Closes	Solicitation No	Version
2016-03-01	2016-03-24 13:30:00	CRFQ 0313 DEP1600000047	3

BID RECEIVING LOCATION

BID CLERK
DEPARTMENT OF ADMINISTRATION
PURCHASING DIVISION
2019 WASHINGTON ST E
CHARLESTON WV 25305
US

VENDOR

Vendor Name, Address and Telephone Number:

EA Engineering, Science, and Technology, Inc., PBC
225 Schilling Circle, Suite 400
Hunt Valley, MD 21031-1800
410-584-7000

FOR INFORMATION CONTACT THE BUYER

Beth Collins
(304) 558-2157
beth.a.collins@wv.gov

Signature X [signature] FEIN # 52-0991911 DATE March 24, 2016

All offers subject to all terms and conditions contained in this solicitation

ADDITIONAL INFORMAITON:

Addendum No. 02
This addendum is issued to modify the solicitation per the attached documentation and the following:
1. To correct the buyer contact error. The Buyer contact should be:
Beth A. Collins, Senior Buyer at 304-558-2157 email: beth.a.collins@wv.gov
The bid opening date will remain March 24, 2016 at 1:30 PM, EST.

No other changes.

Addendum No. 01
This addendum is issued to modify the solicitation per the attached documentation and the following:
1. To publish answers to vendor submitted questions.
The bid opening date will not change and will remains as March 24, 2016 at 1:30 PM, EST
No other changes.

CRFQ
THE WEST VIRGINIA STATE PURCHASING DIVISION FOR THE AGENCY, THE WEST VIRGINIA DEPARTMENT OF ENVIRONMENTAL PROTECTION, IS SOLICITING BIDS FOR AN OPEN END CONTRACT FOR ENVIRONMENTAL RISK ASSESSOR, PER THE ATTACHED SPECIFICATIONS AND DOCUMENTATION.

INVOICE TO	SHIP TO
ENVIRONMENTAL PROTECTION OFFICE OF ENVIRONMENTAL REMEDIATION 601 57TH ST SE CHARLESTON WV25304 US	ENVIRONMENTAL PROTECTION 601 57TH ST CHARLESTON WV 25304 US

Line	Comm Ln Desc	Qty	Unit Issue	Unit Price	Total Price
1	Risk or hazard assessment	700.00000	HOUR	$128.78	$90,146.00

Comm Code	Manufacturer	Specification	Model #
77101501			

Extended Description :
Environmental Risk Assessor

SCHEDULE OF EVENTS

Line	Event	Event Date
1	Tech Question Deadline at 5:00 PM, EST	2016-03-04

ADDITIONAL TERMS AND CONDITIONS

See attached document(s) for additional Terms and Conditions

CERTIFICATION AND SIGNATURE PAGE

By signing below, or submitting documentation through wvOASIS, I certify that I have reviewed this Solicitation in its entirety; that I understand the requirements, terms and conditions, and other information contained herein; that this bid, offer or proposal constitutes an offer to the State that cannot be unilaterally withdrawn; that the product or service proposed meets the mandatory requirements contained in the Solicitation for that product or service, unless otherwise stated herein; that the Vendor accepts the terms and conditions contained in the Solicitation, unless otherwise stated herein; that I am submitting this bid, offer or proposal for review and consideration; that I am authorized by the vendor to execute and submit this bid, offer, or proposal, or any documents related thereto on vendor's behalf; that I am authorized to bind the vendor in a contractual relationship; and that to the best of my knowledge, the vendor has properly registered with any State agency that may require registration.

EA Engineering, Science, and Technology, Inc., PBC
(Company)


Jeffrey Boltz, Vice President
(Authorized Signature) (Representative Name, Title)

Phone: (410) 584-7000; Fax: (410)771-1625; March 24, 2016
(Phone Number) (Fax Number) (Date)

ADDENDUM ACKNOWLEDGEMENT FORM
SOLICITATION NO.: DEP1600000047

Instructions: Please acknowledge receipt of all addenda issued with this solicitation by completing this addendum acknowledgment form. Check the box next to each addendum received and sign below. Failure to acknowledge addenda may result in bid disqualification.

Acknowledgment: I hereby acknowledge receipt of the following addenda and have made the necessary revisions to my proposal, plans and/or specification, etc.

Addendum Numbers Received:
(Check the box next to each addendum received)

[X]	Addendum No. 1	[ ]	Addendum No. 6
[X]	Addendum No. 2	[ ]	Addendum No. 7
[ ]	Addendum No. 3	[ ]	Addendum No. 8
[ ]	Addendum No. 4	[ ]	Addendum No. 9
[ ]	Addendum No. 5	[ ]	Addendum No. 10

I understand that failure to confirm the receipt of addenda may be cause for rejection of this bid. I further understand that any verbal representation made or assumed to be made during any oral discussion held between Vendor's representatives and any state personnel is not binding. Only the information issued in writing and added to the specifications by an official addendum is binding.

EA Engineering, Science, and Technology, Inc., PBC

Company

Authorized Signature

March 24, 2016

Date

NOTE: This addendum acknowledgement should be submitted with the bid to expedite document processing.

RFQ No. DEP1600000047

STATE OF WEST VIRGINIA
Purchasing Division

PURCHASING AFFIDAVIT

MANDATE: Under W. Va. Code §5A-3-10a, no contract or renewal of any contract may be awarded by the state or any of its political subdivisions to any vendor or prospective vendor when the vendor or prospective vendor or a related party to the vendor or prospective vendor is a debtor and: (1) the debt owed is an amount greater than one thousand dollars in the aggregate; or (2) the debtor is in employer default.

EXCEPTION: The prohibition listed above does not apply where a vendor has contested any tax administered pursuant to chapter eleven of the W. Va. Code, workers' compensation premium, permit fee or environmental fee or assessment and the matter has not become final or where the vendor has entered into a payment plan or agreement and the vendor is not in default of any of the provisions of such plan or agreement.

DEFINITIONS:

"Debt" means any assessment, premium, penalty, fine, tax or other amount of money owed to the state or any of its political subdivisions because of a judgment, fine, permit violation, license assessment, defaulted workers' compensation premium, penalty or other assessment presently delinquent or due and required to be paid to the state or any of its political subdivisions, including any interest or additional penalties accrued thereon.

"Employer default" means having an outstanding balance or liability to the old fund or to the uninsured employers' fund or being in policy default, as defined in W. Va. Code § 23-2c-2, failure to maintain mandatory workers' compensation coverage, or failure to fully meet its obligations as a workers' compensation self-insured employer. An employer is not in employer default if it has entered into a repayment agreement with the Insurance Commissioner and remains in compliance with the obligations under the repayment agreement.

"Related party" means a party, whether an individual, corporation, partnership, association, limited liability company or any other form or business association or other entity whatsoever, related to any vendor by blood, marriage, ownership or contract through which the party has a relationship of ownership or other interest with the vendor so that the party will actually or by effect receive or control a portion of the benefit, profit or other consideration from performance of a vendor contract with the party receiving an amount that meets or exceed five percent of the total contract amount.

AFFIRMATION: By signing this form, the vendor's authorized signer affirms and acknowledges under penalty of law for false swearing (*W. Va. Code* §61-5-3) that neither vendor nor any related party owe a debt as defined above and that neither vendor nor any related party are in employer default as defined above, unless the debt or employer default is permitted under the exception above.

WITNESS THE FOLLOWING SIGNATURE:

Vendor's Name: EA Engineering, Science, and Technology, Inc., PBC

Authorized Signature: _____ Date: March 24, 2016

State of Maryland

County of Baltimore, to-wit:

Taken, subscribed, and sworn to before me this 24 day of March, 2016.

My Commission expires July 09, 2019.

AFFIX SEAL HERE

SANDRA M. REDIFER NOTARY PUBLIC CARROLL COUNTY, MD

NOTARY PUBLIC Sandra M Redifer

EA Engineering, Science, and Technology, Inc., PBC (EA) is pleased to submit this proposal in response to Solicitation No. CRFQ 0313 DEP1600000047: Open-End Contract for Environmental Risk Assessor. Per the Request for Quotation, our proposal is included in our WVOasis submission and includes resumes and qualifications for environmental risk assessment personnel (Attachment A), pricing (Attachment B), and an example risk assessment document (Attachment C). We look forward to the chance to work with the state of West Virginia Department of Environmental Protection.