DELAWARE RIVER

Main Channel Deepening Project

General Conformity Analysis and Mitigation Report

November, 2009

Prepared for
U.S. Army Corps of Engineers
Philadelphia District
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List of Acronyms

ADEC - Airfield Development Engineering Consultant

CARB – California Air Resources Board

CEDEP – Corps of Engineers Dredge Estimating Program

EPA – U.S. Environmental Protection Agency

EF – Emission Factor

ER – Emission Rate

ERC – Emission Reduction Credit

LAER – Lowest Achievable Emission Rate

LF – Load Factor

M&N – Moffatt & Nichol

MLW – Mean Low Water

NAAQS – National Ambient Air Quality Standards

NMHC – Non-Methane Hydrocarbons

NMOG – Non-Methane Organic Gases

NSR – New Source Review

OMET – Open Market Emissions Trading

OTC – Ozone Transport Commission

PAMT – Packer Avenue Marine Terminal

PANYNJ – Port Authority of New York and New Jersey

PRPA – Philadelphia Regional Port Authority

SCR – Selective Catalytic Reduction

SFO – San Francisco International Airport

SIP – State Implementation Plan

TEU – Twenty-foot Equivalent Unit

THC – Total Hydrocarbons

TOG – Total Organic Gases

USACE – U.S. Army Corps of Engineers

VOC – Volatile Organic Compounds

EXECUTIVE SUMMARY

In February 2004, the Philadelphia District of the U.S. Army Corps of Engineers (USACE) completed a report titled "Delaware River Main Channel Deepening Project, General Conformity Analysis and Mitigation Report." A new air conformity analysis is needed because more than five years elapsed and two changes to the project and project area occurred since the completion of that report. The two changes were a decrease in estimated dredging quantities and a change in the air quality attainment status of the area.

Technologically advanced preconstruction survey techniques were used to determine that dredged material quantities previously estimated at 26 million cubic yards are now estimated to be 16 million cubic yards; therefore, the project no longer requires construction of three new disposal sites (15D, 15G and Raccoon Island). Likewise, the Egg Island Point wetland restoration is being deferred until sufficient dredged material quantities are available to support its construction.

In 2004, all ten of the counties affected by the project were in either severe or moderate non-attainment for ozone (precursors are VOCs and NOx). Two of the counties were in designated maintenance areas for CO. By 2009, all ten of the counties affected by the project were in moderate non-attainment for ozone and all ten were in attainment for CO. In April of 2005, the EPA introduced a new standard for PM2.5. For 2009, five counties in the project area were in non-attainment for PM2.5.

In response to these changes, the USACE retained Moffatt & Nichol (M&N) in 2009 to conduct a new General Conformity Analysis.

The authorized Delaware River Main Channel Deepening Project (project) provides for modifying the existing Delaware River Federal Navigation Channel from -40 feet to -45 feet mean low water (MLW) with an allowable overdepth of one foot. The project follows the existing channel alignment from the Ports of Camden, New Jersey and Philadelphia, Pennsylvania south to the mouth of Delaware Bay. The existing channel width is 400 feet in Philadelphia Harbor for a length of 2.5 miles; 800 feet wide from the Philadelphia Naval Yard to Bombay Hook for a length of 55.7 miles; and, 1000 feet wide from Bombay Hook to the mouth of Delaware Bay for a length of 44.3 miles. The project includes 12 bend widenings at various ranges as well as provision of a two space anchorage to a depth of 45 feet at Marcus Hook, Pennsylvania.

The project's navigation benefits from the channel deepening are based upon transportation cost savings. A deeper channel will allow vessels to more efficiently apportion vessel operating costs over the same magnitude of tonnage. The largest vessels in the fleet, crude oil tankers that currently lighter, will continue to carry the same amount of imported crude oil to the Big Stone Beach Anchorage in the lower Delaware Bay. The Coast Guard allowance for sailing drafts of the tankers into the anchorage is 55 feet. Lightering requirements will be reduced for these large tankers with the channel deepening, which will also lessen the number of tug and barge trips required to carry lightered crude oil to the benefiting refineries upriver. A deeper channel will also allow other tankers, dry bulk, and container vessels to carry cargo more efficiently, as well as allow for the more effective use of the vessel charter market. The future volume of cargo passing through the Delaware River port system is determined by macroeconomic factors that are not affected by the channel depth. Therefore, there is no induced tonnage as a result of the deepening project.

The dredged material disposal plan for the riverine portion of the project will only utilize the existing Federal sites, which include: National Park, Oldmans, Pedricktown North, Pedricktown South, Penns

Neck, Killcohook, Reedy Point South, and Artificial Island. The Fort Mifflin site in Philadelphia will also be used for disposal of rock removed in the vicinity of Marcus Hook, Pennsylvania. Material dredged from Delaware Bay will be beneficially used for wetland restoration at Kelly Island, Delaware and for direct beach nourishment at Broadkill Beach, Delaware.

The purpose of the study was to estimate the air emissions generated by the equipment that will be used to construct the project and to evaluate the applicability of, and potential methods for complying with, the General Conformity requirements of the Clean Air Act. Detailed emission estimates were developed based on the latest USACE construction estimates. These estimates included equipment types, installed horsepower and work durations for dredging as well as land based disposal area equipment. Emission factors and load factors were developed based on the latest guidance as well as an understanding of typical engine types in the existing industry fleet. A variety of potential mitigation alternatives were evaluated for feasibility and cost-effectiveness. These included both on-site measures as well as off-site air emission reduction projects that could be used to offset the project emissions on an annual basis.

Emission Estimate Results

The first step in the conformity analysis was to compare the annual project emissions of criteria pollutants to the de minimis threshold for each pollutant. In the case where the emissions are below the de minimis threshold, the project is exempt from General Conformity. The resulting annual emissions are shown in Table ES-1. Because the entire area is in attainment of the PM10 and CO standards, General Conformity does not apply to those pollutants and there is no need to compare them to a de minimis threshold. The project area is in non-attainment of ozone, however. The de minimis levels for ozone precursors, NOx and VOCs, are 100 and 50 tons per year, respectively. The area is also in non-attainment for the fine particulate standard (PM2.5). The de minimis level for PM2.5 is 100 tons per year. The de minimis level for each of its precursors, NOx, VOCs, and SOx, is 100 tons per year.

Table ES-1: Summary of Annual Emissions for Each Criteria Pollutant

Calendar Year Emissions - tons						
De Minimis Level (tpy)	100	50	100		100	100
	NOx	VOCs	PM2.5	PM10	CO	SO2
2010	510.5	18.3	7.1	7.5	69.2	2.8
2011	513.1	19.3	8.2	8.8	59.0	1.5
2012	443.4	17.6	7.8	8.4	47.7	0.7
2013	539.8	22.3	10.3	11.1	61.9	1.1
2014	607.2	23.0	9.6	10.3	73.0	0.7
2015	423.7	15.1	6.1	6.5	56.6	0.6
Total Project	3,037.7	115.6	49.1	52.5	367.4	7.4

The only criteria pollutant for which the project exceeds the de minimis level is NOx (as a precursor to ozone). Hence, General Conformity applies in regard to the emission of NOx. Annual NOx emissions range from a low of roughly 424 tons to a high of roughly 607 tons. Every calendar year is higher than the de minimis level of 100 tons per year.

Comparison of Emission Estimate Results to 2004 Report

The total project NOx emissions per the current analysis are only slightly less than the total project NOx emissions estimated in 2004 (3,038 tons in current study vs. 3,290 tons in 2004). The marine equipment emissions for the channel deepening only (not including berth deepenings or landside emissions), is 2,859 tons of NOx. In 2004, the marine emissions associated with the channel deepening were 3,083 tons of NOx. This 8% decrease in marine NOx emissions from 2004 to the current study is surprising given that the quantities to be dredged for the channel deepening were reduced from the 2004 project by nearly 40%. The emission rate per 10,000 cubic yards of dredging increased from 1.2 tons per 10,000 cubic yards of dredging in 2004 to nearly 1.8 tons per 10,000 cubic yards of dredging in the current study.

The 50% increase in NOx emissions per volume of dredging is due to a combination of factors. The largest reason for the difference is that the NOx emission factors used in the current study are 24% to 56% higher than those used in 2004. The 2004 study did not make distinctions among the types of engines that are used in the different kinds of dredges; all dredge types used the same emission factor. According to the latest literature, hopper dredge engines are most similar to medium speed ocean-going vessel auxiliary engines and cutter suction and booster pump engines are generally older locomotive style engines. The emission factors were adjusted accordingly.

In addition, the construction plan shifted to higher horsepower dredging. For example, the volume of work to be performed by a cutter suction dredge using two booster pumps increased by nearly 60%. This increased the emissions per volume of dredging because boosters are a significant source of emissions. The overall production rate per dredge working month also dropped in the current project. In 2004, the overall production rate of the dredging was roughly 435,000 cubic yards per dredge-month. The current project has an overall production rate of approximately 375,000 cubic yards per dredge-month. This 15% decrease in production increases the emissions per volume of material dredged.

Offsetting some of these increases are decreases in the clamshell dredge emission rates and changes to the assumed load factors. The net result is a 50% increase in the rate of emissions per volume of dredging. After factoring in the reduced volume, the net result is a slight reduction in total tons of NOx generated by the project as compared to the 2004 study. Other pollutants also varied from the 2004 study. Most notably, SOx emissions dropped dramatically with the advent of much lower sulfur level standards in fuel.

Mitigation Alternatives Analysis

Various strategies for offsetting the project NOx emissions were identified for this study. Some of the strategies targeted emissions coming directly from the equipment working on the project; these are called “on-site” measures. Other strategies looked at engine emissions that are not part of this deepening project, but that occur within the project area; these are called “off-site” measures. One of the off-site measures involved the USACE’s hopper dredge McFarland. This is a dredge that performs annual maintenance dredging within the project airshed. The work done by the McFarland is not associated with the project.

The goal of mitigation alternatives analysis was to calculate a value for the cost-effectiveness (in dollars per ton of NOx reduced per year) of each proposed strategy as well as to evaluate the capacity of each strategy to offset the project emissions in total tons per year.

The following mitigation strategies were studied.

On-site Mitigation:

1. Electrify dredge equipment
2. Install selective catalytic reduction (SCR) units on dredge equipment
3. Repower dredge equipment

Off-site Mitigation:

4. USACE Hopper Dredge McFarland
    a. Installing SCRs
    b. Repowering
    c. Repowering *and* installing SCRs
5. Cape May-Lewes ferries
    a. Installing SCRs
    b. Repowering
    c. Repowering *and* installing SCRs
6. Repowering local tug boats
7. Cold ironing (providing electric power to ships at berth, allowing auxiliary engines to be shut down)
    a. Packer Ave
    b. Pier 82
8. Electrifying diesel container cranes at Philadelphia Regional Port Authority (PRPA) facilities
9. Purchasing Emission Reduction Credits (ERCs)

For each strategy, the unmitigated and mitigated annual NOx emissions were calculated. Subtracting those values yields the tons of NOx reduced per year. The NOx emissions for the off-site strategies are simple because they are the same every year. However, for on-site measures (#1 – 3 above), the NOx emissions and reductions are different from year to year. For these strategies, the annual NOx reduction used to calculate cost effectiveness was the reduction in *project peak annual emissions*.

This is best explained by example. Electrification of dredges is used here for illustration. The peak NOx emissions for the unmitigated project occurs in 2014 (607 tons). The year 2014 NOx emissions after electrification were 244 tons. The reduction achieved in the year of maximum NOx emissions, or "Maximum Annual Reduction," for this strategy is (607 – 244) = 363 tons. However, the peak NOx emissions after electrification occurs in 2013 (455 tons). The "Peak Annual NOx Reduction" for this strategy is (607 – 455) = 152 tons. The lower of the two values is used to address the fact that electrification does not achieve a 363 ton reduction every year. This method only gives NOx reduction credit for the reduction in the project's peak year emissions.

Each of the mitigations strategies studied was determined to be technically feasible. Cost estimates for each strategy were developed. The cost for the purchase of emission reduction credits was based on discussion with ERC brokers regarding recent market prices.

Dividing the cost for the strategy by the NOx reductions for a single year (or reduction of peak emissions in the case of the on-site measures) gives a cost-effectiveness value that can be used to compare all of the emission reduction strategies under consideration. Figure ES-1 shows the cost-effectiveness of each strategy graphically.

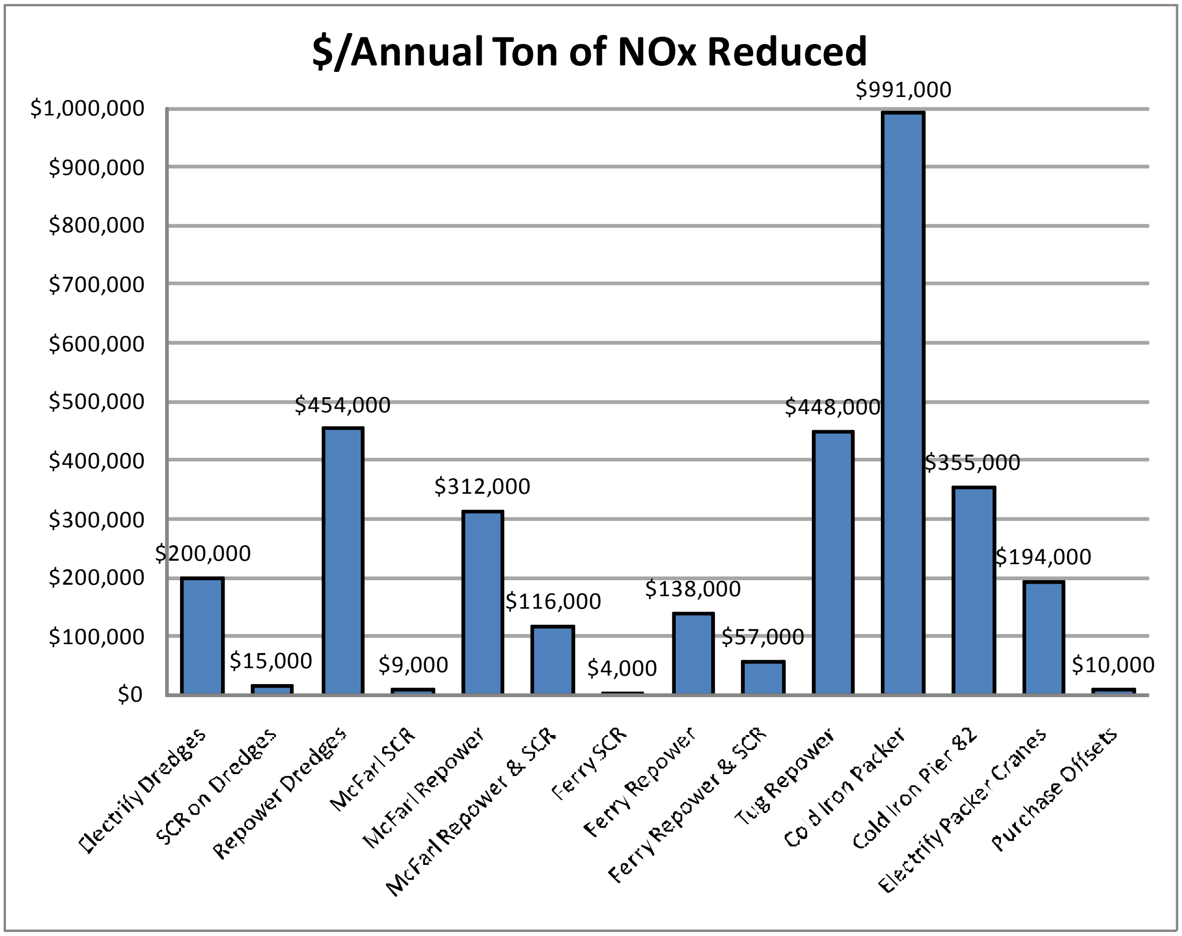

Figure ES-1: Cost Effectiveness of Each Strategy

Conclusions

The total direct[1] (channel deepening) and indirect[2] (berth deepening) NOx emissions were estimated to be 3,038 tons over the life of the project with a peak year of 607 tons in 2014. Based on a detailed evaluation of the emissions, a conformity determination is required for NOx emissions. Therefore, conformity must be demonstrated by one of the following options:

1. Demonstrating that the total direct and indirect emissions are specifically identified and accounted for in the applicable SIP.

[1] Direct emissions are emissions of a criteria pollutant or its precursors that are caused or initiated by the Federal action and occur at the same time and place as the action.

[2] Indirect emissions are emissions of a criteria pollutant or its precursors that: (1) are caused by the federal action, but may occur later in time and/or may be further removed in distance from the action itself but are still reasonably foreseeable; and (2) the federal agency can practically control or will maintain control over due to the controlling program responsibility of the federal action.

2. Obtaining a written statement from the state or local agency responsible for the SIP documenting that the total direct and total indirect emissions from the action along with all other emissions in the area will not exceed the SIP emission budget.

3. Obtaining a written commitment from the state to revise the SIP to include the emissions from the action.

4. Obtaining a statement from the metropolitan planning organization for the area documenting that any on-road motor vehicle emissions are included in the current regional emission analysis for the area's transportation plan or transportation improvement program.

5. Fully offseting the total direct and indirect emissions by reducing emissions of the same pollutant or precursor in the same non-attainment or maintenance area.

6. Where appropriate, in accordance with 40 CFR 51.858(4), conduct air quality modeling that can demonstrate that the emissions will not cause or contribute to new violations of the standards, or increase the frequency or severity of any existing violations of the standards.

Option 5, fully offsetting the NOx emissions, is the most appropriate option for this project. Based on the analyses conducted and the evaluation of potential mitigation strategies, the purchasing of perpetual multi-year emission reduction credits is the preferred plan. This plan is implementable and is the least costly and most efficient way to fully offset NOx emissions and attain conformity for the project.

General Conformity Strategy

Project NOx emissions must be offset to zero to demonstrate General Conformity. As such, emission reduction credits (ERCs) will be purchased from within the non-attainment areas. Presently, there are roughly 2,000 tons of NOx credits available on the open market within the 10-county non-attainment area across the three states in which the project is located. All of the required credits for the project (607 tons) will be acquired after issuance of the Final Statement of Conformity and prior to the commencement of construction. Credits will be obtained from the three states on an equitable basis to the maximum extent practicable; however, the actual allocation of credits will be based on availability and cost.

The non-Federal Sponsor for this project, the Philadelphia Regional Port Authority (PRPA), has entered into a brokerage agreement with Cantor CO2e, a firm that specializes in ERC trading. A copy of the brokerage agreement is provided as Appendix G to this report. The PRPA will acquire the credits as part of their cost sharing obligations on this project.

In the event that some of the credits purchased have expirations, additional credits will be obtained prior to the expiration date so that at no time will there be net NOx emission increases. All required credits will be in place prior to the start of construction on the project.

1. INTRODUCTION

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1.1 Background

The authorized Delaware River Main Channel Deepening Project (project) provides for modifying the existing Delaware River Federal Navigation Channel from -40 feet to -45 feet mean low water (MLW) with an allowable overdepth of one foot. The project follows the existing channel alignment from the Ports of Camden, New Jersey and Philadelphia, Pennsylvania south to the mouth of Delaware Bay. The existing channel width is 400 feet in Philadelphia Harbor for a length of 2.5 miles; 800 feet wide from the Philadelphia Naval Yard to Bombay Hook for a length of 55.7 miles; and, 1000 feet wide from Bombay Hook to the mouth of Delaware Bay for a length of 44.3 miles. The project includes 12 bend widenings at various ranges as well as provision of a two space anchorage to a depth of 45 feet at Marcus Hook, Pennsylvania.

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Several berths at various oil refineries and port facilities along the Delaware River will also be deepened; however, they are not part of the Federal project. The costs of the berth deepenings will be borne by the facility owners and are not part of the project costs. However, based on recommendation from the Environmental Protection Agency (EPA) the emissions from the berth deepenings were included as part of the General Conformity analysis as indirect emissions. Subsequent maintenance dredging of the channel and berths is not included in the General Conformity Analysis because maintenance dredging is specifically exempt[3] from General Conformity.

The definitions of total direct and indirect emissions for conformity determination distinguish emissions by timing and location rather than the type of emission source. Direct emissions occur at the same time and place as the Federal action. Indirect emissions include those that may occur later in time or at a distance from the Federal action. In addition, the conformity rule limits the scope of indirect emissions to those that can be quantified and are reasonably foreseeable by the Federal agency and those which the Federal agency can practicably control through its continuing program responsibility.

1.2 Purpose

The purpose of the study was to estimate the air emissions generated by the equipment that will be used to construct the project and to evaluate the applicability of, and potential methods for complying with, the General Conformity requirements of the Clean Air Act. Detailed emission estimates were developed based on the latest USACE construction estimates. These estimates included equipment types, installed horsepower and work durations for dredging as well as land based disposal area equipment. Emission factors and load factors were developed based on the latest guidance as well as an understanding of typical engine types in the existing industry fleet. A variety of potential mitigation alternatives were evaluated for feasibility and cost-effectiveness. These included both on-site measures as well as off-site emission reduction projects that could be used to offset the project emissions on an annual basis. Off-site emission reduction can be implemented in many different ways. In this context, “off-site” refers to methods that are not directly involved in construction of the project; however, all methods evaluated will take place in the project non-attainment area (i.e. Delaware River/Bay from Philadelphia to the sea) where the emissions are generated.

1.3 Federal Clean Air Act

As part of the Clean Air Act, the Code of Federal Regulations Title 40, Part 50 (40 CFR 50) establishes the overall regulations that specify the allowable concentrations of certain pollutants in the atmosphere. These standards are known as the National Ambient Air Quality Standards (NAAQS)[4].

[3] 40 CFR Part 93, 93.153 c (2) ix

[4] United State Environmental Protection Agency Code of Federal Regulations Title 40, Part 50 (40 CFR 50) – National Primary & Secondary Ambient Air Quality Standards; revised July 1, 2008. ttp://www/access.gpo.gov/nara/cfr/waisidx_08/40crf50_08.html

The EPA's Office of Air Quality Planning and Standards has set, and periodically revises, NAAQS for six principal pollutants. These are called "criteria" pollutants. They are carbon monoxide (CO), nitrogen dioxide (NOx), ozone, lead (Pb), particulates (PM2.5 and PM10), and sulfur dioxide (SOx). The standards are maximum allowable pollutant concentration levels in the air based on different averaging schemes for each specific pollutant.

Under section 107 of the Clean Air Act, areas are designated as being in attainment or non-attainment of these standards. Those designations are subject to revision whenever sufficient data become available to warrant a change. States with areas in non-attainment are required to develop "State Implementation Plans" (SIPs) that demonstrate how the state intends to achieve attainment status.

1.4 General Conformity[5]

Section 176 (c) (42 U.S.C. 7506) of the Clean Air Act requires Federal agencies to ensure that their actions conform to the applicable SIP for attaining and maintaining the NAAQS. The 1990 amendments to the Clean Air Act clarified and strengthened the provisions in section 176 (c). EPA published two sets of regulations to implement section 176 (c) because certain provisions apply only to highway and mass transit funding and approval actions. The transportation conformity regulations address Federal actions related to highway and mass transit funding and approval actions. The General Conformity regulations, published on November 30th, 1993 and codified at 40 CFR 93.150, cover all other Federal actions.

The Clean Air Act was revised in 1995 to limit the applicability of the conformity programs to areas designated as non-attainment under section 107 and areas that had been re-designated as maintenance areas with a maintenance plan under section 175A of the Clean Air Act. Therefore, only Federal actions taken in designated non-attainment and maintenance areas are subject to the General Conformity regulation.

The EPA also included de minimis emission levels based on the type and severity of the non-attainment problem in an area. Before any action can be taken, Federal agencies must perform an applicability analysis to determine whether the total direct and indirect emissions from their action would be below or above the de minimis levels. If the action is determined to create emissions at or above the de minimis level for any of the criteria pollutants, Federal agencies must conduct a conformity determination for the pollutant (unless the action is presumed to conform under the regulation or the action is otherwise exempt). If the emissions are below all of the de minimis levels, the agency does not have to conduct a conformity determination.

When the applicability analysis shows that the action must undergo a conformity determination, Federal agencies must first show that the action will meet all SIP control requirements. Requirements may include taking reasonably available control measures and showing that emissions from the action will not interfere with the timely attainment of the standards, the maintenance of the standards, or the area's ability to achieve an interim emission reduction milestone. Federal agencies then must demonstrate conformity by meeting one or more of the methods specified in the regulations:

1. Demonstrating that the total direct and indirect emissions are specifically identified and accounted for in the applicable SIP.

[5] Taken from EPA's "PM2.5 De Minimis Emission Levels for General Conformity Applicability", Federal Register Document ID (DOCID:fr17jy06-11).

2. Obtaining a written statement from the state or local agency responsible for the SIP documenting that the total direct and total indirect emissions from the action along with all other emissions in the area will not exceed the SIP emission budget.

3. Obtaining a written commitment from the state to revise the SIP to include the emissions from the action.

4. Obtaining a statement from the metropolitan planning organization for the area documenting that any on-road motor vehicle emissions are included in the current regional emission analysis for the area's transportation plan or transportation improvement program.

5. Fully offset the total direct and indirect emissions by reducing emissions of the same pollutant or precursor in the same non-attainment or maintenance area.

6. Where appropriate, in accordance with 40 CFR 51.858(4), conduct air quality modeling that can demonstrate that the emissions will not cause or contribute to new violations of the standards, or increase the frequency or severity of any existing violations of the standards.

Since promulgation in 1993, the General Conformity regulations have been revised once (in 2006) to add a de minimis threshold for fine particulates (PM2.5). On January 8th, 2008, EPA published proposed revisions to the General Conformity regulations. In general, these revisions respond to comments from Federal agencies that EPA has received over the course of applying the current regulations. It does not appear that the revisions proposed would make a material difference in the General Conformity determination for this project.

For more information, see http://www.epa.gov/oar/genconform/ .

1.5 Criteria Pollutants

Emissions were estimated for the following pollutants emitted by the internal combustion engines associated with the project:

Oxides of nitrogen (NOx) – Oxides of nitrogen (or NOx, pronounced "knocks") are an important precursor to ozone. Ozone is a photochemical oxidant and the major component of smog. Ozone is not emitted directly but forms in the atmosphere in a reaction of oxides of nitrogen and volatile organic gases in presence of sunlight. These reactions are stimulated by sunlight and temperature so that peak ozone levels typically occur during the warmer times of the year. Ozone in the upper atmosphere is beneficial to life because it shields the earth from harmful ultraviolet radiation from the sun. However, high concentrations of ozone at ground level are a major health and environmental concern. Ozone and Nitrogen dioxide (a common type of oxide of nitrogen) are criteria pollutants.

Carbon monoxide (CO) – Carbon monoxide is a colorless, odorless, poisonous gas produced by incomplete burning of carbon in fuels. CO is a criteria pollutant.

Hydrocarbons (HC) – Hydrocarbons may also be referred to as total organic gases (TOG) or volatile organic compounds (VOC). They are an important component in the formation of ozone. Ozone is formed through complex chemical reactions between precursor emissions of VOCs and NOx in the presence of sunlight. Hydrocarbon emissions are measured and reported in a few different ways. Total hydrocarbons, or THC, are the hydrocarbons measured by a specific test called FID. This test does not properly detect some alcohols and aldehydes. Separate tests detect these compounds and when the results are added to the THC, the sum is known as TOG. Methane is orders of magnitude less reactive than other hydrocarbons so it is often measured separately, and when subtracted from THC, is known as NMHC (non-methane hydrocarbons) or NMOG (non-methane organic gases).

Some hydrocarbons are less ozone forming than others so EPA has excluded them from the definition of regulated hydrocarbons called VOCs. Although several compounds are excluded, generally speaking VOCs are the result of subtracting methane and ethane from TOG emission estimates. Ultimately, all of these terms and their varying constituents represent only slight variations in the total mass emission of hydrocarbons. For the purposes of this study, all hydrocarbon emissions are converted to and shown as VOCs.

Particulate matter 10 (PM10) – Air pollutants called particulate matter include dust, dirt, soot, smoke, and liquid droplets directly emitted into the air by sources such as factories, power plants, cars, construction activity, fires, and natural windblown dust. Particles formed in the atmosphere by condensation or the transformation of emitted gases such as SO_2 and VOCs are also considered particulate matter. These are called secondary PM as they are not directly emitted but form in the atmosphere. PM10 includes airborne particulates having an aerodynamic diameter of 10 microns or less. PM10 is a criteria pollutant.

Particulate matter 2.5 (PM2.5) – A subset of PM10, PM2.5 is airborne particulate of aerodynamic diameter of 2.5 microns or less. Standards for PM2.5 are relatively new. The EPA revised the PM2.5 limit to a more restrictive concentration. This new limit went into effect in December of 2006 where the 24-hr PM2.5 standard was lowered from 65 ug/m3 to 35 ug/m3. PM2.5 is a criteria pollutant.

Sulfur dioxide (SO_2) – High concentration of sulfur dioxide affects breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. SO_2 is also a primary contributor to acid deposition, or acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings, and statues. In addition, sulfur compounds in the air contribute to visibility impairment in large parts of the country. This is especially noticeable in national parks. Sulfur dioxide emissions are directly proportional to the sulfur content of in-use fuels. Sulfur dioxide is a criteria pollutant.

In addition to the regulated pollutants listed above, lead (Pb) is also one of the pollutants in 40 CFR 93.153. Airborne lead in urban areas is primarily emitted by vehicles using leaded fuels. Lead emissions were more of a concern in past years. However with the increasing use of unleaded gasoline, lead standards are not expected to be violated in any aspect of the project and need not be addressed. The EPA model used to calculate vehicle emissions (discussed in Section 2.2 of this report) assumes that all post-1975 model year vehicles that were not tampered with and all calendar years subsequent to 1991 are free from lead emissions.[6]

1.6 Local Setting

The project encompasses the Delaware River system from the Ports of Camden and Philadelphia to the mouth of Delaware Bay, about 100 river miles. The deepening follows the alignment of the existing 40-foot Federally maintained channel. The project borders the states of New Jersey, Pennsylvania, and Delaware.

[6] "User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor Model", EPA420-R-03-010, United States Environmental Protection Agency, August 2003

In addition to the channel deepening, some berths at various terminals and oil refineries along the Delaware River will also be deepened by the facility owners. The facilities that plan on performing berth deepening work are mostly located in the upper reaches of the project area. They are:

- Sunoco - Marcus Hook, PA
- Conoco Phillips - Marcus Hook, PA
- Valero – Paulsboro, NJ
- Sunoco – Fort Mifflin, PA
- Sunoco Eagle Point – Westville, NJ
- Packer Ave. Terminal – Philadelphia, PA
- Beckett St. Terminal – Camden, NJ

Construction equipment associated with the project would emit criteria pollutants within ten counties in three states (Delaware, Pennsylvania, and New Jersey). There are currently two non-attainment areas that overlap the project boundaries.

All ten counties included within the project area are also within the "Philadelphia-Wilmington-Atlantic City" 8-hour ozone non-attainment area. This is a four state (PA-NJ-MD-DE), 18 county non-attainment area currently in moderate non-attainment for the 8-hour ozone standard. In 2004, this area was in severe non-attainment of the 8-hour ozone standard. The ozone problem has abated somewhat in the intervening years. This has an impact on the ozone and ozone precursor de minimis thresholds. The precursors to ozone include NOx and VOCs.

Five of the ten counties that make up the project area are in non-attainment for the fine particulate standard (PM2.5). These include Delaware and Philadelphia Counties in Pennsylvania, Gloucester and Camden Counties in New Jersey, and New Castle County in Delaware. This is generally the interior half of the project from roughly river mile 45 to the inshore terminus of the channel at roughly river mile 100. This fine particulate non-attainment area is known as the Philadelphia-Wilmington non-attainment area (a three state, nine county area in total). The precursors to PM2.5 are NOx, VOCs, and SOx.

A complication in applying General Conformity to a project that covers such a large area is that there is not one single non-attainment status for the entire project area because the project spans multiple attainment areas. The approach is to treat all of the project area as having the attainment status of the most severe area found within the project limits for a given pollutant. This is a conservative approach and was based on discussion with EPA.

In the case of ozone, this has no effect since all 10 counties in the project area are in the same moderate non-attainment status with respect to the 8-hour ozone standard.

With respect to fine particulate matter, about half the project area is in non-attainment of the standard. Dover, Sussex, Salem, Cumberland and Cape May counties are currently in attainment of the fine particulate standard. The total PM2.5 emissions for the project are compared with the de minimis standards for the areas in non-attainment, as if the total project were in the PM2.5 non-attainment area.

1.7 Emission Sources

The emission sources for the project consist of marine and land based mobile sources that will be used during the six-year project construction (five years for the channel deepening and one year for the berth deepenings). The marine emission sources include the various types of dredges (clamshell, hydraulic, hopper and drillboat) as well as all significant support equipment. The land based emission sources include both off-road and on-road equipment. The off-road equipment consists of the heavy equipment used to construct and maintain the disposal sites. The on-road equipment consists of employee vehicles and any on-road trucks used on the project. Both the marine and off-road equipment consist primarily of diesel powered engines. The on-road vehicles are a combination of gas and diesel powered vehicles.

1.8 Emission Estimate Approach

Operational information and estimates for the equipment performing the work was obtained from the Corps of Engineers Dredge Estimating Program (CEDEP) provided[7] by the USACE Philadelphia District. This included equipment lists, horsepower of each piece of equipment, hours of operation, operating days, etc.

The channel deepening scope was broken up into fifteen project elements, each having an individual CEDEP estimate. These were grouped in seven phases of construction. Additionally, berth deepening emissions were recalculated as part of this study due to new emission factor guidance and updated assumptions on equipment.

The fundamental approach to the emission estimates was to develop daily emissions of each pollutant for each group of equipment in each estimate. The resulting daily emissions were broken out into three components:

- Emissions occurring in the dredge area - this includes all cutterhead, clamshell and drillboat emissions including all associated small attendant plants that stay on-site. It also includes all hopper dredge emissions while loading.

- Emissions occurring in transit to the disposal area - this includes all booster, barge towboat and hopper sailing emissions.

- Emissions occurring at the disposal area – this includes all dredge unloading emissions, all land based non-road equipment in use at the disposal site and all on-road vehicular traffic including worker trips.

Details of this calculation for each of the fifteen channel deepening project elements can be found in Appendix C.

Land based non-road equipment emissions were estimated using EPA's NONROAD model. On-road vehicular traffic associated with worker trips were estimated using EPA's Mobile 6.2 model. Marine diesel engine emissions on dredges, tugs, and attendant plants were estimated using the latest EPA guidance including the January 2006 EPA best practices guide entitled "Current Methodologies and Best Practices Guide for Preparing Port Emission Inventories." The EPA models take into account the changes in diesel fuel sulfur level and resulting changes in emission factors. The marine emission factors were also developed based on the anticipated fuel sulfur level for the particular project element and its anticipated year of execution.

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[7] CEDEP estimate information on the channel deepening was provided by USACE in two emails, dated 2-9-09 and 3-4-09. Because the scope of berth dredging was assumed to be the same as the 2004 report, the scope of the berth deepenings was developed based on information from the 2004 report.

In addition to daily operating emissions, total emissions for the mobilization of each spread of equipment were included in each CEDEP estimate. Monthly emission profiles and total emissions for each calendar year were developed by applying the total daily emissions of each project element (as shown in Appendices A & B), as well as the mobilization emissions, to the current project schedule (provided by the USACE and shown in Appendix D). The annual emissions for the project were then compared to the de minimis threshold level for the combined non-attainment area.

2. METHODOLOGY FOR DETERMINING GENERAL CONFORMITY

2.1 Construction Cost Estimates

As previously stated, the Philadelphia District provided fifteen cost estimates for each component of the project. Estimates were in CEDEP format. The fifteen estimates were grouped in seven separate contracts distributed over a five year period.

Each CEDEP estimate provided detailed information on the type and size of equipment, the type of material dredged, the dredging and disposal location, the hours of operation, and labor requirements. Information regarding land based work performed at the various disposal sites was detailed in additional estimates and production spreadsheets. The estimates included information on equipment types and production rates for disposal site shore crews, rock excavation rehandling, rip rap placement, embankment and groin construction, sluice box construction, and the placement and filling of geotextile tubes.

Detailed construction cost estimates for the berth deepenings at each of the benefiting oil refineries and port terminals were provided as part of the 2004 study. They contained similar information on equipment types and productions. The berth deepening work is assumed to start after the channel deepening project is completed. It was assumed that there are no changes to the berth deepening scope from the information provided for the 2004 study.

2.2 Emission Factor Sources and Emission Models

The EPA has different models or methodologies for calculating emissions depending on the sources involved – marine, off-road, or on-road. Emission calculations depend on inputs such as engine size, operating hours, fuel type, engine load factors, and emission factors. These inputs were obtained from the cost estimates described above.

The EPA guidelines and models are discussed here.

MARINE EMISSIONS

The vast majority of the emissions of this project is generated by commercial marine diesel engines. Well established methodologies and models for on-road and some non-road engine emissions exist. However, the field of marine engine emissions has no such standardized models to apply. Emission inventories for marine equipment have been evolving and are usually based on the latest literature.

The primary guide for estimating marine emissions for this study was the January 2006 EPA document titled "Current Methodologies and Best Practices Guide for Preparing Port Emission Inventories." This decision was based on discussion with representatives of EPA Region II, Region III, and EPA head quarters during a phone conference on February 24, 2009.

The January 2006 document includes guidance for dredges as well as tug boats, ferries, crew boats etc. For dredges, the document recommends collecting engine specifics from equipment operators and using the latest technical literature for both load factor and emissions factors. Equipment specifics and operating details were drawn from the USACE CEDEP estimates for the project.

Table 2-1 summarizes the emissions factors used in the revised marine emissions. Emission factors for eight different engine cases were developed to cover the various engine types anticipated.

Table 2-1: Emission Factors

	Marine Diesel Emission Factors						Sulfur Adjusted						
			Speed	Fuel	NOx (gr/bhp-hr)	VOC (gr-bhp/hr)	PM2.5 gr/bhp-hr	PM10 gr/bhp-hr	CO gr/bhp-hr		Fuel Sulfur % in factor development	Actual Fuel Sulfur	Assumed BSFC lb/hr-hr
1	OGV Aux	Medium Speed Ship Aux Engines MGO	Medium	MGO	10.37	0.31	0.1959	0.2053	0.82	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	0.5000%	0.0500%	0.336
2	Cat1 50-100	Harbor Craft 50 hp to 100 hp- Category 1			8.20	0.21	0.5431	0.5633	1.49	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	0.5000%	0.0500%	0.336
3	Cat1 100-175	Harbor Craft 100 hp to 175 hp- Category 1			7.46	0.21	0.1815	0.1904	1.27	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	0.5000%	0.0500%	0.336
4	Cat1 175-300	Harbor Craft 175 hp to 300 hp- Category 1			7.46	0.21	0.1815	0.1904	1.12	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	0.5000%	0.0500%	0.336
5	Cat1 300-1341	Harbor Craft 300 hp to 1341 hp- Category 1			7.46	0.21	0.1091	0.1158	1.12	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	0.5000%	0.0500%	0.336
6	Cat1 >1341	Harbor Craft >1341hp- Category 1			9.69	0.21	0.1091	0.1158	1.86	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	0.5000%	0.0500%	0.336
7	HC-Cat2				9.84	0.39	0.1732	0.1893	0.82	Source- EPA Best Pracitice Guide- Port Emission Inventories (except PM2.5)	1.5000%	0.0500%	0.336
8	Locomotive				12.38	0.43	0.1637	0.1721	1.51	Based on EPA RSD for Locomotives	0.5000%	0.0500%	0.336

Emission factor 1 is based on the emission factors for medium speed auxiliary (generator) engines on ocean going vessels. Emission factors 2 through 6 are for harbor craft with Category I marine diesel engines of varying horsepower levels. Emission factor 7 is for harbor craft using Category 2 engines. Emission factor 8 is based on locomotive engine emission data contained in an EPA regulatory support document. Hopper dredge engines were assumed to be most similar to ocean going vessel medium speed auxiliary ship engines. Cutter suction and booster engines were assumed to be most similar to locomotive engines. Other harbor craft were assigned emission factors based on horsepower. The emission factor designator for each piece of equipment in each of the 15 channel deepening project components is shown in Appendix C.

PM2.5 calculations were based on the assumption that 92% of the PM10 emissions are fine particulate. Sulfur dioxide emissions were based on the brake specific fuel consumption and the assumed fuel sulfur level. Fuel sulfur levels were projected for each year of the project based on the EPA guidance for marine fuels.

Load factors are the assumed percentage of installed horsepower in demand while operating. Load factors for the marine equipment were developed based on judgment of the power demand while operating as compared to the installed horsepower of the equipment assumed in the cost estimates.

Two example calculations of daily emissions from a dredging spread are shown in Table 2-2 and Table 2-3 (one cutter suction and one hopper). All 15 are included in Appendix C.

Table 2-2: Example Daily Emissions Calculation – Cutter Suction Dredge

Appendix C -Marine Emissions CDEP Estimate #14 (of 15)
Reach AA - National Park
Assumed Year of Analysis 2010
Assumed Fuel Sulfur Level 163 ppm 0.0163%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	13.61	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	3,167	110	42	44	386	13	8
2 Work Tugs	250	50	0.045	0.039	13.61	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	33.6	1.0	0.8	0.9	5.0	0.2	4
1 Crew / Sur	100	40	0.045	0.039	13.61	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0497	7.8	0.2	0.2	0.2	1.3	0.1	3
1 Derrick	200	40	0.011	0.011	13.61	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	11.2	0.3	0.3	0.3	1.7	0.1	4
Subtotal Attnd Plnt Dredge Site								5								52.6	1.5	1.3	1.3	8.0	0.4	
Transportation Route																						
dredge enroute																						
2 boosters	5200	200	0.045	0.039	13.61	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	3,551	124	47	49	433	14	8
Disposal Site																						

Table 2-3: Example Daily Emissions Calculation – Hopper Dredge

Appendix C-Marine Emissions CDEP Estimate #15 (of 15)
Reach A to Pedricktown N.
Assumed Year of Analysis 2013
Assumed Fuel Sulfur Level 31 ppm 0.0031%
Hours per Month 657 (730hrs x 90% TE)

	From CDEP									Emission Factors						Daily Emissions						
	Propulsion Hp	Pumps Hp	Aux & Misc Hp	LF Propulsion	LF Pumps	LF Aux & Misc	% of cycle	Hrs/Day	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 7600 cy dr	9000	3000	2000	45%	50%	30%	21.6%	4.66	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	622	25	11	12	52	1	7
1 Crew/Surv	100	0	40	15%	0%	50%		21.60	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	12	0	0	0	2	0	3
Transportation Route																						
1 7600 cy dr	9000	3000	2000	80%	0%	25%	57.7%	12.47	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	2,083	83	37	40	174	2	7
0 5200 hp bo	0	5200	200	0%	90%	50%	p/o time	4.47	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	0	0	0	0	0	0	8
Subtotal along Transp Route																2,083	83	37	40	174	2	
Disposal Site																						
1 7600 cy dr	9000	3000	2000	0%	80%	25%	20.7%	4.47	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	281	11	5	5	23	0	7
1 Tender Tug	250	0	50	60%	0%	50%		21.60	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	62	2	2	2	9	0	4
Subtotal Dredge at Pumpout							100.0%	21.60								343.6	13.0	6.5	7.0	32.8	0.3	
								90.0%														

LAND BASED EMISSIONS

The land based emissions for the project include off-road equipment such as dozers, loaders, excavators, and cranes, as well as on-road vehicles such as cars and trucks. These emissions were calculated using two different EPA models developed specifically for use with land based equipment, NONROAD2005 Emission Inventory Model and MOBILE6 Vehicle Emission model.

NONROAD Emissions Model

The off-road emissions were calculated using the EPA computer model NONROAD. The EPA developed this model to assist states and regulatory agencies in more accurately estimating air emission inventories. The NONROAD model calculates emissions for over 300 equipment types, categorizing them by horsepower rating and fuel type. The NONROAD model estimates emissions for the following engine exhaust pollutants: HC, NOx, CO, CO_2, SOx, and PM. HC can be reported as total hydrocarbons, total organic gases, non-methane organic gases, non-methane hydrocarbons, or volatile organic compounds. PM emissions can be reported as PM10 or PM2.5.

The NONROAD model contains several different sets of data files that are used to specify the options for a model run. These data files provide the necessary information to calculate and allocate the emissions estimates. The data files contain information on load factors, emission factors, equipment population, annual hours of operation, average engine lifetime hours, engine growth estimates, equipment scrappage, and geographic and temporal allocation. The user specifies options such as fuel type, temperature ranges, period (annual, monthly, or seasonal), region, and equipment sources. The data files can be modified to reflect the project conditions relative to equipment population, annual hours of use, region of use, fuel source, equipment growth, and the engine tier emission factors.

The NONROAD Model Interface Version 2005.0.0 (NR-GUI.EXE 6/12/2006) was used for this project.

Mobile Source Emission Factor Model

The remaining source of emissions for the project is employee vehicles and other on-road trucks used during construction. EPA has an emissions model called MOBILE6, which is used to calculate emissions (in grams per mile) for different vehicle types under different operating conditions. Similar to the NONROAD model, the user specifies vehicle type, quantity, and operating conditions (speed, temperature, distance traveled, etc.). The emission quantities are then multiplied by the number of miles traveled and number of vehicles to determine the final emission amounts. The inputs used for this project are detailed in the analysis section of this report.

3. GENERAL CONFORMITY RESULTS

The annual emissions estimated in this study are shown in Table 3-1. Because the entire area is in attainment of the PM10 and CO standards, General Conformity does not apply to those pollutants and there is no need to compare them to a de minimis threshold.

The area is in non-attainment of ozone, however. The de minimis levels for ozone precursors, NOx and VOCs, are 100 and 50 tons per year, respectively.

The area is also in non-attainment for the fine particulate standard (PM2.5). The de minimis level for PM2.5 is 100 tons per year. The de minimis level for each of its precursors, NOx, VOCs, and SOx, is 100 tons per year.

Table 3-1: Annual Emissions Summary by Pollutant

Calendar Year Emissions - tons						
De Minimis Level (tpy)	100	50	100		100	100
	NOx	VOCs	PM2.5	PM10	CO	SO2
2010	510.5	18.3	7.1	7.5	69.2	2.8
2011	513.1	19.3	8.2	8.8	59.0	1.5
2012	443.4	17.6	7.8	8.4	47.7	0.7
2013	539.8	22.3	10.3	11.1	61.9	1.1
2014	607.2	23.0	9.6	10.3	73.0	0.7
2015	423.7	15.1	6.1	6.5	56.6	0.6
Total Project	3,037.7	115.6	49.1	52.5	367.4	7.4

The only criteria pollutant for which the project exceeds the de minimis level is NOx (as a precursor to ozone). Hence, General Conformity applies in regard to the emission of NOx. Annual NOx emissions range from a low of roughly 424 tons to a high of roughly 607 tons. Every year is higher than the de minimis level of 100 tons per year.

Significance Test

A significance test was performed to determine whether the project emissions are less than 10% of the impacted regions' baseline emissions for each pollutant.

The two areas in question are the Philadelphia-Wilmington-Atlantic City area for 8-hour ozone non-attainment and Philadelphia-Wilmington area for PM2.5 non-attainment. The counties included in each non-attainment area are shown in Table 3-2 below.

Table 3-2: Counties in Each Non-Attainment Area

State	County	Philadelphia-Wilmington-Atlantic City 8-hr ozone non-attainment area	Philadelphia-Wilmington PM2.5 non-attainment area
Pennsylvania			
	Bucks	X	X
	Chester	X	X
	Delaware	X	X
	Philadelphia	X	X
	Montgomery	X	X
New Jersey			
	Atlantic	X	
	Burlington	X	X
	Camden	X	X
	Cape May	X	
	Cumberland	X	
	Gloucester	X	X
	Mercer	X	X
	Ocean	X	
	Salem	X	
Delaware			
	Kent	X	
	New Castle	X	X
	Sussex	X	
Maryland			
	Cecil	X	X

The 2002 point source and nonpoint+mobile source emissions for each pollutant for each county[8] were obtained from the EPA. 2002 was the most recent year available. Adding up the combined point source

[8] Emissions for Mercer and Ocean counties in NJ and Kent and Sussex counties in DE were not available, presumably because they are relatively undeveloped. This is not seen as a problem for significance testing, though because not including any emissions for these four counties makes it conservative (i.e. the baseline is smaller than what is really the case).

and nonpoint+mobile source emissions for each county formed the annual baseline emissions for the region. The maximum year's emissions for each pollutant was compared to the baseline emissions for that pollutant to see if the project's emissions were less than 10% of the regional emissions.

In almost every case, the project's maximum year emissions were less than 0.05% of the region's emissions for that pollutant. Only NOx was higher, and it was only 0.28% of even the smaller region's NOx emissions.

The results for each of the two non-attainment areas are shown in Table 3-3 and Table 3-4 below.

Table 3-3: Significance Test for Ozone Non-Attainment Area

Philadelphia-Wilmington-Atlantic City Ozone Non-Attainment Area

(all emissions reported in tons/year)

De Minimis Level (tpy)	100	50		100	100
	NOx	VOCs	PM10	CO	SO_2
2010	510.5	18.3	7.5	69.2	2.8
2011	513.1	19.3	8.8	59.0	1.5
2012	443.4	17.6	8.4	47.7	0.7
2013	539.8	22.3	11.1	61.9	1.1
2014	607.2	23.0	10.3	73.0	0.7
2015	423.7	15.1	6.5	56.6	0.6
Total Project	3,037.7	115.6	52.5	367.4	7.4
Pollutant Amount in Peak Year	607	23	11	73	3
Annual Total for Counties in Non-Attainment Area	250,822	265,601	94,699	1,427,342	139,369
% of Regional Total for Peak Year of Project	0.24%	0.01%	0.01%	0.01%	0.00%

Table 3-4: Significance Test for PM2.5 Non-Attainment Area

Philadelphia-Wilmington PM2.5 Non-Attainment Area

(all emissions reported in tons/year)

De Minimis Level (tpy)	100	50	100		100	100
	NOx	VOCs	PM2.5	PM10	CO	SO2
2010	510.5	18.3	7.1	7.5	69.2	2.8
2011	513.1	19.3	8.2	8.8	59.0	1.5
2012	443.4	17.6	7.8	8.4	47.7	0.7
2013	539.8	22.3	10.3	11.1	61.9	1.1
2014	607.2	23.0	9.6	10.3	73.0	0.7
2015	423.7	15.1	6.1	6.5	56.6	0.6
Total Project	3,037.7	115.6	49.1	52.5	367.4	7.4
Pollutant Amount in Peak Year	607	23	10	11	73	3
Annual Total for Counties in Non-Attainment Area	213,420	223,825	20,541	83,677	1,229,509	113,040
% of Regional Total for Peak Year of Project	0.28%	0.01%	0.05%	0.01%	0.01%	0.00%

4. COMPARISON TO 2004 RESULTS

4.1 Introduction

The emissions estimates developed for the 2004 General Conformity Analysis and Mitigation Report are different from the totals calculated in 2009. The differences are due to the reduction in estimated dredging quantities, changes in the anticipated equipment types and production rates, and changes in the emission factors applied to various sources. This section describes and explains the changes to the NOx emission estimates. Table 4-1 summarizes the NOx emissions estimates from the 2004 and 2009 reports.

Table 4-1: Comparison of Total NOx Emissions

	2004 Report	2009 Report
NOx (total tons)	3,290	3,038

In total, the estimated NOx emissions decreased by approximately 8% even though the dredging quantity decreased by nearly 40%. This means the tons of NOx per unit of dredging increased. This section of the report investigates the cause of the increase.

4.2 Reduction of Estimated Dredging Quantities

The seven individual channel deepening contracts cannot be directly compared from 2004 to 2009 because the contract dredging areas, quantities and disposal locations were revised based on more current and more detailed surveys. Dredging volumes for the two major pieces of equipment are shown in Table 4-2 below. Clamshell dredging, drilling and blasting, dredge support equipment and land based equipment are not included in this comparison because their contributions are small compared with the main dredging equipment.

Table 4-2: Project Dredging Volume (Cutter Dredge & Hopper Dredge Only)

Dredging Equipment	2004 Report (cy)	2009 Report (cy)
Cutter with no Booster	6,661,246	2,170,700
Cutter with 1 Booster	3,595,635	3,946,300
Cutter with 2 Boosters	1,293,522	2,044,700
Hopper Dredge with no Booster	7,133,361	3,717,700
Hopper Dredge with 1 Booster	7,328,200	4,081,700
Total	26,011,964	15,961,100

Although the volume of dredging was reduced by about 40% from the 2004 amount, the resulting total volume of emissions was not reduced by the same ratio. The emissions generated depend on the amount of horsepower applied, the duration it is applied, and the emission factor assumed for each piece of equipment. A comparison to the previous estimate is not simple because of all these factors. An evaluation of the installed horsepower-months for each of the major dredge types was made in an effort to understand the differences in the scope of dredging estimated in 2004 versus the current study.

Multiplying the estimated number of operating months by the installed horsepower for each dredge type is a way to evaluate critical inputs to the emissions estimates that are separate from the assumed load factor and emission factor. Table 4-3 presents the total installed hp-months of each of the major equipment spreads in the 2004 and 2009 analyses. In very general terms, this can be seen as a comparison of the energy to be expended to move the estimated dredge quantity for the two estimates.

Table 4-3: Comparison of Energy in Installed Horsepower-Months

Dredging Equipment	2004 Report (Work months)	2004 Report (Installed hp-months)	2009 Report (Work months	2009 Report (Installed hp-months)
Cutter with no Booster	8.77	107,959	1.35	16,619
Cutter with 1 Booster	6.97	123,439	8.47	150,004
Cutter with 2 Boosters	3.21	74,183	6.39	147,673
Hopper Dredge with no Booster	18.63	260,820	11.86	166,040
Hopper Dredge with 1 Booster	22.13	429,322	14.65	284,210
Total	59.71	995,723	42.72	764,545

This shows that although the dredge quantity dropped by 40%, the total hp-months dropped by only 23%. Dividing the cubic yards by installed hp-month (a surrogate for energy) shows that the 2004 estimate assumed an average of 26 cubic yards would be dredged per installed hp-month. A similar calculation shows the current estimate assumes an average 21 cubic yards per installed hp-month.

The changes in horsepower and productivity result in an increase in the emissions per cubic yard of dredging that is independent of the load factor or emission factor assumed. This increase is a result of a shift toward more horsepower (i.e. more quantity requiring boosters) and lower production rates.

4.3 Changes to Emissions Calculation Factors

The same emission rate formula was used to calculate the emission rate for both 2004 and 2009 reports:

ER = HP*LF*EF Where: ER = Emission Rate

HP = Engine Horsepower

LF = Load Factor

EF = Emission Factor

Horsepower - The applied equipment horsepower was determined by information contained in the CEDEP estimates provided by the USACE Philadelphia District, and were constant for individual dredge types between the 2004 and 2009 analyses.

Load Factors - The 2004 engine load factors were determined from Table 5-2 of the EPA Report "Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data" (February 2000) using the 'All non-oceangoing' vessel type. It was assumed that the primary engines on the dredges and booster pumps operated at full power (80%) for all hours of operation.

The 2009 load factors were determined from the EPA report "Current Methodologies and Best Practices Guide for Preparing Port Emission Inventories" (January 2006) as well as understanding of dredge operation characteristics. The load factors used are shown in Table 4-4 below. Other than the clamshell dredge assumption, the differences are slight. The large difference in assumed clamshell load factor does not make a significant contribution to the total emission differences because clamshell dredges represent less than 1% of the work.

Table 4-4: Load Factor Changes between 2004 and 2009

Dredging Equipment	2004 Report Load Factor	2009 Report Load Factor
Clamshell Dredge	80%	30%
Cutter Suction Dredge	80%	80%
Hopper Dredge	80%	80%
Booster Pump	80%	90%

Overall, the load factor differences do not contribute substantially to the differences in emissions between 2004 and the current study.

Emission Factors - The 2004 emission factors were calculated based on the following formula, according to the algorithm table detailed on page 5-3 of the February 2000 EPA report:

$$EF = a * LF^{(-x)} + b$$

The variables in the equation, (a, x, and b) had the same constant values for each type of equipment in 2004. This meant that the emission estimates for each piece of equipment varied only by the load factor.

In contrast, the 2009 emission factors were estimated using the latest EPA guidance, including the January 2006 EPA report as well as regulatory support guidance for locomotive style engines. This revised method for assigning emission factors is based on individual equipment horsepower and engine category (classified by engine displacement).

A comparison of the emission factors used for the major pieces of equipment between the two studies is shown in Table 4-5.

Table 4-5: NOx Emission Factor Changes between 2004 and 2009

Dredging Equipment	2004 Report NOx EF (g/hp-hr)	2009 Report NOx EF (g/hp-hr)
Clamshell Dredge	7.92	10.37
Cutter Suction Dredge	7.92	12.38
Hopper Dredge	7.92	9.84
Booster Pump	7.92	12.38

The NOx emission factors for all four of the major pieces of dredging equipment increased from 24% to 56%.

4.4 Comparison Conclusions

The total project NOx emissions calculated in the current analysis (3,038 tons) are only slightly less than the total project NOx emissions estimated in 2004 (3,290 tons). The marine equipment emissions for the channel deepening only (not including berth deepenings or landside emissions), is 2,859 tons of NOx. In 2004, the marine emissions associated with the channel deepening were 3,083 tons of NOx. This 8% decrease in marine NOx emissions from 2004 to the current study is surprising given that the quantities to be dredged for the channel deepening were reduced from the 2004 project by nearly 40%. The emission rate per 10,000 cubic yards of dredging increased from 1.2 tons per 10,000 cubic yards of dredging in 2004 to nearly 1.8 tons per 10,000 cubic yards of dredging in the current study.

The 50% increase in NOx emissions per volume of dredging is due to a combination of factors. The largest reason for the difference is that the NOx emission factors used in the current study are 24% to 56% higher than those used in 2004. The 2004 study did not make distinctions among the types of engines that are used in the different kinds of dredges; all dredge types used the same emission factor. According to the latest literature, hopper dredge engines are most similar to medium speed ocean-going vessel auxiliary engines and cutter suction and booster pump engines are generally older locomotive style engines. The emission factors were adjusted accordingly; see Table 4-5 above.

In addition, the construction plan shifted to higher horsepower dredging. For example, the volume of work to be performed by a cutter suction dredge using two booster pumps increased by nearly 60%. This increased the emissions per volume of dredging because boosters are a significant source of emissions. The overall production rate per dredge working month also dropped in the current project. In 2004, the overall production rate of the dredging was roughly 435,000 cubic yards per dredge-month.

The current project has an overall production rate of approximately 375,000 cubic yards per dredge-month. This 15% decrease in production increases the emissions per volume of material dredged.

Offsetting some of these increases are decreases in the clamshell dredge emission rates and changes to the assumed load factors. The net result is a 50% increase in the rate of emissions per volume of dredging. After factoring in the reduced volume, the net result is a slight reduction in total tons of NOx generated by the project as compared to the 2004 study. Other pollutants also varied from the 2004 study. Most notably, SOx emissions dropped dramatically with the advent of much lower sulfur level standards in fuel.

5. NOX MITIGATION

5.1 Introduction

Various strategies for offsetting the project NOx emissions were identified for this study. Some of the strategies targeted emissions coming directly from the equipment working on the project; these are called "on-site" measures. Other strategies looked at engine emissions that are not part of this deepening project, but that occur within the project area; these are called "off-site" measures. One of the off-site measures involved the USACE's hopper dredge McFarland. This is a dredge that performs annual maintenance dredging within the project airshed. The work done by the McFarland is not associated with the project.

The goal of mitigation alternatives analysis was to calculate a value for the cost-effectiveness (in dollars per ton of NOx reduced per year) of each proposed strategy as well as to evaluate the capacity of each strategy to offset the project emissions in total tons per year.

5.2 Selection of Reduction Strategies

Many of the strategies evaluated for this report are the same, or similar to those introduced in the 2004 report. At the time, they were chosen because they were a proven, practical technology.

Numerous emission reduction technologies exist on the market today. The manufacturers of the technology will claim "significant" reductions for certain regulated constituents. However, getting the manufacturers to provide documentation supporting their claim can be difficult or impossible. In most cases, any supporting documentation that is provided only considers one, two or three pollutants. Furthermore, manufacturers do not always take into consideration the fact that some emission reduction technologies, while having a positive impact (decreased emissions) on one or more pollutants may have a negative impact (increased emissions) on one or more other pollutants (e.g. delayed injection timing reduces NOx emissions but increases fuel consumption which in turn increases HC and PM emissions). This explains why very few emission reduction technologies have been certified under a Federal or state program. In the screening process, any technologies, where it was believed the technology had the potential to increase other emissions were eliminated.

The mitigation strategy focused on emission reduction technologies that have been developed to a stage wherein they provide the highest degree of certainty possible that they will be able to achieve the emission reduction benefits that have been estimated. For this project, the initial screening of emission reduction technology is based primarily on the work performed by Moffatt & Nichol, in joint venture with Fugro West, Inc., (known as Airfield Development Engineering Consultant, or ADEC) for the proposed San Francisco International Airport Airfield Development Program (SFO). For the SFO project, ADEC performed studies to address the construction-related air quality impacts associated with the proposed construction of new runway platforms. Part of this study involved analyzing the state of emission reduction technologies. The results of this study have been compiled in "Preliminary Report No. 7, Construction Air Emissions Analysis and Mitigation Study," prepared by ADEC in October 2000.

The analysis performed for the SFO project considered an array of emission reduction technologies. The technologies considered represent a range of emission reduction technologies available at the time (year 2000). Comparison of the findings made in the SFO report to the draft "Initial Findings Report Emission Reduction Strategies for the New York/New Jersey Harbor Navigation Project," prepared by Starcrest Consulting Group, LLC and Allee King Rosen & Fleming, Inc. (Starcrest) for the New York District in January 2003, found no significant changes to the emission reduction technologies considered in the SFO report.

In addition to the strategies developed in the SFO project and considered in the 2004 analysis for this project, two other strategies were considered. The first was adding shore power to one of the Philadelphia Regional Port Authority (PRPA) terminals; the second was converting some of the PRPA dock cranes from diesel to electric.

Shore power, or cold-ironing, allows ships to turn their auxiliary engines off while they are at berth. Ships have a variety of electrical needs while they are berthed. They need lights, radios, water heaters, safety systems, and electricity for the crew in addition to keep any refrigerated cargo cold. Cold-ironing is being required for container and cruise terminals at all California ports, and is starting to become more common as an emission reduction strategy.

Electrifying diesel dock cranes is another way to reduce emissions from large diesel engines. The Port of Miami electrified seven diesel cranes in 2005. Electric dock cranes are very commonplace, and as such, are a proven, practical way to eliminate diesel engine emissions.

The following mitigation strategies were studied.

On-site Mitigation:

1. Electrify dredge equipment
2. Install selective catalytic reduction (SCR) units on dredge equipment
3. Repower dredge equipment

Off-site Mitigation:

4. USACE Hopper Dredge McFarland
    a. Installing SCRs
    b. Repowering
    c. Repowering *and* installing SCRs
5. Cape May-Lewes ferries
    a. Installing SCRs
    b. Repowering
    c. Repowering *and* installing SCRs
6. Repowering local tug boats
7. Cold ironing
    a. Packer Ave Marine Terminal
    b. Pier 82
8. Electrifying diesel container cranes at PRPA facilities
9. Purchasing Emission Reduction Credits

For each strategy, the unmitigated and mitigated annual NOx emissions were calculated. Subtracting those values yields the tons of NOx reduced per year. The NOx emissions for the off-site strategies are simple because they are the same every year. However, for on-site measures (#1 – 3 above), the NOx emissions and reductions are different from year to year. For these strategies, the annual NOx reduction used to calculate cost effectiveness was the reduction in *project peak annual emissions*.

This is best explained by example. Electrification of dredges is used here for illustration. The peak NOx emissions for the unmitigated project occurs in 2014 (607 tons). The year 2014 NOx emissions after electrification were 244 tons. The reduction achieved in the year of maximum NOx emissions, or "Maximum Annual Reduction," for this strategy is (607 – 244) = 363 tons. However, the peak NOx emissions after electrification occurs in 2013 (455 tons). The "Peak Annual NOx Reduction" for this strategy is (607 – 455) = 152 tons. The lower of the two values is used to address the fact that electrification does not achieve a 363 ton reduction every year. This method only gives NOx reduction credit for the reduction in the project's peak year emissions.

The EPA document titled "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories" dated April 2009[9] was used for guidance on load factors, emission factors, and auxiliary engine sizes. The specific tables and factors that were used in this study are included in Appendix F for reference. The cost for each strategy was also estimated. The sources for the cost estimates are given in each section.

Dividing the cost of a mitigation strategy by the NOx reductions it achieves for a single year yields a cost-effectiveness value that can be used to compare all of the emission reduction strategies under consideration.

5.3 Unmitigated NOx Emissions

The total project NOx emissions are estimated to be 3,038 tons. The vast majority of these emissions (2,820 tons) is associated with the marine equipment used on the channel deepening. A breakdown for each of the seven planned deepening contracts broken out by dredge type is shown in Figure 5-1 below. The emissions included in the chart below are the total marine emissions for the deepening project (2,820 tons) and do not include mobilization, landside emissions or the berth deepenings.

[9] This document can be found at http://www.epa.gov/ispd/ports/bp_portemissionsfinal.pdf.

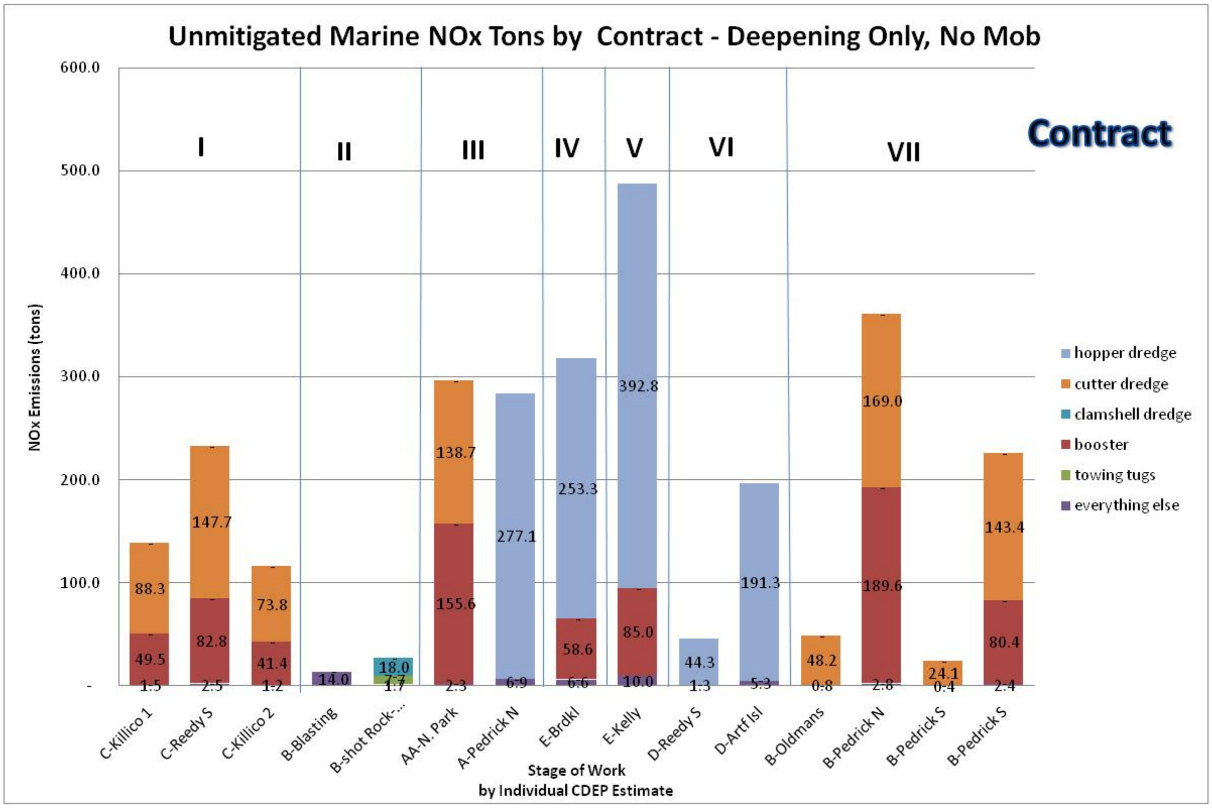

Figure 5-1: Unmitigated Marine NOx Emissions, Channel Deepening by Contract and Source Type

5.4 Cost Effectiveness Comparison

Table 5-1 and Figure 5-2 summarize the results of all 14 mitigation strategies evaluated.

Table 5-1: Summary of On-Site and Off-Site Results

	NOx Tons														
	On-Site Emission Reduction Strategies				Offsite Emission Reduction Strategies										
	Base	Project Mitigation			USACE TSHD McFarland			Cape May Ferries			Local Tugs	PRPA			Credits
		1	2	3	4a	4b	4c	5a	5b	5c	6	7a	7b	8	9
	Project Unmitigated	Cutter & Clam Dredges, Boosters & Towing Tugs Electrify	Dredges Boosters & Towing Tugs SCR	Dredges Boosters & Towing Tugs Repower	McFarland SCR (no repower)	McFarland Repower (no SCR)	McFarland Repower w/SCR	Cape May Ferries SCR (no repower)	Cape May Ferries Repower (no SCR)	Cape May Ferries Repower w/SCR	Local Harbor Tug Repower w/SCR	Cold Ironing PRPA Packer Ave	Cold Ironing PRPA Pier 82	Electrify Diesel Dock Cranes PRPA Packer Ave	Purchase Offsets
Total Project Tons	3,038	1,370	402	2,049											
Peak Annual Tons	607	455	80	403											
Maximum Annual Reduction	0	484	530	204											
Peak Annual NOx Reduction	0	152	527	204											
Total Annual Unmitigated Tons					198	198	198	375	375	375	108	69	33	75	n/a
Annual Tons Eliminated					182	64	187	348	138	355	28	48	31	73	607
% reduction					92.0%	32.4%	94.6%	92.9%	36.8%	94.7%	25.8%	69.3%	95.1%	97.4%	
Peak Annual Tons After Mitigation	607	455	80	403	425	543	420	259	469	252	579	559	576	535	
Reduction of Peak Annual Tons		152	527	204	182	64	187	348	138	355	28	48	31	73	607
Total Cost		$30,500,000	$7,900,000	$92,600,000	$1,700,000	$20,000,000	$21,700,000	$1,500,000	$19,100,000	$20,400,000	$12,500,000	$47,500,000	$11,000,000	$14,100,000	$6,070,000
$/Annual Ton (peak reduction)		$200,000	$15,000	$454,000	$9,000	$312,000	$116,000	$4,000	$138,000	$57,000	$448,000	$991,000	$355,000	$194,000	$10,000

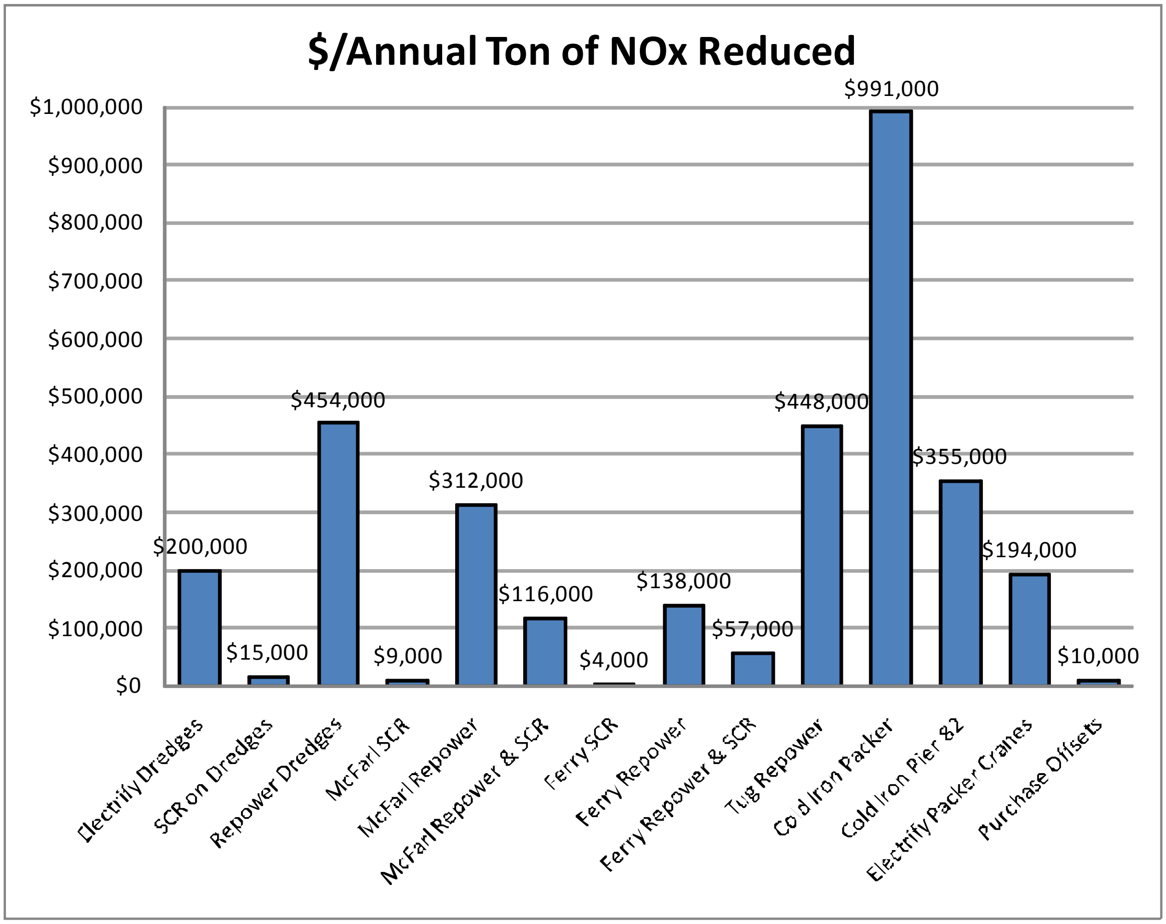

Figure 5-2: Cost Effectiveness of Each Strategy

On the basis of cost effectiveness, installing SCR technology on the Cape May ferries is the most attractive option.

The number of tons estimated to be eliminated by each strategy is shown in Figure 5-3 below.

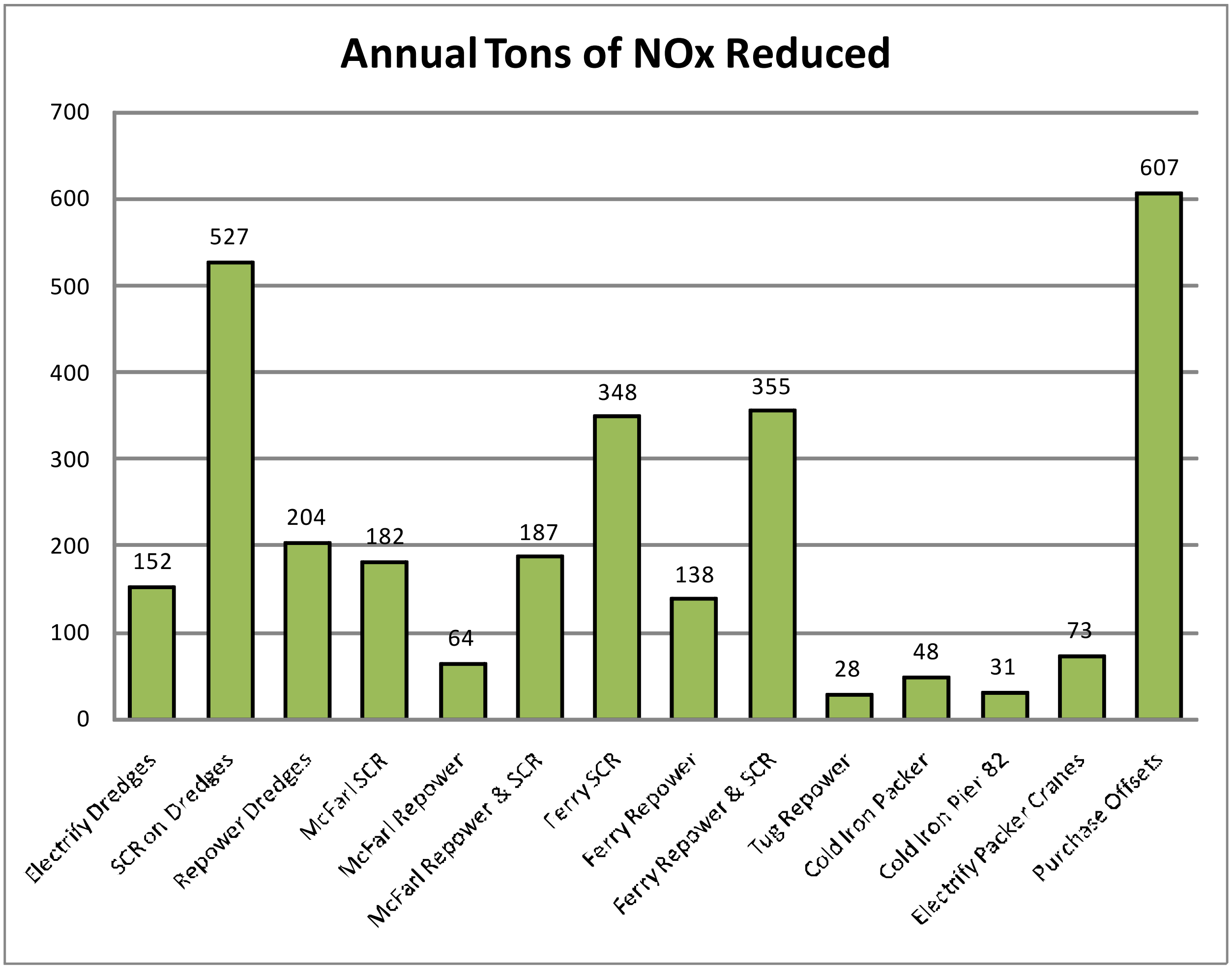

Figure 5-3: Annual Tons of NOx Reduced, by Strategy

The remaining peak annual emissions after the implementation of each of these strategies are shown graphically in Figure 5-4.

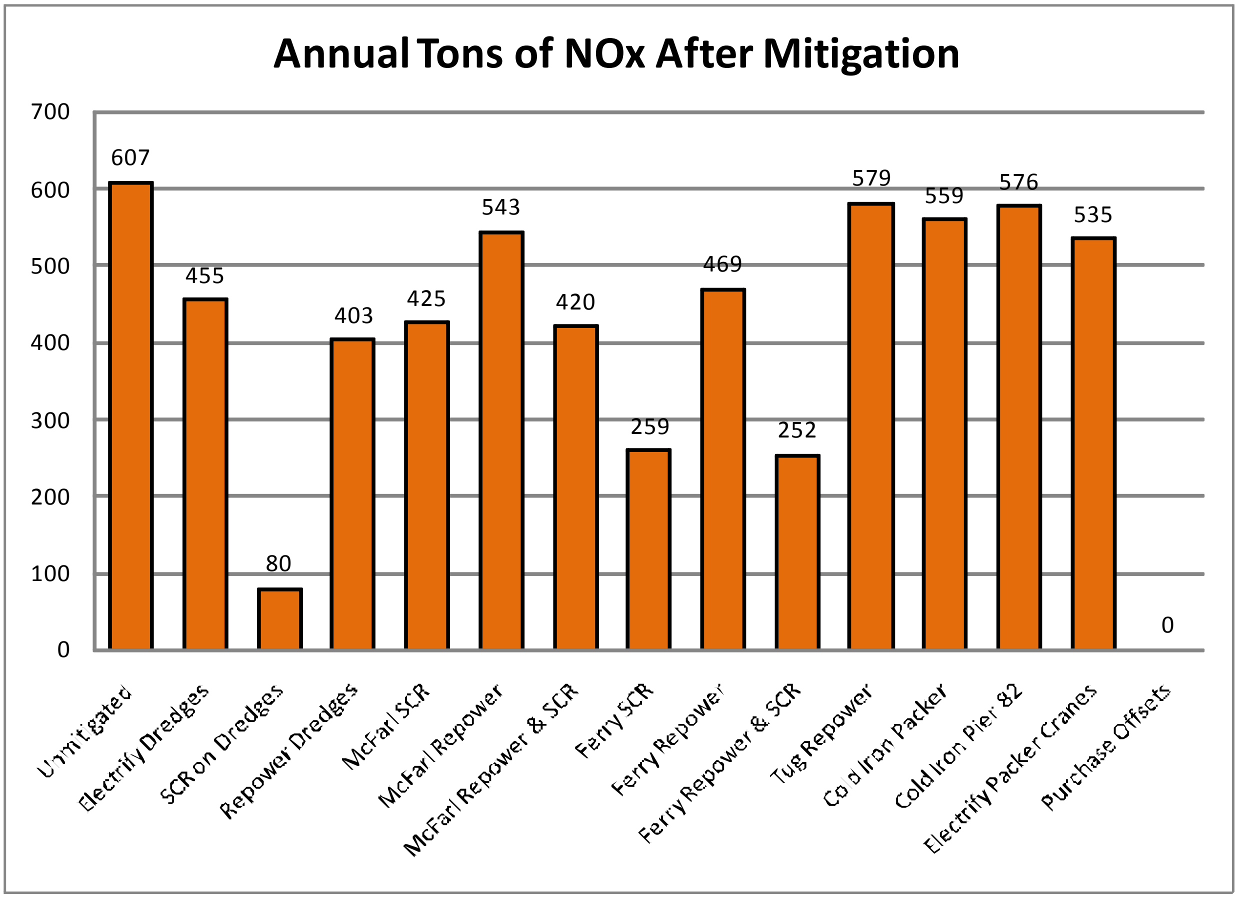

Figure 5-4: Annual Peak Tons of NOx for Project after Mitigation

Since none of the strategies (other than purchasing offsets) completely offsets the project emissions, some combination of the identified mitigation measures would be required to offset the project emissions to zero.

6. ON-SITE STRATEGIES

6.1 Summary Results

Using the same project emissions model applied to the baseline emissions estimate, the profile of emissions over time for each of the three on-site mitigation measures were evaluated. These estimates are based on project schedules for the channel and berth deepenings (given in Appendix D).

The total annual emissions are shown in Figure 6-1 for the unmitigated project and for each of the on-site mitigation strategies studied: repowering, electrification, installing SCRs.

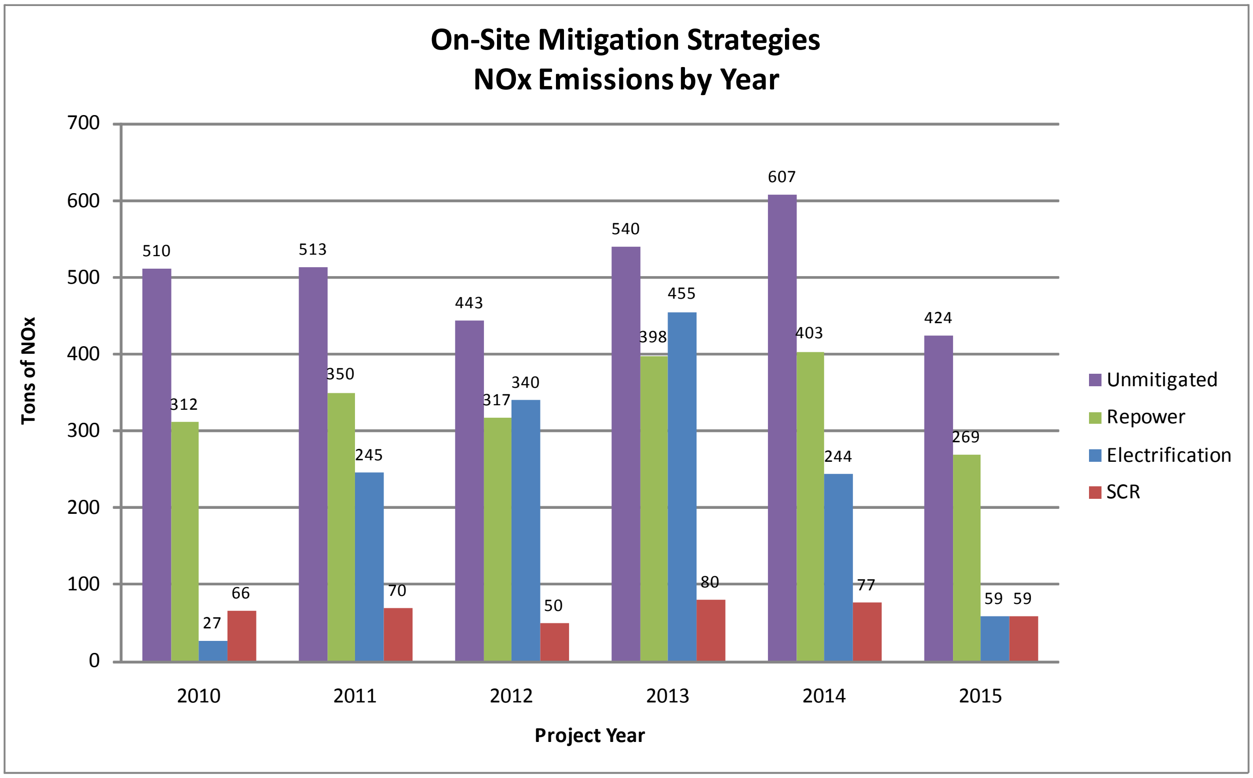

Figure 6-1: NOx Emissions by Year for On-Site Mitigation Strategies

Subtracting the mitigated annual emissions (the total emissions after the mitigation was applied) for each scenario from the baseline emissions yields the total tons eliminated by each on-site mitigation strategy. These NOx reductions are shown graphically in Figure 6-2 below.

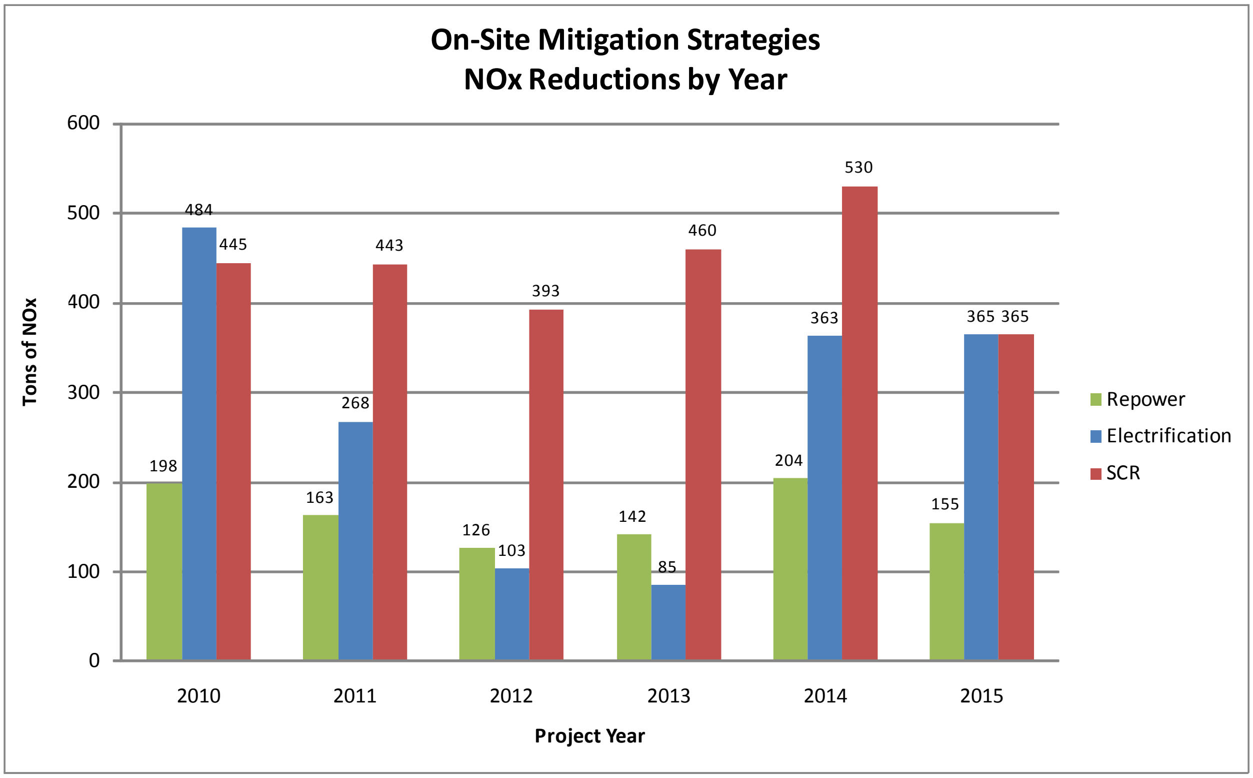

Figure 6-2: NOx Reductions by Year for On-Site Mitigation Strategies

Table 6-1: Summary of On-Site Mitigation Results

		Unmitigated	Electrification	SCR	Repower
Emission Reductions					
	Total Tons	3,038	1,370	402	2,049
	Total Tons Eliminated	0	1,667	2,636	989
	Average Tons Eliminated /yr	0	278	439	165
	Peak Tons	607	455	80	403
	Maximum Annual Reduction	0	484	530	204
	Peak Annual NOx Reduction	0	152	527	204
Cost - Electrification					
	# of Substations		6		
	$/Substation		$3,000,000		
	Dredge / Booster Converstions		5		
	$/Dredge Conversion		$2,500,000		
	Total Cost Electrification		$30,500,000		
Cost SCR & Repower					
	# of Cutter Suction Dredges			2	2
	Installed Hp of CSD			12,310	12,310
	# of Clamshell Dredges			1	1
	Installed Hp of Clamshell Dredges			8,310	8,310
	# of Towing Tugs			2	2
	Installed Hp of Towing Tugs			3,000	3,000
	# of Hopper Dredges			2	2
	Installed Hp of Hopper Dredges			15,000	15,000
	# of Boosters			2	2
	Installed Hp of Boosters			5,200	5,200
	Total Installed Hp			79,330	79,330
	Unit Cost ($/HP)			$100.00	$1,167.00
	Total Cost		$30,500,000	$7,933,000	$92,578,110
$/Annual ton (peak reduction)			$200,159	$15,043	$453,485

6.2 Strategy 1 – Electrify Dredges

In the electrification option, all cutter suction, boosters, and clamshell dredges are plugged into a shore side electrical grid. Other significant sources of emissions which are not electrified include hopper dredges and clamshell dredge towing tugs. Because these vessels are very mobile, it is not practical to plug them into the shore side grid. Drill boats and attendant plants such as crew boats, scows and tender tugs remain unmitigated in this option. The NOx emission factor for the electrified equipment is zero.

Running large cutter suction and clamshell dredges on electricity is fairly common in California. Deepening projects in Oakland, Los Angeles, and Long Beach have all used electric dredges. Cutter suction dredging in the Houston area has also been done by electrically powered dredges. In these applications, there is typically a shoreline substation installed on port property. The contractor plugs into this shoreline substation and pays the cost of the electricity used. The connection between the substation and dredge is via an electrical umbilical cord (typically 750 mcm, 3 conductor cable) laid on the seabed which is deployed and retrieved using large reels mounted on small "reel barges." The practical limit to the amount of submarine cable that can be handled and the time involved in finding a fault when submarine cable lengths are excessive requires a substation within three miles of the dredge areas. This means there would need to be a substation every six miles along the channel length for this project.

Local utilities were contacted to discuss the availability and location of the required power. In general, it seems that the capacity is reasonably available on the Delaware and Pennsylvania side of the river, but some areas in Southern New Jersey may have difficulty providing capacity.

A request was made for a drawing showing the details of the existing transmission lines; however, the utility was unwilling to send the drawing due to security concerns. Other drawings that were available along with information provided by the utility were used to complete an evaluation. The transmission grid drawing used is shown in Figure 6-3 below.

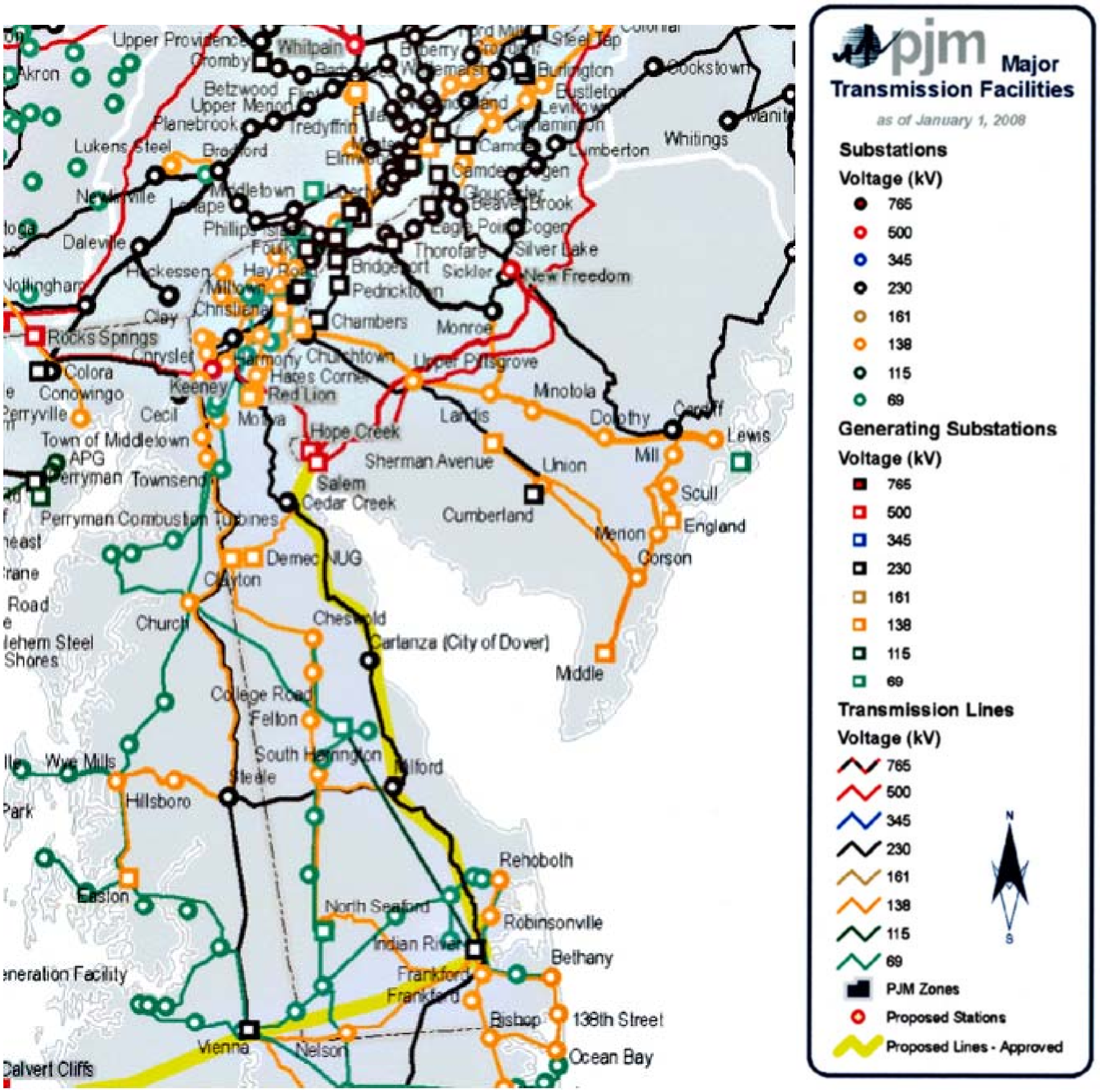

Figure 6-3: Electrical Transmission Grid

As described above, it was assumed that a substation would be built on the shoreline for every six miles of channel to be dredged using electric power. With most of the outer half of the project planned for hopper dredging (reaches D & E), this results in six new substations over roughly 35 miles of river. Detailed information on how much new power line would be required to connect a shore side substation to the local grid was not available from local utilities. Therefore, a cost of $3,000,000 was estimated for each substation installation based on previous experience.

The number of dredges that would actually be converted to electric operation depends in part on how many different contractors execute the seven deepening contracts and whether existing dredges with electric capability are available for the work. For the purposes of this study, it was assumed that five total conversions (dredges, boosters, tugs) would be required with an average cost of $2.5 million each.

Although this mitigation measure is technically feasible, as evidenced by its application elsewhere, it was concluded that it is not viable for this project. The number of substations required, the uncertainty in regard to land rights, the environmental actions necessary to run new transmission lines, and the timing to achieve all of this relative to the project schedule lead to this conclusion.

6.3 Strategy 2 – Install SCR on Dredges, Boosters, and Towing Tugs

The SCR option assumes that all dredges, boosters and towing tugs are outfitted with SCR units. Drill boats and attendant plant equipment such as crew boats, scows, and tender tugs are assumed to remain as unmitigated diesel power. The NOx emission factors for equipment with SCR were reduced from the unmitigated level by 92%.

The application of SCR on large dredges is limited to one 10,000 hp cutter suction dredge on the west coast that has operated a urea injection system since the late 1990's with reportedly excellent results. When the system was first installed, NOx emissions were cut by 99%[10].

Cost for SCR installation assumes that two each of cutter suction dredges, boosters, towboats and hopper dredges will require retrofitting with SCRs throughout the seven contract execution of the deepening. One clamshell dredge is assumed to be retrofitted with an SCR. The number of dredges that will actually be retrofitted depends in part on how many different contractors execute the anticipated seven deepening contracts and if a currently SCR capable dredge is available for the work.

The estimated unit cost for SCR installation of $100/hp is based on estimates provided for an SCR installation on the dredge Essayons as well as research done with SCR vendors for the ferry SCR option (see discussion of Strategy 5 below for further details). For the purposes of this study, the estimated unit cost was increased from $72/hp for the Essayons and $88/hp for the ferries to $100/hp to be conservative. This was done to account for complications that may be encountered on the various installations.

6.4 Strategy 3 – Repower Dredges, Boosters, and Towing Tugs

The repower option assumes that all dredges, boosters and towing tugs are repowered with modern low emitting (Tier 2) engines. Drill boats and attendant plant such as crew boats, scows and tender tugs are assumed to remain as unmitigated diesel power. Emission factors in the emission and schedule model were reduced to 7.3 gr/bhp-hr for these engines and the model was rerun to find the mitigated emissions per year.

The application of Tier 2 engines on large dredges is fairly new but has been done for some specific engines. Some recent repowers of isolated engines on large cutter suction or hopper dredges have occurred, but an entire repowering with Tier 2 engines has not been done in the industry yet. However, there is no reason to expect major difficulty implementing this alternative as the engine technology is well proven.

The repowering cost estimate assumes that two each of cutter suction dredges, boosters, towboats and hopper dredges will require repowering with Tier 2 engines throughout the seven contracts of the

[10] Conversation with Bob Davila, Chief Engineer of Manson Construction 11/13/09 regarding SCR performance on the HR Morris. Initially, NOx emissions dropped from 826 ppm to 2 ppm.

deepening. One clamshell dredge is assumed to be repowered as well. The number of dredges that would actually be repowered depends in part on how many different contractors execute the seven different contracts. Cost for repowering assumed a unit price of $1,167/hp based on input from the Philadelphia District Marine Design Center (see detailed discussion in strategy 5). This cost includes both the engines and installation.

The technical feasibility of this option is not in question given that new, cleaner engines have already been installed on dredges and more will undoubtedly be installed as these engines naturally turn over with retirements and new engine replacements. However, the turnover rate for dredge engines is low, and in some cases they may be replaced with rebuilt older style engines rather than new low emitting engines. Therefore, it cannot be assumed that later phases of the project will be dredged with much lower emitting engines as a result of the normal course of engine replacement. It is expected that a minimum of 12 months would be required to secure a new engine and install it on a dredge.

7. OFF-SITE STRATEGIES

7.1 Summary Results

Table 7-1 summarizes the results of the off-site mitigation strategies.

Table 7-1: Summary of Off-Site Mitigation Results

	4a McFarland	4b McFarland	4c McFarland	5a Cape May Ferries	5b Cape May Ferries	5c Cape May Ferries	6 Local Tugs	7a Cold Ironing	7b Cold Ironing	8 Electrify Cranes	9 Purchase Credits
	Repower w/SCR	SCR (no repower)	Repower (no SCR)	SCR (no repower)	Repower (no SCR)	Repower w/SCR	Repower (no SCR)	PRPA Packer Ave	PRPA Pier 82	PRPA Packer Ave	
Number of pieces of equip	1 dredge	1 dredge	1 dredge	4 of 5 ferries	4 of 5 ferries	4 of 5 ferries	2 tugs	2 berths 25 vessels 155 calls	1 berth 4 vessels 53 calls	5 of 7 cranes	
Total EnginePower (hp)	6,400 (Propulsion) 6,480 (Pumps) 2,000 (Auxiliary)	6,400 (Propulsion) 6,480 (Pumps) 2,000 (Auxiliary)	6,400 (Propulsion) 6,480 (Pumps) 2,000 (Auxiliary)	4 x 4,100 = 16,400	4 x 4,100 = 16,400	4 x 4,100 = 16,400	4,200 + 3,520 + 3,000 = 10,720	7,565 (avg aux engine size per vessel)	2 vessels @ 6,080 2 vessels @ 2,230	2 x 2,000 + 1 x 1,600 + 2 x 1,800 = 9,200	
Total engine hours	1,070 (Propulsion) 954 (Pumps) 2,076 (Auxiliary)	1,070 (Propulsion) 954 (Pumps) 2,076 (Auxiliary)	1,070 (Propulsion) 954 (Pumps) 2,076 (Auxiliary)	9,577	9,577	9,577	9,000	2,917	1,827	19,000	
Load Factor	80%	80%	80%	85%	85%	85%	31%	19%	32%	21%	
Unmitigated NOx Emission Factor (g/bhp-hr)	12.0 - 14.0	12.0 - 14.0	12.0 - 14.0	10.0	10.0	10.0	9.8	10.4	10.4	6.79 - 15.5 depending on crane	
Mitigated NOx Emission Factor (g/bhp-hr)	0.53	0.96 – 1.12	6.64	0.5	6.2	0.31	7.3	0	0	0	
Annual Tons of NOx Unmitigated	197.7	197.7	197.7	375.1	375.1	375.1	108.2	69.1	32.6	74.6	607
Annual Tons of NOx Reduced	187.0	181.9	64.1	348.3	138.1	355.2	27.8	47.9	31.0	72.6	607
Percent Reduction	94.6%	92.0%	32.4%	92.9%	36.8%	94.7%	25.7%	69.3%	95.1%	97.3%	100%
Estimated Cost	$21.65M	$1.65M	$20M	$1.45M	$19.1M	$20.4M	$12.5M	$47.5M	$11M	$14.1M	$6.07M
$/Ton of NOx per year	$115,753	$9,071	$311,933	$4,167	$138,596	$57,384	$448,683	$991,200	$355,406	$194,235	$10,000

In terms of cost-effectiveness, installing SCRs on the Cape May ferries is the best off-site strategy.

7.2 Strategy 4 – McFarland

The Corps of Engineers' hopper dredge McFarland is a twin-screw ocean going hopper dredge with 14,600 hp shipboard for the various operating systems. It was built in 1967. The McFarland is used for regional operations and maintenance dredging.

Table 7-2 summarizes the average daily running hours for the different types of engines aboard the McFarland. The information in this table is from the 2004 report and was compiled from five years worth of daily reports, 1999 to 2003.

In order to obtain a conservative evaluation of the operating cycle, only those days where the McFarland was dredging within the limits of the project non-attainment area were included in the analysis. The emissions benefits received from an engine replacement program for the McFarland could then be used to directly offset the emissions created from construction of the proposed deepening project.

There are several reasons for utilizing five years worth of operating data to determine an average daily operating cycle for the dredge. First, there are quite a few reaches in the Delaware River that are dredged on a 2, 3, or 5-year cycle, thus requiring the inclusion of at least five years of operating data to get a reasonable average dredging cycle. Secondly, a five year average will incorporate any seasonal fluctuations that occur in the operating schedule.

The daily operating times for the various activities were combined depending on the dredging activity being performed and the particular engine being utilized. The different dredging activities and corresponding engine power usage are as follows:

1. Propulsion Only –The propulsion horsepower is based on the propulsion horsepower of 6,400 hp plus the 2,000 hp utilized for the ship service generators.
2. Dredging - During dredging operations the dredge travels at a slower rate of speed than normal and utilizes approximately 50% or less of its available propulsion power. In addition, the dredge utilizes only two of the dredge pump engines, plus the ship's service generators. The total horsepower demand for dredging operations is based on the combination of the dredge pump horsepower (4,320 hp) plus the ship's service horsepower (2,000 hp), with all remaining horsepower available for propulsion.
3. Dumping - The horsepower utilized for dumping the hopper at the open-water disposal site is based on the approximately forty percent or less of its available horsepower plus the ship service horsepower (2,000 hp). The reason for this is that when the dredge is at the disposal site it has slowed to a much slower speed in order to open the dump doors, so the propulsion engines are approximately 50% utilized.
4. Pumping off - When the dredge is pumping off to an upland disposal site, it is typically tied off to a mooring barge. Consequently, the horsepower for pumping off is the combination of all the dredge pumps (6,480 hp) plus the ship service power (2,000 hp).
5. Generator Power only – When the dredge is tied up to the dock, typically only the ship service generators (2,000 hp) are necessary to provide electrical power.

Table 7-2: McFarland – Engine Running Hours

		Total Hours avg daily hrs	Propulsion Engines avg daily hrs	Dredge Pump Engines avg daily hrs	Generator Engines avg daily hrs		
Sailing	To & from disposal	9.20	9.20		9.20	9.87	41.6%
	To & from anchorage	0.35	0.35		0.35		
	Loss time due to traffic & bridges	0.05	0.05		0.05		
	Loss due to mooring barges	0.08	0.08		0.08		
	Transferring between works	0.17	0.17		0.17		
	Fire & boat drills	0.02	0.02		0.02		
Dredging	Pumping	1.50	1.50	1.50	1.50	2.03	8.5%
	Turning	0.06	0.06		0.06		
	Loss due to natural elements	0.47	0.47		0.47		
Disposal	Bottom dumping	0.34	0.34		0.34	9.75	41.1%
	Pump off	9.41		9.41	9.41		
	Generator only	2.10			2.10	2.10	8.8%
	Average hours per day	23.75	12.24	10.91	23.75	23.75	100.0%

UNMITIGATED NOx CALCULATIONS

Table 7-3 shows the NOx emissions for the McFarland without any mitigation measures applied. These emissions form the baseline for this portion of the study.

Table 7-3: McFarland – Unmitigated NOx Emissions

Mode	**Engine**	**Horsepower Utilized**	**Annual Hrs of Operation**	**Load Factor**	**NOx Factor (g/hp-hr)**	**Emissions (tons/hr)**	**Annual Tons of NOx**
Propulsion Only	1967 Propulsion (x3)	4800	863	0.80	14.00	0.0593	51.1
	1982 Propulsion	1600	863	0.80	12.00	0.0169	14.6
Dredging	1967 Propulsion (x3)	2400	178	0.80	14.00	0.0296	5.3
	1982 Propulsion	800	178	0.80	12.00	0.0085	1.5
	Dredge Pump (x2)	4320	131	0.80	14.00	0.0533	7.0
Dumping	1967 Propulsion (x3)	2400	29	0.80	14.00	0.0296	0.9
	1982 Propulsion	800	29	0.80	12.00	0.0085	0.2
Pumpoff	Dredge Pump (x3)	6480	823	0.80	14.00	0.0800	65.8
All Times	Auxiliary Generator (x2)	2000	2076	0.80	14.00	0.0247	51.3
					Totals	**0.3104**	**197.7**

The 80% load factor and NOx emission factor of 12.0 – 14.0 g/bhp-hr comes from the 2004 General Conformity and mitigation analysis report. These emission factors are reasonably consistent with the new emission factors used for the locomotive style engines assumed in the channel dredging estimates, therefore they were left unchanged.

7.3 Strategy 4a – SCR Installation (no repower)

NOx CALCULATIONS

It was assumed that the NOx reductions achieved by the SCRs would be 92%, which allows for time spent in warm-up and light load. Therefore, the emission factors were reduced to 8% of the unmitigated factors in the calculation summarized in Table 7-4.

Table 7-4: McFarland –NOx Emissions with SCR Only

Mode	Engine	Horsepower Utilized	Annual Hrs of Operation	Load Factor	NOx Factor (g/hp-hr)	Emission Rate (tons/hr)	Annual Tons of NOx	Annual Reduction (Tons NOx)
Propulsion Only	1967 Propulsion (x3)	4800	863	0.80	1.12	0.0047	4.1	47.0
	1982 Propulsion	1600	863	0.80	0.96	0.0014	1.2	13.4
Dredging	1967 Propulsion (x3)	2400	178	0.80	1.12	0.0024	0.4	4.9
	1982 Propulsion	800	178	0.80	0.96	0.0007	0.1	1.4
	Dredge Pump (x2)	4320	131	0.80	1.12	0.0043	0.6	6.4
Dumping	1967 Propulsion (x3)	2400	29	0.80	1.12	0.0024	0.1	0.8
	1982 Propulsion	800	29	0.80	0.96	0.0007	0.0	0.2
Pumpoff	Dredge Pump (x3)	6480	823	0.80	1.12	0.0064	5.3	60.6
All Times	Auxiliary Generator (x2)	2000	2076	0.80	1.12	0.0020	4.1	47.2
					Totals	**0.0248**	**15.8**	**181.9**

COST ESTIMATE

The estimated cost to install SCR on the McFarland is $1.65M. This is based on an estimate prepared for a similar SCR installation on board the dredge Essayons in California.

This yields a cost-effectiveness of **$9,071 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that SCRs have been successfully installed on dredges in the past. However, the details of an installation would need to be worked out in a design specific to this vessel. It is expected that a minimum of 12 months would be required to design, build and install the SCR system.

7.4 Strategy 4b – Repower (no SCR)

The repower would replace the ten existing engines with three new engines – two main engines and a smaller auxiliary engine for when the mains are off. A USACE document titled "Dredge McFarland 2005" (document no. 2526-A010-01 Rev 0) published in August 2002 describes the repower and gives an estimate for the cost.

NOx CALCULATIONS

The same 80% load factor was used for the repower calculations, but the emission factor drops to 6.64 g/bhp-hr, as shown in Table 7-5.

Table 7-5: McFarland –NOx Emissions with Repower Only

Mode	Engine	Horsepower Utilized	Annual Hrs of Operation	Load Factor	NOx Factor (g/hp-hr)	Emissions (tons/hr)	Annual Tons of NOx
Propulsion Only	*New Main Engines (x2)*	12000	863	0.80	6.64	0.0703	60.6
Dredging	*New Main Engines (x2)*	12000	178	0.80	6.64	0.0703	12.5
Dumping	*New Main Engines (x2)*	12000	29	0.80	6.64	0.0703	2.0
Pumpoff	*New Main Engines (x2)*	12000	823	0.80	6.64	0.0703	57.8
Idle	*Auxiliary Generator*	2000	51	0.80	6.64	0.0117	0.6
					Totals	**0.2928**	**133.6**

The annual NOx emissions would drop from 197.7 tons to 133.6 tons, a reduction of 64.1 tons per year.

COST ESTIMATE

The USACE cost estimate from the August 2002 paper is $20M. This includes the design, purchase, and installation costs.

This yields a cost-effectiveness of **$311,933 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that engine replacements have been performed on hopper dredges in the past; including the USACE hopper dredge Essayons. However, a detailed design would have to be done. It is expected that a minimum of 18 months would be required to design, build and install the new engines.

7.5 Strategy 4c – Repower and SCR Installation

In this strategy, the McFarland would be repowered and have SCR units installed on the new engines. In this case, the SCR reduction of 92% is taken off the updated emission factor of 6.64 g/bhp-hr.

NOx CALCULATIONS

Table 7-6 shows the NOx calculations for the McFarland with SCRs on new engines.

Table 7-6: McFarland –NOx Emissions with SCR *and* Repower

Mode	**Engine**	**Horsepower Utilized**	**Annual Hrs of Operation**	**Load Factor**	**NOx Factor (g/hp-hr)**	**Emissions (tons/hr)**	**Annual Tons of NOx**
Propulsion Only	*New Main Engines (x2)*	12000	863	0.80	0.53	0.0056	4.9
Dredging	*New Main Engines (x2)*	12000	178	0.80	0.53	0.0056	1.0
Dumping	*New Main Engines (x2)*	12000	29	0.80	0.53	0.0056	0.2
Pumpoff	*New Main Engines (x2)*	12000	823	0.80	0.53	0.0056	4.6
Idle	*Auxilliary Generator*	2000	51	0.80	0.53	0.0009	0.0
					Totals	**0.0234**	**10.7**

The annual NOx emission would drop from 197.7 tons to 10.7 tons, a reduction of 187.0 tons per year.

COST ESTIMATE

The cost estimate for a combined repower and SCR installation was estimated at $21.65M ($20M for the repower plus $1.65M for the SCR units).

This yields a cost-effectiveness of **$115,753 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that engine replacements and SCR installations have been performed on dredges in the past. However, the details of a repowering and SCR installation would need to be worked out in a detailed design for this specific vessel. It is expected that a minimum of 18 months would be required to design, build and install the new engines with SCR systems.

7.6 Strategy 5 – Cape May-Lewes Ferries

The Cape May-Lewes ferries were identified as the best candidates for project mitigation of the ferries in the region. They run a fleet of five older vessels. All five ferries have the same hull and engine design. The two main engines combined are 4,100 hp. The first three were built in the early 1970's, the later two were built in the early 1980's. Two of the ferries were refurbished in the late 1990's when an upper deck was added. At that time, new generators were installed to run larger air conditioning units on board. The main engines were not modified, though.

The capacity of the ferries is approximately 900 people and 100 vehicles. The one-way passage from Cape May to Lewes takes about 80 minutes. There are anywhere from four to eleven round trips per day, depending on holidays and seasons.

Four of the five Cape May ferries would be good candidates for mitigation (either SCR or repower). The fifth ferry only operated 220 hours in 2008 – fuel consumption is high on this vessel because of the second deck, so they use it less often – whereas the other four ferries operate 2,400 hours per year on average.

7.7 Strategy 5a - SCR Installation (no repower)

An inventory of SCR installations on ferries was conducted to determine the viability and approximate cost for this strategy. SCR units have been installed on a total of six ferries in the U.S. Four of those ferries are in operation today, with a fifth ferry being delivered in late 2009. The sixth SCR installation on an existing ferry was not successful in the end.

For different reasons, none of the six installations is a good cost comparison for the Cape May ferries. Two of the ferries were new builds, so the engines and engine compartments were designed to accommodate SCR units. This is easier than trying to fit SCR units into existing engine compartments and layouts. Two other ferries had engine repowers done at the same time as the SCR installation, which also reduces the cost for SCR. All four of these vessels are also smaller, light weight, high speed passenger-only ferries.

The fifth SCR installation on a ferry is a fair comparison in terms of ship size and no accompanying repower, but that vessel (a Staten Island NY ferry named "Alice Austen") was the first ever SCR installation on a ferry. As such, the project cost was likely higher than it would be today because they were addressing many issues (such as safety, training, Coast Guard permitting, etc) for the first time. There have also been many improvements in SCR technology. Most notably, there have been significant advances in reducing the size of the units since the Alice Austen design started in early 2004.

NOx CALCULATIONS

Engine information for the Cape May Ferries and their 2008 running hours[11] are given in Table 7-7 along with estimated NOx emissions. Emissions were calculated using a load factor of 85% and an emission factor of 10.0 g/bhp-hr (13.36 g/bkW-hr), as recommended by the EPA in Tables 3-3 and 3-5 of the April 2009 document.

[11] From information given to by Captain Bryan C. Helm of the Cape May – Lewes Ferries via email, phone, and fax on 5/22/09.

Table 7-7: Cape May Ferries – NOx Emissions, SCR Only

Vessel Name	Engine Year	Annual Operating Hours	Unmitigated NOx (tons/yr)	NOx Reduction (tons/yr)
Cape May	1984	220	8.4	0.0
Cape Henlopen	1980	2,560	98.0	93.1
Twin Capes	1973	2,146	82.2	78.1
Delaware	1973	2,164	82.9	78.7
New Jersey	1973	2,707	103.6	98.5
		Total	375.1	348.3

It was assumed that the SCR units would reduce the NOx emissions by 95%. SCRs have been proven to reliably achieve reductions around 97%[12]. With the relatively long route (80 minutes each way) it was assumed the SCRs would be highly effective.

COST ESTIMATE

Without good cost comparables, Engine Fuel and Emissions Engineering, Inc (EFEE) was contacted to get a preliminary cost estimate for the Cape May ferries. EFEE is the company that performed the design for four of the five ferries running SCR today (Argillon, Inc did the design for the Alice Austen). EFEE's estimated cost for purchase and installation is $363,000 per ferry, which corresponds to $88/hp.

EFEE recently bid on an SCR project for the USACE dredge *Essayons*. The bid cost for the purchase and installation of SCR on seven engines, totaling 23,000 hp, came in at $1.65M. On a per horsepower basis, this comes to $72/hp. This shows that the estimate of $363k per ferry is in the same range as the *Essayons* bid.

The total cost for installing SCRs on four ferries is estimated at $1.45M.

This yields a cost-effectiveness of **$4,167 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that SCRs have been successfully installed on several ferries. However, the details of an SCR installation and the willingness of the ferry operator to participate would need to be worked out in a detailed design and negotiation. It is expected that a minimum of 18 months would be required to work out the terms of an agreement, design, build and install the SCR systems.

[12] Results for SCR performance on San Francisco Bay ferries can be found here http://www.efee.com/scr.html.

7.8 Strategy 5b - Repower (no SCR)

This part of the study analyzes the NOx benefits if the ferries had new Tier II engines installed without the SCR units. Again, it was assumed that the Cape May would not be repowered since it is used so infrequently.

NOx CALCULATIONS

The NOx emission factor drops from 10.0 g/bhp-hr (13.36 g/bkW-hr) for a Tier 0 engine to 6.2 g/bhp-hr (8.33 g/bkW-hr) for a new Tier II engine, as recommended by the EPA in Table 3-5 of the April 2009 document. The same load factor of 85% is used. The NOx emission reduction results are shown in Table 7-8.

Table 7-8: Cape May Ferries – NOx Emissions, Repower Only

Vessel Name	Engine Year	Annual Operating Hrs in 2008	Unmitigated NOx (tons/yr)	Mitigated (Tier II) NOx (tons/yr)	NOx Reduction (tons/yr)
Cape May	1984	220	8.4	8.4	0
Cape Henlopen	1980	2,560	98.0	61.1	36.9
Twin Capes	1973	2,146	82.2	51.2	30.9
Delaware	1973	2,164	82.9	51.7	31.2
New Jersey	1973	2,707	103.6	64.6	39.0
		Total	375.1	237.0	138.1

COST ESTIMATE

The cost for a ferry repower, according to the Philadelphia District Marine Design Center, is $3.5M for a 3,000 hp engine. This includes the purchase and installation cost. For a 4,100 hp vessel, the cost was extrapolated to $4.78M per ferry.

The total cost for four ferries is estimated at $19.1M.

This yields a cost-effectiveness of **$138,596 per ton of NOx reduced per year.**

The technical feasibility of this option is not in question given that engine replacements on ferries such as these are not uncommon. However, the details of an engine replacement and the willingness of the ferry operator to participate would need to be worked out in a detailed design and negotiation. It is expected that a minimum of 18 months would be required to work out the terms of an agreement, design, build and install the new engines.

7.9 Strategy 5c - Repower and SCR Installation

This part of the study explores the cost effectiveness for both repowering and installing SCRs on the ferries. Again, it was assumed that the SCRs would reduce the NOx emissions by 95%. The SCR emission reductions in this case would be in addition to the reductions already achieved by the engine repower.

NOx CALCULATIONS

Table 7-9 summarizes the NOx emissions and NOx reductions from repowering and installing SCRs on the Cape May ferries.

Table 7-9: Cape May Ferries – NOx Emissions, Repower *and* SCR

Vessel Name	Unmitigated NOx (tons/yr)	NOx After Repower (tons/yr)	NOx After SCR Added to Repower (tons/yr)	Total NOx Reduction (tons/yr)
Cape May	8.4	8.4	8.4	0.0
Cape Henlopen	98.0	61.1	3.1	95.0
Twin Capes	82.2	51.2	2.6	79.6
Delaware	82.9	51.7	2.6	80.3
New Jersey	103.6	64.6	3.2	100.4
Total	375.1	237.0	19.9	355.2

COST ESTIMATE

The cost for repowering the ferries is $4.78M per ferry, as described in the previous section. According to EFEE, the cost for installing an SCR goes down when the installation occurs at the same time as an engine repower. Instead of $363k per ferry, the cost decreases by $50k, to $313k per ferry.

The cost for a combined engine repower and SCR installation is estimated at $5.1M per ferry, for a total of $20.4M for four ferries.

This yields a cost-effectiveness of **$57,384 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that engine replacements and SCR installation have been successfully done on ferries in the recent past. However, the details of the project and the willingness of the ferry operator to participate would need to be worked out in a detailed design and negotiation. It is expected that a minimum of 18 months would be required to work out the terms of an agreement, design, build and install the new engines.

7.10 Strategy 6 – Repower Local Harbor Tugs

This part of the study looks at repowering local tug boats. Ocean-going tugs were not included in this analysis, in favor of tugs that spend the majority of their time in the project area. Installing SCR was eliminated as a viable option because the load cycles of harbor assist tug boats are too unpredictable and fluctuate too much to be able to use SCR technology effectively.

Most of the vessel assist work in the Delaware River is performed by tugs from one of three local companies: Wilmington Tug, Moran, and McAllister Towing. These companies were contacted in order to characterize each of the tugs in the local fleet.

NOx CALCULATIONS

Engine information (size and age) as well as 2008 operating hours for each tug were obtained. Each company was also asked to rank their tugs in order of preference for receiving a repower. Many of the local tugs were new builds or have been recently repowered. Most of the tug companies wanted to repower their oldest tugs first, even if those tugs were used less frequently. One company declined to rank their preference; in this case the ranking was done by engine size (largest engine first) since all the engines were Tier 0.

Table 7-10 lists the pertinent information for the six tugs (two from each company) identified as the best candidates for repower. These are either the oldest or biggest boats from each company. A load factor of 31%, a Tier 0 NOx emission factor of 9.8 g/bhp-hr (13.2 g/bkWhr), and a Tier II NOx emission factor of 7.3 g/bhp-hr (9.8 g/bkW-hr) were used, as recommended by the EPA in Tables 3-4 and 3-8 of the April 2009 document.

Table 7-10: Local Harbor Tugs – NOx Emissions

Tug Name Company & Rank	Main Engine Total HP	Annual Operating Hrs	Unmitigated (Tier 0) NOx (tons/yr)	Tier II NOx (tons/yr)	NOx Reduction (tons/yr)
Lindsey Wilmington #1	2,400	3,000	24.2	18.0	6.2
Capt. Harry Wilmington #2	4,200	3,000	42.4	31.5	10.9
Valentine Moran Moran #1	3,520	3,000	35.5	26.4	9.2
Bart Turecamo Moran #2	3,000	3,000	30.3	22.5	7.8
Neill McAllister #1	1,800	3,000	18.2	13.5	4.7
Teresa McAllister #2	1,750	1,500	8.8	6.6	2.3

<u>COST ESTIMATE</u>

The cost for a repower, as given by the Philadelphia District Marine Design Center, is $3.5M for a 3,000 hp engine. On a per horsepower basis, this is $1,167 per horsepower.

If the top three tugs with the most benefit in terms of NOx reductions are repowered then the cost effectiveness shown in Table 7-11 is calculated.

Table 7-11: Local Harbor Tugs – Repower Costs (Purchase and Installation)

Tug	HP	Cost for Repower	NOx Reduction (tons/yr)
Capt. Harry	4,200	$4.9M	10.9
Valentine Moran	3,520	$4.1M	9.2
Bart Turecamo	3,000	$3.5M	7.8
	Total	$12.5M	27.9

This yields a cost effectiveness of **$448,683 per ton of NOx reduced per year**.

Other strategies for selecting individual tugs, such as repowering each company's top choice or top two choices, yield similar results for cost effectiveness.

The repower cost given by the Philadelphia District Marine Design Center includes purchase and installation costs. The Port Authority of New York and New Jersey started a program in 2004 to repower some local tugboats (also as air emission mitigation measures). As part of that program, the Port Authority paid for the purchase cost of the engine and the individual companies paid for the installation.

The engine sizes and purchase costs[13] for the three tug boats in that program are shown in Table 7-12 along with an average dollar per horsepower figure.

Table 7-12: Local Harbor Tugs – NYNJ 2004 Tug Repower Costs (Purchase Only)

Tug	hp	Cost	$/hp
Buchanan 12	3000	$1,000,000	$333
Dorothy J	1200	$311,475	$260
Robert IV	900	$115,739	$129
		average	$240

If the repower costs include the engine purchase price without the installation, the cost for repowering the three Delaware River tugs listed in Table 7-11 drops to $2.6M (using the average cost of $240/hp). The cost effectiveness in this scenario is $93,190 per ton of NOx reduced per year.

The technical feasibility of this option is not in question given that engine replacements on tug boats such as these are not uncommon. However, the details of an engine replacement and the willingness of the tug operators to participate would need to be worked out in a detailed design and negotiation for this specific option. It is expected that a minimum of 18 months would be required to work out the terms of an agreement, design, build and install the new engines.

7.11 Strategy 7 – Install Shore Power (Cold Ironing)

The goal of this emission reduction strategy is to provide shore power for vessels so they can turn off their diesel auxiliary engines while they are at berth. Cold ironing eliminates the emissions while the vessel is plugged in, but does not reduce transit or maneuvering emissions.

The California Air Resources Board (CARB) recently passed a regulation requiring cold ironing at most container, cruise, and reefer terminals in California. The cost estimate portion of this study relies heavily on the published results of their research. The CARB report and the details of their cost effectiveness study can be found in Appendix E of an October 2007 staff report to the rule making body[14].

In brief, CARB uses a cost of $5M per berth and $1.5M per vessel. Their analysis also includes assumptions for fleet turnover, labor costs, fuel and electricity costs, etc, but those were not included at this level of analysis. The methodology for this analysis was to review recent vessel call data for the Philadelphia Regional Port Authority (PRPA) and determine what the costs and NOx benefit would have been had two of their terminals cold ironed a certain segment of their calls that year.

Ship call records for 2007 and 2008 for all the PRPA terminals were obtained. The records included ship names and arrival and departure dates and times. The data were filtered and sorted to develop an understanding of the average berthing times, the number of unique vessels, and the frequency of ship calls. The number of unique vessels is very important because each individual ship must be modified to be able to use shore power. The results were used to determine which terminals would be the best candidates for cold ironing.

[13] These details are given Tables 1, 2, and 3 of a January 13, 2005 report titled "2004 Tugboat Emission Reduction Program for the NYNJLI Ozone Non-attainment Area," written by M.J. Bradley.

[14] This report can be found on CARB's website, http://www.arb.ca.gov/regact/2007/shorepwr07/appe.pdf.

Table 7-13 summarizes the number of ship calls for each terminal by commodity. The top eight commodities listed here represent 94% of all the calls. Unlisted commodities, such as paraffin, salt, lumber, and locomotives, had very few calls.

Table 7-13: Cold Ironing – PRPA Ship Call Data for 2008

Commodity	Number of Calls per Terminal							
	Packer Ave	Tioga	82 South	80 South	TMTII	38-40 South	84 South	All PRPA
Containers	265	0	0	0	0	0	0	265
Fruit	1	46	54	2	0	0	0	103
Paper	1	0	0	32	0	18	0	51
Steel	15	14	0	0	0	0	0	29
Breakbulk	1	27	0	0	0	0	0	28
Chemicals	0	3	0	0	23	0	0	26
General	0	15	0	0	0	0	0	15
Cocoa	0	0	0	0	0	0	13	13
All other	23	7	0	5	3	1	0	39
TOTAL	306	112	54	39	26	19	13	569

Two different terminals were selected for this analysis. Packer Avenue Marine Terminal (PAMT) was chosen because it handles the majority of PRPA's container traffic and almost 50% of the ship calls to Philadelphia. Pier 82 South was chosen because it has a very small and well defined vessel fleet. Four reefer ships made 53 of the terminal's 54 calls in 2008.

The Packer Ave results are presented first, followed by the Pier 82 results.

7.12 Strategy 7a – Packer Avenue Marine Terminal

Table 7-14 summarizes the number of container ship calls and berthing times for PAMT.

Table 7-14: Cold Ironing – Container Ship Calls to PAMT

	2007	2008
Total # calls	273	265
# of unique ships	73	61
Total time on berth (hrs)	3,947	4,209
Average time on berth (hrs)	14.5	16.7
Shortest time on berth (hrs)	2.5	4.5
Longest time on berth (hrs)	48.3	137.7

Even if a berth is equipped to provide shore power, it does not mean that every ship call to that berth will be cold ironed. The ships themselves must have compatible cold ironing capability. Shippers may be reluctant to modify their vessels because it is such an expensive proposition, especially if the ship only calls at a terminal with shore power a few times each year. Therefore, in keeping with CARB standards, the benefits of cold ironing were only assessed for those ships that call 5 or more times per year. The costs and benefits of only cold ironing vessels calling 6+ times per year were also considered. Based on the 2008 vessel call data, it was determined that capturing vessels that call 5+ times per year, gave a fair cost effectiveness number (not the highest, not the lowest).

Table 7-15 shows the number of ships and berth hours that would be captured by cold ironing in the sample scenario.

Table 7-15: Cold Ironing – Container Ships Calling PAMT Five or More Times in 2008

# of vessels requiring modification	25
# of calls cold ironed	155
Percent of the calls/year cold ironed	58%
Berth hours cold ironed	2,917
Percent of the total berth hours cold ironed	69%

PACKER AVE NOx CALCULATIONS

The Clarkson Register (a commercially available database of information on the world fleet) was consulted for vessel characteristics, including engine size, for each of the 25 ships that are included in the 2008 cold ironing scenario. On average, each vessel was 720 feet long, had a carrying capacity of 3,000 TEUs, and a total main engine horsepower of 34,400.

According to Table 2-4 of the EPA's April 2009 guidance document on calculating port related emissions, auxiliary engines on container ships are 22% of the size of the main propulsion engines. Tables 2-7 and 2-16 list the appropriate load factors and emission factors for the auxiliary engines. These are summarized in Table 7-16.

Table 7-16: Cold Ironing – PAMT Container Ship Emission Factors

	Auxiliary Engines
Engine Horsepower	7,564
Fuel Type	MGO 0.10% S
Load Factor	19%
NOx Emission Factor (g/bkW-hr)	13.9
NOx Emission Factor (g/bhp-hr)	10.4

For the purpose of this analysis, it is assumed that the NOx emissions are zero for the entire length of call for the calls that are cold ironed. In reality, the auxiliary engines are kept running during portions of the tie-up and cast-off procedures while the shore power connections are handled.

Table 7-17 shows the NOx emissions by mode for the container ships going to PAMT.

Table 7-17: Cold Ironing – PAMT Container Ship At-Berth NOx Emissions

	Berth Hours Not Cold Ironed	Berth Hours Cold Ironed	NOx (tons/yr)
Unmitigated	4,209	0	69.1
Cold ironing all vessels calling 5+ times	1,292	2,917	21.2
		NOx Reduction	47.9

PACKER AVE COST ESTIMATE

The cost to electrify two berths is estimated at $10M and the cost to modify 25 vessels is estimated at $37.5M, for a total project cost of $47.5M.

This yields a cost effectiveness of **$991,200 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that several ship berths and container ships have been retrofitted for cold ironing in other parts of the country. However, the details of a cold ironing design, coordination with local utilities and the willingness of the ship operators to participate would need to be worked out in a detailed design and negotiation for this specific option. It is expected that a minimum of 24 months would be required to work out the terms of agreements, design, and install the necessary infrastructure.

7.13 Strategy 7b – Pier 82

In 2008, Pier 82 handled refrigerated fruit exclusively. There were 54 calls by five different reefer vessels. One of those vessels only called one time. For this analysis, it was assumed that the other 53 calls were all cold ironed.

Table 7-18: Cold Ironing – Ship Call Information for Pier 82 in 2008

Total # calls	54
# of unique ships	5
Total time on berth (hrs)	1,877
Average time on berth (hrs)	34.8
Shortest time on berth (hrs)	10.3
Longest time on berth (hrs)	57.3

Table 7-19: Cold Ironing – Four Main Vessels Calling at Pier 82

# of vessels requiring modification	4
# of calls cold ironed	53
Percent of the calls/year cold ironed	98%
Berth hours cold ironed	1,827
Percent of the total berth hours cold ironed	97%

PIER 82 NOx CALCULATIONS

Two sets of sister ships composed the fleet of four reefer vessels. The two smaller vessels had main engines of 5,500 hp and made 17 calls; the two larger vessels had main engines of 15,000 hp and made 36 calls. According to Table 2-4 of the EPA's April 2009 guidelines, auxiliary engines on reefer vessels are 40.6% the size of the main engines on average. Table 7-20 summarizes the engine sizes and berthing hours for the ships calling at Pier 82.

Table 7-20: Cold Ironing – Pier 82 Reefer Ship Information

	Smaller Two Ships	Larger Two Ships
Main Engine Size (hp)	5,500	15,000
Auxiliary Engine Size (hp)	2,231	6,077
At-Berth Time (hrs)	573	1,254

Table 2-7 of the EPA guidelines lists the load factor for auxiliary engines on reefer ships as 32%. It is higher than the container ship load factor (19%) because the auxiliary engines are used to keep the perishable goods cold while the ship is at berth. The NOx emission factor is the same as for container ships. The factors used to calculate NOx emissions for the reefer ships are shown in Table 7-21.

Table 7-21: Cold Ironing – Pier 82 Reefer Ship Emission Factors

	Auxiliary Engines
Engine Horsepower	2,231 (two small ships) 6,077 (two large ships)
Fuel Type	MGO 0.10% S
Load Factor	32%
NOx Emission Factor (g/bkW-hr)	13.9
NOx Emission Factor (g/bhp-hr)	10.4

Table 7-22 summarizes the NOx emissions before and after cold ironing Pier 82 in 2008.

Table 7-22: Cold Ironing – Pier 82 Reefer Ship At-Berth NOx Emissions

	Berth Hours Not Cold Ironed	Berth Hours Cold Ironed	NOx (tons/yr)
Unmitigated	1,877	0	32.6
Cold ironing four main vessels	50	1,827	1.6
		NOx Reduction	31.0

PIER 82 COST ESTIMATE

The cost to electrify one berth is estimated at $5M and the cost to modify four vessels is estimated at $6M, for a total project cost of $11M.

This yields a cost effectiveness of **$355,406 per ton of NOx reduced per year**.

The technical feasibility of this option is not in question given that several ship berths and container ships have been retrofitted for cold ironing in other parts of the country. However, the details of a cold ironing design, coordination with local utilities and the willingness of the ship operators to participate would need to be worked out in a detailed design and negotiation for this specific option. It is expected that a minimum of 24 months would be required to work out the terms of agreements, design, and install the necessary infrastructure

ADDITIONAL COLD IRONING ANALYSIS

The number of ship-berth-days required to provide NOx offsets equal to those produced by repowering the McFarland and by electrifying the on-site dredge equipment were also calculated.

A Panamax sized ship was assumed for this portion of the study. A Panamax ship can be roughly defined as one that is about 950 feet long with a capacity of 4,300 TEUs. This is bigger than the typical size vessel currently calling frequently at Packer Ave Marine Terminal. Ten different ships with 4,300 TEU capacity were selected from the Clarkson Register and it was determined that the average propulsion engine size is 53,650 hp. Applying the same EPA factor for the ratio of auxiliary engine to main (22%) as used in the Packer Ave analysis above, the average auxiliary engine size was determined to be 11,800 hp.

The same load factor and emission factor as listed in Table 7-16 were used here. The auxiliary engines from a Panamax ship generate about 0.61 tons of NOx per 24-hour period, calculated as follows:

(11,800 hp) x (19% load factor) x (10.4 g/bhp-hr) x (1.1 e^{-6} tons/g) x (24 hrs/day) = 0.6155 tons/day

The McFarland repower yielded an annual reduction in NOx emissions of 64.1 tons. A Panamax ship would have to cold iron for a little more than 104 entire days per year to obtain equal NOx reductions.

Electrifying the project dredges yields different NOx reductions for different years. The electrification reductions for each year are given in Table 7-23 along with the number of days of cold ironing that would achieve the same NOx reductions.

Table 7-23: Additional Cold Ironing Analysis: Equivalent Reductions on Ship-Berth-Day Basis

	2010	2011	2012	2013	2014	2015
Tons of NOx reduced by project dredge electrification	484	268	103	85	363	365
Number of days of cold ironing required to get equivalent NOx emission reductions*	786	435	167	138	590	593
* A cold ironed day here is defined as a 24 hour period for a Panamax sized ship with zero NOx emissions from its auxiliary engines.						

7.14 Strategy 8 – Electrify Diesel Dock Cranes

The goal of this measure is to electrify the diesel dock cranes in the project area. The Packer Ave terminal in Philadelphia was identified as the best candidate for electrification because it handles the most containers and has the most cranes.

The PRPA provided data for their cranes as shown in Table 7-24.

Table 7-24: Electrify Diesel Cranes – Crane Information from PRPA

CRANE	ENGINE YEAR	HORSE POWER	ANNUAL ENGINE HOURS	LOCATION
Kocks, K-5 Crane	1982	800	500	PAMT
Kocks, K-5 Crane	1982	300	500	PAMT
Kocks, K-2 Crane	1992	2,000	3,000	PAMT
Kocks, K-3 Crane	1992	2,000	2,000	PAMT
Paceco Crane	1986	1,600	4,000	PAMT
Hyundai, H-6	2002	1,800	5,000	PAMT
Hyundai, H-7	2002	1,800	5,000	PAMT
Liebherr, LHM 400		811	400	Pier 82
Liebherr, LHM 400		811	900	Tioga Marine Terminal
Kocks, K-1 Crane		800	500	Tioga Marine Terminal
Kocks, K-1 Crane		300	500	Tioga Marine Terminal
Kocks, K-4 Crane	1982	800	500	Tioga Marine Terminal
Kocks, K-4 Crane	1982	300	500	Tioga Marine Terminal

This information shows that Packer Ave Marine Terminal has the highest crane operating hours of the three terminals. If crane electrification proves cost effective for Packer Ave, then it can be explored at other terminals (such as Tioga, Pier 82, and Wilmington) as well. The two smallest cranes at Packer Ave were not included for electrification because their annual operating hours are so low.

<u>NOx CALCULATIONS</u>

The unmitigated NOx emissions were calculated for all seven Packer Ave cranes using a load factor of 21% and the NOx emission factors shown in Table 7-25. The load factor and emission factors are all from the EPA's NONROAD2005 model.

Once the cranes are electrified, their NOx emissions drop to zero. The NOx reduction results are shown in Table 7-25. The two smallest cranes show zero NOx reductions because it was assumed that they would not be electrified due to low usage.

Table 7-25: Electrify Diesel Cranes – NOx Emissions

Crane	Engine Year	NOx Emission Factor (g/bhp-hr)	Unmitigated NOx (tons/yr)	NOx Reduction (tons/yr)
Kocks, K-5 Crane	1982	15.45	1.4	0.0
Kocks, K-5 Crane	1982	15.45	0.5	0.0
Kocks, K-2 Crane	1992	9.25	12.8	12.8
Kocks, K-3 Crane	1992	9.25	8.6	8.6
Paceco Crane	1986	15.45	22.9	22.9
Hyundai, H-6	2002	6.79	14.1	14.1
Hyundai, H-7	2002	6.79	14.1	14.1
		Total	74.6	72.6

COST ESTIMATE

According to PRPA[15], the estimated cost for the crane electrification is as follows:

$8.1M for infrastructure improvements

$1.2M per crane for drive replacements

Using these figures, total project costs were calculated to be $14.1M ($8.1M plus $6M for the five cranes).

The PRPA's estimated project costs correspond nicely to those from a similar recent project. The Port of Miami electrified seven diesel dock cranes between August 2004 and November 2005[16]. The project manager for Crane Management, Nelson Ferrer, reported some budget cost figures to use for this analysis (via telephone conversation on 5/27/09).

The cost for modifying seven cranes, the on-terminal trenching, and switch gear installation was $12,226,000. This included any required structural work on the cranes, installing cable reels, removing diesel engines, and removing fuel tanks. This corresponds to $1.75M per crane.

The cost for wharf improvements, including reinforcing the crane beam, adding pilings, fender work, and installing the open cable trench was $10M for 4,700 linear feet of wharf. This corresponds to $2,128 per linear foot.

Using the figures from the Port of Miami project, the total cost to electrify the cranes at Packer Ave, with five cranes ($8.73M) and 2,700 linear feet of wharf ($5.74M) would be $14.5M.

Using the PRPA cost of $14.1M, this yields a cost effectiveness of **$194,235 per ton of NOx reduced per year.**

[15] In an email on 6/5/09 from Lisa Magee of PRPA to Greg Lee of Philadelphia District Marine Design Center

[16] The project is described at http://www.cranemgt.com/projects.html.

The technical feasibility of this option is not in question given that many container terminals around the country have converted from diesel to electrically powered cranes. A crane power design has already been completed for PAMT, and has been coordinated with local utilities. The crane operators are willing to participate. It is expected that a minimum of 18 months would be required to permit, contract, build, and install the necessary infrastructure.

7.15 Strategy 9 – Purchase Emission Credits

Generally speaking, the Clean Air Act delegates authority to regulate stationary source emissions to individual states. It mandates minimum requirements for state permitting programs. In addition, there are also a variety of cap and trade programs at the regional level driven by Federal regulation. Two examples are the SO_2 cap and trade program to reduce acid rain in the northeast, and the Ozone Transport Commission (OTC) to reduce regional ozone problems. There are also some relatively new regional greenhouse gas emissions budgeting and trading programs. Some regional programs which regulate emissions of NOx and other pollutants are limited to electrical generation plants. The EPA generally retains authority to regulate mobile sources.

The market for NOx emissions trading in the northeast is generally driven by New Source Review (NSR) regulations. Each state that includes areas in non-attainment of the National Ambient Air Quality Standards is required to have NSR regulations consistent with minimum federal requirements. These are customized for the specific non-attainment area. NSR regulations pertain to stationary major sources[17]. They require any new major facility or new source at an existing major facility to comply with specific NSR requirements. NSR requirements typically include: (1) the installation of the lowest achievable emission rate (LAER), (2) emission offsets, and (3) the opportunity for public involvement.

Emissions offsets are emission reductions, generally obtained from existing sources located in the vicinity of a proposed source. The reductions must offset the emission increase from the new source or modification and provide a net air quality benefit. The obvious purpose for requiring offsetting emissions decreases is to allow an area to move towards attainment of the NAAQS while still allowing some industrial growth. Emission reduction credits (ERCs) must be from "permanent[18], enforceable, quantifiable and surplus" emissions reductions. In some states, ERCs may be created by both major and non-major facilities even though the NSR program only applies to major new or modified sources.

ERCs from existing stationary source trading markets could be used as a means to offset project emissions and demonstrate General Conformity. A precedent is the New York and New Jersey Harbor Deepening Project which used a conditional statement of conformity along with a menu of mitigation measures including emission offsets for early phases of the work. The Port Authority of New York and New Jersey (PANYNJ) purchased 95.68 tons of NOx shutdown credits in early 2003 for $113,065 as part of the then existing open market emissions trading program (OMET) in New Jersey. The PANYNJ also owned 200 tons of NOx reduction credits from a facility on Staten Island. At the time they published their plan (December 2003), those credits were being considered for use in the General Conformity strategy for the NYNJ Harbor Deepening Project[19].

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[17] A major source is a stationary source which emits or has the potential to emit regulated air pollutants such as nitrogen oxides (NOx) at specific threshold limits (typically 100 tons/year).

[18] Emission reductions that are Federally enforceable through an operating permit or a revision to the state implementation plan are considered permanent. The reductions used to generate ERCs must be assured for the duration of the corresponding emissions increase that is being offset with those emissions reductions.

[19] From the December 2003 Harbor Air Management Plan for the New York and New Jersey Harbor Deepening Project, prepared by Starcrest for the USACE NY District.

www.nan.usace.army.mil/harbor/pdf/air.pdf

The project sponsors and the affected states' regulators as well as the EPA have discussed the use of ERCs as a means for demonstrating General Conformity. Based on discussion with a local broker, several thousand credits are expected to be readily available in the Philadelphia area (the five counties in PA that are part of the 18 county, 4 state ozone non-attainment area). The anticipated market price is roughly $10,000 per ton. However, specific availability of credits and actual sale price are subject to negotiation when the project sponsors are ready to make an offer to purchase. Credits from New Jersey are likely to be both more available and less expensive (on the order of $3,000 to $4,000 per ton[20]).

8. SELECTION OF GENERAL CONFORMITY PLAN

8.1 Introduction

Direct (channel deepening) and indirect (berth dredging) emissions have been estimated. The resulting annual emissions are shown below.

Table 8-1: Project Emissions by Year

Calendar Year Emissions - tons						
De Minimis Level (tpy)	100	50	100		100	100
	NOx	VOCs	PM2.5	PM10	CO	SO2
2010	510.5	18.3	7.1	7.5	69.2	2.8
2011	513.1	19.3	8.2	8.8	59.0	1.5
2012	443.4	17.6	7.8	8.4	47.7	0.7
2013	539.8	22.3	10.3	11.1	61.9	1.1
2014	607.2	23.0	9.6	10.3	73.0	0.7
2015	423.7	15.1	6.1	6.5	56.6	0.6
Total Project	3,037.7	115.6	49.1	52.5	367.4	7.4

Based on these emissions, the project is expected to exceed the de minimis threshold for NOx every year of the project, whereas the emissions of other criteria pollutants are expected to be less than the de minimis limits for each year. Table 8-1 depicts the construction contracts and the associated NOx emissions that need to be mitigated on an annual basis. The total NOx emissions are estimated at 3,038 tons over the life of the project with a peak year of 607 tons in 2014.

Therefore, the project must demonstrate conformity by meeting one or more of the following:

1. Demonstrating that the total direct and indirect emissions are specifically identified and accounted for in the applicable SIP.

2. Obtaining a written statement from the state or local agency responsible for the SIP documenting that the total direct and total indirect emissions from the action along with all other emissions in the area will not exceed the SIP emission budget.

[20] Based on telephone conversation with emission credit broker Mason Henderson of CantorCO2e.

3. Obtaining a written commitment from the state to revise the SIP to include the emissions from the action.

4. Obtaining a statement from the metropolitan planning organization for the area documenting that any on-road motor vehicle emissions are included in the current regional emission analysis for the area's transportation plan or transportation improvement program.

5. Fully offset the total direct and indirect emissions by reducing emissions of the same pollutant or precursor in the same non-attainment or maintenance area.

6. Where appropriate, in accordance with 40 CFR 51.858(4), conduct air quality modeling that can demonstrate that the emissions will not cause or contribute to new violations of the standards, or increase the frequency or severity of any existing violations of the standards.

In reviewing the project emissions and the above options, option 5 was the most appropriate means to demonstrate conformity for each year. This option was used in the development and selection of the conformity plan.

8.2 Development of the Conformity Plan

The following criteria were applied in the development of plans to reduce or compensate for all NOx emissions above de minimis within the non-attainment area.

- The plan must reduce or compensate for the annual NOx emissions for each calendar year of the project.
- The plan must be cost effective and efficient.
- The plan must be implementable during the construction of the project

Furthermore, plans were grouped into two categories.

Category 1 - Reduce the emissions below the de minimis level by physically altering equipment – either on site or off site.

Category 2 - Compensate for exceedence through the acquisition of emission credits.

For each of the two categories, plans were developed to compensate for the total NOx emissions estimated over the construction period.

Under Category 1, the most cost effective strategy in terms of $/Annual Ton of NOx reduced (as shown in Figure 5-2) is the use of the SCR technology. Therefore, a plan was developed applying this technology and subsequently evaluated. Under Category 2, consideration was given to available emission credits in the non-attainment areas.

The details and evaluation of the two plans are presented below.

<u>Plan 1 – Using SCR Technology</u>

The SCR technology would reduce NOx emissions below the annual peak and, if the equipment is modified could be utilized for the project's construction. As described in Section 5 and shown in Figure 5-2, there are three strategies that would need to be considered in the development of a plan.

- McFarland SCR - $9000/ton
- Ferries SCR - $4,000/ton
- Dredges and attendant equipment SCR - $15,000/ton

The hopper dredge McFarland is now part of the USACE's ready reserve fleet, and as such would not likely be utilized as in prior years and would not generate the projected SCR emission reductions. Regarding the application of SCRs to ferry operations, while less costly than modifying construction equipment, there is a great deal of uncertainty in realizing the projected emissions in a timely manner. As a result both of these strategies were not pursued. The SCR for construction equipment (dredges and attendant equipment to be used in the construction of the project) will be further evaluated as Plan 1.

<u>Plan 2 – Purchasing Emission Reduction Credits</u>

This involves upfront purchasing of perpetual and multi-year emission reduction credits within the non-attainment area that encompasses the project area to offset the annual peak of 607 tons. This would be a one-time purchase and these credits would be used to compensate for NOx emissions for the balance of project construction. The estimated cost for these credits is $10,000 per ton.

8.3 Plan Evaluation

The following criteria were used to evaluate the two plans.

1. Completeness – Does the plan compensate for all pollutants that exceed the de minimis levels?
2. Cost Effectiveness – What is the cost per ton to generate the reductions needed?
3. Reliability – Will the plan achieve the objective under all conditions?
4. Flexibility – Can the plan respond to changes in funding, scheduling of construction or unanticipated actions?

Plan 1 – Using SCR Technology

This plan meets the criteria of completeness and cost effectiveness. However, there are several concerns with this plan:

- SCR-equipped dredges and appurtenant equipment are not generally available in the existing contractor fleets.
- Significant lead time will be required to fabricate and install the SCR equipment.
- The SCR-modified equipment may not perform as expected and therefore may not achieve the necessary reduction in emissions.

As a result of the above concerns, this plan was eliminated from further consideration.

Plan 2 – Purchasing Emission Reduction Credits

This plan meets the criteria of completeness, cost-effectiveness, reliability, and flexibility. Furthermore, once the emission reduction credits are purchased they can be applied for the balance of the project. Therefore, Plan 2 is the preferred plan. This plan is less costly and more efficient and demonstrates conformity for the project.

8.4 Conclusion

Based on the analyses conducted and evaluation of potential plans, the upfront purchasing of perpetual multi-year emission reduction credits has been selected. This plan is implementable and is the least costly and most efficient way to attain conformity for the project.

8.5 Implementation of the Recommended Plan

Emission reduction credits (ERCs) will be purchased from within the nonattainment areas. Presently, there are roughly 2,000 tons of NOx credits available on the open market within the 10-county nonattainment area across the three states in which the project is located. All of the required credits for the project (607 tons) will be acquired after issuance of the Final Statement of Conformity and prior to the commencement of construction. Credits will be obtained from the three states on an equitable basis to the maximum extent practicable; however, the actual allocation of credits will be based on availability and cost.

The non-Federal Sponsor for this project, the Philadelphia Regional Port Authority (PRPA), has entered into a brokerage agreement with Cantor CO2e, a firm that specializes in ERC trading. A copy of the brokerage agreement is provided as Appendix G to this report. The PRPA will acquire the credits as part of their cost sharing obligations on this project.

In the event that some of the credits purchased have expirations, additional credits will be obtained prior to the expiration date so that at no time will there be net NOx emission increases. All required credits will be in place prior to the start of construction on the project.

9. REFERENCES

1) "Current Methodologies and Best Practices in Preparing Port Emission Inventories", ICF Consulting (for USEPA), January 5, 2006.

2) U.S. Army Corps of Engineers Dredge Estimating Program (CEDEP) - 26 dredge estimates and production worksheets, U.S. Army Corps of Engineers, Philadelphia District

3) United States Environmental Protection Agency Code of Federal Regulations Title 40, Part 93 (40 CFR 93) – Determining Conformity of Federal Actions to State or Federal Implementation Plans; revised July 1, 2008. http://www.access.gpo.gov/nara/cfr/waisidx_08/40cfr93_08.html

4) United States Environmental Protection Agency - June 2006 Final NONROAD2005 Emission Inventory Model. http://www.epa.gov/oms/nonrdmdl.htm

5) United States Environmental Protection Agency – Mobile6 Vehicle Emission Modeling Software. http://www.epa.gov/oms/m6.htm

6) United States Environmental Protection Agency – "Locomotive Emissions Standards Regulatory Support Document", April 1998, revised, http://www.epa.gov/OMSWWW/regs/nonroad/locomotv/frm/locorsd.pdf

APPENDICES

Appendix A – Channel Deepening Emissions Spreadsheet

Delaware River Deepening
A -Construction Emissions Summary - Channel Deepening
5/19/2009

	Contract	I			II		III		IV	V	VI		VII		
	Dredge-Disposal Activity	1	2	3	4	5	13	14	9	10	11	12	6	7	8
		C-Killico 1	C-Reedy S	C-Killico 2	B-Blasting	B-shot Rock-Mifflin	AA-N. Park	A-Peddrick N	E-Brdkl	E-Kelly	D-Reedy S	D-Artf Isl	B-Oldmans	B-Peddrick N	B-Peddrick S	
	Old CDEP Estimate #	2	4	6	8	9	17	18	10	15	7	16	11	12	13	14
	New CDEP Estimate #	1	2	3	4	5	14	15	10	11	12	13	6	7	8	9
	Estimate file	2009-jan-dr-RC01-Hyd-KillicohookNo2	2009-jan-dr-RC02-Hyd-ReedyPtSouth	2009-jan-dr-RC03-Hyd-KillicohookNo2	2008-dec-dr-RB-RcokPart02	2008-dec-dr-RB-RockPart01	2009-jan-dr-RAA-Hyd-NatPark	2009-jan-dr-RA-Hop-PedricktownNorth	2009-jan-dr-RE_HOP-Broadkill	2009-jan-dr-RE_HOP-Kellyls	2009-jan-dr-RD01B-Hop-ReedyPtSouth	2009-jan-dr-RD02-Hop-Artls	2009-jan-dr-RB01-Hyd-Oldmans	2009-jan-dr-RB-Hyd-Pedricktown North	2009-jan-dr-RB-Hyd-PedricktownSouth	2009-jan-dr-RB03-Hyd-PedricktownSouth
Dredge-Disposal Area	Reach	C	C	C	B	B	AA	A	E	E	D	D	B	B	B	B
	Disposal Site	Killcohook 212+500	Reedy Point South (233+667)	Killchhook 212+500	Fort Mifflin	Fort Mifflin	National Park (58+700)	Pedricktown North (141+250)	Delaware Beaches-Broadkill Beach	Kelly Island (Sta 384+223)	Reedy Point South (233+667)	Artificial Island (264+400)	Oldmans (133+00)	Pedricktown north (141+250)	Pedricktown South (149+000)	Pedricktown South (149+000)
	Dredge type	(1) 30" CSD	(1) 30" CSD	(1) 30" CSD	(2) 3 frame drillboats	(2) 26 CY Clamshell	(1) 30" CSD	(1) 7600cy HOP	(1) 7600cy HOP	(1) 7600cy HOP	(1) 7600cy HOP	(1) 7600cy HOP	(1) 30" CSD	(1) 30" CSD	(1) 30" CSD	(1) 30" CSD
	Pipeline (ft)	1 booster 39,500	1 booster 40,800	1 booster 40,150		(2) towboats (8) 3k cy scows	2 boosters 44,000	no booster 6,000	(1) booster 15,000	(1) booster 18,000	no booster 6,000	no booster 6,000	no booster 15,000	2 boosters 58,750	no booster 31,000	1 booster 38,800
	Low Station	183,000	206,201	225,000			19,700	32,756	461,300	351,300	249,000	270,000	124,000	90,000	124,000	137,000
	High Station	206,201	225,000	242,514			32,756	90,000	512,000	461,300	270,000	324,000	end	124,000	137,000	176,000
Volumes / Productions / Durations	Pay cys	932,600	597,800	972,400	77,000	77,000	994,000	1,666,600	1,598,700	2,483,000	396,300	1,654,800	1,671,400	1,050,700	499,300	1,443,500
	Gross cys	1,166,500	731,700	1,120,500	77,000	225,600	1,129,100	1,911,900	2,072,500	3,004,800	509,600	2,128,200	1,828,800	1,244,100	536,500	1,736,800
	Dredging Area ft2				1,585,000	1,542,800										
	Drill /Blast Area (ft2)				771,400	771,400										
	# Rigs	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1
	Drill Area (ft2) /12 hr day/rig				4,000											
	Gross Hourly Production/rig	1,538	577	1,767		262	947	477	545	516	687	699	3,978	856	2,331	1,407
	Hours/Month/rig	460	460	460		507	414	657	657	657	657	657	511	414	511	460
	Monthly Gross Production all rigs	707,480	265,420	812,820	243,360	265,668	392,058	313,389	358,065	339,012	451,359	459,243	2,032,758	354,384	1,191,141	647,220
	Months	1.65	2.76	1.38	3.17	0.85	2.88	6.1	5.79	8.86	1.13	4.63	0.90	3.51	0.45	2.68

0.02 (conversion from lbs/day to total NOx, need to include the timeframe (in months) from row 30)

	total tons														
dredge	88.3	147.7	73.8	-	18.0	138.7	277.1	253.3	392.8	44.3	191.3	48.2	169.0	24.1	143.4
booster	49.5	82.8	41.4	-	-	155.6	-	58.6	85.0	-	-	-	189.6	-	80.4
towing tugs	-	-	-	-	7.7	-	-	-	-	-	-	-	-	-	-
everything else	1.5	2.5	1.2	14.0	1.7	2.3	6.9	6.6	10.0	1.3	5.3	0.8	2.8	0.4	2.4
	139.3	233.0	116.5	14.0	27.5	296.6	284.0	318.5	487.9	45.5	196.5	49.0	361.4	24.5	226.2

NOX			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	3,518	3,518	3,518	218	1,395	3,167	622	797	755	1,124	837	3,518	3,167	3,518	3,518	
	Site	Dredge Attendant Plant	58	58	58	73	94	53	12	12	12	12	12	58	53	58	58	
	Transp	Dredge Transporting	0	0	0	0	635	0	2,083	1,759	1,856	998	1,467	0	0	0	0	
	Route	Booster	1,973	1,973	1,973	0	0	3,551	0	666	631	0	0	0	3,551	0	1,973	
	Disposal	Dredge Unloading	0	0	0	0	0	0	344	383	366	515	474	0	0	0	0	
	Site	Disposal Site Equipment	35.4	30.3	34.3	0.0	82.3	28.6	13.8	68.0	185.7	18.5	103.1	31.8	24.5	18.2	18.2	
		Worker Trips	3.1	3.2	2.9	2.2	2.2	2.86	0.7007	1.2	2.1	0.6	0.6	2.2	2.1	2.2	2.2	
	Total		5,588	5,583	5,587	293	2,208	6,802	3,076	3,686	3,808	2,670	2,894	3,611	6,797	3,597	5,570	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		2.80	2.65	2.53	3.55	4.73	3.85	3.58	0.83	1.54	2.19	2.06	3.18	3.40	3.18		40.09
	Dredge	Dredge Dredging	88.29	147.69	73.84	10.51	18.03	138.70	57.73	70.16	101.73	19.32	58.93	48.16	169.04	24.08	143.40	1,169.61
	Site	Dredge Attendant Plant	1.47	2.45	1.23	3.50	1.21	2.30	1.15	1.09	1.67	0.21	0.88	0.80	2.81	0.40	2.38	23.56
	Transp	Dredge Transporting	0.00	0.00	0.00	0.00	8.21	0.00	193.23	154.92	250.11	17.16	103.30	0.00	0.00	0.00	0.00	726.92
	Route	Booster	49.51	82.82	41.41	0.00	0.00	155.55	0.00	58.61	84.98	0.00	0.00	0.00	189.58	0.00	80.42	742.88
	Disposal	Dredge Unloading	0.00	0.00	0.00	0.00	0.00	0.00	31.88	33.74	49.37	8.85	33.40	0.00	0.00	0.00	0.00	157.24
	Site	Disposal Site Equipment	0.89	1.27	0.72	0.00	1.06	1.25	1.28	5.98	25.02	0.32	7.26	0.44	1.31	0.12	0.74	47.68
		Worker Trips	0.08	0.13	0.06	0.11	0.03	0.13	0.07	0.10	0.28	0.01	0.04	0.03	0.11	0.01	0.09	1.29
	Total		143.04	237.02	119.79	17.67	33.28	301.78	288.92	325.44	514.72	48.07	205.87	52.60	366.24	27.80	227.04	2,909.26
		this row is just a check	143.04	237.02	119.79	17.67	33.28	301.78	288.92	325.44	514.72	48.07	205.87	52.60	366.24	27.80	227.04	

VOCs			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	122.7	122.7	122.7	6.2	42.3	110.4	24.8	31.8	30.1	44.9	33.4	122.7	110.4	122.7	122.7	
	Site	Dredge Attendant Plant	1.7	1.7	1.7	2.1	2.7	1.5	0.4	0.4	0.4	0.4	0.4	1.7	1.5	1.7	1.7	
	Transp	Dredge Transporting	0.0	0.0	0.0	0.0	24.9	0.0	83.1	70.2	74.0	39.8	58.5	0.0	0.0	0.0	0.0	
	Route	Booster	68.8	68.8	68.8	0.0	0.0	123.8	0.0	23.2	22.0	0.0	0.0	0.0	123.8	0.0	68.8	
	Disposal	Dredge Unloading	0.0	0.0	0.0	0.0	0.0	0.0	13.0	14.6	13.9	19.8	18.2	0.0	0.0	0.0	0.0	
	Site	Disposal Site Equipment	3.8	3.3	3.7	0.0	5.6	3.0	1.3	6.4	15.3	2.0	10.4	3.4	2.4	1.8	1.8	
		Worker Trips	3.7	3.9	3.5	2.3	2.3	3.44	0.71	1.3	1.7	0.6	0.6	2.5	2.6	2.6	2.7	
	Total		200.6	200.3	200.4	10.5	77.7	242.2	123.3	147.8	157.4	107.5	121.5	130.2	240.8	128.7	197.6	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.11	0.10	0.10	0.13	0.18	0.15	0.14	0.03	0.06	0.09	0.08	0.12	0.13	0.12		1.56
	Dredge	Dredge Dredging	3.08	5.15	2.58	0.30	0.55	4.84	2.30	2.80	4.06	0.77	2.35	1.68	5.89	0.84	5.00	42.18
	Site	Dredge Attendant Plant	0.04	0.07	0.03	0.10	0.03	0.07	0.03	0.03	0.05	0.01	0.02	0.02	0.08	0.01	0.07	0.67
	Transp	Dredge Transporting	0.00	0.00	0.00	0.00	0.32	0.00	7.71	6.18	9.98	0.68	4.12	0.00	0.00	0.00	0.00	28.99
	Route	Booster	1.73	2.89	1.44	0.00	0.00	5.42	0.00	2.04	2.96	0.00	0.00	0.00	6.61	0.00	2.80	25.91
	Disposal	Dredge Unloading	0.00	0.00	0.00	0.00	0.00	0.00	1.21	1.28	1.87	0.34	1.28	0.00	0.00	0.00	0.00	5.98
	Site	Disposal Site Equipment	0.09	0.14	0.08	0.00	0.07	0.13	0.12	0.57	2.06	0.03	0.73	0.05	0.13	0.01	0.07	4.29
		Worker Trips	0.09	0.16	0.07	0.11	0.03	0.15	0.07	0.12	0.22	0.01	0.04	0.03	0.14	0.02	0.11	1.38
	Total		5.14	8.51	4.30	0.64	1.18	10.76	11.58	13.05	21.27	1.93	8.63	1.91	12.99	1.01	8.06	110.96

PM2.5			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	46.531	46.531	46.531	3.192	26.366	41.878	10.949	14.019	13.285	19.786	14.727	46.531	41.878	46.531	46.531	
	Site	Dredge Attendant Plant	1.422	1.422	1.422	1.082	2.307	1.280	0.302	0.302	0.302	0.302	0.302	1.422	1.280	1.422	1.422	
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	11.438	0.000	36.651	30.957	32.662	17.566	25.813	0.000	0.000	0.000	0.000	
	Route	Booster	26.093	26.093	26.093	0.000	0.000	46.968	0.000	8.802	8.341	0.000	0.000	0.000	46.968	0.000	26.093	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	6.465	7.161	6.865	9.485	8.765	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	3.634	2.977	4.484	0.000	4.450	2.715	1.092	5.180	11.093	1.681	6.892	2.336	1.459	1.127	1.127	
		Worker Trips	0.055	0.055	0.055	0.036	0.039	0.0547	0.0129	0.024	0.050	0.012	0.015	0.053	0.054	0.055	0.054	
	Total		77.735	77.078	78.585	4.310	44.599	92.896	55.472	66.446	72.599	48.834	56.514	50.342	91.639	49.136	75.228	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.051	0.048	0.046	0.061	0.088	0.069	0.063	0.015	0.027	0.039	0.037	0.057	0.061	0.057		0.720
	Dredge	Dredge Dredging	1.168	1.953	0.977	0.154	0.341	1.834	1.016	1.235	1.790	0.340	1.037	0.637	2.236	0.318	1.897	16.931
	Site	Dredge Attendant Plant	0.036	0.060	0.030	0.052	0.030	0.056	0.028	0.027	0.041	0.005	0.021	0.019	0.068	0.010	0.058	0.541
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	0.148	0.000	3.400	2.726	4.401	0.302	1.818	0.000	0.000	0.000	0.000	12.794
	Route	Booster	0.655	1.095	0.548	0.000	0.000	2.057	0.000	0.775	1.124	0.000	0.000	0.000	2.507	0.000	1.064	9.825
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.600	0.631	0.925	0.163	0.617	0.000	0.000	0.000	0.000	2.936
	Site	Disposal Site Equipment	0.091	0.125	0.094	0.000	0.058	0.119	0.101	0.456	1.495	0.029	0.485	0.032	0.078	0.008	0.046	3.217
		Worker Trips	0.001	0.002	0.001	0.002	0.000	0.002	0.001	0.002	0.007	0.000	0.001	0.001	0.003	0.000	0.002	0.027
	Total		2.001	3.284	1.695	0.268	0.665	4.138	5.209	5.866	9.810	0.878	4.016	0.747	4.953	0.394	3.066	46.990

PM10			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	48.918	48.918	48.918	3.388	27.630	44.027	11.968	15.323	14.521	21.626	16.096	48.918	44.027	48.918	48.918	
	Site	Dredge Attendant Plant	1.492	1.492	1.492	1.148	2.420	1.343	0.317	0.317	0.317	0.317	0.317	1.492	1.343	1.492	1.492	
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	12.459	0.000	40.059	33.836	35.699	19.200	28.214	0.000	0.000	0.000	0.000	
	Route	Booster	27.432	27.432	27.432	0.000	0.000	49.378	0.000	9.254	8.769	0.000	0.000	0.000	49.378	0.000	27.432	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	7.000	7.761	7.438	10.301	9.514	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	3.747	3.070	3.491	0.000	4.588	2.7996	1.1258	5.341	11.437	1.734	7.104	2.409	1.505	1.162	1.162	
		Worker Trips	0.119	0.119	0.119	0.077	0.082	0.1189	0.0265	0.052	0.093	0.026	0.030	0.117	0.118	0.121	0.118	
	Total		81.708	81.031	81.452	4.613	47.181	97.665	60.496	71.884	78.274	53.204	61.276	52.936	96.370	51.693	79.123	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.055	0.052	0.050	0.066	0.095	0.075	0.069	0.016	0.030	0.042	0.040	0.063	0.067	0.063		0.784
	Dredge	Dredge Dredging	1.228	2.053	1.027	0.163	0.357	1.928	1.110	1.349	1.957	0.372	1.133	0.670	2.350	0.335	1.994	18.026
	Site	Dredge Attendant Plant	0.037	0.063	0.031	0.055	0.031	0.059	0.029	0.028	0.043	0.005	0.022	0.020	0.072	0.010	0.061	0.568
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	0.161	0.000	3.716	2.979	4.810	0.330	1.987	0.000	0.000	0.000	0.000	13.984
	Route	Booster	0.688	1.151	0.576	0.000	0.000	2.163	0.000	0.815	1.182	0.000	0.000	0.000	2.636	0.000	1.118	10.329
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.649	0.683	1.002	0.177	0.670	0.000	0.000	0.000	0.000	3.182
	Site	Disposal Site Equipment	0.094	0.129	0.073	0.000	0.059	0.123	0.104	0.470	1.541	0.030	0.500	0.033	0.080	0.008	0.047	3.292
		Worker Trips	0.003	0.005	0.002	0.004	0.001	0.005	0.002	0.005	0.013	0.000	0.002	0.002	0.006	0.001	0.005	0.056
	Total		2.106	3.454	1.760	0.288	0.705	4.353	5.681	6.346	10.577	0.957	4.355	0.787	5.211	0.416	3.225	50.221

CO			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	429.144	429.144	429.144	32.715	110.384	386.230	51.855	66.394	62.917	93.706	69.743	429.144	386.230	429.144	429.144	
	Site	Dredge Attendant Plant	8.938	8.938	8.938	10.926	14.304	8.044	2.113	2.113	2.113	2.113	2.113	8.938	8.044	8.938	8.938	
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	55.539	0.000	173.573	146.608	154.683	83.192	122.249	0.000	0.000	0.000	0.000	
	Route	Booster	240.651	240.651	240.651	0.000	0.000	433.172	0.000	81.178	76.926	0.000	0.000	0.000	433.172	0.000	240.651	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	32.775	36.076	34.674	47.081	43.670	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	20.712	19.023	20.200	0.000	29.717	17.818	8.935	44.570	89.538	11.191	55.702	18.127	14.423	10.645	10.645	
		Worker Trips	38.232	55.850	53.306	47.417	49.665	43.8784	10.1113	21.746	20.216	13.412	11.525	28.706	36.969	32.799	47.221	
	Total		737.677	753.606	752.239	91.058	259.609	889.142	279.364	398.685	441.066	250.695	305.003	484.915	878.837	481.527	736.599	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.249	0.236	0.226	0.335	0.436	0.336	0.302	0.073	0.131	0.186	0.175	0.280	0.298	0.280		3.543
	Dredge	Dredge Dredging	10.769	18.013	9.007	1.577	1.427	16.917	4.811	5.846	8.478	1.610	4.911	5.874	20.617	2.937	17.491	130.285
	Site	Dredge Attendant Plant	0.224	0.375	0.188	0.527	0.185	0.352	0.196	0.186	0.285	0.036	0.149	0.122	0.429	0.061	0.364	3.680
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	0.718	0.000	16.103	12.910	20.843	1.430	8.608	0.000	0.000	0.000	0.000	60.611
	Route	Booster	6.039	10.101	5.051	0.000	0.000	18.973	0.000	7.148	10.365	0.000	0.000	0.000	23.123	0.000	9.809	90.609
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	3.041	3.177	4.672	0.809	3.075	0.000	0.000	0.000	0.000	14.774
	Site	Disposal Site Equipment	0.520	0.798	0.424	0.000	0.384	0.780	0.829	3.925	12.065	0.192	3.922	0.248	0.770	0.073	0.434	25.365
		Worker Trips	0.959	2.344	1.119	2.286	0.642	1.922	0.938	1.915	2.724	0.230	0.812	0.393	1.973	0.224	1.925	20.407
	Total		18.760	31.869	16.014	4.725	3.792	39.280	26.218	35.179	59.563	4.494	21.652	6.917	47.212	3.576	30.023	349.274

Sox			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	30.147	14.120	14.120	1.453	6.686	12.708	0.597	0.765	0.725	1.079	0.803	2.685	2.417	1.646	1.646	
	Site	Dredge Attendant Plant	0.831	0.389	0.389	0.483	0.624	0.350	0.016	0.016	0.016	0.016	0.016	0.074	0.067	0.045	0.045	
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	3.268	0.000	1.999	1.689	1.782	0.958	1.408	0.000	0.000	0.000	0.000	
	Route	Booster	16.905	7.918	7.918	0.000	0.000	14.253	0.000	0.508	0.481	0.000	0.000	0.000	2.711	0.000	0.923	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.349	0.387	0.371	0.514	0.474	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	0.641	0.650	0.640	0.000	1.458	0.640	0.371	1.854	4.425	0.370	2.179	0.650	0.641	0.464	0.464	
		Worker Trips	0.034	0.034	0.034	0.022	0.024	0.0342	0.0076	0.015	0.026	0.007	0.009	0.034	0.034	0.035	0.034	
	Total		48.559	23.112	23.102	1.959	12.060	27.986	3.340	5.233	7.826	2.945	4.890	3.443	5.870	2.190	3.112	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.014	0.014	0.013	0.019	0.025	0.020	0.018	0.001	0.001	0.002	0.002	0.003	0.003	0.003		0.139
	Dredge	Dredge Dredging	0.756	0.593	0.296	0.070	0.086	0.557	0.055	0.067	0.098	0.019	0.057	0.037	0.129	0.011	0.067	2.898
	Site	Dredge Attendant Plant	0.021	0.016	0.008	0.023	0.008	0.015	0.001	0.001	0.002	0.000	0.001	0.001	0.004	0.000	0.002	0.105
	Transp	Dredge Transporting	0.000	0.000	0.000	0.000	0.042	0.000	0.185	0.149	0.240	0.016	0.099	0.000	0.000	0.000	0.000	0.732
	Route	Booster	0.424	0.332	0.166	0.000	0.000	0.624	0.000	0.045	0.065	0.000	0.000	0.000	0.145	0.000	0.038	1.839
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.032	0.034	0.050	0.009	0.033	0.000	0.000	0.000	0.000	0.159
	Site	Disposal Site Equipment	0.016	0.027	0.013	0.000	0.019	0.028	0.034	0.163	0.596	0.006	0.153	0.009	0.034	0.003	0.019	1.123
		Worker Trips	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.003	0.000	0.001	0.000	0.002	0.000	0.001	0.016
	Total		1.233	0.984	0.498	0.113	0.181	1.246	0.328	0.462	1.056	0.053	0.346	0.050	0.317	0.018	0.127	7.011

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Appendix B – Berth Deepening Emissions Spreadsheet

Delaware River Deepening
B -Construction Emissions Summary - Berth Deepenings
5/19/2009

		1	2	3	4	5	6	7	8	9	10
	Contract	**Sun Oil Marcus Hook Rock**	**Sun Oil Marcus Hook Dredge 1**	**Sun Oil Marcus Hook Dredge 2**	**Phillips 66-Marcus Hook**	**Valero - Paulsboro**	**Sun Oil - Fort Mifflin**	**Coastal Eagle Point - Westville**	**Packer Ave - Terminal**	**Beckett St - Terminal**	**Whites Basin**
	CDEP Estimate #										
	Estimate file	ASunocoREEVDRROCKpart2	ASunocoREEVdrrcokpart1	SunocoREEVMarcus Hook	Phillips66REEVMarcusHook	ValeroREEVPaulsboro	SunocoREEVFtMifflin	CoastalREEVEaglePt	PhilaRPAREEVPacker	SJPortREEVBeckett	Associated Rehandling Dredging
Dredge-Disposal Area	Reach	B	B	B	B	B	B	B	B	B	B
	Disposal Site		Whites Basin	Whites Basin	Whites Basin	Whites Basin	Whites Basin	Whites Basin	Whites Basin	Whites Basin	Whites Basin
	Dredge type	Drillboat	26 CY Clamshell	21 CY Clamshell	21 CY Clamshell	21 CY Clamshell	21 CY Clamshell	21 CY Clamshell	21 CY Clamshell	21 CY Clamshell	27" CSD
	Pipeline (ft)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	5,250
Volumes / Productions / Durations	Pay cys	25,089	25,089	65,713	118,090	68,686	36,428	17,073	70,194	59,164	460,437
	Gross cys	25,089	62,189	122,213	161,690	126,086	61,328	28,573	97,094	81,364	678,348
	Dredging Area ft2	651,000	230,020	763,304	588,752	775,266	336,611	155,000	363,254	299,993	1,000,000
	Drill /Blast Area (ft2)	250,890									
	# Rigs	1	1	1	1	1	1	1	1	1	1
	Drill Area (ft2) /12 hr day/rig	4000									
	Gross Hourly Production/rig		269	899	1,046	307	1,025	349	1,046	509	1,376
	Hours/Month/rig		507	507	507	507	322	507	216	507	511
	Monthly Gross Production all rigs	121,680	136,383	455,793	530,322	155,649	329,988	176,943	226,412	258,063	703,136
	Months	2.07	0.46	0.27	0.30	0.81	0.19	0.16	0.43	0.32	1.23

0.02 (conversion from lbs/day to total NOx, need to include the timeframe (in months) from row 30)

	total tons									
dredge	-	4.3	2.5	2.8	7.5	1.8	1.5	4.0	3.0	46.1
booster	-	-	-	-	-	-	-	-	-	-
towing tugs	-	4.9	2.9	3.2	8.7	2.0	1.7	4.6	3.4	-
everything else	4.9	0.7	0.4	0.5	1.3	0.3	0.3	0.7	0.5	1.1
	4.9	9.9	5.8	6.5	17.5	4.1	3.5	9.3	6.9	47.2

NOX

			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	109	609	609	609	609	609	609	609	609	2,463	
	Site	Dredge Attendant Plant	46	94	94	94	94	94	94	94	94	58	
	Transp	Dredge Transporting	0	715	715	715	715	715	715	715	715	0	
	Route	Booster	0	0	0	0	0	0	0	0	0	0	
	Disposal	Dredge Unloading	0	0	0	0	0	0	0	0	0	0	
	Site	Disposal Site Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	
		Worker Trips	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	2.3	
	Total		157	1,420	1,420	1,420	1,420	1,420	1,420	1,420	1,420	2,544	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		1.44	2.63	1.44	1.44	1.09	0.95	0.95	0.77	0.77	0.98	12.45
	Dredge	Dredge Dredging	3.43	4.26	2.50	2.78	7.51	1.76	1.48	3.99	2.97	46.07	76.75
	Site	Dredge Attendant Plant	1.46	0.66	0.39	0.43	1.16	0.27	0.23	0.61	0.46	1.09	6.74
	Transp	Dredge Transporting	0.00	5.00	2.94	3.26	8.81	2.07	1.74	4.68	3.48	0.00	31.98
	Route	Booster	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Disposal	Dredge Unloading	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Site	Disposal Site Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.37
		Worker Trips	0.05	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.01	0.04	0.16
	Total		6.38	12.56	7.27	7.92	18.58	5.05	4.40	10.06	7.68	48.56	128.46
			6.38	12.56	7.27	7.92	18.58	5.05	4.40	10.06	7.68	48.56	

VOCs

			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	3.1	18.5	18.5	18.5	18.5	18.5	18.5	18.5	18.5	85.9	
	Site	Dredge Attendant Plant	1.3	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	1.7	
	Transp	Dredge Transporting	0.0	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	0.0	
	Route	Booster	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Disposal	Dredge Unloading	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Site	Disposal Site Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	
		Worker Trips	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	2.5	
	Total		6.0	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	91.9	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.05	0.09	0.05	0.05	0.04	0.03	0.03	0.03	0.03	0.04	0.45
	Dredge	Dredge Dredging	0.10	0.13	0.08	0.08	0.23	0.05	0.04	0.12	0.09	1.61	2.53
	Site	Dredge Attendant Plant	0.04	0.02	0.01	0.01	0.03	0.01	0.01	0.02	0.01	0.03	0.19
	Transp	Dredge Transporting	0.00	0.20	0.12	0.13	0.35	0.08	0.07	0.19	0.14	0.00	1.27
	Route	Booster	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Disposal	Dredge Unloading	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Site	Disposal Site Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
		Worker Trips	0.05	0.01	0.01	0.01	0.02	0.00	0.00	0.01	0.01	0.05	0.17
	Total		0.24	0.45	0.26	0.29	0.67	0.18	0.16	0.36	0.28	1.76	4.65

PM2.5

			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	1.596	11.520	11.520	11.520	11.520	11.520	11.520	11.520	11.520	32.572	
	Site	Dredge Attendant Plant	0.699	2.307	2.307	2.307	2.307	2.307	2.307	2.307	2.307	1.422	
	Transp	Dredge Transporting	0.000	12.652	12.652	12.652	12.652	12.652	12.652	12.652	12.652	0.000	
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.50842	
		Worker Trips	0.03502	0.03751	0.03751	0.03751	0.03751	0.03751	0.03751	0.03751	0.03751	0.05374	
	Total		2.329	26.516	26.516	26.516	26.516	26.516	26.516	26.516	26.516	35.556	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.02	0.05	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.234
	Dredge	Dredge Dredging	0.050	0.081	0.047	0.053	0.142	0.033	0.028	0.075	0.056	0.609	1.175
	Site	Dredge Attendant Plant	0.022	0.016	0.009	0.011	0.028	0.007	0.006	0.015	0.011	0.027	0.152
	Transp	Dredge Transporting	0.000	0.089	0.052	0.058	0.156	0.037	0.031	0.083	0.062	0.000	0.566
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Site	Disposal Site Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028	0.028
		Worker Trips	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
	Total		0.097	0.237	0.136	0.148	0.347	0.095	0.083	0.189	0.144	0.683	2.158

PM10

			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	1.694	12.072	12.072	12.072	12.072	12.072	12.072	12.072	12.072	34.243	
	Site	Dredge Attendant Plant	0.741	2.420	2.420	2.420	2.420	2.420	2.420	2.420	2.420	1.492	
	Transp	Dredge Transporting	0.000	13.818	13.818	13.818	13.818	13.818	13.818	13.818	13.818	0.000	
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56	
		Worker Trips	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.12	
	Total		2.511	28.391	28.391	28.391	28.391	28.391	28.391	28.391	28.391	37.408	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.03	0.05	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.252
	Dredge	Dredge Dredging	0.053	0.084	0.050	0.055	0.149	0.035	0.029	0.079	0.059	0.641	1.234
	Site	Dredge Attendant Plant	0.023	0.017	0.010	0.011	0.030	0.007	0.006	0.016	0.012	0.028	0.159
	Transp	Dredge Transporting	0.000	0.097	0.057	0.063	0.170	0.040	0.034	0.090	0.067	0.000	0.618
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Site	Disposal Site Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.029	0.029
		Worker Trips	0.002	0.001	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.002	0.008
	Total		0.105	0.253	0.146	0.159	0.372	0.102	0.089	0.202	0.154	0.719	2.300

CO

			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	16.357	48.229	48.229	48.229	48.229	48.229	48.229	48.229	48.229	300.401	
	Site	Dredge Attendant Plant	6.994	14.304	14.304	14.304	14.304	14.304	14.304	14.304	14.304	8.938	
	Transp	Dredge Transporting	0.000	60.259	60.259	60.259	60.259	60.259	60.259	60.259	60.259	0.000	
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.53	
		Worker Trips	42.10	46.32	46.32	46.32	46.32	46.32	46.32	46.32	46.32	66.82	
	Total		65.447	169.113	169.113	169.113	169.113	169.113	169.113	169.113	169.113	387.686	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.16	0.26	0.13	0.13	0.10	0.09	0.09	0.08	0.08	0.09	1.220
	Dredge	Dredge Dredging	0.515	0.337	0.198	0.220	0.594	0.139	0.117	0.315	0.235	5.619	8.291
	Site	Dredge Attendant Plant	0.220	0.100	0.059	0.065	0.176	0.041	0.035	0.094	0.070	0.167	1.027
	Transp	Dredge Transporting	0.000	0.422	0.247	0.275	0.742	0.174	0.147	0.394	0.293	0.000	2.694
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Site	Disposal Site Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.216	0.216
		Worker Trips	1.325	0.324	0.190	0.211	0.571	0.134	0.113	0.303	0.225	1.250	4.646
	Total		2.220	1.444	0.828	0.905	2.188	0.581	0.504	1.184	0.901	7.338	18.094

Sox

			lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	lbs/day	
Lbs / Day	Dredge	Dredge Dredging	0.727	2.921	2.921	2.921	2.921	2.921	2.921	2.921	2.921	1.152	
	Site	Dredge Attendant Plant	0.309	0.624	0.624	0.624	0.624	0.624	0.624	0.624	0.624	0.045	
	Transp	Dredge Transporting	0.000	3.626	3.626	3.626	3.626	3.626	3.626	3.626	3.626	0.000	
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	Site	Disposal Site Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	
		Worker Trips	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	
	Total		1.058	7.195	7.195	7.195	7.195	7.195	7.195	7.195	7.195	1.761	
			tons	tons	tons	tons	tons	tons	tons	tons	tons	tons	
Total Tons	Mob		0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.001	0.008
	Dredge	Dredge Dredging	0.023	0.020	0.012	0.013	0.036	0.008	0.007	0.019	0.014	0.022	0.175
	Site	Dredge Attendant Plant	0.010	0.004	0.003	0.003	0.008	0.002	0.002	0.004	0.003	0.001	0.038
	Transp	Dredge Transporting	0.000	0.025	0.015	0.017	0.045	0.010	0.009	0.024	0.018	0.000	0.162
	Route	Booster	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Disposal	Dredge Unloading	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Site	Disposal Site Equipment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010	0.010
		Worker Trips	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002
	Total		0.034	0.052	0.030	0.034	0.089	0.021	0.018	0.048	0.036	0.034	0.396

62.166

Appendix C – Channel Deepening Daily Emission Calculations

Appendix C -Marine Emissions CDEP Estimate #1 (of 15)
Reach C to Killico #1

Assumed Year of Analysis 2009

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Assumed Fuel Sulfur Level 348 ppm 0.0348%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	15.12	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.1061	3,518	123	47	49	429	30	8
2 Work Tugs	250	50	0.045	0.039	15.12	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.1061	37.3	1.1	0.9	1.0	5.6	0.5	4
1 Crew / Survey boat	100	40	0.045	0.039	15.12	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.1061	8.7	0.2	0.2	0.2	1.5	0.1	3
1 Derrick	200	40	0.011	0.011	15.12	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.1061	12.4	0.4	0.3	0.3	1.9	0.2	4
Subtotal Attnd Plnt Dredge Site								5								58.4	1.7	1.4	1.5	8.9	0.8	
Transportation Route																						
1 Dredge Transporting boosters	5200	200	0.045	0.039	15.12	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.1061	1,973	69	26	27	241	17	8
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #2 (of 15)

Reach C to Reedy South

Assumed Year of Analysis 2010

Assumed Fuel Sulfur Level 163 ppm 0.0163%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	15.12	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	3,518	123	47	49	429	14	8
2 Work Tugs	250	50	0.045	0.039	15.12	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	37.3	1.1	0.9	1.0	5.6	0.2	4
1 Crew / Sur	100	40	0.045	0.039	15.12	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0497	8.7	0.2	0.2	0.2	1.5	0.1	3
1 Derrick	200	40	0.011	0.011	15.12	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	12.4	0.4	0.3	0.3	1.9	0.1	4
Subtotal Attnd Plnt Dredge Site								5								58.4	1.7	1.4	1.5	8.9	0.4	
Transportation Route																						
Dredging Transport																						
1 boosters	5200	200	0.045	0.039	15.12	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	1,973	69	26	27	241	8	8
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #3 (of 15)
Reach C to Killico 2

Assumed Year of Analysis 2010
Assumed Fuel Sulfur Level 163 ppm 0.0163%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	15.12	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	3,518	123	47	49	429	14	8
2 Work Tugs	250	50	0.045	0.039	15.12	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	37.3	1.1	0.9	1.0	5.6	0.2	4
1 Crew / Sur	100	40	0.045	0.039	15.12	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0497	8.7	0.2	0.2	0.2	1.5	0.1	3
1 Derrick	200	40	0.011	0.011	15.12	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	12.4	0.4	0.3	0.3	1.9	0.1	4
Subtotal Attnd Plnt Dredge Site								5								58.4	1.7	1.4	1.5	8.9	0.4	
Transportation Route																						
Dredge Transporting																						
1 boosters	5200	200	0.045	0.039	15.12	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	1,973	69	26	27	241	8	8
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #4 (of 15)

Reach B - Drill & Blast

Assumed Year of Analysis 2010

Assumed Fuel Sulfur Level 163 ppm 0.0163%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	factor basis selector
Dredge Site																						
2 Drillboats (2)	500	3200	0.039	0.033	12.76	40%	10%	18	Cat1 300-1341	7.457	0.21201	0.109125	0.115836	1.11855	0.0497	218	6	3	3	33	1	5
2 Tugboats (2)	500	50	0.045	0.039	12.76	20%	50%	5.5	Cat1 300-1341	7.457	0.21201	0.109125	0.115836	1.11855	0.0497	52.4	1.5	0.8	0.8	7.9	0.3	5
1 Workboat (1)	330	40	0.045	0.039	12.76	20%	50%	3.8	Cat1 300-1341	7.457	0.21201	0.109125	0.115836	1.11855	0.0497	18.0	0.5	0.3	0.3	2.7	0.1	5
1 Sweep Barges (1)	100	0	0.011	0.011	12.76	10%	0%	0.1	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0497	2.1	0.1	0.1	0.1	0.4	0.0	3
Subtotal Attnd Plnt Dredge Site								9.3								72.6	2.1	1.1	1.1	10.9	0.5	
Transportation Route																						
Dredge Transporting																						
Boosters																						
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #5 (of 15)
Reach B - Clamshell Rock

Assumed Year of Analysis 2010
Assumed Fuel Sulfur Level 163 ppm 0.0163%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basi	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	factor basis selector
Dredge Site																						
2 26 cy clam	5000	3310	0.039	0.033	16.67	30%	10%	69	OGV Aux	10.36523	0.3140888	0.195924	0.20532	0.82027	0.0497	1,395	42	26	28	110	7	1
2 worktugs	250	50	0.045	0.039	16.67	30%	50%	4.4	Cat1 175-30	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	54.8	1.6	1.3	1.4	8.2	0.4	4
1 crew/surve	100	40	0.045	0.039	16.67	20%	50%	1.7	Cat1 100-17	7.457	0.21201	0.181458	0.190406	1.26769	0.0497	11.0	0.3	0.3	0.3	1.9	0.1	3
2 derrick	200	40	0.011	0.011	16.67	15%	50%	0.6	Cat1 175-30	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	27.4	0.8	0.7	0.7	4.1	0.2	4
1 Fuel/Water	0	10	0.011	0.011	16.67	0%	20%	0.0	Cat1 50-100	8.2027	0.21201	0.543122	0.563256	1.4914	0.0497	0.6	0.0	0.0	0.0	0.1	0.0	2
Subtotal Attnd Plnt Dredge Site								6.6								93.8	2.7	2.3	2.4	14.3	0.6	
Transportation Route																						
2 Towing Tu	3000	300	0.045	0.039	7.04	60%	50%	86.9	HC-Cat2	9.84324	0.3926111	0.173203	0.18931	0.82027	0.0497	595.4	23.8	10.5	11.5	49.6	3.0	7
8 3,000 cy s	0	250	0.011	0.011	24.00	0%	5%	0.1	Cat1 175-30	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	39.5	1.1	1.0	1.0	5.9	0.3	4
Subtotal Transporting																634.9	24.9	11.4	12.5	55.5	3.3	
Boosters																						
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #6 (of 15)
Reach B to Oldmans

Assumed Year of Analysis 2013
Assumed Fuel Sulfur Level 31 ppm 0.0031%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	15.12	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	3,518	123	47	49	429	3	8
2 Work Tugs	250	50	0.045	0.039	15.12	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	37.3	1.1	0.9	1.0	5.6	0.0	4
1 Crew / Sur	100	40	0.045	0.039	15.12	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	8.7	0.2	0.2	0.2	1.5	0.0	3
1 Derrick	200	40	0.011	0.011	15.12	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	12.4	0.4	0.3	0.3	1.9	0.0	4
Subtotal Attnd Plnt Dredge Site								5								58.4	1.7	1.4	1.5	8.9	0.1	
Transportation Route																						
Dredge enroute 0 boosters	0	0	0	0	0.00	90%	50%	0	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	0	0	0	0	0	0	8
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #7 (of 15)
Reach B - Pedrick N

Assumed Year of Analysis 2013
Assumed Fuel Sulfur Level 31 ppm 0.0031%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	13.61	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	3,167	110	42	44	386	2	8
2 Work Tugs	250	50	0.045	0.039	13.61	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	33.6	1.0	0.8	0.9	5.0	0.0	4
1 Crew / Sur	100	40	0.045	0.039	13.61	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	7.8	0.2	0.2	0.2	1.3	0.0	3
1 Derrick	200	40	0.011	0.011	13.61	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	11.2	0.3	0.3	0.3	1.7	0.0	4
Subtotal Attnd Plnt Dredge Site								5								52.6	1.5	1.3	1.3	8.0	0.1	
Transportation Route																						
Dredge enroute 2 boosters	5200	200	0.045	0.039	13.61	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	3,551	124	47	49	433	3	8
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #8 (of 15)
Reach B to Pendrick S (#1)

Assumed Year of Analysis 2014
Assumed Fuel Sulfur Level 19 ppm 0.0019%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	15.12	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0058	3,518	123	47	49	429	2	8
2 Work Tugs	250	50	0.045	0.039	15.12	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0058	37.3	1.1	0.9	1.0	5.6	0.0	4
1 Crew / Sur	100	40	0.045	0.039	15.12	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0058	8.7	0.2	0.2	0.2	1.5	0.0	3
1 Derrick	200	40	0.011	0.011	15.12	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0058	12.4	0.4	0.3	0.3	1.9	0.0	4
Subtotal Attnd Plnt Dredge Site								5								58.4	1.7	1.4	1.5	8.9	0.0	
Transportation Route																						
dredge enroute 0 boosters	0	0	0	0	0.00	90%	50%	0	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0058	0	0	0	0	0	0	8
Disposal Site																						

Appendix C -Marine Emissions CDEP Estimate #9 (of 15)
Reach B to Pendrick S (#2)

Assumed Year of Analysis 2014
Assumed Fuel Sulfur Level 19 ppm 0.0019%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	15.12	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0058	3,518	123	47	49	429	2	8
2 Work Tugs	250	50	0.045	0.039	15.12	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0058	37.3	1.1	0.9	1.0	5.6	0.0	4
1 Crew / Sur	100	40	0.045	0.039	15.12	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0058	8.7	0.2	0.2	0.2	1.5	0.0	3
1 Derrick	200	40	0.011	0.011	15.12	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0058	12.4	0.4	0.3	0.3	1.9	0.0	4
Subtotal Attnd Plnt Dredge Site								5								58.4	1.7	1.4	1.5	8.9	0.0	
Transportation Route																						
dredge enroute 1 boosters	5200	200	0.045	0.039	15.12	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0058	1,973	69	26	27	241	1	8
Disposal Site																						

Appendix C- Marine Emissions CDEP Estimate #10 (of 15)

Reach E to Broadkill

Assumed Year of Analysis 2011

Assumed Fuel Sulfur Level 31 ppm 0.0031%

	From CDEP									Emission Factors						Daily Emissions						
	Propulsion Hp	Pumps Hp	Aux & Misc Hp	LF Propulsion	LF Pumps	LF Aux & Misc	% of cycle	Hrs/Day	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 7600 cy dredge	9000	3000	2000	45%	50%	30%	27.6%	5.97	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	797	32	14	15	66	1	7
1 Crew/Survey Vsl	100	0	40	15%	0%	50%		21.60	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	12	0	0	0	2	0	3
Transportation Route																						
1 7600 cy dredge	9000	3000	2000	80%	0%	25%	48.7%	10.53	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	1,759	70	31	34	147	2	7
1 5200 hp booster	0	5200	200	0%	90%	50%	p/o time	5.10	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	666	23	9	9	81	1	8
Subtotal along Transp Route																2,425	93	40	43	228	2	
Disposal Site																						
1 7600 cy dredge	9000	3000	2000	0%	80%	25%	23.6%	5.10	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	321	13	6	6	27	0	7
1 Tender Tug	250	0	50	60%	0%	50%		21.60	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	62	2	2	2	9	0	4
Subtotal Dredge at Pumpout							100.0%	21.60								383.2	14.6	7.2	7.8	36.1	0.4	
								90.0%														

Appendix C -Marine Emissions CDEP Estimate #11 (of 15)

Reach E to Kelly Isl

Hours per Month 657 (730hrs x 90% TE)

Assumed Year of Analysis 2012

Assumed Fuel Sulfur Level 31 ppm 0.0031%

	From CDEP									Emission Factors						Daily Emissions						
	Propulsion Hp	Pumps Hp	Aux & Misc Hp	LF Propulsion	LF Pumps	LF Aux & Misc	% of cycle	Hrs/Day	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 7600 cy dr	9000	3000	2000	45%	50%	30%	26.2%	5.66	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	755	30	13	15	63	1	7
1 Crew/Surv	100	0	40	15%	0%	50%		21.60	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	12	0	0	0	2	0	3
Transportation Route																						
1 7600 cy dr	9000	3000	2000	80%	0%	25%	51.4%	11.11	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	1,856	74	33	36	155	2	7
1 5200 hp bo	0	5200	200	0%	90%	50%	p/o time	4.83	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	631	22	8	9	77	0	8
Subtotal along Transp Route																2,487	96	41	44	232	2	
Disposal Site																						
1 7600 cy dr	9000	3000	2000	0%	80%	25%	22.4%	4.83	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	304	12	5	6	25	0	7
1 Tender Tu	250	0	50	60%	0%	50%		21.60	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	62	2	2	2	9	0	4
Subtotal Dredge at Pumpout							100.0%	21.60								366.4	13.9	6.9	7.4	34.7	0.4	
								90.0%														

Appendix C -Marine Emissions CDEP Estimate #12 (of 15)

Reach D to Reedy Pt S.

Hours per Month 657 (730hrs x 90% TE)

Assumed Year of Analysis 2013

Assumed Fuel Sulfur Level 31 ppm 0.0031%

	From CDEP									Emission Factors						Daily Emissions						
	Propulsion Hp	Pumps Hp	Aux & Misc Hp	LF Propulsion	LF Pumps	LF Aux & Misc	% of cycle	Hrs/Day	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 7600 cy dr	9000	3000	2000	45%	50%	30%	39.0%	8.43	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	1,124	45	20	22	94	1	7
1 Crew/Surv	100	0	40	15%	0%	50%		21.60	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	12	0	0	0	2	0	3
Transportation Route																						
1 7600 cy dr	9000	3000	2000	80%	0%	25%	27.7%	5.97	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	998	40	18	19	83	1	7
0 5200 hp bo	0	5200	200	0%	90%	50%	p/o time	7.20	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	0	0	0	0	0	0	8
Subtotal along Transp Route																998	40	18	19	83	1	
Disposal Site																						
1 7600 cy dr	9000	3000	2000	0%	80%	25%	33.3%	7.20	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	453	18	8	9	38	0	7
1 Tender Tu	250	0	50	60%	0%	50%		21.60	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	62	2	2	2	9	0	4
Subtotal Dredge at Pumpout							100.0%	21.60								515.3	19.8	9.5	10.3	47.1	0.5	
								90.0%														

Appendix C -Marine Emissions CDEP Estimate #13 (of 15)

Reach D to Artfcl Isl

Hours per Month 657 (730hrs x 90% TE)

Assumed Year of Analysis 2013

Assumed Fuel Sulfur Level 31 ppm 0.0031%

	From CDEP									Emission Factors						Daily Emissions						
	Propulsion Hp	Pumps Hp	Aux & Misc Hp	LF Propulsion	LF Pumps	LF Aux & Misc	% of cycle	Hrs/Day	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 7600 cy dred	9000	3000	2000	45%	50%	30%	29.0%	6.27	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	837	33	15	16	70	1	7
1 Crew/Survey	100	0	40	15%	0%	50%		21.60	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	12	0	0	0	2	0	3
Transportation Route																						
1 7600 cy dred	9000	3000	2000	80%	0%	25%	40.6%	8.78	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	1,467	59	26	28	122	1	7
0 5200 hp boos	0	5200	200	0%	90%	50%	p/o time	6.55	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	0	0	0	0	0	0	8
Subtotal along Transp Route																1,467	59	26	28	122	1	
Disposal Site																						
1 7600 cy dred	9000	3000	2000	0%	80%	25%	30.3%	6.55	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	412	16	7	8	34	0	7
1 Tender Tug	250	0	50	60%	0%	50%		21.60	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	62	2	2	2	9	0	4
Subtotal Dredge at Pumpout							100.0%	21.60								474.3	18.2	8.8	9.5	43.7	0.5	
								90.0%														

Appendix C -Marine Emissions CDEP Estimate #14 (of 15)
Reach AA - National Park

Assumed Year of Analysis 2010
Assumed Fuel Sulfur Level 163 ppm 0.0163%

	From CDEP									Emission Factors						Daily Emissions						
	Primary Hp	Secondary Hp	prime fuel factor	secondary fuel factor	Hrs/Day	Primary LF	Secondary LF	Total Hourly Fuel Consumption per rig (gals)	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 Dredge	9000	3310	0.045	0.039	13.61	80%	40%	376	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	3,167	110	42	44	386	13	8
2 Work Tugs	250	50	0.045	0.039	13.61	20%	50%	3.2	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	33.6	1.0	0.8	0.9	5.0	0.2	4
1 Crew / Sur	100	40	0.045	0.039	13.61	15%	50%	1.5	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0497	7.8	0.2	0.2	0.2	1.3	0.1	3
1 Derrick	200	40	0.011	0.011	13.61	15%	50%	0.6	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0497	11.2	0.3	0.3	0.3	1.7	0.1	4
Subtotal Attnd Plnt Dredge Site								5								52.6	1.5	1.3	1.3	8.0	0.4	
Transportation Route																						
dredge enroute																						
2 boosters	5200	200	0.045	0.039	13.61	90%	50%	215	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0497	3,551	124	47	49	433	14	8
Disposal Site																						

Appendix C-Marine Emissions CDEP Estimate #15 (of 15)

Reach A to Pedricktown N.

Hours per Month 657 (730hrs x 90% TE)

Assumed Year of Analysis 2013

Assumed Fuel Sulfur Level 31 ppm 0.0031%

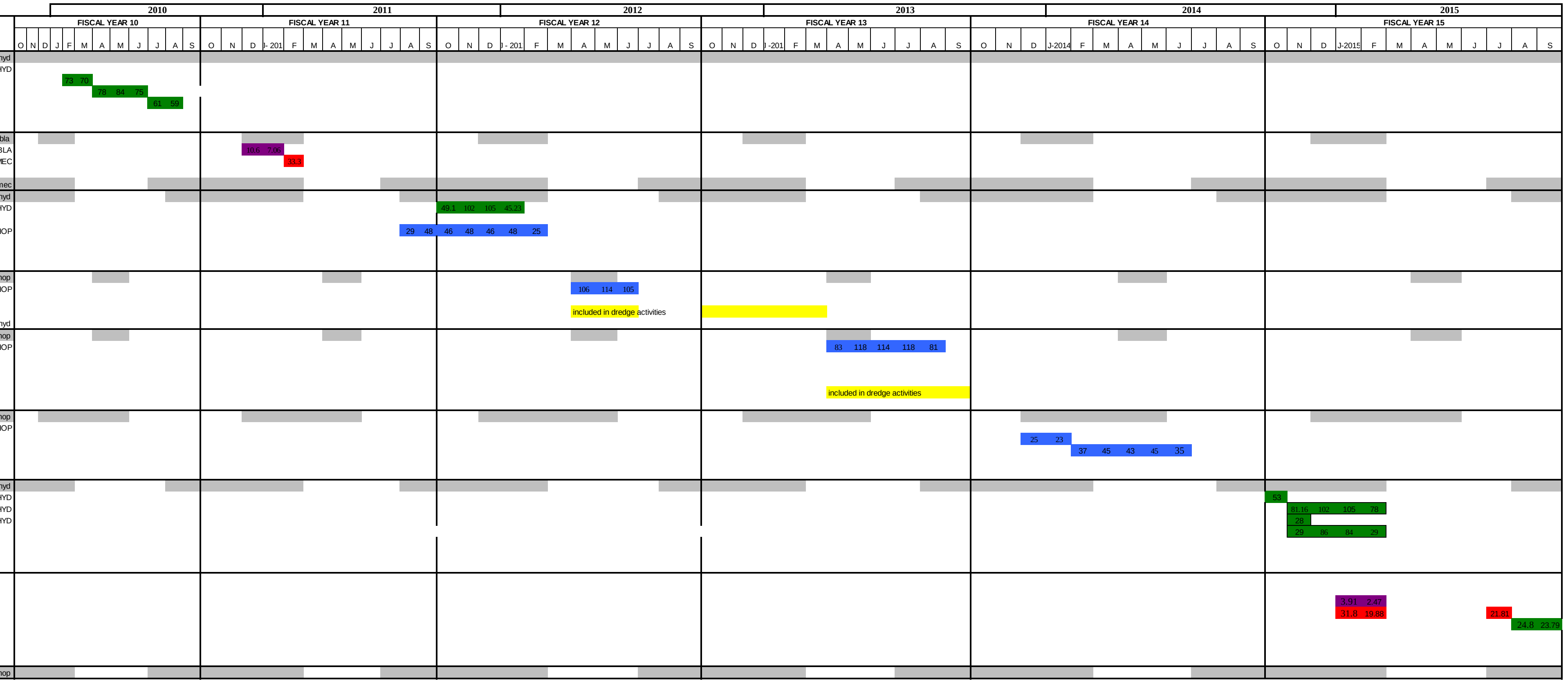
	From CDEP										Emission Factors						Daily Emissions						
	Propulsion Hp	Pumps Hp	Aux & Misc Hp	LF Propulsion	LF Pumps	LF Aux & Misc	% of cycle	Hrs/Day	Engine Basis	NOx gr-bhp/hr	VOC gr-bhp/hr	PM2.5 gr-bhp/hr	PM10 gr-bhp/hr	CO gr-bhp/hr	Sox gr-bhp/hr	NOx lbs/day	VOC lb/day	PM2.5 lbs/day	PM10 lbs/day	CO lbs/day	Sox lbs/day	Factor basis selector
Dredge Site																						
1 7600 cy dr	9000	3000	2000	45%	50%	30%	21.6%	4.66	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	622	25	11	12	52	1	7
1 Crew/Surv	100	0	40	15%	0%	50%		21.60	Cat1 100-175	7.457	0.21201	0.181458	0.190406	1.26769	0.0094	12	0	0	0	2	0	3
Transportation Route																						
1 7600 cy dr	9000	3000	2000	80%	0%	25%	57.7%	12.47	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	2,083	83	37	40	174	2	7
0 5200 hp bo	0	5200	200	0%	90%	50%	p/o time	4.47	Locomotive	12.38	0.43173	0.163726	0.172126	1.51	0.0094	0	0	0	0	0	0	8
Subtotal along Transp Route																2,083	83	37	40	174	2	
Disposal Site																						
1 7600 cy dr	9000	3000	2000	0%	80%	25%	20.7%	4.47	HC-Cat2	9.84324	0.392611	0.173203	0.18931	0.82027	0.0094	281	11	5	5	23	0	7
1 Tender Tug	250	0	50	60%	0%	50%		21.60	Cat1 175-300	7.457	0.21201	0.181458	0.190406	1.11855	0.0094	62	2	2	2	9	0	4
Subtotal Dredge at Pumpout							100.0%	21.60								343.6	13.0	6.5	7.0	32.8	0.3	
								90.0%														

Appendix D – Project Schedule and Monthly Emissions Profile for Each Pollutant

Delaware River Deepening
Construction Emissions (NOx)
Based on USACE CDEP Esimates and 29 Sept Revised Construction Schedule
10/2/2009

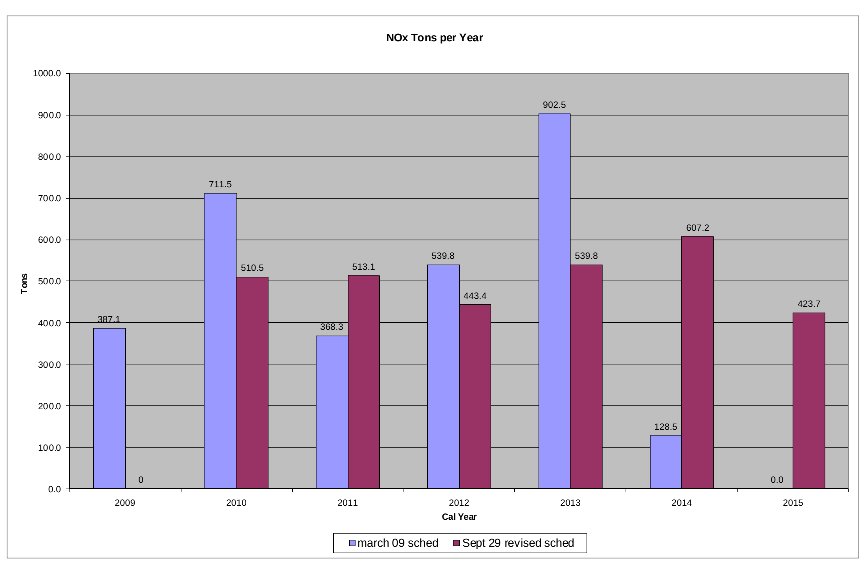
HOP	HOPPER DREDGE
HYD	CUTTER SUCTION DREDGE
	LANDSIDE CONSTRUCTION
MEC	CLAMSHELL DREDGE
BLA	DRILLBOAT (BLASTING)
	DREDGING WINDOW

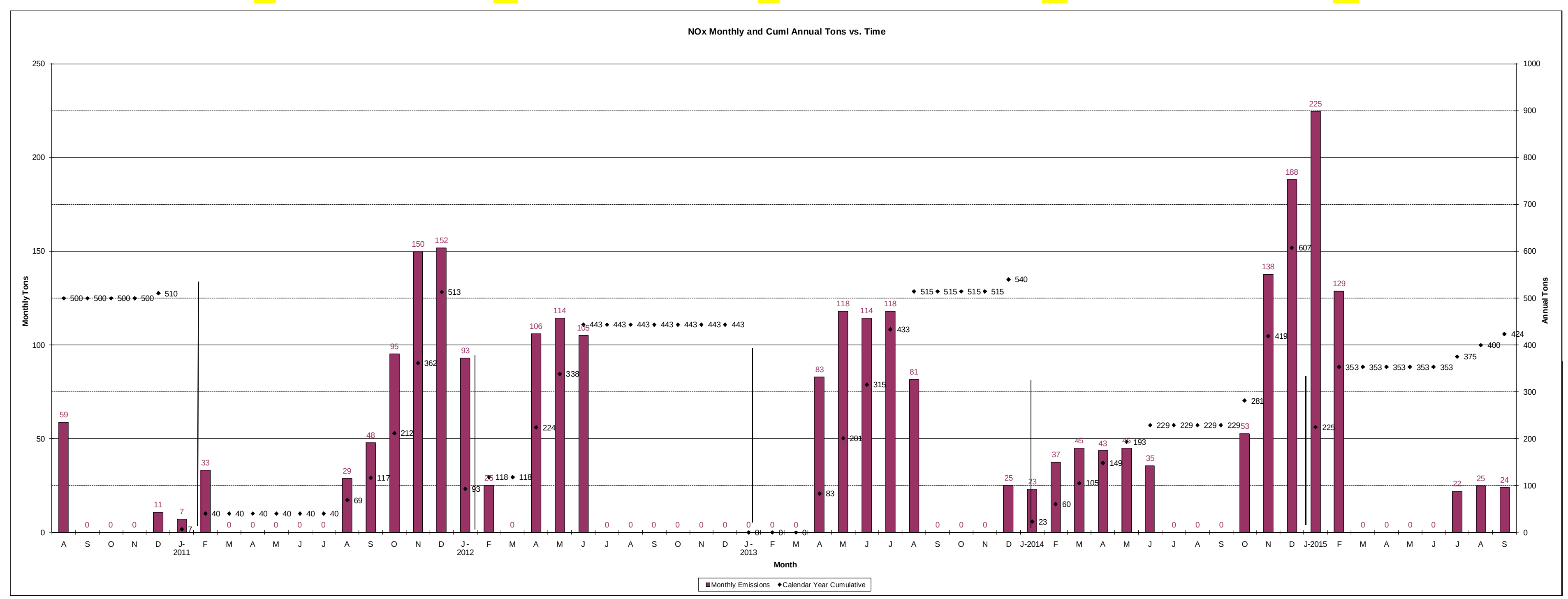
DELAWARE DEEPENING / DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	CDEP Est #	CDEP Pay Cys	CDEP Months	CDEP # of Machines	Dredging NOx lbs / Day	Mobilization Tons Nox	Total Nox Tons	Dredge		
Contract No. 1 (award year 1)													hyd
Reach C- Bulkhead Bar													HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	932,600	1.65	1	5,588	2.80	143.0	1	0.00	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	2	597,800	2.76	1	5,583	2.65	237.0	1	0.00	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	3	972,400	1.38	1	5,587	2.53	119.8	1	#####	
Construct Project			**2,502,800**		**2,502,800**					**499.8**			
Contract No. 2 (award year 1)													bla
Reach B - Rock Blasting		3.17		4	77,000	3.17	2	293	3.55	17.7	2	0.00	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		5	77,000	0.85	2	2,208	4.73	33.3	2	0.00	MEC
Construct Project			**77,000**		**77,000**					**50.9**			mec
Contract No. 3 (award year 2)													hyd
Reach AA - National Park		2.88	994,000	14	994,000	2.88	1	6,802	3.85	301.8	1	0.00	HYD
19+700 to 32+756	99.2												
Reach A - Pedricktown North		6.1	1,666,600	15	1,666,600	6.10	1	3,076	3.58	288.9	1	0.00	HOP
32+756 to 90+000	96.8												
Construct Project			**2,660,600**		**2,660,600**					**590.7**			
Contract No. 4 (award year 3)													hop
Reach E - Broadkill Beach - Dredge		3		10	1,598,700	5.79	1	3,686	0.83	325.4	2	0.00	HOP
461+300 to 512+000	15.6												
Construct Project			**1,598,700**		**1,598,700**					**325.4**			hyd
Contract No. 5 (award year 4)													hop
Reach E - Kelly Island -Dredge		4.5		11	2,483,000	8.86	1	3,808	1.54	514.7	2	0.00	HOP
351+300 to 360+000	36.4		345,800										
360+000 to 381+000	32.1		55,500										
381+000 to 461+300	30.8		2,081,700										
Construct Project			**2,483,000**		**2,483,000**					**514.7**			
Contract No. 6 (award year 5)													hop
Reach D -											1		HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300	12	396,300	1.13	1	2,670	2.19	48.1		0.00	
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800	13	1,654,800	4.63	1	2,894	2.06	205.9			
Construct Project			**2,051,100**		**2,051,100**					**253.9**			
Contract No. 7 (award year 6)													hyd
Reach B - Oldmans		0.89	1,671,400	6	1,671,400	0.90	1	3,611	3.18	52.6	1	0.00	HYD
Reach B - Pedricktown North		3.51	1,050,700	7	1,050,700	3.51	1	6,797	3.40	366.2	1	0.00	HYD
Reach B - Pedricktown South		3.13	1,942,800	8	499,300	0.45	1	3,597	3.18	27.8	1	0.00	HYD
90+000 to 176+000	0.0			9	1,443,500	2.68	1	5,570		227.0		0.00	
Construct Project			**4,664,900**		**4,664,900**					**673.7**			
Total Channel		**40.0**	**16,038,100**		**16,038,100**					**2,909.3**			
Berth Deepenings													
Berth Deepenings Drill/Blast					25,089	2.07	1	157	1.44	6.4			
Berth Deepening Clamshell					460,437	2.94	1	1,420	10.03	73.5			
Berth Deepening CSD Rehandling WP					460,437	1.23	1	2,544	0.98	48.6			
Total Berth Deepenings					**460,437**					**128.5**			
Total Project					**16,498,537**					**3,037.7**			hop



	march 09 sched		Sept 29 revised sched	0.000
			Total Tons NOx	
2009	**387.1**			
2010	**711.5**	**Calendar 2010**	**510.5**	
2011	**368.3**	**Calendar 2011**	**513.1**	
2012	**539.8**	**Calendar 2012**	**443.4**	
2013	**902.5**	**Calendar 2013**	**539.8**	
2014	**128.5**	**Calendar 2014**	**607.2**	
2015	**0.0**	**Calendar 2015**	**423.7**	
	3037.7			**3,037.7**

Monthly Nox Tons	73	70	78	84	75	61	59	0	0	0	11	7	33	0	0	0	0	0	29	48	95	150	152	93	25	0	106	114	105	0	0	0	0	0	0	0	0	0	83	118	114	118	81	0	0	0	25	23	37	45	43	45	35	0	0	0	53	138	188	225	129	0	0	0	0	22	25	24
Cumulative Nox Tons	73	143	221	305	380	441	500	500	500	500	510	518	551	551	551	551	551	551	579	627	722	872	1024	1116	1141	1141	1247	1362	1467	1467	1467	1467	1467	1467	1467	1467	1467	1467	1550	1668	1782	1900	1982	1982	1982	1982	2007	2030	2067	2112	2155	2200	2236	2236	2236	2236	2288	2426	2614	2839	2967	2967	2967	2967	2967	2989	3014	3038
Annual Cuml Nox Tons	73	143	221	305	380	441	500	500	500	500	510	7	40	40	40	40	40	40	69	117	212	362	513	93	118	118	224	338	443	443	443	443	443	443	443	0	0	0	83	201	315	433	515	515	515	515	540	23	60	105	149	193	229	229	229	229	281	419	607	225	353	353	353	353	353	375	400	424

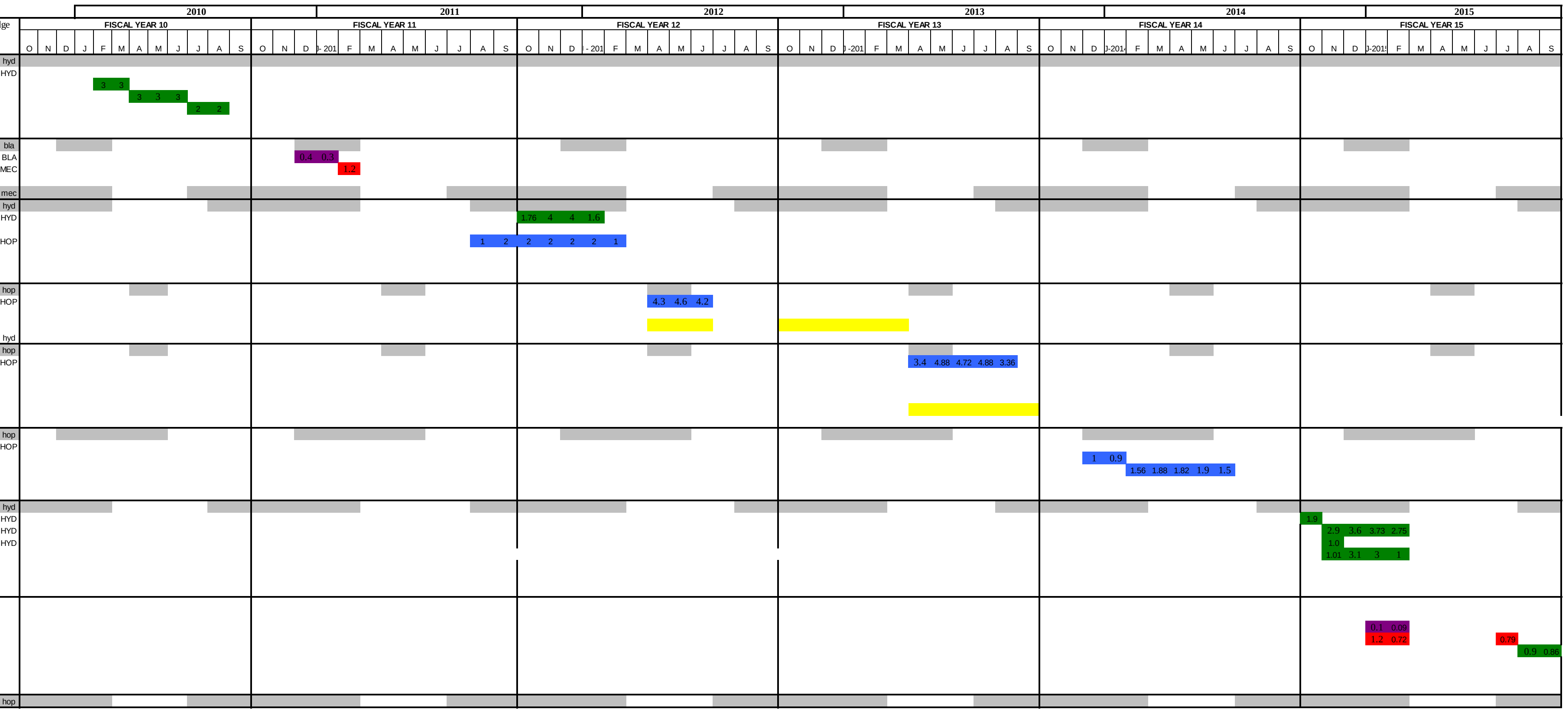




Delaware River Deepening
Construction Emissions (VOC)
Based on USACE CDEP Esimates and 29 Sept Revised Construction Schedule
10/2/2009

Legend	
HOP	HOPPER DREDGE
HYD	CUTTER SUCTION DREDGE
	LANDSIDE CONSTRUCTION
MEC	CLAMSHELL DREDGE
BLA	DRILLBOAT (BLASTING)
	DREDGING WINDOW

DELAWARE DEEPENING DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	CDEP Est #	CDEP Pay Cys	CDEP Months	CDEP # of Machines	Dredging VOCs lbs / Day	Mobilization Tons VOCs	Total VOCs Tons	Dredge	
Contract No. 1 (award year 1)												hyd
Reach C- Bulkhead Bar												HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	932,600	1.65	1	200.6	0.11	5.1	1	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	2	597,800	2.76	1	200.3	0.10	8.5	1	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	3	972,400	1.38	1	200.4	0.10	4.3	1	
Construct Project			**2,502,800**		**2,502,800**					**18.0**		
Contract No. 2 (award year 1)												bla
Reach B - Rock Blasting		3.17		4	77,000	3.17	2	10.5	0.13	0.6	2	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		5	77,000	0.85	2	77.7	0.18	1.2	2	MEC
Construct Project			**77,000**		**77,000**					**1.8**		mec
Contract No. 3 (award year 2)												hyd
Reach AA - National Park		2.88	994,000	14	994,000	2.88	1	242.2	0.15	10.8	1	HYD
19+700 to 32+756	99.2											
Reach A - Pedricktown North		6.1	1,666,600	15	1,666,600	6.10	1	123.3	0.14	11.6	1	HOP
32+756 to 90+000	96.8											
Construct Project			**2,660,600**		**2,660,600**					**22.3**		
Contract No. 4 (award year 3)												hop
Reach E - Broadkill Beach - Dredge		3		10	1,598,700	5.79	1	147.8	0.03	13.1	2	HOP
461+300 to 512+000	15.6											
Construct Project			**1,598,700**		**1,598,700**					**13.1**		hyd
Contract No. 5 (award year 4)												hop
Reach E - Kelly Island -Dredge		4.5		11	2,483,000	8.86	1	157.4	0.06	21.3	2	HOP
351+300 to 360+000	36.4		345,800									
360+000 to 381+000	32.1		55,500									
381+000 to 461+300	30.8		2,081,700									
Construct Project			**2,483,000**		**2,483,000**					**21.3**		
Contract No. 6 (award year 5)												hop
Reach D -											1	HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300	12	396,300	1.13	1	107.5	0.09	1.9		
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800	13	1,654,800	4.63	1	121.5	0.08	8.6		
Construct Project			**2,051,100**		**2,051,100**					**10.6**		
Contract No. 7 (award year 6)												hyd
Reach B - Oldmans		0.89	1,671,400	6	1,671,400	0.90	1	130.2	0.12	1.9	1	HYD
Reach B - Pedricktown North		3.51	1,050,700	7	1,050,700	3.51	1	240.8	0.13	13.0	1	HYD
Reach B - Pedricktown South		3.13	1,942,800	8	499,300	0.45	1	128.7	0.12	1.0	1	HYD
90+000 to 176+000	0.0			9	1,443,500	2.68	1	197.6	0.00	8.1		
Construct Project			**4,664,900**		**4,664,900**					**24.0**		
Total Channel		**40.0**	**16,038,100**		**16,038,100**					**111.0**		
Berth Deepenings												
Berth Deepenings Drill/Blast					25,089	2.07	1	6.0	0.05	0.2		
Berth Deepening Clamshell					460,437	2.94	1	51.2	0.36	2.7		
Berth Deepening CSD Rehandling WP					460,437	1.23	1	91.9	0.04	1.8		
Total Berth Deepenings					**460,437**					**4.6**		
Total Project					**16,498,537**					**115.6**		hop



march 09 sched		Total Tons VOC
13.92	Calendar 2010	18.3
26.57	Calendar 2011	19.3
14.68	Calendar 2012	17.6
22.28	Calendar 2013	22.3
33.51	Calendar 2014	23.0
4.65	Calendar 2015	15.1
0		
115.61		115.61

0.00

Fiscal Year 10:

	O	N	D	J	F	M	A	M	J	J	A	S
Monthly VOC Tons	0.0	0.0	0.0	0.0	2.6	2.5	2.8	3.0	2.7	2.2	2.1	0.0
Cumulative VOC Tons	0.0	0.0	0.0	0.0	2.6	5.1	7.9	11.0	13.7	15.9	18.0	18.0
Annual Cuml VOC Tons	0.0	0.0	0.0	0.0	2.6	5.1	7.9	11.0	13.7	15.9	18.0	18.0

Fiscal Year 11:

	O	N	D	J	F	M	A	M	J	J	A	S
Monthly VOC Tons	0.0	0.0	0.4	0.3	1.2	0.0	0.0	0.0	0.0	0.0	1.1	1.9
Cumulative VOC Tons	18.0	18.0	18.3	18.6	19.8	19.8	19.8	19.8	19.8	19.8	20.9	22.8
Annual Cuml VOC Tons	18.0	18.0	18.3	0.3	1.4	1.4	1.4	1.4	1.4	1.4	2.6	4.5

Fiscal Year 12:

	O	N	D	J	F	M	A	M	J	J	A	S
Monthly VOC Tons	3.6	5.5	5.6	3.5	1.0	0	4.25	4.58	4.22	0	0	0
Cumulative VOC Tons	26.5	32.0	37.6	41.1	42.1	42.1	46.4	51	55.2	55.2	55.2	55.2
Annual Cuml VOC Tons	8.1	13.6	19.3	3.5	4.5	4.5	8.8	13.4	17.6	17.6	17.6	17.6

Fiscal Year 13:

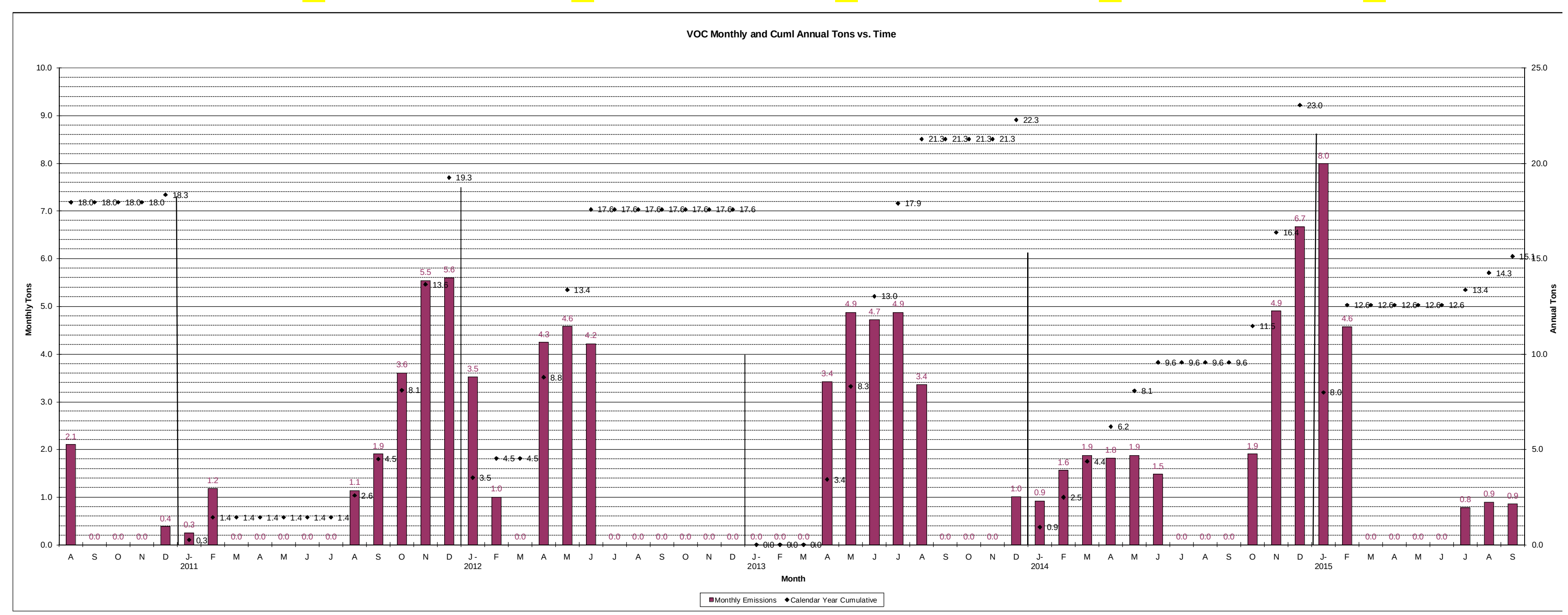
	O	N	D	J	F	M	A	M	J	J	A	S
Monthly VOC Tons	0	0	0	0	0	0	3.4	4.9	4.7	4.9	3.4	0
Cumulative VOC Tons	55.2	55.2	55.2	55	55	55	59	63	68	73	76	76
Annual Cuml VOC Tons	17.6	17.6	17.6	0.0	0.0	0.0	3.4	8.3	13.0	17.9	21.3	21.3

Fiscal Year 14:

	O	N	D	J	F	M	A	M	J	J	A	S
Monthly VOC Tons	0	0	1	0.9	1.6	1.9	1.8	1.9	1.5	0	0	0
Cumulative VOC Tons	76	76	77	78	80	82	84	86	87	87	87	87
Annual Cuml VOC Tons	21.3	21.3	22.3	0.9	2.5	4.4	6.2	8.1	9.6	9.6	9.6	9.6

Fiscal Year 15:

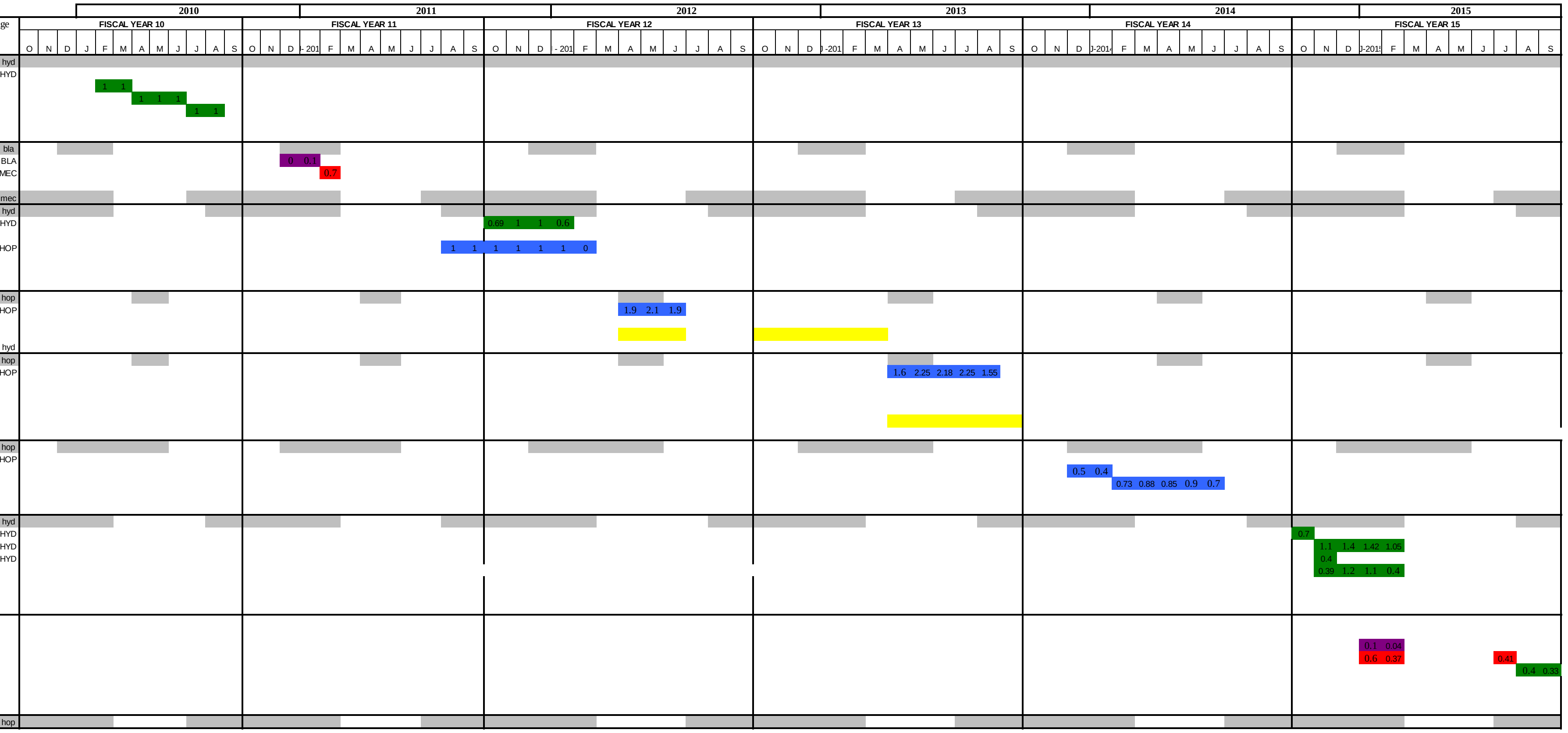
	O	N	D	J	F	M	A	M	J	J	A	S
Monthly VOC Tons	1.9	4.9	6.7	8	4.6	0	0	0	0	0.8	0.9	0.9
Cumulative VOC Tons	89	94	100	108	113	113	113	113	113	114	115	116
Annual Cuml VOC Tons	11.5	16.4	23.0	8.0	12.6	12.6	12.6	12.6	12.6	13.4	14.3	15.1



Delaware River Deepening
Construction Emissions (PM2.5)
Based on USACE CDEP Esimates and 29 Sept Revised Construction Schedule
10/2/2009

HOP (blue)	HOPPER DREDGE
HYD (green)	CUTTER SUCTION DREDGE
(yellow)	LANDSIDE CONSTRUCTION
MEC (red)	CLAMSHELL DREDGE
BLA (purple)	DRILLBOAT (BLASTING)
(grey)	DREDGING WINDOW

DELAWARE DEEPENING / DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	CDEP Est #	CDEP Pay Cys	CDEP Months	CDEP # of Machines	Dredging PM2.5 lbs / Day	Mobilization Tons PM2.5	Total PM2.5 Tons	Dredge	
Contract No. 1 (award year 1)												hyd
Reach C- Bulkhead Bar												HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	932,600	1.65	1	77.7	0.051	2.0	1	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	2	597,800	2.76	1	77.1	0.048	3.3	1	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	3	972,400	1.38	1	78.6	0.046	1.7	1	
Construct Project			**2,502,800**		**2,502,800**					**7.0**		
Contract No. 2 (award year 1)												bla
Reach B - Rock Blasting		3.17		4	77,000	3.17	2	4.3	0.061	0.3	2	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		5	77,000	0.85	2	44.6	0.088	0.7	2	MEC
Construct Project			**77,000**		**77,000**					**0.9**		mec
Contract No. 3 (award year 2)												hyd
Reach AA - National Park		2.88	994,000	14	994,000	2.88	1	92.9	0.069	4.1	1	HYD
19+700 to 32+756	99.2											
Reach A - Pedricktown North		6.1	1,666,600	15	1,666,600	6.10	1	55.5	0.063	5.2	1	HOP
32+756 to 90+000	96.8											
Construct Project			**2,660,600**		**2,660,600**					**9.3**		
Contract No. 4 (award year 3)												hop
Reach E - Broadkill Beach - Dredge		3		10	1,598,700	5.79	1	66.4	0.01	5.9	2	HOP
461+300 to 512+000	15.6											
Construct Project			**1,598,700**		**1,598,700**					**5.9**		hyd
Contract No. 5 (award year 4)												hop
Reach E - Kelly Island -Dredge		4.5		11	2,483,000	8.86	1	72.6	0.03	9.8	2	HOP
351+300 to 360+000	36.4		345,800									
360+000 to 381+000	32.1		55,500									
381+000 to 461+300	30.8		2,081,700									
Construct Project			**2,483,000**		**2,483,000**					**9.8**		
Contract No. 6 (award year 5)												hop
Reach D -											1	HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300	12	396,300	1.13	1	48.8	0.04	0.9		
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800	13	1,654,800	4.63	1	56.5	0.04	4.0		
Construct Project			**2,051,100**		**2,051,100**					**4.9**		
Contract No. 7 (award year 6)												hyd
Reach B - Oldmans		0.89	1,671,400	6	1,671,400	0.90	1	50.3	0.06	0.7	1	HYD
Reach B - Pedricktown North		3.51	1,050,700	7	1,050,700	3.51	1	91.6	0.06	5.0	1	HYD
Reach B - Pedricktown South		3.13	1,942,800	8	499,300	0.45	1	49.1	0.06	0.4	1	HYD
90+000 to 176+000	0.0			9	1,443,500	2.68	1	75.2	0.00	3.1		
Construct Project			**4,664,900**		**4,664,900**					**9.2**		
Total Channel		**40.0**	**16,038,100**		**16,038,100**					**47.0**		
Berth Deepenings												
Berth Deepenings Drill/Blast					25,089	2.07	1	2	0.02	0.1		
Berth Deepening Clamshell					460,437	2.94	1	27	0.19	1.4		
Berth Deepening CSD Rehandling WP					460,437	1.23	1	36	0.02	0.7		
Total Berth Deepenings					**460,437**					**2.2**		
Total Project					**16,498,537**					**49.15**		hop



march 09 sched		Total Tons PM2.5
5.40		
11.07	Calendar 2010	7.14
6.66	Calendar 2011	8.19
10.27	Calendar 2012	7.79
13.60	Calendar 2013	10.27
2.16	Calendar 2014	9.61
0	Calendar 2015	6.14
49.15		49.15

0.00

FISCAL YEAR 10	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM2.5 Tons	0.0	0.0	0.0	0.0	1.0	1.0	1.1	1.2	1.0	0.9	0.8	0.0
Cumulative PM2.5 Tons	0.0	0.0	0.0	0.0	1.0	2.0	3.1	4.2	5.3	6.2	7.0	7.0
Annual Cuml PM2.5 Tons	0.0	0.0	0.0	0.0	1.0	2.0	3.1	4.2	5.3	6.2	7.0	7.0

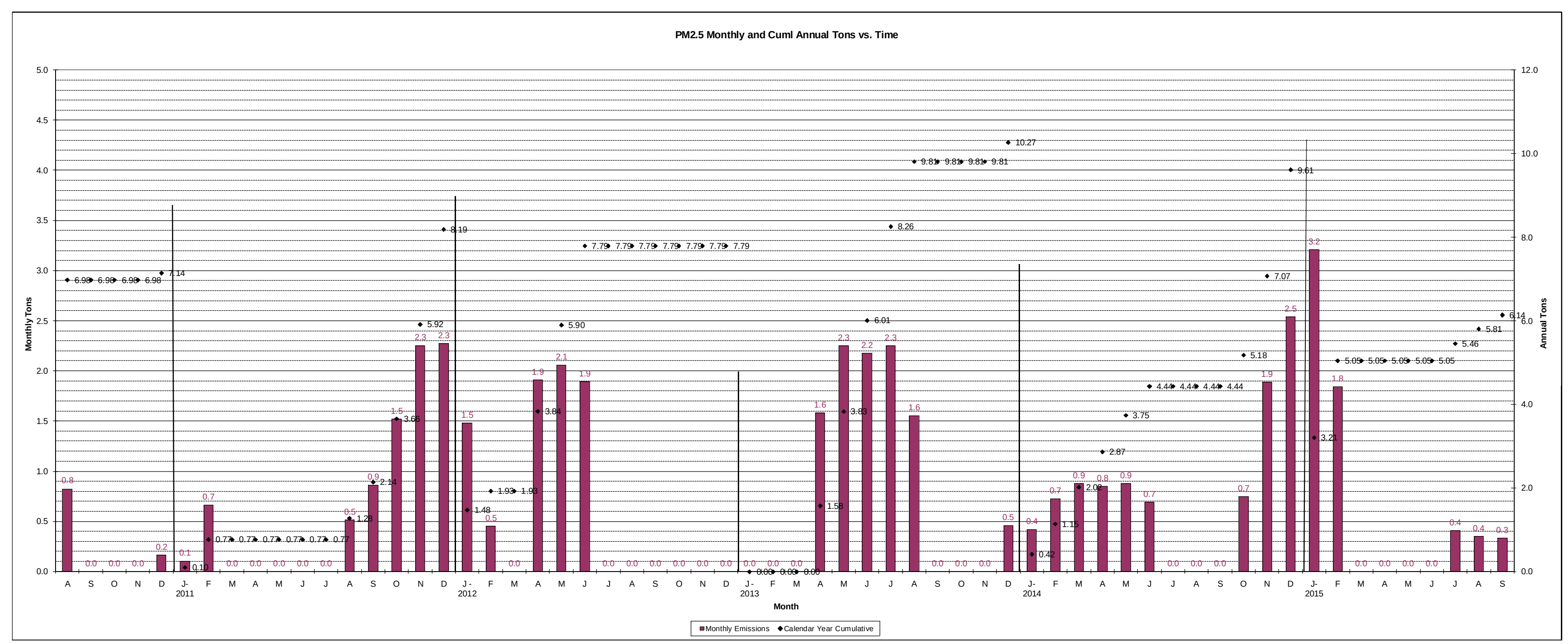
FISCAL YEAR 11	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM2.5 Tons	0.0	0.0	0.2	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.5	0.9
Cumulative PM2.5 Tons	7.0	7.0	7.1	7	8	8	8	8	8	8	8	9
Annual Cuml PM2.5 Tons	7.0	7.0	7.1	0.1	0.8	0.8	0.8	0.8	0.8	0.8	1.28	2.1

FISCAL YEAR 12	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM2.5 Tons	1.5	2.3	2.3	1.5	0.5	0	1.91	2.06	1.9	0	0	0
Cumulative PM2.5 Tons	11	13	15	17	17	17	19	21	23	23	23	23
Annual Cuml PM2.5 Tons	3.66	5.92	8.19	1.48	1.9	1.93	3.84	5.9	7.79	7.79	7.79	7.79

FISCAL YEAR 13	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM2.5 Tons	0	0	0	0	0	0	1.6	2.3	2.2	2.3	1.6	0
Cumulative PM2.5 Tons	23	23	23	23	23	23	25	27	29	31	33	33
Annual Cuml PM2.5 Tons	7.79	7.79	7.79	0	0	0	1.6	3.8	6	8.3	9.8	9.8

FISCAL YEAR 14	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM2.5 Tons	0	0	0.5	0.4	0.7	0.9	0.8	0.9	0.7	0	0	0
Cumulative PM2.5 Tons	33	33	33	34	35	35	36	37	38	38	38	38
Annual Cuml PM2.5 Tons	9.8	9.8	10	0.4	1.1	2	2.9	3.7	4.4	4.4	4.4	4.4

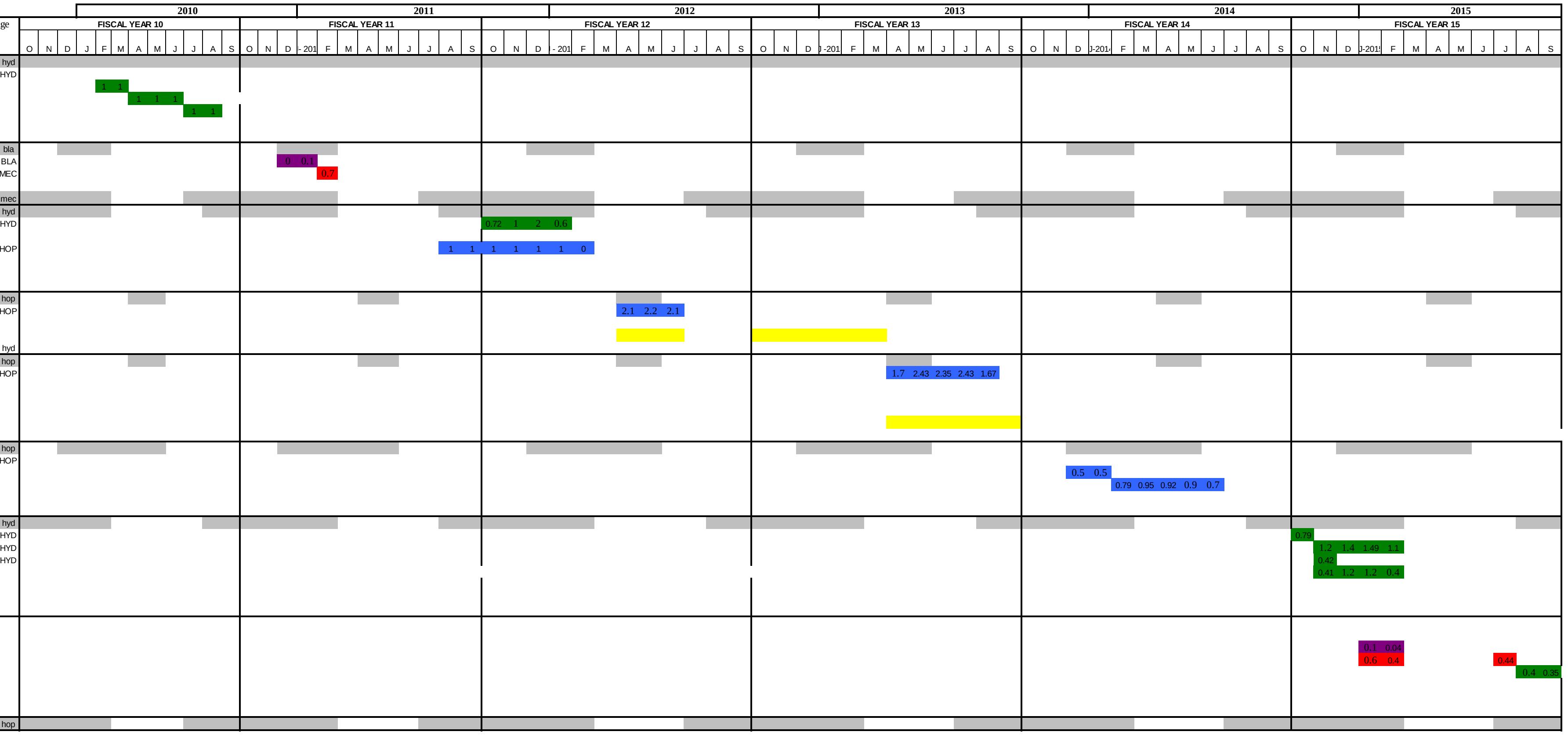
FISCAL YEAR 15	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM2.5 Tons	0.7	1.9	2.5	3.2	1.8	0	0	0	0	0.4	0.4	0.3
Cumulative PM2.5 Tons	39	40	43	46	48	48	48	48	48	48	49	49
Annual Cuml PM2.5 Tons	5.2	7.1	9.6	3.2	5.1	5.1	5.1	5.1	5.1	5.5	5.8	6.1



Delaware River Deepening
Construction Emissions (PM10)
Based on USACE CDEP Esimates and 29 Sept Revised Construction Schedule
10/2/2009

HOP	HOPPER DREDGE (blue)
HYD	CUTTER SUCTION DREDGE (green)
	LANDSIDE CONSTRUCTION (yellow)
MEC	CLAMSHELL DREDGE (red)
BLA	DRILLBOAT (BLASTING) (purple)
	DREDGING WINDOW (grey)

DELAWARE DEEPENING DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	CDEP Est #	CDEP Pay Cys	CDEP Months	CDEP # of Machines	Dredging PM10 lbs / Day	Mobilization Tons PM10	Total PM10 Tons	Dredge	
Contract No. 1 (award year 1)												hyd
Reach C- Bulkhead Bar												HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	932,600	1.65	1	81.7	0.055	2.11	1	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	2	597,800	2.76	1	81.0	0.052	3.45	1	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	3	972,400	1.38	1	81.5	0.050	1.76	1	
Construct Project			**2,502,800**		**2,502,800**					**7.32**		
Contract No. 2 (award year 1)												bla
Reach B - Rock Blasting		3.17		4	77,000	3.17	2	4.6	0.066	0.29	2	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		5	77,000	0.85	2	47.2	0.095	0.71	2	MEC
Construct Project			**77,000**		**77,000**					**0.99**		
												mec
Contract No. 3 (award year 2)												hyd
Reach AA - National Park		2.88	994,000	14	994,000	2.88	1	97.7	0.075	4.35	1	HYD
19+700 to 32+756	99.2											
Reach A - Pedricktown North		6.1	1,666,600	15	1,666,600	6.10	1	60.5	0.069	5.68	1	HOP
32+756 to 90+000	96.8											
Construct Project			**2,660,600**		**2,660,600**					**10.03**		
Contract No. 4 (award year 3)												hop
Reach E - Broadkill Beach - Dredge		3		10	1,598,700	5.79	1	72	0.02	6.35	2	HOP
461+300 to 512+000	15.6											
Construct Project			**1,598,700**		**1,598,700**					**6.35**		hyd
Contract No. 5 (award year 4)												hop
Reach E - Kelly Island -Dredge		4.5		11	2,483,000	8.86	1	78	0.03	10.58	2	HOP
351+300 to 360+000	36.4		345,800									
360+000 to 381+000	32.1		55,500									
381+000 to 461+300	30.8		2,081,700									
Construct Project			**2,483,000**		**2,483,000**					**10.58**		
Contract No. 6 (award year 5)												hop
Reach D -											1	HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300	12	396,300	1.13	1	53	0.04	0.96		
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800	13	1,654,800	4.63	1	61	0.04	4.35		
Construct Project			**2,051,100**		**2,051,100**					**5.31**		
Contract No. 7 (award year 6)												hyd
Reach B - Oldmans		0.89	1,671,400	6	1,671,400	0.90	1	53	0.06	0.79	1	HYD
Reach B - Pedricktown North		3.51	1,050,700	7	1,050,700	3.51	1	96	0.07	5.21	1	HYD
Reach B - Pedricktown South		3.13	1,942,800	8	499,300	0.45	1	52	0.06	0.42	1	HYD
90+000 to 176+000	0.0			9	1,443,500	2.68	1	79	0.00	3.22		
Construct Project			**4,664,900**		**4,664,900**					**9.64**		
Total Channel		**40.0**	**16,038,100**		**16,038,100**					**50.2**		
Berth Deepenings												
Berth Deepenings Drill/Blast					25,089	2.07	1	3	0.03	0.10		
Berth Deepening Clamshell					460,437	2.94	1	28	0.21	1.48		
Berth Deepening CSD Rehandling WP					460,437	1.23	1	37	0.02	0.72		
Total Berth Deepenings					**460,437**					**2.3**		
Total Project					**16,498,537**					**52.5**		hop



march 09 sched		Total Tons PM10
5.68		
11.81	Calendar 2010	7.50
7.20	Calendar 2011	8.77
11.08	Calendar 2012	8.43
14.45	Calendar 2013	11.08
2.30	Calendar 2014	10.26
0.00	Calendar 2015	6.49
52.52		52.52

0.00

FISCAL YEAR 10	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM10 Tons	0.0	0.0	0.0	0.0	1.1	1.0	1.1	1.2	1.1	0.9	0.9	0.0
Cumulative PM10 Tons	0.0	0.0	0.0	0.0	1.1	2.1	3.3	4.5	5.6	6.5	7.3	7.3
Annual Cuml PM10 Tons	0.0	0.0	0.0	0.0	1.1	2.1	3.3	4.5	5.6	6.5	7.3	7.3

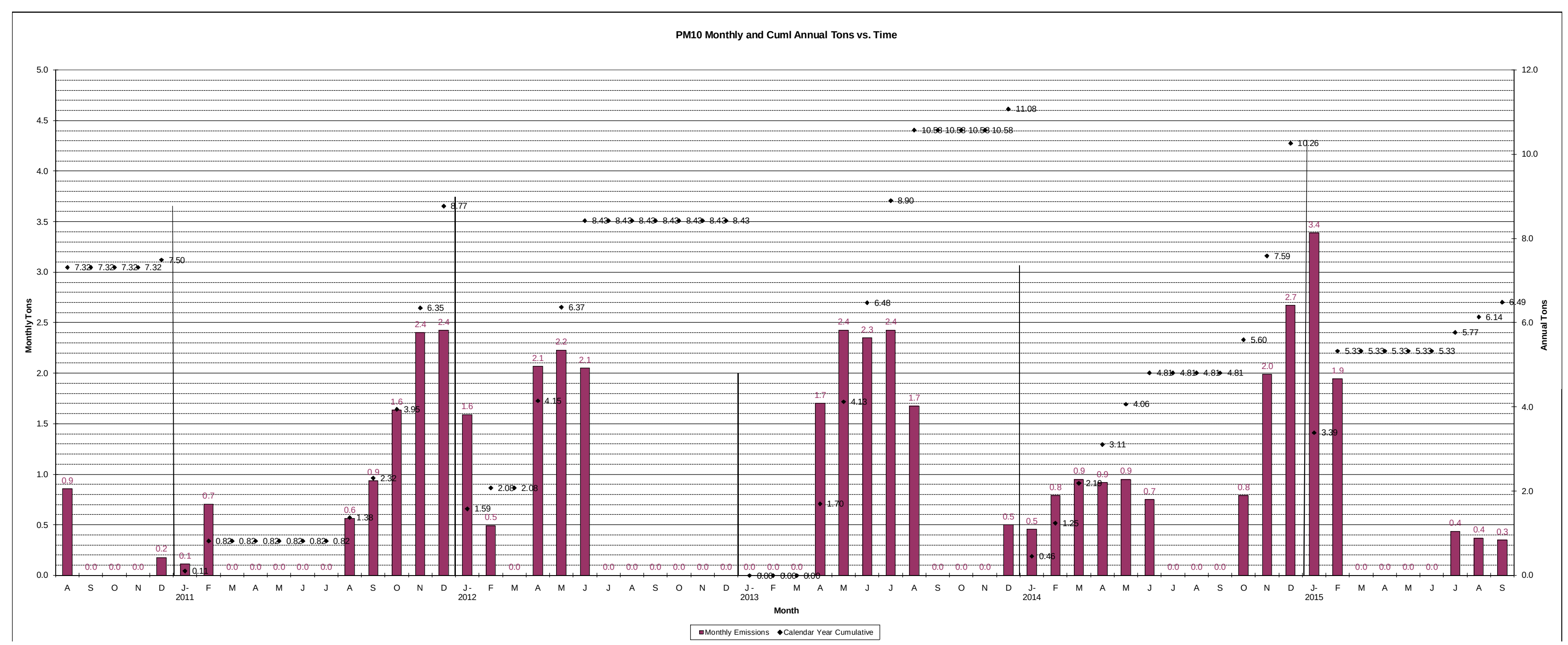
FISCAL YEAR 11	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM10 Tons	0.0	0.0	0.2	0.1	0.7	0.0	0.0	0.0	0.0	0.0	0.6	0.9
Cumulative PM10 Tons	7.3	7.3	7.5	7.6	8.3	8.3	8.3	8.3	8.3	8.3	8.9	9.8
Annual Cuml PM10 Tons	7.3	7.3	7.5	0.1	0.8	0.8	0.8	0.8	0.8	0.8	1.4	2.3

FISCAL YEAR 12	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM10 Tons	1.6	2.4	2.4	1.6	0.5	0	2.07	2.23	2.05	0	0	0
Cumulative PM10 Tons	11.4	13.8	16.3	17.9	18.3	18.3	20.4	22.6	24.7	24.7	24.7	24.7
Annual Cuml PM10 Tons	3.9	6.4	8.8	1.6	2.1	2.1	4.1	6.4	8.4	8.4	8.4	8.4

FISCAL YEAR 13	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM10 Tons	0	0	0	0	0	0	1.7	2.4	2.3	2.4	1.7	0
Cumulative PM10 Tons	24.7	24.7	24.7	24.7	24.7	24.7	26.4	28.8	31.2	33.6	35.3	35.3
Annual Cuml PM10 Tons	8.4	8.4	8.4	0.0	0.0	0.0	1.7	4.1	6.5	8.9	###	###

FISCAL YEAR 14	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM10 Tons	0	0	0.5	0.5	0.8	0.9	0.9	0.9	0.7	0	0	0
Cumulative PM10 Tons	35.3	35.3	35.8	36.2	37.0	38.0	38.9	39.8	40.6	40.6	40.6	40.6
Annual Cuml PM10 Tons	###	###	###	0.5	1.2	2.2	3.1	4.1	4.8	4.8	4.8	4.8

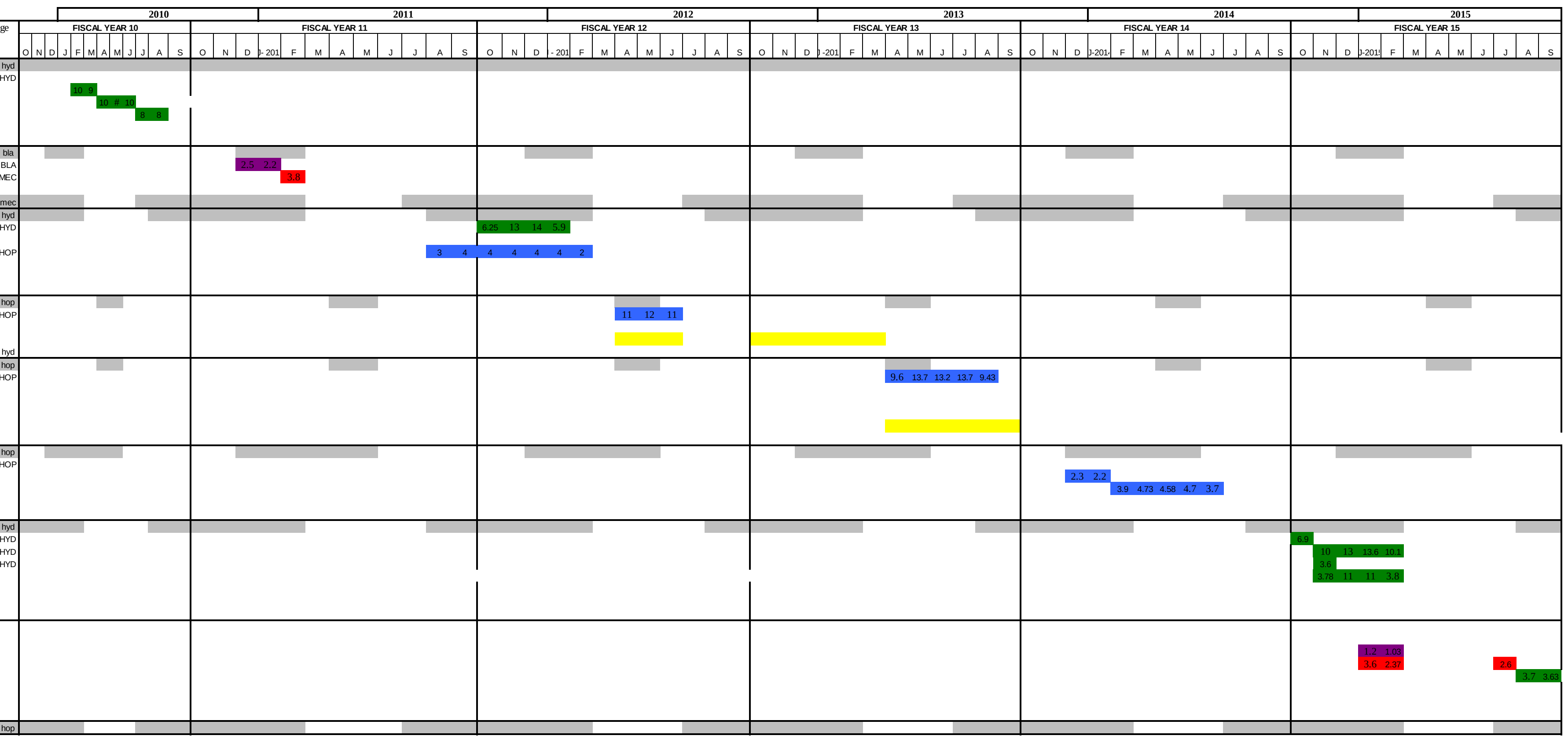
FISCAL YEAR 15	O	N	D	J	F	M	A	M	J	J	A	S
Monthly PM10 Tons	0.8	2	2.7	3.4	1.9	0	0	0	0	0.4	0.4	0.3
Cumulative PM10 Tons	41.4	43.4	46.0	49.4	51.4	51.4	51.4	51.4	51.4	51.8	52.2	52.5
Annual Cuml PM10 Tons	5.6	7.6	###	3.4	5.3	5.3	5.3	5.3	5.3	5.8	6.1	6.5



Delaware River Deepening
Construction Emissions (CO)
Based on USACE CDEP Esimates and 29 Sept Revised Construction Schedule
10/2/2009

HOP	HOPPER DREDGE
HYD	CUTTER SUCTION DREDGE
	LANDSIDE CONSTRUCTION
MEC	CLAMSHELL DREDGE
BLA	DRILLBOAT (BLASTING)
	DREDGING WINDOW

DELAWARE DEEPENING DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	CDEP Est #	CDEP Pay Cys	CDEP Months	CDEP # of Machines	Dredging CO lbs / Day	Mobilization Tons CO	Total CO Tons	Dredge	
Contract No. 1 (award year 1)												hyd
Reach C- Bulkhead Bar												HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	932,600	1.65	1	737.7	0.249	18.8	1	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	2	597,800	2.76	1	753.6	0.236	31.9	1	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	3	972,400	1.38	1	752.2	0.226	16.0	1	
Construct Project			**2,502,800**		**2,502,800**					**66.6**		
Contract No. 2 (award year 1)												bla
Reach B - Rock Blasting		3.17		4	77,000	3.17	2	91.1	0.335	4.7	2	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		5	77,000	0.85	2	259.6	0.436	3.8	2	MEC
Construct Project			**77,000**		**77,000**					**8.5**		mec
Contract No. 3 (award year 2)												hyd
Reach AA - National Park		2.88	994,000	14	994,000	2.88	1	889.1	0.336	39.3	1	HYD
19+700 to 32+756	99.2											
Reach A - Pedricktown North		6.1	1,666,600	15	1,666,600	6.10	1	279.4	0.302	26.2	1	HOP
32+756 to 90+000	96.8											
Construct Project			**2,660,600**		**2,660,600**					**65.5**		
Contract No. 4 (award year 3)												hop
Reach E - Broadkill Beach - Dredge		3		10	1,598,700	5.79	1	399	0.07	35.2	2	HOP
461+300 to 512+000	15.6											
Construct Project			**1,598,700**		**1,598,700**					**35.2**		hyd
Contract No. 5 (award year 4)												hop
Reach E - Kelly Island -Dredge		4.5		11	2,483,000	8.86	1	441	0.13	59.6	2	HOP
351+300 to 360+000	36.4		345,800									
360+000 to 381+000	32.1		55,500									
381+000 to 461+300	30.8		2,081,700									
Construct Project			**2,483,000**		**2,483,000**					**59.6**		
Contract No. 6 (award year 5)												hop
Reach D -											1	HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300	12	396,300	1.13	1	251	0.19	4.5		
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800	13	1,654,800	4.63	1	305	0.17	21.7		
Construct Project			**2,051,100**		**2,051,100**					**26.1**		
Contract No. 7 (award year 6)												hyd
Reach B - Oldmans		0.89	1,671,400	6	1,671,400	0.90	1	485	0.28	6.9	1	HYD
Reach B - Pedricktown North		3.51	1,050,700	7	1,050,700	3.51	1	879	0.30	47.2	1	HYD
Reach B - Pedricktown South		3.13	1,942,800	8	499,300	0.45	1	482	0.28	3.6	1	HYD
90+000 to 176+000	0.0			9	1,443,500	2.68	1	737	0.00	30.0		
Construct Project			**4,664,900**		**4,664,900**					**87.7**		
Total Channel		**40.0**	**16,038,100**		**16,038,100**					**349.3**		
Berth Deepenings												
Berth Deepenings Drill/Blast					25,089	2.07	1	65	0.16	2.2		
Berth Deepening Clamshell					460,437	2.94	1	169	0.97	8.5		
Berth Deepening CSD Rehandling WP					460,437	1.23	1	388	0.09	7.3		
Total Berth Deepenings					**460,437**					**18.1**		
Total Project					**16,498,537**					**367.4**		hop



march 09 sched		Sept 29 revised sched Total Tons CO
52.1		
83.5	Calendar 2010	69.2
40.2	Calendar 2011	59.0
61.9	Calendar 2012	47.7
111.5	Calendar 2013	61.9
18.1	Calendar 2014	73.0
0.0	Calendar 2015	56.6
367.4		367.4

0.00

FY10	O	N	D	J	F	M	A	M	J	J	A	S
Monthly CO Tons	0	0	0	0	10	9	10	11	10	8	8	0
Cumulative CO Tons	0	0	0	0	10	19	29	40	51	59	67	67
Annual Cuml CO Tons	0	0	0	0	10	19	29	40	51	59	67	67

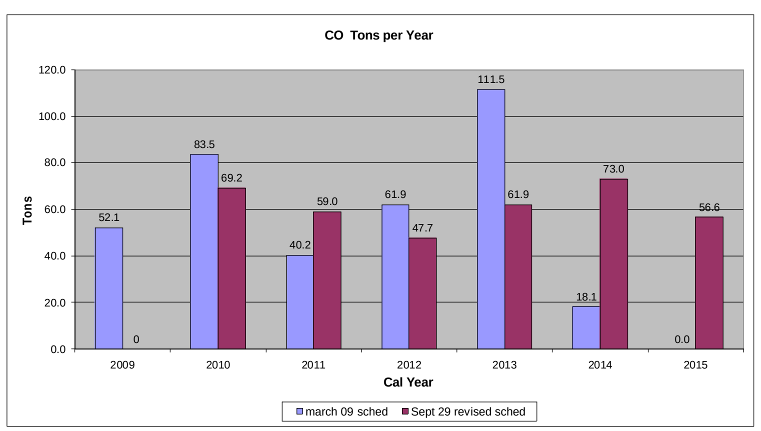
FY11	O	N	D	J	F	M	A	M	J	J	A	S
Monthly CO Tons	0.0	0.0	2.5	2.2	3.8	0.0	0.0	0.0	0.0	0.0	2.6	4.3
Cumulative CO Tons	67	67	69	71	75	75	75	75	75	75	78	82
Annual Cuml CO Tons	67	67	69	2.2	6	5.99	5.99	5.99	5.99	5.99	8.56	12.9

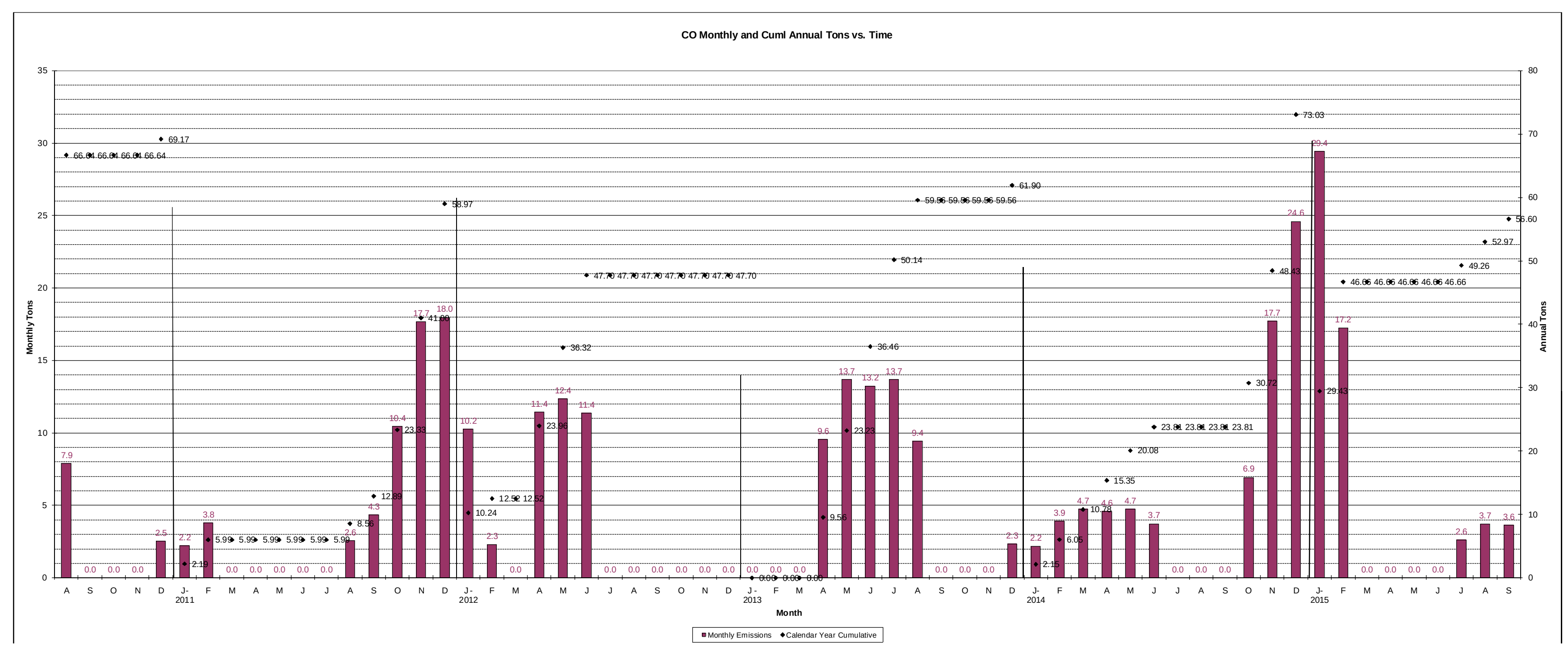
FY12	O	N	D	J	F	M	A	M	J	J	A	S
Monthly CO Tons	10.4	17.7	18.0	10.2	2.3	0	11.4	12.4	11.4	0	0	0
Cumulative CO Tons	93	110	128	138	141	141	152	164	176	176	176	176
Annual Cuml CO Tons	23.3	41	59	10.2	13	12.5	24	36.3	47.7	47.7	47.7	47.7

FY13	O	N	D	J	F	M	A	M	J	J	A	S
Monthly CO Tons	0	0	0	0	0	0	9.6	14	13	14	9.4	0
Cumulative CO Tons	176	176	176	176	176	176	185	199	212	226	235	235
Annual Cuml CO Tons	47.7	47.7	47.7	0	0	0	9.6	23	36	50	60	60

FY14	O	N	D	J	F	M	A	M	J	J	A	S
Monthly CO Tons	0	0	2.3	2.2	3.9	4.7	4.6	4.7	3.7	0	0	0
Cumulative CO Tons	235	235	238	240	244	249	253	258	262	262	262	262
Annual Cuml CO Tons	60	60	62	2.2	6.1	11	15	20	24	24	24	24

FY15	O	N	D	J	F	M	A	M	J	J	A	S
Monthly CO Tons	6.9	18	25	29	17	0	0	0	0	2.6	3.7	3.6
Cumulative CO Tons	268	286	311	340	357	357	357	357	357	360	364	367
Annual Cuml CO Tons	31	48	73	29	47	47	47	47	47	49	53	57

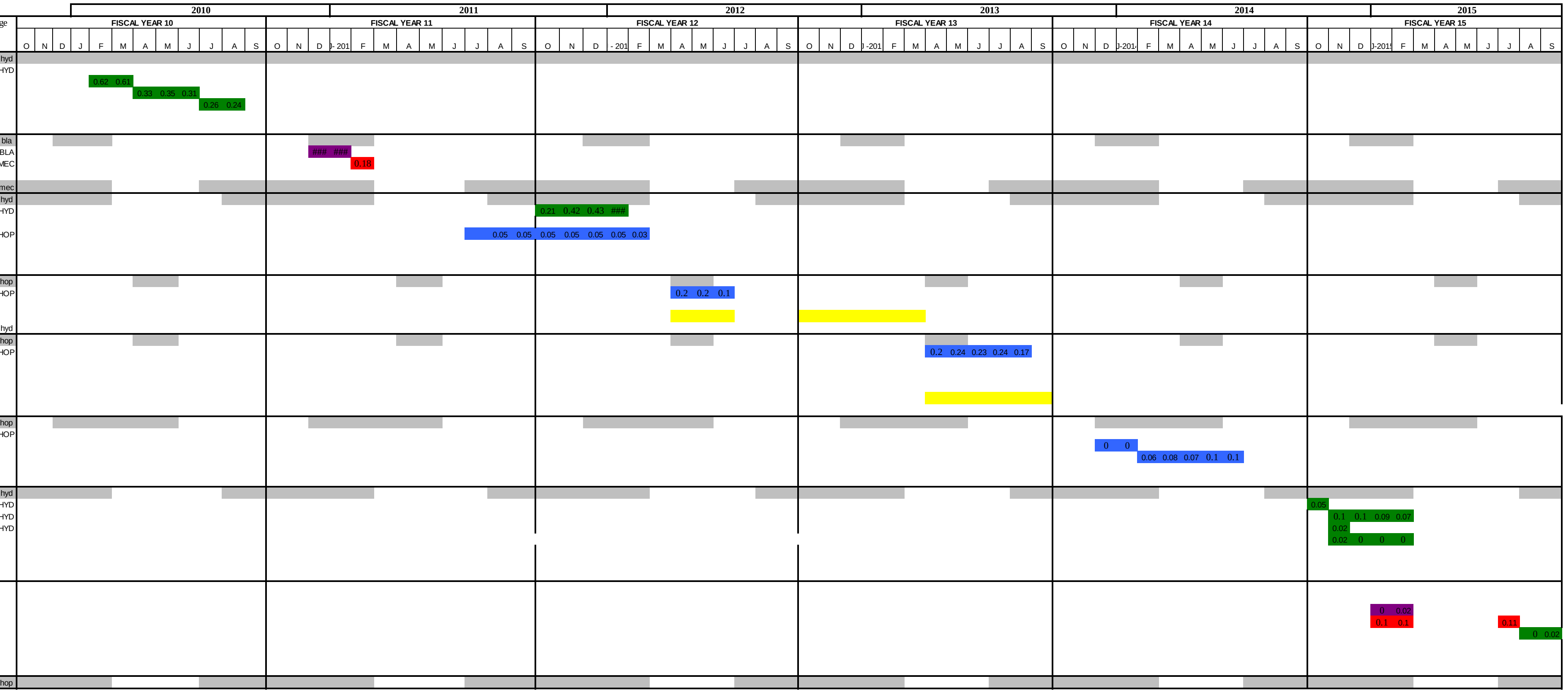




Delaware River Deepening
Construction Emissions (SOx)
Based on USACE CDEP Esimates and 29 Sept Revised Construction Schedule
10/2/2009

HOP	HOPPER DREDGE (blue)
HYD	CUTTER SUCTION DREDGE (green)
	LANDSIDE CONSTRUCTION (yellow)
MEC	CLAMSHELL DREDGE (red)
BLA	DRILLBOAT (BLASTING) (purple)
	DREDGING WINDOW (grey)

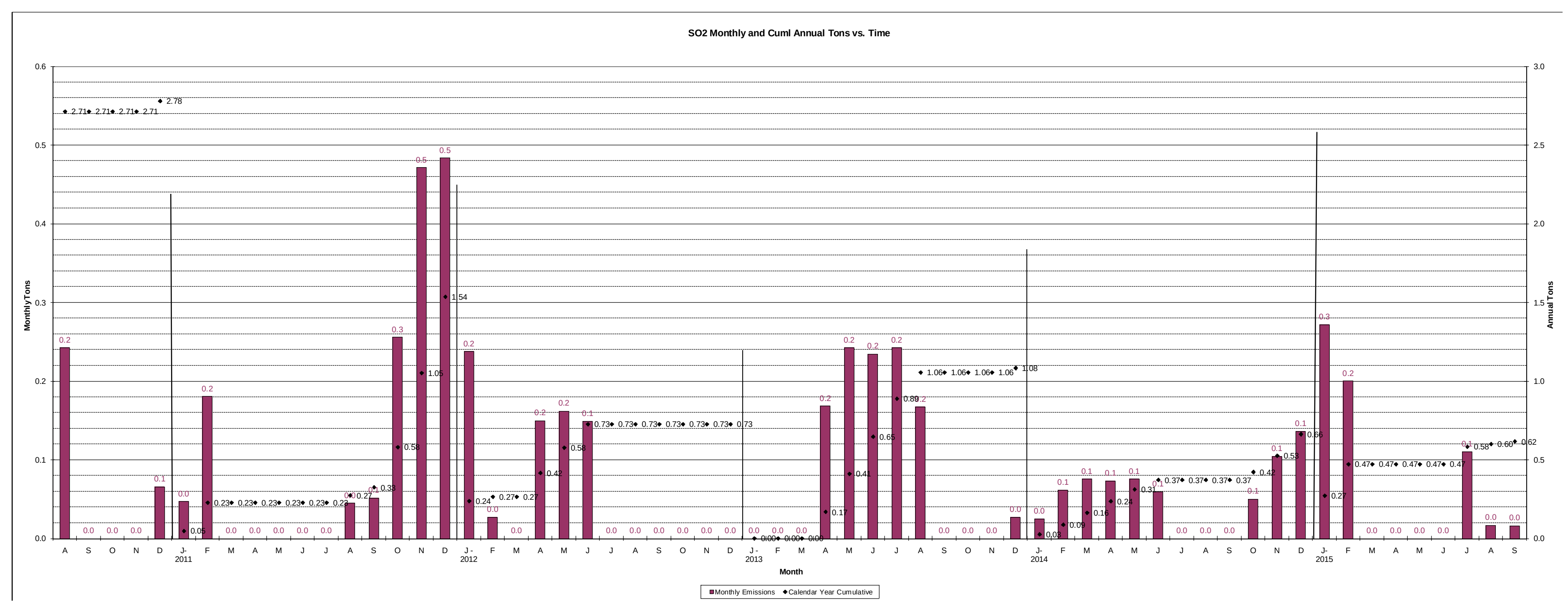
DELAWARE DEEPENING / DREDGING CONTRACTS	River Mile	Duration (Mo)	Estimated Quantity (cy)	CDEP Est #	CDEP Pay Cys	CDEP Months	CDEP # of Machines	Dredging SO2 lbs / Day	Mobilization Tons SO2	Total SO2 Tons	Dredge	
Contract No. 1 (award year 1)												hyd
Reach C- Bulkhead Bar												HYD
183+000 to 206+201 - Killicohook	68.3	1.65	932,600	1	932,600	1.65	1	48.6	0.014	1.23	1	
206+201 to 225+000 - Reedy Pt South	63.9	2.76	597,800	2	597,800	2.76	1	23.1	0.014	0.98	1	
225+000 to 242+514 - Killicohook	60.3	1.38	972,400	3	972,400	1.38	1	23.1	0.013	0.50	1	
Construct Project			**2,502,800**		**2,502,800**					**2.71**		
Contract No. 2 (award year 1)												bla
Reach B - Rock Blasting		3.17		4	77,000	3.17	2	2.0	0.019	0.11	2	BLA
Reach B - Rock Dredging - Fort Mifflin		1.27		5	77,000	0.85	2	12.1	0.025	0.18	2	MEC
Construct Project			**77,000**		**77,000**					**0.29**		mec
Contract No. 3 (award year 2)												hyd
Reach AA - National Park		2.88	994,000	14	994,000	2.88	1	28.0	0.020	1.25	1	HYD
19+700 to 32+756	99.2											
Reach A - Pedricktown North		6.1	1,666,600	15	1,666,600	6.10	1	3.3	0.018	0.33	1	HOP
32+756 to 90+000	96.8											
Construct Project			**2,660,600**		**2,660,600**					**1.57**		
Contract No. 4 (award year 3)												hop
Reach E - Broadkill Beach - Dredge		3		10	1,598,700	5.79	1	5.2	0.00	0.46	2	HOP
461+300 to 512+000	15.6											
Construct Project			**1,598,700**		**1,598,700**					**0.46**		hyd
Contract No. 5 (award year 4)												hop
Reach E - Kelly Island -Dredge		4.5		11	2,483,000	8.86	1	7.8	0.00	1.06	2	HOP
351+300 to 360+000	36.4		345,800									
360+000 to 381+000	32.1		55,500									
381+000 to 461+300	30.8		2,081,700									
Construct Project			**2,483,000**		**2,483,000**					**1.06**		
Contract No. 6 (award year 5)												hop
Reach D -											1	HOP
249+000 to 270+000 - Reedy Pt. South	55.8	1.13	396,300	12	396,300	1.13	1	2.9	0.00	0.05		
270+000 to 324+000 - Artificial Island	51.8	4.63	1,654,800	13	1,654,800	4.63	1	4.9	0.00	0.35		
Construct Project			**2,051,100**		**2,051,100**					**0.40**		
Contract No. 7 (award year 6)												hyd
Reach B - Oldmans		0.89	1,671,400	6	1,671,400	0.90	1	3.4	0.00	0.05	1	HYD
Reach B - Pedricktown North		3.51	1,050,700	7	1,050,700	3.51	1	5.9	0.00	0.32	1	HYD
Reach B - Pedricktown South		3.13	1,942,800	8	499,300	0.45	1	2.2	0.00	0.02	1	HYD
90+000 to 176+000	0.0			9	1,443,500	2.68	1	3.1	0.00	0.13		
Construct Project			**4,664,900**		**4,664,900**					**0.51**		
Total Channel		**40.0**	**16,038,100**		**16,038,100**					**7.0**		
Berth Deepenings												
Berth Deepenings Drill/Blast					25,089	2.07	1	1.1	0.00	0.03		
Berth Deepening Clamshell					460,437	2.94	1	7.2	0.01	0.33		
Berth Deepening CSD Rehandling WP					460,437	1.23	1	1.8	0.00	0.03		
Total Berth Deepenings					**460,437**					**0.4**		
Total Project					**16,498,537**					**7.4**		hop



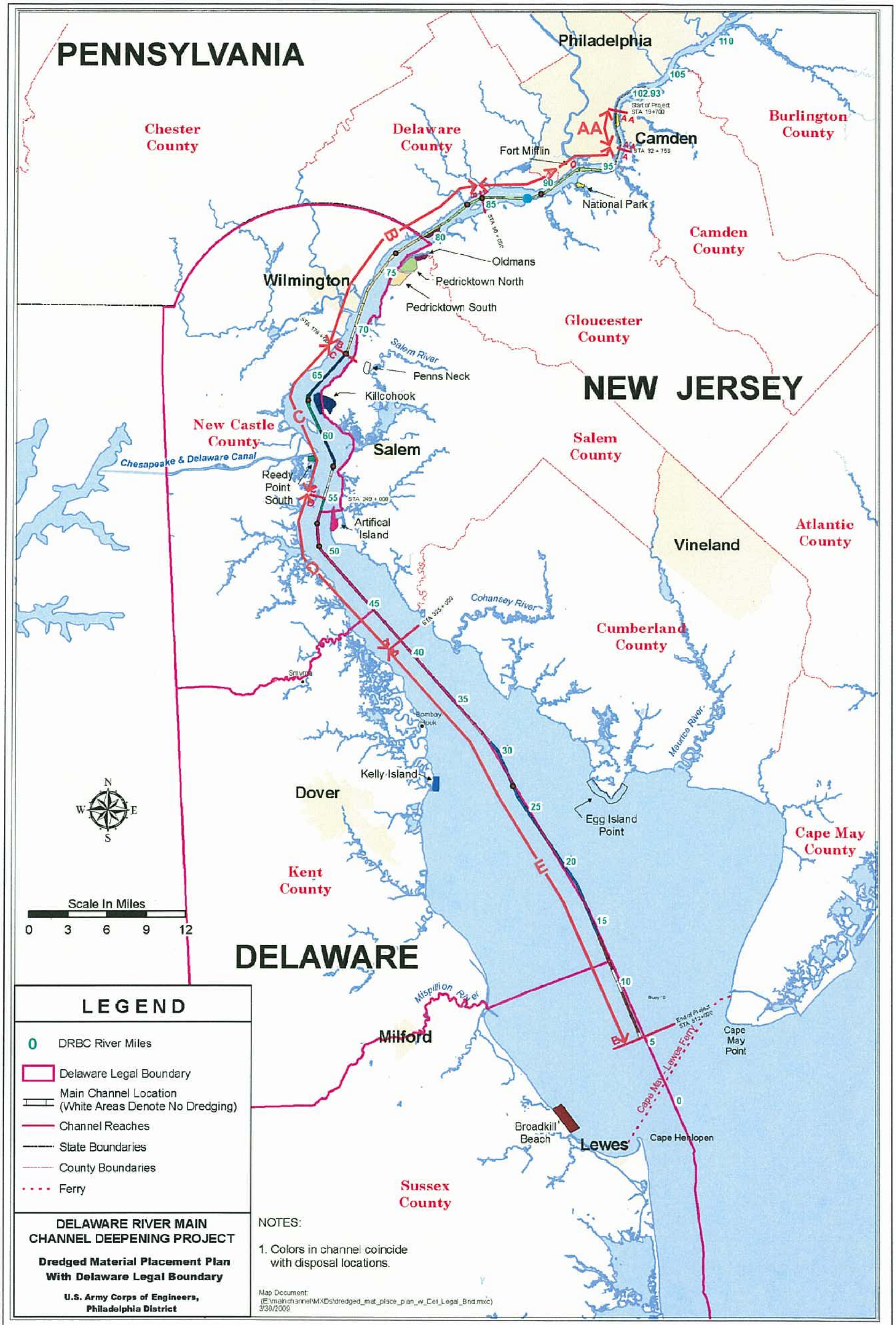
march 09 sched		Total Tons SO2
2.26		
2.19	Calendar 2010	2.78
0.59	Calendar 2011	1.54
1.08	Calendar 2012	0.73
0.88	Calendar 2013	1.08
0.40	Calendar 2014	0.66
0.00	Calendar 2015	0.62
7.41		7.41

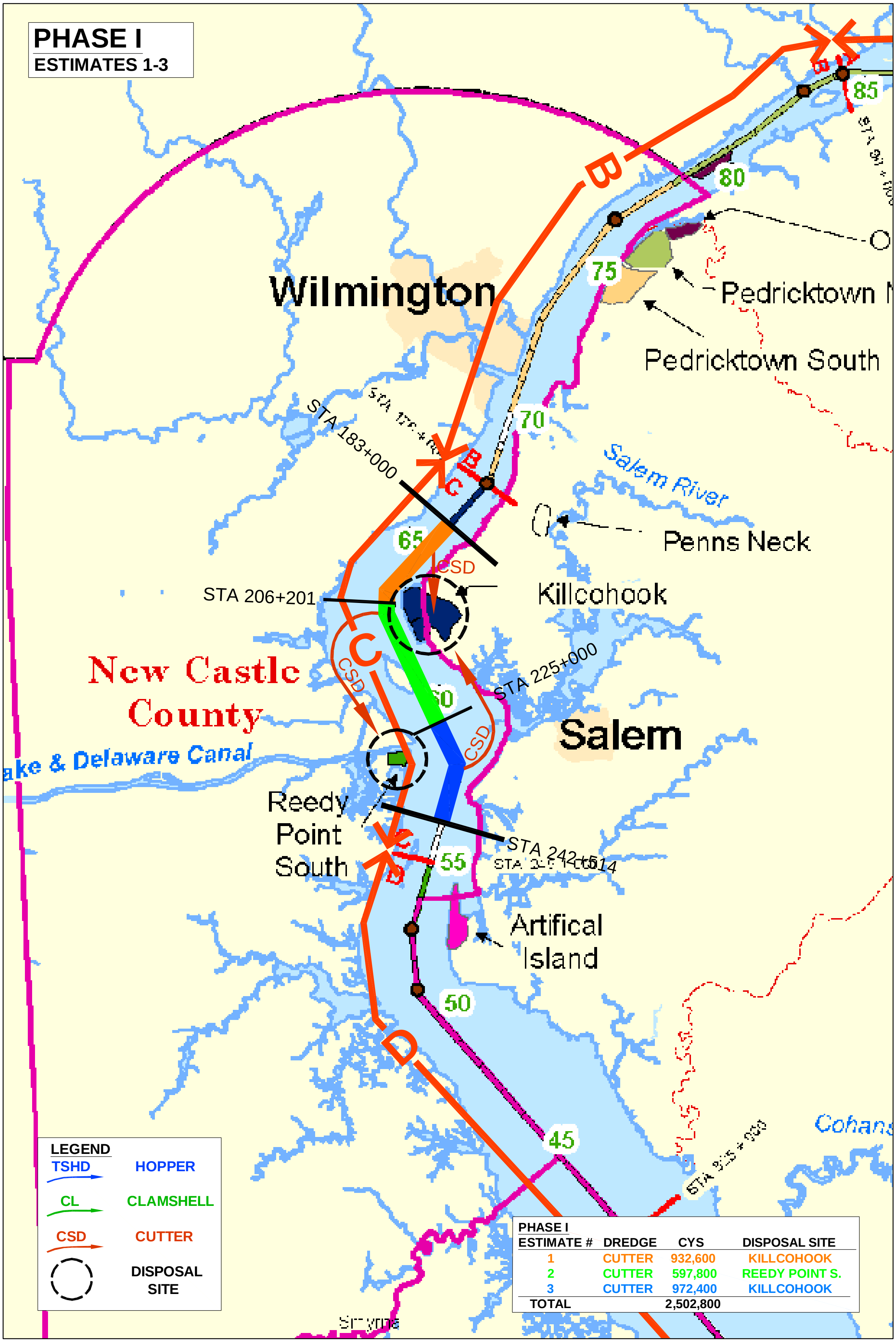
0.00

Fiscal Year	Month	Monthly SO2 Tons	Cumulative SO2 Tons	Annual Cuml SO2 Tons
FY10	O	0.0	0.0	0.0
FY10	N	0.0	0.0	0.0
FY10	D	0.0	0.0	0.0
FY10	J	0.0	0.0	0.0
FY10	F	0.6	0.6	0.6
FY10	M	0.6	1.2	1.2
FY10	A	0.3	1.6	1.6
FY10	M	0.3	1.9	1.9
FY10	J	0.3	2.2	2.2
FY10	J	0.3	2.5	2.5
FY10	A	0.2	2.7	2.7
FY10	S	0.0	2.7	2.71
FY11	O	0.0	2.7	2.7
FY11	N	0.0	2.7	2.7
FY11	D	0.1	2.8	2.8
FY11	J-201	0.0	2.8	0
FY11	F	0.2	3.0	0.2
FY11	M	0.0	3.0	0.23
FY11	A	0.0	3.0	0.23
FY11	M	0.0	3.0	0.23
FY11	J	0.0	3.0	0.23
FY11	J	0.0	3.0	0.23
FY11	A	0.0	3.1	0.27
FY11	S	0.1	3.1	0.33
FY12	O	0.3	3.4	0.58
FY12	N	0.5	3.8	1.05
FY12	D	0.5	4.3	1.54
FY12	J-201	0.2	4.6	0.24
FY12	F	0.0	4.6	0.3
FY12	M	0	4.6	0.27
FY12	A	0.15	4.7	0.42
FY12	M	0.16	4.9	0.58
FY12	J	0.15	5.0	0.73
FY12	J	0	5.0	0.73
FY12	A	0	5.0	0.73
FY12	S	0	5.0	0.73
FY13	O	0	5.0	0.73
FY13	N	0	5.0	0.73
FY13	D	0	5.0	0.73
FY13	J-201	0	5.0	0
FY13	F	0	5.0	0
FY13	M	0	5.0	0
FY13	A	0.2	5.2	0.2
FY13	M	0.2	5.5	0.4
FY13	J	0.2	5.7	0.6
FY13	J	0.2	5.9	0.9
FY13	A	0.2	6.1	1.1
FY13	S	0	6.1	1.1
FY14	O	0	6.1	1.1
FY14	N	0	6.1	1.1
FY14	D	0	6.1	1.1
FY14	J-201	0	6.2	0
FY14	F	0.1	6.2	0.1
FY14	M	0.1	6.3	0.2
FY14	A	0.1	6.4	0.2
FY14	M	0.1	6.4	0.3
FY14	J	0.1	6.5	0.4
FY14	J	0	6.5	0.4
FY14	A	0	6.5	0.4
FY14	S	0	6.5	0.4
FY15	O	0.1	6.5	0.4
FY15	N	0.1	6.7	0.5
FY15	D	0.1	6.8	0.7
FY15	J-201	0.3	7.1	0.3
FY15	F	0.2	7.3	0.5
FY15	M	0	7.3	0.5
FY15	A	0	7.3	0.5
FY15	M	0	7.3	0.5
FY15	J	0	7.3	0.5
FY15	J	0.1	7.4	0.6
FY15	A	0	7.4	0.6
FY15	S	0	7.4	0.6



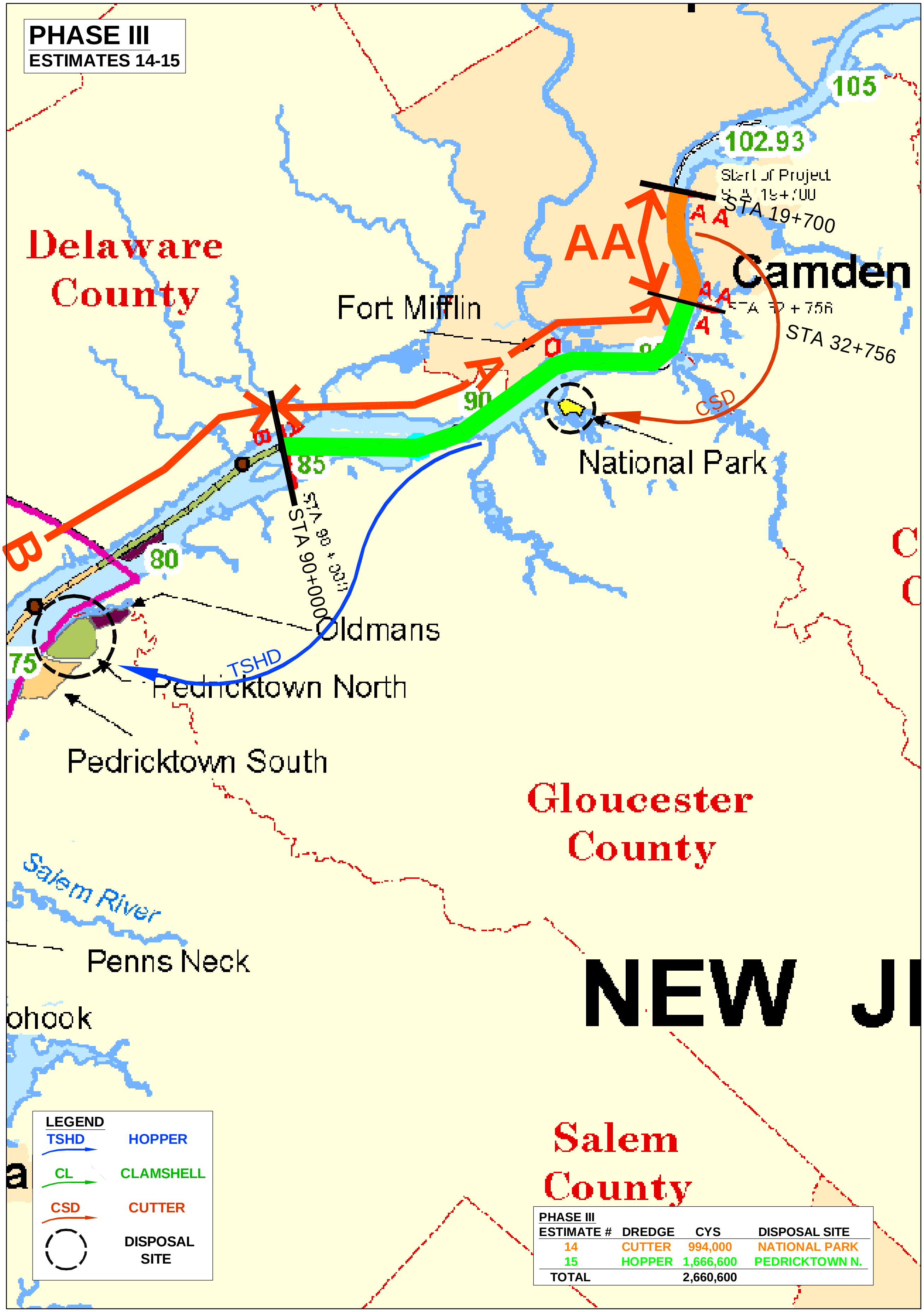
Appendix E – Project Figures


PENNSYLVANIA
Philadelphia
Chester County
Delaware County
Burlington County
Camden
Start of Project STA 19+700
Fort Mifflin
National Park
Camden County
Oldmans
Pedricktown North
Pedricktown South
Wilmington
Gloucester County
Salem River
Penns Neck
Killcohook
NEW JERSEY
New Castle County
Chesapeake & Delaware Canal
Salem
Salem County
Reedy Point South
Artifical Island
Vineland
Atlantic County
Cohansey River
Cumberland County
Smyrna
Bombay Hook
Maurice River
Kelly Island
Dover
Egg Island Point
Cape May County
Kent County
Scale In Miles
0 3 6 9 12
DELAWARE
Mispillion River
Milford
End of Project
Cape May Point
Cape May - Lewes Ferry
Broadkill Beach
Lewes
Cape Henlopen
Sussex County
LEGEND
0 DRBC River Miles
Delaware Legal Boundary
Main Channel Location (White Areas Denote No Dredging)
Channel Reaches
State Boundaries
County Boundaries
Ferry
DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
Dredged Material Placement Plan With Delaware Legal Boundary
U.S. Army Corps of Engineers, Philadelphia District
NOTES:
1. Colors in channel coincide with disposal locations.
Map Document: (E:\mainchannel\MXDs\dredged_mat_place_plan_w_Del_Legal_Bnd.mxd)
3/30/2009

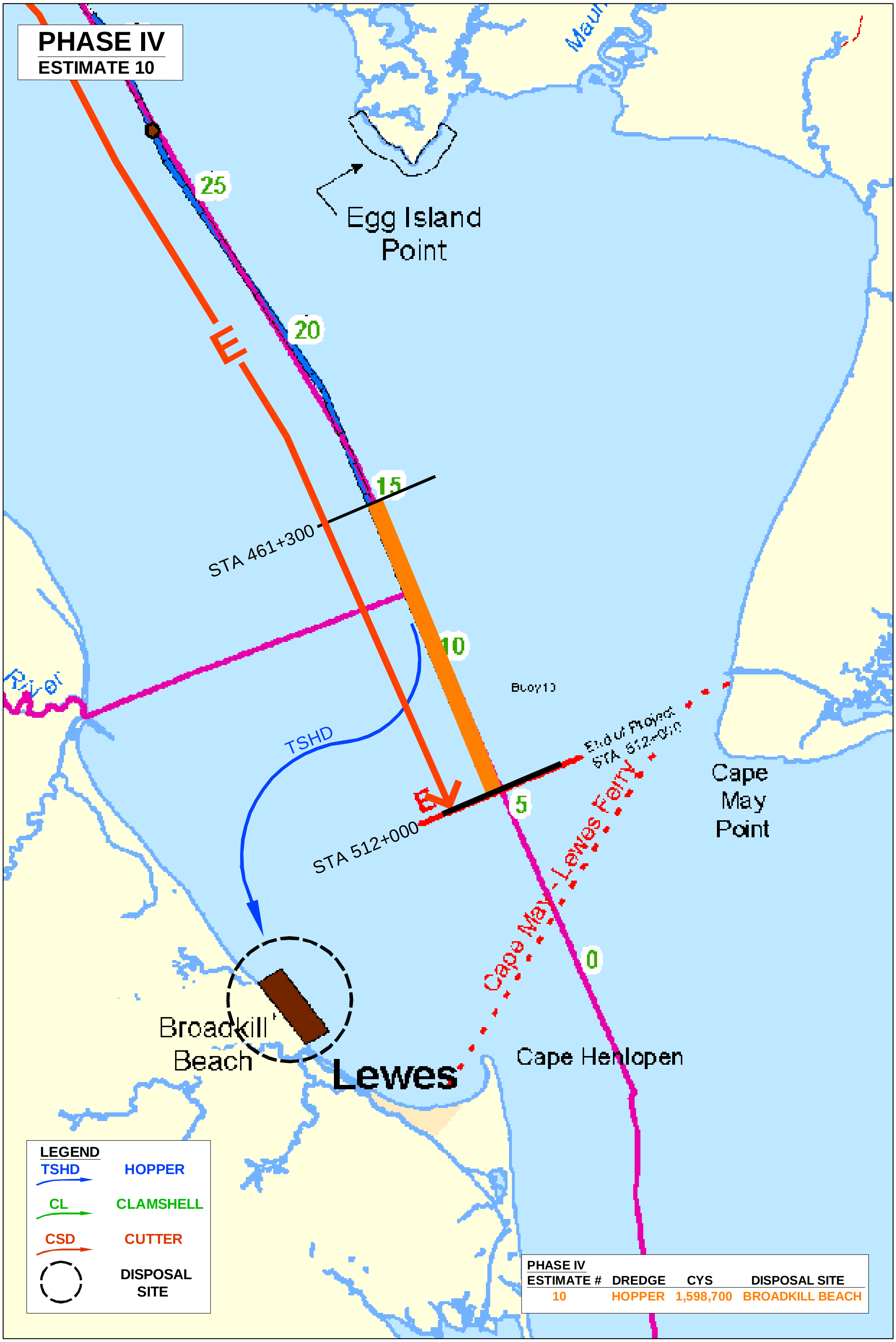


PHASE I ESTIMATE #	DREDGE	CYS	DISPOSAL SITE
1	CUTTER	932,600	KILLCOHOOK
2	CUTTER	597,800	REEDY POINT S.
3	CUTTER	972,400	KILLCOHOOK
TOTAL		2,502,800	

PHASE II ESTIMATE #	DREDGE	CYS	DISPOSAL SITE
4	DRILLBOAT	77,000	FORT MIFFLIN
5	CLAMSHELL	77,000	FORT MIFFLIN
TOTAL		154,000	

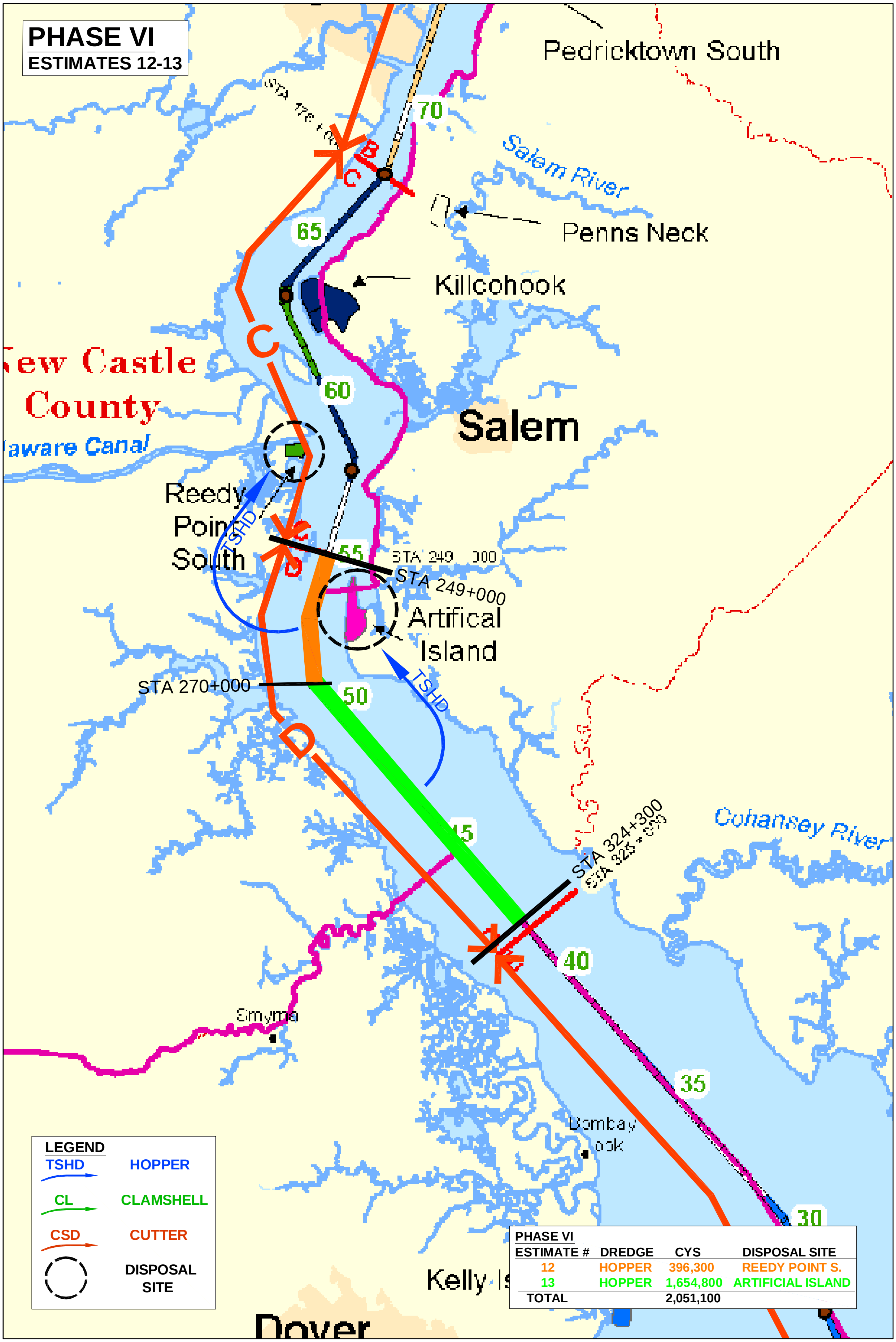


PHASE III ESTIMATE #	DREDGE	CYS	DISPOSAL SITE
14	CUTTER	994,000	NATIONAL PARK
15	HOPPER	1,666,600	PEDRICKTOWN N.
TOTAL		2,660,600	



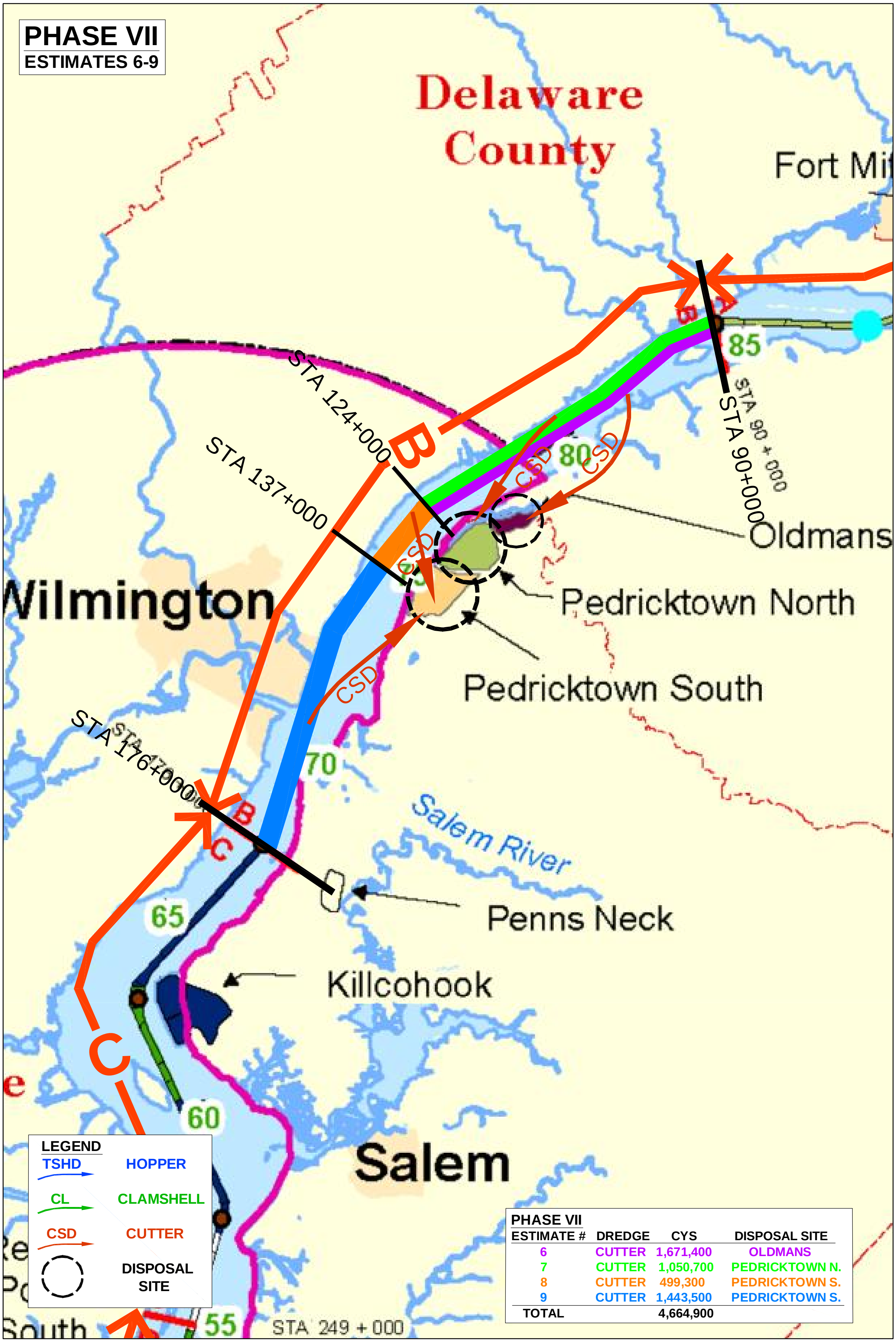
PHASE IV
ESTIMATE 10
25
20
15
10
5
0
E
B
Egg Island Point
STA 461+300
STA 512+000
TSHD
End of Project
Cape May - Lewes Ferry
Cape May Point
Broadkill Beach
Lewes
Cape Henlopen
River
LEGEND
TSHD HOPPER
CL CLAMSHELL
CSD CUTTER
DISPOSAL SITE
PHASE IV
ESTIMATE # | DREDGE | CYS | DISPOSAL SITE
10 | HOPPER | 1,598,700 | BROADKILL BEACH


PHASE V
ESTIMATE 11
Vinelan
Cohansey River
Cumberland
County
STA 351+300
Bombay
Hook
Maurice River
Kelly Island
Dover
Egg Island
Point
TSHD
E
Kent
County
STA 461+300
AWARE
Mispillion River
Milford
Cape May - Lewes Ferry
LEGEND
TSHD HOPPER
CL CLAMSHELL
CSD CUTTER
DISPOSAL SITE
PHASE V
ESTIMATE # | DREDGE | CYS | DISPOSAL SITE
11 | HOPPER | 2,483,000 | KELLY ISLAND
Broadkill Beach
Lewes
Cape Henlopen
50
45
40
35
30
25
20
15
10
5
0



PHASE VI

ESTIMATE #	DREDGE	CYS	DISPOSAL SITE
12	HOPPER	396,300	REEDY POINT S.
13	HOPPER	1,654,800	ARTIFICIAL ISLAND
TOTAL		2,051,100	



PHASE VII

ESTIMATE #	DREDGE	CYS	DISPOSAL SITE
6	CUTTER	1,671,400	OLDMANS
7	CUTTER	1,050,700	PEDRICKTOWN N.
8	CUTTER	499,300	PEDRICKTOWN S.
9	CUTTER	1,443,500	PEDRICKTOWN S.
TOTAL		4,664,900	

Appendix F – EPA Tables Used for NOx Calculations

Appendix F – EPA Tables Used for NOx Calculations

Pertinent tables from EPA's document titled "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories" (written by ICF and dated April 2009) are included here for reference.

Tables 3-3, 3-4, 3-5, and 3-8 are from the Harbor Craft chapter. The specific factors that were used in the ferry and tug boat NOx calculations are circled in red.

Table 3-3: EPA Load Factors for Harbor Craft

Engine Category	Engine Size	Likely Annual Transit Days	Average Annual Activity	Load Factor
Category 2		219		0.85
Category 1 Main	<805 HP		943	0.45
	>805 HP		4503	0.79
Category 1 Aux	<805 HP		798	0.56
	>805 HP		2500	0.65

Table 3-4: Load Factors for Harbor Craft (Port of Los Angeles and Long Beach)

Vessel Category	Load Factor	Source
Assist Tugboat	31%	PoLA
Dredge Tenders	69%	PoLA
Recreational	21%	PoLA
Recreational, Auxiliary	32%	PoLA
Crew Boat	45%	PoLB
Excursion	42%	PoLB
Ferry	42%	PoLB
Government	51%	PoLB
Ocean Tug	68%	PoLB
Tugboat	31%	PoLB
Work Boat	43%	PoLB
Other Categories	43%	PoLA
Other Auxiliaries	43%	PoLA

Table 3-5: Harbor Craft Emission Factors

Engine Type	Disp Category (Max L/Cyl)	Engine EFs (g/kW hr)											
		PM_{10}			NOx			HC			CO		
		Tier 0	Tier1	Tier2	Tier 0	Tier1	Tier2	Tier 0	Tier1	Tier2	Tier 0	Tier1	Tier2
Cat 1 Main	<0.9	0.54	0.54	0.23	10.0	9.8	5.7	0.41	0.41	0.41	1.6	1.6	1.6
	<1.2	0.47	0.47	0.12	10.0	9.8	6.1	0.32	0.32	0.32	1.6	1.6	0.9
	<2.5	0.34	0.34	0.13	10.0	9.8	6.0	0.27	0.27	0.19	1.6	1.6	1.1
	<3.5	0.30	0.30	0.13	10.0	9.1	6.0	0.27	0.27	0.19	1.6	1.6	1.1
	<5	0.30	0.30	0.13	11.0	9.2	6.0	0.27	0.27	0.19	1.8	1.8	1.1
Cat 1 Auxiliary	<0.9	0.84	0.84	0.23	11.0	9.8	5.7	0.41	0.41	0.41	2.0	2.0	1.6
	<1.2	0.53	0.53	0.21	10.0	9.8	5.4	0.32	0.32	0.32	1.7	1.7	0.8
	<2.5	0.34	0.34	0.15	10.0	9.8	6.1	0.27	0.27	0.21	1.5	1.5	0.9
	<3.5	0.32	0.32	0.15	10.0	9.1	6.1	0.27	0.27	0.21	1.5	1.5	0.9
	<5	0.30	0.30	0.15	11.0	9.2	6.1	0.27	0.27	0.21	1.8	1.8	0.9
Cat2		0.32	0.32	0.32	13.36	10.55	8.33	0.134	0.134	0.134	2.48	2.48	2.00

Table 3-8: Harbor Craft Emission Factors (g/kWh)

Minimum Power (kW)	NOx (g/kWh)	VOC (g/kWh)	CO (g/kWh)	PM_{10} (g/kWh)	SO_2 (g/kWh)	CO_2 (g/kWh)	N_2O (g/kWh)	CH_4 (g/kWh)
Tier 0 Engines								
37	11	0.27	2	0.9	1.3	690	0.02	0.09
75	10	0.27	1.7	0.4	1.3	690	0.02	0.09
130	10	0.27	1.5	0.4	1.3	690	0.02	0.09
225	10	0.27	1.5	0.3	1.3	690	0.02	0.09
450	10	0.27	1.5	0.3	1.3	690	0.02	0.09
560	10	0.27	1.5	0.3	1.3	690	0.02	0.09
1,000	13	0.27	2.5	0.3	1.3	690	0.02	0.09
Cat 2	13.2	0.5	1.1	0.72	1.3	690	0.02	0.09
Tier 1 Engines								
37	9.8	0.27	2	0.9	1.3	690	0.02	0.09
75	9.8	0.27	1.7	0.4	1.3	690	0.02	0.09
130	9.8	0.27	1.5	0.4	1.3	690	0.02	0.09
225	9.8	0.27	1.5	0.3	1.3	690	0.02	0.09
450	9.8	0.27	1.5	0.3	1.3	690	0.02	0.09
560	9.8	0.27	1.5	0.3	1.3	690	0.02	0.09
1,000	9.8	0.27	2.5	0.3	1.3	690	0.02	0.09
Cat 2	9.8	0.5	1.1	0.72	1.3	690	0.02	0.09
Tier 2 Engines								
37	6.8	0.27	5	0.4	1.3	690	0.02	0.09
75	6.8	0.27	5	0.3	1.3	690	0.02	0.09
130	6.8	0.27	5	0.3	1.3	690	0.02	0.09
225	6.8	0.27	5	0.3	1.3	690	0.02	0.09
450	6.8	0.27	5	0.3	1.3	690	0.02	0.09
560	6.8	0.27	5	0.3	1.3	690	0.02	0.09
1,000	6.8	0.27	5	0.3	1.3	690	0.02	0.09
Cat 2	9.8	0.5	5	0.72	1.3	690	0.02	0.09

Tables 2-4, 2-7, and 2-16 are from the Ocean Going Vessel chapter. The specific factors that were used in the cold ironing analysis are circled in red.

Table 2-4: Auxiliary Engine Power Ratios (ARB Survey)

Ship Type	Average Propulsion Engine (kW)	Average Auxiliary Engines				Auxiliary to Propulsion Ratio
		Number	Power Each (kW)	Total Power (kW)	Engine Speed	
Auto Carrier	10,700	2.9	983	2,850	Medium	0.266
Bulk Carrier	8,000	2.9	612	1,776	Medium	0.222
Container Ship	30,900	3.6	1,889	6,800	Medium	0.220
Cruise Ship[a]	39,600	4.7	2,340	11,000	Medium	0.278
General Cargo	9,300	2.9	612	1,776	Medium	0.191
RORO	11,000	2.9	983	2,850	Medium	0.259
Reefer	9,600	4.0	975	3,900	Medium	0.406
Tanker	9,400	2.7	735	1,985	Medium	0.211

[a] Cruise ships typically use a different engine configuration known as diesel-electric. These vessels use large generator sets for both propulsion and ship-board electricity. The figures for cruise ships above are estimates taken from the Starcrest Vessel Boarding Program.

Table 2-7: Auxiliary Engine Load Factor Assumptions

Ship-Type	Cruise	RSZ	Maneuver	Hotel
Auto Carrier	0.15	0.30	0.45	0.26
Bulk Carrier	0.17	0.27	0.45	0.10
Container Ship	0.13	0.25	0.48	0.19
Cruise Ship	0.80	0.80	0.80	0.64
General Cargo	0.17	0.27	0.45	0.22
Miscellaneous	0.17	0.27	0.45	0.22
OG Tug	0.17	0.27	0.45	0.22
RORO	0.15	0.30	0.45	0.26
Reefer	0.20	0.34	0.67	0.32
Tanker	0.24	0.28	0.33	0.26

Table 2-16: Auxiliary Engine Emission Factors, g/kWh

Fuel Type	Sulfur	Emission Factors (g/kWh)							
		NOx	PM_{10}	$PM_{2.5}$	HC	CO	SOx	CO_2	BSFC
RO	2.70%	14.7	1.44	1.32	0.40	1.10	11.98	722.54	227
MDO	1.00%	13.9	0.49	0.45	0.40	1.10	4.24	690.71	217
MGO	0.50%	13.9	0.32	0.29	0.40	1.10	2.12	690.71	217
MGO	0.10%	13.9	0.18	0.17	0.40	1.10	0.42	690.71	217

Appendix G – Emission Reduction Credit Brokerage Agreement

SERVICE CONTRACT
DATE:
PROJECT #:
EXPIRATION DATE:
CONTRACT #: 1404

PHILADELPHIA REGIONAL PORT AUTHORITY
3460 N. Delaware Avenue, 2nd Floor
Philadelphia Pennsylvania 19134
Attn:
(the "Authority"), a body corporate and politic and an independent agency of the Commonwealth of Pennsylvania,

And
CantorCO2e, L.P.
345 California Street, Suite 1260
San Francisco, California
Attn Josh Margolis

(the "Contractor"), a Limited Partnership authorized under the laws of the Delaware.

Services: The Contractor shall perform the services as provided in Exhibit "B" attached hereto and incorporated herein by reference and constitute part of the Contract. The Contractor shall perform its services hereunder properly and in accordance with the standards of its profession. The Contractor shall act as an independent contractor and reserves the right to use subcontractors.

Contract Amount: The payment from the Authority for the services provided by the Contractor hereunder, inclusive of all expenses, shall be as provided in Section 10 of Exhibit "B".

Term of Contract: This Contract shall have a term of one year starting, December 1, 2009 through, November 30, 2010.

Terms and Conditions: The terms and conditions set forth in Exhibits "A" & "B" attached hereto are incorporated by reference and constitute part of the Contract.

CANTORCO2E, L.P.

By: ____________________

Name: **Joshua Margolis**

Title: co-CEO

PHILADELPHIA REGIONAL PORT AUTHORITY

By: ____________________

Name: James T. McDermott, Jr.

Title: Executive Director

Approved as to Legality and Form:

PHILADELPHIA REGIONAL PORT AUTHORITY

By: ____________________

Name: Gregory V. Iannarelli, Esq.

Title: Chief Counsel

Approved as to Fiscal Responsibility and Budgetary Appropriateness:

PHILADELPHIA REGIONAL PORT AUTHORITY

By: ____________________

Name: Edward G. Henderson

Title: Director of Finance & Capital Funding

OFFICE OF THE ATTORNEY GENERAL

By: ____________________

Name: Robert A. Mulle, Esq.

Title: Chief Deputy Attorney General

OFFICE OF THE BUDGET

By: ____________________

Name: Joseph Lawruk

Title: Comptroller

CANTORCO2E, L.P.

By:______________________________
Name: **Joshua Margolis**
Title: co-CEO

Approved as to Legality and Form:

PHILADELPHIA REGIONAL PORT AUTHORITY

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Name: Gregory V. Iannarelli, Esq.
Title: Chief Counsel

OFFICE OF THE ATTORNEY GENERAL

By:______________________________
Name: Robert A. Mulle, Esq.
Title: Chief Deputy Attorney General

PHILADELPHIA REGIONAL PORT AUTHORITY

By:______________________________
Name: James T. McDermott, Jr.
Title: Executive Director

Approved as to Fiscal Responsibility and Budgetary Appropriateness:

PHILADELPHIA REGIONAL PORT AUTHORITY

By:______________________________
Name: Edward G. Henderson
Title: Director of Finance & Capital Funding

OFFICE OF THE BUDGET

By:______________________________
Name: Joseph Lawruk
Title: Comptroller

Exhibit "A"
GENERAL CONDITIONS
FOR SERVICE CONTRACTS

Section I. Definitions:

The following terms and expressions used in the Contract Documents shall be defined and understood as follows:

"Agreement" shall mean the contract between the Authority and the Contractor.

"Authority" shall mean the Philadelphia Regional Port Authority.

"City" shall mean the City of Philadelphia.

"Commonwealth" shall mean the Commonwealth of Pennsylvania.

"Contract" shall mean the contract between the Authority and the Contractor.

"Contract Documents" shall mean the documents described in Article IV of the Contract.

"Contractor" shall mean the party of the second part to the Contract.

"Contract Sum" shall mean the amount stated in Article II of the Contract for the payment to the Contractor.

"Contracting Officer" The Contracting Officer shall be the Procurement Director prior to the execution of the Contract. Subsequent to the execution of the Contract, the Contracting Officer shall be the Director of Engineering of the Authority.

"Date of Completion" shall mean the last day of the term specified in Article III of the Contract for the completion of the Work.

"Day(s)" shall mean the number of days, excluding the first and including the last day of such period. Whenever the last day of any such period shall fall on a Saturday or Sunday, or on any day made a legal holiday by the laws of the Commonwealth or the United States, such day shall be omitted from the computation.

"Engineer" shall mean either the Director of Engineering of the Authority, or any successor or successors duly appointed in writing by the Director of Engineering, or any deputy or substitute who may be so designated, in writing, by the Executive Director or through a duly authorized representative within the scope of the particular duties assigned such representative.

"Executive Director" shall mean the Executive Director of the Authority, or any deputy or substitute who may be so designated in writing by the Executive Director.

"Inspector" shall mean the representative of the Engineer assigned to the inspection of the Work under the Contract.

"Plans" shall mean the general plans and designs accompanying the Specifications and such supplementary drawings as may be furnished from time to time.

"Professional" shall mean the Engineer unless designated otherwise.

"Project" shall mean the total of the work to be performed under the Contract and any other separate prime contracts as so designated by the Authority.

"Site" shall mean the location where the construction or services will be performed or where the materials or equipment will be used pursuant to the Contract.

"Special Conditions" shall mean those special conditions which modify the General Conditions.

"Specifications" shall mean the written documentation accompanying the Plans, which set forth the Work to be performed and the methods to be used to perform the Work.

"Subcontractor" shall mean persons, firms, or corporations having a direct contract with the Contractor to perform a portion of the Work specified, but not including those who merely furnish materials or equipment.

"Work" shall mean the subject matter of the Contract, *i.e.*, the labor or service to be performed and/or the material and/or equipment to be supplied, delivered and/or installed as stated in Article I of the Contract or otherwise as described in the Contract Documents.

"Working Day" shall mean a calendar day except Saturday, Sunday, and any day made a legal holiday by the laws of the Commonwealth or the United States.

Wherever in the Specifications or the Plans the words "directed", "required", "permitted", "ordered", "designated", "prescribed", or words of similar meaning are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer is intended, and similarly the words "approved", "acceptable", "satisfactory", or words of similar meaning, shall mean approved by, or acceptable to, or satisfactory to the Engineer, subject in each case to the final determination of the Executive Director. Reference herein to the terms "offeror" and "offerors" shall also include prospective offerors.

Section II. Payment:

A. Except as agreed in a confirmation, the Contractor shall invoice the Authority on a monthly basis for actual time expended at the rates listed on Exhibit "B" with sufficient detail of services rendered acceptable to the Authority. Provided the Contractor has performed its services in accordance with this Contract, the Authority shall pay the Contractor for such services within forty-five (45) days from the date of receipt by the Authority of the Contractor's invoice. All invoices are to be sent to the Accounts Payable Department of the Authority at the address listed on the Contract.

Section III. Disputes:

A. All claims, disputes and other matters in question between the parties to this Contract arising out of or relating to this Contract or the breach thereof, shall be decided by arbitration before the Board of Claims created by Pa. Stat. Ann. tit. 72, § 4651-1 et seq., in the manner and under the terms and conditions provided therein. If the total amount in controversy does not amount to three hundred dollars ($300.00) or more, or if, for any reason, the Board of Claims cannot exert jurisdiction over the matter, the matter shall be referred to and decided by a panel consisting of the Executive Director of the Authority and the Director of Real Estate and Insurance of the Authority or their respective deputy or deputies.

Section IV. Nondiscrimination:

A. In accordance with Pa. Stat. Ann. tit. 55, § 697.16, the nondiscrimination and contract compliance plans used by the Authority are required to be the same as those used by the Commonwealth of Pennsylvania's Department of General Services.

B. During the term of this Contract, the Contractor agrees to comply with the following "nondiscrimination clause":

i. The Contractor shall not discriminate against any employee, applicant for employment, independent contractor, or any other person because of race, color, religious creed, ancestry, national origin, age, or sex. The Contractor shall take affirmative action to ensure that applicants are employed, and that employees or agents are treated during employment, without regard to their race, color, religious creed, ancestry, national origin, age, or sex. Such affirmative action shall include, but is not limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training. The Contractor shall post in conspicuous places, available to employees, agents, applicants for employment, and other persons, a notice to be provided by the Authority setting forth the provisions of this nondiscrimination clause.

C. The Contractor shall in advertisements or requests for employment placed by it or on its behalf state that it is an equal opportunity employer (pursuant to which all qualified applicants will receive consideration for employment without regard to race, color, religious creed, ancestry, national origin, age, or sex);

D. The Contractor shall send each labor union or workers' representative with which it has a collective bargaining agreement or other contract or understanding, a notice advising said labor union or workers' representative of its commitment to this nondiscrimination clause. Similar notice shall be sent to every other source of recruitment regularly utilized by the Contractor;

E. It shall be no defense to a finding of noncompliance with the Contract Compliance Regulations the "Contract Compliance Regulations", 16 Pa. Code Chapter 49) issued by the Pennsylvania Human Relations Commission (the "Commission") or with the terms and provisions of this nondiscrimination clause that the Contractor had delegated some of its employment practices to any union, training program, or other source of recruitment which prevents it from meeting its obligations. However, if the evidence indicates that the Contractor was not on notice of the third-party discrimination or made a good faith effort to correct such discrimination, such factor shall be considered in mitigation in determining appropriate sanctions;

F. Where the practices of a union or any training program or other source of recruitment will result in the exclusion of minority group persons, so that the Contractor will be unable to meet its obligations under the Contract Compliance Regulations or pursuant to the terms and provisions of this nondiscrimination clause, the Contractor shall then employ and fill vacancies through other nondiscriminatory employment procedures;

G. The Contractor shall comply with the Contract Compliance Regulations, which are incorporated herein by reference as if fully set forth herein, and with all laws prohibiting discrimination in hiring or employment opportunities. In the event of the Contractor's noncompliance with the terms and provisions of this nondiscrimination clause or with any such laws, the Contractor may, after hearing and adjudication, be terminated or suspended, in whole or in part, and the Contractor may be declared temporarily ineligible for other contracts with agencies of the Commonwealth of Pennsylvania, and such other sanctions may be imposed and remedies invoked as provided by the Contract Compliance Regulations;

H. Upon request of the Authority or the Commission, the Contractor shall furnish to the Authority and the Commission, all necessary employment documents and records and shall permit access by the Authority and the Commission to the Contractor's books, records, and accounts, for purposes of investigation to ascertain compliance with the provisions of the Contract Compliance Regulations, subject the Authority's and Commission's agreement to take reasonable steps to maintain the confidentiality of such information.. If the Contractor does not possess documents or records reflecting the necessary information requested, it shall furnish such information on reporting forms supplied by the Authority or the Commission;

J. The Contractor shall actively recruit minority subcontractors or subcontractors with substantial minority representation among their employees;
K. The Contractor shall include the provisions of this nondiscrimination clause in every subcontract, so that such provisions will be binding upon each subcontractor;

L. The terms used in this nondiscrimination clause shall have the same meanings as used in the

Contract Compliance Regulations; and

M. The Contractor's obligations under this Section IV are limited to the Contractor's facilities within the Commonwealth of Pennsylvania and to those employees of the Contractor (and potential applicants by the Contractor) working in the Contractor's facilities within the Commonwealth of Pennsylvania, if any.

Section V. Termination and Suspension:

A. For the convenience of the Authority, this Contract may be terminated for any reason by the Authority after seven (7) calendar days' written notice to the Contractor. In the event of termination under this Section V. (A.), the Contractor shall be paid that portion of the payment due to the Contractor hereunder which represents the compensation for services performed to the date of termination and all termination expenses. Termination expenses are defined as those expenses arising prior, during, and subsequent to termination that are directly attributable to the termination.

B. This Contract may be terminated by either party hereto upon seven (7) calendar days' written notice should the other party fail substantially to perform in accordance with the terms hereof through no fault of the party initiating the termination. In the event of termination under this Section V. (B.), the Contractor shall be paid that portion of the payment due to the Contractor hereunder which represents the compensation for services performed to the date of termination.

C. The Authority may, in writing, order the Contractor to suspend all or any part of the Contractor's services hereunder for the convenience of the Authority. In the event of suspension under this Section V (C.), notwithstanding Article II of this Contract, an equitable adjustment in the Contractor's compensation shall be made for the increase, if any, in the cost of the Contractor's performance of this Contract caused by such suspension, and this Contract shall be modified in writing accordingly.

Section VI. Contractor Integrity:

A. The following terms used in this Section VI shall be defined and understood as follows:

"Confidential" means information that is not public knowledge, or available to the public on request, disclosure of which would give an unfair, unethical, or illegal advantage to another desiring to contract with the Authority;

"Consent" means written permission by a duly authorized member or employee of the Authority, provided that where the material facts have been disclosed, in writing, by prequalification or contractual terms, the Authority shall be deemed to have consented by virtue of execution of this Contract;

"Financial Interest" means ownership of more than a five (5) percent interest in any business; or holding a position as an officer, director, trustee, partner, employee, or the like, or holding any position of management; and

"Gratuity" means any payment of more than nominal monetary value in the form of cash, travel, entertainment, gifts, meals, lodging, loans, subscriptions, advances, deposits of money, services, employment, or contracts of any kind.

B. The Contractor shall maintain professional standards of integrity in the performance of the services required hereunder and shall take no action in violation of federal or state laws, regulations, or other requirements that govern contracting with the Commonwealth of Pennsylvania or the authority.

C. The Contractor shall not disclose to others any confidential information gained by virtue of this Contract except in order to fulfill its obligations hereunder. Notwithstanding anything set forth in this Agreement, the confidentiality provisions of this Agreement, shall not apply to: (a) information which (A) is already in the possession of the party subject to the confidentiality obligations, (B) is or becomes generally available to the public other than as a result of an improper disclosure by the party subject to the confidentiality obligations, (C) is independently developed by the party subject to the confidentiality obligations, or (D) becomes available to the party subject to the confidentiality obligations on a non-confidential basis from a source which, to the best of such party's knowledge, is not prohibited from disclosing such information to the party subject to the confidentiality obligations by a legal, contractual or fiduciary obligation to the disclosing party, (b) disclosures to legal counsel or auditors of the party who are subject to an obligation of confidentiality, or (c) disclosures required by applicable law, rule, regulation, regulator request or order, provided that, to the extent practical and permitted by such requirement, the party from whom disclosure is sought shall promptly notify the other party so as to provide such other party an opportunity to seek a protective order or other confidential treatment.

D. The Contractor shall not, in connection with this Contract or any other contract with the Authority or the Commonwealth of Pennsylvania, directly or indirectly, offer, confer, or agree to confer any pecuniary benefit on anyone as consideration for the decision, opinion, recommendation, vote, other exercise of discretion, or violation of a known legal duty by any member or employee of the Authority or the Commonwealth of Pennsylvania.

E. The Contractor shall not, in connection with this Contract or any other contract with the Authority or the Commonwealth of Pennsylvania, directly or indirectly, offer, give or agree or promise to give to anyone any gratuity for the benefit of or at the direction or request of any member or employee of the Authority or the Commonwealth of Pennsylvania.

F. Except with the consent of the Authority or the Commonwealth of Pennsylvania, neither the

Contractor nor anyone in privity with the Contractor shall accept or agree to accept from, or give or agree to give to, any person, any gratuity from any person in connection with the performance of the services required hereunder except as provided herein.

G. Except with the consent of the Authority, the Contractor shall not have a financial interest in any other contractor, subcontractor, or supplier providing services, labor, or material for the services required hereunder.

H. The Contractor, upon being informed that any violation of this Section VI has occurred or may occur, shall immediately notify the Authority in writing.

I. The Contractor, by execution of this Contract and by the submission of any bills or invoices for payment pursuant hereto, certifies and represents that the Contractor has not violated any of these provisions.

J. The Contractor shall, upon request of the Authority or the Office of State Inspector General, reasonably and promptly make available to the Authority and that office and its representatives, for inspection and copying, all business and financial records of the Contractor of, concerning, and referring to this Contract or which are otherwise relevant to the enforcement of this Section VI.

K. For a violation of this Section VI, the Authority may terminate this Contract and any other contract with the Contractor, claim liquidated damages in an amount equal to the value of anything received in breach of this Section VI, claim damages for all expenses incurred in obtaining another appraiser to complete performance under this Contract, and debar and suspend the Contractor from doing business with the Authority. These rights and remedies are cumulative, and the use or nonuse of any one shall not preclude the use of all or any other. These rights and remedies are in addition to those the Authority and/or the Commonwealth of Pennsylvania may have under law, statute, regulation or otherwise.

Section VII. Commonwealth Audit:

A. The funds for this Contract are subject to audit by the Authority and other agencies and representatives of the Commonwealth of Pennsylvania in accordance with applicable laws and regulations. The Authority reserves the right to perform additional audits of a financial/compliance, economy/efficiency or program results nature, if deemed necessary.

B. The Contractor will submit to the Authority copies of any audits conducted by or at the request of the Contractor that involve the funds for this Contract.

Section VIII. Insurance:

A. The Contractor shall, at its sole cost and expense, procure and maintain in full force and effect, covering the performance of the Contractor's services required under this Contract, the types of insurance specified in this Section VIII. The insurance required by this Section VIII shall be procured from reputable insurers, acceptable to the Authority and authorized to do business in the Commonwealth of Pennsylvania. The insurance required by this Section VIII, except the Contractor Liability Insurance, shall be written on an "occurrence" basis and not a "claims-made" basis. In no event shall work be performed pursuant to this Contract until the required evidence of insurance has been furnished to the Authority. If the Contractor fails to obtain or maintain the required insurance, the Authority shall have the right to treat such failure as a material breach of this Contract and to exercise all appropriate rights and remedies. The insurance policies required by this Section VIII shall provide for at least thirty (30) calendar days' prior written notice to be given to the Authority in the event coverage is materially changed, cancelled or non-renewed.

B. The Authority and the Commonwealth of Pennsylvania, their officers, employees, and agents are to be named as additional insureds on the General Liability Insurance policy of the Contractor. In addition, an endorsement to the insurance policy is required stating that the coverage afforded the Authority and the Commonwealth of Pennsylvania and their officers, employees, and agents as additional insureds will be primary to any coverage available to the Contractor.

C. The amount of Insurance required by this Section VIII is as follows:

i. Workers Compensation and Employers Liability:
Workers Compensation: Statutory limits.
Employers Liability: \$500,000 each accident - bodily injury by accident
\$500,000 each employee - bodily injury by disease
\$500,000 policy limit - bodily injury by disease.
Other States' coverage and Pennsylvania endorsement.

ii. General Liability Insurance:
Limit of Liability: \$1,000,000 per occurrence combined single limit for bodily injury and property damage;
\$1,000,000 personal and advertising injury;
\$2,000,000 general aggregate.

Coverage: Premises operations; blanket contractual liability; personal injury liability (employee exclusion deleted); products and completed operations; independent contractors; employees and volunteers as additional insureds; cross liability; and broad form property damage (including completed operations).

iii. Automobile Liability:
Limit of Liability: \$1,000,000 per occurrence combined single limit for bodily injury and property damage liability.
Coverage: Owner, non-owned and hired vehicles.

iv. Professional Liability Insurance:
Limit of Liability: $1,000,000 with a deductible not to exceed $25,000.
Coverage: Errors and omissions.
Coverage for occurrences happening during the performance of the services required under this Agreement shall be maintained in full force and effect under the insurance policy or "tail" coverage for a period of at least two (2) years after completion of the services.

D. Certificates of insurance evidencing the required coverages shall be submitted to the Authority's Insurance Department at least ten (10) calendar days before work is begun. This ten (10) calendar day requirement for advance documentation of coverage may be waived in situations where such waiver will benefit the Authority, but under no circumstances shall the Contractor actually begin work without providing the required evidence of insurance. The Authority reserves the right to require the Contractor to furnish certified copies of the original policies of all insurance required under this Contract at any time upon ten (10) calendar days' prior written notice to the Contractor.

E. It is expressly understood and agreed that the furnishing of insurance pursuant to this Section VIII shall in no way limit the liability or responsibilities and obligations of the Contractor as provided in this Contract.

Section IX. Indemnification:

A. **Limitation of Liability.** Except for losses caused by Contractor's negligence or willful misconduct in the performance of Contractor's duties under the contract, whether by way of an action for breach of contract, warranty, tort (including negligence), indemnity, contribution or otherwise, Customer agrees that in no event shall CantorCO2e, its affiliates, officers, directors, employees or agents be liable for direct damages in excess of the total fees actually received by Contractor from the Authority pursuant to the Contract or applicable confirmation.

Section X. Ownership of Documents:
A. Except for confirmations issued by the Contractor in the ordinary course of business, all reports, plans, specifications, computer files, field data, notes and other documents and instruments prepared by the Contractor in accordance with this Contract are and shall remain the property of the Authority. Any use or reuse by the Contractor without the express written approval of the Authority will be at the Contractors sole risk and without liability or legal exposure to the Authority.

Section XI. Sovereign Immunity:
A. The Contractor acknowledges that the Authority, as an agency of the Commonwealth of Pennsylvania, enjoys sovereign immunity as provided in Section 18 of the Philadelphia Regional Port Authority Act, Pa. Stat. Ann. tit. 55, § 697.18.

Section XII. Notices:

A. All notices required by this Contract or other communications to either party by the other shall be deemed given when made in writing and received or when made in writing and deposited in the United States Mail, first class, postage prepaid, addressed as on the Service Contract. Notices shall be effective upon actual receipt by the named recipient.

Section XIII. Entire Contract:

A. This Contract constitutes the entire agreement and understanding between the parties with respect to the subject matter contained herein and supersedes all prior agreements, understandings, negotiations, and discussions, both written and oral, among the parties hereto with respect to the subject matter hereof.

Section XIV. Severability:

A. The provisions of this Contract are severable and if any of its provisions become or are found to be unlawful, the decision so holding shall not be construed to impair or affect the enforceability of the remaining provisions of this Contract or any part hereof.

Section XV. Amendments:

A. This Contract may not be amended or modified in any way except by a written instrument executed by each of the parties hereto. In the event that an amendment to this Contract is desired by either party, the party wishing to amend must present the proposed amendment in writing to the other party. If the amendment is accepted by the other party, a true copy of the amendment shall be signed by the parties' official representatives and shall be attached as a rider to this Contract.

Section XVI. Section Headings:

A. The section headings contained in this Contract are for reference purposes only and shall not affect the meaning or interpretation of any provisions of this Contract.

Section XVII. Other Laws:

A. Any and all other applicable state or federal laws not specifically mentioned in this Contract shall also apply to the parties.

Section XVIII. Governing Law:

A. This Contract shall be governed by and construed and enforced in accordance with the laws of the Commonwealth of Pennsylvania, without giving effect to the principles of conflicts of law thereof.

EXHIBIT B

BROKERAGE TERMS

In consideration of CantorCO2e, L.P. ("CantorCO2e") agreeing to provide brokerage and other services with respect to transactions involving:

(a) Emission Reduction Credits ("ERCs") and Discrete Emission Reductions ("DERs") issued by various State and local governments throughout the world; and
(b) any other emissions, wastewater, greenhouse gas or renewable energy trading program and its rules and regulations as they may be promulgated, as agreed to by Customer and CantorCO2e;

(all collectively referred to as the "Instruments" and the regulations governing such Instruments collectively referred to as "Regulations"), the undersigned (the "Customer") hereby agrees with CantorCO2e as follows:

1. **Authorization.** Customer hereby retains CantorCO2e to act as its broker on an agency basis on a sole and exclusive basis with respect to the marketing, purchase and/or sale of Instruments. The Customer authorizes CantorCO2e to purchase, sell, or otherwise transfer Instruments, and rights to purchase, sell, or otherwise transact Instruments ("Rights"), and any other type of environmental credit ("Credit"), product or instrument the Customer may elect on the Customer's behalf, pursuant to the terms and conditions set forth in this Agreement. The authority hereby conferred shall remain in effect for the term of this Contract unless and until this Agreement is terminated under the terms of the Contract.

2. **Instructions to Purchase and Sell.** In order to purchase, sell, or otherwise transfer Instruments hereunder, the Customer shall deliver to CantorCO2e written instructions in such form as CantorCO2e shall require from time to time ("Instructions"). The Customer shall authorize one or more individuals (each an "Authorized Person") to deliver Instructions to CantorCO2e by providing a written list, substantially in the form of Schedule 1 hereto, containing the name(s) of such Authorized Person(s) to CantorCO2e, which Schedule the Customer may amend in writing from time to time; CantorCO2e may rely upon Instructions or any other communication delivered or transmitted by any such Authorized Person without any duty or obligation on CantorCO2e's part to inquire as to the purpose or propriety thereof. CantorCO2e may rely upon and shall be protected in acting or refraining from acting upon any communication received from an individual that CantorCO2e reasonably believes is an Authorized Person, and upon any instruction, notice, request, direction, consent, report, certificate or other instrument, paper or document that CantorCO2e reasonably believes to be genuine and to have been presented or executed by the proper party or parties.

3. **Offers to Purchase, Sell, and Otherwise Transact.** CantorCO2e will solicit offers to purchase, sell, or otherwise transact Instruments, as the case may be, pursuant to the Customer's Instructions, and is authorized to accept on behalf of the Customer any offer that

conforms to the terms of such Instructions (any such offer being hereinafter referred to as a "Conforming Offer"). Prior to a Conforming Offer becoming a legally binding agreement to transfer Instruments pursuant to the terms of this Agreement and the Transaction (as hereafter defined) it is subject to approval pursuant to the Commonwealth Attorney's Act (P.L. 950, No. 164) 71 P.S. § 731-101 et. Seq. Promptly upon the acceptance of a Conforming Offer, CantorCO2e will provide, by facsimile transmission, confirmation thereof to the Customer ("Confirmation"), indicating (as applicable) the quantity and effective date(s) of the Instruments being transferred, the purchase price(s), transaction fee owed CantorCO2e, settlement date(s), Allowance Tracking System account, and other terms and conditions of the transaction ("Transaction"). The Confirmation shall also specify the requirement, if any, to deposit Instruments, securities or other financial instruments ("Collateral") with CantorCO2e or a designated third-party escrow agent ("Escrow Agent") to ensure performance by buyer and/or seller, as well as the terms and conditions governing the maintenance and release of such Collateral. The Customer shall indicate its acceptance of the Confirmation by affixing the signature of an Authorized Person and returning the Confirmation as so accepted by facsimile and first class mail. The Confirmation shall constitute Customer's irrevocable and legally binding acceptance of the terms and conditions set forth therein upon it being fully executed by the parties.

This Agreement and the Confirmation executed by the Customer and each counter-party to each specific purchase and sale of Instruments shall comprise the terms and conditions of the Transaction. In the event that CantorCO2e does not receive a Conforming Offer within 30 days of the date on which the Instructions relating thereto were received by CantorCO2e, CantorCO2e shall discontinue soliciting offers in respect to those instructions unless and until new Instructions thereafter are issued by Customer.

4. **Recordation of Instruments.** Unless otherwise specified in the Confirmation, Instruments purchased or sold on behalf of the Customer, or Instruments used as Collateral, shall be transferred into a Clearing Account (the "Clearing Group Account") prior to being transferred into the account designated by the purchaser of such Instruments in the Confirmation. To facilitate the sale of Instruments or to preserve Customer's anonymity, Customer also may request CantorCO2e to hold Instruments as custodian ("Custodian") in a Clearing Group Account pending sale or ultimate delivery, provided that CantorCO2e, in its sole discretion, may decline such a request. CantorCO2e will effect the recordation of Instrument(s) being transferred hereunder on the later to occur of (i) the date indicated in the Confirmation relating to such Instrument(s), and (ii) the earliest date that such Instrument(s) may be transferred to the purchaser thereof pursuant to the applicable Regulations. The Customer hereby agrees to comply fully with the deposit of Collateral and other arrangements that are set forth in each Confirmation. The Customer agrees to execute the appropriate transfer forms and such other documents as CantorCO2e shall reasonably request in connection with the transfer of Instruments.

5. **Clearing Group Account; Clearing Group Account Representative.** The Customer shall be deemed to be an owner of the Clearing Group Account to the extent of any Instruments that have been transferred from the Customer's account to the Clearing Group

Account pending the transfer of those Instruments to an Allowance Tracking System account, or such other account, pursuant to the directions of the purchaser thereof in the applicable Confirmation. Customer hereby (i) appoints Josh Margolis of CantorCO2e to act as the Customer's authorized account representative with respect to the Clearing Group Account (the "Clearing Group Account Representative"), (ii) appoints Harold Henderson of CantorCO2e to act as the Customer's alternate authorized account representative with respect thereto (the "Alternate Clearing Group Account Representative") (the term "Clearing Group Account Representative" shall be hereinafter construed to include the "Alternate Clearing Group Account Representative" unless the context indicates otherwise), (iii) authorizes CantorCO2e to appoint a successor Clearing Group Account Representative. The Clearing Group Account Representative's sole duties hereunder shall be to undertake the transfer of Instruments from and to the Clearing Group Account in accordance with the provisions of this Agreement and one or more Transactions, and to perform such other duties as the applicable Regulations may require. The Customer acknowledges and agrees (a) that the Customer shall be fully bound by the actions, inactions, or submissions of the Clearing Group Account Representative made on behalf of the Customer with respect to a transfer of Instruments made pursuant to the Agreement and one or more Transactions, (b) that entities and/or individuals other than the Customer may possess an ownership interest in the Clearing Group Account to the extent of Instruments transferred to the Clearing Group Account by any such entity or individual, and (c) that any control which CantorCO2e may be authorized to exercise over Instruments transferred to the Clearing Group Account by the Customer shall be exercised solely in conformity with the provisions of this Agreement.

6. **Customer's Representations and Covenants.** The Customer represents and agrees (i) that it will independently determine the appropriateness of any transaction that the Customer initiates pursuant to the terms of this Agreement, (ii) that it will not rely on any statement of opinion or fact made by CantorCO2e, the Clearing Group Account Representative, or any of CantorCO2e's employees, agents or representatives, in making such determination, (iii) that it assumes the full risk as to the value, if any, that the Instruments may have at any time, and (iv) that, with respect to any transaction in Rights as to which it makes a Conforming Offer, it is a commercial user of Instruments, or merchant engaged in the handling of Instruments, and it enters into such transaction solely for purposes related to its business as such. The Customer represents and warrants to and for the benefit of CantorCO2e as of the date hereof, and shall be deemed to represent and warrant for the benefit of CantorCO2e as of each date that Instructions are given or a Confirmation is executed by Customer, that: (i) it is duly organized and validly existing in good standing under the laws of the jurisdiction in which it is organized and is duly qualified to do business and is in good standing in each other jurisdiction in which such qualification is required (except where the failure to so qualify would not have a material adverse effect on its ability to perform its obligations under this Agreement or such Instructions or Confirmation); (ii) it has full power and authority (corporate and other) to execute and deliver this Agreement and such Instructions and Confirmation and to perform its obligations hereunder and thereunder; (iii) its execution and delivery of this Agreement and such Instructions and Confirmation and the performance of its obligations hereunder and thereunder have been duly authorized by all requisite corporate action; (iv) all authorizations of and exemptions, actions, approvals and consents by, and all notices to or filings with, any governmental or other authority

or other person that are necessary to enable it to execute and deliver this Agreement and such Instructions and Confirmation and to perform its obligations hereunder and thereunder have been obtained or made and are in full force and effect, and it has complied with all the conditions thereof; (v) this Agreement and such Instructions and Confirmation are duly executed and delivered by it; (vi) this Agreement and such Instructions and Confirmation are legal, valid and binding obligations on its part, enforceable against it in accordance with their respective terms; and (vii) its execution and delivery of this Agreement and such Instructions and Confirmation and the performance of its obligations hereunder and thereunder do not violate or conflict with any law, regulation, or judicial or governmental order or decree to which it is subject, any provision of its constitutional or governing documents, or any term of any agreement or instrument to which it is a party or by which it or its property or assets is bound or affected.

7. [Intentionally Omitted]

8. [Intentionally Omitted]

9. [Intentionally Omitted]

10. Fees. The Customer shall pay to CantorCO2e a fee of three and a half percent (3.5%) on the natural value of the trade with respect to each Transaction initiated hereunder and on such payment terms as shall be specified on the Confirmation. Any fee earned by CantorCO2e hereunder shall be due and payable in immediately available funds no later than the time set forth in the Confirmation of the Transaction to which such fee relates.

11. Limitation of Liability. Except for losses caused by Contractor's negligence or willful misconduct in the performance of Contractor's duties under the contract, whether by way of an action for breach of contract, warranty, tort (including negligence), indemnity, contribution or otherwise, Customer agrees that in no event shall CantorCO2e, its affiliates, officers, directors, employees or agents be liable for direct damages in excess of the total fees actually received by Contractor from the Authority pursuant to the Contract or applicable confirmation.

12. Notices. Notices and other written communications required by or contemplated to be made pursuant to the terms of this Agreement may be sent by first-class mail, postage prepaid, by overnight courier or other guaranteed-delivery service, or by facsimile transmission, as follows:

<u>If to CantorCO2e:</u>

CantorCO2e, LP 345 California Street, Suite 1260 San Francisco, California Attn: Josh Margolis Fax Number: 415-296-9582	With a copy to :	CantorCO2e, L.P. 110 East 59th Street New York, New York 10022 Attn: General Counsel Fax Number: 212-829-4708

<u>If to the Client:</u>

Philadelphia Regional Port Authority	With a copy to:	Philadelphia Regional Port Authority

3460 North Delaware Avenue
2nd Floor
Philadelphia, PA 19134
Attn: Lisa Magee
Tel Number: 215-426-2600
Fax Number: 215-423-1917

3460 North Delaware Avenue
2nd Floor
Philadelphia, PA 19134
Attn: Gregory V. Iannarelli
Tel Number: 215-426-2600
Fax Number: 215-423-4947

Either party may change the address or fax number to which notices are to be sent by giving notice thereof in the manner described herein. Any notice or communication to be delivered hereunder shall be deemed to have been delivered when the party for whom delivery is intended is in actual receipt thereof. Neither CantorCO2e nor the Customer shall be held responsible for delays in the transmission or execution of Instructions, notices or other communications due to a breakdown or failure of transmission or communication facilities, or for any other cause beyond the control of CantorCO2e or the Customer, as the case may be.

13. Binding Agreement; Assignment; Waiver and Amendment; Certain Definitions. This Agreement, upon execution and delivery hereof by the parties hereto, shall be the legally binding agreement of each such party, superseding all prior agreements and/or understandings relating to the subject matter hereof, whether oral or written, between the parties hereto and shall inure to the benefit of, and be enforceable against, any and all of such party's successors and permitted assigns, except as such enforcement may be limited by bankruptcy, insolvency and other laws affecting the rights of creditors, and by the application of general principles of equity. In no event shall either party hereto assign any of its rights and/or obligations hereunder without the prior written consent of the other party. No provision of this Agreement may be waived or amended unless such waiver or amendment is in writing and signed by each of the parties hereto. Capitalized terms used and not defined herein shall have the same meanings ascribed to them in the applicable Regulations.

14. Termination; Events of Default. (a) Either party hereto may terminate this Agreement upon giving not less than one business day's notice to the other party advising the effective date of such termination, provided, however, that any such termination shall not relieve either party of any liability or obligation that was incurred prior to the effectiveness of such termination. The Customer acknowledges that any Conforming Offer that has been accepted by CantorCO2e on the Customer's behalf prior to the effective date of such termination shall remain binding on the Customer pursuant to the terms of this Agreement.

(b) Notwithstanding the provisions of Paragraph 14a, in the event that the Customer enters into a Transaction and (i) fails to make payment of the fee (or any part thereof) that is due to CantorCO2e hereunder within the time or in the manner described in the Confirmation relating thereto, (ii) fails to provide and maintain Collateral if and as required pursuant to the terms of a confirmation, (iii) breaches any other obligation on its part hereunder or under any Transaction and such breach shall not be cured on the first business day after notice thereof from CantorCO2e or the counterparty to such Transaction, (iv) is bankrupt or insolvent, is otherwise unable to pay its debts as they become due, makes a general assignment, arrangement or composition with or for the benefit of creditors, or admits in writing that it is unable to pay its debts as they become due, (v) thereafter disaffirms or repudiates such Transaction or any of its obligations hereunder or thereunder, or (vi) any representation or warranty made or given or deemed to have been made or given shall prove to be false or misleading in any material respect at the time it was made or given or deemed to have been made or given, CantorCO2e shall have the right, in its sole discretion, (A) to cancel such Transaction, (B) to substitute another party in the place of the Customer, or (C) to permit the completion of such Transaction; provided, however, that in the event of a cancellation or substitution as provided in Clauses (A) and (B) above, respectively, CantorCO2e's sole obligation shall be to return to the Customer any cash, Collateral and Instruments relating to such Transaction that CantorCO2e or the Escrow Agent, if any, may hold on behalf of the Customer at the time of such substitution or cancellation; and provided further, that if CantorCO2e permits the completion of a Transaction as provided in Clause (C) above, CantorCO2e shall have the right to set off the Customer's obligation to pay CantorCO2e's fee (or any part thereof) hereunder against any cash, Collateral or Instruments that may be held by CantorCO2e or the Escrow Agent on behalf of the Customer. Any delay or failure on the part of CantorCO2e in exercising its rights of substitution, cancellation or set off hereunder in connection with a particular Transaction shall not be deemed a waiver of any such right with respect either to that, or to any other, Transaction.

15. Interpleader. If (i) CantorCO2e shall receive Instructions, claims or demands from any party with respect to Instruments held in the Clearing Group account, or (ii) there shall be a change in the applicable Regulations, or in any law or regulation affecting the Instruments, or any interpretation thereof by a court or government agency of competent jurisdiction, either of which, in CantorCO2e's good faith belief, creates a conflict with any of the provisions of this Agreement, or (iii) CantorCO2e's ability to perform under this Agreement is restricted, removed or subject to delay in any way due to any reason or cause beyond CantorCO2e's control, including without limitation nationalization, expropriation, currency restrictions, acts of war, terrorism, insurrection, revolution, nuclear accident or acts of God, then CantorCO2e shall be entitled to refrain from taking any action with respect to Instruments held in the Clearing Group Account (and/or to maintain any Collateral that CantorCO2e may hold in connection therewith), and its sole obligation shall be to maintain such Instruments (and/or such Collateral) until it shall be directed otherwise in writing by a final order or judgment of a court of competent jurisdiction. CantorCO2e shall notify Customer in writing of its decision to refrain from acting, and the reason(s) therefore. Customer may then request CantorCO2e to take such action(s) nevertheless. On receipt of such request CantorCO2e shall take such action(s) on behalf of Customer, provided, that notwithstanding the foregoing, CantorCO2e shall not be required to take any action that CantorCO2e, in good faith, considers unlawful, or otherwise improper.

16. Governing Law; Severability. This Agreement shall be governed by and construed in accordance with the laws of the Commonwealth of Pennsylvania, without giving effect to the conflict-of-laws provisions thereof. If any term or condition contained in this Agreement is declared by a court of competent jurisdiction to be invalid or unenforceable, such invalidity or unenforceability shall not affect the remaining provisions of this Agreement, which otherwise shall remain in full force and effect.

SCHEDULE 1

LIST OF AUTHORIZED PERSONS

PURSUANT TO

CantorCO2e Brokerage, L.P.
BROKERAGE AGREEMENT

In accordance with paragraph 2 of the Brokerage Agreement, the Customer designates the following as Authorized Person(s) with the authority to deliver binding Instructions to CantorCO2e in order to purchase or sell Instruments.

Name	**Title**	**Signature**
____________________	____________________	____________________
____________________	____________________	____________________
____________________	____________________	____________________

Customer

By: ____________________________
(Signature)

____
(Print Name)

____
(Title)

Dated: ______________

Philadelphia Regional Port Authority

3460 N. Delaware Avenue, Philadelphia, PA 19134
(215) 426-2600 • FAX (215) 426-6800

Executive Director

MEMORANDUM

TO: **PRPA STAFF**

FROM: James T. McDermott, Jr.
Executive Director

DATE: November 2, 2009

RE: **AUTHORIZATION**

I will be out of the office from Wednesday, November 4, 2009 thru Tuesday, November 10, 2009 in my absence Robert Blackburn is in charge of the office and authorized to sign any necessary documents.

Moffatt & Nichol

www.moffattnichol.com