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April 23, 2014

Mr. Michael Scott
Philadelphia Regional Port Authority
3460 N. Delaware Avenue
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Philadelphia, PA 19134

RE: FINAL Container Crane Conversion Analysis Report – Packer Avenue Terminal

Dear Mr. Scott:

Please find enclosed a draft of Compliance Management International's (CMI's) *Container Crane Conversion Analysis Report – Packer Avenue Terminal*. CMI requests a PRPA review of the information, data and cost assumptions included herein.

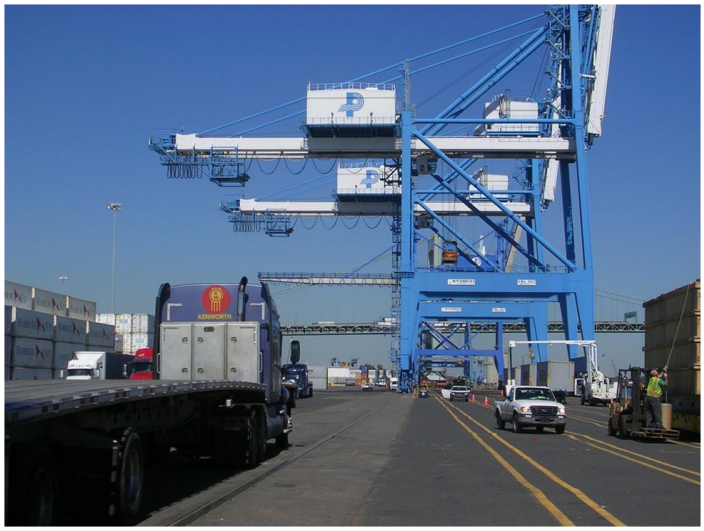
Please call with questions or additional clarifications needed.

Best Regards,

Chris C. Maye, P.E.
Manager, Environmental Services

William McMahon, P.E., C.E.M.
Senior Engineer

Enclosure;



April 2014

Container Crane Conversion Energy Analysis Report
Packer Avenue Marine Terminal

Prepared for:

Philadelphia Regional Port Authority
3601 Delaware Avenue
Philadelphia, Pennsylvania

Prepared by:
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EXECUTIVE SUMMARY

The Philadelphia Regional Port Authority (PRPA) has authorized CMI to conduct an energy analysis of the Packer Avenue Marine Terminal (PAMT) in Philadelphia, Pennsylvania to determine energy savings opportunities for reducing energy usage, energy costs, and direct emissions of existing PRPA crane operations.

This analysis was based on a review and analyses of two years of past diesel fuel usage (2012 and 2013), current fuel costs, and a site visit conducted with CMI personnel in October 2013. In the past year energy usage for the two Hyundai (H-6 and H-7) cranes was 160,000 gallons of diesel fuel. At the current price of $4.16 per gallon the annual cost of diesel fuel for these cranes calculates to $665,600 per year.

Table ES-1 Energy Conservation Measure (ECM) - Simple Payback Summary

ECM	Construction Cost	Annual Savings	Simple Payback
ECM-1: Convert Hyundai H-6 and H-7 Cranes from Diesel to Electric	$20,000,000	$455,000	40.6
ECM-2: Add LNG Fuel to Diesel Fuel System for H-6 and H-7 Cranes	$ 500,000	$125,000	4.0
ECM-3: Add CNG Fuel to Diesel Fuel System for H-6 and H-7 Cranes	$ 400,000	$170,000	2.4

Table ES-2 ECM Emission Reductions Summary

Metric	ECM	% Reduction vs. 2013	30-year Cumulative Change (tons)
CO2e Emissions	ECM-1	56%	90,000
	ECM-2	11%	14,400
	ECM-3	11%	14,400
TOPC Emissions	ECM-1	56%	2,300
	ECM-2	27%	825
	ECM-3	27%	825
DPM Emissions	ECM-1	56%	56
	ECM-2	38%	28
	ECM-3	38%	28

While the above results appear to point towards ECM-2 or ECM-3, further analysis was completed on the long range prospects for growth of operations at the PRPA facilities. This investigation included various alternatives using growth rates from 2% to 10% per year projected out to 20 years from 2014. Under these scenarios, and the likelihood that newer cranes would not be diesel driven, ECM-1 appears to be the most desirable option.ECM-1 also has the greatest reduction of emissions for both the short and long runs.

1.0 INTRODUCTION

1.1 Purpose/Scope

The Philadelphia Regional Port Authority (PRPA) requested Compliance Management International (CMI) evaluate options for re-powering cranes located at the Packer Avenue Marine Terminal (PAMT). The purpose of the evaluation was to determine a cost-benefit analysis for re-powering the cranes under the various options available in practice (due to the changing crane supplier design from diesel to electric).

Through discussions with PRPA personnel, each cost-benefit analysis for each energy conservation measure (ECM) for re-powering the container cranes was to include the following evaluation criteria:

- Construction Costs (Capital Investment)
- Operating Costs (on-going costs to operate under identified power method)
- Air Emission Reductions
- Simple Payback Period
- Identification of other potential benefits

Each of these components of the ECM cost-benefit analysis was analyzed over PRPA's long-term projected plan for container ship unloading activities.

1.2 Facility Description

The Packer Avenue Marine Terminal (PAMT) is located on the Delaware River in the southeast area of the City of Philadelphia, near the intersection of Interstates 95 and 76. The site occupies approximately 112 acres and is bounded by the Delaware River to the east, Packer Avenue to the north, Delaware Avenue to the west, and undeveloped land to the south (see Figure 1). The Walt Whitman Bridge, which connects Pennsylvania and New Jersey, spans the Delaware River and transects the PAMT property.

The property and all structures thereon are owned and managed by the Philadelphia Regional Port Authority (PRPA), a state agency, and are operated through a long-term agreement by Holt Logistics (Holt). Holt Logistics is headquartered in Gloucester City, New Jersey. Please refer to Figure 2 for a current layout site plan. PECO currently provides electricity to the site's operations.

PAMT has the largest container capacity, and is currently the busiest terminal in the area. Six (6) normal ship berths are present along the approximately 3,800-foot dock. The depth of water at the berths is a minimum of 40 feet mean low water (MLW). The majority of the cargo unloaded at the facility is transported off-site via truck. However, there is a nearby train terminal jointly operated by CSX and Norfolk Southern for rail off-loading activities.

Equipment and Process Description
PAMT is configured to handle standard containers, steel, refrigerated containers (perishables), and other heavy lifts of non-containers.

Currently, PAMT has seven (7) cranes available to unload ships in berth:

- One Kocks Heavy Lift Crane (K-5, 375-short ton capacity)
- Two Kocks Container Cranes (K-2 and K-3, each 45-short ton capacity)
- One Kocks Container Crane (South, 40-short ton capacity)
- One Paceco Container Crane (P-1, 45-short ton capacity)
- Two Hyundai Container Cranes (H-6 and H-7, each 72.8-short ton capacity)

Also, each of these cranes is primarily powered by one (or two) crane-mounted compression ignition engines and associated generators. Once the cargo is unloaded from the berthed ship, it is further handled and transported throughout the site by six (6) top loaders of 95,000-pound capacity, five (5) top loaders of 30,000-pound capacity, and by approximately 100 forklift trucks.

For self-powered refrigerated container units, the site maintains approximately 1,160 refrigerated container plug-in sites.

PAMT also maintains four storage warehouses on the property that range between 90,000 cubic feet (CF) and 100.000 CF. A fifth refrigerated warehouse is also maintained on site, and has a capacity of 2.2 million CF.

Container Movements

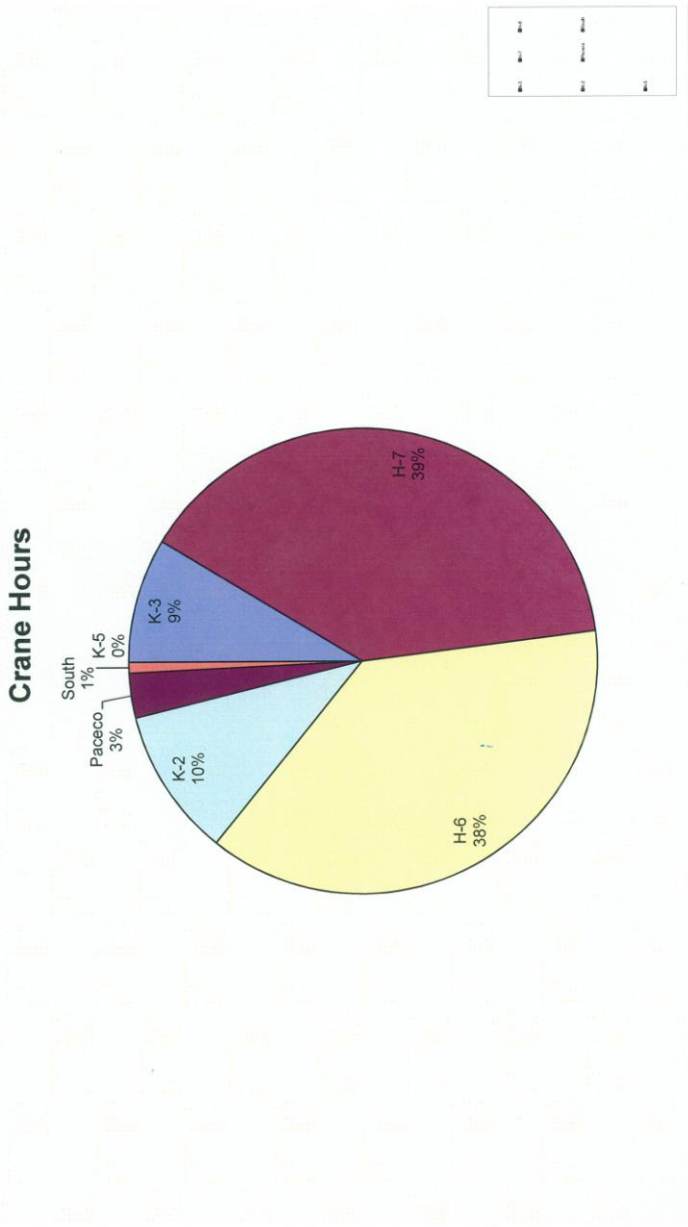
Container movements begin with the berthing of ships at PAMT. The cranes are the first movement of the containers once the ship is berthed at the facility. Container crane operations that unload berthed ships consumes a significant amount of energy. Currently, the energy consumption is the combustion of diesel fuel in the on-crane engine-generator units, and is directly related to the amount of cargo off-loaded from ships.

The majority of PAMT's cargo movement is containers, which vary in size and weight. For purposes of standardizing the amount of cargo moved, twenty-foot equivalent units (TEUs) are used to measure the standard amount of cargo unloaded at ports. As noted earlier, there is one heavy lift crane (Crane K-5) that off-loads high density cargo, such as steel. Chart 1.1, provided by PRPA, shows crane operating hours through mid-December 2013.

Chart 1.1 2013 PAMT Crane Hours

Crane Hours - 2013

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total	Percent
K-3	5.000	3.750	38.250	48.250	43.750	30.500	114.420	60.750	13.500	41.750	77.133	41.250	518.303	8.65%
H-7	171.250	151.083	204.167	196.750	232.083	225.333	210.170	256.000	200.417	224.750	207.500	77.167	2356.669	39.34%
H-6	158.333	125.750	180.750	182.583	229.250	232.333	205.420	243.250	208.417	213.000	217.167	68.500	2264.753	37.80%
K-2	45.333	43.000	15.000	57.000	113.583	69.250	0.000	79.250	92.250	67.667	34.500	3.667	620.500	10.36%
Paceco	23.917	20.000	23.333	24.000	24.000	17.333	27.500	24.750	0.000	0.000	1.750	0.000	186.583	3.11%
South	4.417	0.000	0.000	16.750	0.000	6.250	17.000	0.000	0.000	0.000	0.000	0.000	44.417	0.74%
K-5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00%
Total	408.25	343.58	461.50	525.33	642.67	581.00	574.51	664.00	514.58	547.17	538.05	190.58	5991.22	100.00%



Number of Containers Handled
The number of containers handled by these cranes varies with the size and type of ships involved. A typical cargo ship can handle from 3,500 to 7,000 40 foot containers. This measure is probably a closer measure of the work of the cranes. The most recent available data shows the following:

Crane H-6	2012	50,000 Containers
	2013	60,000 Containers
Crane H-7	2012	45,000 Containers
	2013	55,000 Containers.
Combined	2012	95,000 Containers
	2013	115,000 Containers

Number of TEUs Handled
The number of containers handled by these cranes varies with the size and type of the containers involved. The standard measures of cargo handled are called TEUs which stand for Twenty Foot (container) Equivalent Units. Despite the inexact nature of containers (and their internal cargo weights and dimensions), this measure is the closest available measure of the work of the cranes. The most recent available data shows the following:

Crane H-6	2012	100,000 TEUs
	2013	120,000 TEUs
Crane H-7	2012	90,000 TEUs
	2013	110,000 TEUs
Combined	2012	190,000 TEUs
	2013	230,000 TEUs

Attachment 1 contains a summary of historical and projected container and TEU off-loading activities at PAMT.

Container Crane Energy Analysis Scope
Based on discussions with PRPA personnel, and the historical cargo of-loading data in Table 1, the scope of the project involves an evaluation of several energy conservation measures for the two Hyundai cranes (H-6 and H-7), in their existing configuration. These are then evaluated for future operation as used, to offload the vast majority of the containers at the site.

Based on design specifications provided by PRPA, the Hyundai H-6 and H-7 container lift cranes are capable of lifting up to 73 short tons (66 metric tons) of load each. They are the tallest cranes at the Packer Avenue Terminal and are approximately 12 years old (purchased in 2002). Power to operate each crane is generated by one Cummins KTA50-GP diesel powered engine. Each engine has a maximum capacity of 2,011 HP (horsepower). Each diesel engine drives a 2,700 KVA alternator which produces 575 volts, maximum 2,000 amps, three phase power or approximately 2,086 KW maximum.

Generated power is split into four separate loads: 1) Two (2)Main Hoist Motors or a total of 1,700 HP, 2) One (1) 885 HP Trolley Motor, 3) One (1) 35 HP Catenary Motor and 4) a 575/480

volt transformer which supplies Auxiliary Power (150 KW maximum) to other crane circuits. Electrical power to the first three motor loads above is changed by three (3) Inverters from AC (alternating current) to DC (direct current).

The engines operate at various power levels and periods of the week, depending on ships available for unloading or loading operations. Based on our interviews with operators and our calculations, the main diesel engines are started and operational but not necessarily in peak use for approximately 40 hours per week or 2,000 hours per year. Fuel usage rates vary from a low of 20 gallons per hour to a maximum of 100 gallons per hour each. The invoice histories for these cranes indicate usage of 80,000 gallons of diesel fuel per year per crane (160,000 gallons total). This equates to an average rate of diesel fuel consumption of 40 gallons per hour per crane when in operation. This results in a total annual operating cost of $665,000 (160,000 gallons X $4.16 per gallon).

2.0 CURRENT ENERGY USE AND COSTS

The current total energy use at the site consists primarily of electric power (for building operations [refrigeration, office use, small motors, internal lighting, etc.], exterior facility lighting, and refrigerated container plug-in site use) and diesel fuel (crane operation, cargo-moving truck/equipment).

This energy analysis is based on billing information from 2012 to 2013. The table below shows the estimated summary of energy costs for the terminal.

	Cost	% of Total
Electricity	$100,000	14 % (Assumed-see below)
Diesel Fuel	$640,000	86 %
Totals	*$740,000*	*100 %*

The following section outlines the current energy use and costs that are further evaluated in this report.

2.1 Electricity

The cranes are currently fully dependent on the operation of the compression ignition (CI) engine to provide power for modes of use (lateral dock movement, container movement, trolleying, etc.).

Because the cranes currently do not use electric power, electric invoices were not evaluated in depth. One of the ECMs identified in this report (ECM-1) includes the electrification of Hyundai container cranes H-6 and H-7. As detailed in Section 4.1, this would require the construction of a completely separate electrical service infrastructure. Therefore, the existing electrical use and infrastructure would not be materially affected.

2.2 Diesel Fuel

As mentioned earlier, diesel fuel is the sole energy source for the existing cranes at PAMT. Fuel is delivered to each crane by a private supplier via 3,500-gallon tanker truck. The tanker truck enters PAMT, and drives to the base of the crane requiring refueling. The base of the crane is equipped with a fueling port that also is equipped with a booster pump that ensures adequate pressure to deliver the liquid fuel to the elevated storage tanks approximately 50 feet overhead on the crane's superstructure.

The tanks are approximately 1,500 gallons. When the crane is in use, re-fueling is required once or twice per week.

PRPA has elected to mandate the delivery of only ultra-low sulfur diesel (ULSD) for use in its cranes. ULSD contains various additives that provide necessary properties to operate in existing engines and reduce emissions. This fuel contains a maximum of 15 parts per million sulfur, as determined by ASTM-ASTM D975. The selection of this grade of diesel fuel results in a reduction of emissions of oxides of sulfur (SOx) when compared to non-ULSD diesel. Its use

also precludes treating the fuel with additives that would achieve the same emission reduction goal, thus eliminating fuel additives as a viable ECM because these additives have already been incorporated into the fuel's formulation.

Historical consumption of diesel fuel in the cranes was provided to CMI by the PRPA in the form of annual, per crane consumption. Individual delivery ticket costs were not provided for the PAMT; however, a recent bill (February 2014) indicates an average per gallon cost of $4.16 (with Philadelphia sales tax included as an additional charge to the base rate of $3.8543 per gallon rate). The cost of diesel fuel has increased over the past 5 years, with additional increases and decreases noted throughout the period. For purposes of this report, the February 2014 rate is used as a base rate for future years in the economic analyses.

In 2013, approximately 160,000 gallons of ULSD was used by the H-6 and H-7 cranes. The annual cost, using the $4.16 per gallon, is approximately $665,000.

Maintenance cost for the operation of diesel-fired generators is estimated $0.030 per kilowatt-hour (kWh) generated, which includes periodic rebuilds (based on published industry averages and experience). With an estimated 1,600,000 kWh generated in 2013, this equates to an annual maintenance cost of approximately $48,000.

2.3 Natural Gas

Currently, PAMT does not utilize any commercial pipeline natural gas at the facility. However, it is noted that Philadelphia Gas Works (PGW) operates a facility less than a mile from PAMT that stores natural gas.

In addition, two of the ECMs identified in this report propose two different forms of natural gas:

- Liquefied Natural Gas (ECM-2)
- Compressed Natural Gas (ECM-3)

3.0 EMISSIONS

Aside from energy usage, air emissions is another criteria used for evaluation of each ECM. The baseline emissions condition is the emissions of the operation of the cranes utilizing the current power system, compression ignited reciprocating internal combustion engines. These engines are currently burning ULSD-diesel fuel.

The pollutant emissions of concern include:

- Carbon Dioxide and Carbon Dioxide equivalents (CO2e, also known as greenhouse gases)
- Oxides of Nitrogen (NOx)
- Carbon Monoxide (CO)
- Volatile Organic Compounds (VOCs)
- Diesel Particulate Matter (DPM)

For purposes of comparison, ground level ozone pre-cursors (NOx, CO, and VOCs) are presented combined as TOPC (total ozone precursors).

Data gathered to prepare emission estimates included crane run hours, actual and forecasted TEUs, average diesel consumption rate, and the following assumptions:

- Emission factors utilized were engine-specific, where available. Where engine specific emission factors were not available, generally accepted AP-42 emission factors were utilized.
- Forecast per crane TEU estimates assume 80% of all containers off-loaded at the PAMT utilize H-6 and H-7.
- Due to forecasted growth, the maximum number of run hours for each of the Hyundai cranes is assumed to be 4,000 hours per year per crane.

3.1 Baseline Condition

The baseline conditions are established as the 2013 actual emissions, summarized below:

Table 3.1 2013 Container Crane Emissions

Pollutant	2013 Emissions (tpy)
CO2e	2,319
TOPC	57.7
DPM	1.43

4.0 ENERGY CONSERVATION MEASURES

The following energy conservation measures are evaluated in this report:

ECM-1 Convert Hyundai H-6 and H-7 Cranes from Diesel to Electric
ECM-2 Add LNG Fuel to Diesel Fuel System for H-6 and H-7 Cranes
ECM-3 Add CNG Fuel to Diesel Fuel System for H-6 and H-7 Cranes

Note that the evaluations in this section focus on post-ECM changes as compared to 2013 baseline, as well as projected crane utilization.

The following ECMs were not further evaluated:

Use of Diesel Fuel Additive: This option would only be viable if none of the other ECMs were selected. It should be noted that the use of ULSD incorporates many of additives that would normally be blended into non-ULSD to provide an emissions benefit. This scenario wa also not evaluated further because there are no measureable energy efficiency benefits.

Use of Biodiesel: This option replaces the ULSD with biodiesel, a blend of ULSD and biofuels. The quality of the biodiesel fuel is called B20, and is available in limited quantities at this time. Biodiesel was initially considered based on its source (“natural” or sources of readily available materials to be refined) and potential to reduce certain air quality emissions.

- VOC: Decrease of 20%
- CO: Decrease of 11%
- DPM: Decrease of 10%

However, biodiesel is about 1% to 2% less energy efficient than regular diesel fuel. Thus, the amount of biodiesel fuel required for the two Hyundai cranes would increase about 2% to a total equivalent volume of 163,000 gallons for 2013.

The cost of biodiesel is approximately 10% more expensive than ULSD, or approximately $4.40 per gallon. No modifications or capital costs are required for this option. However, there would be no energy savings or maintenance savings.

Since there is no energy benefit, nor is there any cost benefit based on the criteria in this study, this measure is not recommended in light of the other ECMs.

4.1 ECM-1: Convert Hyundai H-6 and H-7 Cranes to Electric and Infrastructure

Proposed Modifications: Convert both cranes from diesel engines to new electric motors with utility-supplied electrical power. This would require installing a new local site electrical distribution and supply system to the crane motors/other power needs of the cranes. Reconfigure the existing diesel engines, diesel fuel systems, alternator equipment, associated controls, supports, and other related system to a backup status.

The existing PAMT electrical distribution system must be supplemented by a new additional electrical distribution system to accommodate the proposed electric motor operations of both of the cranes, as well as future electric cranes and other potential uses (e.g., cold ironing).

First, PECO would be required to upgrade its off-site distribution system (as determined by PECO) to supply a dual feed 13.2 kVA service. This would include new underground cables, a new meter, and possibly a new electric rate. The offsite upgrade would accommodate electrifying both cranes under consideration, additional cranes, and possibly other on-dock uses.

Secondly, the terminal would need to install a new 13.2 kVA local substation to accommodate the new crane loads and other potential future uses. Consideration should be given to allow for future expansion of the on-site grid for cold ironing, notably a growing trend when ships are powered by grid-supplied power instead of their own diesel engines while in port. In addition to a new substation, it would also be necessary to construct new underground conduit structures, manholes, crane-trailing cable trenches, 13.2 kV cables, control circuits, associated demolition and modification projects.

The crane itself must be modified to accept the new crane trailing cable including vertical and horizontal cable supports, roller and cable guides, a large cable reel system, a new electrical substation, transformers, circuit breakers, power conditioning equipment, a new transfer switch (if needed), cable trays, various sizes and lengths of new power cables, conduits, supports, associated demolition, and modification projects.

The existing invertors, main hoist motors, trolley motor, and centenary motor would remain and would be connected to the new utility-supplied electrical power. Also, instrumentation and controls would require modification to accommodate the new changes.

The existing diesel generator, alternator, fuel supply systems, controls, and other systems would remain in place for future/emergency use in case of non-operation of the utility-supplied system. A manual transfer switch would be needed to switch the power source for the motors and auxiliary power from or to the diesel engine/alternator and new utility power system (to prevent back feed or unsafe operations).

Electricity usage for the modified cranes is estimated at 1.6 million kWh per year equivalent to 2013 levels. The expected demand levels for two cranes and no seasonal variation is projected at 1,000 kW per month. At an average cost for electricity of $0.132 per kWh the expected 2013 equivalent annual cost for electricity after the crane conversion is completed would be $210,000.

Electrical motors and auxiliary power loads have no significant, on-site direct emissions.

Nominal maintenance costs are assumed to be associated with implementing this measure. A lower level of maintenance for the diesel engines plus minor maintenance on the electrical distribution system would be incurred. For purposes of this report, an assumption of reduced maintenance costs has been estimated at $10,000 per year ($5,000 per crane).

Construction Cost
The estimated construction cost to implement this ECM is $20,000,000. This total construction cost includes the following:

- Upgrades to the PECO distribution system up to the site meter ($6,000,000).
- New site distribution system ($10,000,000; see Attachment 2)
- Crane electrification ($2,000,000 each crane; see Attachment 2)

Energy Savings
The annual energy savings for this ECM is $455,000 ($665,000-$210,000). 160,000 gallons (or more) would be saved, and electricity use would increase to 1.6 million kWh per year.

Emissions Reductions
The following direct emission reductions would result:

Table 4.1 ECM-1 Emission Reductions

Pollutant	**Emissions Reductions (tpy) vs. 2013**	**% Reduction**
CO2e	1,295	56%
TOPC	32.1	56%
DPM	0.81	56%

It should be noted that the only emissions included in this scenario are the emissions from non-Hyundai cranes. If pre- and post-ECM emissions of only the Hyundai cranes are considered, the % Reduction would be 100%. Attachment 1 contains the detailed calculations.

Reduced Maintenance
Maintenance cost from this ECM would decrease by $38,000 per year, or 60%.

Discussion
The simple payback period for the ECM is 40.6 years ($20,000,000 divided by [$455,000+$38,000 = $493,000]), assuming equivalent 2013 activity. Normally, with such a long payback period, this project would not be recommended. However, consideration of additional implications makes this a viable alternative (see Section 5.0).

4.2 ECM-2: Add LNG Fuel to Diesel Fuel System for H-6 and H-7 Cranes

Proposed Modifications: Modify the diesel engines to accept both diesel fuel and Liquefied Natural Gas (**LNG**) or dual-fuel engine operations. For the most part, this would not modify the diesel fuel supply systems or the existing diesel engines (engine block, pistons, valves, exhaust equipment, etc).

The major change would involve adding LNG equipment to the cranes. The new equipment would include LNG fuel delivery items (connectors, valves, piping, etc), LNG storage tanks, LNG evaporation equipment, supply piping, regulators, control valves and associated controls. The key component of the system would be the controls required to regulate the amount and condition of the LNG gas delivered to the engine needed to maximize LNG use (because of lower cost and lower emissions) and retain sufficient diesel fuel oil use to maintain engine performance (OEM standards, power, efficiency and reliability). Also included are necessary insulation, supports, electrical power, wiring, software and manufacturer's technical support.

It would be necessary to transport the LNG from the wholesale storage area (possibly the nearby PGW LNG storage site) to the terminal. This could either sub-contracted to an outside vendor or conducted by employees of the terminal requiring the purchase of a suitable vehicle. Typically such a vehicle, perhaps a Chart Orca Unit which can hold 5,500 gallons of LNG, cost about $500,000. This report assumes subcontracting LNG transport to the cranes. Please see Attachment 4 for information on the Orca unit.

Such conversions are new to the shipping industry and each conversion arrangement must be customized for particular diesel engines. However, many large diesel engine conversions have been made for other industries such as the mining and rail transportation. Literature for one such manufacturer, Gaseous Fuel Systems or GFS, is attached in Attachment 5 of this report.

There would be no need to change the electrical distribution system of the terminal as a result of this proposal (for only two cranes). This alternative would not be viable y if electrical distribution service is needed for other or future cranes.

Experience with similar systems at other locations, indicates a replacement of diesel fuel usage by LNG ranges from 50 to 70 percent. For this report a 50% replacement of existing diesel fuel (or 80,000 gallons for both cranes per year) has been assumed. LNG fuel would replace diesel fuel on an equivalent BTU (British Thermal Unit) basis or about 1.7 gallons of LNG per gallon of Diesel Fuel. This results in approximately a required 140,000 gallons/yr of LNG. The current wholesale market cost for LNG fuel is approximately $1.18 per gallon. The cost to transport LNG from storage to the terminal is estimated to be $0.32 per gallon. The combined cost of wholesale and transport LNG fuel is $1.50 per gallon. Thus the approximate cost for LNG is estimated at $210,000/yr.

The revised cost for diesel fuel oil for both cranes is expected to be $330,000 per year (80,000 gallons per year X $4.16 per gallon). The combined costs for diesel and LNG fuels would be $540,000 per year.

Maintenance costs for the dual-fuel systems are not expected to change significantly from the existing levels.

Construction Cost
The estimated cost to implement this ECM is $500,000 for both cranes.

Energy Savings
The annual energy cost savings for this ECM is $125,000 ($665,000 minus $540,000). 80,000 gallons of diesel fuel would be saved and LNG fuel use would increase 140,000 gallons per year.

Emission Reductions
The following emission reductions would result from the implementation of this ECM as follows based on 2013 activity:

Table 4.2 ECM-2 Emission Reductions

Pollutant	**Emissions Reductions (tpy) vs. 2013 Actual**	**% Reduction**
CO2e	266	11%
TOPC	15.7	27%
DPM	0.54	38%

Reduced Maintenance
Maintenance costs from this ECM would not decrease as compared to existing conditions.

Discussion
The simple payback period for the ECM is 4.0 years ($500,000 divided by $125,000).

Under ECM-2 there would be no other future benefits to the terminal, such as expansion, “Cold Ironing”, more significant emissions reductions, and maintenance savings in the future.

4.3 ECM-3: Add CNG Fuel to Diesel Fuel System for H-6 and H-7 Cranes

Proposed Modifications
This proposal is similar to ECM-2 except for the type of fuel. Modify the diesel engines to accept both diesel fuel and Compressed Natural Gas (CNG) or dual-fuel engine operations. For the most part, this would not change the diesel fuel supply systems or the diesel engines themselves (engine block, pistons, valves, exhausts equipment, etc).

This change, however, would involve adding required CNG equipment to the cranes. The new equipment would include CNG fuel delivery items (connectors, valves, piping, etc), CNG storage tanks, supply piping, regulators, control valves and associated controls. The key component of the system is the controls that regulate the amount and condition of the CNG gas delivered to the engine required to maximize CNG use (because of lower cost and lower emissions) but retain sufficient diesel fuel oil use to maintain engine performance (OEM standards, power, efficiency and reliability). Also included are necessary supports, electrical power, wiring, software and manufacturer's technical support.

The sizing of the on-board CNG storage tank must be determined by future use considerations and delivery cycles. CNG is stored at high pressures (about 3,000 to 3,600 psi) and required approximately two and a half times the volume of LNG. An approximate size of the tank needed at current use is 7,500 gallons equivalent.

CNG fuel is considered to be safer than diesel fuel as it vaporizes and disperses in the atmosphere quickly.

It would be necessary to transport the CNG from the wholesale storage area (possibly the nearby PGW storage site) to the terminal. This can be either subcontracted to an outside vendor or conducted by employees of the terminal with the necessity of purchasing a suitable vehicle. This report assumes subcontracting CNG transport to the cranes.

Such conversions are new to the shipping industry and each conversion arrangement must be customized for particular diesel engines. However, many large diesel engine conversions have been made for other industries such as the mining and rail transportation.

There would be no need to change the electrical distribution system of the terminal as a result of this proposal (for only two cranes). This proposal would not apply if electrical distribution service is needed for other or future cranes.

Similar to LNG, experience with similar systems at other locations, indicates a replacement of diesel fuel usage by CNG ranges from 50 to 70 percent. For this report a 50% replacement of existing diesel fuel (or 80,000 gallons for both cranes per year) has been assumed. CNG fuel would replace diesel fuel on an equivalent BTU (British Thermal Unit) basis. This results in approximately 11,000 MMbtus/yr. The current market cost for CNG fuel is approximately $15.00 per MMBTU delivered or $2.13 per gallon equivalent. Thus, the approximate annual cost for CNG would be about $165,000 (110,000 MMbtus X $15.00/ MMbtu).

The revised cost for diesel fuel oil for both cranes is expected to be $330,000 per year (80,000 gallons per year X $4.16 per gallon). The combined costs for diesel and LNG fuels would be $495,000 per year.

Maintenance costs for the dual-fuel systems are not expected to change significantly from the existing levels.

Construction Cost
The estimated cost to implement this ECM is $400,000 for both cranes.

Energy Savings
The annual energy cost savings for this ECM is $170,000 ($665,000 minus $495,000). 80,000 gallons of diesel fuel would be saved and CNG fuel use would increase 11,000 MMBTU per year.

Emission Reductions
The following emissions emission reductions would result from the implementation of this ECM as follows (identical to ECM-2):

Table 4.3 ECM-3 Emission Reductions

Pollutant	**Emissions Reductions (tpy) vs. 2013 Actual**	**% Reduction**
CO2e	266	11%
TOPC	15.7	27%
DPM	0.54	38%

Reduced Maintenance
Maintenance costs for this ECM-3 would not decrease as compared to the existing condition.

Discussion
The simple payback period for ECM-3 is 2.4 Years ($400,000 divided by $170,000).

Under ECM-3 there would be no other future benefits to the terminal, such as expansion, “Cold Ironing”, more significant emissions reductions, and maintenance savings in the future.

5.0 DISCUSSION OF RESULTS

The ECMs evaluated in this report are based on 2013 levels. It appears that the level of shipping activity at PAMT has been increasing and forecasts for future increases are substantial. Thus, it is prudent to examine the impact of the proposed energy and emission reduction alternative in this report with respect to projected growth trends, especially for ECM-1, which offers additional site benefits.

5.1 Electrical Site Distribution

ECM-1 assumes that it is necessary to incur $20 million worth of site electrical distribution construction costs for two Hyundai cranes. In reality, this $20 million cost also includes site upgrades that enable future use of electrically-powered cranes and other at dock power functions.

The basis of design for the proposed electrical distribution system is for four (4) large electric cranes on the port with a capability of handling up to ten (10) large electric cranes (or equivalent load) in the future. In addition, the proposed distribution system has the future capability of adding “cold ironing” (electric service to docked ships- permitting the ships to turn off their own polluting diesel engines – the current practice). On this basis, a more accurate cost distribution to future projects (and their benefits) would provide a more realistic cost-benefit analysis. However, the long-term plans of PAMT for expansion, crane replacement, and cold-ironing were not a part of the scope of this evaluation.

A more equitable method of allocating construction costs for the proposed electrical site distribution is to take 20% of the new $6 Million PECO development costs plus 20% of the $10 Million Site electrical distribution costs plus all of the $4 Million crane electrification costs for a total of $6.8 Million. 20% represents two cranes proportion of the ultimate ten crane-equivalent power load design capacity.

It would be possible to greatly reduce the initial electrical distribution costs in order to serve only the two Hyundai cranes. This would make the conversions of the two Hyundai cranes appear more attractive and cost effective.

However, the design of the proposed site electrical distribution system was made for the long term, for a more economical future expansion to future electrical cranes as is the current industrial trend in the shipping industry. The proposed improvements prevent a continual replacement of electric distribution systems that were not sized for expansions. The proposed distribution system design also provides redundancy that would prevent numerous outages, delays in port operations for expansions, higher construction costs, more time for planning, and more requests to PECO for upgrading. In general, the current plan would possibly prevent some if not all future distribution system expansions to electricity.

Thus, a revised simple payback period for a more fair allocation of construction costs would be 13.8 years ($6,800,000 divided by $455,000 energy savings per year and $38,000 maintenance savings per year or $493,000). This equivalent to a 7.25% Return on Investment.

5.2 Cargo Handling Projections

In the past ten years, the amount of cargo passing through PAMT has increased by more than 100% despite significant slowdowns in the national economy (from 169,000 TEUs in 2003 to 353,000 TEUs in 2013). The trend in increased growth in PAMT cargo handling for the future is projected to continue with proper management and planning. A recent PRPA projection (see Attachment 1) shows cargo handling to double again in the next seven years (to 720,000 TEUs) and tripling in the next seven years (1,200,000 TEUs).

The proposed electrical distribution system in ECM-1, if implemented, can accommodate all of the proposed growth, whether the growth is slow or fast. The number and placement of cranes can be determined by the PRPA as necessary.

5.3 Future New Cranes

There has been a steady change in the design and size of container ships over the past 20 years. The number of containers transported on one ship has risen from 1,000 to over 25,000 in the largest ships. This has and will require changes to the cranes that support the new larger ships that are being built to more efficiently pass through the Panama Canal once those improvements are complete (a.k.a, “New PanaMax Ships”).

One other prevalent change in particular relating to this report is the design of the crane power systems. The current trend is moving from on-board diesel-fueled engines to shore-based electric powered units. This change has been driven by the high cost of diesel fuel, a greater desire to reduce diesel emissions, customer demand for “greener” services, increased efficiencies, reduced maintenance, lower cost cranes, and other factors.

It is not the purpose of this report to evaluate the cost of new cranes, their energy efficiency, emissions reductions, and other cost-benefit evaluations. Rather, it is necessary to indicate current trends that may affect the ability of PAMT to replace existing cranes, and how the proposed ECMs will assist these replacement or expansion plans. The majority of new cranes will be electrically powered, will be larger, and more efficient that the old diesel cranes that have historically served the industry so effectively. As the existing fleet of diesel cranes at PAMT ages, their natural replacements will most likely be electric cranes.

The proposed ECM-1, if implemented, is well-designed to accommodate the new larger cranes expected in the future.

5.4 Cold Ironing

In the past, international shippers relied on their internally-generated electricity for at-sea and in-dock power needs through the use of the ship’s diesel engines. Historically, this practice was not considered a problem. However, environmental concerns and awareness have been forcing shippers and port owners to adopt new measures which reduce or eliminate emissions. Specifically, newer ships and ports are being designed to provide on-shore power to those new ships once they are berthed and ready to load or unload for their power demands.

The practice of “Cold Ironing” or providing shore based power to berthed ships is increasing and is considered more desirable. The practice of “cold ironing” is not new and has been used for decades by the U.S. Navy at its major bases. However, the commercial and international shipping industry has not used “cold ironing” in the past but is now witnessing a major shift to shore-based power, primarily to eliminate emissions and reduce diesel consumption.

The proposed ECM-1, if adopted, is well designed from a capacity perspective to accommodate “Cold Ironing” with minimal increased construction costs.

5.5 Maintenance

Maintenance costs have been addressed in ECM-1. However, there are other important concerns with the current diesel engines powering the PAMT cranes. Diesel engines must be completely overhauled every couple of years, typically based on run hours. It can take weeks of down time to overhaul a 2,000 HP engine that is mounted high in the air. Depending on timing, such maintenance can be a problem for meeting schedules and expediting unloading or loading operations.

Diesel engines, while normally safe, do contend with combustible fuels and require special care. There are fuel supply operations, fuel storage tanks and pumps, fuel lines, filters, valves, etc. that must be carefully maintained and operated to avoid fires.

Based on the maintenance discussion, an additional recommendation for future consideration is provided. Instead of retaining the existing diesel engines, as noted in ECM-1, completely removing the diesel engines, generators, and fuel tanks on the Hyundai cranes will reduce construction costs, reduce maintenance costs further, reduce emissions and should not affect reliability of the crane operations.

The proposed ECM-1, if adopted, is well designed to reduce the possibility of fires. Obviously, there are no fuel storage concerns with land-based power systems.

5.6 Projected Electrical Construction Cost

There are no additional site construction costs for the first four cranes (i.e., only the cost of the crane itself would be incurred). After four, there would be an expected cost of $100,000 to extend the electrical distribution system for each new crane.

	Cumulative Construction Cost
ECM-1	$20,000,000
2 Additional Cranes	$20,000,000 + Crane Procurement Cost
Each Additional Crane	$20,000,000 + Crane Procurement Cost + $100,000/crane

5.7 Emission Reductions

Analyses of the combined emission reductions from all types of pollutants have been made and projected for differing growth rates and time periods. The basis for these projections is emissions with no project alternative (i.e., all cranes operating with diesel) and the TEU projections provided by PRPA. Table 5.13 shows the projected emission reductions.

Table 5.13 Projected Emission Reductions (tons)

Years from	**Emissions Reductions Per Year (Tons)**		
2014	*CO2e*	*TOPC*	*DPM*
0	0	0	0
5-20	3,090	79.0	1.93

Note that the reductions above assume no purchase of electric only cranes during the projected timeframe; only the electrification of H-6 and H-7 (ECM-1).

This report does not attempt to place a dollar value on the emissions currently generated by the diesel engines on the Hyundai cranes. It should be noted, however, that various entities have been discussing adding carbon taxes to fuel users sometime in the future. Some other countries have already levied taxes or more than $100 per ton (e.g., Sweden). While still not a legal requirement in the United States, the future could assess additional taxes and/or fees.

The proposed ECM-1, if adopted, is well designed to reduce the impacts of carbon-based taxes on the PAMT and its customers.

6.0 OTHER CONSIDERATIONS NOT DETAILED IN EVALUATION

Several other considerations regarding the choice of ECMs were not evaluated within the scope of energy and emissions reductions. These include:

- Competitive economic positioning of the terminal with selected shippers who consider emissions in conjunction with other factors in selecting a port;
- Compounding benefits of ECM-1 for future utilization of the port (ability to provide cold-ironing, accommodation of additional electric cranes, etc.);
- Replacement of aging cranes with diesel units may prove difficult, and required site improvement costs for upgrading the electricity supply and distribution would be incurred if a diesel replacement crane could not be procured; and
- Logistics challenges associated with transporting and maintaining both LNG and CNG on-site.

FIGURES

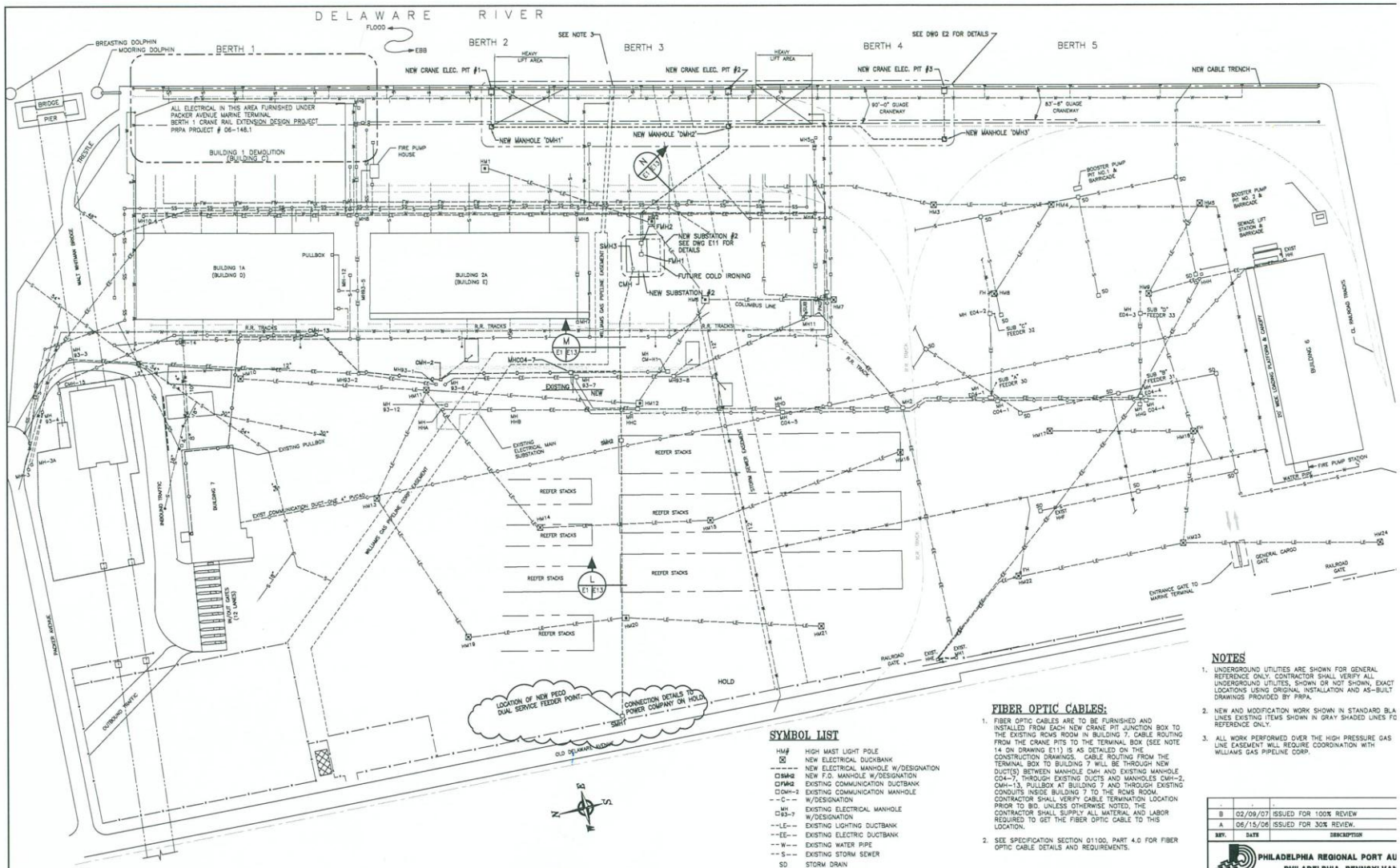
COMPLIANCE MANAGEMENT INTERNATIONAL

North Wales, Pennsylvania 19454
215.699.4800 fax 215.699.8315

Figure 1

Site Location Map
Packer Avenue Marine Terminal
Columbus Boulevard, Philadelphia, Pennsylvania

Date:	Photo Information:	Scale:
April 2014	Google Earth, Image 10/7/2011	As Noted



ELECTRICAL SITE PLAN

SCALE:1"=100'

SYMBOL LIST

HM#	HIGH MAST LIGHT POLE
⊠	NEW ELECTRICAL DUCKBANK
———	NEW ELECTRICAL MANHOLE W/DESIGNATION
□SMH2	NEW F.O. MANHOLE W/DESIGNATION
□FMH2	EXISTING COMMUNICATION DUCTBANK
□CMH-2	EXISTING COMMUNICATION MANHOLE
--C--	W/DESIGNATION
□ MH 93-7	EXISTING ELECTRICAL MANHOLE W/DESIGNATION
--LE--	EXISTING LIGHTING DUCTBANK
--EE--	EXISTING ELECTRIC DUCTBANK
--W--	EXISTING WATER PIPE
--S--	EXISTING STORM SEWER
SD	STORM DRAIN
--FW--	EXISTING FIRE WATER PIPE
FH	FIRE HYDRANT
--SS--	EXISTING SANITARY SEWER
►---	CAPPED WATER PIPE EXISTING
RR	RAILROAD TRACK

FIBER OPTIC CABLES:

1. FIBER OPTIC CABLES ARE TO BE FURNISHED AND INSTALLED FROM EACH NEW CRANE PIT JUNCTION BOX TO THE EXISTING ROWS ROOM IN BUILDING 7. CABLE ROUTING FROM THE CRANE PITS TO THE TERMINAL BOX (SEE NOTE 14 ON DRAWING E11) IS AS DETAILED ON THE CONSTRUCTION DRAWINGS. CABLE ROUTING FROM THE TERMINAL BOX TO BUILDING 7 WILL BE THROUGH NEW DUCT(S) BETWEEN MANHOLE CMH AND EXISTING MANHOLE CO4-7, THROUGH EXISTING DUCTS AND MANHOLES CMH-2, CMH-13, PULLBOX AT BUILDING 7 AND THROUGH EXISTING CONDUITS INSIDE BUILDING 7 TO THE ROWS ROOM. CONTRACTOR SHALL VERIFY CABLE TERMINATION LOCATION PRIOR TO BID. UNLESS OTHERWISE NOTED, THE CONTRACTOR SHALL SUPPLY ALL MATERIAL AND LABOR REQUIRED TO GET THE FIBER OPTIC CABLE TO THIS LOCATION.
2. SEE SPECIFICATION SECTION 01100, PART 4.C FOR FIBER OPTIC CABLE DETAILS AND REQUIREMENTS.

NOTES

1. UNDERGROUND UTILITIES ARE SHOWN FOR GENERAL REFERENCE ONLY. CONTRACTOR SHALL VERIFY ALL UNDERGROUND UTILITES, SHOWN OR NOT SHOWN, EXACT LOCATIONS USING ORIGINAL INSTALLATION AND AS-BUILT DRAWINGS PROVIDED BY PRPA.
2. NEW AND MODIFICATION WORK SHOWN IN STANDARD BLA LINES EXISTING ITEMS SHOWN IN GRAY SHADED LINES FO REFERENCE ONLY.
3. ALL WORK PERFORMED OVER THE HIGH PRESSURE GAS LINE EASEMENT WILL REQUIRE COORDINATION WITH WILLIAMS GAS PIPELINE CORP.

REV.	DATE	DESCRIPTION
B	02/09/07	ISSUED FOR 100% REVIEW
A	06/15/06	ISSUED FOR 30% REVIEW.

PHILADELPHIA REGIONAL PORT AU
PHILADELPHIA, PENNSYLVAN

ENGINEER:
W. D. BROWN, P.E., INC.
ELECTRICAL ENGINEERING
34 SUMMITER DRIVE
WILLIAMSTOWN, NJ 08094
PHONE: (856) 877-4477
FAX: (856) 877-7773

CRANE ELECTRIFICATION PROJECT
PACKER AVENUE MARINE TERMINAL
PRPA CONTRACT #1064

GBH
Gottlieb, Bernard & Hedges, LLC
Consulting Engineers

Drawn By:	BB	Date:	06/12/06
Checked By:	DWH	Date:	06/12/06
Scale:	1"=100'	Job No.	1882A

PACKER AV
MARINE TER

ELECTRIC
SITE PL

Drawing No. E1

SITE PHOTOS

Photo 1: Upper Deck Photo of Hyundai Crane

Photo 2: Lateral tracks for crane movement along dock.

Photo 3: Hyundai Cranes along dock.

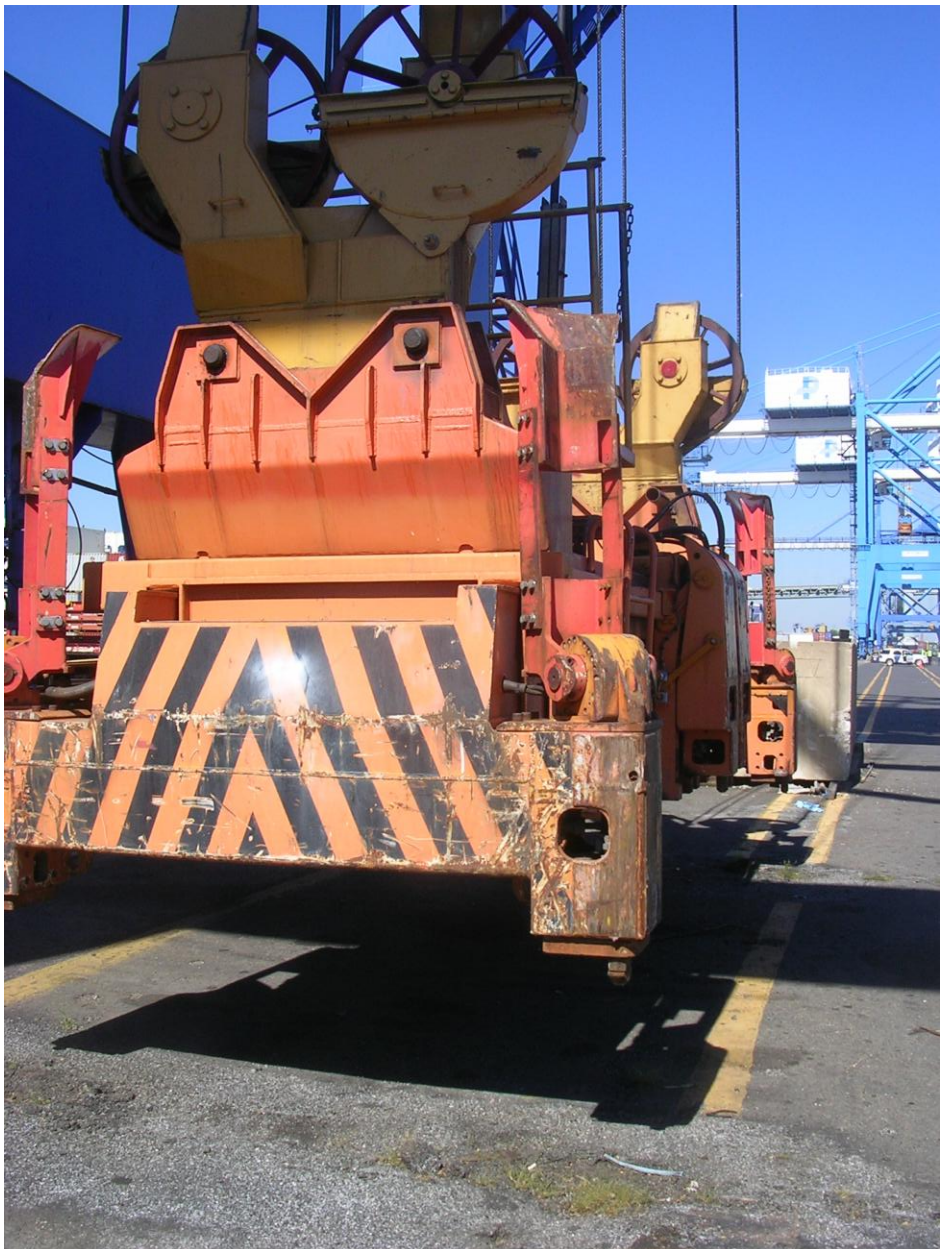


Photo 4: Container lift apparatus.

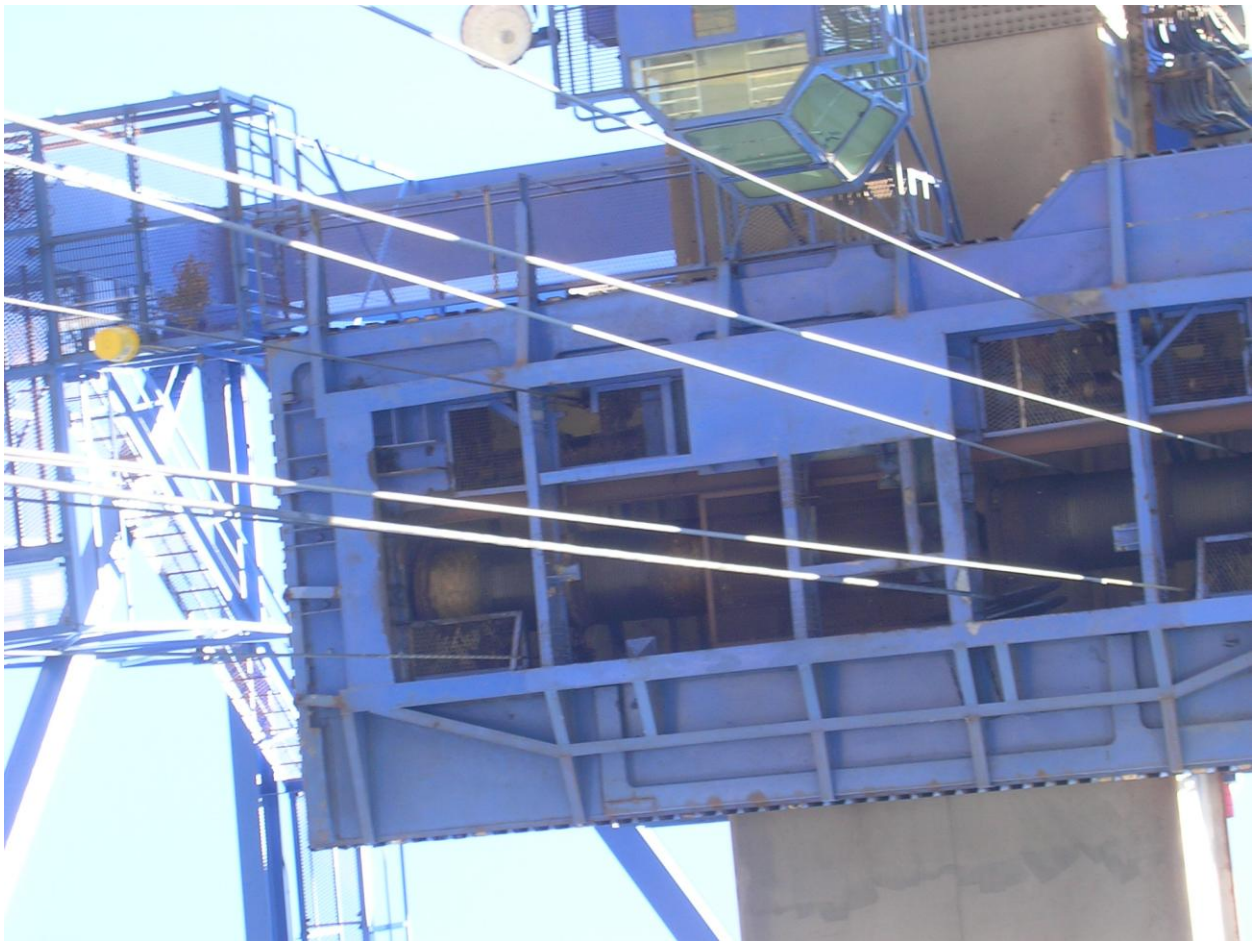


Photo 5: View into container handling hoist.

Photo 6: Substation for refrigerated container storage pad (cranes in background).

Photo 7: Existing switchgear.

ATTACHMENT 1

CONTAINER PROJECTIONS AND EMISSION CALCULATIONS

PAMT Container Lift Projection

(Assumes Full RTG Yard Development Plan)

FORECAST YEARS		Lifts	TEUs *	% Change	CAGR	GMPH	Crane Hours	MLLW'	Comments:	
	2003	99,421	169,016					40	Actual	
	2004	115,203	195,845	15.9				40	Actual	
	2005	134,758	229,089	17.0	16.4%			40	Actual	
	2006	159,531	271,203	18.4	17.1%			40	Actual	
	2007	161,623	274,759	1.3	12.9%			40	Actual	
	2008	158,997	270,295	(1.6)	9.8%			40	Actual	
	2009	132,006	224,410	(17.0)	4.8%			40	Actual	
	2010	143,744	244,365	8.9	5.4%			40	Actual	
	2011	150,358	255,609	4.6	5.3%			40	Actual	
	2012	158,355	269,204	5.3	5.3%			40	Actual	
	2013	207,834	353,318	31.2	7.7%			40	Actual	
	2014	223,330	379,661	7.5	7.6%	31	7,204	40	Budget	
1	**2015**	238,963	406,237	7.0		31	7,708	40	7.0%	Organic growth
2	**2016**	255,691	434,674	7.0		31	8,248	42	7.0%	Organic growth
3	**2017**	281,260	478,141	10.0		31	9,073	45	10.0%	Panama Canal expanded and Delaware River channel deepened
4	**2018**	384,386	653,455	36.7		32	12,012	45	10.0%	Carriers canal adjustment continued (10%) and Asia service (75k)
5	**2019**	403,605	686,128	5.0		32	12,613	45	5.0%	Organic growth
6	**2020**	423,785	720,435	5.0		32	13,243	45	5.0%	Organic growth
7	**2021**	438,618	745,650	3.5		32	13,707	45	3.5%	Organic growth
8	**2022**	503,969	856,748	14.9		33	15,272	45	3.5%	Organic growth and another service (50k)
9	**2023**	521,608	886,734	3.5		33	15,806	45	3.5%	Organic growth
10	**2024**	539,864	917,769	3.5		33	16,360	45	3.5%	Organic growth
11	**2025**	558,760	949,891	3.5		33	16,932	45	3.5%	Organic growth
12	**2026**	628,316	1,068,137	12.4		33	19,040	45	3.5%	Organic growth and another service (50k)
13	**2027**	650,307	1,105,522	3.5		33	19,706	45	3.5%	Organic growth
14	**2028**	673,068	1,144,216	3.5		33	20,396	45	3.5%	Organic growth
15	**2029**	696,625	1,184,263	3.5		33	21,110	45	3.5%	Organic growth
16	**2030**	696,625	1,184,263	-		33	21,110	45	At capacity	
17 +	**2031**	696,625	1,184,263	-		33	21,110	45	At capacity	
18	**2032**	696,625	1,184,263	-		33	21,110	45	At capacity	
19	**2033**	696,625	1,184,263	-		33	21,110	45	At capacity	
20	**2034**	696,625	1,184,263	-		33	21,110	45	At capacity	
21	**2035**	696,625	1,184,263	-		33	21,110	45	At capacity	
22	**2036**	696,625	1,184,263	-		33	21,110	45	At capacity	
23	**2037**	696,625	1,184,263	-		33	21,110	45	At capacity	
24	**2038**	696,625	1,184,263	-		33	21,110	45	At capacity	
25	**2039**	696,625	1,184,263	-		33	21,110	45	At capacity	
26	**2040**	696,625	1,184,263	-		33	21,110	45	At capacity	
27	**2041**	696,625	1,184,263	-		33	21,110	45	At capacity	
28	**2042**	696,625	1,184,263	-		33	21,110	45	At capacity	
29	**2043**	696,625	1,184,263	-		33	21,110	45	At capacity	
30	**2044**	696,625	1,184,263	-		33	21,110	45	At capacity	

* 1.7:1 conversion factor used as annual average for the entire 4 decade period shown.

Philadelphia Regional Port Authority

Crane Engine Data and Emission Factors

- For engines with no manufacturer specifications, AP-42 emission factors were used to calculate emissions.
- For engines with manufacturer specifications with emission rate data, the average 2013 consumption rate was used to estimate the average horsepower

				Engine-Specific Fuel Consumption and Emission Factors								Default (AP-42 for size of engine; see table below)							
				Fuel Consumption (gph)				@ avg hp = Emission Factors (lb/1000 gal)				Emission Factors (lb/1000 gal)							
Crane	**Engine**	**Rated HP**	**Avg HP**	**25% Load**	**50% Load**	**75% Load**	**Full Load**	**NOx**	**VOC/HC**	**CO**	**PM**	**Nox**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**
H-6, Hyundai	Cummins KTA50-G9	2,011	528	32.8	55.8	79.4	103.6	244	35.4	301	14.2					0.0017	22610	1.11	0.18
H-7, Hyundai	Cummins KTA50-G9	2,011	520	32.8	55.8	79.4	103.6	241	34.9	297	14.0					0.0017	22610	1.11	0.18
K-5, Kocks	Caterpillar D-348	810										438.5	11.22	116.5	13.70	0.0017	22610	1.11	0.18
K-2, Kocks	Detroit Diesel P-149	1,274										438.5	11.22	116.5	13.70	0.0017	22610	1.11	0.18
K-3, Kocks	Detroit Diesel P-149	1,274										438.5	11.22	116.5	13.70	0.0017	22610	1.11	0.18
Paceco	Caterpillar D-3508	850	668				44.5	159	0.83	74.3	12.4					0.0017	22610	1.11	0.18
South Kocks (Holt)	Caterpillar D-3512	1,280	72.2		39.9	55.6	71.7	337	0.0	0.0	0.0					0.0017	22610	1.11	0.18

AP-42 Emission Factors:

	Units >600 hp (AP-42 Sec. 3.4)		Units <600 hp (AP-42 Sect. 3.3)	
	lb/MMBTU	lb/1000 gal**	lb/MMBTU	lb/1000 gal**
Nox-Uncontrolled	3.2	438.50	4.41	604.3
VOC	0.0819	11.22	0.36	49.33
CO	0.85	116.5	0.95	130.2
PM	0.1	13.70	0.31	42.48
Sox*	0.000012135	0.0017	0.00029	0.04
CO2	165	22610	164	22473
CH4	0.0081	1.11	0.0324	4.44
N2O		0.18		0.18

* Sulfur content for emission factors utilizing sulfur content assumes ultra-low sulfur diesel at 15 ppm; this translates to S = 0.0015
For AP-42, Section 3.3, EF assumed to be presented for 1.5% sulfur content diesel; AP-42 EF presented is adjusted for the ULSD used at PRPA.

** Conversion from lb/MMBTU to lb/1000 gallons uses an average heating value of: 137.03 MMBTU/1000 gal

Packer Avenue Diesel Fuel Consumption & Hours - 2013

Crane	2013 Twenty-Foot Equivalent Units (TEUs)	2013 Consumption (gals)	2013 Hours	2013 Avg Rate (gph)	2013 Emissions (tons) NOx	VOC/HC	CO	PM	SOx	CO2	CH4	N2O	CO2e
H-6, Hyundai		77,960	2265	34.42	9.53	1.38	11.74	0.55	6.5E-05	881	0.04	0.01	884.51
H-7, Hyundai		80,000	2357	33.95	9.64	1.40	11.88	0.56	6.7E-05	904	0.04	0.01	907.65
K-5, Kocks		200	0	0	0.06	0.00	0.01	0.00	1.7E-07	2	0.00	0.00	2.27
K-2, Kocks		20,816	621	33.55	4.56	0.12	1.21	0.14	0.00041	234	0.05	0.00	235.61
K-3, Kocks		18,775	518	36.22	4.12	0.11	1.09	0.13	1.6E-05	212	0.01	0.00	213.01
Paceco		6,531	187	35.00	0.52	0.00	0.24	0.04	5.4E-06	74	0.00	0.00	74.10
South Kocks (Holt)		200	44	4.50	0.03	0.00	0.00	0.00	1.7E-07	2	0.00	0.00	2.27
TOTAL	***353,318***	***204,482***	***5,991***		***28.47***	***3.01***	***26.18***	***1.43***	***0.0006***	***2,310***	***0.15***	***0.02***	***2,319.43***
					TOPC	57.66							

Packer Avenue Fuel Consumption Projections

If, in 2013: 80% of all containers were moved by Hyundai cranes, then each Hyundai crane can move:
61.2 TEU's/Hr

H-6 + H-7 Capacity is: 8000 hrs/yr (4,000 hrs/crane)

Annual Capacity Hyundai Cranes H-6 and H-7: 489,294 TEUs/yr
272000 gals fuel/yr

	Hyundais (H-6 and H-7)		Other Diesel Crane		TOTAL	
Forecast	**TEUs**	**gals/yr**	**TEUs**	**gals/yr**	**TEUs**	**gals/yr**
2015	324,990	180,663	81,247	90,331	406,237	270,994
2016	347,739	193,309	86,935	96,655	434,674	289,964
2017	382,513	212,640	95,628	106,320	478,141	318,960
2018	489,294	272,000	130,691	145,303	619,985	417,303
2019	489,294	272,000	137,226	152,568	626,520	424,568
2020	489,294	272,000	144,087	160,197	633,381	432,197
2021	489,294	272,000	149,130	165,803	638,424	437,803
2022	489,294	272,000	171,350	190,507	660,644	462,507
2023	489,294	272,000	177,347	197,175	666,641	469,175
2024	489,294	272,000	183,554	204,076	672,848	476,076
2025	489,294	272,000	189,978	211,219	679,273	483,219
2026	489,294	272,000	213,627	237,512	702,922	509,512
2027	489,294	272,000	616,228	685,126	1,105,522	957,126
2028	489,294	272,000	654,921	728,145	1,144,216	1,000,145
2029	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2030	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2031	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2032	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2033	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2034	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2035	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2036	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2037	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2038	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2039	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2040	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2041	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2042	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2043	489,294	272,000	694,969	772,670	1,184,263	1,044,670
2044	489,294	272,000	694,969	772,670	1,184,263	1,044,670

NO PROJECT

	Hyundai Cranes (H-6 + H-7)										*Other Diesel Crane(s)*										*TOTAL*									
	EF (lb/kgal)	244	35	301	14	0.0017	22610	1.11	0.18		EF (lb/kgal)	438	11.2	116.5	13.7	0.0	22610	1.1	0.2											
Forecast	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**
2015	180.7	22.1	3.2	27.2	1.3	0.0	2042.4	0.1	0.02	2050	90.3	19.80	0.51	5.26	0.62	0.00	1021.19	0.05	0.01	1025	271.0	41.9	3.7	32.5	1.9	0.0	3063.6	0.2	0.0	3075
2016	193.3	23.6	3.4	29.1	1.4	0.0	2185.4	0.1	0.02	2193	96.7	21.19	0.54	5.63	0.66	0.00	1092.68	0.05	0.01	1097	290.0	44.8	4.0	34.7	2.0	0.0	3278.0	0.2	0.0	3290
2017	212.6	26.0	3.8	32.0	1.5	0.0	2403.9	0.1	0.02	2413	106.3	23.31	0.60	6.19	0.73	0.00	1201.95	0.06	0.01	1206	319.0	49.3	4.4	38.2	2.2	0.0	3605.8	0.2	0.0	3619
2018	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	145.3	31.86	0.82	8.46	1.00	0.00	1642.65	0.08	0.01	1649	417.3	65.1	5.6	49.4	2.9	0.0	4717.6	0.2	0.0	4735
2019	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	152.6	33.45	0.86	8.89	1.05	0.00	1724.78	0.08	0.01	1731	424.6	66.7	5.7	49.8	3.0	0.0	4799.7	0.2	0.0	4817
2020	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	160.2	35.12	0.90	9.33	1.10	0.00	1811.02	0.09	0.01	1818	432.2	68.4	5.7	50.3	3.0	0.0	4886.0	0.2	0.0	4904
2021	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	165.8	36.35	0.93	9.66	1.14	0.00	1874.40	0.09	0.01	1881	437.8	69.6	5.7	50.6	3.1	0.0	4949.4	0.2	0.0	4967
2022	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	190.5	41.77	1.07	11.09	1.31	0.00	2153.68	0.11	0.02	2161	462.5	75.0	5.9	52.1	3.2	0.0	5228.6	0.3	0.0	5247
2023	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	197.2	43.23	1.11	11.48	1.35	0.00	2229.06	0.11	0.02	2237	469.2	76.5	5.9	52.4	3.3	0.0	5304.0	0.3	0.0	5323
2024	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	204.1	44.74	1.15	11.88	1.40	0.00	2307.08	0.11	0.02	2315	476.1	78.0	6.0	52.8	3.3	0.0	5382.0	0.3	0.0	5401
2025	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	211.2	46.31	1.19	12.30	1.45	0.00	2387.82	0.12	0.02	2396	483.2	79.6	6.0	53.3	3.4	0.0	5462.8	0.3	0.0	5482
2026	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	237.5	52.07	1.33	13.83	1.63	0.00	2685.07	0.13	0.02	2695	509.5	85.3	6.2	54.8	3.6	0.0	5760.0	0.3	0.0	5781
2027	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	685.1	150.21	3.84	39.90	4.69	0.00	7745.33	0.38	0.06	7773	957.1	183.5	8.7	80.9	6.6	0.0	10820.3	0.5	0.1	10859
2028	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	728.1	159.64	4.09	42.41	4.99	0.00	8231.66	0.40	0.07	8261	1000.1	192.9	8.9	83.4	6.9	0.0	11306.6	0.6	0.1	11347
2029	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2030	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2031	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2032	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2033	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2034	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2035	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2036	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2037	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2038	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2039	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2040	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2041	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2042	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2043	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852
2044	272.0	33.2	4.8	41.0	1.9	0.0	3075.0	0.2	0.02	3086	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	1044.7	202.7	9.2	86.0	7.2	0.0	11810.0	0.6	0.1	11852

ECM-1: ELECTRIFY HYUNDAIS ONLY PROJECT

Other Diesel Crane (Kocks) only crane with emissions

2013 Compare									
1000gal/yr	**NOx**	**VOC/HC**	**CO**	**DPM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**
125.9	8.66	2.50	20.92	0.81	0.00	1289.04	0.10	0.01	1295

	Other Diesel Crane(s)										*REDUCTION FROM "NO PROJECT"*									
	EF (lb/kgal)	438	11.2	116.5	13.7	0.0	22610	1.1	0.2											
Forecast	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**DPM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**
2015	90.3	19.80	0.51	5.26	0.62	0.00	1021.19	0.05	0.01	1025	180.7	22.08	3.20	27.21	1.28	0.00	2042.39	0.10	0.02	2050
2016	96.7	21.19	0.54	5.63	0.66	0.00	1092.68	0.05	0.01	1097	193.3	23.63	3.42	29.11	1.37	0.00	2185.35	0.11	0.02	2193
2017	106.3	23.31	0.60	6.19	0.73	0.00	1201.95	0.06	0.01	1206	212.6	25.99	3.77	32.02	1.51	0.00	2403.89	0.12	0.02	2413
2018	145.3	31.86	0.82	8.46	1.00	0.00	1642.65	0.08	0.01	1649	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2019	152.6	33.45	0.86	8.89	1.05	0.00	1724.78	0.08	0.01	1731	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2020	160.2	35.12	0.90	9.33	1.10	0.00	1811.02	0.09	0.01	1818	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2021	165.8	36.35	0.93	9.66	1.14	0.00	1874.40	0.09	0.01	1881	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2022	190.5	41.77	1.07	11.09	1.31	0.00	2153.68	0.11	0.02	2161	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2023	197.2	43.23	1.11	11.48	1.35	0.00	2229.06	0.11	0.02	2237	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2024	204.1	44.74	1.15	11.88	1.40	0.00	2307.08	0.11	0.02	2315	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2025	211.2	46.31	1.19	12.30	1.45	0.00	2387.82	0.12	0.02	2396	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2026	237.5	52.07	1.33	13.83	1.63	0.00	2685.07	0.13	0.02	2695	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2027	685.1	150.21	3.84	39.90	4.69	0.00	7745.33	0.38	0.06	7773	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2028	728.1	159.64	4.09	42.41	4.99	0.00	8231.66	0.40	0.07	8261	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2029	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2030	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2031	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2032	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2033	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2034	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2035	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2036	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2037	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2038	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2039	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2040	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2041	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2042	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2043	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086
2044	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766	272.0	33.25	4.82	40.96	1.93	0.00	3074.95	0.15	0.02	3086

ECM-2 & 3: LNG- or CNG-DIESEL CONVERSION - HYUNDAIS

50% LNG or CNG-50% Diesel

2013 Compare									
1000gal/yr	**NOx**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**
ECM-2/3	19.17	1.7	21.1	0.9	0.1	2046.8	0.1	0.0	2053.8
Reduction	**9.29**	**1.35**	**5.06**	**0.54**	**-0.05**	**263.41**	**0.02**	**0.01**	**266**

	Hyundai Cranes - 50% DIESEL										*Hyundai Cranes - 50% LNG*										*REDUCTION FROM "NO PROJECT"*									
	EF (lb/kgal)	244	35	301	14	0.0017	22610	1.11	0.18		EF (lb/mmcf)	19	1.4	1218.0	0.0	9.4	115500	4.2	0.2											
Forecast	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**DPM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**	mmcf/yr	**NOx**	**VOC/HC**	**CO**	**DPM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**PM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**
2015	90.3	11.04	1.60	13.60	0.64	0.00	1021.19	0.05	0.01	1025	12.0	0.11	0.01	7.33	0.00	0.06	696	0.03	0.00	697	168.6	10.93	1.59	6.27	0.64	-0.06	325.64	0.03	0.01	328
2016	96.7	11.82	1.71	14.55	0.68	0.00	1092.68	0.05	0.01	1097	12.9	0.12	0.01	7.85	0.00	0.06	744	0.03	0.00	745	180.4	11.69	1.70	6.71	0.68	-0.06	348.44	0.03	0.01	351
2017	106.3	13.00	1.88	16.01	0.75	0.00	1201.95	0.06	0.01	1206	14.2	0.13	0.01	8.63	0.00	0.07	819	0.03	0.00	820	198.5	12.86	1.87	7.38	0.75	-0.07	383.28	0.03	0.01	386
2018	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	263.2	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2019	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	270.4	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2020	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	278.1	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2021	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	283.7	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2022	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	308.4	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2023	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	315.0	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2024	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	321.9	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2025	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	329.1	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494

2026	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	355.4	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2027	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	803.0	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2028	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	846.0	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2029	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2030	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2031	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2032	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2033	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2034	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2035	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2036	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2037	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2038	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2039	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2040	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2041	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2042	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2043	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494
2044	136.0	16.62	2.41	20.48	0.96	0.00	1537.48	0.08	0.01	1543	18.1	0.17	0.01	11.04	0.00	0.09	1047	0.04	0.00	1049	890.5	16.45	2.40	9.44	0.96	-0.09	490.28	0.04	0.01	494

	Other Diesel Crane(s)									
	EF (lb/kgal)	438	11.2	116.5	13.7	0.0	22610	1.1	0.2	
Forecast	1000gal/yr	**NOx**	**VOC/HC**	**CO**	**DPM**	**Sox***	**CO2**	**CH4**	**N2O**	**CO2e**
2015	90.3	19.80	0.51	5.26	0.62	0.00	1021.19	0.05	0.01	1025
2016	96.7	21.19	0.54	5.63	0.66	0.00	1092.68	0.05	0.01	1097
2017	106.3	23.31	0.60	6.19	0.73	0.00	1201.95	0.06	0.01	1206
2018	145.3	31.86	0.82	8.46	1.00	0.00	1642.65	0.08	0.01	1649
2019	152.6	33.45	0.86	8.89	1.05	0.00	1724.78	0.08	0.01	1731
2020	160.2	35.12	0.90	9.33	1.10	0.00	1811.02	0.09	0.01	1818
2021	165.8	36.35	0.93	9.66	1.14	0.00	1874.40	0.09	0.01	1881
2022	190.5	41.77	1.07	11.09	1.31	0.00	2153.68	0.11	0.02	2161
2023	197.2	43.23	1.11	11.48	1.35	0.00	2229.06	0.11	0.02	2237
2024	204.1	44.74	1.15	11.88	1.40	0.00	2307.08	0.11	0.02	2315
2025	211.2	46.31	1.19	12.30	1.45	0.00	2387.82	0.12	0.02	2396
2026	237.5	52.07	1.33	13.83	1.63	0.00	2685.07	0.13	0.02	2695
2027	685.1	150.21	3.84	39.90	4.69	0.00	7745.33	0.38	0.06	7773
2028	728.1	159.64	4.09	42.41	4.99	0.00	8231.66	0.40	0.07	8261
2029	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2030	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2031	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2032	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2033	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2034	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2035	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2036	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2037	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2038	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2039	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2040	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2041	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2042	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2043	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766
2044	772.7	169.41	4.34	45.00	5.29	0.00	8735.02	0.43	0.07	8766

ATTACHMENT 2

ECM-1 COST ESTIMATES

Site Improvements

COMPLIANCE MANAGEMENT INTERNATIONAL
PHILADELPHIA REGIONAL PORT AUTHORITY
CRANE CONVERSION PROJECT
Cost Estimate of Site Improvements

12/4/2013
WMM
Basis: December 2013 Dollars

No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
1	**Preliminary Work**				**$110,000**		**200**		**$18,000**	**$128,000**
2	**Sitework**				**$53,107**		**10,724**		**$1,055,085**	**$1,108,193**
3	**Structures**				**$637,343**		**28,167**		**$3,226,523**	**$4,598,856**
4	**Electrical**				**$1,024,420**		**5,973**		**$698,620**	**$1,681,428**
5	**Controls**				**$80,000**		**900**		**$81,000**	**$161,000**
6	**Not Used**									
7	**Not Used**									
	Subtotal Direct Costs				**$1,904,870**		**45,964**		**$5,079,229**	**$7,677,477**
8	**Temporary Construction Facilities & Services @ 2% of Direct**									**$150,000**
9	**Engineering Services**									**$920,000**
10	**PRPA Costs**									**$0**
	Subtotal Indirect Costs									**$1,070,000**
11	**Contingency @ 15%**									**$1,310,000**
12	**Escalation (None)**									**$0**
	Total Project Costs									**$10,057,477**
									Use =	**$10,000,000**

Accuracy +/- 30%

COMPLIANCE MANAGEMENT INTERNATIONAL
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WMM
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No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
1	**Preliminary Work**									
	Mobilization	1	LS	$25,000	$25,000	100	100	$90.00	$9,000	$34,000
	Barricades etc	1	LS	$10,000	$10,000	100	100	$90.00	$9,000	$19,000
	Permits	1	LS	$75,000	$75,000	0	0	$90.00	$0	$75,000
	Subtotal Mobilization		**0**	**$0**	**$110,000**	**0**	**200**	**$0.00**	**$18,000**	**$128,000**
2	**Sitework**									
2.1	**Excavation & Backfill**									
2.1.1	Manhole Excav & Backfill									
2.1.1.1	Manhole SMH#1									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	40	CY	$0	$0	1.00	40	$100.00	$4,000	$4,000
	Backfill	5	CY	$10	$50	2.00	10	$100.00	$1,000	$1,050
	Subtotal SMH#1 Excav&Back				$50		90		$9,000	$9,050
2.1.1.2	Manhole SMH#2									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	40	CY	$0	$0	1.00	40	$100.00	$4,000	$4,000
	Backfill	5	CY	$10	$50	2.00	10	$100.00	$1,000	$1,050
	Subtotal SMH#2 Excav&Back				$50		90		$9,000	$9,050
2.1.1.3	Manhole DMH#1									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	40	CY	$0	$0	1.00	40	$100.00	$4,000	$4,000
	Backfill	5	CY	$10	$50	2.00	10	$100.00	$1,000	$1,050
	Subtotal DMH#1 Excav&Back				$50		90		$9,000	$9,050

COMPLIANCE MANAGEMENT INTERNATIONAL
PHILADELPHIA REGIONAL PORT AUTHORITY
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No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
2.1.1.4	Manhole DMH#2									
	Demo Special	1	Lot	$0	$0	40.00	40	$90.00	$3,600	$3,600
	Excavation	40	CY	$0	$0	1.00	40	$90.00	$3,600	$3,600
	Backfill	5	CY	$100	$500	10.00	50	$90.00	$4,500	$5,000
	Subtotal DMH#2 Excav&Back				$500		130		$11,700	$12,200
2.1.1.5	Manhole DMH#3									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	40	CY	$0	$0	1.00	40	$100.00	$4,000	$4,000
	Backfill	5	CY	$10	$50	2.00	10	$100.00	$1,000	$1,050
	Subtotal DMH#3 Excav&Back				$50		90		$9,000	$9,050
2.1.1	**Subtotal MH Excav& Backfill**				**$700**		**490**		**$47,700**	**$48,400**
2.1.2	**Substation Excav & Backfill**									
	Demo Special	1	Lot	$0	$0	200.00	200	$100.00	$20,000	$20,000
	Excavation	395	CY	$0	$0	0.50	197	$100.00	$19,741	$19,741
	Backfill	197	CY	$10	$1,974	1.00	197	$100.00	$19,741	$21,715
2.1.2	**Subtotal DMH#3 Excav&Back**				**$1,974**		**595**		**$59,481**	**$61,456**

COMPLIANCE MANAGEMENT INTERNATIONAL
PHILADELPHIA REGIONAL PORT AUTHORITY
CRANE CONVERSION PROJECT
Cost Estimate of Site Improvements

12/4/2013
WMM
Basis: December 2013 Dollars

No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
2.1.3	**Elec Crane Pits Excav & Backfill**									
2.1.3.1	Elec Crane Pit #1 Excav &Backfill									
	Demo Special	1	Lot	$0	$0	80.00	80	$100.00	$8,000	$8,000
	Excavation	30	CY	$0	$0	1.00	30	$100.00	$3,000	$3,000
	Backfill	15	CY	$10	$150	2.00	30	$100.00	$3,000	$3,150
	Subtotal Elec Crane Pit #1 Excav & Back				$150		140		$14,000	$14,150
2.1.3.2	Elec Crane Pit #2 Excav & Backfill									
	Demo Special	1	Lot	$0	$0	80.00	80	$100.00	$8,000	$8,000
	Excavation	30	CY	$0	$0	1.00	30	$100.00	$3,000	$3,000
	Backfill	15	CY	$10	$150	2.00	30	$100.00	$3,000	$3,150
	Subtotal Elec Crane Pit #2 Excav & Back				$150		140		$14,000	$14,150
2.1.3.3	Elec Crane Pit #3 Excav & Backfill									
	Demo Special	1	Lot	$0	$0	80.00	80	$100.00	$8,000	$8,000
	Excavation	30	CY	$0	$0	1.00	30	$100.00	$3,000	$3,000
	Backfill	15	CY	$10	$150	2.00	30	$100.00	$3,000	$3,150
	Subtotal Elec Crane Pit #3 Excav & Back				$150		140		$14,000	$14,150
2.1.3	**Subtotal EL Crane Pit Excav& Backfill**				**$450**		**420**		**$42,000**	**$42,450**
2.1.4	**Crane Trail Cable Trench Excav& Backfill (with Drain Excavation)**									
	Demo Special	0	Lot	$0	$0	0.00	0	$100.00	$0	$0
	Excavation	0	CY	$0	$0	1.00	0	$100.00	$0	$0
	Backfill	0	CY	$10	$0	2.00	0	$100.00	$0	$0
2.1.4	**Subtotal Elec Crane Pit #3 Excav & Back**				**$0**		**0**		**$0**	**$0**
2.1.5	**Cable Trench Drains -Crane Trail Cable Trench Excav& Backfill**									
	Demo Special	2,500	Lot	$0	$0	0.50	1,250	$100.00	$125,000	$125,000
	Excavation	1,204	CY	$0	$0	1.00	1,204	$100.00	$120,370	$120,370
	Backfill	1,083	CY	$10	$10,833	1.00	1,083	$100.00	$108,333	$119,167
2.1.5	**Subtotal Drains Elec Crane Pit #3 Excav & Back**				**$10,833**		**3,537**		**$353,704**	**$364,537**

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2.1.6	**All Duct Bank Excav & Backfill**									
2.1.6.1	Duct Bank SMH1 to SMH2 660LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	330.00	330	$100.00	$33,000	$33,000
	Excavation	220	CY	$0	$0	1.00	220	$100.00	$22,000	$22,000
	Backfill	110	CY	$10	$1,100	2.00	220	$100.00	$22,000	$23,100
	Subtotal Duct Bank SMH1 to SMH2 Excav & Backfill				$1,100		770		$77,000	$78,100
2.1.6.2	Duct Bank SMH2 to SMH3 420LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	210.00	210	$100.00	$21,000	$21,000
	Excavation	140	CY	$0	$0	1.00	140	$100.00	$14,000	$14,000
	Backfill	70	CY	$10	$700	2.00	140	$100.00	$14,000	$14,700
	Subtotal Duct Bank SMH2 to SMH3 Excav & Backfill				$700		490		$49,000	$49,700
2.1.6.3	Duct Bank MHC04 to Mid SMH2-3 120LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	60.00	60	$100.00	$6,000	$6,000
	Excavation	40	CY	$0	$0	1.00	40	$100.00	$4,000	$4,000
	Backfill	20	CY	$10	$200	2.00	40	$100.00	$4,000	$4,200
	Subtotal Duct Bank MHC04 to SMH3 Excav & Backfill				$200		140		$14,000	$14,200
2.1.6.4	Duct Bank FMH1 to FMH2 25LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	12.00	12	$100.00	$1,200	$1,200
	Excavation	8	CY	$0	$0	1.00	8	$100.00	$833	$833
	Backfill	4	CY	$10	$42	2.00	8	$100.00	$833	$875
	Subtotal Duct Bank FMH! to FMH2 Excav & Backfill				$42		29		$2,867	$2,908
2.1.6.5	Duct Bank FMH2 to DMH2 360LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	180.00	180	$100.00	$18,000	$18,000
	Excavation	120	CY	$0	$0	1.00	120	$100.00	$12,000	$12,000
	Backfill	60	CY	$10	$600	2.00	120	$100.00	$12,000	$12,600
	Subtotal Duct Bank FMH2 to DMH2 Excav & Backfill				$600		420		$42,000	$42,600

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2.1.6.6	Duct Bank DMH2 to NCRPit2 80LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	27	CY	$0	$0	1.00	27	$100.00	$2,667	$2,667
	Backfill	13	CY	$10	$133	2.00	27	$100.00	$2,667	$2,800
	Subtotal Duct Bank DMH2 to NCRPit2 Excav & Backfill				$133		93		$9,333	$9,467
2.1.6.7	Duct Bank DMH2 to DMH3 540LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	270.00	270	$100.00	$27,000	$27,000
	Excavation	180	CY	$0	$0	1.00	180	$100.00	$18,000	$18,000
	Backfill	90	CY	$10	$900	2.00	180	$100.00	$18,000	$18,900
	Subtotal Duct Bank DMH2 to DMH3 Excav & Backfill				$900		630		$63,000	$63,900
2.1.6.8	Duct Bank DMH2 to DMH1 580LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	290.00	290	$100.00	$29,000	$29,000
	Excavation	193	CY	$0	$0	1.00	193	$100.00	$19,333	$19,333
	Backfill	97	CY	$10	$967	2.00	193	$100.00	$19,333	$20,300
	Subtotal Duct Bank DMH2 to DMH1 Excav & Backfill				$967		677		$67,667	$68,633
2.1.6.9	Duct Bank DMH1 to NCRPit1 80LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	27	CY	$0	$0	1.00	27	$100.00	$2,667	$2,667
	Backfill	13	CY	$10	$133	2.00	27	$100.00	$2,667	$2,800
	Subtotal Duct Bank DMH1 to NCRPit1 Excav & Backfill				$133		93		$9,333	$9,467
2.1.6.10	Duct Bank DMH3 to NCRPit3 80LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	40.00	40	$100.00	$4,000	$4,000
	Excavation	27	CY	$0	$0	1.00	27	$100.00	$2,667	$2,667
	Backfill	13	CY	$10	$133	2.00	27	$100.00	$2,667	$2,800
	Subtotal Duct Bank DMH3 to NCRPit3 Excav & Backfill				$133		93		$9,333	$9,467
2.1.6.11	Duct Bank CO4 to SMH3 (CMH) 120LF Excav & Baskfill									
	Demo Special	1	Lot	$0	$0	60.00	60	$100.00	$6,000	$6,000
	Excavation	40	CY	$0	$0	1.00	40	$100.00	$4,000	$4,000
	Backfill	20	CY	$10	$200	2.00	40	$100.00	$4,000	$4,200
	Subtotal Duct CO4 to SMH3(CMH) Excav & Baskfill				$200		140		$14,000	$14,200

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2.1.6.12	Duct Bank SMH3 to Sect4 30LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	15.00	15	$100.00	$1,500	$1,500
	Excavation	10	CY	$0	$0	1.00	10	$100.00	$1,000	$1,000
	Backfill	5	CY	$10	$50	2.00	10	$100.00	$1,000	$1,050
	Subtotal Duct Bank SMH3 to Sect4 30LF Excav & Backfill				$50		35		$3,500	$3,550
2.1.6.13	Duct Bank SMH3 to Sect7 40LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	20.00	20	$100.00	$2,000	$2,000
	Excavation	13	CY	$0	$0	1.00	13	$100.00	$1,333	$1,333
	Backfill	7	CY	$10	$67	2.00	13	$100.00	$1,333	$1,400
	Subtotal Duct Bank SMH3 to Sect7 40LF Excav & Backfill				$67		47		$4,667	$4,733
2.1.6.14	Duct Bank FutureX to FMH1 40LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	20.00	20	$100.00	$2,000	$2,000
	Excavation	13	CY	$0	$0	1.00	13	$100.00	$1,333	$1,333
	Backfill	7	CY	$10	$67	2.00	13	$100.00	$1,333	$1,400
	Subtotal Duct Bank FutureX to FMH1 40LF Excav & Backfill				$67		47		$4,667	$4,733
2.1.6.1	Duct Bank FutureX to FMH1 40LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	20.00	20	$100.00	$2,000	$2,000
	Excavation	13	CY	$0	$0	1.00	13	$100.00	$1,333	$1,333
	Backfill	7	CY	$10	$67	2.00	13	$100.00	$1,333	$1,400
	Subtotal Duct Bank FutureX to FMH1 40LF Excav & Backfill				$67		47		$4,667	$4,733
2.1.6.15	Duct Bank Sect1 CF to FMH1 30LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	15.00	15	$100.00	$1,500	$1,500
	Excavation	10	CY	$0	$0	5.00	50	$100.00	$5,000	$5,000
	Backfill	5	CY	$100	$500	10.00	50	$100.00	$5,000	$5,500
	Subtotal Duct Bank Sect1 CF to FMH1 30LF Excav & Backfill				$500		115		$11,500	$12,000
2.1.6.16	Duct Bank Sect2 CF to FMH1 & Stub Out 30LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	15.00	15	$100.00	$1,500	$1,500
	Excavation	10	CY	$0	$0	1.00	10	$100.00	$1,000	$1,000
	Backfill	5	CY	$10	$50	2.00	10	$100.00	$1,000	$1,050
	Subtotal Duct Bank Sect2 CF to FMH1 & Stub Out 30LF Excav & Ba				$50		35		$3,500	$3,550

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2.1.6.17	Duct Bank Sect 9 Future Capacitor C/B 10LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	5.00	5	$100.00	$500	$500
	Excavation	3	CY	$0	$0	1.00	3	$100.00	$333	$333
	Backfill	2	CY	$10	$17	2.00	3	$100.00	$333	$350
	Subtotal Duct Bank Sect 9 Future Capacitor C/B 10LF Excav & Back				$17		12		$1,167	$1,183
2.1.6.18	Duct Bank Sect 10 Crane Feed C/B 40LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	20.00	20	$100.00	$2,000	$2,000
	Excavation	13	CY	$0	$0	1.00	13	$100.00	$1,333	$1,333
	Backfill	7	CY	$10	$67	2.00	13	$100.00	$1,333	$1,400
	Subtotal Duct Bank Sect 10 Crane Feed C/B 40LF Excav & Backfill				$67		47		$4,667	$4,733
2.1.6.19	Duct Bank Future Exp 10LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	5.00	5	$100.00	$500	$500
	Excavation	3	CY	$0	$0	1.00	3	$100.00	$333	$333
	Backfill	2	CY	$10	$17	2.00	3	$100.00	$333	$350
	Subtotal Duct Bank Future Exp 10LF Excav & Backfill				**$17**		**12**		**$1,167**	**$1,183**
2.1.6.20	Duct Bank Future Exp 10LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	5.00	5	$100.00	$500	$500
	Excavation	3	CY	$0	$0	1.00	3	$100.00	$333	$333
	Backfill	2	CY	$10	$17	2.00	3	$100.00	$333	$350
	Subtotal Duct Bank Future Exp 10LF Excav & Backfill				$17		12		$1,167	$1,183
2.1.6.21	Duct Bank FMH1 to Note 11 50LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	25.00	25	$100.00	$2,500	$2,500
	Excavation	17	CY	$0	$0	1.00	17	$100.00	$1,667	$1,667
	Backfill	8	CY	$10	$83	2.00	17	$100.00	$1,667	$1,750
	Subtotal Duct Bank FMH1 to Note 11 50LF Excav & Backfill				**$83**		**58**		**$5,833**	**$5,917**

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2.1.6.22	Duct Bank CMH to Panel 14 10LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	5.00	10	$100.00	$1,000	$1,000
	Excavation	3	CY	$0	$0	1.00	3	$100.00	$333	$333
	Backfill	2	CY	$10	$17	2.00	3	$100.00	$333	$350
	Subtotal Duct Bank CMH to Panel 14 10LF Excav & Backfill				$17		17		$1,667	$1,683
2.1.6.23	Duct Bank CMH to Note 10 Future 15LF Excav & Backfill									
	Demo Special	1	Lot	$0	$0	7.00	15	$100.00	$1,500	$1,500
	Excavation	5	CY	$0	$0	1.00	5	$100.00	$500	$500
	Backfill	3	CY	$10	$25	2.00	5	$100.00	$500	$525
	Subtotal Duct Bank CMH to Panel 15 10LF Excav & Backfill				**$25**		**25**		**$2,500**	**$2,525**
2.1.6	**Subtotal Duct Bank Excavation & Backfill**				**$6,150**		**4,082**		**$408,200**	**$414,350**
2.1	**Subtotal All Excavation & Backfill**				**$20,107**		**9,124**		**$911,085**	**$931,193**
2.2	**Fencing**	**400**	**LF**	**$20**	**$8,000**	**1.00**	**400**	**$90.00**	**$36,000**	**$44,000**
2.3	**Asphalt Paving**	**2,000**	**SY**	**$10**	**$20,000**	**0.50**	**1,000**	**$90.00**	**$90,000**	**$110,000**
2.4	**Misc.**	**1**	**Lot**	**$5,000**	**$5,000**	**200.00**	**200**	**$90.00**	**$18,000**	**$23,000**
2	**Subtotal Sitework**				**$53,107**		**10,724**		**$1,055,085**	**$1,108,193**

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3	**Structures**									
3.1	**Manholes**									
3.1.1	Manhole SMH1 - 10"X10'10' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$20,000	$20,000	100.0	100	$100.00	$10,000	$30,000
3.1.2	Manhole SMH2 - 10"X10'10' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$20,000	$20,000	100.0	100	$100.00	$10,000	$30,000
3.1.3	Manhole SMH3 - 8'X8'X7' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$15,000	$15,000	80.0	80	$100.00	$8,000	$23,000
3.1.4	Manhole CMH - 4'X4'X6' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$5,000	$5,000	20.0	20	$100.00	$2,000	$7,000
3.1.5	Manhole FMH1 - 8'X8'X7' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$15,000	$15,000	80.0	80	$100.00	$8,000	$23,000
3.1.6	Manhole FMH2 - 8'X8'X7' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$15,000	$15,000	80.0	80	$100.00	$8,000	$23,000
3.1.7	Manhole DMH1 - 10'X10'X8' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$20,000	$20,000	100.0	100	$100.00	$10,000	$30,000
3.1.8	Manhole DMH2 - 10'X10'X8' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$20,000	$20,000	100.0	100	$100.00	$10,000	$30,000
3.1.9	Manhole DMH3 - 10'X10'X8' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$20,000	$20,000	100.0	100	$100.00	$10,000	$30,000
3.1	**Subtotal Manholes**				**$150,000**		**1,120**		**$112,000**	**$337,000**

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3.2	**Electrical Substation Structure 52' X 82' X 12"thk**									
	Forms 24" high	536	SF	$2	$1,072	0.20	107	$100.00	$10,720	$11,792
	Rebar	34,112	lbs	$1	$34,112	0.05	1,706	$110.00	$187,616	$221,728
	Concrete	174	CY	$100	$17,372	1.0	174	$90.00	$15,635	$33,007
3.2	**Subtotal Electric Substation Structure**				**$52,556**		**1,987**		**$213,971**	**$266,527**
3.3	**Electric Crane Pits**									
3.3.1	Crane Pit #1 - 12'X11'X8-1/2' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$25,000	$25,000	120.0	120	$100.00	$12,000	$37,000
3.3.2	Crane Pit #2 - 12'X11'X8-1/2' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$25,000	$25,000	120.0	120	$100.00	$12,000	$37,000
3.3.3	Crane Pit #3 - 12'X11'X8-1/2' Inside Reinforced Conc. W/Embeds Prefabricated & Delivered	1	Ea	$25,000	$25,000	120.0	120	$100.00	$12,000	$37,000
3.3	**Subtotal Electric Crane Pits**				**$75,000**		**360**		**$36,000**	**$111,000**
3.4	**Crane Trailing Cable Trench -2,500 LF**									
	Forms	5,000	SF	$2	$10,000	0.10	500	$100.00	$50,000	$60,000
	Rebar	20,000	lbs	$1	$20,000	0.05	1,000	$110.00	$110,000	$130,000
	Concrete	417	CY	$100	$41,667	1.0	417	$90.00	$37,500	$79,167
3.4	**Subtotal Crane Trailing Cable Trench**				**$61,667**		**1,417**		**$147,500**	**$209,167**

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3.5	**Duct Banks**									
3.5.1	Duct Bank SMH1 to SMH2 660LF	"L"								
	Rebar	8,580	lbs	$1	$8,580	0.05	429	$110.00	$47,190	$55,770
	Concrete	132	CY	$100	$13,200	1.0	132	$90.00	$11,880	$25,080
	PVC Conduit 5"Dia - 6ea (3 X 3)	3,960	LF	$5	$19,800	0.1	396	$110.00	$43,560	$63,360
	Subtotoal Duct Bank SMH1 to SMH2 660LF				$41,580		957		$102,630	$144,210
3.5.2	Duct Bank SMH2 to SMH3 420LF	"M"								
	Rebar	2,940	lbs	$1	$2,940	0.05	147	$110.00	$16,170	$19,110
	Concrete	84	CY	$100	$8,400	1.0	84	$90.00	$7,560	$15,960
	PVC Conduit 5"Dia - 8ea	3,360	LF	$5	$16,800	0.1	336	$110.00	$36,960	$53,760
	Subtotal Duct Bank SMH2 to SMH3 420LF				$28,140		567		$60,690	$88,830
3.5.3	Duct Bank MHC04 to Mid SMH2-3 120LF									
	Rebar	2,940	lbs	$1	$2,940	0.05	147	$110.00	$16,170	$19,110
	Concrete	24	CY	$100	$2,400	1.0	24	$90.00	$2,160	$4,560
	PVC Conduit 5"Dia - 2ea	240	LF	$5	$1,200	0.1	24	$110.00	$2,640	$3,840
	Subtotal Duct Bank MHC04 to Mid SMH2-3 120LF				$6,540		195		$20,970	$27,510
3.5.4	Duct Bank FMH1 to FMH2 25LF	"D"								
	Rebar	500	lbs	$1	$500	0.05	25	$110.00	$2,750	$3,250
	Concrete	132	CY	$100	$13,200	1.0	132	$90.00	$11,880	$25,080
	PVC Conduit 5"Dia - 4ea	100	LF	$5	$500	0.1	10	$110.00	$1,100	$1,600
	Subtotal Duct Bank FMH1 to FMH2 25LF				$14,200		167		$15,730	$29,930
3.5.5	Duct Bank FMH2 to DMH2 360LF									
	Rebar	3,600	lbs	$1	$3,600	0.05	180	$110.00	$19,800	$23,400
	Concrete	72	CY	$100	$7,200	1.0	72	$90.00	$6,480	$13,680
	PVC Conduit 5"Dia - 18ea	6,480	LF	$5	$32,400	0.1	648	$110.00	$71,280	$103,680
	Subtotal Duct Bank FMH2 to DMH2 360LF				$43,200		900		$97,560	$140,760

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No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
3.5.6	Duct Bank DMH2 to NCRPit2 80LF									
	Rebar	800	lbs	$1	$800	0.05	40	$110.00	$4,400	$5,200
	Concrete	16	CY	$100	$1,600	1.0	16	$90.00	$1,440	$3,040
	PVC Conduit 5"Dia - 10ea	800	LF	$5	$4,000	0.1	80	$110.00	$8,800	$12,800
	Subtotal Duct Bank DMH2 to NCRPit2 80LF				$6,400		136		$14,640	$21,040
3.5.7	Duct Bank DMH2 to DMH3 540LF									
	Rebar	5,400	lbs	$1	$5,400	0.05	270	$110.00	$29,700	$35,100
	Concrete	108	CY	$100	$10,800	1.0	108	$90.00	$9,720	$20,520
	PVC Conduit 5"Dia - 10ea	5,400	LF	$5	$27,000	0.1	540	$110.00	$59,400	$86,400
	Subtotal Duct Bank DMH2 to DMH3 540LF				$43,200		918		$98,820	$142,020
3.5.8	Duct Bank DMH2 to DMH1 580LF									
	Rebar	5,800	lbs	$1	$5,800	0.05	290	$110.00	$31,900	$37,700
	Concrete	116	CY	$100	$11,600	1.0	116	$90.00	$10,440	$22,040
	PVC Conduit 5"Dia - 8ea	4,640	LF	$5	$23,200	0.1	464	$110.00	$51,040	$74,240
	Subtotal Duct Bank DMH2 to DMH1 580LF				$40,600		870		$93,380	$133,980
3.5.9	Duct Bank DMH1 to NCRPit1 80LF									
	Rebar	800	lbs	$1	$800	0.05	40	$110.00	$4,400	$5,200
	Concrete	16	CY	$100	$1,600	1.0	16	$90.00	$1,440	$3,040
	PVC Conduit 5"Dia - 10ea	800	LF	$5	$4,000	0.1	80	$110.00	$8,800	$12,800
	Subtotal Duct Bank DMH1 to NCRPit1 80LF				$6,400		136		$14,640	$21,040
3.5.10	Duct Bank DMH3 to NCRPit3 80LF									
	Rebar	800	lbs	$1	$800	0.05	40	$110.00	$4,400	$5,200
	Concrete	16	CY	$100	$1,600	1.0	16	$90.00	$1,440	$3,040
	PVC Conduit 5"Dia -10ea	800	LF	$5	$4,000	0.1	80	$110.00	$8,800	$12,800
	Subtotal Duct Bank DMH3 to NCRPit3 80LF				$6,400		136		$14,640	$21,040

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3.5.11	Duct Bank CO4 to SMH3 (CMH) 120LF		"A"							
	Rebar	1,200	lbs	$1	$1,200	0.05	60	$110.00	$6,600	$7,800
	Concrete	24	CY	$100	$2,400	1.0	24	$90.00	$2,160	$4,560
	PVC Conduit 5"Dia - 8ea	960	LF	$5	$4,800	0.1	96	$110.00	$10,560	$15,360
	Subtotal Duct Bank CO4 to SMH3 (CMH) 120LF				$8,400		180		$19,320	$27,720
3.5.12	Duct Bank SMH3 to Sect4 30LF Excav & Backfill									
	Rebar	300	lbs	$1	$300	0.05	15	$110.00	$1,650	$1,950
	Concrete	6	CY	$100	$600	1.0	6	$90.00	$540	$1,140
	PVC Conduit 5"Dia - 3ea	90	LF	$5	$450	0.1	9	$110.00	$990	$1,440
	Subtotal Duct Bank SMH3 to Sect4 30LF Excav & Backfill				$1,350		30		$3,180	$4,530
3.5.13	Duct Bank SMH3 to Sect7 40LF Excav & Backfill									
	Rebar	400	lbs	$1	$400	0.05	20	$110.00	$2,200	$2,600
	Concrete	8	CY	$100	$800	1.0	8	$90.00	$720	$1,520
	PVC Conduit 5"Dia - 3ea	120	LF	$5	$600	0.1	12	$110.00	$1,320	$1,920
	Subtotal Duct Bank SMH3 to Sect7 40LF Excav & Backfill				$1,800		40		$4,240	$6,040
3.5.14	Duct Bank FutureX to FMH1 40LF Excav & Backfill									
	Rebar	400	lbs	$1	$400	0.05	20	$110.00	$2,200	$2,600
	Concrete	8	CY	$100	$800	1.0	8	$90.00	$720	$1,520
	PVC Conduit 5"Dia - 3ea	120	LF	$5	$600	0.1	12	$110.00	$1,320	$1,920
	Subtotal Duct Bank FutureX to FMH1 40LF Excav & Backfill				$1,800		40		$4,240	$6,040
3.5.15	Duct Bank FutureX to FMH1 40LF Excav & Backfill									
	Rebar	520	lbs	$1	$520	0.05	26	$110.00	$2,860	$3,380
	Concrete	8	CY	$100	$800	1.0	8	$90.00	$720	$1,520
	PVC Conduit 5"Dia - 3ea	120	LF	$5	$600	0.1	12	$110.00	$1,320	$1,920
	Subtotal Duct Bank FutureX to FMH1 40LF Excav & Backfill				$1,920		46		$4,900	$6,820

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3.5.16	Duct Bank Sect1 CF to FMH1 30LF Excav & Backfill									
	Rebar	390	lbs	$1	$390	0.05	20	$110.00	$2,145	$2,535
	Concrete	6	CY	$100	$600	1.0	6	$90.00	$540	$1,140
	PVC Conduit 5"Dia - 3ea	90	LF	$5	$450	0.1	9	$110.00	$990	$1,440
	Subtotal Duct Bank Sect1 CF to FMH1 30LF Excav & Backfill				$1,440		35		$3,675	$5,115
3.5.17	Duct Bank Sect2 CF to FMH1 & Stub Out 30LF Excav & Backfill									
	Rebar	300	lbs	$1	$300	0.05	15	$110.00	$1,650	$1,950
	Concrete	6	CY	$100	$600	1.0	6	$90.00	$540	$1,140
	PVC Conduit 5"Dia - 3ea	90	LF	$5	$450	0.1	9	$110.00	$990	$1,440
	Subtotal Duct Bank Sect2 CF to FMH1 & Stub Out 30LF Excav & Ba				$1,350		30		$3,180	$4,530
3.5.18	Duct Bank Sect 9 Future Capacitor C/B 10LF Excav & Backfill									
	Rebar	100	lbs	$1	$100	0.05	5	$110.00	$550	$650
	Concrete	2	CY	$100	$200	1.0	2	$90.00	$180	$380
	PVC Conduit 5"Dia - 2ea	20	LF	$5	$100	0.1	2	$110.00	$220	$320
	Subtotal Duct Bank Sect 9 Future Capacitor C/B 10LF Excav & Back				$400		9		$950	$1,350
3.5.19	Duct Bank Sect 10 Crane Feed C/B 40LF Excav & Backfill									
	Rebar	400	lbs	$1	$400	0.05	20	$110.00	$2,200	$2,600
	Concrete	8	CY	$100	$800	1.0	8	$90.00	$720	$1,520
	PVC Conduit 5"Dia - 2ea	80	LF	$5	$400	0.1	8	$110.00	$880	$1,280
	Subtotal Duct Bank Sect 10 Crane Feed C/B 40LF Excav & Backfill				$1,600		36		$3,800	$5,400
3.5.20	Duct Bank Future Exp 10LF Excav & Backfill									
	Rebar	100	lbs	$1	$100	0.05	5	$110.00	$550	$650
	Concrete	2	CY	$100	$200	1.0	2	$90.00	$180	$380
	PVC Conduit 5"Dia - 3ea	30	LF	$5	$150	0.1	3	$110.00	$330	$480
	Subtotal Duct Bank Future Exp 10LF Excav & Backfill				$450		10		$1,060	$1,510

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3.5.21	Duct Bank Future Exp 10LF Excav & Backfill									
	Rebar	100	lbs	$1	$100	0.05	5	$110.00	$550	$650
	Concrete	2	CY	$100	$200	1.0	2	$90.00	$180	$380
	PVC Conduit 5"Dia - 3ea	30	LF	$5	$150	0.1	3	$110.00	$330	$480
	Subtotal Duct Bank Future Exp 10LF Excav & Backfill				$450		10		$1,060	$1,510
3.5.22	Duct Bank FMH1 to Note 11 50LF Excav & Backfill									
	Rebar	500	lbs	$1	$500	0.05	25	$110.00	$2,750	$3,250
	Concrete	10	CY	$100	$1,000	1.0	10	$90.00	$900	$1,900
	PVC Conduit 5"Dia - 4ea	200	LF	$5	$1,000	0.1	20	$110.00	$2,200	$3,200
	Subtotal Duct Bank FMH1 to Note 11 50LF Excav & Backfill				$2,500		55		$5,850	$8,350
3.5.23	Duct Bank CMH to Panel 14 10LF Excav & Backfill									
	Rebar	100	lbs	$1	$100	0.05	5	$110.00	$550	$650
	Concrete	2	CY	$100	$200	1.0	2	$90.00	$180	$380
	PVC Conduit 5"Dia - 14ea	140	LF	$5	$700	0.1	14	$110.00	$1,540	$2,240
	Subtotal Duct Bank CMH to Panel 14 10LF Excav & Backfill				$1,000		21		$2,270	$3,270
3.5.24	Duct Bank CMH to Note 10 Future 15LF Excav & Backfill									
	Rebar	150	lbs	$1	$150	0.05	8	$110.00	$825	$975
	Concrete	3	CY	$100	$300	1.0	3	$90.00	$270	$570
	PVC Conduit 5"Dia - 10ea	150	LF	$5	$750	0.1	15	$110.00	$1,650	$2,400
	Subtotal Duct Bank CMH to Panel 14 10LF Excav & Backfill				$1,200		26		$2,745	$3,945
3.5	**Subtotal Duct Banks**				**$262,320**		**5,549**		**$594,170**	**$856,490**
3.6	**Cable Trench Drains -Crane Trail Cable Trench Piping**									
	PVC Piping 8"Dia	2,500	LF	$10	$25,000	0.20	500	$100.00	$50,000	$75,000
	PVC Piping 4" Dia Vert.	728	LF	$5	$3,640	0.20	146	$100.00	$14,560	$18,200
	PVC Fillings - 25%	1	Lot		$7,160		161	$100.00	$16,140	$23,300
3.6	**Subtotal Drains Elec Crane Pit #3 Excav & Back**				$35,800		807		$80,700	$116,500
3	**Subtotal Structures**				**$637,343**		**28,167**		**$3,226,523**	**$4,598,856**

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4	**Electrical**									
4.1	**Transformers 5000 KVA** 13.2 KW Pri, 13.2 KW Sec.	**2**	**ea**	**$25,000**	**$50,000**	**100**	**200**	**$110.00**	**$22,000**	**$72,000**
4.2	**Switchgear**		ea		$0		0	$110.00	$0	$0
4.2.1	Main Servce Swtichgear									
4.2.1.1	Section 1 Crane Feeder C/B Spare Outdoor, Walk In,	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.1.2	Section 2 Future Capacitor C/B Aux Outdoor, Walk In,	1	ea	$20,000	$20,000	50	50	$110.00	$5,500	$25,500
4.2.1.3	Section 3 PECO Meter Outdoor, Walk In,	1	ea	$20,000	$20,000	50	50	$110.00	$5,500	$25,500
4.2.1.4	Section 4 Line 1 Main C/B Line 1 VT Outdoor, Walk In,	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.1.5	Section 5 Bus Trans Aux Int Face Outdoor, Walk In,	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.1.6	Section 6 Crane Feeder C/B Spare Outdoor, Walk In,	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.1.7	Section 4 Line 2 Main C/B Line 1 VT Outdoor, Walk In,	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.1.8	Section 8 PECO Meter Outdoor, Walk In,	1	ea	$20,000	$20,000	50	50	$110.00	$5,500	$25,500

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4.2.1.9	Section 9 Future Capacitor C/B Aux Outdoor, Walk In,	1	ea	$20,000	$20,000	50	50	$110.00	$5,500	$25,500
4.2.1.10	Section 10 Crane Feeder C/B Spare Outdoor, Walk In,	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.1	**Subtotal Main Service Switchgear**				**$260,000**		**800**	**$1,100.00**	**$129,612**	**$348,000**
4.2.2	**Crane Feeder Switchgear**									
4.2.2.1	Section 1 Feeder C/B Feeder C/B Outdoor, Walk In, 15KV	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.2.2	Section 2 Auxiliary Power Blank Outdoor, Walk In, 15KV	1	ea	$25,000	$25,000	75	75	$110.00	$8,250	$33,250
4.2.2.3	Section 3 Line 2 VT's Line 2 Main C Outdoor, Walk In, 15KV	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.2.4	Section 4 Aux Int Face Bus Trans. Outdoor, Walk In, 15KV	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.2.5	Section 5 Blank Tie Break Outdoor, Walk In, 15KV	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.2.6	Section 6 Line 1 VT's Line 1 Main C Outdoor, Walk In, 15KV	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.2.7	Section 7 Auxiliary Power Blank Outdoor, Walk In, 15KV	1	ea	$25,000	$25,000	75	75	$110.00	$8,250	$33,250
4.2.2.8	Section 8 Feeder C/B Feeder C/B Outdoor, Walk In, 15KV	1	ea	$30,000	$30,000	100	100	$110.00	$11,000	$41,000
4.2.2	**Subtotal Crane Feeder Switchgear**				**$230,000**		**750**	**$880.00**	**$82,500**	**$312,500**
4.2	**Subtotal Switchgear**				**490,000**		**1,550**		**$212,112**	**$660,500**

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4.3	**Panels w/ Breakers**	**20**	**ea**	**$5,000**	**$100,000**	**40**	**800**	**$110.00**	**$88,000**	**$188,000**
4.4	**Busbar**									
4.4.1	**Main Service Switchgear Busbar**	108	LF	$30	$3,240	1.00	108	$110.00	$11,880	$15,120
4.4.2	**Crane Feeder Switchgear Busbar**	84	LF	$30	$2,520	1.00	84	$110.00	$9,240	$11,760
4.4	**Subtotal Busbar**				**$5,760**		**192**		**$21,120**	**$26,880**
4.5	**Cable**									
4.5.1	Cable - Lg 750 MCM 15KV Shielded	7,128	LF	$20	$142,560	0.10	713	$110.00	$78,408	$220,968
4.5.2	Cable - Med 250 MCM 15KV Shield	600	LF	$15	$9,000	0.10	60	$110.00	$6,600	$15,600
4.5.3	Cable - Med No 2 15KV Shielded	19,360	LF	$10	$193,600	0.05	968	$110.00	$106,480	$300,080
4.5.4	Cable - Small est	5,000	LF	$3	$12,500	0.05	250	$110.00	$27,500	$40,000
4.5	**Subtotal Cable**				**$357,660**	**0.05**	**1,991**		**$218,988**	**$576,648**
4.6	**Terminations**	**500**	**ea**	**$5**	**$2,500**	**1.0**	**500**	**$110.00**	**$55,000**	**$57,500**
4.7	**Grounding System**	**700**	**LF**	**$15**	**$10,500**	**1.0**	**700**	**$110.00**	**$77,000**	**$87,500**
4.6	**Lighting and Power w/poles**	**8**	**LS**	**$1,000**	**$8,000**	**5.0**	**40**	**$110.00**	**$4,400**	**$12,400**
	Subtotal Electrical				**$1,024,420**		**5,973**	**$550.00**	**$698,620**	**$1,681,428**

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5	**Controls**									
	Control Points	100	ea	$500	$50,000	2	200	$90.00	$18,000	$68,000
	Wiring & Tubing	5,000	ea	$2	$10,000	0	500	$90.00	$45,000	$55,000
	Other	1	LS	$20,000	$20,000	200	200	$90.00	$18,000	$38,000
	Subtotal Controls				**$80,000**		**900**		**$81,000**	**$161,000**

Crane Improvements

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No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
1	**Preliminary Work**				**$35,000**		**700**		**$63,000**	**$98,000**
2	**Equipment**				**$84,000**		**656**		**$72,160**	**$156,160**
3	**Structures**				**$47,947**		**3,502**		**$385,251**	**$433,197**
4	**Electrical**				**$433,677**		**1,776**		**$195,326**	**$629,003**
5	**Controls**				**$72,000**		**500**		**$45,000**	**$117,000**
6	**Not Used**				**$0**		**0**		**$0**	**$0**
7	**Not Used**				**$0**		**0**		**$0**	**$0**
	Subtotal Direct Costs				**$672,623**		**7,134**		**$760,737**	**$1,433,360**
8	**Temporary Construction Facilities & Services @ 2% of Direct**									**$30,000**
9	**Engineering Services**									**$170,000**
10	**PRPA Costs**									**$0**
	Subtotal Indirect Costs									**$200,000**
11	**Contingency @ 15%**									**$250,000**
12	**Escalation (None)**									**$0**
	Total Project Costs									**$1,883,360**
									Use =	**$2,000,000**

Accuracy +/- 30%

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1	**Preliminary Work**									
	Mobilization	1	LS	$5,000	$5,000	100	100	$90.00	$9,000	$14,000
	Barricades etc	1	LS	$5,000	$5,000	100	100	$90.00	$9,000	$14,000
	Permits	1	LS	$25,000	$25,000	0	0	$90.00	$0	$25,000
	Demolition	1	LS	$0	$0	500	500	$90.00	$45,000	$45,000
	Subtotal Mobilization	**0**		**$0**	**$35,000**	**0**	**700**	**$0.00**	**$63,000**	**$98,000**
2	**Equipment**									
2.1	**Cavotec Cable Reel**	1	Ea	$50,000	**$50,000**	500	**500**	$110.00	**$55,000**	**$105,000**
2.2	**Cavotec Roller Guides**									
2.2.1	Type 1A Roller Guide w/bolts	1	Ea	$500	$500	2	2	$110.00	$220	$720
2.2.2	Type 1B Roller Guide w/bolts	1	Ea	$500	$500	2	2	$110.00	$220	$720
2.2.3	Type 2 Roller Guide w/bolts	3	Ea	$500	$1,500	2	6	$110.00	$660	$2,160
2.2.4	Type 3 Roller Guide w/bolts	3	Ea	$500	$1,500	2	6	$110.00	$660	$2,160
2.2	**Subtotal Cavotec Roller Guides**				**$4,000**		**16**	**$440.00**	**$1,760**	**$5,760**
2.3	**Cavotec Cable Diverter (low)**	**2**	**Ea**	**$10,000**	**$20,000**	**40**	**80**	**$110.00**	**$8,800**	**$28,800**
2.4	**Cavotec Cable Guide (High)**	**1**	**Ea**	**$10,000**	**$10,000**	**40**	**60**	**$110.00**	**$6,600**	**$16,600**
2	**Subtotal Equipment**				**$84,000**		**656**		**$72,160**	**$156,160**

Draft

COMPLIANCE MANAGEMENT INTERNATIONAL
PHILADELPHIA REGIONAL PORT AUTHORITY
CRANE CONVERSION PROJECT
Cost Estimate of Crane Improvements - Two Cranes

12/16/2013
WMM
Basis: December 2013 Dollars

No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
3	**Structures**									
3.1	**Cavotec Reel Support Platform**									
3.2.1	Outside Frame C8X18.75	1,369	lbs	$1	$1,369	0.20	274	$110.00	$30,113	$31,481
3.1.2	End Beams & Reel Supp WF8 X 35	1,085	lbs	$1	$1,085	0.20	217	$110.00	$23,870	$24,955
3.1.3	Inside Frame C8 X 18.7	1,964	lbs	$1	$1,964	0.20	393	$110.00	$43,197	$45,161
3.1.4	Bracing w/spine & diags L3 X 3 X 3/8	295	lbs	$1	$295	0.20	59	$110.00	$6,494	$6,790
3.1.5	Stairways	2	ea	$250	$500	4.00	8	$110.00	$880	$1,380
3.1.6	Base Plates 3'-2" X 10" X 1/2" 2ea	53	lbs	$1	$53	0.20	11	$110.00	$1,168	$1,221
3.1.7	Knee Bracing W15 X 15 3 ea	405	lbs	$1	$405	0.20	81	$110.00	$8,910	$9,315
3.1.8	Bracing Attach L6 X 4 X 3/8 7 ea	172	lbs	$1	$172	0.20	34	$110.00	$3,788	$3,961
3.1.9	Metal Grating, Galv	1,830	SF	$15	$27,450	0.20	366	$110.00	$40,260	$67,710
3.1.10	Handrailing	128	LF	**$5**	$638	1.00	128	$110.00	$14,025	$14,663
3.1	**Subtotal Cavotec Reel Support Platform**				**$33,930**		**1,570**		**$172,705**	**$206,635**

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No.	Description	Quantity	U/M	Unit Matl $/Qty	Material Cost $	Unit Labor Qty/Hr	Labor Hours	Labor Rate $/Hr	Labor Cost $	Total Cost $
3.2	**Cavotec Roller Guide Supports**									
3.2.1	Type 1A Roller Guide Support 1 ea	142	lbs	$1	$142	0.20	28	$110.00	$3,120	$3,261
	Type 1B Roller Guide Support 1ea	142	lbs	$1	$142	0.20	28	$110.00	$3,120	$3,261
	Type 2 Roller Guide Support 3 ea	272	lbs	$1	$272	0.20	54	$110.00	$5,986	$6,258
	Type 3 Roller Guide Support 3 ea	272	lbs	$1	$272	0.20	54	$110.00	$5,986	$6,258
3.2	**Subtotal Cavotec Roller Guide Supports**				**$828**		**166**		**$18,212**	**$19,039**
3.3	**Cavotec Cable Diverter Supports (Low)**									
3.3.1	Beams, Plates, Diags, Welds	523	lbs	$1	$523	0.10	52	$110.00	$5,748	$6,270
3.3.2	Guard, 6" Pipe, Flanges, Etc.	34	LF	$30	$1,032	0.50	17	$110.00	$1,892	$2,924
3.3	**Subtotal Cavotec Cable Diverter Supports (Low)**				**$1,555**		**69**		**$7,640**	**$9,194**
3.4	**Cavotec Cable Guide Support (High)**									
3.4.1	Beams, Plates, Diags, Welds	1,181	lbs	$1	$1,181	0.20	236	$110.00	$25,978	$27,158
3.4.2	Support Plate and Grating	32	SF	$30	$960	0.20	6	$110.00	$704	$1,664
3.4	**Subtotal Cavotec Cable Guide Support (High)**				**$2,141**		**243**		**$26,682**	**$28,822**
3.5	**Transfer Switch Platform**									
3.5.1	Outside Frame l5 X 3 X 3/8	245	lbs	$1	$245	0.20	49	$110.00	$5,390	$5,635
3.5.2	Inside Beams L3 X 3 3 3/8	72	lbs	$1	$72	0.20	14	$110.00	$1,584	$1,656
3.5.3	Vert Supports w6 X 10.5 5 ea	53	lbs	$1	$53	0.20	11	$110.00	$1,155	$1,208
3.5.4	Base Plates 3'-2" X 10" X 1/2" 2ea	53	lbs	$1	$53	0.20	11	$110.00	$1,168	$1,221
3.5.5	Metal Grating, Galv	150	SF	$15	$2,250	0.20	30	$110.00	$3,300	$5,550
3.5	**Subtotal Cavotec Reel Support Platform**				**$2,673**		**115**		**$12,597**	**$15,270**

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3.6	**Electric Substation Support Platform**									
3.6.1	Outside Frame C8X18.75	1,388	lbs	$1	$1,388	0.20	278	$110.00	$30,525	$31,913
3.6.2	Main Beams WF8 X 35	2,100	lbs	$1	$2,100	0.20	420	$110.00	$46,200	$48,300
3.6.3	Bracing w/spine & diags L3 X 3 X 3/8	396	lbs	$1	$396	0.20	79	$110.00	$8,712	$9,108
3.6.4	Stairways	2	ea	$250	$500	4.00	8	$110.00	$880	$1,380
3.6.5	Base Plates 3'-2" X 10" X 1/2" 5ea	133	lbs	$1	$133	0.20	27	$110.00	$2,920	$3,053
3.6.6	Bracing W5 X 15 7 ea	1,050	lbs	$1	$1,050	0.20	210	$110.00	$23,100	$24,150
3.6.7	Bracing Attach L6 X 4 X 3/8 7 ea	172	lbs	$1	$172	0.20	34	$110.00	$3,788	$3,961
3.6.8	GE Supplied Platform	1	LS	$0	$0	100.00	100	$110.00	$11,000	$11,000
3.6.9	Handrailing	40	LF	**$5**	$200	0.20	8	$110.00	$880	$1,080
3.6	**Subtotal Substation Support Platform**				**$5,938**		**1,164**		**$128,005**	**$133,944**
3.7	**Misc Supports (Cable Tray)**	882	Lbs	$1	**$882**	0.20	**176**	$110.00	**$19,411**	**$20,293**
3	**Subtotal Structures**				**$47,947**		**3,502**		**$385,251**	**$433,197**

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4	**Electrical**									
4.1	**Substation By GE**									
4.1.1	Prefabricated, Enclosure w/AC 26.5'L X 11.5'WX 10'H	1	Lot	$250,000	$250,000	250	250	$110.00	$27,500	$277,500
4.1.2	GE Platform		ea	w/above	$0	0		$110.00	$0	$0
4.1.3	15KV Transformer 13.2 to 575 KV		ea	w/above	$0	0		$110.00	$0	$0
4.1.4	Main Breaker		ea	w/above	$0	0		$110.00	$0	$0
4.1.5	Switchgear - 5 Sections		ea	w/above	$0	0		$110.00	$0	$0
4.1.6	Harmonic Section		ea	w/above	$0	0		$110.00	$0	$0
4.1.7	120 V Panels		ea	w/above	$0	0		$110.00	$0	$0
4.1.8	Lighting/Power		ea	w/above	$0	0		$110.00	$0	$0
4.1	**Subtotal Substation by GE**				**$250,000**		**250**		**$27,500**	**$277,500**
4.2	**Panels w/ Breakers**	**0**	**ea**	$5,000	**$0**	40	**0**	$110.00	**$0**	**$0**
4.3	**Transfer Switch (Diesel - Electric) w/Enclosure 3'W X 5.5'D X 10.5'H**	1	**LS**	$80,000	**$80,000**	120	**120**	$110.00	**$13,200**	**$93,200**
4.4	**Cable Tray**									
4.4.1	**Cable Tray SS 12" Wide, 4"Deep**	42	LF	$15	**$630**	0.50	**21**	$110.00	**$2,310**	**$2,940**
4.4.2	**Cable Tray SS 24" Wide, 4"Deep**	96	LF	$25	**$2,400**	0.50	**48**	$110.00	**$5,280**	**$7,680**
4.4.3	**Cable Tray SS 36" Wide, 4"Deep**	8	LF	$35	**$280**	0.50	**4**	$110.00	**$440**	**$720**
4.4	**Subtotal Cable Tray**				**$3,310**		**73**		**$8,030**	**$11,340**
4.5	**Conduit**	1,000	LF	$10	**$10,000**	0.20	**200**	$110.00	**$22,000**	**$32,000**

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4.6	**Cable (Feeder, Size,Descript.)**									
4.6.1	**F1(3)#1/0 AWG 15KV EPR 133% Insul (1)#2 AWG GRD**	150	LF	$18.00	$2,700	0.10	15	$110.00	$1,650	$4,350
4.6.2	**F2 PROTOLON 3x35+2x25/2+1x(6G62.5/125U) 15KV**	515	LF	$15.00	$7,725	0.10	52	$110.00	$5,665	$13,390
4.6.3	**F3 (7)-3/C 350 MCM Per W/#3 ARG GND**	901	LF	$50.00	$45,045	0.10	90	$110.00	$9,910	$54,955
4.6.4	**F01 Fibre Optic 62.5/125u (12 Fibre Assmbly)**	50	LF	$1.00	$50	0.10	5	$110.00	$550	$600
4.6.5	**F02 Fibre Optic 62.5/125u (8 Fibre Assmbly)**	20	LF	$1.00	$20	0.10	2	$110.00	$220	$240
4.6.6	**F03 Fibre Optic 62.5/125u (12 Fibre Assmbly)**	1,330	LF	$1.00	$1,330	0.10	133	$110.00	$14,630	$15,960
4.6.7	**W1 4 Shielded Pair #20AWG w/Overall Shield**	50	LF	$1.00	$50	0.10	5	$110.00	$550	$600
4.6.8	**W2 4/C #10 AWG w/ Overall Shield**	50	LF	$3.00	$150	0.10	5	$110.00	$550	$700
4.6.9	**W3 4/C #8 AWG w/ Overall Shield**	65	LF	$3.50	$228	0.10	7	$110.00	$715	$943
4.6.10	**W5 3/C #10 AWG w/ Overall Shield**	50	LF	$2.00	$100	0.10	5	$110.00	$550	$650
4.6.11	**W6 3/C #10 AWG w/ Overall Shield**	65	LF	$2.00	$130	0.10	7	$110.00	$715	$845
4.6.12	**W8 3/C #10 AWG w/ Overall Shield**	50	LF	$2.00	$100	0.10	5	$110.00	$550	$650
4.6.13	**W9 3/C #12 AWG w/ Overall Shield**	50	LF	$2.25	$113	0.10	5	$110.00	$550	$663
4.6.14	**W10 3/C #8 AWG w/ Overall Shield**	10	LF	$3.50	$35	0.10	1	$110.00	$110	$145
4.6.15	**W11 12/C #12 AWG w/ Overall Shield**	125	LF	$6.85	$856	0.10	13	$110.00	$1,375	$2,231
4.6.16	**W12 12/C #12 AWG w/ Overall Shield**	125	LF	$6.85	$856	0.10	13	$110.00	$1,375	$2,231
4.6.17	**W13 12/C #12 AWG w/ Overall Shield**	142	LF	$6.85	$973	0.10	14	$110.00	$1,562	$2,535
4.6.18	**W14 12/C #12 AWG w/ Overall Shield**	142	LF	$6.85	$973	0.10	14	$110.00	$1,562	$2,535
4.6.19	**W15 3/C #12 AWG w/ Overall Shield**	50	LF	$2.25	$113	0.10	5	$110.00	$550	$663
4.6.20	**W16 6/C #12 AWG w/ Overall Shield**	50	LF	$3.85	$193	0.10	5	$110.00	$550	$743
4.6.21	**W17 5/C #12 AWG w/ Overall Shield**	195	LF	$3.35	$653	0.10	20	$110.00	$2,145	$2,798
4.6.22	**W18 5/C #12 AWG w/ Overall Shield**	142	LF	$3.35	$476	0.10	14	$110.00	$1,562	$2,038
4.6	**Subtotal Cable**				**$62,867**		**433**		**$47,596**	**$110,463**
4.7	**Terminations**	**500**	**ea**	**$5**	**$2,500**	**1.0**	**500**	**$110.00**	**$55,000**	**$57,500**
4.8	**Grounding Systems**	**1**	**Lot**	**$5,000**	**$5,000**	**100.0**	**100**	**$110.00**	**$11,000**	**$16,000**
4.9	**Lighting and Power**	20	ea	$1,000	**$20,000**	**5.0**	**100**	**$110.00**	**$11,000**	**$31,000**
4	**Subtotal Electrical**				**$433,677**		**1,776**	**$660.00**	**$195,326**	**$629,003**

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5	**Controls**									
	Control Points	100	ea	$500	$50,000	2	200	$90.00	$18,000	$68,000
	Wiring & Tubing	1,000	ea	$2	$2,000	0	100	$90.00	$9,000	$11,000
	Other	1	LS	$20,000	$20,000	200	200	$90.00	$18,000	$38,000
	Subtotal Controls				**$72,000**		**500**		**$45,000**	**$117,000**

ATTACHMENT 3

CURRENT ULSD BILL (COSTING)

INVOICE

PAYABLE UPON RECEIPT

DATE	INVOICE#
02/10/14	35657

ROYAL PETROLEUM CORPORATION
PO BOX 16846
PHILADELPHIA PA 19142
610-586-6700

PLEASE INSERT AMOUNT PAID
$ _____

BILL TO ACCOUNT #: 1908

GREENWICH TERMINALS LLC
PO BOX 416
GLOUCESTER CITY, NJ 08030

Deliver To
GREENWICH TERMINALS LLC
3301 S. COLUMBUS BLVD
PHILADELPHIA, PA 19148

TEAR ON DOTTED LINE AND RETURN TOP PORTION WITH YOUR PAYMENT

Date	Invoice #
02/10/14	35657

DATE	DESCRIPTION	AMOUNT
02/10/14	986.5 GALLONS DULSD @ $ 3.8543 ✓	3,802.27
	PA SLS TX (PHILA)	304.18
	GRT29089	

Company: CRTP
Vendor #: 75597
Invoice Number: 35657
Invoice Date: 2-10-14
Entered By: [illegible]
Date Entered: 2/27/14
Scheduled Date: 3.7.14
Memo: 986.5

45 | 3-12 | 4106.45
2034-98 | ( )
PJ Total: 4106.45

Delivery Address:
GREENWICH TERMINALS LLC
3301 S. COLUMBUS BLVD
PHILADELPHIA, PA 19148

ROYAL PETROLEUM CORPORATION 1908

On balances of 30 days or over we will compute a FINANCE CHARGE OF 1.50 % PER MONTH, WHICH IS 18.0 % ANNUAL PERCENTAGE RATE.

PAY THIS AMOUNT ► 4,106.45

AP '14 FEB26 AM11:47

ATTACHMENT 4

ORCA LNG TRANSPORT INFORMATION

ORCA HL SERIES

TRUCK DELIVERY SYSTEM – MICROBULK SOLUTIONS

Take control of the packaged gas market with the Orca delivery system

Chart's MicroBulk delivery system has revolutionized the gas industry by making on-site distribution for smaller accounts a profitable reality. The Orca truck has been designed to complete an entire fill operation in 3-15 minutes (depending on storage volume) with no pump cooling or product loss (inert service). Automatic fill termination with the Perma-Cyl® storage vessels eliminates safety hazards and lost product associated with overfilling. In total, the Chart MicroBulk system increases asset utilization, reduces labor costs and maximizes distribution efficiency.

Chart offers the complete MicroBulk delivery system as a solution to reliably and effortlessly manage a diverse range of applications. At the foundation of the MicroBulk system, the Orca truck offers fast, reliable and accurate onsite delivery to Perma-Cyl storage vessels or small bulk tanks. Next, the Perma-Cyl line offers the widest range of sizes and piping options and the greatest flexibility with accommodations for indoor and outdoor installations. Finally, the innovative Cyl-Tel® digital level gauge accurately monitors liquid contents and provides a seamless connection to a variety of Chart telemetry platforms.

Product Highlights

- Fast onsite filling of the Perma-Cyl storage system
- Low maintenance exclusive submerged pump for instant starts and continuous delivery
- Filling of small bulk tanks
- Instantaneous push-button delivery of product
- Simple valves to operate
- "Smart" flow metering system reduces required operator training
- NIST*/California Weights and Measures approved delivery metering system
- Special delivery hose minimizes contamination, cool down and pressure loss
- Vessel designed with robust inner support system for rugged road conditions
- Electronic control allows for fast in-and-out deliveries and invoicing
- Stainless steel plumbing with bronze valves for long service life and reliability

*NIST is the National Institute of Standards and Technology

MicroBulk Delivery

CHART®

Innovation. Experience. Performance.

ATTACHMENT 5

GASEOUS FUEL SYSTEM INFORMATION

EVO-SP Conversion System for Industrial, Diesel Engines to be Demonstrated During OTC 2013

New Bi-Fuel Generator Conversion | EVO-SP System to be unveiled at PowerGen 2012

Karen Zall Joins GFS Corp as Director of Human Resources

Bi-Fuel Enters the Digital Age... Introducing the EVO-SP™ System

The Next EVOlution in Bi-Fuel Technology

Building on a powerful platform designed for the most demanding off-road applications for mine haul trucks, GFS Corp announces an advanced bi-fuel solution for the stationary power sector. The EVO-SP System applies lessons learned in converting dynamic, variable speed off-road engines to natural gas + diesel (NG+D) operation in some of the world's harshest, most demanding environments. The EVO-SP System is ready to meet the demands of the most challenging industrial applications including oil and gas drilling, prime power, peak-shaving and critical stand-by power systems.

Smart and Powerful Controls with Advanced Engine Monitoring

Dynamic stationary applications require powerful and smart controls. The EVO-SP System has been optimized for precise and responsive control of natural gas fueling using a proprietary electronic control unit (ECU) coupled with a fast-acting, integrated mixer-throttle body. The EVO-SP System provides high resolution, dynamic mapping of natural gas and diesel mixtures across the engine load range using a 50 hertz / 50X per second control loop. This rapid control loop allows the EVO-SP System to safely and efficiently replace up to 70% of the engine's diesel fuel requirement with natural gas without compromising engine response or power output. In the event of a fault or loss of natural gas supply, the EVO-SP System seamlessly reverts the engine to 100% diesel operation without loss of power. See which EVO-SP System is right for your application. Download our **EVO-SP System selection questionnaire** to find out.

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- **Contact**
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