STATE OF NEW JERSEY
BOARD OF PUBLIC UTILITIES

I/M/O THE PETITION OF PUBLIC SERVICE ELECTRIC & GAS COMPANY FOR APPROVAL OF THE ENERGY STRONG PROGRAM	))))	BPU Docket Nos. EO13020155 and GO13020156

APPENDIX TO
CHARLES P. SALAMONE'S DIRECT TESTIMONY
ON BEHALF OF THE
DIVISION OF RATE COUNSEL

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Dated: October 28, 2013

PUBLIC VERSION

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

QUANTIFY INCREASED RESILIENCY

QUESTION:
Regarding page 2, line 36 of Mr. Cardenas' direct testimony, please explain how the Company intends to quantify increased resiliency of the electric delivery system.

ANSWER:
The attached charts document the assumptions used for customers impacted from each electric investment along with assumptions for the associated reductions in outages and improved restoration times. The assumptions are based on a major Sandy-like storm event with over 90% of customers affected, including storm surge and river flooding.

Based on these assumptions and a storm of the magnitude of Superstorm Sandy, which had 162,495,633 of customer hours interrupted, PSE&G estimates that on average all customers would have seen a 39% reduction in outage time if the proposed investments were in place.

A different set of assumptions on storm impact may lead to different results. However, in all storm events, the investments proposed would lead to decreased outages and improved restoration times than what would otherwise occur.

Program	Description	Actions	Assumptions in quantifying customers Impacted by either elimination of outage or decrease in outage duration	Assumption in quantifying outages that are eliminated Outage duration is 3 days unless noted	Assumptions in quantifying outages that are reduced in duration
1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	Number of customers supplied either directly or indirectly by the Stations to be protected assuming each station will be impacted once	33% reduction in 5-day customer outages	With station supply in, customer still out reduced from 5 Days to 4 days
2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	5% of Customers supplied by 4kV	20% Reduction of Outages	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service
		Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	5% of Customers supplied by 26/4kV substations	50% Reduction due to raised conductors.	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service
		Add spacer cable to eliminate open wire to targeted areas	Assume 10 circuits. Average customers/13kV section = 735 Customers/section x 10 circuits	40% Reduction due to increased ability to withstand weather events	No Benefit
3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	# of poles impacted/total poles in system * customers	2% Reduction in the number of Outages Due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	No Benefit
	This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	# of poles impacted/total poles in system * customers	2% Reduction due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	No Benefit
4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	Customers supplied by backyard circuits	50% Reduction	Due to better access and newer facilities restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service
5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	Estimate # circuits that could be done to get customer count. Assume 1 mile per circuit, 20 Circuits with average of 735 customers/section	Assume 60% reduction due to damage being avoided on primary lines now Underground.	No Benefit
		B. Replace PM xfmrs with submersible xfmrs in target areas	Avg Customers per padmounted transformers in flood area	Assume 90% reduction in PSE&G equipment outages due to storm surge. Outage duration of 3 days avoided.	No Benefit
		C. Replace ATS switches/transformers with submersible switches	Customer benefit aligned with PM Transformer program as ATS typically supply PM in these areas	Combined with 5B	No Benefit
6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	Total number of Customers	N/A	Low probability event. Assume 1% probability in a major event with Average 6 hour increase in overall restoration.
Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**System Visibility** **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	# Customers in Stations	No Benefit	Assume 4 hour improvement in overall restoration time due to indication of circuit outages, immediate load data for decision making and the ability to remotely set-up circuits for work.
		1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	Benefits Aligned with 1A	Combined with 1A	Combined with 1A
		Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	Benefits Aligned with 1A	Combined with 1A	Combined with 1A
		2b. Pilot Satellite Communication Program	Total number of Customers	No Benefit	Low probability event. Assume 5% probability in a major event with Average 12 hour increase in overall restoration.
		Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	Benefits Aligned with 1A	Combined with 1A	Combined with 1A
		3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	Total number of Customers	No Benefit	Through confirmed damage location visibility, improved look-up process and elimination of duplicate records restoration process will be improved. Assume 4 hour improvement in average restoration in overall storm work.
		3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	Total number of Customers	No Benefit	No Benefit
Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme	Using CIP 2 Major Results of $1.2M per circuit equal 167 13kV circuits. Avg customer count of 1500 = 250,500	Due to reconfiguration of circuits, loop improvement and fusing, 10% reduction in outages.	With greater system redundancy restoration time on average will improve by 10% (7.2 Hours)
Emergency Backup Generator and Quick Connect Stockpile Program	PSE&G to purchase and stockpile emergency backup generators to utilize during storm restoration. Technologies exist whereby a connection can be made to a residential customer electric meter which allows the quick connection of a portable generator.	PSE&G to deploy emergency generators to customers based on priorities driven by local municipal officials. In addition, PSE&G will maintain the supply of quick connects to be deployed as directed.	Number of Generators	No Benefit	Assuming a two day implementation of these measures, outage time reduced by 2 days
Municipal Pilot Program	To improve resiliency of the electric system, particularly by engaging valuable municipal resources in the event of prolonged outages	Develop a municipal storm plan which addresses vegetation maintenance, mobile field applications and a combined heat and power (CHP) pilot for targeted critical municipal facilities meeting the high efficiency specifications for application of this technology.	TBD	TBD	TBD

Program	Description	Actions	Number of Customers	Avoided Outages (Hrs)	Number of Customer Outages Eliminated	Outage Duration Decrease	Total Customer Hours Outage Reduction (Sum Of Outages Avoided and Duration Decreases)
1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	748,500	29,640,600	247,005	11,856,240	41,496,840
2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	30,449	438,471	6,090	175,388	613,859
		Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	29,873	1,075,437	14,937	107,544	1,182,981
		Add spacer cable to eliminate open wire to targeted areas	7,350	211,680	2,940	0	211,680
3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	50,634	72,913	1,013	0	72,913
	This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	1,407	2,025	28	0	2,025
4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	36,973	1,331,028	18,487	133,103	1,464,131
5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	14,700	635,040	8,820	0	635,040
		B. Replace PM xfmrs with submersible xfmrs in target areas	1,894	122,731	1,705	0	122,731
		C. Replace ATS switches/transformers with submersible switches	Combined with 5B	Combined with 5B		Combined with 5B	Combined with 5B
6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	2,250,511	0	0	135,031	Risk Item not included in hours saved
Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**System Visibility** **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	1,134,374	0	0	4,537,496	4,537,496
		1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	Combined with 1A	Combined with 1A		Combined with 1A	Combined with 1A
		Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	Combined with 1A	Combined with 1A		Combined with 1A	Combined with 1A
		2b. Pilot Satellite Communication Program	2,250,511	0	0	1,350,307	Risk Item not included in hours saved
		Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	Combined with 1A	Combined with 1A		Combined with 1A	Combined with 1A
		3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	2,250,511	0	0	9,002,044	9,002,044
		3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	2,250,511	0	0	0	0
Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme	245,824	1,769,933	24,582	1,592,940	3,362,872
Emergency Backup Generator and Quick Connect Stockpile Program	PSE&G to purchase and stockpile emergency backup generators to utilize during storm restoration. Technologies exist whereby a connection can be made to a residential customer electric meter which allows the quick connection of a portable generator.	PSE&G to deploy emergency generators to customers based on priorities driven by local municipal officials. In addition, PSE&G will maintain the supply of quick connects to be deployed as directed.	200	0	0	9,600	9,600
Municipal Pilot Program	To improve resiliency of the electric system, particularly by engaging valuable municipal resources in the event of prolonged outages	Develop a municipal storm plan which addresses vegetation maintenance, mobile field applications and a combined heat and power (CHP) pilot for targeted critical municipal facilities meeting the high efficiency specifications for application of this technology.	TBD	TBD	TBD	TBD	TBD
						Total Outage Hour Reduction	62,714,213
						Total Customers	2,250,511
			Number of Customer Outages Avoided		**325,606**	**Average Outage Reduction Per Customer**	**28**

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

DAMAGE IN TERMS OF DOLLARS, OUTAGES AND EQUIPMENT

QUESTION:
Regarding page 2, lines 44 through 46 of Mr. Cardenas' direct testimony, please quantify the damage in terms of (a) dollar amounts, (b) outage statistics, and (c) damage to PSEG electric infrastructure system equipment for each of the three referenced events.

ANSWER:
Following is a summary of electric costs incurred, outage statistics and infrastructure equipment damage. The summary below is for electric damage only; gas amount and statistics are not included.

A. Dollar Amounts

Electric Distribution Infrastructure ($Millions)	
	Total Cost
Irene	**$ 50.6**
October 2011 Snow Storm	**$ 45.8**
Superstorm Sandy	**$ 282.4**

B. Outage Statistics

Storm	**Customers Affected**
Hurricane Irene	872,492
October 29, 2011 Snow Storm	636,898
Super Storm Sandy	2,014,516

C. Damage To PSE&G Electric Infrastructure System Equipment

Storm	**Outside Plant Damage**
Hurricane Irene	69/26-kV Locations - 78 13/4-kV Locations - 1,384 Transformers - 383 Secondaries - 519 Services - 2,223 Poles - 599 Tree Locations - 2,314
October 29, 2011 Snow Storm	69/26-kV Locations - 66 13/4-kV Locations - 1,340 Transformers - 274 Secondaries - 541 Services - 16,174 Poles - 298 Tree Locations - 12,041
Superstorm Sandy	69/26-kV Locations - 355 13/4-kV Locations - 2,504 Transformers - 1,022 Secondaries - N/A Services - 8,330 Poles - 2,500 Tree Locations - 48,000

Inside Plant Damage:

A list of PSE&G electric station equipment damaged during Hurricane Irene is as follows:

Rahway Cranford Marshall Street Garfield Place River Edge Somerville Hillsdale New Milford	4 kV and 13kV breakers, voltage regulator controls and relay equipment damaged; AC and DC control systems, auxiliary power system damaged.

There was no damage to substation equipment during the October 2011 Snow Storm.

A list of PSE&G electric station equipment damaged during Superstorm Sandy follows:

Bayway Substation	26 and 4 kV breakers and control cabinets and voltage regulator controls damaged.
Linden Switch	138kV breakers and control cabinets, battery chargers and relay equipment damaged.
Sewaren Switch	230, 138 & 26 kV breakers and control cabinet, AC and DC control systems, auxiliary power system damaged.
Cliff Road Substation	26/13kV Unit Substation’s breaker damaged.
Essex Switch and Substation	230 kV Transformers’ auxiliary equipment, breaker and disconnect motor operators; battery chargers, DC control system and relay equipment, 26 kV breakers and both 26/13kV unit substation and 132 kV Reactor Shunt breakers damaged.
Port Street Substation	26/13kV Unit Substations breaker and relay controls, all 4 kV breakers, voltage regulator controls and relay equipment damaged.
Marion Switch	132-3 Phase 2 Transformer failed, six 26 kV reactors failed, six 26 kV reactors failed, 138/26kV breakers, station battery, DC and AC control systems were damaged.
Hudson Switch	230 kV breakers and disconnect motor operators damaged.
Jersey City Switch	Transformer control cabinets, battery chargers, relay equipment and 13 kV breakers damaged.
South Waterfront Switch and Substation	230 kV disconnect motor operators, 26 kV breakers and control cabinets, 13 kV breakers damaged.
Bayonne Switch and Substation	138 and 13 kV disconnect motor operators, relay equipment and 13 kV breakers damaged.
St. Paul’s Avenue Substation	26/13 kV Unit Substation, station battery and relay equipment damaged.
Howell Street Substation	4 kV breakers and voltage regulator controls damaged.
River Road Substation	26/13 kV auxiliary switches damaged.

Marshall Street Substation	4 kV breakers, voltage regulator controls and relay equipment damaged
Madison Street Substation	26 kV breaker compartments, 4 kV breakers, voltage regulator controls and relay equipment damaged.
Hoboken Substation	Disconnect motor operator and 13 kV breakers damaged.
Third Street Substation	4 kV breakers, voltage regulator controls and relay equipment damaged.
Hackensack Substation	4 kV reactors failed; 4 kV breakers, voltage regulator controls and relay equipment damaged.
Little Ferry Substation	Relay equipment damaged.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

IMPROVEMENTS IN REDUCED OUTAGE FREQUENCY AND DURATION

QUESTION:
Regarding page 2, lines 38 through 41 of Mr. Cardenas' direct testimony, has the Company quantified the anticipated improvements in reduced outage frequency and duration associated with the proposed Energy Strong program? If so, please quantify and provide supporting documentation. If not, please explain why not.

ANSWER:
Please see the response to RCR-E-2, which was developed to estimate the impact of avoided outages and reduced durations. Based on these assumptions and a storm of the magnitude of Superstorm Sandy, which had 162,495,633 of customer hours interrupted, PSE&G estimates that on average all customers would see an approximate 39% reduction in outage time due to the investments proposed.

The 39% reduction is calculated as the total reduced customer outage time from the response to RCR-E-2, page 3, divided by the total customer outage time for Superstorm Sandy listed above (62,714,213 / 162,495,633 = 38.59%).

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

COMPANY'S STATION FLOOD MITIGATION STANDARDS

QUESTION:
For the Company's proposed Station Flood Mitigation program, please provide the Company's current standards and/or mitigation plans to address station flood mitigation.

ANSWER:
Please see the attached PSE&G directive entitled "Preventing/Controlling Tidal Surge and Other Flood-Related Damages in Electric Substations" that was issued on March 13, 2013, after FEMA-adjusted flood data was published on January 24, 2013, as a result of Superstorm Sandy. This directive is intended to address re-design of stations which had work planned prior to Superstorm Sandy. Since FEMA published new flood data, re-design projects have been required to include the recently established flood levels. In all other stations where re-designs were not already planned, PSE&G will follow this directive as work is performed based on equipment failure or based upon assessment of equipment that indicates equipment failure is likely.

Following this directive will only provide incremental improvements in stations over time based upon such equipment failures or assessments. With Energy Strong, PSE&G will complete comprehensive mitigation at the impacted stations in the Program within the term of the Program.

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From: Kevin Davideit

Date: March 13, 2013

Subject: **<u>DIRECTIVE</u> – Preventing / Controlling Tidal Surge & Other Flood Related Damage in Substations & Switching Stations**

Historically, the New Jersey Department of Environmental Protection (NJDEP) has taken a strong role in the development of a rigorous floodplain management program at the state level, both pre-dating and supporting those same efforts at the federal level with the Federal Emergency Management Agency (FEMA).
NJDEP is the state agency responsible for coordinating Federal, State and local aspects of flood plain management activities as required under the provisions of the National Flood Insurance Program (NFIP).
The embedded document below provides a high level overview of the aftermath of recent devastating storm events affecting PSE&G substations and switching stations:

- Twenty-one (21) stations impacted by the tidal surge from Superstorm Sandy that fall within the new FEMA Advisory Base Flood Elevations (ABFE).
- Thirteen (13) stations impacted by Hurricane Irene and Other Water Intrusion Events causing flood conditions associated with heavy rains and elevated water levels in rivers, streams, etc. These stations have been cross-referenced with the

NJDEP Flood Hazard Area Limit (FHAL) mapping to define the design elevations in on-going studies (Initial study prepared by Black & Veatch, 3/2/12).

- Sixty-one (61) other stations subsequently identified as being located within the new FEMA ABFE, the FEMA 100-year base flood elevation (BFE) or are on the fringe of either of these FEMA designated areas. Each station will need to be cross-referenced with the NJDEP FHAL mapping to define flood impacts (if applicable) and the design elevations in future studies. Unlike the ABFE or BFE, FHAL information is not readily available in GIS. Each site will need to be cross-referenced to off-line mapping files. The Surveys and Mapping Group can provide these files. (David.coleman@pseg.com, 973-430-8109).

See page 7 below for site details.

In the aftermath of Superstorm Sandy, a number of PSE&G substations and switching stations were directly impacted by the tidal surge of rivers in northern and central New Jersey.
FEMA has adjusted flood data along this corridor, increasing levels by 2ft to 8ft above previously recorded base flood elevations (BFE).
In January, initial Advisory Base Flood Elevation (ABFE) data was released primarily applying to the following 10 coastal counties and superseding portions of previous FEMA mapping: Atlantic, Bergen, Burlington, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean and Union.
The remaining counties in which PSE&G services electric customers (Passaic, Somerset, Mercer, Camden and Gloucester) may not be updated if they were not directly affected by the Sandy tidal surges (coastal).
For stations outside of the coastal areas, refer to previously enacted flood hazard area (pre-Sandy) data from:

1. FEMA – Existing fluvial (river/inland waterway) 100-year flood plain base flood elevation (BFE) maps, or

2. NJDEP - Developed maps based on their New Jersey FHAL which may exceed FEMA pre-Sandy 100-year Base Flood Elevations (BFE) by 2 to 3 feet. FHAL, where applicable, will govern for permitting new construction in the state.

Emergency Regulations approved by Governor Christie and NJDEP on 1/24/13 adopted FEMA's updated ABFE maps as the uniform rebuilding standard for the municipalities affected by the tidal surge. The regulations stated that this preliminary ABFE data reflects the most accurate information about 100 year floods available right now. As the mitigation process moves forward, the ABFEs could be adjusted and may be lower as the mapping is finalized and the formal federal maps are adopted over the next 18 to 24 months.

Furthermore, it should be noted that the causes for flooding of stations not directly affected by the tidal surges discussed above are the result of significant rainfall events coupled with any one or a combination of the following scenarios:

1. Overflow of delineated inland (fluvial) waterways.

2. Rapid accumulation and runoff of surface waters from any source. (partially attributable to overdevelopment above the location of older stations causing an increase in impervious surfaces and subsequent decrease in infiltration rates within existing drainage basins/watersheds)
3. Backup or curtailment of surface flow resulting from clogged inlets directly connected to municipal storm sewer systems.

Scenarios 2 and/or 3 may exacerbate a flood condition but can't be readily quantified without direct visual observation/measurement during and after the storm event. To say that the increase in flood level caused by these conditions, if over and above Scenario 1, could possibly mean the difference between a station remaining in service or tripping out may be difficult to ascertain.

In order to prevent future tidal surge and other flood related damage and to consider all possible design alternatives up to and including perimeter flood walls, treat each station site as unique in its own right, greatly influenced by the location and physical characteristics of the parcel of land that it is constructed upon. The following procedure should be implemented going forward:

Phase I

1. Identify and categorize the affected stations as:
    - Sites that were originally constructed in or near established flood hazard zones (excluding those stations that pre-date the formation of NJDEP in 1972 and the development of comprehensive flood studies for the substation areas).
    - Sites that were impacted for the first time by the tidal surges of Sandy and now fall within the new FEMA Advisory Base Flood Elevations (ABFE).

2. At minimum, assume that all critical equipment/structures shall be elevated to 1ft. above the highest design flood elevation as determined by:
    - FEMA Advisory Base Flood Elevation (ABFE + 1)
    - FEMA Base Flood Elevation (BFE + 1)
    - NJDEP Flood Hazard Limit (FHAL + 1)

    This would include, but not be limited to, transformer control boxes and secondary containment walls, control enclosures of dead and live tank circuit breakers, CT/PT connection boxes, motor operator control boxes of circuit switchers, AC distribution panels, control house and switchgear floors, neutral grounding resistors, 26kV current limiting reactors, pad mount station light and power transformers, etc.

3. Coordinate the following engineering drawings to produce composite profiles that specifically illustrate the critical equipment/structures and existing 'top of concrete' elevations for all foundations (piers, slabs, walls, etc.) that currently support them. Include key site features (driveways, drainage appurtenances, perimeter fencing, property lines, retaining walls, transformer secondary containment and/or other SPCC diversionary structures, etc.) as appropriate to accurately represent a complete profile:
   - Bus Plans and Sections
   - Property Layout / Site Plan, Sections and Details
   - Foundation Plans, Sections and Details

4. Additionally, request updated boundary and topographic surveys from the Surveys & Mapping Group (Internal Services) for each station. Coordinate development of topographic profiles of the property that correspond to the engineering profiles produced in item 3. Add the associated ABFE, BFE, or FHAL line to each profile. These composite scaled images should provide an accurate representation of existing conditions at each station.

5. **<u>Vertical Datums</u>**
   The National Geodetic Vertical Datum of 1929 (NGVD 29), established by the United States Coast and Geodetic Survey (USC&GS), was the official U.S. datum for vertical surveying until the North American Vertical Datum of 1988 (NAVD 88) was released in 1991. Currently, NAVD 88 is the official vertical datum for the United States, against which federal agencies like FEMA measure elevations. It is important to note that PSE&G substations and switching stations whose boundary and topographic surveys were produced prior to PSE&G's transition to NAVD 88 were based on either:
   - PS Datum (tied to a local benchmark with an arbitrarily set elevation of 100.00) or
   - NGVD 29

   Of those stations, only the ones that have experienced major expansions/upgrades in the last 20 years or so (requiring municipal site plan approval) have been re-surveyed in accordance with NAVD 88. This can become an issue especially when the engineering drawings associated with the original installations (item 3) reference the PS Datum or NGVD 29 elevations. These elevations must be converted to NAVD 88 in order to be consistent with FEMA ABFEs. **In other words, all 'active' civil and electrical drawings currently stored in PSE&G's Document Management System (DMS) that contain elevation references must be reviewed and updated to reflect the most recent vertical datum data.** The Surveys and Mapping Group will prepare a vertical datum chart for each station surveyed that will provide conversions between station vertical datum/NGVD29/NAVD88, the associated FEMA 100yr flood elevation, and if applicable, the NJ State studied 100yr flood elevation and Flood Hazard Area Limit elevation.

6. Assume that some major reconstruction of foundations will be required. When the appropriate design alternatives are finalized for each location, obtain new/recently updated geotechnical engineering investigations as necessary to expedite completion of the licensing and permitting process.

Phase II

1. Schedule individual site visits to confirm drawing accuracy and identify other onsite/offsite structures, equipment, topographic and other natural/man-made features requiring consideration when developing flood mitigation design alternatives for discussion.

2. In all cases, the alternative selection process must provide due consideration for continued barrier-free accessibility to these sites for operations and maintenance activities as well as for the safety and security of our employees and customers.

Hardening – Electric
Station Flood Mitigation

PSE&G has recently proposed several "hardening and resiliency" initiatives as part of the Energy Strong Program. The Energy Strong Program focuses on those items that will allow the electric system to effectively sustain or quickly respond to future severe, damaging weather related events. In response to concerns associated with flooding this paper provides definitions and tables that describe the stations impacted by Hurricane Irene, Superstorm Sandy and other water intrusion events. Additionally, this paper utilizes the "new" coastal FEMA Advisory Base Flood Elevations (ABFE) and the existing fluvial (river) FEMA 100-year flood plain Base Flood Elevations (BFE) to classify those stations and/or equipment that are at risk to future flooding events or tidal surge events. In general, the stations defined in these tables require further engineering evaluation including, but not limited to updated geo-technical, topographic surveys, storm surge analysis, and hydraulic studies. These engineering efforts will help determine the level of risk and aid in defining the scope for flood protection schemes (relocate/raise-rebuild/flood walls).

- In January 2013 FEMA released the "new" coastal Advisory Base Flood Elevations. These new advisory elevations were approved and accepted by the NJDEP and provide new flood elevations for 10 counties in New Jersey. The new advisory elevations primarily apply to coastal counties only, and supersede portions of previous FEMA mapping.

- The existing fluvial (river) FEMA 100-year flood plain Base Flood Elevation (BFE) maps are based on hydrologic and hydraulic models, topographic and bathymetric surveys (depth of water bodies), and detailed engineering studies. These elevations have been available and historically utilized. For purposes of this paper, the BFE will be applied to all PSE&G facilities not within the new ABFE.

The (21) stations listed in the "Stations Impacted by Sandy" table define the stations that were affected by the tidal surge from Superstorm Sandy and are within the new ABFE.

Stations (21) Impacted by Sandy			
Station Name	**Location**	**Station Name**	**Location**
Sewaren 230/138/26kV	Woodbridge	* Bayway Sw. /Sub.	Elizabeth
Essex 230/138/26kV	Newark	Madison	Hoboken
Hudson 230kV	Jersey City	Hackensack	Hackensack
Linden 230/138/26kV	Linden	Jersey City 13kV	Jersey City
Bayonne 138/26/13	Bayonne	St Paul's	Jersey City
* Marion 138/26kV	Jersey City	Little Ferry	Little Ferry
Hoboken	Hoboken	Howell	Jersey City
* Marshall St	Hoboken	Cliff Rd	Woodbridge
River Rd	North Bergen	Third St	South Kearny
South Waterfront	Jersey City	Port St	Newark
** Newark Airport Breaker Station	Newark /Elizabeth		

* Stations impacted by both Hurricane Irene and Superstorm Sandy
** As a result of temporary measures taken prior to Superstorm Sandy, this breaker station was not impacted by storm surge, and is therefore not included in the total number of station outages resulting from the storm.

The (13) stations listed in the "Stations Impacted by Irene and Other Water Intrusion Events" are the stations that were affected by the flooding events from storms with heavy rains and usually associated with elevated water levels from rivers, streams, etc. The majority of these stations do not fall within the new ABFE but, are part of the FEMA BFE. These stations have been cross-referenced with the NJDEP Flood Hazard Limit mapping to define the design elevations in on-going studies.

Stations (13) Impacted by Irene and Other Water Intrusion Events			
Station Name	**Location**	**Station Name**	**Location**
* Marion 138/26kV	Jersey City	* Bayway Sw. /Sub.	Elizabeth
New Milford	New Milford	* Marshall St	Hoboken
Hillsdale	Hillsdale	Ewing	Ewing
Somerville Substation	Somerville	Belmont	Garfield
Jackson Road	Wayne	Garfield Place	Wallington
Rahway Substation	Rahway	River Edge	River Edge
Cranford	Cranford		

* Stations impacted by both Hurricane Irene and Superstorm Sandy

The stations (61) listed below were identified using FEMA mapping. Each station will be cross-referenced with the NJDEP Flood Hazard Limit mapping to define flood impacts (if applicable) and the design elevations in future studies.

Stations (61) identified using FEMA mapping			
Station Name	**Location**	**Station Name**	**Location**
49TH Street Pothead Rack	North Bergen	Lakeside Avenue Substation	Orange
Academy Street Substation	Jersey City	Lawnside Substation	Lawnside
Albany Street Breaker Station	New Brunswick	Leonia Substation	Leonia
Arcola Substation	Paramus	Locust Street Substation	Camden
Beaver Brook Substation	Beaver Brook	Market Street Substation	Camden
Bennett's Lane Substation	Franklin Twp.	McLean Boulevard Substation	Paterson
Bergen Point Substation	Bayonne	Morgan Street Substation	Jersey City
Bergen Switching Station	Ridgefield Park	Mountain Avenue Substation	Bridgewater
Bridgewater Switching Station	Bridgewater	New Freedom Switching Station	Winslow Twp
Camden Switching Station	Pennsauken	Newport Substation	Jersey City
Carlstadt Substation	Carlstadt	North Avenue Substation	Elizabeth
Clay Street Substation	Newark	North Bergen Substation	North Bergen
Constable Hook Substation	Bayonne	Orange Valley Substation	Orange
Cuthbert Blvd. Substation	Cherry Hill	Paramus Park Mall Substation	Paramus
Dayton Unit Substation	Dayton	Passaic Substation	Passaic
Deans Switching Station	South Brunswick	Paterson Substation	Paterson
Devils Brook Substation	South Brunswick	Penhorn Substation	Jersey City
Edison Switching Station	Edison	Plank Road Substation	Newark
Elizabeth Substation	Elizabeth	Ridgefield Substation	Ridgefield Park
First Street Substation	Elizabeth	Roseland Switching Switch	Roseland
Foundry Street Substation	Newark	Runnemede Substation	Runnemede
Frank Rodgers Unit Substation	Harrison	State Street Substation	Trenton
Franklin Substation	Franklin Twp	Toney's Brook Substation	Bloomfield
Gloucester Switching Station	Gloucester	Tremley Substation	Linden
Hasbrouck Heights Substation	Hasbrouck Heights	Turnpike Substation	Kearny
Hinchman's Avenue Substation	Wayne	Warinanco Substation	Linden
Homestead Substation	North Bergen	Waverly Substation	Newark
Ironbound Substation	Newark	Westfield Substation	Westfield

Stations (61) identified using FEMA mapping			
Kearny Switch Switching Station	South Kearny	Woodbury Substation	Woodbury
Kilmer Substation	Piscataway	Woodlynne Substation	Woodlynne
Kingsland Substation	North Arlington		

Note:

1. The ABFE were released January 2013 and apply only to the following counties: Atlantic, Bergen, Burlington, Cape May, Essex, Hudson, Middlesex, Monmouth, Ocean and Union.
2. Counties that were not updated in the new ABFE and where PSE&G electric customers are served include: Passaic, Somerset, Mercer, Camden and Gloucester.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SUPPORTING STUDIES TO ASSESS RESILIENCY

QUESTION:
With regard to the response to RCR-E-2, please provide supporting studies, if any, relied upon by the Company to assess the resiliency of its electric delivery system.

ANSWER:
The assumptions supporting the impact of the Company's Energy Strong resiliency investments are based on operational knowledge in daily operations and in extreme weather events from experienced PSE&G personnel. Those assumptions were used by the Brattle Group to quantify the benefit to customers. For the Brattle Group Study, see the responses to S-PSEG-ES-2 & S-PSEG-ES-25.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PAD-MOUNTED SWITCHES

QUESTION:
Regarding page 20, lines 444 of Mr. Cardenas' Direct Testimony, please identify the number of customers served by the 75 identified pad-mounted switches.

ANSWER:
The 58 units that were flooded during Sandy feed approximately 27,000 customers, a combination of both office buildings and residential. The remaining 17 locations in flood prone areas serve approximately 7,900 customers.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PAD-MOUNTED SWITCHES AND EXISTING TECHNOLOGIES

QUESTION:
Regarding page 20, lines 444 of Mr. Cardenas' Direct Testimony, please provide the estimated cost of replacing the 75 pad-mounted switches with existing technologies.

ANSWER:
The cost of replacing an Automatic Transfer Switch (ATS), post-Superstorm Sandy, was an average of $85,000. The total estimated cost to replace the 75 pad-mounted switches with existing technologies is $6.375M.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

CUSTOMERS SERVED BY PAD-MOUNTED TRANSFORMERS

QUESTION:
Regarding page 22, lines 465 and 466 of Mr. Cardenas' Direct Testimony, please identify the number of customers served by the 200 identified pad-mounted transformers.

ANSWER:
An exact number of customers cannot be determined, until the specific transformers are identified. These large three phase transformers typically supply one to six customers; therefore the number of customers supplied by the submersible replacement transformers will be between 200 and 1200. It is important to note that one customer could be a building with 200 household units expanding the potential impact of a pad mount transformer failing.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

REPLACEMENT COST OF PAD-MOUNTED TRANSFORMERS

QUESTION:
Regarding page 22, lines 465 and 466 of Mr. Cardenas' Direct Testimony, please provide the estimated cost of replacing the 200 pad-mounted transformers with existing technologies.

ANSWER:
Depending on the complexity of the job and the size of the transformer, the cost to replace a pad mounted transformer is approximately $10,000. The total estimated cost of replacing the 200 pad-mounted transformers with existing technologies is $2,000,000.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PROPOSED CONTINGENCY RECONFIGURATION STRATEGY

QUESTION:
Regarding page 31, lines 679 and 680 of Mr. Cardenas' Direct Testimony, through its proposed contingency reconfiguration strategy is the Company proposing to reconfigure its entire distribution system? If so, please explain. If not, please quantify the number of feeders and circuits targeted for loop reconfiguration.

ANSWER:
The contingency reconfiguration strategy does not propose to reconfigure the entire distribution system. The intent of this strategy is to optimally reconfigure those circuits that could benefit most from this program. The circuit selection criteria consists of the number of customers impacted, historical storm outage data, high profile customers such police, hospitals, sewage and water treatment facilities that have global impact on the community. After completion of the engineering design, the Company will determine the number of targeted circuits.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

CIRCUIT OUTAGE DATA AND PLANT DAMAGE REPORTS

QUESTION:
Regarding page 14, line 299 of Mr. Cardenas' Direct Testimony, please provide the "circuit outage data and plant damage reports" referenced in the testimony.

ANSWER:
The Company objects to this request due to the volume of all the circuit damage and outage reports and the onerous nature of providing all that information. Notwithstanding or in any way limiting the foregoing, the Company is hereby providing a sample of the data the Company would analyze to select the equipment to be upgraded. Each record is referred to as a plant damage report. Plant damage reports over the past several years will be analyzed, which equates to tens of thousands of records.

Additional data can be provided upon request.

Enterprise Detail Report On Demand with Alerts for: > 3 Hours and Watch List

From: 05/12/2013 To: 05/12/2013

05/12/2013

Central Division

Incident	Event	Time	- Source Station - (POR DIV)	- Station Circuit - Device	Momentary Customers <=5 Minutes	Extended Customers >5 Minutes to 1 Hour	>1 Hour to 3 Hours	>3 Hours	Cust. Not Restored	Total Extended Cust.	Dur.	Type of Construction	Equipment Damaged	Cause of Trouble
2004258049	2004552780	13:59	Bennetts Lane (03)	BEN8023 SSUB	0	916	0	0	0	916	0:14	13-kv Insulation(spacer)	Oh transformer	OH - TRANSFORMER
50 kva Transformer On P-63o57 Redmond St. Near Omaha Rd..trouble Has it So It Is In and Working Presently,however It Is All Burnt And Damaged,and Should Be Replaced Asap. Cbs Tdgpw														
2004258112	2004552763	14:01	Brunswick Sub (03)	BRU8013 FUSE	0	0	0	70	0	70	7:17	Bud Construction	Bud primary cable	UG - BUD - CABLE
Bud 98 Multi problems... Pd 175 Transformer Was Filled With Mud And Could Not Operate... Cable Failure Between 628 And 111... And To Top It Off The Cutout Had To Be Change Before Energizing... All Cust Restored... Cbs Tdgpw														
2004258149	2004552827	17:06	Kilmer (03)	KIL8023 SSUB Watch List	0	0	1,712	0	0	1,712	1:18	Owa 3 Ph Covered	Oh conductor	OH - CONDUCTOR - OPEN WIRE ARMLESS
	2004552830	17:06	Kilmer (03)	KIL8023 REC_FRL Watch List	79	0	0	0	0	0	0:01	Owa 3 Ph Covered	Oh conductor	OH - CONDUCTOR - OPEN WIRE ARMLESS
Phase Down. Made Safe And Restored. Line Dept To Make Repairs. Cbs Tdgpw														
				Central Division Totals:	79	916	1,712	70	0	2,698			**Preliminary Daily CAIDI:**	**65.59**

Enterprise Detail Report On Demand with Alerts for: > 3 Hours and Watch List

From: 05/12/2013 To: 05/12/2013

05/12/2013

Metro Division

Incident	Event	Time	- Source Station - (POR DIV)	- Station Circuit - Device	Momentary Customers <=5 Minutes	Extended Customers >5 Minutes to 1 Hour	>1 Hour to 3 Hours	>3 Hours	Cust. Not Restored	Total Extended Cust.	Dur.	Type of Construction	Equipment Damaged	Cause of Trouble
2004258216	2004552884 PORPRI PSED-05122 013-0185	18:51	Paterson (07)	PAT4012 SSUB	0	685	0	0	0	685	0:45	4-kv Spacer Cable	Oh transformer	OH - TAP
Primary Tap To A 50kva Lighting Pot Of A Open Delta @ 83 Lafayette St, Pat Pulled Out Of Bushing And Grounded Pot On Pole 65165, Repaired Temp														
Metro Division Totals:					0	685	0	0	0	685		**Preliminary Daily CAIDI:**	**45.00**	

05/12/2013

Palisades Division

Incident	Event	Time	- Source Station - (POR DIV)	- Station Circuit - Device	Momentary Customers <=5 Minutes	Extended Customers >5 Minutes to 1 Hour	>1 Hour to 3 Hours	>3 Hours	Cust. Not Restored	Total Extended Cust.	Dur.	Type of Construction	Equipment Damaged	Cause of Trouble
2004257976	2004552618 PORPRI PSED-05122 013-0026	06:30	Saddle Brook (05)	SAD8043 REC_FRL	1,068	0	0	0	0	0	0:01	13-kv Shielded Spacer Cable	None	UNKNOWN - NO TROUBLE FOUND
Fr-tr, No Reports Of Trouble To Be Patrolled Cbs Tdj9t														
2004258000	2004552653 PORPRI PSED-05122 013-0034	07:10	East Rutherford Sub (05)	EAT8021 FUSE	0	0	274	0	0	274	1:01	2 Ph Covered(crossarm)	None	OH - TREE - NON PREVENTABLE
F-o, Limb Cut Clear Refused Ok Cbs Tdj9d														
2004258122	2004552787 PORPRI PSED-05122 013-0134	14:21	River Edge (05)	RIG8003 FUSE Watch List	0	0	44	0	0	44	2:09	2 Ph Covered(crossarm)	Oh conductor	OH - TREE - NON PREVENTABLE
F-o, Tree Condition Brought Phase Down Cbs Tdj9t														
2004258171	2004552850 PORPRI PSED-05122 013-0163	17:04	Waldwick (05)	WAD8015 FUSE Watch List	0	0	11	0	0	11	1:07	Bud Construction	Bud riser cable	UG - BUD - RISER
F-o, Riser Cable Bad Ref To Ug P62303, Primary Break Closed Everyone Back In Power , 18:12 Cbs Tdj9t														
Palisades Division Totals:					1,068	0	329	0	0	329		**Preliminary Daily CAIDI:**		**70.29**

05/12/2013

Southern Division

Incident	Event	Time	- Source Station - (POR DIV)	- Station Circuit - Device	Momentary Customers <=5 Minutes	Extended Customers >5 Minutes to 1 Hour	>1 Hour to 3 Hours	>3 Hours	Cust. Not Restored	Total Extended Cust.	Dur.	Type of Construction	Equipment Damaged	Cause of Trouble
2004257973	2004552593 PORPRI PSED-05122 013-0024	06:07	Marlton (08)	MAR8003 REC_FRL	536	0	0	0	0	0	0:01	13-kv Insulation(spacer)	Oh conductor	OH - ANIMAL - HAD GUARD
Oh Called Out To Repair Main Line Spacer. Custs Bis. Feeding Both Ways.. cbs Cmves														
2004257979	2004552625 PORPRI PSED-05122 013-0028	06:30	Lawnside (08)	LAW8015 SSUB	0	0	536	0	0	536	1:14	1 Ph Covered(standoff)	Oh transformer	OH - ANIMAL - HAD GUARD
	2004552622 PORPRI PSED-05122 013-0172	06:31	Lawnside (08)	LAW8015 REC_FRL	240	0	0	0	0	0	0:01	1 Ph Covered(ridge Pin)	Oh transformer	OH - ANIMAL - NO GUARD
P#60739 Transformer Lid Blew Off. Animal Contact. Trans. Jumpers Installed In Front Of House #43....law 8015 Fr Would Not Close And Had To Wait Til Op Went To Station To Get Cust Back, Law 8015-25 X-fer Bkr Closed Due To Tran Outage, Cbs Cmves														
2004257981	2004552627 PORPRI PSED-05122 013-0037	07:10	Beaver Brook (08)	BEA8006 FUSE	0	0	14	0	0	14	1:13	1 Ph Bare(ridge Pin)	None	OH - ANIMAL - HAD GUARD
P#60740 Animal Contact At Transformer, Refused Lateral At 100a. Trans Ok cbs Cmves														
2004257986	2004552632 PORPRI PSED-05122 013-0029	06:49	Bustleton (08)	BUS8011 FUSE	0	0	7	0	0	7	2:21	13-kv Shielded Spacer Cable	Arrester	OH - ANIMAL - HAD GUARD
All Custs. Bis 0910hrs. Rfo. Cbs Cmves														

05/12/2013

Southern Division

Incident	Event	Time	- Source Station - (POR DIV)	- Station Circuit - Device	Momentary Customers <=5 Minutes	Extended Customers >5 Minutes to 1 Hour	Extended Customers >1 Hour to 3 Hours	Extended Customers >3 Hours	Extended Customers Cust. Not Restored	Extended Customers Total Extended Cust.	Dur.	Type of Construction	Equipment Damaged	Cause of Trouble
2004258042	2004552689 PORPRI PSED-05122 013-0089	11:17	Maple Shade (08)	MAD8038 FUSE	0	0	21	0	0	21	1:23	3 Ph Bare(armless)	None	UNKNOWN - NO TROUBLE FOUND
Patrolled Clear, Refused Ok. All Custs. Cbs Cmves														
2004258183	2004552878 PORPRI PSED-05122 013-0170	17:48	Fernwood Unit 8051 (08)	FEN8051 FUSE	0	27	0	0	0	27	0:41	1 Ph Covered(ridge Pin)	None	OH - CUTOUT - SWITCH
Cutout Blew At Pole 66758 Patrolled Circuit Line Was Clear..refused At Same Pole 65amp..fuse Holding Customers Back In Power..complete cbs Cmves														
2004258219	2004552883 PORPRI PSED-05122 013-0184	18:56	Penns Neck (08)	PEK8035 FUSE	0	19	0	0	0	19	0:38	1 Ph Covered(ridge Pin)	None	OH - TREE - NON PREVENTABLE
Tree Limb Down On 1/0 Primary And Neutral. Cut Clear And Refuse 100 Amps At Pole 62109 To Restore Power. Cbs Cmves														
Southern Division Totals:					776	46	578	0	0	624		**Preliminary Daily CAIDI:**		**72.51**

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
BACKYARD CONSTRUCTION AREAS

QUESTION:
Regarding page 18, lines 389 and 392 of Mr. Cardenas' Direct Testimony, please identify the number of linear feet of lines and the number of back yard poles in the Company's service territory.

ANSWER:
PSE&G has identified the associated towns and approximate number of customers supplied by backyard construction areas. PSE&G does not track backyard construction and other construction types separately and distinctly in its data and mapping systems. Based on this customer count, an estimate was made of the linear feet of conductor and the number of poles for backyard areas.

DESCRIPTION	**QUANTITY**
Municipalities	53
Customers	36, 970
Linear feet of conductor	2,218,380 (420 miles)
Number of poles	22,184

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

CIRCUITS CURRENTLY WITH SCADA

QUESTION:
Regarding the response to RCR-E-66, how many of those circuits and feeders with supervisory control and data acquisition ("SCADA") field equipment were damaged in each of the following three major storm events: Hurricane Irene, Derecho, and Superstorm Sandy.

ANSWER:
Approximately 405 circuits with SCADA field equipment were damaged during Superstorm Sandy and 225 were damaged during Hurricane Irene.

The Derecho event did not affect PSE&G's service territory.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
STUDIES SUPPORTING UNDERGROUNDING PROGRAM

QUESTION:
With regard to the response to RCR-E-2, please provide any and all studies conducted, commissioned, and/or relied upon by the company regarding converting circuits from Overhead to Underground as part of the Undergrounding program

ANSWER:
In the development of the targeted underground program, PSE&G reviewed the following documents: Edison Electric Institute (EEI) report entitled "Out of Sight, Out of Mind – 2012, An Updated Study on the Undergrounding Of Overhead Power Lines," published in January 2013, and the Edison Electric Institute (EEI) report entitled "Before And After The Storm, A compilation of recent studies programs and policies related to storm hardening and resiliency," published in January 2013.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

UNDERGROUNDING PROGRAM CRITERIA

QUESTION:
With regard to the response to RCR-E-2, what criteria were used to determine which circuits would be converted from Overhead to Underground as part of the Undergrounding program?

ANSWER:
The selection criteria for the target undergrounding program is based on

- area accessibility (for trucks and heavy equipment)
- conditions of the terrain (including vegetation density and tree root mitigation)
- soil conditions (rock vs. dirt and compactness of ground material)
- outage history (based on major storm events)
- circuit criticality (number of critical customers such as emergency services, water treatment plants, etc.)
- station supply circuits (circuits which feed substations)

The identification of the exact circuits to be selected for this program is still a work in progress.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

VEGETATION MANAGEMENT

QUESTION:
Has the Company evaluated enhanced vegetation management as an alternative to its proposed Energy Strong program? If so, please provide any analyses. If not, please explain why not.

ANSWER:
Please see the responses to S-PSEG-ES-61 and RCR-E-82.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

FREQUENCY OF MAJOR STORM EVENTS

QUESTION:
Is it the Company's opinion that major events like Hurricane Irene and Sandy will be more frequent in the future? Please explain the Company's position and identify the sources of information relied upon by the Company to support its conclusion.

ANSWER:
Based on recent experiences of extreme weather such as the storms reverenced in this question, the Company proposed Energy Strong to harden the PSE&G distribution systems and system and make the systems more resilient to better withstand and respond to extreme weather conditions in the future. The Company has not developed a forecast of future extreme events.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

RESPONSE TO MAJOR STORM EVENTS

QUESTION:
Is it the Company's opinion that its (a.) present and (b.) proposed response for major storm events is reasonable and prudent? If so, please explain. If not, please explain why not.

ANSWER:
Yes. The Company's current plans to respond to major storm events build upon the plans used and implemented during Superstorm Sandy, which were reasonable and prudent by any reasonable measure. Since the future plans build upon and improve on that response, PSE&G's proposed plans are also reasonable and prudent.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

COST/BENEFIT ANALYSIS FOR OTHER STORMS

QUESTION:
With reference to the response to S-PSEG-ES-2, please restate the cost benefit analysis of the proposed Energy Strong program for (a.) Hurricane Irene and (b.) October Storm scenarios. Please provide all supporting inputs and calculations in electronic format with formulae intact.

ANSWER:

a. Please refer to Excel document named RCR-E-131-1 - Hurricane Irene.xls Tab Q131.

b. Please refer to Excel document named RCR-E-131-2 - October SnowStorm.xls Tab Q131.

Cost Benefits Analysis – Hurricane Irene

Program	Actions	Total Estimated Costs ($ Million)	Number of Customers affected	Avoided Outages (Hrs)	Outage Duration Decrease (Hrs)	Total Customer Outage Reduction (Hrs)	Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio	Rank Based on Cost/Benefit Ratio
1. Station Flood Mitigation	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	$ 1,678	169,020	2,342,617	937,047	3,279,664	$ 1,244.82	1.35	1
2. Outside Plant Higher Design and Construction Standards	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	$ 65	12,012	46,132	18,453	64,584	$ 24.51	1.68	2
	Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	$ 60	11,784	113,147	11,315	124,462	$ 47.24		
	Add spacer cable to eliminate open wire to targeted areas	$ 10	2,899	22,271	0	22,271	$ 8.45		
3. Strengthening Pole Infrastructure	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	$ 102	19,631	7,540	0	7,540	$ 2.86	35.70	4
	Non-wood poles	$ 3	545	209	0	209	$ 0.08		
4. Rebuild/Relocate Backyard poles	Rebuild backyard poles (including tree trimming)	$ 100	14,585	140,038	14,004	154,042	$ 0.12	827.85	5
5. Undergrounding	A. Convert certain OH areas to UG	$ 60	5,799	66,813	0	66,813	$ 25.36	2.51	3
	B. Replace PM xfmrs with submersible xfmrs in target areas	$ 8	747	12,913	0	12,913	$ 4.90		
	C. Replace ATS switches/transformers with submersible switches	$ 8	Combined with 5B	Combined with 5B	Combined with 5B	Combined with 5B	$ -		
6. Relocate ESOC/GSOC/DERC/SR	Relocate critical operating centers	$ 15	872,492	0	0	0	$ -	No Benefit	0

Cost Benefits Analysis – 2011 October Snowstorm

Program	Actions	Total Estimated Costs ($ Million)	Number of Customers affected	Avoided Outages (Hrs)	Outage Duration Decrease (Hrs)	Total Customer Outage Reduction (Hrs)	Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio	Rank Based on Cost/Benefit Ratio
1. Station Flood Mitigation	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	$ 1,678	0	0	0	0	$ -	No Benefit	0
2. Outside Plant Higher Design and Construction Standards	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	$ 65	8,768	38,622	15,449	54,071	$ 20.52	2.01	1
	Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	$ 60	8,602	94,729	9,473	104,202	$ 39.55		
	Add spacer cable to eliminate open wire to targeted areas	$ 10	2,116	18,646	0	18,646	$ 7.08		
3. Strengthening Pole Infrastructure	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	$ 102	14,330	6,312	0	6,312	$ 2.40	42.64	3
	Non-wood poles	$ 3	398	175	0	175	$ 0.07		
4. Rebuild/Relocate Backyard poles	Rebuild backyard poles (including tree trimming)	$ 100	10,647	117,242	11,724	128,966	$ 0.10	988.81	4
5. Undergrounding	A. Convert certain OH areas to UG	$ 60	4,233	55,937	0	55,937	$ 21.23	3.00	2
	B. Replace PM xfmrs with submersible xfmrs in target areas	$ 8	545	10,811	0	10,811	$ 4.10		
	C. Replace ATS switches/transformers with submersible switches	$ 8	Combined with 5B	Combined with 5B	Combined with 5B	Combined with 5B	$ -		
6. Relocate ESOC/GSOC/DERC/SR	Relocate critical operating centers	$ 15	636,898	0	0	0	$ -	No Benefit	0

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

UPDATED COST-BENEFIT ANALYSIS

QUESTION:
With reference to the response to AARP-9, will PSE&G provide an updated cost-benefit analysis if the proposed Energy Strong Program is approved?

ANSWER:
Please see the Response to RCR-G-POL-83.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PA CONSULTING REPORTS

QUESTION:
Regarding page 5, line 112 of Mr. Cardenas' direct testimony, please provide the PA Consulting reports referenced in footnote 1.

ANSWER:
Please note that in footnote 1 there is no reference to "PA Consulting" reports. The PA Consulting Group does issue a letter each year where outstanding reliability performance is recognized. In PSE&G's case, the letters state that PSE&G's process for collecting, analyzing, verifying and reporting reliability statistics has been certified by PA Consulting for its accuracy and completeness and that the reported reliability statistics fairly represent the actual reliability of the system.

Below is a listing of the performance years and awards for which PSE&G was recognized:

2001 - Mid-Atlantic Award
2002 - Mid-Atlantic Award
2003 - Mid-Atlantic Award
2004 - Mid-Atlantic Award, National Award
2005 - Mid-Atlantic Award, National Award
2006 - Mid-Atlantic Award
2007 - Mid-Atlantic Award, National Award
2008 - Mid-Atlantic Award, National Award
2009 - Mid-Atlantic Award
2010 - Mid-Atlantic Award, Outage Response to a Major Event (March 2010 Nor'easter)
2011 - Mid-Atlantic Award, National Award, Outage Response to a Major Event (Hurricane Irene and the October Snowstorm)

Attached are copies of the letters to PSE&G from the PA Consulting Group recognizing PSE&G's outstanding reliability performance for the years 2011 and 2010.

ReliabilityOne™
AWARDED BY PA Consulting Group

PA Consulting Group
45th Floor
The Chrysler Building
405 Lexington Avenue
New York, NY 10174
www.paconsulting.com
Tel: +1 212 973 5900
Fax: +1 212 973 5959

October 23rd, 2012

Mr. John Latka
Vice President, Electric Operations
Public Service Electric and Gas Company
80 Park Plaza
Newark, NJ 07101

Dear John:

PA Consulting Group has completed its Reliability Certification Review of Public Service Electric and Gas (PSE&G) Company's distribution reliability results for the year ending December 31, 2011. We are pleased to report that within industry norms and standards PSE&G's process for collecting, analyzing, verifying and reporting reliability statistics has been certified by PA Consulting Group for its accuracy and completeness and we believe that the reported reliability statistics fairly represent the actual reliability of the system.

Our examination was made in accordance with generally accepted utility industry practices and formulas, and accordingly included a review of the outage records and all relevant procedures. These efforts included: (1) conducting interviews with the personnel involved in the data collection, calculation and reporting of electric distribution outage statistics, (2) reviewing and documenting the processes involved, (3) examining the policies, procedures, forms and records used to gather and report results, and (4) sampling and analysis of outage data.

PA Consulting Group congratulates PSE&G for their outstanding reliability performance for the year 2011.

Best regards,

Jeffrey H. Lewis

Jeffrey H. Lewis
Program Director - ReliabilityOne™
Practice Head and Member of PA's Management Group

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45th Floor
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405 Lexington Avenue
New York, NY 10174
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www.paconsulting.com

November 15, 2011

Mr. John Latka
Vice President, Electric Operations
Public Service Electric and Gas Company
80 Park Plaza
Newark, NJ 07101

Dear John:

PA Consulting Group has completed its Reliability Certification Review of Public Service Electric and Gas (PSE&G) Company's distribution reliability results for the year ending December 31, 2010. We are pleased to report that within industry norms and standards PSE&G's process for collecting, analyzing, verifying and reporting reliability statistics has been certified by PA Consulting Group for its accuracy and completeness and we believe that the reported reliability statistics fairly represent the actual reliability of the system.

Our examination was made in accordance with generally accepted utility industry practices and formulas, and accordingly included a review of the outage records and all relevant procedures. These efforts included: (1) conducting interviews with the personnel involved in the data collection, calculation and reporting of electric distribution outage statistics, (2) reviewing and documenting the processes involved, (3) examining the policies, procedures, forms and records used to gather and report results, and (4) sampling and analysis of outage data.

PA Consulting Group congratulates PSE&G for their outstanding reliability performance for the year 2010.

Best regards,

Jeffrey H. Lewis
Program Director - ReliabilityOne™
Practice Head and Member of PA's Management Group

Encl: ReliabilityOne™ Replica

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

BOARD OF DIRECTORS PRESENTATIONS

QUESTION:
Please provide copies of any presentations to the PSE&G and PEG Boards of Directors concerning the Energy Strong Program.

ANSWER:
Attached please find the following presentations to the PSEG Board of Directors on the Energy Strong Program:

1. PSE&G - Transmission and Distribution (Energy Strong Infrastructure Program) Infrastructure Investments, dated February 19, 2012

2. PSE&G - Current Developments and Initiatives dated April 16, 2013

PSE&G – Transmission and Distribution (Energy Strong Infrastructure Program) Infrastructure Investments

February 19, 2013

Ralph LaRossa
President and Chief Operating Officer, PSE&G

PSEG

Transmission and Distribution Infrastructure Investments

- As a result of unprecedented weather events over the last two years, PSE&G is proposing investments to work towards improving our ability to withstand and recover from severe storms
- PSE&G is proposing to file a petition with the NJBPU seeking approval for an Energy Strong Infrastructure Program (ESIP) which will harden electric and gas distribution infrastructure making it less susceptible to extreme wind and water damage
- In addition, the filing would propose investments to increase the resiliency of the electric distribution system to recover more quickly from damage to any of its components or any of the external systems on which it depends
- The filing complements the NJBPU's recently issued order requiring all Electric Distribution Companies to take specific actions to improve preparedness and response to major storms
- ESIP's methodology and cost recovery are modeled after the 2009 Capital Infrastructure Program (CIP I) providing contemporaneous returns and requesting our allowed ROE of 10.3% and cost of capital approved in our 2010 rate case

Transmission and Distribution Infrastructure Investments (cont'd)

- In addition to the filing, there are Transmission projects associated with station flood mitigation that are proposed and would be handled separately through the FERC Formula Rate process and are not part of the NJBPU filing
- Transmission projects are assumed to receive the allowed ROE of 11.68% with no incentives

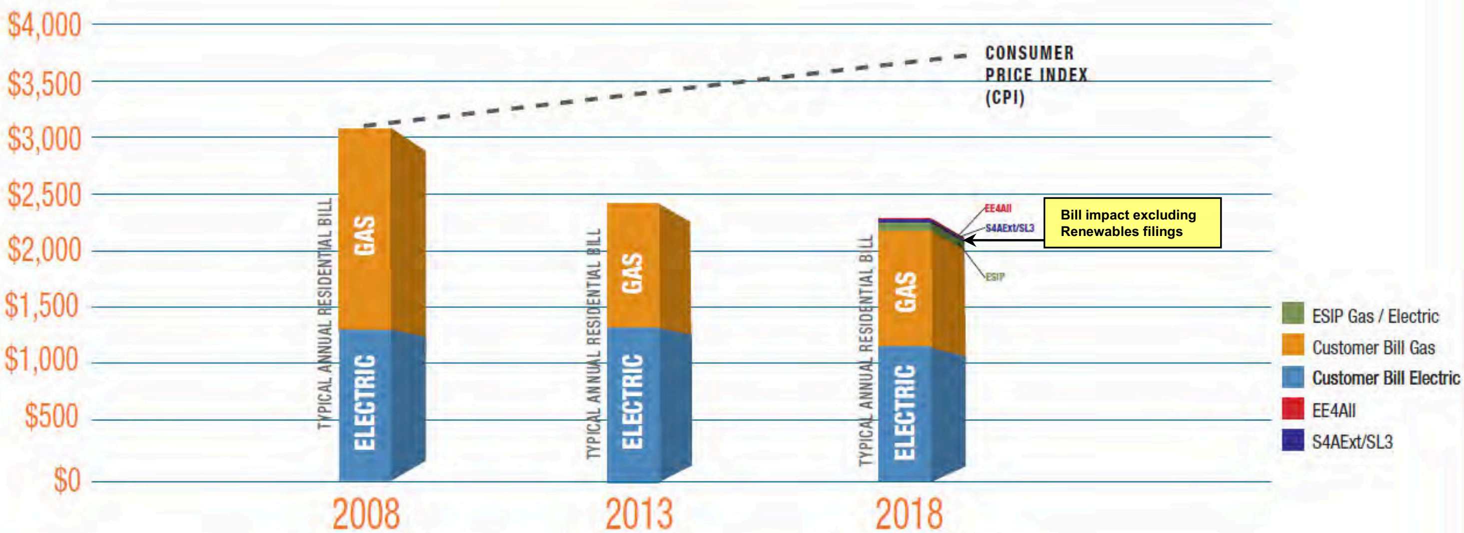
Distribution (ESIP) and Transmission Investment Levels

$ Millions	2013	2014	2015	2016	2017	2018-2023	Total
Electric Distribution Investment	40	183	291	421	415	1,412	**2,762**
Gas Distribution Investment	30	195	222	223	235	276	**1,180**
Transmission Investment	-	99	107	181	183	974	**1,544**
Total	**70**	**476**	**621**	**825**	**833**	**2,662**	**5,486**
O&M	1	5	5	3	2	0	15

- ESIP represents a potential investment of approximately $2.8 billion for Electric Distribution and $1.2 billion for Gas Delivery over a 10 year period
- Transmission investment of approximately $1.5 billion would be included in future FERC Formula Rate filings

PSEG Making New Jersey energy strong

environmentally responsible, forward-looking investments that enhance our energy infrastructure, create **economic activity** and **jobs**, while keeping **utility rates lower** than the rate of inflation



2008

- Named Most Reliable Electric Utility in the nation
- Solar loan program approved, breaking down barriers to installation
- Programs approved to offer home energy efficiency audits, programmable thermostats and CFL bulbs

2013

- Named Most Reliable Electric Utility in the nation – five time winner
- EEI Awards for Emergency Recovery and Outstanding Response to a Major Event (Sandy, Irene, Oct. 2011 snowstorm)
- Electric and gas infrastructure, transmission, solar, and energy efficiency investments create 8,600 jobs and related economic activity
- 160 MWs of solar – enough to power 27,000 homes and avoid emissions equal to taking 25,000 cars off the road for a year
- Energy efficiency investments save 160 GWhs – enough to power 23,000 homes – and save 5 million therms, equal to taking almost 6,000 cars off the road for a year

2018

- Investments in solar, energy efficiency, electric and gas infrastructure putting more than 7,500 people to work, creating hundreds of millions in related economic activity
- 393 MWs of solar – enough to power 65,000 homes and avoid emissions equal to taking 60,000 cars off the road for a year
- Energy efficiency investments save 640 GWhs – enough to power 90,000 homes – and 35 million therms, equal to taking 40,000 cars off the road for a year

ESIP and Transmission Hardening Scenario

Caroline Dorsa
Executive Vice President and Chief Financial Officer

ESIP Scenario Assumptions

Remove Unapproved Utility Programs

- Gas CIP III ($1.4B)
- Solar 4 All extension ($0.6B)
- Solar Loan III ($0.1B)
- Energy Efficiency for All ($0.2B)

Replace with:

- Electric Distribution Hardening $1.4B
- Gas Distribution Hardening $0.9B
- Transmission Hardening $0.6B

Net $0.6B increase in Capital Spending over the Plan horizon

Earnings profiles assume contemporaneous returns on Distribution investments and formula rates for Transmission investments

REDACTED

Enterprise Financial Results – ESIP Scenario

	2013	2014	2015	2016	2017	EPS CAGR 2013-2017
Operating EPS						
PSE&G	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Power	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Holdings/Parent	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
PSEG	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Delta from Final Plan	[redacted]	[redacted]	[redacted]	[redacted]		
Earnings % from Regulated	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Delta from Final Plan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Payout Ratio	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Delta from Final Plan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
ROIC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Delta from Final Plan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Power FFO/Debt	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Delta from Final Plan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Investment Capacity *($ in Billions)*	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Delta from Final Plan	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

- Investments at PSE&G result in a rate base CAGR of [redacted] through 2015 and [redacted] through 2017 from year-end 2012 levels

8

Request for approval

- Request your approval to file the 5 year Energy Strong Infrastructure Program with the NJBPU on Feb 20, 2013
- Request approval for Electric Transmission investments as described

Appendix

Energy Strong Infrastructure Program (ESIP) – Hardening – Electric Distribution

Program	Description	Actions	Length of Program* (years)	Distribution ($ Million)		Total Estimated Costs ($ Million)
				Capital	O&M	
1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls	10	$ 1,680.0	$ -	$ 1,680.0
2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	5	$ 65.0	$ -	$ 65.0
		Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	5	$ 60.0	$ -	$ 60.0
		Add spacer cable to eliminate open wire to targeted areas	5	$ 10.0	$ -	$ 10.0
3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	5	$ 102.0	$ 10.0	$ 112.0
	This program will evaluate the use of new non-wood material to replace wood poles in the future	Non-wood poles	5	$ 3.0	$ -	$ 3.0
4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	5	$ 100.0	$ -	$ 100.0
5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Replace ATS switches/transformers with submersible switches	5	$ 8.0	$ -	$ 8.0
		B. Replace PM xfmrs with submersible xfmrs in target areas	5	$ 8.0		$ 8.0
		C. Convert certain OH areas to UG	5	$ 60.0	$ -	$ 60.0
6. Relocate critical operating centers	This program will relocate our critical dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc	Relocate DERC/GSOC	2	$ 15.0	$ 1.0	$ 16.0
			Sub Total	**$ 2,111.0**	**$ 11.0**	**$ 2,122.0**

Energy Strong Infrastructure Program (ESIP) – Resiliency – Electric Distribution

Program	Description	Actions	Length of Program* (years)	Distribution ($ Million) Capital	Distribution ($ Million) O&M	Total Estimated Costs ($ Million)
Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**System Visibility** **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more	10	$ 250.0	$ -	$ 250.0
		1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy (DMS)	10	$ 50.0	$ -	$ 50.0
		Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- . Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system	10	$ 73.0	$ -	$ 73.0
		2b. Evaluate Satellite Communication	5	$ 3.0	$ -	$ 3.0
		Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS	10	$ 15.0	$ -	$ 15.0
		3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions	4	$ 50.0	$ -	$ 50.0
		3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	3	$ 10.0	$ -	$ 10.0
Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme	5	$ 200.0	$ -	$ 200.0
			Sub Total	**$ 651.0**	**$ -**	**$ 651.0**

12

Energy Strong Infrastructure Program (ESIP) – Electric Distribution – Supplemental Projects

Program	Description	Actions	Length of Program* (years)	Distribution		Total Estimated Costs ($ Million)
				Capital	O&M	
Emergency Backup Generator and Quick Connect Stockpile	The program involves stockpiling generators which can be used to power critical business sectors during extended outages. Technologies exist whereby a connection can be made to a customer electric meter which allows the quick connection of a portable generator	PSE&G proposes a program to stockpile emergency generators and quick connects	TBD	TBD	TBD	TBD
Municipal Pilot Program	To improve resiliency of the electric system, particularly by engaging valuable municipal resources in the event of prolonged outages	Develop a municipal storm plan which addresses vegetation management and mobile field applications	TBD	TBD	TBD	TBD

Energy Strong Infrastructure Program (ESIP) – Hardening – Gas Delivery

Program	Description	Actions	Length of Program* (years)	Distribution		Total Estimated Costs ($ Million)
				Capital	O&M	
Metering & Regulating Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls	8	$ 140.0	$ -	$ 140.0
Utilization Pressure Cast Iron (UPCI)	This program will consider accelerated UPCI main and associated services and district regulator replacements located within or in proximity of a flood hazard zone.	Replace existing UPCI main and associated district regulators with plastic or coated cathodically protected welded steel. Replace with high pressure and abandon regulators where feasible - 750 miles	5	$ 870.0	$ -	$ 870.0
		Replace existing unprotected steel services connected to the UPCI mains - 40,000	5	$ 170.0	$ -	$ 170.0
			Gas Total	**$ 1,180.0**	**$ -**	**$ 1,180.0**

Hardening and Resiliency - Transmission

Program	Description	Actions	Length of Program* (years)	Transmission		Total Estimated Costs ($ Million)
				Capital	O&M	
Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls	10	$ 1,520.0	$ -	$ 1,520.0
Relocate critical operating centers	This program will relocate our critical dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc	Relocate ESOC/System Reliability	2	$ 21.0	$ 1.5	$ 22.5
Advanced Technologies	This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers	Evaluate Satellite Communication	5	$ 3.0	$ -	$ 3.0
		ED Transmission Total		$ 1,544.0	$ 1.5	$ 1,545.5

ESIP and Transmission Modeling Assumptions

ESIP assumptions

- Electric and gas distribution assets are placed in service monthly. Spending is assumed to start in July 2013 for both Electric and Gas projects
- The program's methodology and recovery of costs are modeled after the 2009 Capital Infrastructure Program (CIP I) providing contemporaneous returns and requesting our allowed ROE of 10.3% and cost of capital approved in our 2010 rate case

Transmission Hardening and Resiliency assumptions

- Transmission assets are placed in service on an annual basis. Spending is assumed to start in January 2014
- Transmission projects are assumed to receive the allowed ROE of 11.68% with no incentives

PSE&G – Current Developments and Initiatives

April 16, 2013

Ralph LaRossa
President and Chief Operating Officer, PSE&G

PSE&G – Initiatives

PSE&G Key Priorities

Operational Excellence	• Maintain top quartile operational results • Flawlessly execute capital investment programs
Financial Strength	• Successfully manage regulatory relationships • Continue execution of initiatives focused on cost control
Disciplined Investment	• Identification of additional Transmission investment opportunities • **Approval and implementation of Energy Strong program (ES), Solar 4 All Extension (S4Ae) and Solar Loan III** • Approval and implementation of Energy Efficiency 4 All* (EE4A)

*Program not filed with the New Jersey Board of Public Utilities

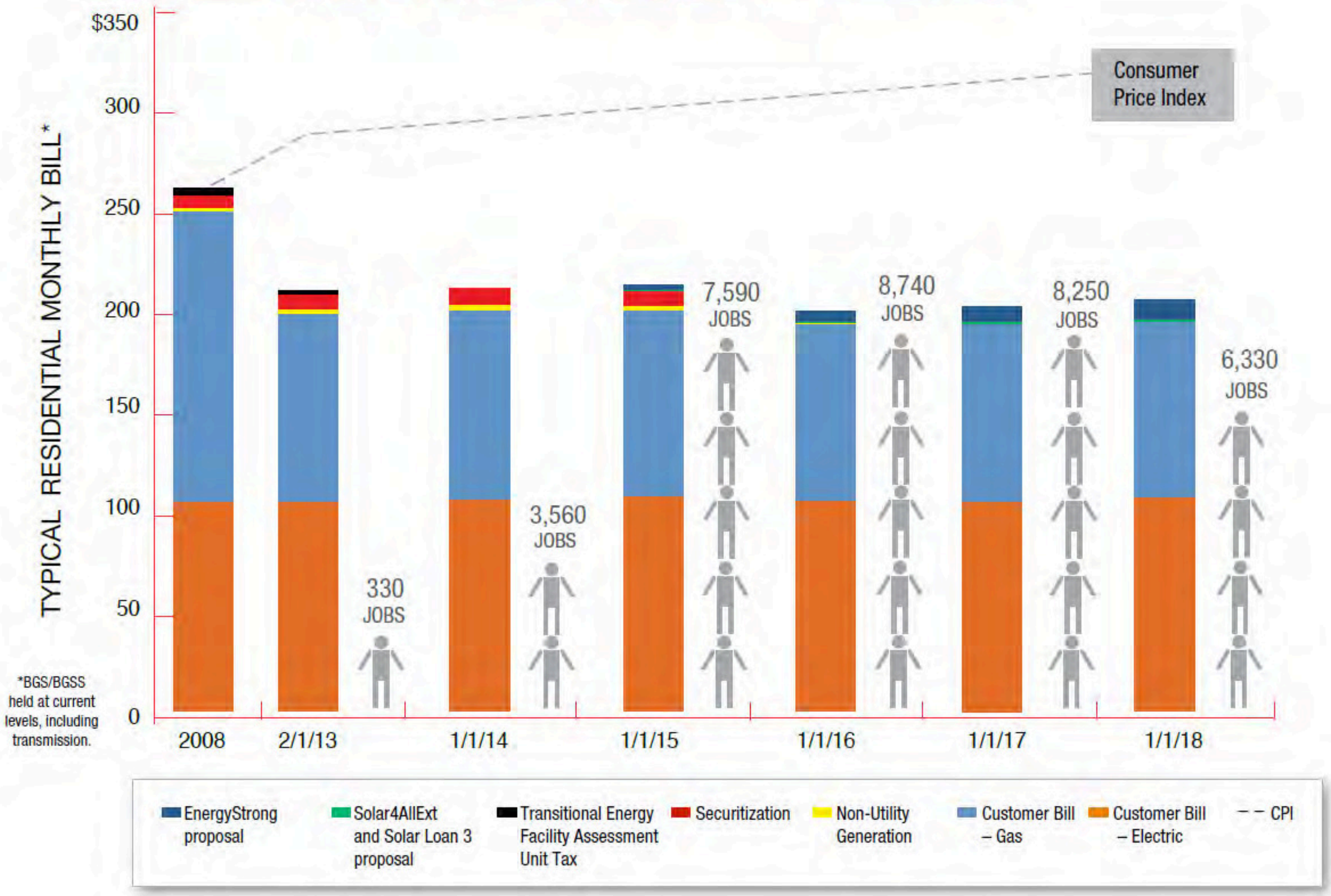
Energy Strong Update

- Filed Rates for Energy Strong on March 20, 2013
  - Customer bills expected to remain steady while making necessary improvements to reduce outages
- Established multi-tiered advocacy approach
  - Created PSEGAdvocacy.com website
  - Reaching out to employees, unions, customers, municipalities and businesses
  - Received support from Mayors, Chamber of Commerce and others
  - Quickly addressing questions and negative comments
- NJBPU response
  - Order establishing Generic Proceeding to review costs, benefits, and reliability impacts of major storm event mitigation efforts and review of Energy Strong petition
  - Order establishing Generic Proceeding to evaluate prudency of major storm event restoration costs for 2011 and 2012

Making New Jersey **energy strong**

PSEG

environmentally responsible, forward-looking investments that enhance our energy infrastructure, create **economic activity** and **jobs**, while keeping **utility rates lower** than the rate of inflation



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
COST BENEFIT ANALYSIS

QUESTION:
Describe the internal cost benefit analysis conducted by PSE&G prior to filing the Energy Strong application. In your response, describe the internal analysis and identify the information that was provided to and led to internal management's approval of these proposed investments in each general category.

ANSWER:
No formal cost benefit analysis was performed prior to internal management approval. While no formal analysis was performed, each of the investments proposed address a specific issue experienced during the major storm event of the previous two years.

After experiencing the damaging effects of Superstorm Sandy, PSE&G developed this plan to harden the Company's infrastructure and increase the resilience of the system in the context of a major weather event. The Company believes that the programs proposed in the Energy Strong Petition are prudent investments, but that these investments do not need to be made in order to provide safe, adequate and proper service.

PSE&G Engineering associates were assembled to identify system enhancements that would accomplish hardening and resiliency benefits. The projects selected represent the best engineering judgment of PSE&G internal experts. PSE&G's internal management approved the proposed investments being submitted to the BPU as part of the overall Energy Strong Program.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PROPOSED CONTINGENCY RECONFIGURATION STRATEGY

QUESTION:
Regarding page 31, lines 679 and 680 of Mr. Cardenas' Direct Testimony, through its proposed contingency reconfiguration strategy is the Company proposing to reconfigure its entire distribution system? If so, please explain. If not, please quantify the number of feeders and circuits targeted for loop reconfiguration.

ANSWER:
The contingency reconfiguration strategy does not propose to reconfigure the entire distribution system. The intent of this strategy is to optimally reconfigure those circuits that could benefit most from this program. The circuit selection criteria consists of the number of customers impacted, historical storm outage data, high profile customers such police, hospitals, sewage and water treatment facilities that have global impact on the community. After completion of the engineering design, the Company will determine the number of targeted circuits.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PROPOSED SUPPLEMENTAL VEGETATION MANAGEMENT PROGRAM

QUESTION:
Regarding pages 34 and 35, lines 752 and 754 of Mr. Cardenas' Direct Testimony, is the Company's proposed vegetation management program in addition to the Company's current vegetation management program? If so, please explain.

ANSWER:
The proposed vegetation management program is in addition to the Company's current vegetation management program. This would be a pilot program to establish a collaborative plan with a municipality on how vegetation will be managed around electric distribution facilities. The plan is to include educational components regarding utility line clearance trimming standards and the selection and placement of vegetation in close proximity to electric infrastructure. The plan will also develop a process to engage the municipality in identifying and removing danger trees that potentially compromise electric distribution facilities.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PSEG INVESTMENT EVALUATION SYSTEM

QUESTION:
For each project included in the Company's Energy Strong Program, please indicate if the project has been ranked in the PSEG Scorecard - Investment Evaluation System. If so, please indicate the ranking for the project, what the results mean, and when the analysis was conducted. If not, please explain why not.

ANSWER:
The Energy Strong programs were defined after the events of Superstorm Sandy, which occurred outside the normal prioritization process where the Investment Evaluation System (IES) is used. More importantly the Energy Strong investments are for improved storm response to extreme weather events, which fall beyond the scope of the current IES system. The IES system prioritizes projects using current scorecard metrics which do not reflect extreme weather events and therefore is not used to evaluate the Energy Strong investments.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

WORKPAPERS ASSOCIATED WITH RCR-E-2.

QUESTION:
Provide the workpapers associated with the attachment provided in response to RCR-E-2.

ANSWER:
Please see the Excel workbook provided with this response for the workpapers associated with this response.

Table ES- 5. Estimated Average Electric Customer Interruption Costs US 2008$ Anytin

Interruption Cost			Interruption Duration
	Momentary	30 minutes	1 hour
Medium and Large C&I		0.5	1
Cost Per Event	$6,558	$9,217	$12,487
Cost Per Average kW	$8.0	$11.3	$15.3
Cost Per Un-served kWh	$96.5	$22.6	$15.3
Cost Per Annual kWh	$0.0009	$0.0013	$0.0018
Small C&I		0.5	1
Cost Per Event	$293	$435	$619
Cost Per Average kW	$133.7	$198.1	$282.0
Cost Per Un-served kWh	$1,604.1	$396.3	$282.0
Cost Per Annual kWh	$0.0153	$0.0226	$0.0322
Residential		0.5	1
Cost Per Event	$2.1	$2.7	$3.3
Cost Per Average kW	$1.4	$1.8	$2.2
Cost Per Un-served kWh	$16.8	$3.5	$2.2
Cost Per Annual kWh	$0.0002	$0.0002	$0.0002

	KW	Load factor
Residential		
Small C&I		
Large C&I		

ne By Duration and Customer Type

4 hours	8 hours
4	8
$42,506	$69,284
$52.1	$85.0
$13.0	$10.6
$0.0060	$0.0097
4	8
$2,623	$5,195
$1,195.8	$2,368.6
$298.9	$296.1
$0.1370	$0.2700
4	8
$7.4	$10.6
$4.9	$6.9
$1.2	$0.9
$0.0006	$0.0008

Source: FERC F

	Average number of Customers
Residential	
Residential Service RS	1,846,380
Resiential Heating Service RHS	12,297
Water Heating Service WH	2,046
Water Heating Storage Service WHS	26
Residential Load Management RLM	13,023
Commercial and industrial	
Water Heating Service WH	16
General ltg and power service	271,430
Large Power and Ltg Service	9,417
High Tension Service HTS	206

Total customers	2,162,684
Total PSE&G customers in 2013 from PSE&G	2,250,511

Mix of customers in use	
	# of customers
Residential	1,873,795
Small C&I	279,271
Medium and Large C&I	9,618
Total	2,162,684

From Berkeley's study

Sector Annual kWh	
Medium and Large C&I	7,140,501
Small C&I	19,214
Residential	13,351

ORM 1 for 2012

KWh of Sales Per Customer
7,116
12,426
980
1,500
19,175
1,313
28,798
1,592,205
23,143,539

Mix of customers based on Form 1	
	# of customers
Residential	1,873,772
Small C&I	271,446
Medium and Large C&I	9,623
Total	2,154,841

Percent
86.64%
12.91%
0.44%
1

Mix of customers from PSE&G

	# of customers
Residential	1,873,795
Small and medium C&I	279,271
Large C&I	9,618
Lighting	25,868
Total	2,188,551
Total excluding lighting	2,162,684

Percent
86.64%
12.55%
0.44%
0.996373488

Kwh used in a year	Rates
13,463,591,430	RS, WH,WHS, RLM
7,914,259,281	GLP and HS
19,741,791,968	LPL and HTS
448,806,642	PSAL/BPL/BPLPOF
41,568,449,321	

Customer class	Total KWH	Average customers	kwh/customer
Residential	13,543,739,382	1,871,632	7,236
Commercial	23,537,934,535	289,308	81,359
Industrial	4,221,149,930	9,046	466,632
Lighting	329,190,762	10,094	32,613
Total	41,632,014,609	2,180,080	

kwh/customer/hour
0.82
9.26
53.12
3.71

Title:	Gross Domestic Product: Implicit Price Deflator
Series ID:	GDPDEF
Source:	U.S. Department of Commerce: Bureau of Economic Analysis
Release:	Gross Domestic Product
Seasonal Adjustment:	Seasonally Adjusted
Frequency:	Annual
Aggregation Method:	Average
Units:	Index 2005=100
Date Range:	1990-01-01 to 2012-10-01
Last Updated:	2013-03-28 8:01 AM CDT
Notes:	The number of decimal places reported varies over time. A Guide to the National Income and Product Accounts of the United States (NIPA) - (http://www.bea.gov/national/pdf/nipaguid.pdf)

DATE	VALUE
1990-01-01	72.263
1991-01-01	74.820
1992-01-01	76.592
1993-01-01	78.287
1994-01-01	79.935
1995-01-01	81.603
1996-01-01	83.154
1997-01-01	84.624
1998-01-01	85.579
1999-01-01	86.837
2000-01-01	88.718
2001-01-01	90.726
2002-01-01	92.194
2003-01-01	94.128
2004-01-01	96.779
2005-01-01	99.993
2006-01-01	103.228
2007-01-01	106.222
2008-01-01	108.589
2009-01-01	109.529
2010-01-01	110.989
2011-01-01	113.355
2012-01-01	115.383

Between 2008 and 2010 1.06

Program	Actions
1. Station Flood Mitigation	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.
2. Outside Plant Higher Design and Construction Standards	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)
	Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)
	Add spacer cable to eliminate open wire to targeted areas
3. Strengthening Pole Infrastructure	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards
	Non-wood poles
4. Rebuild/Relocate Backyard poles	Rebuild backyard poles (including tree trimming)
5. Undergrounding	A. Convert certain OH areas to UG
	B. Replace PM xfmrs with submersible xfmrs in target areas
	C. Replace ATS switches/transformers with submersible switches
6. Relocate ESOC/GSOC/DERC/SR	Relocate critical operating centers

Advanced Technologies	**System Visibility** **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.
	1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)
	Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.
	2b. Pilot Satellite Communication Program
	Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.
	3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.
	3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)
Contingency Reconfiguration Strategies	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme
Emergency Backup Generator and Quick Connect Stockpile Program	PSE&G to deploy emergency generators to customers based on priorities driven by local municipal officials. In addition, PSE&G will maintain the supply of quick connects to be deployed as directed.

Municipal Pilot Program	Develop a municipal storm plan which addresses vegetation maintenance, mobile field applications and a combined heat and power (CHP) pilot for targeted critical municipal facilities meeting the high efficiency specifications for application of this technology.

Total Estimated Costs ($ Million)	Number of Customers	Avoided Outages (Hrs)	Outage Duration Decrease (Hrs)	Total Customer Outage Reduction (Hrs)	Total Custom Custc
					Residential
$ 1,678	748,500	29,640,600	8,982,000	41,496,840	29,482,064
$ 65	30,449	438,471	365,392	613,859	436,125
$ 60	29,873	1,075,437	358,479	1,182,981	840,467
$ 10	7,350	211,680	88,200	211,680	150,391
$ 102	50,634	72,913	607,611	72,913	51,802
$ 3	1,407	2,025	16,879	2,025	1,439
$ 100	36,973	1,331,028	443,676	1,464,131	1,200,587
$ 60	14,700	635,040	176,400	635,040	451,174
$ 8	1,894	122,731	22,728	122,731	87,196
$ 8	Combined with 5B	ombined with 5	ombined with 5	Combined with 5B	Combined with 5B
$ 15	2,250,511	0	27,006,132	135,031	95,935

$	250	1,134,374	0	13,612,488	4,537,496	3,223,733
$	50	Combined with 1A	ombined with 1	ombined with 1	Combined with 1A	Combined with 1A
$	73	Combined with 1A	ombined with 1	ombined with 1	Combined with 1A	Combined with 1A
$	3	2,250,511	0	27,006,132	1,350,307	959,346
$	15	Combined with 1A	ombined with 1	ombined with 1	Combined with 1A	Combined with 1A
$	50	2,250,511	0	27,006,132	9,002,044	6,395,640
$	10	2,250,511	0	27,006,132	0	0
$	200	245,824	1,769,933	2,949,888	3,362,872	2,389,204
$	2	200	0	2,400	9,600	6,820

TBD	TBD	TBD	TBD	TBD	TBD

ner Outage Reduction By omer Types (hrs)		Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio Per Action	Cost/Benefit Ratio Per Program
Small C&I	Large C&I			
49,620,231	9,803,131	$ 15,750	0.11	0.11
734,027	145,017	$ 233	0.28	0.18
1,414,560	279,465	$ 449	0.13	
253,118	50,007	$ 80	0.12	
87,187	17,225	$ 28	3.69	3.69
2,422	478	$ 1	3.90	
0	0	$ 1	87.10	87.10
759,355	150,021	$ 241	0.25	0.26
146,757	28,994	$ 47	0.17	
Combined with 5B	Combined with 5B	$ -	Combined with 5B	
161,464	31,899	$ 51	0.29	0.29

5,425,753	1,071,929	$ 1,722	0.15	
Combined with 1A	Combined with 1A	$ -	Combined with 1A	
Combined with 1A	Combined with 1A	$ -	Combined with 1A	
1,614,642	318,994	$ 482	Combined with 1A	0.08
Combined with 1A	Combined with 1A	$ -	Combined with 1A	
10,764,278	2,126,625	$ 3,417	0.01	
0	0	$ -	Combined with 1A	
4,021,186	794,438	$ 1,276	0.16	0.16
11,479	2,268	$ 4	0.55	0.55

TBD	TBD	TBD	TBD	TBD

	Program	Description	Actions	Length of Program* (years)	Distribution First 60 Months ($ Million)	Distribution Second 60 Months ($ Million)	Total Estimated Costs ($ 2012 Million)
Electricity delivery Infrastructure Hardening Investments	1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	10	$ 819.00	$ 859.00	$ 1,678.00
	2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	5	$ 65.00	$ -	$ 65.00
			Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	5	$ 60.00	$ -	$ 60.00
			Add spacer cable to eliminate open wire to targeted areas	5	$ 10.00	$ -	$ 10.00
	3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	5	$ 102.00	$ -	$ 102.00
		This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	5	$ 3.00	$ -	$ 3.00
	4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	5	$ 100.00	$ -	$ 100.00
	5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	5	$ 60.00	$ -	$ 60.00
			B. Replace PM xfmrs with submersible xfmrs in target areas	5	$ 8.00	$ -	$ 8.00
			C. Replace ATS switches/transformers with submersible switches	5	$ 8.00	$ -	$ 8.00
	6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	2	$ 15.00	$ -	$ 15.00
Electricity delivery Infrastructure Resilience Investments	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**System Visibility** **1a**. Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	10	$ 120.00	$ 130.00	$ 250.00
			1b. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	10	$ 24.00	$ 26.00	$ 50.00
			Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	10	$ 35.00	$ 38.00	$ 73.00
			2b. Pilot Satellite Communication Program	5	$ 3.00	$ -	$ 3.00
			Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	10	$ 9.00	$ 6.00	$ 15.00
			3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	4	$ 50.00	$ -	$ 50.00
			3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	3	$ 10.00	$ -	$ 10.00
	Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme	5	$ 200.00	$ -	$ 200.00
Supplemental Investment	Emergency Backup Generator and Quick Connect Stockpile Program	PSE&G to purchase and stockpile emergency backup generators to utilize during storm restoration. Technologies exist whereby a connection can be made to a residential customer electric meter which allows the quick connection of a portable generator.	PSE&G to deploy emergency generators to customers based on priorities driven by local municipal officials. In addition, PSE&G will maintain the supply of quick connects to be deployed as directed.	1	$2.00	0	$2.00
	Municipal Pilot Program	To improve resiliency of the electric system, particularly by engaging valuable municipal resources in the event of prolonged outages	Develop a municipal storm plan which addresses vegetation maintenance, mobile field applications and a combined heat and power (CHP) pilot for targeted critical municipal facilities meeting the high efficiency specifications for application of this technology.	TBD	TBD	TBD	TBD
Gas Projects	Metering & Regulating Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	8	$ 76.00	$ 64.00	$ 140.00
	Utilization Pressure Cast Iron (UPCI)	This program will consider accelerated UPCI main and associated services and district regulator replacements located within or in proximity of a flood hazard zone.	Replace existing UPCI main and associated district regulators with plastic or coated cathodically protected welded steel. Replace with high pressure and abandon regulators where feasible - 750 miles	6	$ 830.00	$ 210.00	$ 1,040.00

Program / Action	Ranking	Assumptions in quantifying customers Impacted by either elimination of outage or decrease in outage duration	Number of Customers	Source	Assumption in quantifying outages that are eliminated Outage duration is 3 days unless noted	Avoided Outages (Hrs)	Assumptions in quantifying outages that are reduced in duration	Outage Duration Decrease
1. Station Flood Mitigation	1	Number of customers supplied either directly or indirectly by the Stations to be protected assuming each station will be impacted once	748,500	Station List in File XXX	* 33% reduction in 5-day customer outages	29,640,600	With station supply in, customer still out reduced from 5 Days to 4 days	11,856,240
2. Outside Plant (4kV to 13kV)	13	5% of Customers supplied by 4kV	30,449	Customer Count Details for Assumptions	20% Reduction of Outages	438,471	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service	175,388
2. Outside Plant (26kV to 69kV)	7	5% of Customers supplied by 26/4kV substations	29,873	Customer Count Details for Assumptions minus Federal Square Substation	50% Reduction due to raised conductors.	1,075,437	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service	107,544
2. Outside Plant (spacer cable)	12	Assume 10 circuits. Average customers/13kV section = 735 Customers/section x 10 circuits	7,350	Customer Count Details for Assumptions	40% Reduction due to increased ability to withstand weather events	211,680	No Benefit	0
3. Strengthening Pole Infrastructure (accelerate replacements)	10	# of poles impacted/total poles in system * customers	50,634		2% Reduction in the number of Outages Due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	72,913	No Benefit	0
3. Strengthening Pole Infrastructure (non-wood poles)	16	# of poles impacted/total poles in system * customers	1,407		2% Reduction due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	2,025	No Benefit	0
4. Rebuild/Relocate Backyard poles	6	Customers supplied by backyard circuits	36,973		50% Reduction	1,331,028	Due to better access and newer facilities restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service	133,103
5. Undergrounding (A)	9	Estimate # circuits that could be done to get customer count. Assume 1 mile per circuit, 20 Circuits with average of 735 customers/section	14,700		Assume 60% reduction due to damage being avoided on primary lines now Underground.	635,040	No Benefit	0
5. Undergrounding (B)	8	Avg Customers per padmounted transformers in flood area	1,894		Assume 90% reduction in PSE&G equipment outages due to storm surge. Outage duration of 3 days avoided.	122,731	No Benefit	0
5. Undergrounding (C)	8	Customer benefit aligned with PM Transformer program as ATS typically supply PM in these areas.	Combined with 5B		Combined with 5B	Combined with 5B	Combined with 5B	Combined with 5B
6. Relocate ESOC/GSOC/DERC/SR	14	Total number of Customers	2,250,511		N/A	0	Low probability event. Assume 1% probability in a major event with Average 6 hour increase in overall restoration.	135,031
Advanced Technologies (1a)	2*	# Customers in Stations	1,134,374		No Benefit	0	Assume 4 hour improvement in overall restoration time due to indication of circuit outages, immediate load data for decision making and the ability to remotely set-up circuits for work.	4,537,496
Advanced Technologies (1b)	2*	Benefits Aligned with 1A	Combined with 1A		Combined with 1A	Combined with 1A	Combined with 1A	Combined with 1A
Advanced Technologies (2a)	2*	Benefits Aligned with 1A	Combined with 1A		Combined with 1A	Combined with 1A	Combined with 1A	Combined with 1A
Advanced Technologies (2b)	15	Total number of Customers	2,250,511		No Benefit	0	Low probability event. Assume 5% probability in a major event with Average 12 hour increase in overall restoration.	1,350,307
Advanced Technologies (3a)	2*	Benefits Aligned with 1A	Combined with 1A		Combined with 1A	Combined with 1A	Combined with 1A	Combined with 1A
Advanced Technologies (3b)	3	Total number of Customers	2,250,511		No Benefit	0	Through confirmed damage location visibility, improved look-up process and elimination of duplicate records restoration process will be improved. Assume 4 hour improvement in average restoration in overall storm work.	9,002,044
Advanced Technologies (3c)	5	Total number of Customers	2,250,511		No Benefit	0	No Benefit	0
Contingency Reconfiguration Strategies	4	Using CIP 2 Major Results of $1.2M per circuit equal 167 13kV circuits. Avg customer count of 1500 = 250,500	245,824		Due to reconfiguration of circuits, loop improvement and fusing, 10% reduction in outages.	1,769,933	With greater system redundancy restoration time on average will improve by 10% (7.2 Hours)	1,592,940
Emergency Backup Generator and Quick Connect Stockpile Program	17	Number of Generators	200		No change in outage reduction	0	Assuming a two day implementation of these measures, outage time reduced by 2 days	9,600
Municipal Pilot Program	18	TBD	TBD		TBD	TBD	TBD	TBD
Metering & Regulating Station Flood Mitigation	Summary							

Program / Action	Total Customer Hours Outage Reduction (Sum Of Outages Avoided and Duration Decreases)	Total Customer Hours Outage Reduction for Residential (kwh)	Total Customer Hours Outage Reduction Small C&I (kwh)	Total Customer Hours Outage Reduction Medium and Large C&I (kwh)	Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio per action	Rank	Cost/Benefit ratio per program	RANK for cost/benefit ratio	Program RANK
1. Station Flood Mitigation	41,496,840	29,482,064	49,620,231	9,803,131	15,750	0.11	2	0.11	2	2
2. Outside Plant (4kV to 13kV)	613,859	436,125	734,027	145,017	233	0.28	9	0.18	4	10
2. Outside Plant (26kV to 69kV)	1,182,981	840,467	1,414,560	279,465	449	0.13	4			6
2. Outside Plant (spacer cable)	211,680	150,391	253,118	50,007	80	0.12	3			11
3. Strengthening Pole Infrastructure (accelerate replacements)	72,913	51,802	87,187	17,225	28	3.69	12	3.69	8	13
3. Strengthening Pole Infrastructure (non-wood poles)	2,025	1,439	2,422	478	1	3.90	13			14
4. Rebuild/Relocate Backyard poles	1,464,131	1,200,587	0	0	1	87.10	14	87.10	9	15
5. Undergrounding (A)	635,040	451,174	759,355	150,021	241	0.25	8	0.26	5	9
5. Undergrounding (B)	122,731	87,196	146,757	28,994	47	0.17	7			7
5. Undergrounding (C)	Combined with 5B	Combined with 5B	Combined with 5B	Combined with 5B	-	Combined with 5B				8
6. Relocate ESOC/GSOC/DERC/SR	135,031	95,935	161,464	31,899	51	0.29	10	0.29	6	12
Advanced Technologies (1a)	4,537,496	3,223,733	5,425,753	1,071,929	1,722	0.15	5	0.08	1	1
Advanced Technologies (1b)	Combined with 1A	Combined with 1A	Combined with 1A	Combined with 1A	-	Combined with 1A				
Advanced Technologies (2a)	Combined with 1A	Combined with 1A	Combined with 1A	Combined with 1A	-	Combined with 1A				
Advanced Technologies (2b)	1,350,307	959,346	1,614,642	318,994	482	Combined with 1A				
Advanced Technologies (3a)	Combined with 1A	Combined with 1A	Combined with 1A	Combined with 1A	-	Combined with 1A				
Advanced Technologies (3b)	9,002,044	6,395,640	10,764,278	2,126,625	3,417	0.01	1			
Advanced Technologies (3c)	0	0	0	0	-	Combined with 1A				
Contingency Reconfiguration Strategies	3,362,872	2,389,204	4,021,186	794,438	1,276	0.16	6	0.16	3	3
Emergency Backup Generator and Quick Connect Stockpile Program	9,600	6,820	11,479	2,268	4	0.55	11	0.55	7	16
Municipal Pilot Program	TBD	TBD	TBD	TBD	TBD	TBD		TBD		17
Metering & Regulating Station Flood Mitigation		45,771,925	75,016,460	14,820,490	23,783					4
Utilization Pressure Cast Iron (UPCI)										5

Program / Action	1st Billion	2nd Billion	3rd Billion	4th Billion	VOLL Res	Small CI	Voll Large		
1. Station Flood Mitigation	$ 631	$ 188	$ 227	$ 632	28	15,612	110	15,750	
2. Outside Plant (4kV to 13kV)			$ 65	$ -	0	231	2		
2. Outside Plant (26kV to 69kV)			$ 60	$ -	1	445	3		
2. Outside Plant (spacer cable)			$ 10	$ -	0	80	1		
3. Strengthening Pole Infrastructure (accelerate replacements)			$ 102	$ -	0	27	0		
3. Strengthening Pole Infrastructure (non-wood poles)			$ 3	$ -	0	1	0		
4. Rebuild/Relocate Backyard poles			$ 26	$ 74	1	0	0		
5. Undergrounding (A)			$ 60	$ -	0	239	2		
5. Undergrounding (B)			$ 8	$ -	0	46	0		
5. Undergrounding (C)			$ 8	$ -					
6. Relocate ESOC/GSOC/DERC/SR			$ 15	$ -	0	51	0		
Advanced Technologies (1a)	$ 120	$ 130	$ -	$ -	3	1,707	12		
Advanced Technologies (1b)	$ 24	$ 26	$ -	$ -					
Advanced Technologies (2a)	$ 35	$ 38	$ -	$ -					
Advanced Technologies (2b)			$ 3	$ -	1	508	4		
Advanced Technologies (3a)	$ 9	$ 6	$ -	$ -					
Advanced Technologies (3b)	$ 50			$ -	6	3,387	24		
Advanced Technologies (3c)	$ 10		$ -	$ -	0	0	0		
Contingency Reconfiguration Strategies	$ 45	$ 69	$ 86	$ -	2	1,265	9		
Emergency Backup Generator and Quick Connect Stockpile Program			$ -	$ 2	0	4	0		
Municipal Pilot Program				$ -					
Metering & Regulating Station Flood Mitigation	$ 76		$ 64	$ -	44	23,602	167 Total VOLL	23,813	0.991152
Utilization Pressure Cast Iron (UPCI)		$ 543	$ 263	$ 234	1,873,795	279,271	9,618 Total Customers		
	1000	1000	1000	942	23	84,513	17,356 Avg Savings		

Assumptions (not already listed):

Based on Sandy, average customer outage duration was 4 days (awaiting confirmation)
Each program was evaluated as an independent project (benefits may not be cummulative)
Areas where Brattle input needed
Numbers or assumptions awaiting input for confirmation

Actions	Total Estimated Costs ($ Million)	Number of Customers affected	Avoided Outages (Hrs)
Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	$ 1,678	748,500	29,640,600
Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	$ 65	30,449	438,471
Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	$ 60	29,873	1,075,437
Add spacer cable to eliminate open wire to targeted areas	$ 10	7,350	211,680
Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	$ 102	50,634	72,913
Non-wood poles	$ 3	1,407	2,025
Rebuild backyard poles (including tree trimming)	$ 100	36,973	1,331,028
A. Convert certain OH areas to UG	$ 60	14,700	635,040
B. Replace PM xfmrs with submersible xfmrs in target areas	$ 8	1,894	122,731
C. Replace ATS switches/transformers with submersible switches	$ 8	Combined with 5B	Combined with 5B
Relocate critical operating centers	$ 15	2,250,511	0

Outage Duration Decrease (Hrs)	Total Customer Outage Reduction (Hrs)	Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio	Rank Based on Cost/Benefit Ratio
11,856,240	41,496,840	$ 15,750.42	0.11	1
175,388	613,859	$ 232.99	0.18	2
107,544	1,182,981	$ 449.01		
0	211,680	$ 80.34		
0	72,913	$ 27.67	3.69	5
0	2,025	$ 0.77		
133,103	1,464,131	$ 1.15	87.10	6
0	635,040	$ 241.03	0.26	3
0	122,731	$ 46.58		
Combined with 5B	Combined with 5B	$ -		
135,031	135,031	$ 51.25	0.29	4

Program	Description	Actions	Assumptions in quantifying customers Impacted by either elimination of outage or decrease in outage duration	Assumption in quantifying outages that are eliminated Outage duration is 3 days unless noted	Assumptions in quantifying outages that are reduced in duration
1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	Number of customers supplied either directly or indirectly by the Stations to be protected assuming each station will be impacted once	* 33% reduction in 5-day customer outages	With station supply in, customer still out reduced from 5 Days to 4 days
2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	5% of Customers supplied by 4kV	20% Reduction of Outages	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service
		Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	5% of Customers supplied by 26/4kV substations	50% Reduction due to raised conductors.	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service
		Add spacer cable to eliminate open wire to targeted areas	Assume 10 circuits. Average customers/13kV section = 735 Customers/section x 10 circuits	40% Reduction due to increased ability to withstand weather events	No Benefit
3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	# of poles impacted/total poles in system * customers	2% Reduction in the number of Outages Due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	No Benefit
	This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	# of poles impacted/total poles in system * customers	2% Reduction due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	No Benefit
4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	Customers supplied by backyard circuits	50% Reduction	Due to better access and newer facilities restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service
5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	Estimate # circuits that could be done to get customer count. Assume 1 mile per circuit, 20 Circuits with average of 735 customers/section	Assume 60% reduction due to damage being avoided on primary lines now Underground.	No Benefit
		B. Replace PM xfmrs with submersible xfmrs in target areas	Avg Customers per padmounted transformers in flood area	Assume 90% reduction in PSE&G equipment outages due to storm surge. Outage duration of 3 days avoided.	No Benefit
		C. Replace ATS switches/transformers with submersible switches	Customer benefit aligned with PM Transformer program as ATS typically supply PM in these areas	Combined with 5B	Combined with 5B
6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	Total number of Customers	No Benefit	Low probability event. Assume 1% probability in a major event with Average 6 hour increase in overall restoration.

Program
Advanced Technologies

Actions	Total Estimated Costs ($ Million)	Number of Customers	Avoided Outages (Hrs)
System Visibility **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	$ 250	1,134,374	0
1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	$ 50	Combined with 1A	Combined with 1A
Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	$ 73	Combined with 1A	Combined with 1A
2b. Pilot Satellite Communication Program	$ 3	2,250,511	0
Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	$ 15	Combined with 1A	Combined with 1A
3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	$ 50	2,250,511	0
3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	$ 10	2,250,511	0

Outage Duration Decrease (Hrs)	Total Customer Outage Reduction (Hrs)	Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio
4,537,496	4,537,496	$ 1,722	0.08
Combined with 1A	Combined with 1A	$ -	
Combined with 1A	Combined with 1A	$ -	
1,350,307	1,350,307	$ 482	
Combined with 1A	Combined with 1A	$ -	
9,002,044	9,002,044	$ 3,417	
0	0	$ -	

Program
Advanced Technologies

Description
1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.

Actions	Potential Customer Benefits
System Visibility **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	# Customers in Stations
1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	Benefits Aligned with 1A
Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	Benefits Aligned with 1A
2b. Pilot Satellite Communication Program	Total number of Customers
Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	Benefits Aligned with 1A
3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	Total number of Customers
3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	Total number of Customers

Avoided Outage Assumptions	Outage Duration Decrease Assumptions
No Benefit	Assume 4 hour improvement in overall restoration time due to indication of circuit outages, immediate load data for decision making and the ability to remotely set-up circuits for work.
Combined with 1A	Combined with 1A
Combined with 1A	Combined with 1A
No Benefit	Low probability event. Assume 5% probability in a major event with Average 12 hour increase in overall restoration.
Combined with 1A	Combined with 1A
No Benefit	Through confirmed damage location visibility, improved look-up process and elimination of duplicate records restoration process will be improved. Assume 4 hour improvement in average restoration in overall storm work.
No Benefit	No Benefit

Program Grouping	Program	Description	Actions	Cost/Benefit Ratio per action	Cost/Benefit ratio per program	RANK for cost/benefit ratio	Program RANK	$1 Billion Program	$1 Billion Program	$1 Billion Program	$1 Billion Program
Electricity delivery Infrastructure Hardening Investments	1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	0.11	0.11	2	2	$ 631	$ 188	$ 227	$ 632
	2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	0.28	0.18	5	10			$ 65	$ -
	2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	0.13			6			$ 60	$ -
	2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Add spacer cable to eliminate open wire to targeted areas	0.12			11			$ 10	$ -
	3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	3.69	3.69	8	13			$ 102	$ -
	3. Strengthening Pole Infrastructure	This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	3.90			14			$ 3	$ -
	4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	87.10	87.10	9	15			$ 26	$ 74
	5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	0.25	0.26	6	9			$ 60	$ -
	5. Undergrounding		B. Replace PM xfmrs with submersible xfmrs in target areas	0.17			7			$ 8	$ -
	5. Undergrounding		C. Replace ATS switches/transformers with submersible switches	Combined with 5B			8			$ 8	$ -
	6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	0.29	0.17	4	12			$ 15	$ -
Electricity delivery Infrastructure Resilience Investments	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**System Visibility** **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	0.15	0.08	1	1	$ 120	$ 130	$ -	$ -
	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**1c**. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	Combined with 1A				$ 24	$ 26	$ -	$ -
	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**Communication Network** **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	Combined with 1A				$ 35	$ 38	$ -	$ -
	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance	**2b.** Pilot Satellite Communication Program	Combined with 1A						$ 3	$ -
	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**Storm Damage Assessment (need all items in System Visibility)** **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	Combined with 1A				$ 9	$ 6	$ -	$ -
	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**3b.** Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	0.01				$ 50			$ -
	Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**3c**. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	Combined with 1A				$ 10		$ -	$ -
	Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme	0.16	0.16	3	3	$ 45	$ 69	$ 86	$ -
Supplemental Investment	Emergency Backup Generator and Quick Connect Stockpile Program	PSE&G to purchase and stockpile emergency backup generators to utilize during storm restoration. Technologies exist whereby a connection can be made to a residential customer electric meter which allows the quick connection of a portable generator.	PSE&G to deploy emergency generators to customers based on priorities driven by local municipal officials. In addition, PSE&G will maintain the supply of quick connects to be deployed as directed.	0.55	0.55	7	16			$ -	$ 2
	Municipal Pilot Program	To improve resiliency of the electric system, particularly by engaging valuable municipal resources in the event of prolonged outages	Develop a municipal storm plan which addresses vegetation maintenance, mobile field applications and a combined heat and power (CHP) pilot for targeted critical municipal facilities meeting the high efficiency specifications for application of this technology.	TBD	TBD		17				$ -
Gas Hardening	Metering & Regulating Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.				4	$ 76		$ 64	$ -
	Utilization Pressure Cast Iron (UPCI)	This program will consider accelerated UPCI main and associated services and district regulator replacements located within or in proximity of a flood hazard zone.	Replace existing UPCI main and associated district regulators with plastic or coated cathodically protected welded steel. Replace with high pressure and abandon regulators where feasible - 750 miles				5		$ 543	$ 263	$ 234
								1000	1000	1000	942

Program	Description	Actions
Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme

Assumptions in quantifying customers Impacted by either elimination of outage or decrease in outage duration	Assumption in quantifying outages that are eliminated Outage duration is 3 days unless noted	Assumptions in quantifying outages that are reduced in duration
Using CIP 2 Results of $1.2M per circuit equals 167 13kV circuits. Avg customer count of 1472	Due to reconfiguration of circuits, loop improvement and fusing, 10% reduction in outages.	With greater system redundancy restoration time on average will improve by 10% (7.2 Hours)
Number of Customers affected	**Avoided Outages (Hrs)**	**Outage Duration Decrease (Hrs)**
245,824	1,769,933	1,592,940

Total Customer Outage Reduction (Hrs)
3,362,872

Program	Description	Actions	Assumptions in quantifying customers Impacted by either elimination of outage or decrease in outage duration	Number of Customers	Assumption in quantifying outages that are eliminated Outage duration is 3 days unless noted	Avoided Outages (Hrs)	Number of Customer Outages Eliminated	Assumptions in quantifying outages that are reduced in duration	Outage Duration Decrease	Total Customer Hours Outage Reduction (Sum Of Outages Avoided and Duration Decreases)
1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	Number of customers supplied either directly or indirectly by the Stations to be protected assuming each station will be impacted once	748,500	* 33% reduction in 5-day customer outages	29,640,600	247,005	With station supply in, customer still out reduced from 5 Days to 4 days	11,856,240	41,496,840
2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	5% of Customers supplied by 4kV	30,449	20% Reduction of Outages	438,471	6,090	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service	175,388	613,859
		Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	5% of Customers supplied by 26/4kV substations	29,873	50% Reduction due to raised conductors.	1,075,437	14,937	Due to reduced damage, restoration work will be less, assuming a 10% reduction in outage time of 3 days (7.2 Hours) for Customers out of service	107,544	1,182,981
		Add spacer cable to eliminate open wire to targeted areas	Assume 10 circuits. Average customers/13kV section = 735 Customers/section x 10 circuits	7,350	40% Reduction due to increased ability to withstand weather events	211,680	2,940	No Benefit	0	211,680
3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	# of poles impacted/total poles in system * customers	50,634	2% Reduction in the number of Outages Due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	72,913	1,013	No Benefit	0	72,913
	This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	# of poles impacted/total poles in system * customers	1,407	2% Reduction due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	2,025	28	No Benefit	0	2,025
4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	Customers supplied by backyard circuits	36,973	50% Reduction	1,331,028	18,487	Due to better access and newer facilities restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service	133,103	1,464,131
5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	Estimate # circuits that could be done to get customer count. Assume 1 mile per circuit, 20 Circuits with average of 735 customers/section	14,700	Assume 60% reduction due to damage being avoided on primary lines now Underground.	635,040	8,820	No Benefit	0	635,040
		B. Replace PM xfmrs with submersible xfmrs in target areas	Avg Customers per padmounted transformers in flood area	1,894	Assume 90% reduction in PSE&G equipment outages due to storm surge. Outage duration of 3 days avoided.	122,731	1,705	No Benefit	0	122,731
		C. Replace ATS switches/transformers with submersible switches	Customer benefit aligned with PM Transformer program as ATS typically supply PM in these areas	Combined with 5B	Combined with 5B	Combined with 5B		Combined with 5B	Combined with 5B	Combined with 5B
6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	Total number of Customers	2,250,511	N/A	0	0	Low probability event. Assume 1% probability in a major event with Average 6 hour increase in overall restoration.	135,031	Risk Item not included in hours saved
Advanced Technologies	1. This program will utilize new and significantly enhanced technologies, including GIS, OMS, Mobile Solutions, Predictive Analytics, and Advanced Customer Communications solutions to improve storm and emergency response and enhance communications to customers.	**System Visibility** **1a.** Expand implementation of 26kV, 13kV, and 4kV Microprocessor Relays and SCADA field equipment (RTUs) to enable remote operation and position indication of each feeder circuit breaker, provide remote monitoring capabilities including circuit and transformer loading, circuit breaker position, load imbalance, will assist in fault location and more.	# Customers in Stations	1,134,374	No Benefit	0	0	Assume 4 hour improvement in overall restoration time due to indication of circuit outages, immediate load data for decision making and the ability to remotely set-up circuits for work.	4,537,496	4,537,496
		1c. System to visualize, control, collect and analyze all monitored points from each Distribution station. This includes SCADA monitors and servers, dispatch consoles, communications switches and servers, historical serves with appropriate back-up and redundancy. (DMS)	Benefits Aligned with 1A	Combined with 1A	Combined with 1A	Combined with 1A		Combined with 1A	Combined with 1A	Combined with 1A
		Communication Network **2a**. High Speed Fiber Optic Network (Backbone)- Transmission - Complete build out equating to approximately 30% of the total system (in-progress). Distribution - Build fiber optic network from (91) of the (125) Distribution substations (Class A, B, C, CN, CS, etc) to facilitate the information transfer from the station to the new DMS system.	Benefits Aligned with 1A	Combined with 1A	Combined with 1A	Combined with 1A		Combined with 1A	Combined with 1A	Combined with 1A
		2b. Pilot Satellite Communication Program	Total number of Customers	2,250,511	No Benefit	0	0	Low probability event. Assume 5% probability in a major event with Average 12 hour increase in overall restoration.	1,350,307	Risk Item not included in hours saved
		Storm Damage Assessment (need all items in System Visibility) **3a**. Advanced Distribution Management System (ADMS) functionality to improve visibility of circuit operations in storm conditions and support restoration of customers. Integration of SCADA, DMS, OMS and GIS.	Benefits Aligned with 1A	Combined with 1A	Combined with 1A	Combined with 1A		Combined with 1A	Combined with 1A	Combined with 1A
		3b. Enhance Storm Management Systems to improve plant damage assessment process, optimize restoration work plans, integrate mutual aid crews, and develop capability to provide predictive ETRs under complex storm conditions.	Total number of Customers	2,250,511	No Benefit	0	0	Through confirmed damage location visibility, improved look-up process and elimination of duplicate records restoration process will be improved. Assume 4 hour improvement in average restoration in overall storm work.	9,002,044	9,002,044
		3c. Expand communication channels to improve ability to communicate storm-related information to customers. (Outage Map, Mobile App, Preference Management, SMS, Mobile Web)	Total number of Customers	2,250,511	No Benefit	0	0	No Benefit	0	0
Contingency Reconfiguration Strategies	This program refers to the ability of utilities to recover quickly from damage to any of its components	Establish contingency reconfiguration strategies by creating multiple sections, utilizing smart switches, smart fuses, and adding redundancy within our loop scheme	Using CIP 2 Major Results of $1.2M per circuit equal 167 13kV circuits. Avg customer count of 1500 = 250,500	245,824	Due to reconfiguration of circuits, loop improvement and fusing, 10% reduction in outages.	1,769,933	24,582	With greater system redundancy restoration time on average will improve by 10% (7.2 Hours)	1,592,940	3,362,872
Emergency Backup Generator and Quick Connect Stockpile Program	PSE&G to purchase and stockpile emergency backup generators to utilize during storm restoration. Technologies exist whereby a connection can be made to a residential customer electric meter which allows the quick connection of a portable generator.	PSE&G to deploy emergency generators to customers based on priorities driven by local municipal officials. In addition, PSE&G will maintain the supply of quick connects to be deployed as directed.	Number of Generators	200	No Benefit	0	0	Assuming a two day implementation of these measures, outage time reduced by 2 days	9,600	9,600
Municipal Pilot Program	To improve resiliency of the electric system, particularly by engaging valuable municipal resources in the event of prolonged outages	Develop a municipal storm plan which addresses vegetation maintenance, mobile field applications and a combined heat and power (CHP) pilot for targeted critical municipal facilities meeting the high efficiency specifications for application of this technology.	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
								Total Customer Hour Outage Reductions		62,714,213
								Total Customers		2,250,511
				Summary	**Number of Customer Outages Avoided**		**325,606**	**Average Outage Reduction Per Customer**		**28**

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
SUBSTATION FLOOD MITIGATION COST

QUESTION:
For purposes of this request, please refer to RCR-ECON-8.

a. Please provide all "office level estimates using PSE&G's experience with substation construction projects."
b. Please provide yearly estimates of the total expenditures on substation construction projects over the last 5 years.
   Please provide the estimated percent of expenditures on s ubstation construction projects that were contracted to outside vendors for each of the last 5 years.
   Please provide a list of all outside vendors utilized for substation construction projects over the last 5 years.
   Please provide the physical address of each of these companies.
   Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project over the last 5 years.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. Please see the Company's response to S-PSEG-ES-79

b. i.

Total $$	$57,861,465
Contractor $$	$14,500,451
% Contractor	25%

ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

OUTSIDE PLANT HIGHER DESIGN AND CONSTRUCTION STANDARDS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-10.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. Costs in the "other" category consists of traffic control costs.
b.

Project	Cost
Bergen to River Rd(C.91008)	$5,096,741
Southampton(C.90814)	$4,368,670
Bergen-Englewood	$11,874,259

c. Bergen to River Rd(C.91008)
   i. $567,819 =11.14%

   Southampton(C.90814)
   i. $43,889 = 1.00%

   Bergen-Englewood
   i. $1,893,995 = 15.95%

   ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

OPEN WIRE OVERHEAD CONSTRUCTION WITH SPACER CABLE

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-11.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. Costs in "other" category consist of traffic control costs.
b. Bare wire replacement is generally a component of more complex construction upgrades. The projects below are two projects completed in the last five years that are predominantly bare wire replacement, although other facilities were replaced as well.

Project	Cost
MTL 8012 SAIFI Major	$1,275,554
BEA 8009 SAIFI Major	$1,013,613

c. MTL 8012 SAIFI Major
   i. 44.9% = $573,617

   BEA 8009 SAIFI Major
   i. 43.6% = $441,965

   ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
STRENGTHENING POLE INFRASTRUCTURE

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-12.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. The "other" costs are related to traffic control and pole contractors.

b. SAIFI Improvement Pole Project - $13,625,492

c. i. 58% = $7,949,559
   ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
REBUILDING BACKYARD POLE LINES

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-13.

a. Please provide a breakdown of all major costs in the “other” category.
b. Please provide a list of all “similar type projects” that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
    i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
    ii. Please provide a list of all outside vendors utilized for these projects.
    iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
    iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. Costs in “other” category consist of traffic control costs.
b. Backyard pole lines have existed in PSE&G's territory for decades. The Company has extensive experience constructing backyard poles in an emergency scenario but has not implemented a formal program in the past five years. The Company's estimates are based on the time required to replace poles, wires, and equipment in a normal front of yard scenario as well as the special requirements to implement this work in a customer's back yard, such as specialized equipment and altered work practices. Emergent work is not tracked as individual jobs; therefore, the specific information requested is not available.
c. Please see above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
TARGETED UNDERGROUNDING TO MITIGATE STORM IMPACTS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-14.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. Costs in "other" category consiste of traffic control costs.
b. The Company has not converted any overhead circuits to underground construction in the past five years. The Company's estimates are based on experience in constructing overhead and underground circuits.
c. Please see above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

REPLACE PAD-MOUNTED SWITCHES

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-15.

a. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
b. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. See attached list of projects
b. i. 0.71% = $7,394
   ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

ORDERS	MAINTACTIVTYPE	Order_Desc	REF_NUMBER1	TOTAL_ACT_COSTS
300323889	BEQ	UG - INSTALL ATS PMH9	500221985	$ 36,026.47
300337217	BEQ	GENE/FRAT. MEADOW/FLOW THRU SWITCH/SKETC	500213495	$ 15,473.48
300343048	BEQ	UG - PMH9 (PAD 956)	500172074	$ 17,360.49
300352149	BEQ	5th Bldg Lockheed Martin - ug work	500212491	$ 44,586.83
300352721	BEQ	PAD#3069 - INSTALL PMH-9 SWITCH	500230747	$ 17,177.80
300364407	BMC	Repair ATS 464 Cooper & Delaware - CM	500243871	$ 6,494.82
300371388	BEQ	RTE 4 E/B W/O GRAND AVE EW. FLATROCK (NE	500212902	$ 10,690.13
300371389	BEQ	RTE 4 E/B W/O GRAND AVE EW. FLATROCK (NE	500212903	$ 14,705.36
300371390	BEQ	FLAT ROCK RTE 4 E/B AND W.SHEFFIELD AVE.	500212905	$ 13,021.51
300380115	BEQ	JS-FLOW THRU SWITCH	500170434	$ 17,649.99
300387133	BEQ	UG - PMH9 (ATS)	500244253	$ 45,353.95
300387458	BEQ	9/22 start Inst. pmh9, PAD#3463	500251040	$ 17,883.86
300400769	BEQ	SWITCH Scheduled for week of 09/16	500252650	$ 9,126.15
300421787	BEQ	HILLTOP-3-PMH9 6463-6464-6465	500254768	$ 47,438.86
300430929	BEQ	ATS Pad 2944	500280501	$ 51,895.09
300465111	BEQ	ATS PAD 818 REPLACMENT	500279954	$ 60,766.10
300489165	BEQ	Install PMH 12 Style Switch PMH# 2971	500306325	$ 15,667.53
300489534	BEQ	INS & RMV 838/837 (SECTIONALIZER)	500288939	$ 115,117.07
300495683	BEQ	PAD#3469 & PAD#3470 - 2 PMH-9 SWITCHES	500284388	$ 38,607.05
300499186	BEQ	Replacement for switch 345	500324303	$ 4,809.16
300504188	BEQ	PUMP STATION - BILLABLE ATS-SWITCH	500332881	$ 48,926.00
300528815	BEQ	STIMULUS BUD-1089 PE 47	500316052	$ 25,795.44
300542621	BEQ	PAD#3480 - INS. PMH-9 SWITCH	500375619	$ 37,711.00
300542723	BEQ	PAD#3473 - INS. PMH-9 SWITCH	500296345	$ 19,231.71
300548080	BEQ	PAD#3475 - INSTALL PMH-9 SWITCH	500360741	$ 17,149.71
300552980	BEQ	(2) MANUAL PM SWITCH PADS -JC	500366723	$ 40,152.28
300569174	BEQ	Install ATS Auto Switch	500379957	$ 20,931.13
300591570	BEQ	INS/RMV ATS PAD5383	500245005	$ 62,157.94
300592638	BEQ	REM/INS PMH-9 SWITCH	500258069	$ 46,447.41
300604109	BEQ	replace ats switches	500408093	$ 32,619.44
300605670	BEQ	SERVICE TO PAR @ LINDEN GEN	500398779	$ 38,822.77
300636370	BEQ	PEH 8008 DCR- ATS SWITCH &TERMINATORS	500428042	$ 48,982.10

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

REPLACE PAD-MOUNTED TRANSFORMERS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-16.

a. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
b. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. See attached list of projects
b. i. 0.55% = $84,072
   ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

ORDERS	MAINTACTIVTYPE	Order Descr	REF_NUMBER1	TOTAL_ACT_COSTS
300094593	BEQ	Htown Phase 2 transformers/pme	500044091	$ 158,355.33
300191615	BEQ	TRANSF. FROM #1 TO #31FEHERVARI CT	500115488	$ 29,574.14
300191619	BEQ	TRANSF.FROM #10 TO #57 SPANGENBERG	500115488	$ 20,848.45
300205591	BEQ	54 homes/3- TRANSFORMERS	500126329	$ 12,936.02
300233915	BEQ	transformers 2305- 2307	500143410	$ 32,092.98
300251248	BEQ	BUD HEARTHSTONE @ HBT/10 transformers	500148696	$ 33,886.89
300261626	BEQ	PAD,TRF,ELBOWS	500170149	$ 64,894.78
300262055	BEQ	Switching,Transformers-Elbows,Pads-PSEG	500102189	$ 99,489.19
300269935	BEQ	INS XFMR BLDG A - 11-3-11	500179611	$ 12,004.22
300277984	BEQ	PAULIUS WAREHOUSE- TRANSFORMER	500192869	$ 36,184.40
300283577	BEQ	TRANSFORMERS BLDG 1 & 2	500193881	$ 21,357.01
300302105	BEQ	PADS, TRFS AND ELBOWS	500084700	$ 25,769.38
300305077	BEQ	Install Transformer 100kva - EH	500211667	$ 6,347.28
300308203	BEQ	1 PH TRANSFORMER WORK	500127463	$ 72,702.93
300312183	BEQ	TRANSFORMERS- ph 1	500150401	$ 34,734.27
300315952	BEQ	150 KVA TRF	500213668	$ 10,831.45
300321097	BEQ	REPLACE/UPGRADE PADMOUNT TRANSFORMERS	500217826	$ 68,146.49
300329151	BEQ	JK-PINNACLE BUD 612 INSTALL MINI PADS	500209176	$ 20,963.55
300333010	BEQ	switching/transformers (elbows/pads)	500180748	$ 57,115.94
300335776	BEQ	SWITCHING/TRANSFORMERS	500125647	$ 82,355.22
300339465	BEQ	TRANSFORMERS FOR LARA & CORDA LN	500095979	$ 5,018.29
300339575	BEQ	PAD/TRF 4086	500229624	$ 11,070.78
300346311	BEQ	JK-PAD MOUNT TRANSFORMER	500235096	$ 11,001.84
300347350	BEQ	TRANSFORMERS- ph 2	500150401	$ 37,306.70
300347517	BEQ	transformer	500216689	$ 6,658.94
300355259	BEQ	TRANSFORMER ADDED - T1266	500213603	$ 2,587.10
300361778	BEQ	INSTALLATION OF PADMOUNT TRANSFORMER	500225051	$ 12,773.73
300364259	BEQ	1500Kva-trans., pad & elbows.	500210172	$ 26,877.00
300367909	BEQ	TRANSFORMERS - PHASE 2 released to order	500174157	$ 23,222.14
300370033	BEQ	XFMR - T-3599 (750 KVA)	500232818	$ 23,205.08
300370040	BEQ	XFMR - T-3601 (300 KVA)	500232818	$ 12,207.17
300373745	BEQ	Pad#147 Replacement	500237371	$ 3,854.31
300373953	BEQ	Replace Leaking 1000KVA PM Transformer	500250851	$ 25,158.18
300379796	BEQ	PT MANOR PH 3-BUD 1754-Inst Transformers	500072541	$ 44,130.15
300387555	BEQ	1 ph transformers	500232818	$ 20,543.75
300390455	BEQ	INSTALL TRANSF #T2301 150KVA	500143298	$ 13,420.25
300392491	BEQ	INSTALL PADMOUNT TRANSFORMER	500253475	$ 7,898.77
300393238	BEQ	INSTALL T2297,2298,2299&2300	500143298	$ 19,332.63
300393368	BEQ	TRANSFORMERS, ELBOWS,PERFORM SWITCHING	500152413	$ 84,485.82
300396745	BEQ	FRANKLIN GREENS SOUTH 50KVA REPLACEMENTS	500263426	$ 19,121.51
300401874	BEQ	Replace Def. Transformers T-14,T-13,T-12	500248296	$ 4,926.31
300404002	BEQ	NEW PAD 3010	500264778	$ 3,496.42
300410094	BEQ	BUD1042 HM /INST & REM TRFS. & ELBOWS	500237370	$ 67,165.74
300412092	BEQ	BUD1387 JEFFERSON AT EWING /Transformers	500259221	$ 45,178.30
300421025	BEQ	Install 4 X-formers	500237923	$ 49,176.96
300423941	BEQ	500 KVA PAD	500210511	$ 10,848.59
300424625	BEQ	RIVEREDGE--50KVA LF13KV (2) - JC	500266758	$ 5,722.81
300424626	BEQ	RIVEREDGE--100KVA LF13KV (11)- JC	500266758	$ 27,828.98
300424627	BEQ	RIVEREDGE--167KVA LF13KV (1)	500266758	$ 13,805.63
300429519	BEQ	DARIO-INSTALL 1500KVA SEE TEXT	500335717	$ 39,442.61
300430072	BEQ	Relocate T3142 ON COPE COURT	500280025	$ 3,780.96
300433382	BEQ	INSTALL COFFIN PME & DBL PAD	500227525	$ 65,955.02
300433443	BEQ	INSTALLATION OF T-438	500234918	$ 16,357.46
300435869	BEQ	750 kva 277/480-4w 13kv rdf padmount	500275996	$ 19,754.81

300443937	BEQ	INSTALL 300KVA 120/208 4W PADMOUNT TRANS	500259280	$	10,918.91
300445457	BEQ	REPLACE TRANSF'S T290 + T291 + T287	500286188	$	17,889.75
300450643	BEQ	INSTALL 100KVA T#1244	500222278	$	5,875.63
300450646	BEQ	INSTALL 50KVA T#1247	500222278	$	2,924.48
300450647	BEQ	INSTALL 100KVA T#1248	500222278	$	4,046.70
300450653	BEQ	INSTALL 100KVA T#1251	500222278	$	4,556.41
300450660	BEQ	INSTALL 167KVA T#1255	500222278	$	11,120.74
300450663	BEQ	INSTALL 100KVA T#1257	500222278	$	4,093.17
300450664	BEQ	INSTALL 100KVA T#1258	500222278	$	8,514.50
300450668	BEQ	INSTALL 100KVA T#1260	500222278	$	3,358.84
300450670	BEQ	INSTALL 100KVA T#1262	500222278	$	2,697.94
300450671	BEQ	INSTALL 100KVA T#1263	500222278	$	3,358.85
300450673	BEQ	INSTALL 100KVA T#1265	500222278	$	3,579.15
300454639	BEQ	3 PHASE TRANSFORMER 1283	500237581	$	13,526.54
300454640	BEQ	3 PHASE TRANSFORMER 1284	500237581	$	13,526.53
300454642	BEQ	50KVA TRANSFORMER 1286	500237581	$	10,300.50
300454743	BEQ	50KVA TRANSFORMER 1287	500237581	$	1,845.33
300454744	BEQ	50KVA TRANSFORMER 1288	500237581	$	1,845.33
300454745	BEQ	50KVA TRANSFORMER 1289	500237581	$	2,181.72
300454851	BEQ	REPLACE XFMR'S T4 + T102	500292574	$	6,819.51
300457308	BEQ	750 kva 120/208-w pad mount	500294228	$	23,032.16
300457737	BEQ	Inst 100Kva pad mounted trans. Pad-3729	500276810	$	3,643.27
300464358	BEQ	Transformers - Phase 3-5	500180748	$	26,328.51
300465855	BEQ	REPLACE T-439 TO 100KVA	500285672	$	4,449.78
300467287	BEQ	REPL T-268/T-269/T-202/T-201/T-200 1/3	500300686	$	23,997.02
300470851	BEQ	750 KVA-PADMOUNT TRANSFORMER-120/208-4W	500294208	$	1,410.81
300473383	BEQ	REPLACE XFMR'S T953, T956	500298740	$	9,433.67
300473521	BEQ	REPLACE XFMR T714	500298740	$	3,760.61
300474933	BEQ	REPLACE 1 PHASE T-441 & T-442	500285672	$	10,406.25
300475612	BEQ	5 REPLACE T-103 AND T-85	500300688	$	10,113.72
300475614	BEQ	5 REPLACE T-70 AND T-341	500300688	$	5,421.52
300475616	BEQ	5 REPLACE T-342 AND T-335	500300688	$	7,988.74
300475618	BEQ	5 REPLACE T-340 AND T-343	500300688	$	5,550.78
300476382	BEQ	INSTALL NEW T-3671	500273572	$	3,989.88
300478399	BEQ	INSTALLATION OF T-3679	500291238	$	10,135.62
300478640	BEQ	UG T-2167 REPL 750KVA 265/460V PAD MOUNT	500277718	$	35,065.30
300478957	BEQ	Sheet 1: TRANSFORMERS	500315231	$	136,782.08
300478962	BEQ	Sheet 2: TRANSFORMERS	500315231	$	13,531.00
300479692	BEQ	BUD#186 REPLACE 10 TRANSFORMERS	500315229	$	24,781.53
300482139	BEQ	INS/RMV TRANSF & HHs A-PH, SEC 1	500315232	$	28,164.54
300482231	BEQ	INS/RMV TRANSF C-PH, SEC 1	500315232	$	20,302.30
300483035	BEQ	Replace Trans. 260/261/262/264 Sheet A	500317095	$	21,549.42
300483855	BEQ	3 REPLACE TWO TRANSFORMERS TASKS	500315226	$	8,670.59
300484759	BEQ	SHELTON-TRANSFORMER ORDER	500289454	$	24,171.01
300484863	BEQ	INS/RMV PME's & TRANF - B-PH SEC 2	500315232	$	6,085.99
300485374	BEQ	SHEET 3 REPL XFORMERS NON LEAKERS	500315235	$	27,507.73
300486395	BEQ	SHEET 4 REPL XFORMERS NON LEAKER	500315235	$	11,190.10
300486400	BEQ	Sheet 1: Transformers	500315233	$	21,203.06
300486415	BEQ	PAD 1091 PAD REPLACEMENT	500289445	$	5,184.63
300486470	BEQ	Sheet 2: Transformers	500315233	$	15,899.85
300486474	BEQ	SHEET 5 REPL XFORMERS NON LEAKERS	500315235	$	28,880.53
300486475	BEQ	SHEET 3 REPL XFORMERS LEAKERS 339 & 264	500315235	$	3,940.83
300489390	BEQ	(PS) 1090 Thomas Busch Hwy. /Repl. trf.	500432924	$	20,248.86
300491277	BEQ	PAD 2486	500308918	$	1,984.59
300491344	BEQ	Replace XFMR T6 & T7	500285673	$	7,587.32

300500700	BEQ	PAD#4000 - INSTALL 150KVA 120/208V 4W	500322587	$	10,952.00
300501763	BEQ	UG PADMOUNTED TRANSFORMER	500322568	$	33,248.32
300504080	BEQ	PUMP STATION - TRANSFORMER	500332881	$	8,990.53
300505281	BEQ	Inst 1500Kva 277/480v & elbows Pad-1329	500257410	$	27,747.94
300505505	BEQ	INS 500KVA RDF PMT PAD#2345	500331703	$	19,543.75
300506508	BEQ	UG PAD XFORMER WORK (EXACT DATE: 8/14)	500330943	$	9,862.38
300507302	BEQ	Inst. 1000kVA 277/480v Pad	500332507	$	20,362.12
300509901	BEQ	DARIO-INSTALL 300KVA SEE TEXT	500332913	$	14,652.03
300512999	BEQ	750 277/480v 3PH 13KV	500335561	$	20,565.02
300514650	BEQ	XFMRS - VILLAGES @ DELAWARE RUN-BUD 1940	500225973	$	18,847.09
300519193	BEQ	Remove & Install Transformers - WOR8021	500340395	$	7,288.68
300519194	BEQ	Remove & Install Transformers - LAF8011	500340395	$	9,325.29
300520100	BEQ	Emergency transformer replacement for 1	500345506	$	23,748.93
300521485	BEQ	padmount 189 upgrade 277/480 1000kva	500346177	$	18,436.86
300521590	BEQ	Stimulus-TRF'S	500334477	$	51,991.37
300522084	BEQ	Stimulus-TRF'S & PRI ENCLOSERS	500334447	$	56,410.91
300522778	BEQ	(BR) 361 Benigno Blvd / Repl Trf	500440793	$	29,409.58
300523061	BEQ	PAD#4150 300KVA 120/208V XFMR	500340797	$	13,792.82
300523526	BEQ	REPLACE T-86 WITH 50KVA	500292579	$	5,136.70
300524783	BEQ	Stimulus-REPLACE TRF'S AND RECLOSERS	500334446	$	28,106.49
300527582	BEQ	INSTALLATION OF T-1189	500336653	$	28,586.03
300527666	BEQ	Inst. 2-2000kVA with PME	500265650	$	75,142.97
300527828	BEQ	Stimulus-BUD 28 - UG TRANSFORMERS	500334478	$	63,980.72
300528743	BEQ	T-135 2500KVA TRANS.	500348331	$	38,080.91
300530012	BEQ	rmv/ins transformer mayfield ave edison	500351020	$	19,580.56
300530043	BEQ	TRANSF FOR MURPHY DR	500319540	$	8,360.50
300530044	BEQ	TRANSF. FOR GALLIGEN & McCARLES	500319540	$	25,169.87
300530153	BEQ	(WW) BUD1966 Inst Transformers	500228763	$	70,073.65
300530495	BEQ	Stimulus-REPLACE TRANSFORMERS	500334459	$	40,211.02
300531602	BEQ	Replace Padmounts	500350979	$	9,437.88
300534580	BEQ	PAD#2900 - REPLACE TRANSFORMER 277/480V	500353435	$	30,257.29
300535041	BEQ	INSTALLATION OF T-3271	500343731	$	2,502.79
300535447	BEQ	Stim BUD 38 REM/INS TRNASF	500334481	$	70,832.38
300535713	BEQ	INSTALL 300KVA PADMOUNT TRASF. W/ PAD	500354015	$	10,727.95
300536090	BEQ	PHASE 1-UG TRANSFORMERS	500346569	$	20,693.67
300536140	BEQ	CN HARBOUR - PHASE 6.UG PADS & SWITCHING	500353947	$	22,775.50
300536433	BEQ	INSTALL 300KVA 120/208V DR. @ PAD 1977	500345851	$	19,000.63
300536890	BEQ	DARIO-I-2-PE'S & 500KVA	500356450	$	33,523.88
300537031	BEQ	PADS & PERFORM SWITCHING -PHASE 2B	500341661	$	18,221.34
300537057	BEQ	PADS & SWITCHING-PHASE 2C	500350936	$	8,190.31
300537145	BEQ	SINGLE PH & 3 PH UG TRANSFORMERS	500317357	$	44,057.83
300537406	BEQ	PADMOUNTED TRANSFORMERS	500125880	$	33,316.94
300538942	BEQ	UG PADS-PHASE 1	500317795	$	37,208.38
300539772	BEQ	EQUIPMENT-500kva d/r 120/208-4w rdf	500346073	$	14,663.48
300540091	BEQ	UG PADMOUNT TRANSFORMER	500356884	$	14,731.85
300540713	BEQ	INSTALL 750 KVA PAD MOUNT TRANS	500351720	$	19,297.91
300541729	BEQ	(WW) Princeton Theological BLDG#2 Trf.	500335315	$	18,129.38
300541730	BEQ	(WW) Princeton Theological BLDG#3 Trf.	500335316	$	16,435.37
300542773	BEQ	Stim-BUD1084- UG to rem/inst 23 TRANSFOR	500334448	$	66,164.49
300542906	BEQ	PH 1-XFMRS CONDOS BLG 14 (2 xfmrs)	500318279	$	14,667.72
300542910	BEQ	PH 1 Xfmr's(3) TH Blg's: 9-7-5-6	500317417	$	10,785.42
300543362	BEQ	Ph 4 Xfmr's(4) TH Blg's: 11-12-13-14	500317417	$	7,873.09
300543378	BEQ	INSTALLATION OF T-541	500343036	$	19,326.70
300543425	BEQ	PH 5&6 Xfmr's(4) TH Blg's: 8-10-17-18	500317417	$	9,819.86
300543618	BEQ	PH 5/6-XFMRS Condo Blg's 9 & 10	500318279	$	28,779.78

300543874	BEQ	INSTALLATION OF NEW T-3696	500358121	$	28,834.49
300544835	BEQ	transformer 500kva 120/208	500360722	$	9,850.55
300544837	BEQ	500 kva 120/208 transformer	500360635	$	14,555.21
300544838	BEQ	500 kva transformer 120/208	500359881	$	12,010.94
300545427	BEQ	REPLACE T-8 & T-5 WITH 100KVA	500361765	$	4,003.70
300546219	BEQ	repl padmounted xfmrs 448 & 379	500309395	$	3,842.80
300547013	BEQ	INSTALL 750 KVA PAD MOUNT TRANS	500357843	$	19,100.73
300547180	BEQ	INST. 750kVA DR 277/480V	500336866	$	23,914.57
300547453	BEQ	INSTALLATION OF NEW T-3697	500358536	$	29,646.02
300548079	BEQ	PAD#3476 - 2500KVA 277/480V TRANSFORMER	500360741	$	37,754.13
300548317	BEQ	INS X-FRMR/CELL SITE 120/240V 1PH 200A	500361807	$	4,664.80
300549296	BEQ	PADMOUNT TRANSFORMERS - LEIA WAY	500354529	$	21,158.41
300549301	BEQ	PADMOUNT TRANSFORMERS - ELLA LANE	500354529	$	13,318.15
300550068	BEQ	PAD#2786 REP. 1500KVA w/ 2000KVA XFMR	500362023	$	36,541.15
300550178	BEQ	Pad mount transformers BUD# 1133	500367141	$	23,205.22
300550673	BEQ	ENBC 1400 RIVER RD, EWR XFMR	500356731	$	15,095.75
300550709	BEQ	DARIO-PE & TRANSFORMER WORK	500358040	$	6,630.43
300550841	BEQ	Tenby Towne BUD 63 - DR-transformers	500367224	$	42,739.06
300551019	BEQ	INST T-1460 500KVA PAD MOUNT TRANS	500361490	$	15,001.29
300551543	BEQ	INS TRF & ELBOS/McD's 120/208V 3PH 1000A	500360538	$	12,667.84
300552136	BEQ	INSTALLATION OF T-1192	500360117	$	14,325.37
300552394	BEQ	PAD/TRF 750 Kva	500329645	$	21,260.27
300552622	BEQ	Stim 2 Woodridge BUD 293 Transformer	500367356	$	15,171.80
300552750	BEQ	BUD636 (3-75KVA) -TS	500352349	$	10,604.30
300552752	BEQ	BUD636 (4-100KVA)- TS	500352349	$	29,680.52
300552973	BEQ	(5) 150KVA 3PHASE 120-208 PAD XFMRS -JC	500366723	$	40,095.34
300553020	BEQ	RMV & INS XMERS FOR BUD-25	500353392	$	7,087.21
300553373	BEQ	ins. pad. transf'r baekeland ave mid.	500363811	$	9,322.46
300555749	BEQ	INSTALL/REMOVE T-291	500308655	$	101.60
300556335	BEQ	INS. 750KVA XFMR 277/480V @ PAD 1477	500365533	$	20,818.41
300557136	BEQ	Transformers PH1	500368574	$	7,119.14
300557150	BEQ	ins. padmount transformer rte 27 edison	500367712	$	13,431.83
300557781	BEQ	BUD# 1161 Padmount Transformers	500371253	$	33,763.23
300557971	BEQ	Inst 167Kva 120/240v 3w trans, Pad#1341	500365420	$	8,565.01
300558012	BEQ	INS. 1500KVA XFMR @ PAD 2386	500368636	$	29,468.17
300558526	BEQ	PAD TRF 750 KVA	500332503	$	18,575.35
300558581	BEQ	MCGOWEN TRANS WORK SEC.#1	500305792	$	60,929.57
300558816	BEQ	BUD 109-INS&RMV XMERS	500361764	$	20,311.97
300558829	BEQ	750 kva 120/208 D/R RDF	500265838	$	27,201.72
300559013	BEQ	25kva Padmount and pad	500364049	$	3,961.16
300559035	BEQ	BUD 264 - INS&RMV TRANSFORMERS	500340108	$	11,639.37
300559101	BEQ	Inst. 4 LPF 13kV 750kVA pad mounts	500363838	$	77,956.47
300559341	BEQ	BUD 324 - INS & RMV TRANSFORMERS	500361766	$	4,863.66
300559448	BEQ	RMV & INS XMERS FOR BUD-105	500340397	$	27,067.20
300559615	BEQ	INSTALLATION OF T-1286	500371951	$	10,535.48
300559750	BEQ	PAD#3996 - 25KVA TRANSFORMER	500371967	$	2,981.02
300561528	BEQ	PAD#3477 - INS. 225KVA 120/208v XFMR	500368893	$	12,808.11
300562158	BEQ	PAD#3999 - INS. 500KVA 120/208v XFMR	500372291	$	15,171.19
300562473	BEQ	500kva D/R 277/480-4W RDF	500367309	$	4,886.97
300562531	BEQ	replace existing 225kVA UG padmount tran	500359840	$	16,004.61
300562774	BEQ	Inst. PME & 2 - 1500kVA 277/480V Pads	500360728	$	64,551.66
300562789	BEQ	750 kva 13kv RDF 277/480-4w	500355339	$	18,669.24
300562916	BEQ	(LM) 1594 Rte38 Miller Ford/Repl Trf	500374381	$	11,821.68
300563818	BEQ	Replace XFMRS-Stimulus-canterbury-BUD14	500334484	$	44,519.39
300564053	BCA	1. Springdale - DL, UG P# 63256 (p)	500361770	$	38,726.19

300564183	BEQ	UG-Inst 225Kva 120/208v 13Kv radial pad4	500374128	$	11,930.61
300565709	BEQ	357 RIVER RD, EW PDMT XFMR	500371488	$	20,756.40
300565710	BEQ	357 RIVER RD, EW PDMT XFMR	500371489	$	12,347.86
300566402	BEQ	277/480v 2500kva pad# 108	500373964	$	36,040.93
300566498	BEQ	Inst 120/208v 500Kva radial & 3a pad1342	500374425	$	12,809.39
300566528	BEQ	UG PADMOUNT TRANSFORMER	500440527	$	15,302.59
300566529	BEQ	PME & TRANSFORMERS FOR DAHLIA CT	500356915	$	77,032.81
300566530	BEQ	TRANSFORMERS FOR CROCUS CT	500356915	$	1,870.61
300566535	BEQ	TRANSFORMERS FOR CALADIUM CT	500356915	$	2,562.18
300566636	BEQ	INS PAD #3995-150 KVA/ 3ph 120/208v 400A	500248721	$	10,168.85
300566694	BEQ	PME & TRANSFORMERS FOR AMARYLLIS LANE	500356915	$	8,302.80
300566695	BEQ	TRANSFORMERS FOR LILY LANE	500356915	$	22,155.09
300566696	BEQ	TRANSFORMERS FOR BEGONIA COURT	500356915	$	32,404.79
300566760	BEQ	PAD#3998 - 1000KVA 277/480v XFMR	500298596	$	19,539.64
300567231	BEQ	rmv/ins padmount saw mill pond rd edison	500375954	$	30,826.51
300567268	BEQ	Padmount Xfmr.	500359856	$	3,931.10
300567350	BEQ	Ins Padmount Xfmrr	500346199	$	7,345.35
300567584	BEQ	UG PADMOUNT TRANSFORMER	500341659	$	18,394.96
300568004	BEQ	NEW ELEC SVC - 277/480V, 3 PH, 2500 AMPS	500377661	$	31,021.19
300568166	BEQ	transformer upgrade 500kva	500377221	$	16,598.42
300568168	BEQ	upgrade transformer 500 kva	500375948	$	14,667.74
300568346	BEQ	Inst 300Kva 120/208v 13Kv loopfeed	500371821	$	11,401.20
300568467	BEQ	UG-Inst 500Kva 120/208v radial 4Kv & pad	500362446	$	19,007.22
300568616	BEQ	INS PAD # 506 / 120/208V 3PH 2000 A	500377355	$	14,612.93
300568673	BEQ	UG-inst 300kva dual, pad 1343	500376945	$	14,295.81
300569801	BEQ	750 kva120/208-4w D/R padmount trans rdf	500379160	$	27,699.39
300569865	BEQ	120/208-4w 300kva RDF padmount	500365771	$	11,409.07
300569866	BEQ	120/208-4w 300kva RDF padmount	500365772	$	10,066.88
300569905	BEQ	Install 2000kVA 277/480V RDF	500265981	$	34,117.87
300570070	BEQ	Stim-BUD46-rem/inst TRANSFORM additional	500334458	$	71,483.53
300570348	BEQ	Install Pad Mount Transformer -EH	500374019	$	24,080.31
300570993	BEQ	NEW PAD/TRF #3369	500378905	$	3,324.50
300571175	BEQ	UG PADMOUNT TRANSFORMERS	500378813	$	11,959.06
300571332	BEQ	INSTALLATION OF T-3709	500345582	$	25,375.63
300571337	BEQ	INSTALLATION OF T-3710	500345583	$	23,211.53
300571346	BEQ	INSTALLATION OF T-3711	500345584	$	26,270.31
300571748	BEQ	INST. T-3277 1500KVA TRANS. 277/480	500374372	$	28,315.64
300572169	BEQ	MUG - PADMT TRF WORK - BLDG# 43	500362045	$	12,498.83
300572248	BEQ	INS. 1500KVA 277/480v LF XFMR	500348853	$	27,866.36
300572469	BEQ	ug xfmr	500377375	$	28,674.59
300572614	BEQ	TRANSFORMERS ON GRAPHITE DR-JC	500163110	$	17,371.38
300573198	BEQ	CHANGE OUT T-1420 WITH A SHUTDOWN	500285932	$	11,071.24
300573199	BEQ	INSTALLATION OF T-1423	500285932	$	12,495.73
300573272	BEQ	INSTALLATION OF T-1465	500285931	$	12,963.11
300573809	BEQ	Install Pad Mount Transformer-EH	500267179	$	20,123.03
300574090	BEQ	150 kva padmount	500367244	$	8,120.64
300574149	BEQ	INS. 2000KVA XFMR @ PAD 2396 277/480V D	500377665	$	14,627.02
300574431	BEQ	Inst 150Kva 120/208 13Kv radial pad-2982	500378895	$	8,738.79
300574695	BEQ	PAD/DOGHOUSE	500380668	$	4,332.24
300574996	BEQ	750Kva radial 277/480v 1200a, 4Kv dual	500372324	$	20,973.88
300575122	BEQ	(DR) #2904 Rte130 / Inst Pad & Trf.	500383655	$	11,175.17
300575928	BEQ	UG Inst 1-ph pad mount transformer 167Kv	500382980	$	5,692.91
300576604	BEQ	UG PADMOUNT TRANSFORMER	500377383	$	1,696.77
300576726	BEQ	500 KVA PAD/TRF	500374457	$	13,316.42
300576846	BEQ	UG 1000Kva 277/480v 13Kv trans, pad-1133	500381581	$	24,234.64

300577123	BEQ	UG PADMOUNT TRANSFORMER	500368875	$	12,069.87
300577271	BEQ	UG PADMOUNT TRANSFORMER (LNB)	500380642	$	23,094.72
300577452	BEQ	BUD 636 (1-167kVA) -TS	500352349	$	8,251.75
300577576	BEQ	ins. padmount transformer runyons la ed.	500367222	$	18,566.29
300578828	BEQ	New 1000kVA 13kV 120/208V Padmount	500386652	$	27,687.80
300578829	BEQ	New 1000kVA 13kV 277/480V Padmount	500386656	$	28,102.62
300579172	BEQ	PAD#2791 - INS. 1500KVA 277/480V LOOP XF	500357888	$	28,705.76
300579462	BEQ	INS. 500KVA XFMR @ PAD #2308	500386679	$	19,023.01
300579907	BEQ	Install Transformers - ADA8024 - PAGE1	500341999	$	7,014.09
300579958	BEQ	Install XFMER'S - BEN8012 - PAGE2	500341999	$	27,864.23
300579973	BEQ	Install Transformers - BEN8012 - PAGE1	500341999	$	9,193.54
300580074	BEQ	New 150kVA 13kV Padmount Transformer	500387161	$	13,626.24
300580090	BEQ	DARIO-INSTALL 50KVA SEE TEXT	500340478	$	4,801.07
300580139	BEQ	UG EQUIPMENT -SHEET 1	500340702	$	16,342.82
300580145	BEQ	UG PADMOUNT TRANSFORMER	500371824	$	9,486.61
300580194	BEQ	T-1437,RPL 100kVA,C-PH,Leaking	500390673	$	6,425.31
300580448	BEQ	(MO) BUD608 Repl. Trf. @ Pad665	500381539	$	25,697.43
300580483	BEQ	PAD/TRF #3372	500383303	$	4,715.33
300580583	BEQ	Transformer-Install pad #2933 25kva	500390860	$	4,726.00
300581153	BEQ	MUG - PADMT TRF WORK - CLUBHOUSE	500362044	$	10,965.88
300581237	BEQ	UG - PADMOUNT TRANSFORMER	500364633	$	43,839.29
300581389	BEQ	Ph 2: Transformers	500368574	$	7,269.36
300581399	BEQ	UPGRADE OF 3 PH PDMT XFMR T-324	500390657	$	30,109.81
300581882	BEQ	Ins/Rem Pad845- Leaker	500286490	$	17,368.49
300582193	BEQ	UG XFMR	500387774	$	9,473.55
300582226	BEQ	straighten Transformer	500358233	$	4,702.35
300582440	BEQ	PAD#3077 - INS. 25KVA TRANSFORMER	500389881	$	3,852.97
300582586	BCA	UG XFMR	500387272	$	14,215.72
300582938	BEQ	GML-500KVA 277/480 PADMNT. TRANS. ORDER	500387139	$	14,775.35
300582939	BEQ	GML-500KVA 277/480 PADMNT. TRANS. ORDER	500387139	$	17,515.78
300583234	BEQ	INSTALL/REMOVE PAD#1206VT	500286490	$	12,196.74
300583333	BEQ	PAD#3532 - INS. 25KVA TRANSFORMER	500377492	$	4,012.88
300583461	BEQ	NEW PAD/TRF	500387641	$	13,497.76
300583650	BEQ	UG Equipment	500386675	$	12,646.91
300583765	BEQ	Install XFMER'S	500360750	$	111,946.92
300583838	BEQ	PAD#3075 - INS. 50KVA TRANSFORMER	500377507	$	4,498.07
300583863	BEQ	300 kva UG padmount	500286137	$	9,830.18
300583885	BEQ	UG PADMOUNT TRANSFORMER	500385878	$	10,472.82
300584382	BEQ	PAD#3442 - INS. 500KVA 120/208v XFMR	500355162	$	14,735.70
300584660	BEQ	INSTALLATION OF NEW T-452	500390654	$	12,113.69
300585018	BEQ	UG XFMR	500388469	$	4,746.54
300585235	BEQ	INSTALL & REMOVE TRANSFORMER -JC	500388484	$	4,684.82
300585353	BEQ	Replace Transformer T-2725	500368625	$	5,697.30
300585727	BEQ	(BT)4 Manhatten Dr. Repl. Trf. Pad#1316	500395046	$	15,343.93
300586898	BEQ	INST 1000KVA PADMOUNT	500341751	$	21,338.47
300586998	BEQ	UG Transformer Replacement Order For T30	500368649	$	4,147.75
300587309	BEQ	120/208-4w 300kva 13kv rdf	500374210	$	11,903.95
300587615	BEQ	Install 50KVA XFMR	500353914	$	3,525.52
300587823	BEQ	INST. T-138 277/480V	500378901	$	11,002.29
300587849	BEQ	Transformers - Phase 1	500365675	$	27,775.88
300588264	BEQ	INS (2)50KVA & (1)75KVA - JD	500134754	$	17,197.43
300588357	BEQ	500 PAULISON AVE,PC-Pad Xfrmr-JK	500394714	$	7,055.99
300588396	BEQ	ug repl. Pad & Trf.	500320612	$	10,735.44
300588588	BEQ	INSTALL TEMP XFMR - JC	500391050	$	4,340.08
300588779	BEQ	install padmount xfmr wade st s. plfld	500395519	$	18,308.74

300588781	BEQ	1463 FINNEGANS LN - PADMOUNT	500392783	$	12,457.81
300589167	BEQ	INS PAD 6671 - JK	500072019	$	4,624.15
300589513	BEQ	UG TRANSFORMER 300KVA	500390904	$	13,521.18
300589846	BEQ	REPLACE 25KVA WITH 50KVA PDMT TRANSF.	500398719	$	4,247.76
300589944	BEQ	UG PADMOUNT TRANSFORMER	500382998	$	29,116.99
300590010	BEQ	Replace Transf.- Eastern Regional HS,VT	500397877	$	18,495.27
300590046	BEQ	UG-inst padmount transformer	500389960	$	12,727.23
300590430	BEQ	inst 300kva padmount (pad#470)	500387548	$	10,323.53
300590640	BEQ	INS. 1500KVA XFMR @ T-2459 277/480V	500386531	$	55,765.90
300590641	BEQ	INS. 1500KVA XFMR @ T-2460 277/480V	500386531	$	3,840.32
300591189	BEQ	(EH) 1309 Woodlane / Transformer	500394823	$	14,103.00
300591252	BEQ	UG PADMOUNT XFMR	500392136	$	5,347.31
300592047	BEQ	2 PADMOUNT TRANSFORMERS FOR RIGGER CT	500390943	$	5,745.30
300592177	BEQ	PAD5935--150KVA 120/208 -JC	500163110	$	12,002.93
300592182	BEQ	inst 150kva 3-phase padmount	500354194	$	8,420.27
300592244	BEQ	Inst. 2500kVA 277/480V 13kV Padmount	500394648	$	47,140.60
300592716	BEQ	Install (6) mini pads	500313138	$	9,541.91
300593184	BEQ	UG Transformer/pads/elbows	500371770	$	12,598.75
300593213	BEQ	Install 100kva mini pad	500342880	$	3,400.90
300593962	BEQ	750KVA-13KV-277/480 PAD6676-JK	500151033	$	19,712.47
300595173	BEQ	8 UG Trans.50KVA,1 100KVA	500356969	$	41,341.30
300595796	BEQ	INSTALL 50KVA & 100KVA PADMOUNT TRANS.	500365687	$	39,905.26
300596340	BEQ	INS PM TRANSFS - 4--100KVA & 1- 167KVA	500383157	$	24,708.69
300596538	BEQ	PADMOUNT TRANSFORMER	500396863	$	11,364.13
300596585	BEQ	2300 RTE 130 - PDMNT TRANSFORMER	500396834	$	12,256.46
300596600	BEQ	277/480 750 KVA PAD CO# 451519	500399528	$	19,418.49
300596627	BEQ	750 KVA 13KV RDF 277/480-4W	500383431	$	19,641.69
300596800	BEQ	REPLACE UG TRANSFORMER BUD 1100 T-10	500403414	$	5,777.48
300596830	BEQ	66 SICARD ST - PDMNT TRANSFORMER	500395716	$	13,643.62
300596833	BEQ	SOLAR/140 DOCKS CORNER RD-PDMNT XFRMR	500400807	$	62,586.08
300597084	BEQ	UG Transformer	500310370	$	1,880.93
300597281	BEQ	INS PAD # 4024 /WHSE 277/480V 800A MTR	500400098	$	12,992.29
300597509	BEQ	INS PAD #2935 / NEW SVC-NEW CONST'N	500401725	$	4,797.03
300597522	BEQ	UG PADMOUNT TRANSFORMER	500383274	$	29,150.54
300598181	BCA	Stimulus II BUD 238-1 - TERMS, SWITCHING	500397071	$	21,498.09
300598360	BEQ	INS. 750KVA XFMR @ PAD 2472 277/480V	500401276	$	19,588.51
300598616	BEQ	INS/RMV T-313 BUD 11	500245005	$	5,479.84
300598621	BEQ	REPLACE UG TRANSFORMER, T-736,A-PH	500403663	$	4,288.73
300598879	BEQ	PAD#4009 - INS. 150KVA 277/480V XFMR	500397896	$	9,787.49
300598888	BEQ	(MTL) 554 FELLOWSHIP / PAD&TRF.	500400146	$	9,911.32
300599334	BEQ	DARIO-R-225KVA & I-300KVA SET AT 4KV	500392664	$	17,448.89
300599410	BEQ	INSTALL XFMR PAD#2620	500401372	$	21,431.38
300599487	BEQ	INS. 1000KVA XFMR @ PAD 2473 120/208V 4W	500358846	$	22,018.66
300599518	BEQ	441 ELIZABETH AVE - PDMNT XFRMR	500227310	$	20,539.76
300599618	BEQ	PAD#2632 - REM. 25KVA & INS. 50KVA XFMR	500403517	$	8,197.61
300599732	BEQ	INS 100KVA LDF PMT PAD#6673-JC	500393303	$	13,898.05
300599909	BEQ	INSTALL 1PH 75KVA PAD TRANSFORMER	500385446	$	6,371.72
300600064	BEQ	1 INDUSTRIAL RD - PDMNT XFRMR	500374050	$	32,776.30
300600121	BEQ	T-116 QUINCY CIRCLE 100KVA LEAKER RPL	500405561	$	5,077.01
300600365	BEQ	INS PAD #4026 / UG Svc 3ph 277/480v 800A	500387631	$	14,213.98
300600682	BEQ	Inst 25kva padmount transformer Pad 3076	500360694	$	5,872.16
300600779	BEQ	484 BUNKER HILL RD - PDMNT XFRMR	500401752	$	10,948.99
300600870	BEQ	666 SOMERSET ST - PDMNT XFRMR	500403098	$	6,763.44
300600882	BEQ	50 W FERRIS ST - PDMNT XFRMR	500385225	$	18,950.38
300600963	BEQ	RPL 2 DEF XFORMERS HILLSIDE AVE	500405561	$	3,397.77

300600977	BEQ	INSTALL 6 - PADMNT TRANSF./ 1 PME	500383160	$	26,827.85
300601074	BEQ	REPLACE PADMOUNT TRANSFORMER	500383031	$	3,451.66
300601140	BEQ	BUD 112 - RMV/INS PAD1615--50KVA BPH -JC	500245005	$	2,037.58
300601340	BEQ	(EP) 4225 Rte130 Bottom Dollar /UG XFMR	500399803	$	11,174.32
300601401	BEQ	UG PAD TRANSFORMER (NEW ORDER)	500382998	$	35,447.41
300601431	BEQ	INSTALL T-1472 300KVA PADMOUNT	500402033	$	11,462.06
300601578	BEQ	JK- 410 HOWE AVE. PAD-XFMR	500397700	$	11,004.72
300601599	BEQ	INSTALL PADMOUNT XFMR PD2588	500403355	$	13,930.21
300601716	BEQ	StimII BUD110G&H - Inst/Rmv Pad116 & 120	500367157	$	28,817.10
300601988	BEQ	UG TRANSFORMERS & PE WORK (PHASE I)	500373269	$	27,033.54
300604241	BEQ	DURING FUTURE SCHEDULED SHUTDOWN (DUE TO	500408798	$	11,641.80
300604363	BEQ	UG TRANSFORMER	500391195	$	9,471.76
300604451	BEQ	(HP) 1924 Ark Rd / Padmount Trf.	500380614	$	11,143.91
300604538	BEQ	750kva 13kv 120/208-4w rdf	500294208	$	26,468.06
300604583	BEQ	rmv/ins pad. transfr. ethel rd edison	500405727	$	14,191.69
300604625	BEQ	UG PADMOUNT TRANSFORMER WORK	500394604	$	6,733.72
300604925	BEQ	(EH) Lina Lane / Pad & Trf,	500391152	$	16,046.20
300604949	BEQ	INSTALL 300KVA 120/208V 13KV XFMR PDMT	500400069	$	14,729.96
300605181	BEQ	Install (10) Padmounts	500340601	$	43,979.05
300605640	BEQ	REPLACE LEAKING TRANSFORMER FOR MERCK DU	500409315	$	45,211.15
300605670	BEQ	SERVICE TO PAR @ LINDEN GEN	500398779	$	38,822.77
300605824	BEQ	BUD 450---PAD 6682 50 KVA-TS	500403921	$	4,791.39
300605945	BEQ	REPL TRF / Res net meter	500390924	$	2,587.14
300606420	BEQ	INS TRANSFROMERS - WILLINGBORO WALK PHAS	500276925	$	30,331.65
300606519	BEQ	TRANSFORMER WORK	500406914	$	2,732.12
300606739	BEQ	UG TRANSFORMER	500407277	$	19,294.84
300606824	BEQ	+ HERITAGE VILLAGE BUD 1884.	500102189	$	29,439.25
300606926	BEQ	UG-Install padmount Transformer	500385424	$	3,375.69
300607361	BEQ	PADMOUNT XFMR	500200517	$	30,367.82
300607563	BEQ	HILLTOP CENROSE--(2) 750KVA 120/208-JC	500387526	$	47,943.31
300607767	BEQ	PADMOUNT TRANSFORMER	500402430	$	4,092.85
300607850	BEQ	INS PAD #4028 / NEW SHOPPING CTR	500380911	$	9,037.83
300608282	BEQ	UG- INSTALL 50KVA PADMOUNT -#2 TRAFF LIG	500401848	$	2,791.76
300608403	BEQ	UG INSTALL 50KVA TRANSF - #3 TRAFF LIGH	500401850	$	2,791.76
300608488	BEQ	(CN) Hoeganes / Padmount Trfs.	500392635	$	43,464.53
300608597	BEQ	XFMR-PAD#3015 BLG C 1500kva	500310380	$	27,775.70
300608600	BEQ	INS TRANFORMER - PRINCETON MANOR PHASE 3	500072541	$	1,081.74
300608947	BEQ	(BC) 1004 High St / UG TRF.	500368868	$	4,843.13
300608956	BEQ	(BC) Burl Chevy / Pad & Trf	500406432	$	10,107.04
300609175	BEQ	UG PADMOUNT TRANSFORMERS	500383858	$	149,819.35
300609312	BEQ	INS/REM PAD/TRF'S	500398750	$	32,721.09
300609328	BEQ	TRANSFORMER	500408797	$	18,280.01
300609365	BEQ	REM/INS TRF'S/PADS	500398750	$	13,899.68
300609489	BEQ	REPL 750KVA WITH 1000KVA TRANSFORMER	500404062	$	20,309.43
300609512	BEQ	INST. 500kVA 277/480V PAD	500413533	$	13,411.81
300610053	BEQ	BUD#600--INS 500KVA LDF PMT PAD#6238 - J	500151210	$	17,420.76
300610203	BEQ	UG PADMOUN TRANSFORMERS	500407247	$	15,411.82
300612456	BEQ	bud 602--300kva pads 5927 & 5928-JC	500163110	$	29,501.48
300612602	BEQ	TRANSFORMER	500404424	$	24,185.48
300612783	BEQ	(CN) Rte73 Trans Axle / Pad & Trf.	500254300	$	18,849.11
300612792	BEQ	Stim II BUD 110 D -Pad#54	500367157	$	10,346.75
300612816	BEQ	TRANSFORMERS	500408157	$	14,690.19
300612849	BEQ	install padmount transformer rte 27 ed.	500391830	$	15,678.16
300612927	BEQ	STIM II BUD 63 Repl xfmr 74 & 80	500367224	$	9,120.33
300612961	BEQ	Replace (3) mini Pads	500414779	$	14,897.60

300612981	BEQ	Replace leaking pad #2403 @ C/O W Grand	500414411	$	29,127.41
300614618	BEQ	Stim II BUD 175 Ins/Rmv Transformers	500397077	$	9,010.69
300615055	BEQ	120/208-4W 300KVA 13KV RDF	500403623	$	10,220.64
300615217	BEQ	UG Transformer	500387550	$	3,766.57
300615334	BEQ	Repl 500kVA PAD @ GR Countrt Club - JC	500371245	$	20,096.85
300615485	BEQ	INSTALL PADMOUNT TRANSFORMERS	500390927	$	21,247.79
300615616	BEQ	INS/REM PAD 41-HT	500286490	$	24,821.76
300615655	BEQ	INS. 500KVA DR XFMR @ T-2401 277/480V	500414345	$	15,937.95
300615656	BEQ	INS. 500KVA DR XFMR @ T-2400 277/480V	500410828	$	16,384.13
300615659	BEQ	INS. 300KVA XFMR @ T-2464 120/208V	500391687	$	14,039.39
300615822	BEQ	PAD 3309 Replace leaking 1500kva transfo	500337913	$	27,397.80
300616626	BEQ	3940 RTE 1 - PADMOUNT XFRMR	500407563	$	10,645.52
300616933	BEQ	INS TRANSFORMERS, PH 2	500382865	$	20,242.25
300617024	BEQ	Repl. 750kVA with 1500kVA padmount	500389680	$	31,103.82
300617159	BEQ	(BT) 3 Manhatten / Pad&Transformer	500391713	$	12,288.54
300617525	BEQ	277/480 500kva 13kv rdf	500412927	$	12,260.80
300618208	BEQ	INSTALL PADMOUNT XFMR PAD#1738	500361170	$	39,204.52
300618213	BEQ	Stimulus II BUD 335 Xformer Repl	500365603	$	9,881.57
300618295	BEQ	Stimulus II BUD 335 Pad #85	500365603	$	5,701.89
300618419	BEQ	INSTALL PADMOUNT XFMR PAD#60/RMV MAT#2	500414461	$	16,418.02
300618462	BEQ	TRANSFORMERS,545,546,547	500391613	$	12,163.09
300619046	BEQ	Pad 2727 Rusted, Wires Exposed	500398274	$	2,592.21
300619277	BEQ	INS PAD# 3020 /New 120/208 3ph 1600A	500419646	$	14,060.77
300619350	BEQ	Stimulus II BUD 238 LARCHMONT - RPL PADS	500397071	$	21,943.46
300620071	BEQ	UG-3ph PADMOUNT 277/480V	500402176	$	12,317.02
300620242	BEQ	ENCLOSURE#598 & PAD#240	500414337	$	10,509.81
300620274	BEQ	UG PADMOUNT TRANSFORMERS	500361041	$	80,937.90
300620310	BEQ	install transformers,133,134,135	500328029	$	10,866.78
300620701	BEQ	621 RT 18 BDLG-D - PDMNT TRANSFORMER	500254348	$	9,424.80
300620835	BEQ	BUD1167 Greenbriar Xfmrs Repl-PT	500399910	$	21,012.06
300620964	BEQ	UG INS XFMR	500418215	$	9,444.68
300621056	BEQ	XFMRS(5)-PH 1A OF WYNGATE IN BUD1939	500386613	$	13,162.55
300621511	BEQ	SCHINDLER CT TRANSFORMERS	500115488	$	10,199.48
300621623	BEQ	INS PAD # 4030 / NEW ELEC SERVICE	500417215	$	24,930.90
300621773	BEQ	NEW PADMOUNT TRANSFORMER WORK	500409481	$	13,375.64
300621805	BEQ	INS. 750KVA XFMR @ PAD 2331 277/480V 4W	500381560	$	20,308.60
300621882	BEQ	REPLACE LEAKING TRANSFORMER PAD T-774 (2	500421158	$	25,701.13
300621945	BEQ	500KVA TRF/PAD	500238086	$	16,069.21
300621979	BEQ	Inst. 75kVA 1ph. pad	500306447	$	11,115.97
300622289	BEQ	install pad. transformer hadley rd ed.	500418526	$	20,295.22
300622400	BEQ	TRANSFORMER - Stimulus II BUD 141 ROLLIN	500397080	$	5,333.42
300622993	BEQ	(HP) 1261 Rte.38 /Inst. Pad & Trf.	500420059	$	13,489.79
300622995	BEQ	16 PATRICK ST EBW-PDMNT XFRMR	500418672	$	11,081.35
300623117	BEQ	REPLACE ROTTED T-578,A-PH,50KVA,BUD#356	500422425	$	4,090.19
300623120	BEQ	REPLACE ROTTED T-670,B-PH,50KVA,BUD#356	500422425	$	2,511.95
300623244	BEQ	REPLACE ROTTED T-702,B-PH,50KVA,BUD#356	500422425	$	3,362.94
300623374	BEQ	REPLACE LEAKING T-706,13KV,B-PH,50KVA	500422425	$	2,548.46
300623912	BEQ	(EH ST) 1043 OXMEAD / UG TRANSFORMER	500404164	$	3,974.49
300623920	BEQ	INS PAD EQUIP PAD#986 PAD#98 PAD#988	500419740	$	12,298.87
300623925	BEQ	Stim II BUD141 ROLLING HILLS-REPL PAD#13	500397080	$	7,660.04
300623997	BEQ	INSTALL PADMOUNT XFMR PAD#63	500383091	$	13,703.46
300624308	BEQ	JC -INS 167KVA(5953) & 100KVA(5952)	500163110	$	12,450.30
300624430	BEQ	UG PADMOUNTS XFMERS WORK	500412430	$	44,271.01
300624618	BEQ	REPL. XFMR @ PAD 2429 WITH 750KVA 277/48	500374889	$	22,684.69
300624708	BEQ	40C COTTERS LN EBW-PDMNT XFRMR	500420426	$	23,451.75

300624943	BEQ	DARIO-R & I 50KVA TRANS. SET AT 4KV	500392664	$	4,245.22
300624944	BEQ	DARIO-R & I 50KVA TRANS. SET AT 4KV	500392664	$	5,687.28
300625066	BEQ	PME/TRANS FOR Ph. 2	500365675	$	34,458.57
300625249	BEQ	INS. 300KVA XFMR @ T-2331 277/480V 4W	500421432	$	13,773.32
300625341	BEQ	Stimulus II BUD 238 - REPLACE PAD 1292	500397071	$	6,052.62
300625438	BEQ	(WI) WI High Sch. / UG Transformer	500420997	$	34,487.98
300625563	BEQ	Inst. 500Kva 13kV 277/480V Padmount	500421330	$	18,005.45
300626470	BEQ	SEGMENT 1B - 1000KVA 277/480V 4W	500394651	$	19,389.66
300626472	BEQ	REPLACE Leaking T-1196,100kVA,B-PH	500422425	$	4,813.12
300626478	BEQ	REPLACE Leaking T-1033,100kVA,B-PH	500422425	$	4,726.39
300626521	BEQ	2070 RTE 130 - PDMNT XFRMR	500392732	$	9,809.93
300626805	BEQ	TRANSFORMER	500406017	$	10,257.07
300626864	BEQ	INS PAD# 2723 /RETAIL UPGR 120/240V 600A	500407409	$	5,003.87
300627016	BEQ	TRANSFORMER - 1000 KVA	500390904	$	23,533.48
300627070	BEQ	TRANSFORMER INSTALLS	500406842	$	168,123.92
300627092	BEQ	INS PAD # 4037	500367717	$	3,375.82
300627415	BEQ	REPLACE LEAKING PD1051, 13KV, 3 PH, 1000	500423829	$	20,860.99
300627511	BEQ	INS. 2-1500 KVA 277/480V @ P-#2478 & #2	500423554	$	61,459.98
300627515	BEQ	INS. 500 KVA 277/480V 800 amps @ T-2482	500402446	$	14,767.42
300627608	BEQ	XFMR - INST -P#466-69 BUD1977 -	500355303	$	13,998.58
300627655	BEQ	Inst. 1500kVA RDF Padmount	500421463	$	27,225.32
300627812	BEQ	INSTALL 167KVA T#1255	500222278	$	5,360.60
300628445	BEQ	UG-Inst 500kva padmount	500420245	$	12,721.46
300628639	BEQ	BUD-PADMOUNT TRANS.-EN	500423298	$	26,304.88
300628688	BEQ	Stim II BUD 238 - RPL PADS 1267 & 1272	500397071	$	7,098.08
300628698	BEQ	INSTALL PADMOUNT XFMR PAD73	500418232	$	17,614.43
300629606	BEQ	BUD223--PAD1401 75KVA RMV/INS-DP	500245005	$	7,167.43
300629732	BEQ	INS/RMV PAD 27 SURREY PL-JC	500245005	$	8,730.56
300629805	BEQ	UG TRANSFORMER	500406720	$	12,868.51
300629998	BEQ	(LM) Rte38 Bottom Dollar/ Transformer	500424617	$	10,181.42
300630639	BEQ	BUD238 - CHADBURY CT - RPL TRF'S	500427553	$	19,358.84
300630650	BEQ	INS. 500KVA XFMR DR @T-2481 277/480V	500419690	$	16,504.93
300630667	BEQ	500 kva 120/208 13kv	500421328	$	3,567.88
300630695	BEQ	Pad mount xfmr - JK	500423514	$	47,599.77
300630782	BEQ	INSTALL NEW T-537	500420084	$	4,677.09
300630873	BEQ	120/208 500 d/r	500412928	$	15,211.10
300630874	BEQ	300 kva 13kv rdf 120/208	500424446	$	13,430.22
300631297	BEQ	UG PAD TRANSFORMERS	500395666	$	15,235.10
300631349	BEQ	360 DEMOTT LN, FL - PDMNT XFRMR	500424720	$	12,978.93
300631529	BEQ	WEW8033,BUD325,RMV/INS PAD2671-RV	500245005	$	23,183.64
300631634	BEQ	UG XFMR	500426168	$	10,146.47
300631964	BEQ	INSTALL NEW 750KVA PDMT TRANSF.	500406205	$	25,531.93
300631986	BEQ	XFMR PAD#80	500424175	$	14,375.86
300632067	BEQ	INSTALL AND REMOVE 3PH.XFRMR. #3566	500420450	$	5,431.77
300632326	BEQ	Stim2 BUD52-Replace Padmounted Xfmr-405	500397072	$	4,279.38
300632344	BEQ	BUD TRANSFORMER	500422451	$	6,535.36
300632533	BEQ	SHUTDOWN--RMV & INST PAD#2491-GRE4006-JK	500417426	$	11,640.38
300632741	BEQ	+ HERITAGE VILLAGE BUD 1884.	500102189	$	14,004.80
300632835	BEQ	rmv/ins padmount xfrm'r edison	500409926	$	13,943.27
300632847	BEQ	BUD TRANSFORMER	500359982	$	8,958.40
300633332	BEQ	INS 50KVA XFMR'S-JC	500383078	$	12,457.79
300633805	BEQ	TRANSFORMERS	500072542	$	16,095.32
300633896	BEQ	replace t-2 transformer	500428264	$	6,570.07
300634013	BEQ	INST PADMOUNT TRANS.	500260378	$	7,999.04
300634108	BEQ	REPLACE T-4 100KVA DR	500420107	$	7,044.73

300634117	BEQ	Stim II BUD110A Repl Pads PY Harbour	500367157	$	14,463.25
300634244	BEQ	rmv/ins pad xfrm'r st nicholas ave s.p.	500418610	$	22,713.33
300634314	BEQ	UG Install 3-ph padmount Transformer	500412615	$	12,911.65
300634373	BEQ	INSTALL 500kVA 277/480V PAD MOUNT	500412521	$	13,067.49
300634458	BEQ	Leaker-INS/REM PADMT#212-1656 Kaighns-CM	500286490	$	14,296.65
300635204	BEQ	REPLACE LEAKING PAD#1569--SAD8042/2-JK	500417426	$	36,405.03
300635218	BEQ	UG-TRANS.INSTALL/REM.-K	500428614	$	49,972.65
300635226	BEQ	1112 CORPORATE RD - PDMNT XFRMR	500401006	$	12,648.14
300635958	BEQ	REPL 277/480 W/ 120/208 PDMNT XFRMR	500403098	$	13,701.15
300636344	BEQ	UG XFMR pads and elbos	500425453	$	18,614.45
300636416	BEQ	TRANSFORMER	500426110	$	4,650.72
300636747	BEQ	1600 BERGEN TOWN CNTR RTE 4 EB E/O SPRIN	500401064	$	15,552.72
300636752	BEQ	1600 BERGEN TOWN CNTR RTE 4 EB E/O SPRIN	500401069	$	14,121.63
300636830	BEQ	TRANSFORMER WORK	500428220	$	18,159.89
300636950	BEQ	UG Transformer replacement for 4kv 1500k	500431433	$	40,373.67
300637528	BEQ	UG XFMR	500426205	$	19,099.36
300637966	BEQ	UG Transformer	500422743	$	22,714.99
300638000	BEQ	TRANSFORMERS - WEST WINDSOR GARDENS BUD	500228763	$	17,689.63
300638232	BEQ	BUD605--PAD 6257 RAISE SINKING PAD-JC	500429681	$	4,790.81
300638363	BEQ	Install mini pads	500207351	$	39,782.75
300638725	BEQ	TRANSFORMER - replacing 4 service upgrad	500420468	$	29,227.02
300638795	BEQ	XFRMRS INSTALLS	500419684	$	26,762.75
300639190	BEQ	Install mini pads Phase II	500207351	$	49,807.24
300639191	BEQ	Install mini padmounts	500392666	$	17,974.01
300639390	BEQ	replace leaking transformer t-65	500433294	$	3,318.05
300639460	BEQ	BUD 554 - REPL T-763 / PME 825	500433463	$	4,159.36
300639481	BEQ	JC-BUD160-REPLACE PAD #10-100KVA-JC	500245005	$	2,476.25
300639582	BEQ	BUD 474 - REPLACE TRANSFORMER	500433463	$	2,964.75
300639588	BEQ	BUD 329 - REPLACE TRANSFORMER	500433463	$	4,938.26
300639594	BEQ	BUD 4 - REPLACE TRANSFORMERS	500433463	$	28,182.36
300639600	BEQ	BUD-24,REPLACE XFRMRS-14,15,16,17	500433463	$	12,087.64
300639602	BEQ	BUD-24,REPLACE XFRMRS-19,20,31,32	500433463	$	23,455.57
300639646	BEQ	BUD-24,REPLACE XFRMRS-27,28,29,30	500433463	$	21,466.82
300639647	BEQ	BUD-24,REPLACE XFRMRS-26	500433463	$	3,399.57
300639651	BEQ	BUD-24,REPLACE XFRMRS-21,22,23,24,25	500433463	$	25,063.36
300639657	BEQ	BUD-24,REPLACE XFRMRS-33,34,35,36,37,38	500433463	$	24,855.01
300639664	BEQ	BUD 68 REPL T-226 & 227	500433463	$	8,663.51
300639671	BEQ	BUD 21 - REPL TRANS KUHN ST.	500433463	$	10,432.77
300639858	BEQ	BUD 5- REPLACE TRANSFORMERS	500433463	$	34,062.06
300639859	BEQ	BUD 397- TRANSFORMER REPLACEMEN	500433463	$	53,717.10
300639900	BEQ	INST 500KVA 277/480V RD W 3A PAD#2309	500430991	$	12,920.03
300639958	BEQ	INST 750KVA, 120/208V, 13KV ON PAD# 201	500409185	$	19,116.81
300640074	BEQ	BUD 21 HADLER DR. REPL. T-13	500433463	$	3,449.12
300640076	BEQ	BUD 21 BERGER ST. REPL TRANS	500433463	$	8,257.47
300640078	BEQ	BUD 21 MAC AFEE RD REPL TRANS	500433463	$	15,783.85
300640081	BEQ	BUD 21 BOULDER LN REPL TRANS	500433463	$	5,538.98
300640143	BEQ	BUD 21 MEADE CT REPL T-1	500433463	$	7,289.21
300640176	BEQ	BUD 1041, 1042, 1042a - REPL TRANS	500433463	$	10,936.30
300640191	BEQ	TRANSFORMER	500432821	$	7,022.31
300640224	BEQ	BUD 1041, 1042, 1042a - REPL TRAN	500433463	$	5,997.70
300640787	BEQ	BUD - TRANSFORMER	500395537	$	13,605.99
300640869	BEQ	UG-INSTALL PADMOUNT TRANSFORMER	500424263	$	11,138.82
300641077	BEQ	rmv/ins pad xfmr'r hadley rd south plfld	500395786	$	19,789.54
300641493	BEQ	BUD171--REPLACE 25KVA WITH 50KVA-TS	500245005	$	20,003.70
300641621	BEQ	D.Paris-UG transformer Order & set	500420298	$	14,750.56

300641781	BEQ	TRANSFORMER	500428667	$	35,900.87
300641838	BEQ	INS & RMV PAD #3555/RELOCATE TRANSFORMER	500433330	$	2,748.32
300642188	BEQ	1500 KVA DR 277/480V TRANSFORMER	500433745	$	7,642.82
300642211	BEQ	XFMR-REPL 50 W -167 KVA BUD 561	500423767	$	4,553.66
300642214	BEQ	UG - INSTALL 300kVA LOOPED PADMOUNT	500428589	$	11,994.97
300642291	BEQ	750KVA DR 277/480V TRANSFORMER	500433650	$	20,648.21
300642395	BEQ	xfmr-pri enclosure-switch	500420981	$	27,790.19
300642396	BEQ	ins transformer	500420982	$	23,775.72
300642398	BEQ	Bldg. G - Service #3 4000 amps	500420983	$	23,118.04
300642695	BEQ	D.Paris-UG transformer order	500434747	$	24,201.95
300643111	BEQ	INS TRF#4033 / SIGN 120/240V 1PH 60A	500434849	$	6,107.45
300643508	BEQ	MAI8011-1 BUD82 FAULT LOCATE PRIMARY	500417426	$	4,008.34
300643516	BEQ	UG-Install/Remove Transformer	500406320	$	20,420.94
300643612	BEQ	INST 750KVA DR, 120/208V 3A PAD 4KV BLG5	500412931	$	23,649.05
300643616	BEQ	INST 750KVA DR, 120/208V 3A PAD 4KV BLG4	500412932	$	25,541.67
300644039	BEQ	HNC 8021, BUD 186, RMV/INS XFMR-JC	500245005	$	7,222.68
300644291	BEQ	1500kVA 13kV 277/480V Padmount	500414662	$	32,532.41
300644293	BEQ	300kVA 13kV 120/208V Padmount	500423126	$	10,456.56
300644347	BEQ	(EH) 1309 Woodlane Rd / Repl Trf	500394823	$	16,948.56
300644442	BEQ	300kVA 13kV 120/208V PADMOUNT	500432057	$	11,913.07
300644530	BEQ	285 GEORGE ST - PDMNT XFRMR	500049879	$	40,615.12
300644665	BEQ	INS. 300KVA XFMR @ PAD 2465 120/208V 4W	500418687	$	12,659.31
300644678	BEQ	INS. 1500KVA XFMR @ PAD 2485 277/480V 4W	500166372	$	29,658.63
300644729	BEQ	INS. 300KVA XFMR @ PAD 2402 120/208V 4W	500433440	$	13,254.90
300644764	BEQ	BUD82, REPLACE PAD 1658,1671,1660-BW	500245005	$	22,802.42
300645157	BEQ	ug pad/doghouse	500430358	$	5,860.91
300645171	BEQ	UG- INST XFRM PAD # 3071	500402484	$	4,437.65
300645340	BEQ	UG TRANSFORMER	500423716	$	3,886.50
300645757	BEQ	UG PADMOUNT TRANSFORMER BLDG.1	500381577	$	18,105.38
300645857	BEQ	Inst. 2000kva Pad mount	500432356	$	34,639.81
300646617	BEQ	UG-BUD-TRANS.INSTALL-NA	500428613	$	13,814.15
300646629	BEQ	INS. 750 KVA DR. XFMR @ PAD 2486 277/480	500430825	$	21,251.97
300646720	BEQ	2451 RTE 1 NBW - PDMNT XFRMR	500421502	$	24,852.66
300646918	BEQ	INSTALL NEW T-3768 PDMT TRANSF.	500435840	$	6,196.61
300647206	BEQ	750 KVA 13KV 277/480 RDF	500435420	$	19,506.77
300647212	BEQ	RIVER WALK/LENNAR BUD1988- INS XFMR	500404144	$	46,591.51
300647675	BEQ	TRANSFORMER 50KVA	500432451	$	7,000.77
300647782	BEQ	RELOCATE TRANSFORMER INS/RMV PAD	500422933	$	5,553.40
300648023	BEQ	REPLACE PAD#1569--SAD8042/2-RV	500417426	$	4,123.43
300648072	BEQ	INS TRF PAD # 4035 / 800Amps	500436050	$	7,135.55
300648205	BEQ	BUD 397 - REPLACE T-1046	500433463	$	1,019.57
300648331	BEQ	INS PAD # 4034 100KVA 1PH /Cellsite 600A	500438977	$	3,958.94
300648484	BEQ	ENBC 1600 QUEEN ANNE RD, TN XFMR ORDER	500438157	$	25,874.48
300648495	BEQ	INS TRANSFORMER	500421174	$	7,755.08
300648772	BEQ	Inst. 2 - 1000kVA 13kV 277/480V Pads	500379957	$	35,779.72
300648922	BEQ	Fairways - BUD TRANSFORMER	500425685	$	54,635.02
300649207	BEQ	UG-inst padmount transformer & pad	500426067	$	3,443.53
300649257	BEQ	PH 2 - TRANSFORMER	500346569	$	26,535.08
300649309	BEQ	750kVA 13kV 277/480V Padmount	500395594	$	23,601.59
300649484	BEQ	Install 25 Kva Padmount transformer	500428005	$	5,366.23
300649494	BEQ	RIVER WALK/LENNAR TRNSFRMRS 25s/75s/100s	500404144	$	57,146.77
300649899	BEQ	UG TRANSFORMER	500427959	$	5,039.22
300650109	BEQ	471 DOREMUS AVE E/O RUTLAND RD GR. INSTA	500368726	$	5,006.74
300650338	BEQ	PAD#2718 - REM 25KVA & INS 50KVA	500440752	$	9,047.38
300650926	BEQ	UG PADMOUNT TRANSFORMERS	500424354	$	17,925.30

300650928	BEQ	INST 2 PADMT TRANS	500423547	$	7,923.88
300651080	BEQ	TRANSFORMER	500432461	$	31,225.85
300651089	BEQ	Install XFMRS	500439843	$	60,620.92
300651443	BEQ	UG TO REPLACE LEAKING PAD T-1306 500 KVA	500441463	$	20,455.62
300651793	BEQ	PADMOUNT TRANSFORMER	500439994	$	15,178.04
300652198	BEQ	REPLACE T-11	500442345	$	5,975.65
300652363	BEQ	277/480 3 PH 1000 KVA 13KV RDF	500433446	$	20,497.05
300652419	BEQ	INS TRANSFORMER 500KVA 120/208	500385861	$	20,040.26
300652420	BEQ	INS 500 KVA TRANSFORMER	500385862	$	16,058.83
300652593	BEQ	3079 RTE 27 FL - PDMNT XFRMR	500427561	$	12,344.15
300652661	BEQ	INSTALL 300kVA, 120/208V, 3P PAD MOUNTED	500305484	$	12,194.46
300652777	BEQ	Inst 750kva padmount-PAD# 655	500435116	$	29,241.20
300652836	BEQ	UG-Install 500kva padmount-PAD# 656	500435117	$	13,773.32
300653324	BEQ	XMFRS 1 Phase BUD	500425685	$	74,076.69
300653354	BEQ	INS. 500 KVA XFMR. @ PAD 2466 277/480V 3	500439093	$	13,227.68
300654391	BEQ	HANDLER ESTATES TRANSFORMERS	500429714	$	17,230.39
300654632	BEQ	UG PADMOUNT TRANSFORMER BLDG.2	500439083	$	18,796.64
300654724	BEQ	UG-INST 2500KVA PADMOUNT PAD# 654	500423726	$	41,902.14
300654843	BEQ	4 PROGRESS RD, SB - PDMNT XFRMR	500434961	$	18,245.29
300655176	BEQ	UG PADMOUNTS XFMERS WORK	500254514	$	60,347.39
300655216	BEQ	INSTALL PADMOUNT XFMR PD#72	500442824	$	13,078.01
300655326	BEQ	45 River Rd/Bldg C2-L/EWR/Padmount	500424611	$	12,407.46
300655361	BEQ	WHITLOCK MILLS INS TRANSFORMERS..	500422777	$	9,406.18
300655554	BEQ	INSTALL 15 - -50KVA PDMT TRANSFORMERS	500443655	$	41,553.57
300655926	BEQ	UG-inst 150kva 277/480v padmount transfo	500434319	$	10,415.65
300656119	BEQ	ug xfmr	500440525	$	30,314.12
300656269	BEQ	UG TRANSFORMER	500392883	$	13,233.65
300656330	BEQ	NDS 400 AMPS UNDERGROUND TRANSFORMER	500439645	$	4,183.19
300656474	BEQ	Stim. II BUD 95 B - RPL PAD 191	500397073	$	7,037.30
300656676	BEQ	BUD 19 - REPLACE T-2 & T-3	500433463	$	7,427.81
300656677	BEQ	BUD 19 - REPLACE T-4	500433463	$	3,372.45
300656679	BEQ	BUD 19 - REPLACE T-6	500433463	$	3,030.97
300656714	BEQ	BUD 6 - REPLACE T-2	500433463	$	6,968.44
300656715	BEQ	BUD 6 - REPLACE T-3	500433463	$	3,713.51
300656716	BEQ	BUD 6 - REPLACE T-4 & T5	500433463	$	2,719.09
300656718	BEQ	BUD 6 - REPLACE T-6	500433463	$	1,359.54
300656719	BEQ	BUD 6 - REPLACE T-7 & T8	500433463	$	5,535.56
300656720	BEQ	BUD 8 - REPLACE T1 & T2	500433463	$	4,222.30
300656721	BEQ	BUD 8 - REPLACE T3, T4, T5, T6, T7 & T8	500433463	$	14,336.64
300656722	BEQ	BUD 8 - REPLACE T9	500433463	$	8,681.77
300656764	BEQ	BUD 40-REPLACE T-188	500433463	$	5,595.12
300656766	BEQ	BUD 36 CIVIC CENTER DR	500433463	$	25,713.10
300656783	BEQ	BUD 29 - REPLACE T-21 & T-22	500433463	$	9,847.13
300656784	BEQ	BUD 29 - REPLACE T-25 & T-26	500433463	$	9,847.23
300656786	BEQ	BUD 32 - REPLACE T-110	500433463	$	5,105.83
300657268	BEQ	BUD602--INS 2 50KVA LDF PAD#5954 & 5955-	500163110	$	7,716.01
300657637	BEQ	INS. 750KVA XFMR @ PAD #2409 120/208V 4W	500435754	$	20,659.01
300657774	BEQ	INST. 1000kVA 277/480V T-1916	500402064	$	21,700.66
300657854	BEQ	45 River Rd/Bldg E2/EWR/Padmount	500425824	$	18,887.36
300657991	BEQ	BUD 44/45 - REPL. T-11, 8, 80, 7	500433463	$	19,101.35
300657995	BEQ	BUD 44/45 - REPL. T-1	500433463	$	2,160.18
300658007	BEQ	REPLACE RUSTY TRANSFORMER T-1 &T-2	500446638	$	9,845.53
300658008	BEQ	INST. 2500kVA 13kV 277/480V	500426114	$	37,442.37
300658050	BEQ	T-2407&T-2408,RPL LEAKERS	500446642	$	4,944.68
300658375	BEQ	277/480- 500 KVA 13KV RDF	500442477	$	16,623.64

300658450	BEQ	Inst & Rem 1000kVA LPF	500386652	$	26,122.41
300658804	BEQ	INSTALL PDMT TRANSFORMERS & 2 PMEs	500406205	$	10,382.24
300658818	BEQ	INSTALL PDMT TRANSF. - DELROCCO CT	500406205	$	27,985.37
300658982	BCA	REPLACE TRANSFORMER	500446900	$	4,566.36
300659036	BEQ	BUD 44/45 - REPL T-24, T-25, T-26	500433463	$	5,891.65
300659039	BEQ	BUD 44/45-REPL T-13,14,16-18,20,22,23,28	500433463	$	44,545.43
300659070	BEQ	INSTALL PME'S & PDMT TRANSFORMERS	500428056	$	18,436.44
300659138	BEQ	Install XFMR #1056 Crab Shack	500443058	$	13,833.13
300659176	BEQ	INS. 100KVA TRANSFORMER	500444727	$	7,190.48
300659271	BEQ	UG TRANSFORMER	500422861	$	4,288.99
300659360	BEQ	RPL T-2377[BURIED PADMOUNT]	500446642	$	8,220.12
300659375	BEQ	UG TRANSFORMER WORK	500442927	$	15,228.35
300659407	BEQ	RPL T-2379[BURIED PADMOUNT]	500446642	$	7,116.02
300659953	BEQ	PADMOUNT TRANSFORMERS	500218851	$	12,536.79
300660111	BEQ	BUD 13 #3-4	500433463	$	11,720.05
300660113	BEQ	BUD 13 #5-6	500433463	$	1,963.87
300660114	BEQ	BUD-13 #212	500433463	$	3,823.76
300660215	BEQ	Transformer replacement for 877 North Av	500448267	$	40,466.88
300660409	BEQ	REPLACE XFMR PD#145	500447060	$	21,970.88
300660456	BEQ	INS/RMV XFMR BUD 436-JC	500245009	$	11,093.61
300660481	BEQ	INSTALL PADMOUNT XFMR PD#1135	500441272	$	15,324.29
300660736	BEQ	ug padmount xfmr	500439729	$	23,759.51
300661192	BEQ	UG TRANSFORMER	500420419	$	19,770.65
300661254	BEQ	INS. 1500KVA XFMR @ PAD 2488 277/480V 13	500446694	$	22,382.60
300661452	BEQ	750 E MAIN ST, BWT - PDMNT XFRMR	500438165	$	12,488.20
300661986	BEQ	Temp 1200 amp 277/480 PDMT XFMR	500444328	$	23,636.08
300662379	BEQ	EQUIP-INS 300KVA 120/208 & 4 POS PE	500435706	$	22,206.43
300662592	BEQ	UG Transformer - replace leaking transfo	500286490	$	5,340.07
300662945	BEQ	INSTALL 300KVA 277/480V RD, IIA PAD	500445784	$	12,838.17
300663959	BEQ	PAD#2877 - INS. 50KVA TRANSFORMER	500447554	$	6,534.53
300665531	BEQ	GATEWAY BLVD. 50 KVA TRANS	500420817	$	16,394.66
300665535	BEQ	REED RD. 50 KVA TRANS	500420817	$	22,088.60
300665536	BEQ	HANKINS RD. 50 KVA TRANS	500420817	$	2,387.87
300665783	BEQ	INST. 300kVA 120/208V PAD MOUNT	500424217	$	16,092.75
300665949	BEQ	BUD 29 - REPLACE T-24	500433463	$	1,641.79
300666166	BEQ	INS TRANSFORMERS	500228763	$	8,813.06
300666925	BEQ	bud534--INS 50KVA LDF PMT PAD#6761 - JC	500313181	$	5,094.57
300667398	BEQ	BUD 19 - REPLACE T-414	500433463	$	5,096.85
300667603	BEQ	INS PAD #4036 / NEW HSE 300 AMPS	500452802	$	3,570.87
300667688	BEQ	INS/REM TRANSFORMER PAD 3976	500228763	$	4,990.54
300668533	BEQ	Replace pad 2366 On Grasselli Ln & South	500453314	$	50,701.15
300668630	BEQ	INSTALL PDMT TRANSF - 14 TULSA CT	500213603	$	5,796.80
300670675	BEQ	INSTALL TRANSFORMER T-2962 - MURPHY DR	500319540	$	5,151.11
300671024	BEQ	UG-TRANS/PAD INSTALL-WR	500452114	$	16,303.04
300672485	BEQ	INSTALL NEW T-550 PDMT TRANSF.	500451329	$	4,852.68
300672553	BEQ	Ravenswood Padmount transformers work	500423112	$	41,218.61
300672645	BEQ	BUD602-INS 150KVA LDF PMT PAD#5961 -JC	500163110	$	20,498.60
300672653	BEQ	BUD602-INS 100KVA LDF PAD#5966 & 5960 -J	500163110	$	15,707.07
300673621	BEQ	INSTALL 1500KVA 277/480V T-551	500458447	$	32,657.42
300673653	BEQ	Install PAD # 2354	500447455	$	2,143.01
300673784	BEQ	T-2439 INSTALL	500427933	$	5,020.72
300674009	BEQ	COR8034, BUD207, PAD1341 INS/RMV-JC	500245005	$	6,143.22
300674603	BEQ	INS TRF PAD # 3385 / New Hampton Hotel	500442886	$	13,260.16
300674772	BEQ	PAD#2966 - REM & INS TRANSFORMER	500453872	$	25,852.78
300675001	BEQ	UG Transformer	500422780	$	14,058.01

300675222	BEQ	UG TRANSFORMERS WORK (PHASE II)	500373269	$	18,277.02
300675391	BEQ	UG-INST 1500KVA 277/480&PAD	500420677	$	23,004.13
300675639	BEQ	UG PADMOUNT TRANSFORMER	500425469	$	15,148.71
300676446	BEQ	Replace Pad 66 @ Weldon Asphalt 2651 Mar	500463231	$	14,772.17
300677603	BEQ	UG Transformer	500422778	$	34,842.15
300677604	BEQ	UG Transformer	500422779	$	14,058.01
300677652	BEQ	GMS-TRANS ORDER 277/480 750 KVA	500456324	$	19,153.21
300678280	BEQ	500KVA 277/480-13KV RDF	500440843	$	12,827.15
300678441	BEQ	D.Paris-Switch&Xfmr order	500442650	$	19,306.92
300679042	BEQ	PADMOUNT TRANSFORMER WORK	500453902	$	10,949.31
300679280	BEQ	10 UNION ST NBK - PDMNT XFRMR	500453362	$	11,683.59
300679485	BEQ	BUD # 13 TRANSFORMER PAD T-210 NEEDS INS	500465603	$	6,692.59
300680455	BEQ	XMFR PAD#876	500429966	$	7,533.56
300680485	BEQ	REMOVE / INSTALL 167kVA T-16	500465892	$	12,417.51
300680496	BEQ	TRANSFORMER WORK	500440944	$	8,739.09
300681297	BEQ	BUD-TRANS.INST.-LH	500464928	$	10,217.13
300681864	BEQ	INST/REM PAD3619	500468529	$	27,998.17
300682189	BEQ	REPLACE 500kVA T-2075D	500468480	$	16,679.23
300682487	BEQ	UG-INST 500KVA 277/480V 4W PADMOUNT TRAN	500462817	$	15,976.03
300682674	BEQ	REPLACE T-1004 WITH 50KVA	500406959	$	3,583.19
300682839	BEQ	UG-INST 300KVA PADMOUNT	500440654	$	13,668.91
300682999	BEQ	UG XFMR	500443781	$	3,539.57
300683008	BEQ	REPLACE VADALIZED PADMT TRF PAD#498	500468835	$	4,826.75
300683266	BEQ	ug xfmr 511	500438051	$	5,683.58
300683753	BEQ	REPLACE 300 KVA 120/208 PAD-STORM DAMAGE	500462851	$	19,517.23
300683875	BEQ	CHANGE OUT 500 KVA TO 1000 KVA PADMOUNT	500421328	$	28,380.29
300683930	BEQ	INS XFMR	500450892	$	7,402.02
300683986	BEQ	REPLACE PDMT T-1185	500465715	$	3,583.19
300684638	BEQ	INS TRANSFORMER	500440716	$	28,878.89
300685444	BEQ	RELOCATE T-3580	500166822	$	3,927.61
300685488	BEQ	JC- INS (4)100 KVA PADMOUNT XFMR & (5)50	500432146	$	39,228.70
300685578	BEQ	INS. 2000KVA XFMR @ PAD #2490 277/480V	500462369	$	33,122.09
300685600	BEQ	REPL T-7 & T-1034 100kVA	500453678	$	8,344.79
300686024	BEQ	UG - Pad&Transformer - SC	500464293	$	4,250.87
300686079	BEQ	1500KVA PADMOUNT TRANSFORMER REPLACEMENT	500466684	$	39,115.15
300686264	BEQ	REPLACE 300 KVA PAD - HURRICAN SANDY	500471339	$	16,412.10
300686549	BEQ	INS TRANSFORMER	500228763	$	15,261.60
300686916	BEQ	GMS-750KVA 277/480V PDMNT. TRANS ORDER	500471211	$	18,926.66
300686967	BEQ	T-496 REPLACE DEF75KVA w/ NEW 100KVA	500472648	$	3,039.96
300687058	BEQ	UG XFMRS-Ph 1A-Heritage @ MF-BUD 1997	500447697	$	28,410.05
300687582	BEQ	BUD602--INS (2)100KVA & (1) 50KVA -JC	500163110	$	13,359.10
300687632	BEQ	INS TRANSF/EQUIP, PH 1B-1	500439955	$	33,880.61
300687640	BEQ	PAD#3067 - REM. 50KVA & INS. 167KVA XFMR	500472285	$	3,436.67
300688188	BEQ	GMS-TRANS ORDER 277/480 PDMNT - 500 KVA	500464766	$	23,653.53
300689178	BEQ	4 MACINTOSH CT, EBW T-258 REPLACEMENT	500474717	$	7,111.82
300689980	BEQ	TS- replace 1-phase, 120/240v, 50kva pad	500456503	$	5,709.20
300690250	BEQ	344 crosspoint leaker replacement	500474717	$	8,113.48
300690304	BEQ	PADMOUNT TRANSFORMER "BODY SHOP"	500460671	$	10,427.95
300690343	BEQ	00-4888, 277/480 500kVA - JK	500456503	$	7,407.37
300690405	BEQ	replace t-237, t-238 & t-239	500474976	$	27,964.39
300691389	BEQ	transformer installs,alerica lane	500218756	$	12,904.98
300691546	BEQ	INSTALL 2500KVA 13/4KV STEPDOWN	500476443	$	7,745.71
300691799	BEQ	500KVA transformer	500473391	$	13,170.78
300692038	BEQ	UG-INSTALL 300 KVA PADMOUNT TRANSFORMER.	500419747	$	10,084.22
300692090	BEQ	INS TRANSFORMER	500440716	$	4,286.04

300692206	BEQ	INST TRANSFORMERS	500352089	$	13,480.46
300692980	BEQ	D.Paris-Xfmr.changeout-defective	500341771	$	20,791.47
300693158	BEQ	REPLACE T-2155	500476878	$	8,337.32
300693596	BEQ	7 BURLINGTIN LANE RPL 100KVA T-6	500474717	$	5,662.58
300695124	BEQ	UG PADMOUNT TRANSFORMER BLDG#46	500443025	$	8,704.87
300695125	BEQ	UG PADMOUNT TRANSFORMER BLDG#40	500477079	$	8,704.87
300695846	BEQ	INSTALL 100KVA PDMT TRANSFORMER	500469943	$	6,540.45
300696833	BEQ	WEW8022-2 PAD286 TRANSFORMER	500456503	$	23,684.67
300698062	BEQ	T-9 50KVA REPLACE 407 CRICKET LN	500422690	$	7,603.16
300698369	BEQ	D.Paris-Equip Work	500454422	$	7,946.13
300698643	BEQ	ENBC 989 RIVER RD, EWR BEQ	500461121	$	16,640.85
300699048	BEQ	T-6 100KVA RPL 967 HOOVER DR	500474717	$	3,509.17
300699050	BEQ	T-211 50KVA RPL 6 CURRIER RD	500474717	$	3,088.27
300701447	BEQ	REPLACE T-736 Dainel dr	500474717	$	2,140.85
300702147	BEQ	MAI 8014, BUD261 PAD1750 INS XFMR -JK	500245005	$	2,586.92
300702237	BEQ	HNC 8012, BUD146, PAD#153, RMV/INS XFMR	500245005	$	1,012.36

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

SCADA/MICROPROCESSOR RELAYS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-18.

a. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
b. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a.

Project #	Name	Total Cost
C.91238	s0386 Install TMP- Kilmer Substation	$2,606,405.72
C.91239	s0386 Install TMP- Meadow Rd Substation	$1,414,419.36
C.91257	s0386 Install TMP- Jackson Rd Substation	$2,698,754.91
C.91258	s0386 Install TMP- Marlton Substation	$258,231.37
C.91260	s0386 Install TMP- Medford Substation	$2,375,300.88
C.91261	s0386 Install TMP- MountLaurelSubstation	$2,598,812.63
C.91262	s0386 Install TMP- Polhemus Substation	$1,526,594.20
C.91362	s0506 Install TMP - Yardville Substation	$36,028.21
C.99200	s0386 Install TMP - Bayway 132-1, 2 & 3	$68,125.56
C.99201	s0386 Install TMP-Linden PAR	$111,768.50
C.99202	s0386 Install TMP-Clarksville Substation	$51,967.82
C.99203	s0386 Install TMP-Greenbrook Substation	$1,342,868.19
C.99204	s0386 Install TMP - Hawthorne Sw Station	$49,291.39

Project #	Name	Total Cost
C.99205	s0386 Install TMP - Hinchmans Substation	$54,596.56
C.99206	s0386 Install TMP - Maywood Substation	$152,844.51
C.99207	s0386 Install TMP - Sewaren 220-1	$38,663.71
C.99208	s0386 Install - TMP - South Hampton Sub	$117,254.12
C.99211	s0433.1 Install TMP - Waldwick 1 PAR	$28,460.22
C.99212	s0433.2 Install TMP - Waldwick 2 PAR	$23,489.27

b. i. 65.45% = $10,222,694

ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

INSTALLATION OF A DMS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-19.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
    i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
    ii. Please provide a list of all outside vendors utilized for these projects.
    iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
    iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. Costs in the "other" category are related to Outside Vendor Consulting and Implementation Services.

b. PSE&G has implemented several major systems in the last 10-15 years, including Geographic Information System for the Company's gas and electric systems, SAP Work Management Module, Computerized Maintenance Management System for substation asset management, Outage Management System, and a n ew customer information system. Experience related to implementing these systems was used in developing this estimate as well as consultations with outside vendors. The only project implemented in the last 5 years is the Customer Information System. The total cost was $155.1M.

c. i. 53.3% - $82.66
    ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

IMPROVEMENTS TO COMMUNICATION NETWORK

QUESTION:

For purposes of this request, please refer to response to part (a) of RCR-ECON-20.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:

a. The costs in "other" are related to traffic control

b.

Customer	LIST_NAME2	Total
5004202	69kV Bennett's-Rutgers Fiber	$2,839.20
5004211	Bennetts - Lawrence Fiber	$309,004.83
5004219	Runnemede Fiber	$173,601.44
5004220	Runnemede Fiber 2011 tap	$13,290.20
5004278	69kV Fiber - Bergen Sw - River Rd.	$319,751.34
5004284	Deptford Fiber Transmission Project	$417,131.89
5004325	Fiber - Taps to FAV-TON-POL	$30,413.57
5004334	69kV Cedar Grove - Hinchman's Fiber	$461,889.01
5004369	69kV RIR-EAT Fiber	$548,042.01
5004375	Linden-Bayway TLC Project (Fiber)	$192,556.00
5004409	69kV Bridgewater - DuPont Fiber	$250,860.87

Customer	LIST_NAME2	Total
5004410	69kV Lake Nelson - DuPont Fiber	$91,927.62
5004476	69kV MAD-LAW Fiber	$119,362.16
5004477	69kV MAD-CAS Fiber	$458,599.01
5004524	Transmission Fiber Fair Lawn Atheni	$1,150,901.70
5004540	69kV Locust St Fiber 69kV	$548,971.38
5004541	69kV Locust St Fiber LOC-GLO	$395,284.34
5004585	Transmission Fiber - Newark Grid	$690,516.37
5004652	69kV Mountain Ave Fiber	$576,584.69
5004725	Montgomery 69kV Fiber	$158,907.80
5004760	H-2208 Fiber Project	$8,419.67
5004822	69kV Kingsland-Ea. Rutherford Fiber	$163,275.76
5004843	69kV ENG-TEA Fiber	$166,486.20
5004844	69kV TEA-BEF Fiber	$81,079.78

c. i. 1.97% = $144,076.79

ii-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

STORM DAMAGE ASSESSMENT

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-22.

a. Please provide a breakdown of all major costs in the “other” category.
b. Please provide a list of all “similar type projects” that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
    i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
    ii. Please provide a list of all outside vendors utilized for these projects.
    iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
    iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company’s response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
Please see the Response to RCR-ECON-39.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
MOBILE PLANT DAMAGE FIELD APPLICATION

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-23.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
    i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
    ii. Please provide a list of all outside vendors utilized for these projects.
    iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
    iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
Please see the Response to RCR-ECON-39.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

EXPAND COMMUNICATION CHANNELS FOR CUSTOMERS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-24.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
Please see the Response to RCR-ECON-39.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

CONTINGENCY RECONFIGURATION STRATEGIES

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-25.

a. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
b. Please provide a breakdown of costs for each of these projects including the following:
   i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
   ii. Please provide a list of all outside vendors utilized for these projects.
   iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
   iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:

a. CIP2 Project ED2-006 SAIFI Improvement Program
Estimated Cost- $49,659,815

b. i. 20.9% = $10,397,152
ii.-iv. See the confidential attachment for total share of contractor expenditures referenced above.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

SATELLITE COMMUNICATIONS

QUESTION:
For purposes of this request, please refer to response to part (a) of RCR-ECON-21.

a. Please provide a breakdown of all major costs in the "other" category.
b. Please provide a list of all "similar type projects" that have been completed over the last 5 years and the estimated cost of these projects.
c. Please provide a breakdown of costs for each of these projects including the following:
    i. Please provide the estimated percent of expenditures on these projects that were contracted to outside vendors.
    ii. Please provide a list of all outside vendors utilized for these projects.
    iii. Please provide the physical address of each of these companies. If the physical address is not available, please provide just the city and state where the company is located.
    iv. Please provide the estimated relative share of expenditures that was spent on each of these outside vendors for each project.

Please provide all supporting workpapers and source documents supporting the Company's response in electronic spreadsheet form with all links and formulas intact, source data used, and explain all assumptions and calculations used. To the extent that data requested is not available in the form requested, please provide the information in the form that most closely matches what has been requested.

ANSWER:
a. "Other" costs are related to Outside Vendor Consulting and Implementation Services
b&c. PSE&G has experience with many communication technologies for relaying, station telecommunications and pole mounted solar panels and therefore has technical background related to communications infrastructure. The company has not implemented a communications system pilot in the last five years but leveraged this expertise in developing estimates for this program.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
RANKING OF ELECTRIC SUB-PROGRAMS

QUESTION:
Regarding the Electric Delivery Infrastructure Hardening Investments proposed under Energy Strong, list the subprograms in order of benefit and impact to storm mitigation. Quantify these rankings based on cost/benefit ratio, outage decrease, and outage duration decrease.

ANSWER:
The attached chart shows the associated rankings of the Electric Delivery Infrastructure Hardening Investments. The rankings are based on estimates of the number of customers benefiting from the program, the hours of outages avoided and the hours of outages reduced due to the proposal.

The benefits to the customer were evaluated looking at each investment in isolation. The benefits of the different programs are not necessarily additive.

Customer benefits were approximated using the value of lost load (VOLL) metric as described below:

A primary benefit associated with reduced levels of power outages is accrued by customers and can be measured by the value that they place on avoiding the loss of electric service. Specifically, the loss of power causes disruptions as well as the incurrence of costs and/or the loss of revenues; customers place a value on avoiding a loss of power and thus avoid disruptions, costs and/or lost revenues. The notion of such a VOLL, has been studied by economists and engineers and used in regulatory and policy proceedings. A current and widely accepted VOLL analysis was conducted by the Lawrence Berkeley National Laboratory (Berkeley).[1] The Interruption Cost Estimate Calculator web site that is funded by the U.S. Department of Energy[2] (DOE) utilizes this study as its basis for calculations.

The Berkeley/DOE study provides an indication of the VOLL by class of customer (i.e., residential, commercial and industrial) by time of year and day (as well as for an average day)

1 Sullivan, M., Mercurio, M., and Schellenberg, J. (2009) Estimated Value of Service Reliability for Electric Utility Customers in the United States. Lawrence Berkeley National Laboratory available at: <http://certs.lbl.gov/pdf/lbnl-2132e.pdf>.

2 ICECalculator.com: "The Interruption Cost Estimate (ICE) Calculator is a tool designed for electric reliability planners at utilities, government organizations or other entities that are interested in estimating interruption costs and/or the benefits associated with reliability improvements."

and for various durations of outages (from momentary outage through outages lasting eight hours).[3] The VOLLs by customer class for an outage of eight hour duration is shown below.

Table 1
Estimated Value of Lost Load For an Outage of Eight Hour Duration By Customer Class
(2008 $ Per Un-served kwh)

Medium and Large C&I	$10.6
Small C&I	$296.1
Residential	$0.9

PSE&G's proposed Energy Strong investments concern hardening assets and adding resiliency into its electric system in order to mitigate prolonged outages (i.e., longer than eight hours in duration). The Company used the VOLL estimates included in the Berkeley/DOE study for durations of eight hours to calculate the value of lost load associated with each of the proposed investment programs, because it represents the VOLL for the longest power outage duration available. (To our knowledge, based on research concerning VOLL studies, VOLL estimates are not available for outage durations of greater than eight hours.) This is a conservative approach because it is likely that the VOLL for longer outage events (say, outages of 48 hours or more) will be higher than VOLLs for outages of shorter durations; prolonged outages result in major disruptions and costs to all customer classes and lost revenues and productivity to business customers.

The calculation of VOLL benefits that are accrued to customers is based on four steps. First, we estimate the hours of avoided and reduced outages. The assumptions underlying the estimate of hours of avoided and reduced outages are included in Table 2. Second, we allocate the hours to customer classes. All customer classes are impacted by many of the proposed Energy Strong programs, so the hours are allocated to customer classes based on PSE&G average mix of customers in 2012 (i.e., roughly 87% to residential customers, roughly 13% to small commercial and industrial customers, and less than 0.5% to large commercial and industrial customers).[4] Third, we estimate the number of unserved kWhs for each customer class by considering the hours (above), the average load demand (kWs) for each customer class and the average load factor for each customer class.[5] Fourth, we multiply the total hours of customer interruptions avoided by the per unserved kWh VOLL for each customer class.[6] The values of lost loads for

[3] The Berkeley study used research and results from 28 customer value of service reliability studies conducted by 10 major US electric utilities over the 16 year period from 1989 to 2005. The 28 studies considered used very similar methods (i.e., interruption cost estimation or willingness-to-pay/accept) to estimate VOLL. These results were integrated into a "meta-database" which was then used in two-part regression model that estimated VOLL. Specifically, the study provides estimates of the VOLL and for various durations of interruptions. VOLL is calculated on an event basis; that is, the various customer estimates of cost or willingness to pay are expressed in terms of events (i.e., outages) of various durations. The study also converts these VOLLs into per kW, per unserved kWh and per annual kWh terms.

[4] Based on PSE&G's 2012 FERC Form 1.

[5] Based on data used in rate proceedings.

[6] To be consistent (with cost dollars), we escalated the VOLL estimates, which are in 2008, by the GDP deflator in order to reflect 2012 dollars.

each customer class are then summed to provide the VOLL for each Energy Strong program segment are included in Table 3. The cost/benefit ratio for each Hardening Investment subprogram is calculated as the total estimated cost for the subprogram divided by its respective VOLL, and the results are shown in Table 3. A cost-benefit ratio less than one indicates that the benefits of the investment from one major storm event is greater than the cost for the subprogram.

Looking at the individual programs, the majority of the projects are cost-beneficial based on a single major event (cost/benefit ratio below 1.0). The analysis was done to demonstrate the value of each investment for a single major storm event, but in practice these investments will help in storm events of any magnitude. By hardening the overall system, the value of each program will increase with each additional storm event by reducing future outages and/or limiting the damage experienced. The pole related investments that do not meet the standard of payback in a single event should not be viewed as non-beneficial, but rather having less relative value to the other projects. Pole damage is typically the most resource and time consuming aspect of restoration activities, particularly when it occurs in backyard services. While difficult to quantify in terms of a major storm event, limiting pole damage will free up resources to concentrate on other restoration work.

TABLE 2

Program	Description	Actions	Assumptions in quantifying customers Impacted by either elimination of outage or decrease in outage duration	Assumption in quantifying outages that are eliminated Outage duration is 3 days unless noted	Assumptions in quantifying outages that are reduced in duration
1. Station Flood Mitigation	This program will target appropriate stations for raising infrastructure, building flood walls and revising standards based on new FEMA flood guidelines	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	Number of customers supplied either directly or indirectly by the Stations to be protected assuming each station will be impacted once	* 33% reduction in 5-day customer outages	With station supply in, duration on average reduced by 1 day
2. Outside Plant Higher Design and Construction Standards	This program will involve improvements to design standards to strengthen construction	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	5% of Customers supplied by 4kV	20% Reduction of Outages	Due to reduced damage, restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service
		Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	5% of Customers supplied by 26/4kV substations	50% Reduction due to raised conductors.	Due to reduced damage, restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service
		Add spacer cable to eliminate open wire to targeted areas	Assume 10 circuits. Average customers/13kV section = 735 Customers/section x 10 circuits	40% Reduction due to increased ability to withstand weather events	N/A
3. Strengthening Pole Infrastructure	This program will involve accelerated pole replacements, additional construction hardening, including reduced pole span lengths, and increased pole diameters	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	# of poles impacted/total poles in system * customers	2% Reduction in the number of Outages Due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	N/A
	This program will evaluate the use of new non-wood material to replace wood poles in the future.	Non-wood poles	# of poles impacted/total poles in system * customers	2% Reduction due to Poles replaced. Value low due to low coincidence of possible damage with replaced poles.	N/A
4. Rebuild/Relocate Backyard poles	This program will consider the relocation and rebuilding of backyard pole lines to front lot and/or UG configuration	Rebuild backyard poles (including tree trimming)	Customers supplied by backyard circuits	50% Reduction	Due to better access and newer facilities restoration work will be decreased by 7.2 hours(10% of 3 days) for Customers out of service
5. Undergrounding	This program will consider the conversion of OH to UG in selected areas and the replacement of PM equipment with a submersible equivalent in targeted areas	A. Convert certain OH areas to UG	Estimate # circuits that could be done to get customer count. Assume 1 mile per circuit, 20 Circuits with average of 735 customers/section	Assume 60% reduction due to damage being avoided on primary lines now Underground.	N/A
		B. Replace PM xfmrs with submersible xfmrs in target areas	Avg Customers per padmounted transformers in flood area	Assume 90% reduction in PSE&G equipment outages due to storm surge. Outage duration of 3 days avoided.	N/A
		C. Replace ATS switches/transformers with submersible switches	Customer benefit aligned with PM Transformer program as ATS typically supply PM in these areas	Combined with 5B	Combined with 5B
6. Relocate ESOC/GSOC/DERC/SR	This program will relocate our critical Electrical & Gas dispatch operating centers to a higher level within the existing building, making it less susceptible flooding, etc.	Relocate critical operating centers	Total number of Customers	N/A	Duration on average reduced by 6 hours. Very low probability event. Assume 1% probability in a major event.

TABLE 3

Program	Actions	Total Estimated Costs ($ Million)	Number of Customers affected	Avoided Outages (Hrs)	Outage Duration Decrease (Hrs)	Total Customer Outage Reduction (Hrs)	Value (to customers) of Lost Load ($ Million)	Cost/Benefit Ratio	Rank Based on Cost/Benefit Ratio
1. Station Flood Mitigation	Review and identify stations in newly defined FEMA/NJ DEP flood elevations and develop mitigation plans where appropriate. This will include raising/rebuilding infrastructure and installing flood walls.	$ 1,678	748,500	29,640,600	11,856,240	41,496,840	$ 15,750.42	0.11	1
2. Outside Plant Higher Design and Construction Standards	Change existing 4kV OP distribution to 13kV standards (this represents 5% of the 4kV infrastructure)	$ 65	30,449	438,471	175,388	613,859	$ 232.99	0.18	2
	Change existing 26kV to 69kV standards while still operating at 26kV (this represents 5% of the 26kV infrastructure)	$ 60	29,873	1,075,437	107,544	1,182,981	$ 449.01		
	Add spacer cable to eliminate open wire to targeted areas	$ 10	7,350	211,680	0	211,680	$ 80.34		
3. Strengthening Pole Infrastructure	Accelerate pole replacements including increased pole diameters and reduced span lengths where appropriate. Enhanced storm guying standards	$ 102	50,634	72,913	0	72,913	$ 27.67	3.69	5
	Non-wood poles	$ 3	1,407	2,025	0	2,025	$ 0.77		
4. Rebuild/Relocate Backyard poles	Rebuild backyard poles (including tree trimming)	$ 100	36,973	1,331,028	133,103	1,464,131	$ 1.15	87.10	6
5. Undergrounding	A. Convert certain OH areas to UG	$ 60	14,700	635,040	0	635,040	$ 241.03	0.26	3
	B. Replace PM xfmrs with submersible xfmrs in target areas	$ 8	1,894	122,731	0	122,731	$ 46.58		
	C. Replace ATS switches/transformers with submersible switches	$ 8	Combined with 5B	Combined with 5B	Combined with 5B	Combined with 5B	$ -		
6. Relocate ESOC/GSOC/DERC/SR	Relocate critical operating centers	$ 15	2,250,511	0	135,031	135,031	$ 51.25	0.29	4

PUBLIC SERVICE ELECTRIC AND GAS COMPANY
PSE&G CAPITAL EXPENDITURE COMMITMENT

QUESTION:
If PSE&G is granted all or a portion of the funding requested in the Petition, what commitment will PSE&G make to capital expenditures, outside of this program, over the next ten (10) years?

ANSWER:
While the Company does not have any commitments to capital spending other than electric distribution for 2013,the attached confidential table shows the Company's expected electric and gas distribution capital spending over the next five years. Note: The table shows a "Total Net of NB" (New Business) since New Business spending is out of the Company's control.

Distribution of the attached table is limited to those parties that receive material designated as confidential in this docket.

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

STRENGTHENING POLE INFRASTRUCTURE

QUESTION:
Referencing Paragraphs 37-43, with respect to Subprogram 3, Strengthening Pole Infrastructure, please explain how the proposed mitigation efforts exceed the normal operations and maintenance efforts associated with the provision of safe, reliable, and adequate utility service, including but not limited to:

a. A detailed explanation of the normal pole inspection and replacement program currently conducted by PSE&G;
b. A detailed explanation of how the proposed mitigation measures exceed the normal pole inspection and replacement programs;
c. A detailed analysis providing empirical evidence indicating how the enhanced pole infrastructure programs are likely to mitigate against the need for future recovery efforts; and
d. A detailed study comparing the number of poles replaced after Hurricane Irene to the number of poles replaced after Superstorm Sandy, including a discussion of how many poles replaced after Hurricane Irene were subsequently destroyed by Superstorm Sandy, and evidence that mitigation efforts would reduce the reoccurrence of pole damage from a subsequent Major Storm Event.

ANSWER:
New Jersey is located within the heavy loading zone as defined by Section 250 of the North America by the National Electric Safety Code (NESC). The PSE&G overhead electric distribution system is constructed as compliance requires. Span lengths are dictated by field conditions and when possible they will be reduced to provide an overall system hardening. It is recognized that spans leading up to the dead end of a pole line or a junction are the most critical and will be addressed as the highest priority. Although NESC compliant, additional high stress points on the overhead distribution system will be reinforced with additional guying and anchoring to reduce the occurrence of cascading pole failures. Composite poles will be installed on pole lines serving critical customers to absorb the energy from wind loads and reduce cascading pole failures. They will also be evaluated as a replacement to wooden poles for installation during a storm restoration event.

a. PSE&G inspects wood poles on a 10 year cycle. Poles are inspected for groundline decay and visual defects, and chemical preservatives and inspect treatments are applied as needed. Based upon the remaining circumference and pole strength, steel re-enforcement trusses are added to restore pole strength as appropriate. If excessive decay is present, or if other defects deem it appropriate, the pole is scheduled for replacement. PSE&G coordinates inspection and treatment of joint poles with Verizon.

b. Based upon the remaining strength, the enhanced program will replace all identified poles and not use typical reinforcement methods such as pole trusses. New poles are better able to withstand wind load because of their consistent structure and are more resilient to storm failure.

c. PSE&G's storm recovery efforts are dependent upon many factors including access to damage areas. During the period between 10/29/12 and 11/16/12 (Superstorm Sandy) there were 1,115 blocked road conditions, as reported by customers. Experience has shown that this is typical during any major storm restoration effort. Roads are blocked mainly by fallen trees, but also by flooding and downed utility poles/wires. Improving the overhead electric support structures and guying will allow these facilities to support smaller trees and limbs rather than failing resulting in faster recovery efforts due to fewer downed poles/wires and better road access to damage areas.

d. During the August 2011 (Irene) storm restoration effort, PSE&G replaced 599 poles in the service territory. During the October / November 2012 (Sandy) restoration effort, PSE&G replaced 2,500 poles. A concise pole by pole comparison is not available, however since the two storms had different location impacts, it is not likely that the damage had any location duplications. Sandy had more than double the customer outages and caused more than four times as many pole problems. PSE&G anticipates that the pole hardening efforts proposed under the Energy Strong Program (pole replacement, guying, and composite poles) will reduce the reoccurrence of pole damage in future major storms.

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PUBLIC VERSION

PUBLIC SERVICE ELECTRIC AND GAS COMPANY

PSE&G'S FLOOD MITIGATION STUDY

QUESTION:
Please provide a copy of the PSE&G's flood mitigation study cited in Paragraph 17.

ANSWER:
See attachment documents:

- Preliminary Substation Flood Impact Report
- Flood Impact Study For New Milford Switching Station
- Flood Impact Study For Cranford Substation
- Flood Impact Study For Hillsdale Substation
- Flood Impact Study For River Edge Substation
- Flood Impact Study For Rahway Substation
- Flood Impact Study For Somerville Substation
- Flood Impact Study For Jackson Road Substation
- Flood Impact Study For Marion Switching Station
- Flood Impact Study For Ewing Substation
- Flood Impact Study For Belmont Substation
- Substation Flood Protection - Summary Evaluation Report

PRELIMINARY SUBSTATION FLOOD IMPACT REPORT

Public Service Electric & Gas

31 OCTOBER 2012

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1.0 Executive Summary

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing substantial impact to some electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. As a result of Hurricane Irene, as well as prior flooding events, Black & Veatch was engaged to prepare a "Substation Flood Protection Report" for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, March 2, 2012). The Substation Flood Protection Report presents the results of evaluations that were performed to determine the maximum observed flood water elevations and flood depths at each site and provides preliminary recommendations for providing appropriate flood protection measures.

Flood protection measures that were considered consisted of earthen berms, sheetpile barriers and concrete floodwalls. In general, earthen berms were selected for flood protection when sufficient space existed at the substation site as this is the lowest cost alternative, and sheetpile barriers were selected for use at sites where sufficient space does not exist for use of berms. Due to high cost, concrete floodwalls were not selected for any of the sites. Based on the preliminary evaluations, the total estimated cost for providing the recommended flood protection at all sites is $10,115,000 in 2012 dollars. The estimated cost at each site varies considerably based on the height of flood protection required and the perimeter length of the protected area.

It is recognized that the magnitude of potential upstream flood impacts, in terms of increased water surface elevations upstream of the sites resulting from implementation of the recommended flood protection measures, will be an important factor during project permitting. In order to determine the potential for upstream flood impacts, Black & Veatch was engaged to perform detailed Flood Impact Studies for ten of the twelve substation sites. Flood impact studies are unnecessary for Bayway, where the site is not in the floodplain and is located behind the City of Elizabeth Levee, or for Garfield where any improvements would be performed within the existing perimeter wall of the site.

The ten stations that were studied further in this Flood Impact Study are listed below.

Central Division
Cranford Substation
Rahway Substation
Somerville Substation

Palisades Division
New Milford Switching Station
River Edge Substation
Hillsdale Substation
Marion Switching Station

Metro Division
Belmont Substation
Jackson Road Substation

Southern Division
Ewing Substation

In general, the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, was used to develop a hydraulic model for the river or stream adjacent to each substation site. The HEC-RAS program is the accepted state of the practice software by regulatory agencies. Updated, site specific topographic survey data provided by PSE&G was used in augmenting the existing NJDEP and FEMA flood modeling data for each of the substation sites and for development of the flood impact computer models. Models and data used by FEMA and the NJDEP to establish the existing flood mapping in the region were used as the baseline for the updated HEC-RAS hydraulic models.

Black & Veatch provided Technical Memoranda presenting the results of the detailed flood impact studies at each substation site to PSE&G as the individual studies were completed. These memoranda provide comprehensive summaries of the studies at each site and are included in the Appendix to this report.

The results of the flood impact studies are summarized in the Table 1. Five of the ten substations have been characterized as having upstream impacts resulting from construction of the flood protection measures. Two of the sites, Cranford and Ewing, would have very small increases in upstream water surface elevation. However, NJDEP regulations state that "no" water surface elevation increase can result from new flood protection construction. The level of accuracy that the NJDEP will apply to model results will need to be clarified. B&V has followed state of the practice methodologies and reported water surface elevations to one-hundredth of a foot accuracy.

The Preliminary Flood Protection Report estimated site locations using large scale FEMA flood mapping. The recent, detailed site surveys have shown that only one station is located within a floodway. The floodway is considered the extended channel of higher velocity flows during a flood event, and also incurs a higher degree of scrutiny and permitting restrictions. The only station located in the floodway is Ewing, but additional modeling shows no impact under that criteria. There have been no changes to the NJDEP Riparian buffer requirements.

TABLE 1. FLOOD PROTECTION SUMMARY							
Site	Max WSEL Impact Upstream (ft)	Upstream Impact Distance (ft)	Wall Height (ft)	Permitting Considerations	NJDEP Riparian Buffer Impact	Site Specific Considerations	Cost
New Milford	n/a	n/a	4.0	Standard	Yes	n/a	$1,900,000
Cranford	0.03	2600	4.7	Updated model approval from NJDEP	Yes	n/a	$525,000
Hillsdale	0.27	1000	4.0	Upstream Impacts	Yes	n/a	$1,525,000
River Edge	n/a	n/a	2.5	Standard	Yes	n/a	$450,000
Rahway	1.0	3000	4.3	Updated model approval from NJDEP	Yes	Flood level lower than existing mapping	$730,000
Somerville	n/a	n/a	4.0	Updated model approval from NJDEP	No	n/a	$750,000
Jackson Rd.	0.21	400	2.2	Upstream Impacts	Yes	Includes site expansion	$1,170,000
Marion	n/a	n/a	3.9	Standard	Hackensack Meadowlands Commission	Re-Assess Surge Analysis and wall height	$1,715,000
Ewing	0.05	1180	4.7	Floodway Approval from NJDEP	No	Located in Floodway	$570,000
Belmont	n/a	n/a	9.0	Standard	Yes	Deep flooding	$320,000
Bayway	n/a	n/a	3.0	Verify City of Elizabeth Levee status	Yes	n/a	$310,000
Garfield	n/a	n/a	n/a	Standard	n/a	Rehabilitation of existing flood wall	$150,000

Notes:

1. All sites except Belmont will utilize sheetpile wall flood protection as cited in B&V Preliminary Substation Protection Report, March 2, 2012.
2. Ewing Substation is located within the floodway, which could require more rigorous permitting activities.
3. Upstream Impact Distance indicates where the Water Surface Elevation (WSEL) returns to existing conditions.
4. Wall heights are one foot higher than the maximum observed storm or NJDEP Flood Hazard Limit, whichever is greater.
5. Belmont cost will need to be revised to reflect new flood wall type.

Jackson Road and Hillsdale will have increases of approximately 2.5 to 3.5 inches directly upstream. There will likely be more detailed permitting discussion required with the NJDEP regarding these substations, to address the small increase in water surface elevation.

The Rahway analysis results in an increased water surface elevation of 1 foot for several thousand feet upstream of the site. This result, however, has only been realized through the updated modeling performed by Black & Veatch that takes into account a small length of the channelized Rahway River. The increase that we have calculated lies within the established NJDEP Flood Hazard Limits, which were developed in a more conservative ("worst case") model. So while there is an estimated increase from construction of the recommended flood protection measures using the new model, the resulting flood level is actually a foot less than what is presented in the current flood mapping the NJDEP and FEMA for this area.

During the permitting process, discussion and collaboration with the NJDEP and FEMA regarding the sites would be appropriate where the Black &Veatch model has changed the flood elevation results. In all cases where there are elevation changes due to revised modeling, we believe that the Black &Veatch models more accurately depict the actual site conditions. The regulating agencies will, however, need to recognize and accept the updated model results.

This Flood Impact Study addresses the potential for upstream flood impacts that would result from construction of the recommended flood protection scheme at each site. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at each site, and will support the eventual permitting process. It is recognized that review and supplemental input to the flood studies will likely be required to support the permitting process moving forward since the majority of the sites are located within the NJDEP Flood Hazard Limit.

Subsequent activities associated with implementation of the flood protection measures at one or more sites would include permitting, site subsurface investigations, engineering design, and construction. These activities could be conducted for all substation sites together, or could be conducted over a period of time to provide for a phased implementation of the flood protection measures at selected sites.

It is noted that other approaches to providing the desired level of flood protection may be considered during subsequent evaluations. These alternate approaches may include, but are not limited to, strategic substation relocations or protection of only the critical portions and components of the substation site such as the control building. A risk analysis has not been performed as part of this study, and should be considered for subsequent evaluations if needed to support PSE&G's business case for the flood protection measures to be implemented. The flood protection measures considered in this study have been developed to a conceptual level of detail. A site specific practicality/constructability review should be completed during preliminary design to identify site specific flood protection requirements.

2.0 Summary of Flood Impact Studies

2.1 SUBSTATION FLOOD PROTECTION REPORT (MARCH 2, 2012)

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing substantial impact to some electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. As a result of Hurricane Irene, as well as prior flooding events, Black & Veatch was engaged to prepare a "Substation Flood Protection Report" for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, March 2, 2012). The Substation Flood Protection Report presents the results of evaluations that were performed to determine the maximum observed flood water elevations and flood depths at each site and provides preliminary recommendations for providing appropriate flood protection measures.

Flood protection measures that were considered consisted of earthen berms, sheetpile barriers and concrete floodwalls. In general, earthen berms were selected for flood protection when sufficient space existed at the substation site as this is the lowest cost alternative, and sheetpile barriers were selected for use at sites where sufficient space does not exist for use of berms. Due to high cost, concrete floodwalls were not selected for any of the sites. Based on the preliminary evaluations, the total estimated cost for providing the recommended flood protection at all sites is $10,115,000 in 2012 dollars. The estimated cost at each site varies considerably based on the height of flood protection required and the perimeter length of the protected area.

Based on the detailed site surveys recently performed by PSE&G, each site's baseline elevation and proposed flood protection elevation have been updated in reference to the detailed flood studies herein. The NJDEP Flood Hazard Limit (FHL) is the more conservative measure used in New Jersey that applies an increase of 25% to the FEMA 100-yr flood flows. The NJDEP FHL criterion supersedes the FEMA 100-year flood plain elevations referenced in the Preliminary Flood Protection Report, and is the baseline for the projects in this report and moving forward.

For each site, the most recently observed flooding from Hurricane Irene was compared to the NJDEP FHL in determining the updated top of flood protection elevations. For the sites, we recommend that flood protection extend one foot above the NJDEP FHL or observed Hurricane Irene flood elevation, whichever is greater. In the case of Marion, where the Hackensack River is tidally influenced, a storm surge assessment was performed to determine the appropriate water surface elevations. Based on the events of Hurricane Sandy on October 29-30, 2012, this will need to be re-assessed.

The Belmont substation flood protection would not result in an increase in the water surface elevation, however the updated survey has indicated that the site will be inundated by 8 feet of water for the NJDEP FHL. The flood protection approach and estimated costs presented in the preliminary report will need to be re-evaluated in light of this greater depth. The updated site details are presented in the table below.

Table 1. Summary of Substation Flood Protection Requirements

SITE ELEVATION SUMMARY							
Site	Surveyed Minimum Site EL. (NAVD 88)	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL. (NAVD 88)	Max. Observed Storm	Proposed Flood Protection EL.	Reference	Wall Height
New Milford	8.5	11.5	9.2	Greater than NJDEP FHL	12.5	1 ft over observed	4.0
Cranford	60.5	63.5	64.2	Less than NJDEP FHL	65.2	1 foot over NJDEP	4.7
Hillsdale	63.0	66.0	63.8	Greater than NJDEP FHL	67.0	1 ft over observed	4.0
River Edge	6.5	8.0	7.3	Greater than NJDEP FHL	9.0	1 ft over observed	2.5
Rahway	10.0	13.0	13.33	Less than NJDEP FHL	14.33	1 ft over NJDEP	4.3
Somerville	46.0	49.0	48.4	Greater than NJDEP FHL	50.0	1 ft over observed	4.0
Jackson Rd.	175	176.2	175.3	Greater than NJDEP FHL	177.2	1 ft over observed	2.2
Marion	5.0	6.5	7.9	FEMA 100 year and Max Tide	8.9	1 ft over FEMA 100 yr flow and 1% tide level	3.9
Ewing	72.5	74.5	76.2	Less than NJDEP FHL	77.2	1 ft over NJDEP	4.7
Belmont	14.5	17	22.5	Less than NJDEP FHL	23.5	1 ft over NJDEP	9.0

2.2 SELECTED SITES FOR FLOOD IMPACT STUDIES

In order to determine the potential for upstream flood impacts as result of implementation of the recommended flood protection measures, Black & performed detailed Flood Impact Studies for ten of the previously considered twelve substation sites. Flood impact studies are unnecessary for Bayway, where the site is not in the floodplain and is located behind the City of Elizabeth Levee, or for Garfield where any improvements would be performed within the existing perimeter wall of the site.

The ten stations that were studied further in this Flood Impact Study are listed below.

Central Division
Cranford Substation
Rahway Substation
Somerville Substation

Palisades Division
New Milford Switching Station
River Edge Substation
Hillsdale Substation
Marion Switching Station

Metro Division
Belmont Substation
Jackson Road Substation

Southern Division
Ewing Substation

2.3 WATER SURFACE PROFILE MODELS

In general, the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, was used to develop a hydraulic model for the river or stream adjacent to each substation site. The HEC-RAS program is the accepted state of the practice software by regulatory agencies. Updated, site specific topographic survey data provided by PSE&G was used in augmenting the existing NJDEP and FEMA flood modeling data for each of the substation sites and for development of the flood impact computer models. Models and data used by FEMA and the NJDEP to establish the existing flood mapping in the region were used as the baseline for the updated HEC-RAS hydraulic models.

In order to achieve the goals of this study, four geometry models were generally considered for each site as follows.

- The first model was the Effective Model. This model is the HEC-RAS model with its saved results as provided by NJDEP. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were copies of NJDEP's HEC-RAS model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is a copy of the NJDEP HEC-RAS model with no modifications, but rerun to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections.

- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river were used to represent the potential flood impact associated with the proposed improvements.

The Black & Veatch models are accurate and appropriately characterize the each site and associated water body. The largest of the calibration differentials were found several thousand feet upstream of the sites, near the start of the model where boundary conditions can cause the numerical shift due to the iterative nature of the calculations. The model differential is also typically found at bridge crossings, where the constriction of the channel and other obstructions create numerical variation.

2.4 FLOOD IMPACT STUDY RESULTS

Black & Veatch provided Technical Memoranda presenting the results of the detailed flood impact studies at each substation site to PSE&G as the individual studies were completed during the course of the studies. These memoranda provide comprehensive summaries of the studies at each site and are included in the Appendix to this report. The potential flood impacts are indicated in Table 1 above.

2.5 IMPLEMENTATION CONSIDERATIONS

Subsequent activities associated with implementation of the flood protection measures at one or more sites would include permitting, site subsurface investigations, engineering design, and construction. These activities could be conducted for all substation sites together, or could be conducted over a period of time to provide for a phased implementation of the flood protection measures at selected sites.

Specific site logistics such as fence relocation, replacement, and temporary security fencing during construction will need to be considered during design and construction. Construction staging areas for the smaller sites may require additional consideration. Work planning should be performed in accordance with PSE&G safety and operations criteria.

It is noted that other approaches to providing the desired level of flood protection may be considered during subsequent evaluations. These alternate approaches may include, but are not limited to, strategic substation relocations or protection of only the critical portions and components of the substation site such as the control building. A risk analysis has not been performed as part of this study, and should be considered for subsequent evaluations if needed to support PSE&G's business case for the flood protection measures to be implemented. The flood protection measures considered in this study have been developed to a conceptual level of detail. A site specific practicality/constructability review should be completed during preliminary design to identify site specific flood protection requirements.

Appendix A - Individual Flood Studies 1

FLOOD IMPACT STUDY NEW MILFORD SWITCHING STATION

Public Service Electric & Gas

11 OCTOBER 2012

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Table of Contents

1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing significant impact to electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Black & Veatch, Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Ewing) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. <u>New Milford Switching Station (1)</u>
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the New Milford Switching Station. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The New Milford Switching Station is located on Henley Avenue, west of River Road. Primary gated access is from Henley Avenue. The north side is open for access, however all other sides of the site are not easily accessible. The entire site is approximately 8 acres. Elevations along the Hackensack River during Hurricane Irene were reportedly higher, possibly due to flood gate releases from the Oradell Dam, upstream of the site. The site is located within the NJDEP Riparian Buffer Zone.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the New Milford Switching Station.

1) NJDEP. HEC-2 Input and Output Printouts from 22 September 2006 (Hackensack_River_New_Milford_FW_Hacknmfy3.pdf)
2) NJDEP. HEC-2 Input and Output Printouts from 9 April 1981 (Hackensack_River_Amended_Run_FW.pdf)
3) Site survey of the New Milford Switching Station (17 May 2012)
4) Black & Veatch. 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

The HEC-2 Input and Output printouts (documents 1 and 2) were the basis of the model development. Cross-sectional characteristics were obtained directly from these documents. The site survey (document 3) was used to refine ground elevations at the site and distances to the river, and to append existing hydrologic cross-sections along the site. The Substation Flood Protection Report (document 4) provided the estimated height for the flood protection measures. The vertical datum for all elevations reported in the HEC-2 files (documents 1 and 2) is NGVD 29, while the vertical datum for documents 3 and 4 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevation. All elevations presented in this report are NAVD 88.

Based on this report, the flood protection wall at the New Milford Switching Station will have a top elevation 2 feet above the 100-year flood level. Based on documents 1 and 2, the 100-year flood elevation in the vicinity of the site ranges from 8.80 ft near the northern end to 8.55 ft near the southern end. The top of the wall was modeled at EL. 11.0.

HYDRAULIC MODEL DEVELOPMENT

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Hackensack River in the vicinity of the New Milford Substation. The hydraulic model was based on hardcopy printouts of NJDEP's HEC-2 input data (documents 1 and 2) and included cross-sections 104000 through 109530.

The NJDEP HEC-2 file from 2006 (document 1) indicates that cross-section 108930 is at the downstream face of River Edge Road. Upstream and downstream cross-sections were located based on centerline distances between cross-sections as indicated in the HEC-2 files. See Figure 1 for the location of River Edge Road relative to the New Milford Site and the locations of the modeled cross-sections, shown in white.

In addition to Station and Elevation data, the following variables were also obtained from the HEC-2 files (documents 1 and 2) for each of the modeled cross-sections: Downstream Reach Lengths; Manning's n Values; Main Channel Bank Stations; and Contraction and Expansion Coefficients. The downstream boundary condition in the model was set as a "Known Water Surface Elevation" (WSE) equal to the 100-year flood level at cross-section 104000, 8.03 feet (NAVD 88) as reported in the 1981 NJDEP HEC-2 output printout (document 2). The River Edge Road Bridge was also modeled as indicated in the HEC-2 files.

Four cross-sections were added to the hydraulic model in the vicinity of the New Milford Site, and one NJDEP existing cross-section (106850) was modified in order to more accurately reflect recent survey data at the site. The added and modified cross-sections are shown in yellow in Figure 1.

The following flows were considered:

- 6,900 cfs – Hackensack River, 100-year flood flow
- 8,625 cfs – Flood Hazard Limit Criterion = 125% of the Hackensack River, 100-year flood flow

HYDRAULIC MODEL SCENARIOS

In order to achieve the goal of this study, four geometry models are considered.

- The first model was the Effective Model. This was developed from the NJDEP HEC-2 files including input and results. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were prepared using the HEC-RAS software: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model was the HEC-RAS model which is based entirely on the Effective Model information from the HEC-2 printouts.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections and slightly modified cross-sections in order to more accurately describe topography in the vicinity of the site.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed changes, which in this case was sheet pile walls for flood protection, at the New Milford Site. This was modeled as blocked obstructions in the HEC-RAS model. Figures 2 through 6 illustrate the impacted cross-sections in the HEC-RAS model both with and without the obstruction to flow.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are very similar to those of the Effective Model especially in the vicinity of the New Milford Site, downstream of River Edge Road. In this reach, WSEs in the Duplicate Effective model vary by 0.0 to 0.03 foot from the Effective Model results. Based on the existing data and the model output, the Black & Veatch model is properly calibrated and accurately estimates the flows and elevations within the Hackensack River. Table 1 presents the results from the four models. River stations in bold indicate the additional cross-section added to the model at the site.

Table 1: Hydraulic Model Results - FEMA 100-year Flood (6,900 cfs)

	1	2	3	4	4-3
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
109530	10.02	10.3	10.37	10.36	-0.01
109032	9.57	9.77	9.86	9.85	-0.01
108968	9.27	9.42	9.53	9.53	0
108967	River Edge Road Bridge				
108930	9.29	9.29	9.41	9.4	-0.01
108880	9.22	9.27	9.38	9.38	0
108580	9.2	9.22	9.34	9.34	0
108100	9.09	9.11	9.24	9.24	0
107955	8.76	8.78	8.91	8.9	-0.01
107860	8.7	8.72	8.86	8.85	-0.01
107765	8.74	8.77	8.91	8.9	-0.01
107625	8.8	8.83	8.97	8.96	-0.01
107610	**n/a**	**n/a**	**8.97**	**8.96**	**-0.01**
107510	**n/a**	**n/a**	**8.91**	**8.9**	**-0.01**
107140	**n/a**	**n/a**	**8.83**	**8.83**	**0**
106850	**8.63**	**8.66**	**8.74**	**8.74**	**0**
106665	**n/a**	**n/a**	**8.49**	**8.5**	**0.01**
106560	8.55	8.58	8.58	8.58	0
106100	8.41	8.43	8.43	8.43	0
105700	8.39	8.41	8.41	8.41	0
105080	8.25	8.26	8.26	8.26	0
104500	8.12	8.13	8.13	8.13	0
104000	8.03	8.03	8.03	8.03	0

The Existing Conditions Model, which includes additional cross-sections in the vicinity of the site, yielded flood levels that are similar to those in the Duplicate Effective Model. The Proposed Conditions Model includes the sheet pile walls for flood protection in the right bank of the model starting at the 8-foot contour line in the vicinity of the site. This model yielded flood levels that are 0.00 to 0.01 feet different than those in the Existing Conditions Model. The maximum rise seen in the vicinity of the site was 0.01 feet at cross-section 106665. These results indicate that the proposed flood protection facility will not significantly impact 100-year flood levels in the Hackensack River floodplain. Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 8,625 cfs.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (8,625 cfs)

	3	4	4-3
River Station	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)
109530	11.11	11.09	-0.02
109032	10.53	10.51	-0.02
108968	10.15	10.11	-0.04
108967	River Edge Road Bridge		
108930	10.03	9.98	-0.05
108880	9.99	9.95	-0.04
108580	9.94	9.89	-0.05
108100	9.83	9.78	-0.05
107955	9.35	9.29	-0.06
107860	9.28	9.22	-0.06
107765	9.35	9.29	-0.06
107625	9.44	9.38	-0.06
107610	**9.44**	**9.37**	**-0.07**
107510	**9.34**	**9.3**	**-0.04**
107140	**9.19**	**9.21**	**0.02**
106850	**9.05**	**9.09**	**0.04**
106665	**8.72**	**8.73**	**0.01**
106560	8.85	8.85	0
106100	8.64	8.64	0
105700	8.6	8.6	0
105080	8.39	8.39	0
104500	8.19	8.19	0
104000	8.03	8.03	0

Based on model results, the proposed sheetpile flood wall around New Milford Switching Station has little impact on water surface elevations in the Hackensack River Floodplain under Flood Hazard Flow Conditions. The maximum rise as a result of the sheetpile wall is 0.04 feet.

Black & Veatch modeled the observed flooding condition of approximately EL. 10.5 to 11 feet reported by PSE&G during Hurricane Irene. In order to realize an inundation of that depth at the site, a flow of approximately 12,500 to 16,500 cfs would be necessary. According to USGS flow data from instrumentation more than a mile upstream of the New

Milford site, Hurricane Irene had a recurrence interval greater than the 100-year storm, with flood flows estimated at 10,500 cfs.

3.0 Conclusions and Recommendation

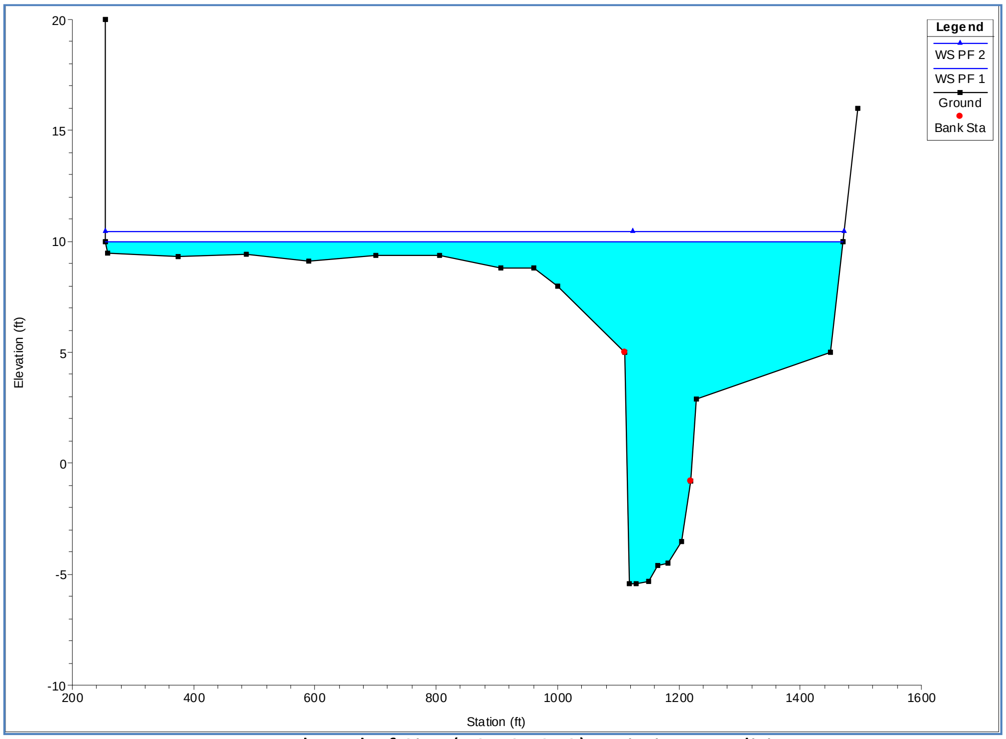
The proposed flood protection facilities will not impact flooding upstream of the New Milford Switching Station. If PSE&G proceeds with the design and construction of the proposed flood mitigation measures for the New Milford Switching Station, there will be no significant upstream impacts to existing structures. Hydraulically and shown through the models, this same conclusion applies to adjacent and downstream structures as well.

Because the flow and inundation from Hurricane Irene were greater than the required FEMA 100-year and NJDEP Flood Hazard flows, the top of flood protection elevation is 1 foot above the maximum elevation observed during Hurricane Irene. This will provide flood protection greater than the 100-year flood recurrence interval, but appropriately conservative to protect the site during extreme storm events.

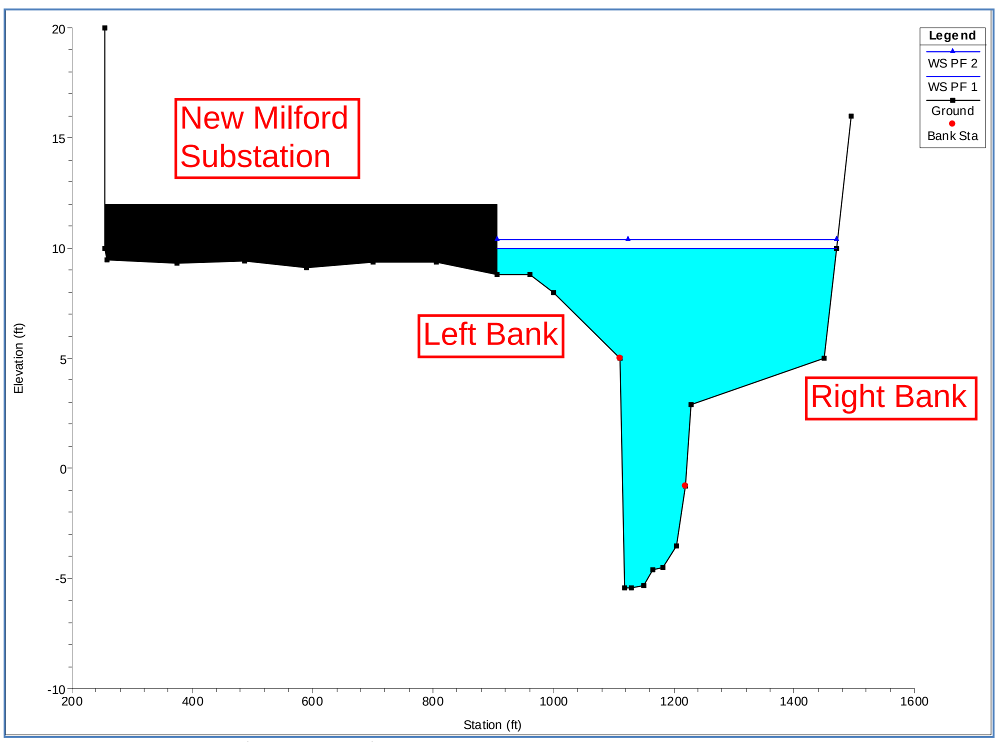
ELEVATION SUMMARY				
Site	Minimum Site EL. (NAVD 88)	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL. (NAVD 88)	Proposed Flood Protection EL.
New Milford	8.5	11.5	9.2	12.5

[redacted]

[redacted]

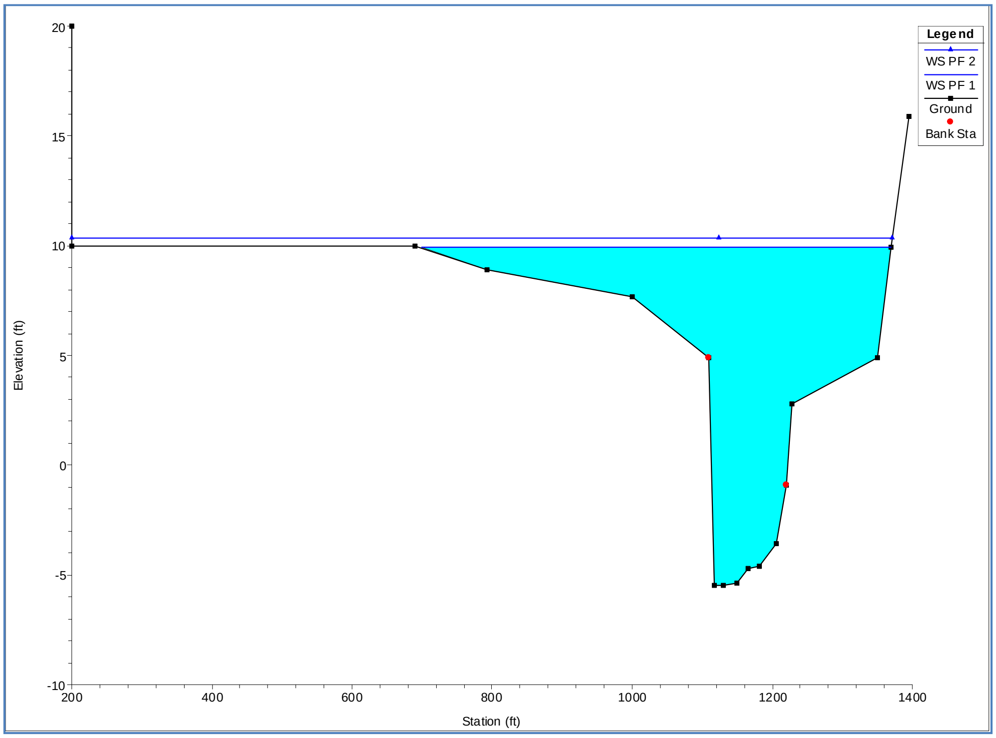


North End of Site (XS 107610): Existing conditions.

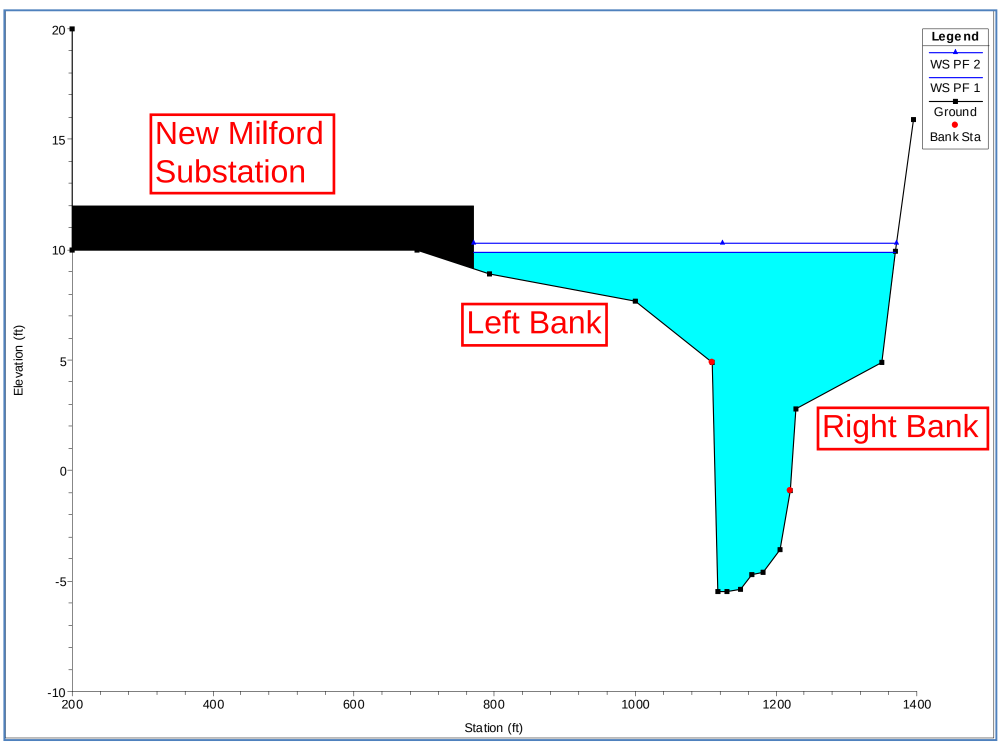


North End of Site (XS 107610): Proposed Condition - Sheetpile Flood Protection Installed.

Figure 2: Cross-sectional view from Upstream End of Site looking downstream.
PF1 = FEMA 100-yr flow 6,900 cfs; PF2 = NJDEP Flood Hazard flow 8,625 cfs.

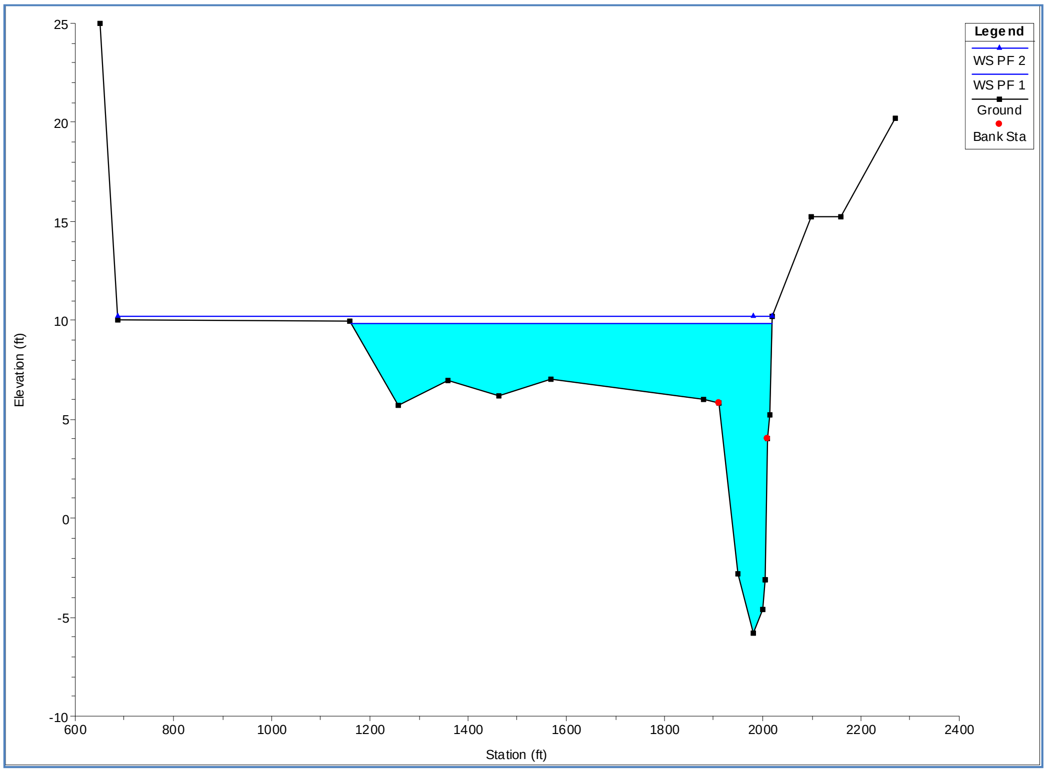


XS 107510: Existing conditions.

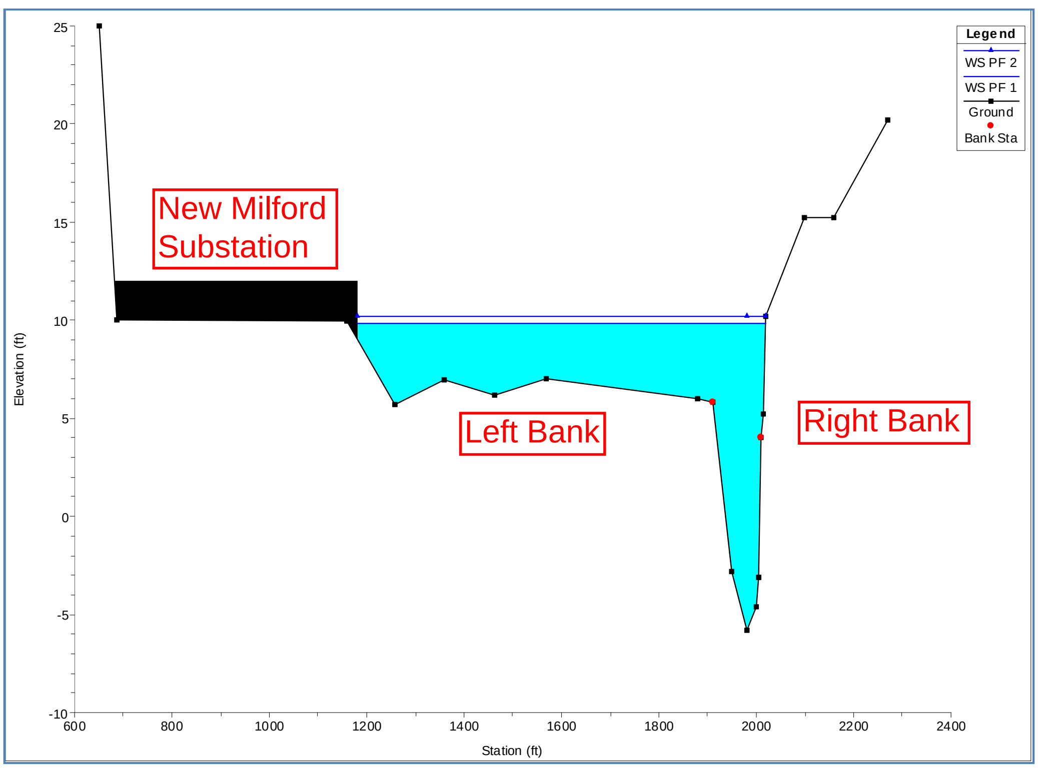


XS 107510: Proposed Condition – Sheetpile Flood Protection Installed.

Figure 3: Cross-sectional view from XS 107510 looking downstream.
PF1 = FEMA 100-yr flow 6,900 cfs; PF2 = NJDEP Flood Hazard flow 8,625 cfs.

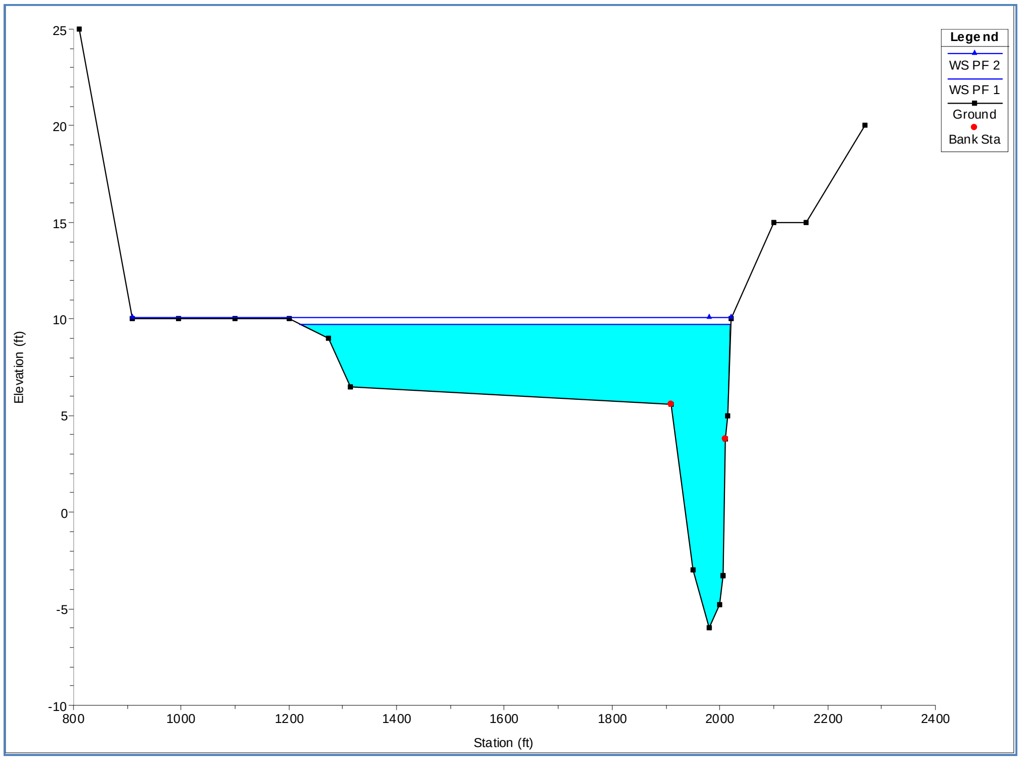


XS 107140 (Added XS): Existing conditions

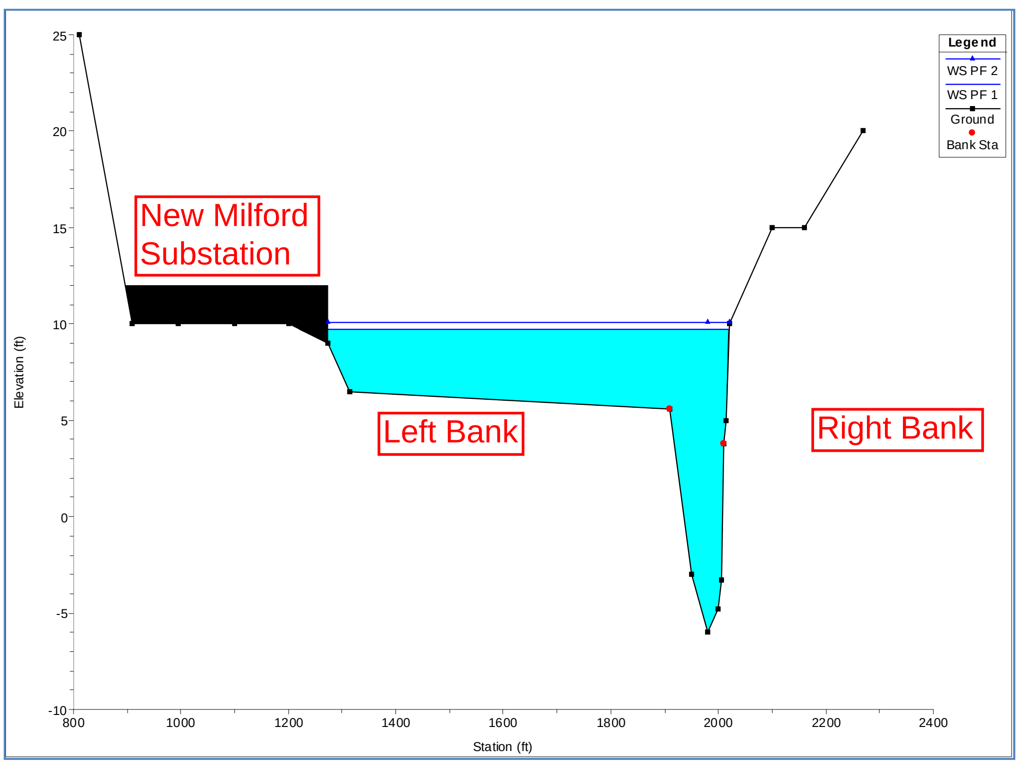


XS 107140 (Added XS): Proposed Condition – Sheetpile Flood Protection Installed

Figure 4: Cross-sectional view from XS 107140 looking downstream.
PF1 = FEMA 100-yr flow 6,900 cfs; PF2 = NJDEP Flood Hazard flow 8,625 cfs.

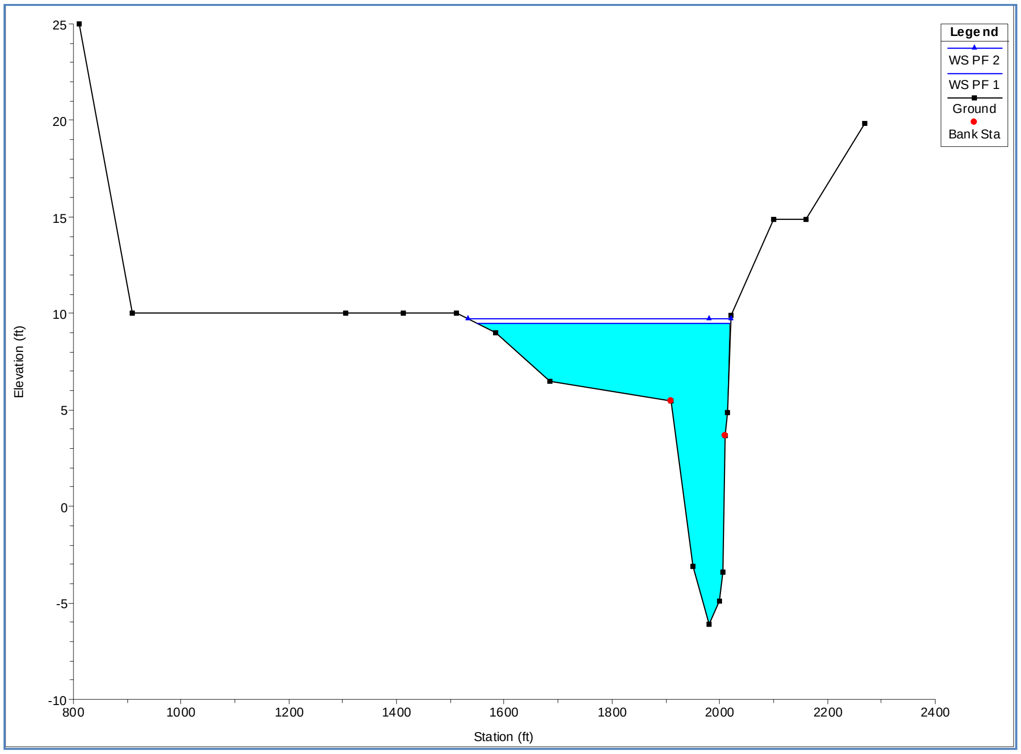


XS 106850 (Modified XS): Existing conditions

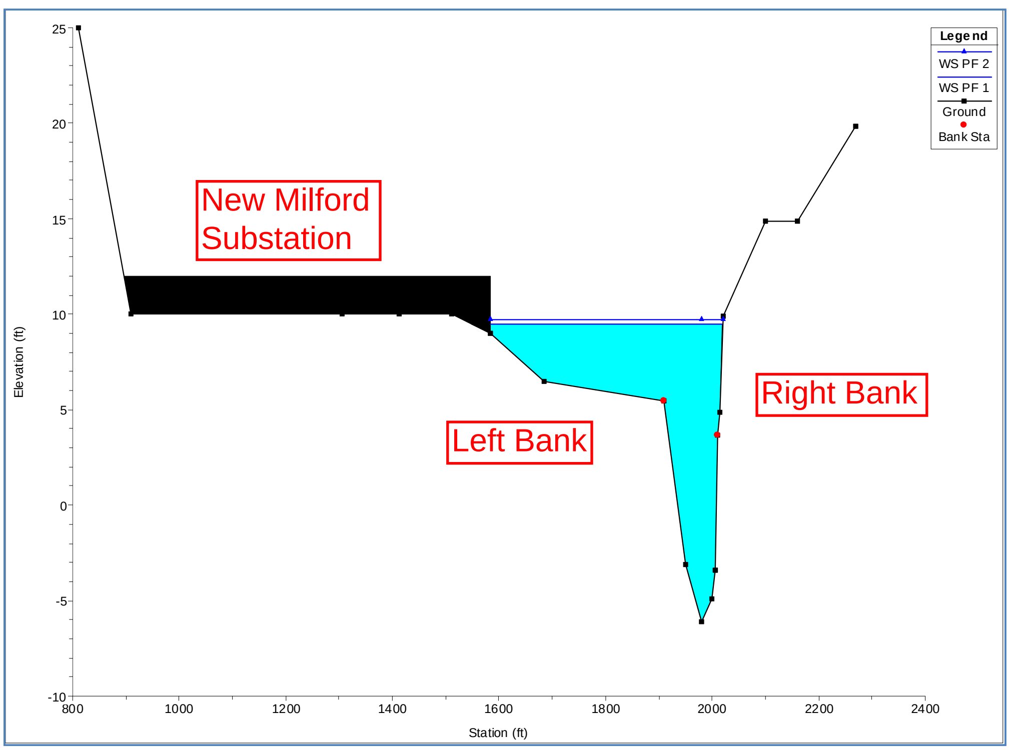


XS 106850 (Modified XS): Proposed Condition – Sheetpile Flood Protection Installed

Figure 5: Cross-sectional view from XS 106850 looking downstream.
PF1 = FEMA 100-yr flow 6,900 cfs; PF2 = NJDEP Flood Hazard flow 8,625 cfs.



XS 106665 (Added XS): Existing conditions



XS 106665 (Added XS): Proposed Condition – Sheetpile Flood Protection Installed

Figure 6: Cross-sectional view from XS 106665 looking downstream.
PF1 = FEMA 100-yr flow 6,900 cfs; PF2 = NJDEP Flood Hazard flow 8,625 cfs.

FLOOD IMPACT STUDY FOR CRANFORD SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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Building a world of difference.

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Table of Contents

1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing significant impact to electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Ewing) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Cranford Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The Cranford Substation is located on South Avenue east of High Street, at the Rahway River. The site is bounded to the north by a high NJ Transit retaining wall; the Rahway River to the east; South Avenue to the south; and an adjacent driveway to the east. On the east side of the site there is a 12" thick concrete retaining wall at the crest of the river bank. PSE&G equipment is 15 feet from the edge of the river bank, and access to the east side of the site is limited. The site is located within the NJDEP Riparian Buffer Zone.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Cranford Substation.

1) NJDEP. HEC-RAS model for the Rahway River from 13 November 2002 (111302Rahway.prj)
2) NJDEP. Delineation of Floodway and Flood Hazard Area: Plans – Township of Cranford, NJ. 8 December 1981.
3) Kennon Surveying Services, Inc (KSS). Boundary and Topographic Survey - Cranford Substation (6 June 2012)
4) Black & Veatch (B&V). 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

NJDEP's HEC-RAS model (document 1) was the basis of the model development. The site survey (document 3) assisted in determining ground elevations at the site and distances to the river, and to append the existing hydrologic cross-sections along the site. The Substation Flood Protection Report (document 4) provided the estimated height for the flood protection measures. The vertical datum for all elevations reported in the HEC-RAS model (document 1) is NGVD 29, while the vertical datum for documents 3 and 4 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevations. All elevations presented in this report are NAVD 88.

Based on recommendations presented in the Substation Flood Protection – Summary Evaluation report (document 4), the flood protection wall at the Cranford Substation will have a top elevation 2 feet above the 100-year flood level. Based on references 1 and 2, the 100-year flood level in the vicinity of the site is 62.8 ft (NAVD 88) near its northeastern edge. The top of the wall was modeled at 65 ft (NAVD 88).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Rahway River in the vicinity of the Cranford Substation. The hydraulic model used for this study was a copy of NJDEP's HEC-RAS floodway model for the entire Rahway River.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. This model is the HEC-RAS model with its saved results as provided by NJDEP. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were copies of NJDEP's HEC-RAS model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is a copy of the NJDEP HEC-RAS model with no modifications, but rerun to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

A profile of the river indicating exact cross-section locations was not provided. Hence, the cross-section locations had to be estimated based on available information within NJDEP's HEC-RAS model. The existing NJDEP model indicates that cross-section 11.916 is just downstream of the Central Railroad Bridge, while cross-section 11.873 is at the upstream face of the South Avenue Bridge. The distance between the railroad bridge and the South Avenue Bridge is approximately 220 feet. These cross-sections are shown in white in Figure 1. Profile views of these cross-sections are presented in Figure 2. As these were the only two cross-sections modeled in this reach, the flow was allowed to expand onto the site from the right bank (west side) of the Central Railroad Bridge to the extent of the downstream cross-section. The extent of the effective flow in this reach of the NJDEP model is shown as a green-line labeled EF_EC_NJDEP (Effective Flow-Existing Conditions-NJDEP) in Figure 1.

In development of the Existing Conditions Model (Model 3), cross-sections were added at the site and modifications were made to the decking of the South Avenue Bridge and it's bounding upstream cross-section. As shown in Figures 3 and 4, the decking at the South Avenue Bridge and the west bank profile at cross-section 11.837 were modified to match 2012 survey information (KSS, 2012). In the NJDEP model, the decking on the west side of South Avenue Bridge was modeled as below the grade of the bounding upstream cross-section (11.837), which is inconsistent with survey data and site inspection. Figure 5 presents the Boundary and Topographic Survey.

Three additional cross-sections transecting the Cranford site were added to the Existing Conditions Model and were also based on the KSS site survey (KSS, 2012). The additional cross-sections are shown in yellow on Figure 1.

Ineffective flow markers were placed in these cross-sections to maintain consistency with the flow expansion ratio as modeled in the NJDEP model. However, the existing building on site should be taken into consideration as it will limit the flow area and the ability of the water to effectively expand to the west upon exiting the railroad bridge. The building was not included as part of the NJDEP model; therefore lower than realistic WSEL result from the NJDEP model. The extent of the effective flow in the Existing Conditions Model is illustrated in Figure 1 by the green line labeled EF-EC_rev1 (Effective Flow – Existing Conditions_revion1). Figures 6 through 8 illustrate the placement of the non-effective flow markers and blocked obstructions (representing the existing building) in each of the added cross-sections.

In Figure 6 – Existing Conditions Model, the ineffective flow area is presented as the green hatched area on the west bank, which is the site of Cranford Substation. Although this area would likely experience flooding under the modeled flow conditions, the flow would have little to no velocity. This area is pooled water, which is typical at the edges of flood plains. This effect is especially prevalent at Cranford, where the railroad viaduct bounds the northern end of the site.

In development of the Proposed Conditions Model (Model), the proposed flood protection was inserted on the west bank in each of the three added cross-sections. At the south end of the Cranford Substation Site, where the sheet piling would end, flows were allowed to expand out to the full width of cross-section 11.837. The extent of the effective flow in the Proposed Conditions Model is illustrated in Figure 1 by the green line labeled EF-PC (Effective Flow – Proposed Conditions).

Expansion and contraction coefficients at cross-sections 11.916, 11.907 and 11.896 were set to 0.1 and 0.3 respectively, as the potential for flow expansion is limited by the sheet pile flood protection wall. The expansion and contraction coefficients at cross-section 11.889, where the sheet pile flood protection wall ends, were set to 0.6 and 0.8 respectively. However, these values have a minor impact on the model results as the South Avenue Bridge is acting as a weir providing downstream control at this reach. The resultant backwater condition reduces velocities hence reducing the influence of any contractions or expansions.

The following flows were considered:

- 6,170 cfs - The Rahway River's FEMA 100-year flood flow in the vicinity of the Cranford Site.
- 7,713 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the Rahway River, 100-year flood flow

During Hurricane Irene, the Cranford Substation was flooded up to an approximate WSEL of 63.5 ft. Based on the HEC-RAS model; this would correspond with a Rahway River flow of approximately 7,500 cfs in the vicinity of the substation, in the range of a 100-year storm flow.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are equivalent to those of the Effective Model. However, the Existing Conditions Model, which includes additional cross-sections in the vicinity of the site and modification to the decking at South Avenue, yielded flood levels that are higher than those in the Duplicate Effective Model. It is our belief that our Existing Conditions Model more accurately describes the potential for flooding upstream of South Avenue Bridge than he NJDEP model. The South Avenue Bridge structure is the controlling cross section for water surface elevations in this area. Table 1 presents the results from the four models considered. River stations in bold indicate the additional cross-section added to the model at the site.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (6,170 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
12.329	66.22	66.22	66.32	66.33	0.01
12.204	66.13	66.13	66.23	66.24	0.01
12.2	66.09	66.09	66.19	66.20	0.01
12.1975	Dam				
12.197	66.01	66.01	66.11	66.12	0.01
12.191	66.01	66.01	66.12	66.13	0.01
12.166	66.03	66.03	66.13	66.14	0.01
12.156	66.06	66.06	66.16	66.17	0.01
12.15	North Union Avenue Bridge				
12.146	65.43	65.43	65.60	65.62	0.02
12.136	65.00	65.00	65.20	65.22	0.02
12.089	65.13	65.13	65.32	65.34	0.02
11.992	64.06	64.06	64.38	64.40	0.02
11.983	64.00	64.00	64.33	64.35	0.02
11.977	North Avenue Bridge				
11.971	62.92	62.92	63.37	63.39	0.02
11.935	62.98	62.98	63.42	63.44	0.02
11.9255	Central Railroad Bridge				
11.916	**62.79**	**62.79**	**63.26**	**63.28**	**0.02**
11.907	**n/a**	**n/a**	**63.28**	**63.30**	**0.02**
11.896	**n/a**	**n/a**	**63.27**	**63.28**	**0.01**
11.889	**n/a**	**n/a**	**63.24**	**63.26**	**0.02**
11.873	**62.72**	**62.72**	**63.27**	**63.27**	**0.00**
11.8675	South Avenue Bridge				
11.862	60.94	60.94	60.94	60.94	0.00
11.775	60.59	60.59	60.59	60.59	0.00
11.642	60.12	60.12	60.12	60.12	0.00
11.548	60.19	60.19	60.19	60.19	0.00
11.541	60.18	60.18	60.18	60.18	0.00
11.5405	Droescher's Dam				
11.54	60.00	60.00	60.00	60.00	0.00
11.537	60.02	60.02	60.02	60.02	0.00
11.518	59.68	59.68	59.68	59.68	0.00

11.463	59.68	59.68	59.68	59.68	0.00
11.455	High Street Bridge				
11.45	58.69	58.69	58.69	58.69	0.00
11.44	56.91	56.91	56.91	56.91	0.00
11.43	57.12	57.12	57.12	57.12	0.00
11.429	56.75	56.75	56.75	56.75	0.00
11.209	54.50	54.50	54.50	54.50	0.00

The Existing Conditions Model yields WSEs that are 0.55 foot higher than the Effective and Duplicate Effective models at South Avenue Bridge. Approximately ½ mile upstream, the difference is only 0.1 foot.

The Proposed Conditions Model includes the flood protection on the west bank of the model. A slight rise in WSEL is noted in the vicinity of the site and upstream due to the flood protection installation. A maximum rise of 0.02 feet is noted at the south end of the flood wall as a result of the flood protection wall.

Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 7,713 cfs. River stations in bold indicate the additional cross-sections added to the model at the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (7,713 cfs)

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
12.329	67.15	67.24	67.25	0.01
12.204	67.02	67.11	67.12	0.01
12.200	66.97	67.07	67.07	0.00
12.1975	Dam			
12.197	66.88	66.98	66.99	0.01
12.191	66.89	66.99	66.99	0.00
12.166	66.91	67	67.01	0.01
12.156	66.96	67.05	67.06	0.01
12.150	North Union Avenue Bridge			
12.146	66.46	66.61	66.62	0.01
12.136	65.98	66.16	66.17	0.01
12.089	66.12	66.29	66.30	0.01
11.992	64.9	65.24	65.26	0.02
11.983	64.81	65.16	65.18	0.02
11.977	North Avenue Bridge			
11.971	63.82	64.27	64.30	0.03
11.935	63.89	64.31	64.34	0.03
11.9255	Central Railroad Bridge			

11.916	**63.6**	**64.08**	**64.10**	**0.02**
11.907	**n/a**	**64.14**	**64.16**	**0.02**
11.896	**n/a**	**64.12**	**64.14**	**0.02**
11.889	**n/a**	**64.09**	**64.12**	**0.03**
11.873	**63.61**	**64.14**	**64.14**	**0.00**
11.8675	South Avenue Bridge			
11.862	61.91	61.91	61.91	0.00
11.775	61.63	61.63	61.63	0.00
11.642	61.18	61.18	61.18	0.00
11.548	61.26	61.26	61.26	0.00
11.541	61.25	61.25	61.25	0.00
11.5405	Droescher's Dam			
11.540	61.12	61.12	61.12	0.00
11.537	61.14	61.14	61.14	0.00
11.518	60.88	60.88	60.88	0.00
11.463	60.91	60.91	60.91	0.00
11.455	High Street Bridge			
11.450	60.15	60.15	60.15	0.00
11.440	57.95	57.95	57.95	0.00
11.430	58.38	58.38	58.38	0.00
11.429	57.39	57.39	57.39	0.00
11.209	55.78	55.78	55.78	0.00

Based on model results, the proposed sheetpile flood wall around the Cranford Substation will only slightly impact water surface elevations in the Rahway River Floodplain under Flood Hazard Flow Conditions. The maximum rise as a result of the sheetpile wall is 0.03 feet under Flood Hazard Flow Conditions. Approximately one-half mile upstream of the site the resulting change in WSE is 0.01 ft.

Black & Veatch modeled the observed flooding condition of approximately EL. 63.5 feet reported by PSE&G during Hurricane Irene. In order to realize an inundation of that depth at the site, a flow of approximately 7,500 cfs would be necessary. According to USGS, their flow gauge, which is located 7,000 feet upstream of the Cranford site, was destroyed during Hurricane Irene. However, the last gauge reading during the storm was about 7,000 cfs.

3.0 Conclusions and Recommendation

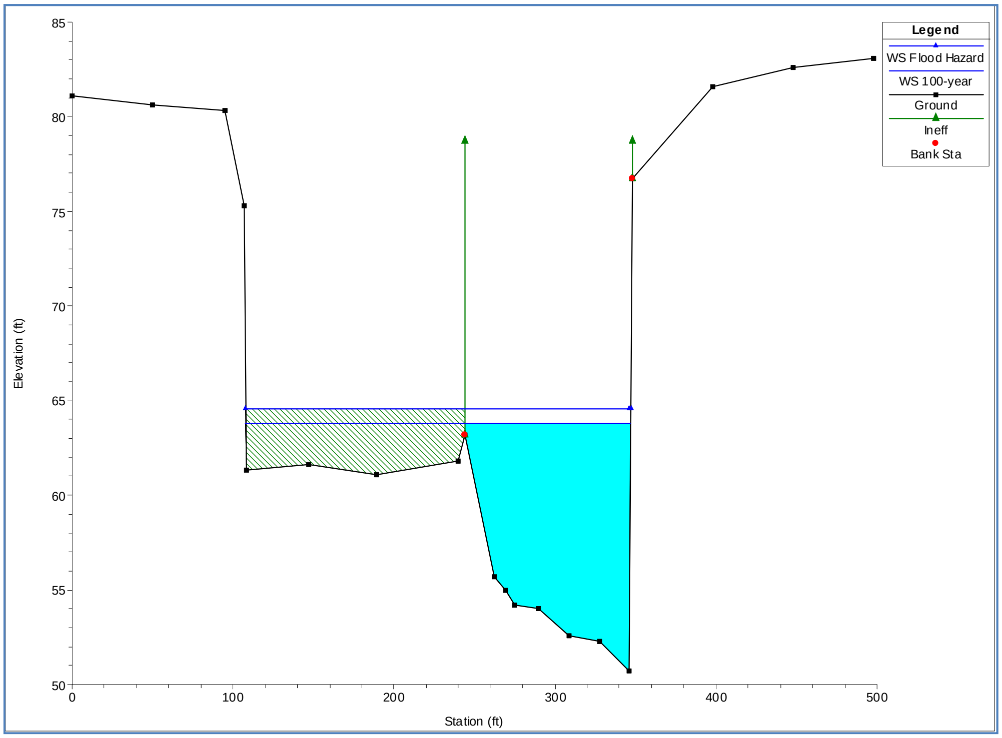
The proposed flood protection facilities will only slightly impact flooding upstream of the Cranford Substation. If PSE&G proceeds with the design and construction of the proposed flood mitigation measures for the Cranford Substation, there should be little to no impact to upstream existing structures. Hydraulically and based on the model results, there are no impacts to downstream structures.

The existing conditions model prepared for this study was based on the NJDEP model but was modified to more accurately describe South Avenue and the South Avenue Bridge based on recent survey data. The updates resulted in a rise in predicted flood levels. For the 100-year flood, an increase of 0.55 foot upstream of South Avenue (63.27 feet NAVD 88) was predicted. This fact will be addressed during the permitting process and will require approval of the NJDEP and FEMA.

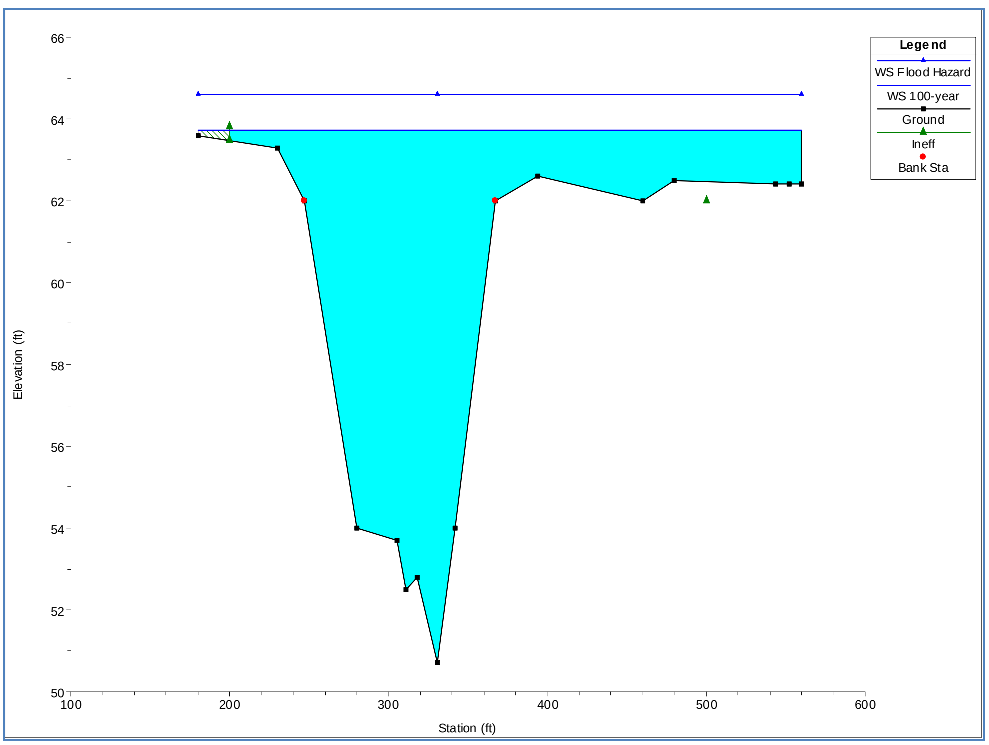
The flow and inundation from Hurricane Irene were greater than the required FEMA 100-year, and nearly equivalent to the NJDEP Flood Hazard flows. An Elevation of 65.2 feet, which is approximately 1 foot above the Black & Veatch estimated Flood Hazard Elevation, was selected as the top of wall design level.

ELEVATION SUMMARY (FEET NAVD 88)				
Site	Minimum Site EL.	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL.	Proposed Flood Protection EL.
Cranford	60.5	63.5	64.2	65.2

[redacted]

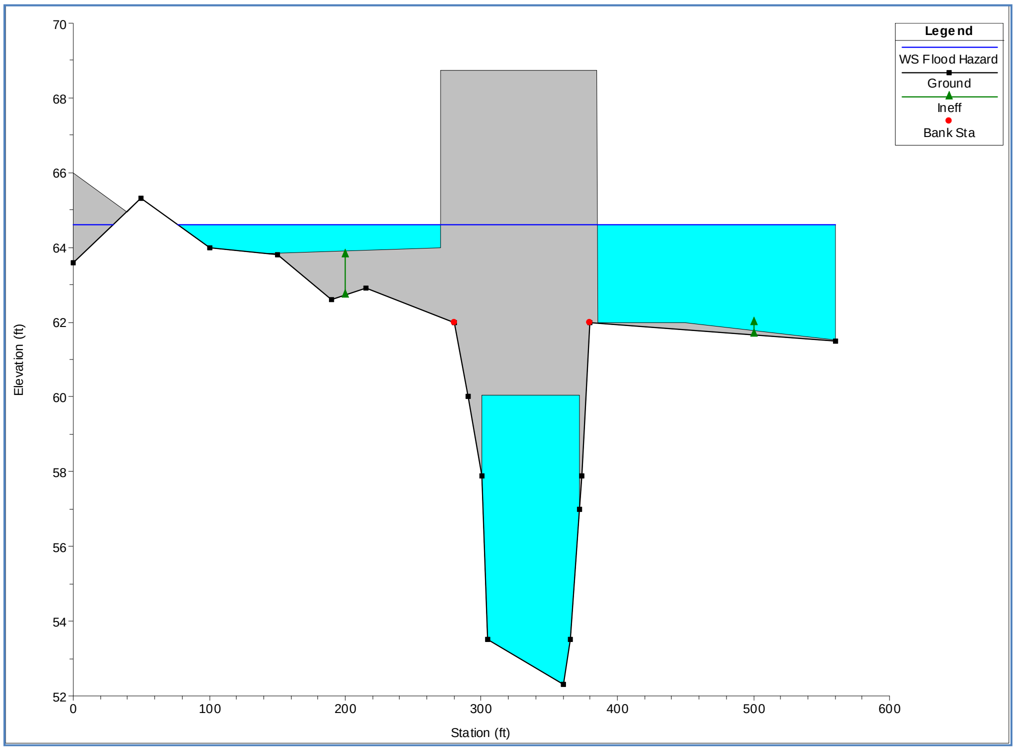


NJDEP XS 11.916 – Railroad Bridge

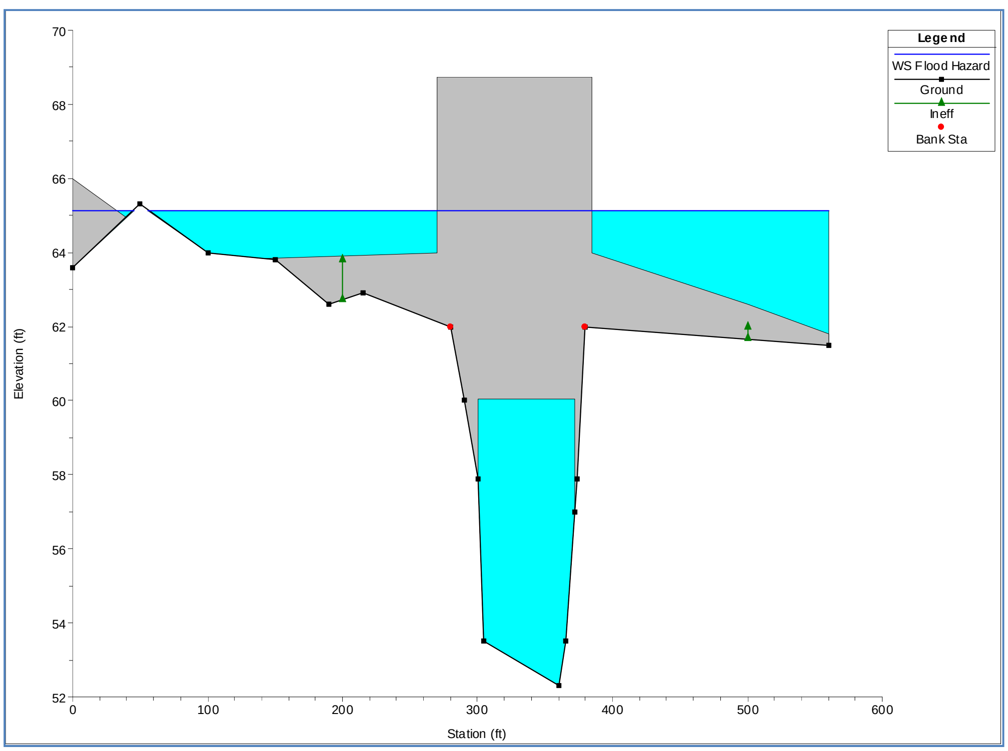


NJDEP XS 11.873 – South End of Site before South Ave, Bridge.

Figure 2: Cross-sectional views (looking downstream) of cross-sections 11.916 and 11.873 as modeled in NJDEP Hec-Ras Model. PF1 = FEMA 100-yr flow 6,170 cfs; PF2 = NJDEP Flood Hazard flow 7,713 cfs.

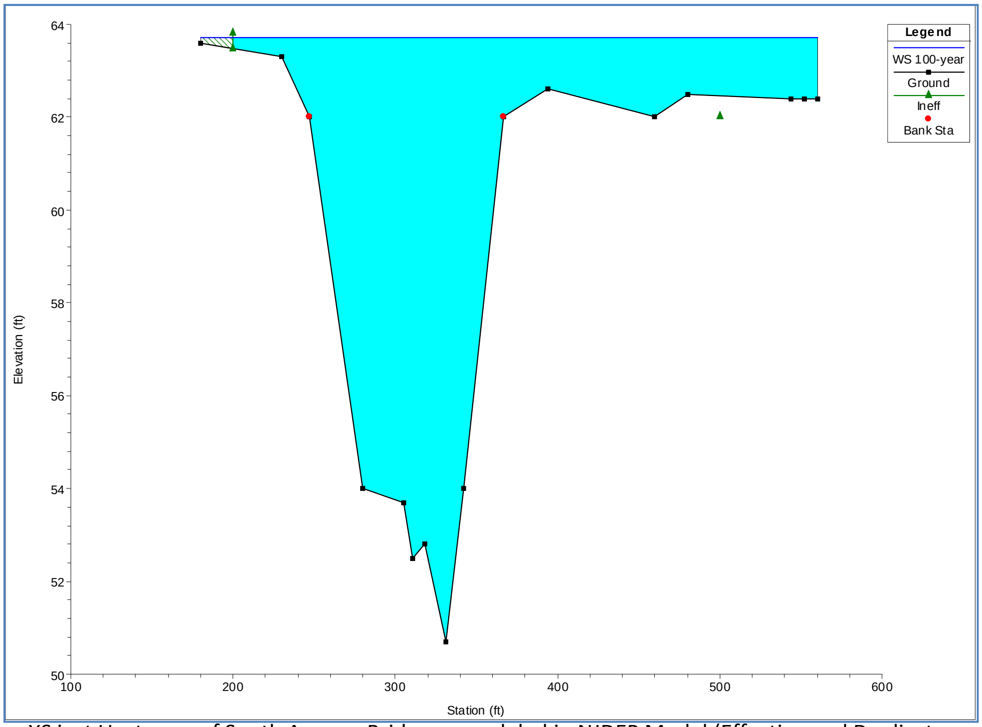


South Avenue Bridge as modeled in Effective and Duplicate Effective Models

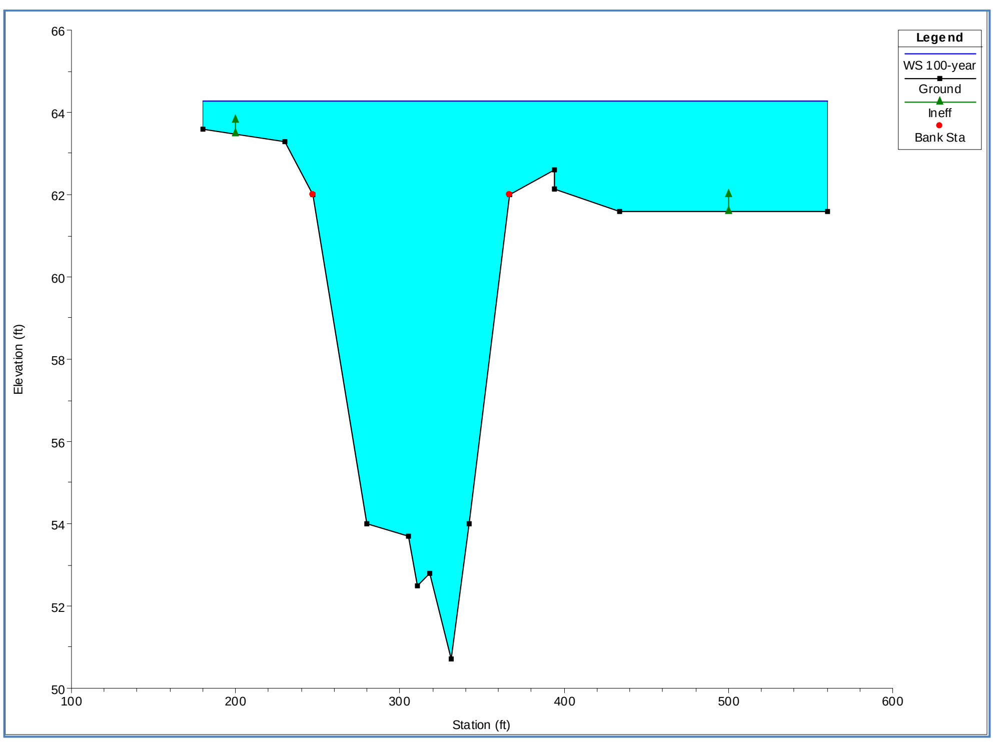


South Avenue Bridge as modeled in Existing Conditions and Proposed Conditions Models

Figure 3: Cross-sectional views (looking downstream) of South Avenue Bridge as modeled in NJDEP HEC-RAS Model and as modified based on 2012 survey data in Existing Conditions and Proposed Conditions Models. PF1 = FEMA 100-yr flow 6,170 cfs; PF2 = NJDEP Flood Hazard flow 7,713 cfs.



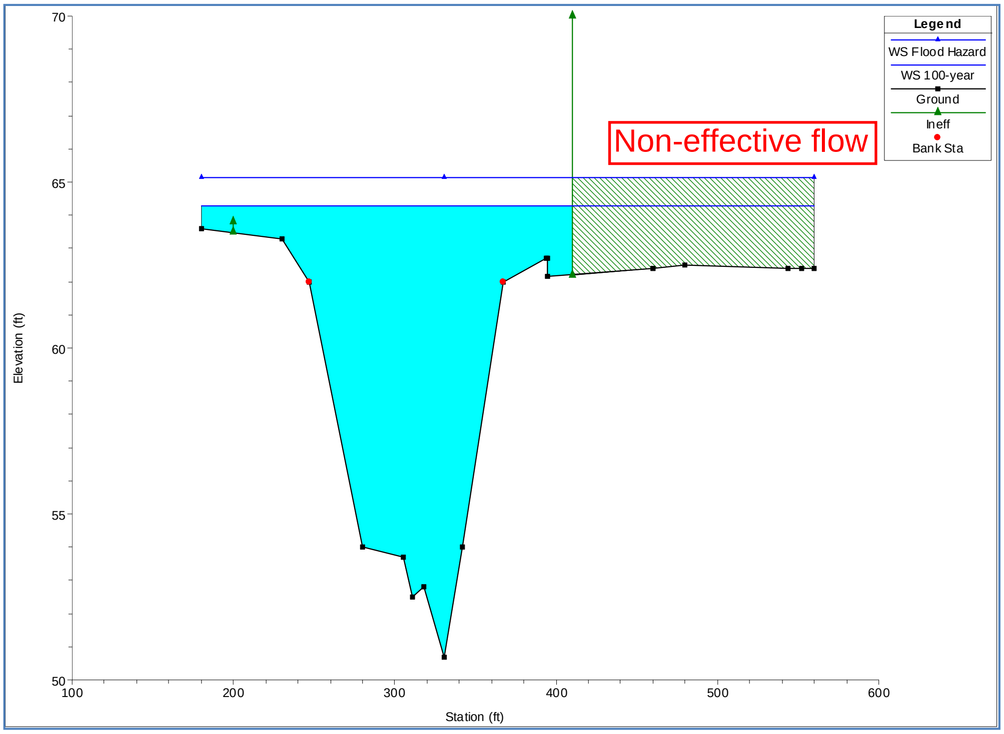
XS just Upstream of South Avenue Bridge as modeled in NJDEP Model (Effective and Duplicate Effective Models)



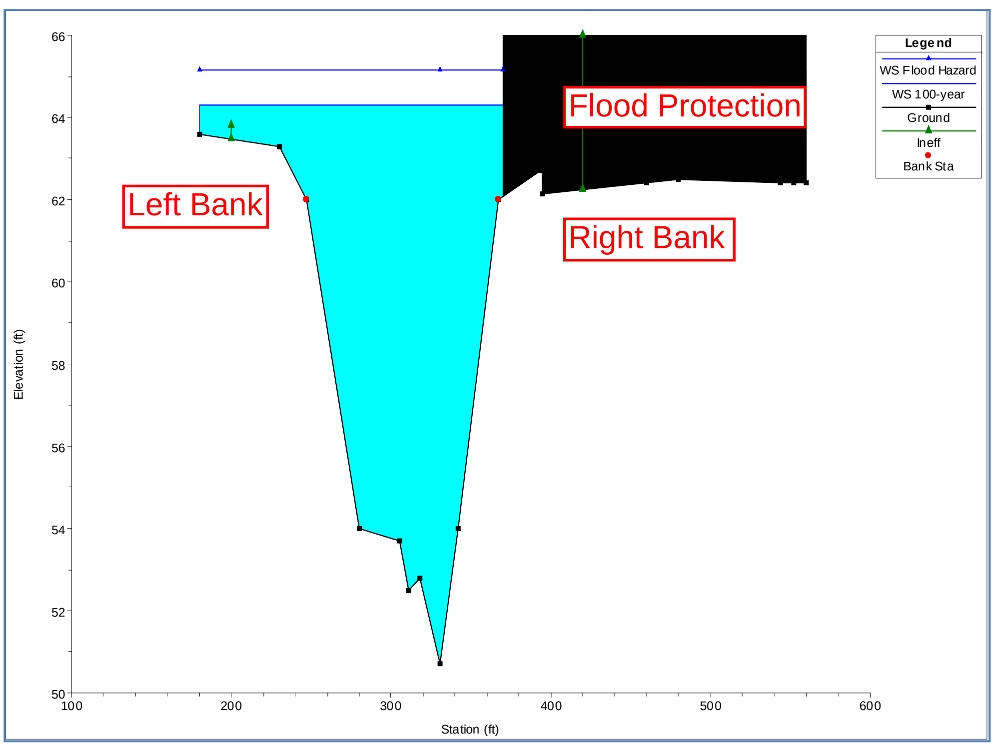
XS just Upstream of South Avenue Bridge as modeled in Existing Conditions and Proposed Conditions Models

Figure 4: Cross-sectional views (looking downstream) of cross-section just upstream of South Avenue Bridge as modeled in NJDEP HEC-RAS Model and as modified based on 2012 survey data in Existing Conditions and Proposed Conditions Models. PF1 = FEMA 100-yr flow 6,170 cfs; PF2 = NJDEP Flood Hazard flow 7,713 cfs.

[redacted]

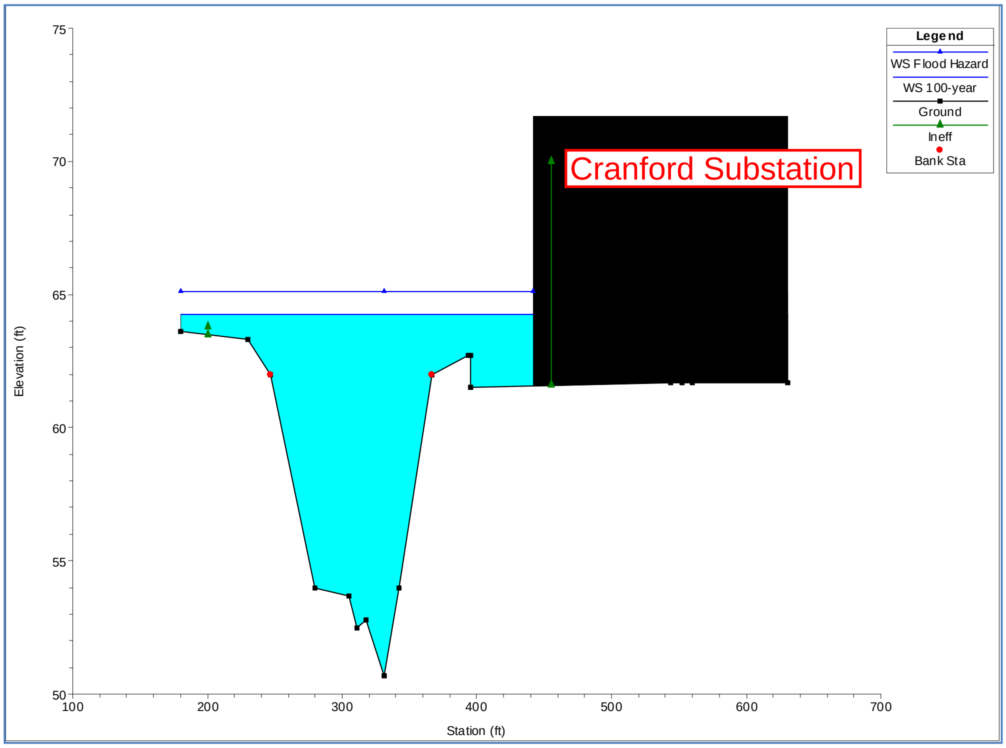


North End of Site (XS 11.907): Existing conditions.

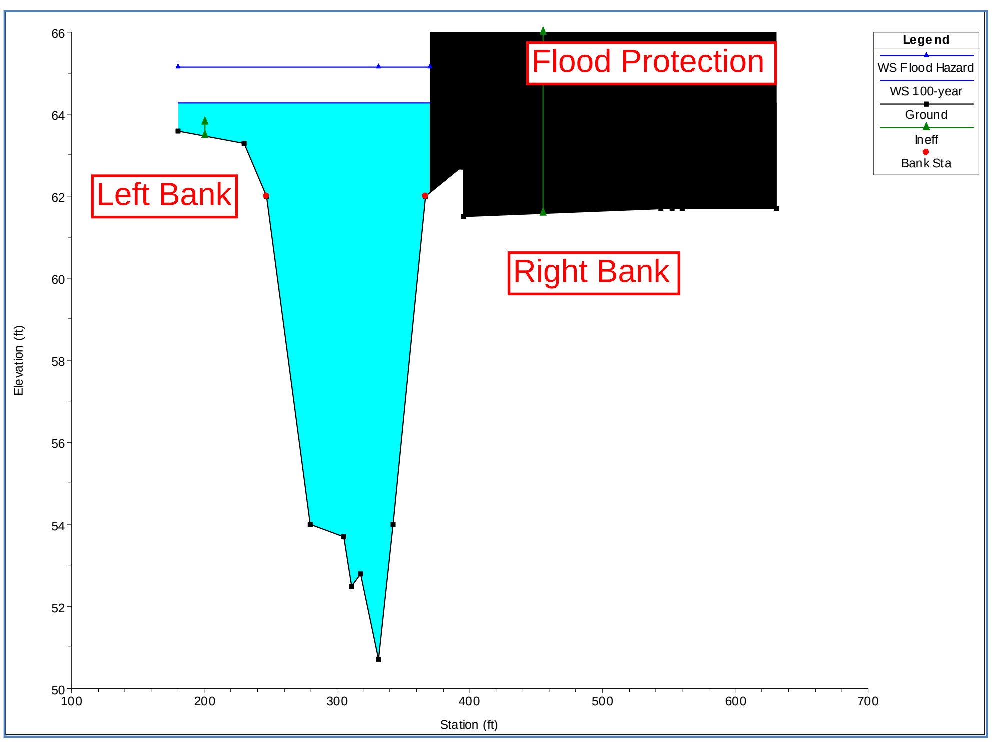


North End of Site (XS 11.907): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 6: Cross-sectional view from Upstream End of Site looking downstream.
PF1 = FEMA 100-yr flow 6,170 cfs; PF2 = NJDEP Flood Hazard flow 7,713 cfs.

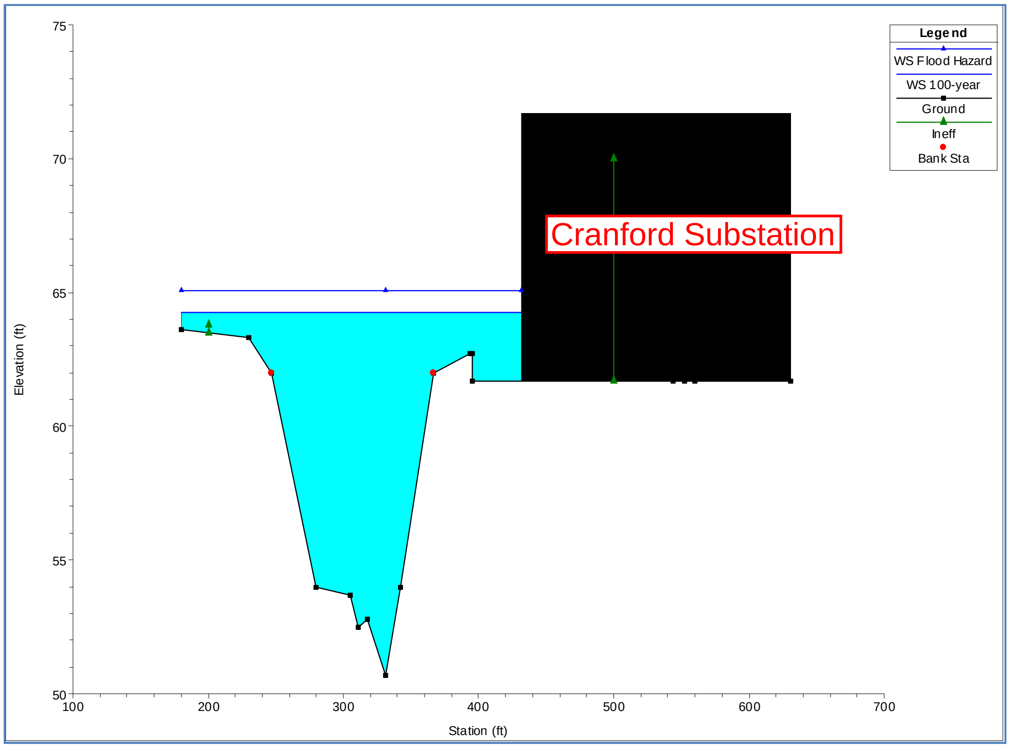


Middle of Site (XS 11.896): Existing conditions.

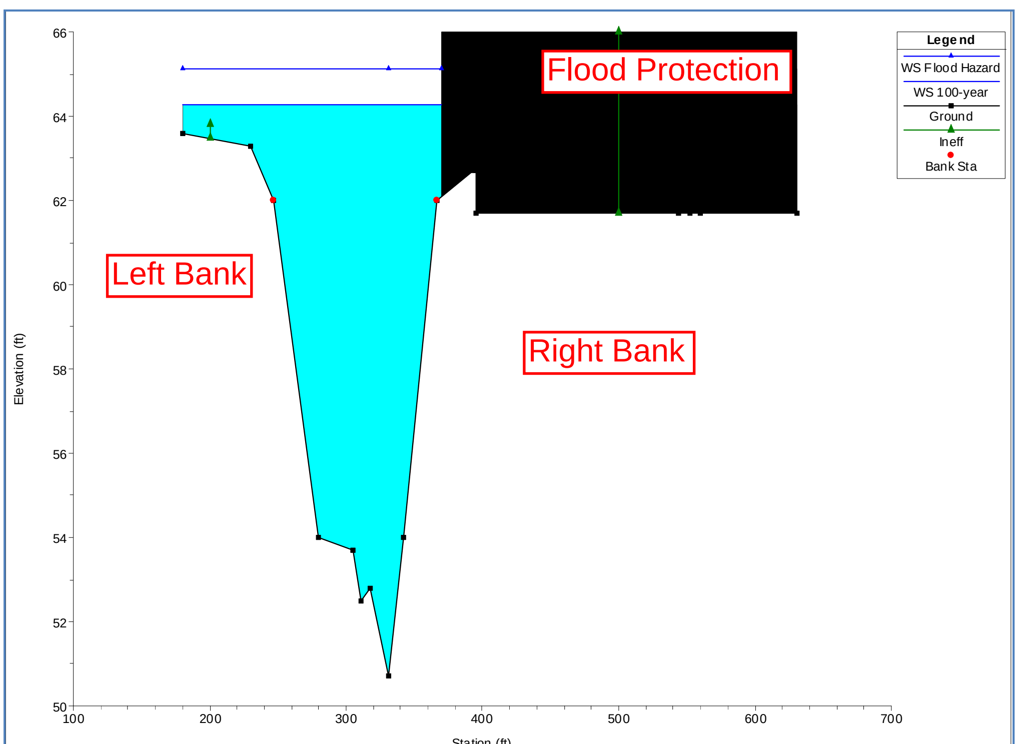


Middle of Site (XS 11.896): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 7: Cross-sectional view from XS 11.896 looking downstream.
PF1 = FEMA 100-yr flow 6,170 cfs; PF2 = NJDEP Flood Hazard flow 7,713 cfs.



South End of Site (XS 11.889): Existing conditions.



South End of Site (XS 11.889): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 8: Cross-sectional view from XS 11.889 looking downstream.
PF1 = FEMA 100-yr flow 6,170 cfs; PF2 = NJDEP Flood Hazard flow 7,713 cfs.

FLOOD IMPACT STUDY FOR HILLSDALE SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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Table of Contents

1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing significant impact to electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Bayway) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Hillsdale Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The Hillsdale Substation is located at Knickerbocker Avenue, west of Paterson Street, and encompasses approximately 2.5 acres. Primary gated access is off of Knickerbocker Avenue, and secondary gated access is off of Paterson Street. The north and east sides are heavily wooded, and businesses are located on the other sides of the site. The substation is located less than 200 feet from the Pascack Brook.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Hillsdale Substation.

1) NJDEP. HEC-RAS printout for the Pascack Brook from 6 September 2000 (PASCACK_BR_DEWBERRY.PDF)
2) NJDEP. Delineation of Floodway and Flood Hazard Area: Plans – Borough of Hillsdale, NJ. June 1978, Plate 14.
3) Dresdner Robin Hanson Engineering Division, Boundary and Topographic Survey - Hillsdale Substation, Block 1212, Lot 14 Borough of Hillsdale, NJ. (17 April 2012)
4) Black & Veatch (B&V). 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.
5) New Jersey Post-Hurricane Floyd Flood Study Hydrologic Analyses of Musquapsink and Pascack Brooks, FEMA June 2002 (PASCACK_MUSQUAPSINK_NEWER_HYDROLOGY.PDF)

NJDEP's HEC-RAS printout (document 1) was the basis of the model development. The NJDEP Delineation of Floodway and Flood Hazard Area (document 2) assisted in the appropriate placement of modeled cross-sections relative to the Hillsdale Substation Site. The site survey (document 3) assisted in determining ground elevations at the site, distances to the river, and appropriate modifications to the existing hydraulic cross-sections along the site. The New Jersey Post-Hurricane Floyd Flood Study (document 5) provided updated flows for the model.

The estimated height for the flood protection measures was initially based on information provided in the Substation Flood Protection Report (document 4). However, after modeling results were obtained, it was decided that the height for the flood protection measures should be increased due to the updated flows (document 5).

The vertical datum for all elevations reported in the HEC-RAS model (document 1) is NGVD 29, while the vertical datum for documents 3 and 4 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevations. All elevations presented in this report unless otherwise noted are NAVD 88, (i.e. cross section profile views which were taken directly from the HEC-RAS model are in NGVD 29. (See Figures 2-6).

Based on updated flows and model results, the top of the flood protection wall at the Hillsdale Substation was initially set at 2 feet above the updated NJDEP's Flood Hazard level. Based on model results for Flood Hazard flow, which is equal to 125% of the 100-year flow, the corresponding flood level in the vicinity of the site is 63.8 ft (NAVD 88) near its northern edge. This would have made the top elevation of the wall at elevation 66 ft. However, during Hurricane Irene the maximum observed flood elevation was 66 ft. A one foot of freeboard has been added to this observed level for a top of wall elevation at 67 ft. (NAVD 88).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Pascack Brook in the vicinity of the Hillsdale Substation. The hydraulic model used for this study was a portion of NJDEP's HEC-RAS model in printout form of the Pascack Brook. The model started approximately 0.5 miles downstream from the site and continued upstream to the downstream end of the energy dissipater and stilling basin for Woodcliff Lake Dam.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. This model is the printout of results from the HEC-RAS model as provided by NJDEP. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were constructed models using NJDEP's HEC-RAS print out model as the basis, (document 1). These models are: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is an entered version of the printout of the NJDEP HEC-RAS model with no modifications, but rerun to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections. In addition the flows have been increased due to the study results by FEMA (document 5)
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along Pascack Brook will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

A profile of the river indicating exact cross-section locations was not provided. Hence, the cross-section locations had to be estimated based on available information within NJDEP's HEC-RAS model. The cross-sections in the model are labeled by stationing of the stream. The provided Delineation of Floodway and Flood Hazard Area map also had the stream stationing located on the map. The two downstream bridges, Hillsdale Avenue and Patterson Street, have stationing in the model that agrees with the stationing shown on the map. Therefore, it was possible to place the cross-section locations by their river stationing name in accordance with the stationing on the Delineation of Floodway and Flood Hazard map. The cross-sections used in the model are shown in Figure 1. The white cross-sections are representative of where the existing NJDEP cross-sections are located.

In development of the Existing Conditions Model (Model 3), three cross-sections were added at the site, (28792, 28706, and 28575) and two existing cross-sections (28830, 28620) were modified. The additional cross-sections and extensions to existing cross sections are shown in yellow on Figure 1. Profile views of these cross-sections are presented in Figures 2 - 6.

Figures 2a and 2b show cross-section 28830 located just north of the upstream end of the site. The figures illustrate the Effective and Duplicate Effective cross-section along with the Existing and Proposed Conditions cross-section. For the Existing and Proposed Conditions, cross-section 28830 was modified to match 2012 survey information (document 3, 2012). Cross-section 28830 in the NJDEP Effective Model had a left bank floodplain elevation of 59 ft. This was raised up to match the 2012 survey to an elevation of 60 ft. The cross-section was also extended to the east to cover the full length of the site. Survey information indicates that there is a contour at elevation 63 ft along the north edge of the site, thus WSEs would need to exceed 63 feet in order to flow onto the site from the north. There is also a partial berm running east to west on the northern half of the site with a top elevation of 63 ft. Any water east of this berm would be ineffective unless WSEs exceed 63 feet. Therefore, an ineffective flow marker was placed on cross-section 28830 to prevent effective flow from utilizing the eastern portion of the cross-section for levels less than 63 feet.

Figure 5a illustrates the modification to cross-section 28620 between the Effective and Duplicate Effective model and the Existing Conditions model, which contains blocked obstructions to represent buildings and other site features which will impede flows. Figure 5b shows the Proposed Conditions cross-section. Again, all cross-section modifications were taken from the 2012 survey (document 3, 2012).

The last cross-section at the southern edge of the plant site starts at 62 ft then gradually slopes up to 63 ft before increasing grade at a faster rate as indicated in the survey. Figure 6 shows the last cross-section at the southern edge of the site, cross-section 28575. The southern edge of the site has a curb with a top elevation of approximately 63 ft. Therefore an ineffective flow marker was placed on cross-section 28575 at the western edge of that curb to prevent flow east of the curb until the curb is overtopped.

In development of the Proposed Conditions Model (Model 4), the proposed flood protection was inserted on the east bank in each of the three added cross-sections and one of the existing cross-sections. Any buildings that were illustrated on the existing conditions model are now shown as a flood protection wall or an ineffective area in the Proposed Conditions Model. Cross-section 28830, at the northern edge of the plant site, is believed to be located just north of the drainage ditch on the north end of the plant. Therefore, this cross-section does not show the proposed flood protection.

The following flows were considered:

For the Duplicate Effective Model

- 2,745 cfs - The Pascack Brook NJDEP model 100-year flood flow in the vicinity of the Hillsdale Substation Site.
- 3,431 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the Pascack Brook 100-year flood flow.

For the Existing Conditions and Proposed Conditions Models

- 3,647 cfs - The Pascack Brook updated NJDEP model 100-year flood flow in the vicinity of the Hillsdale Substation Site. (document 5)
- 4,556 cfs – Updated NJDEP Flood Hazard Limit Criterion = 125% of the Pascack Brook 100-year flood flow. (document 5)

During Hurricane Irene, an observation was made at the Hillsdale Substation that placed the maximum observed water surface elevation at approximately 66.0 ft. According to the USGS website for gage station USGS 01377500 Pascack Brook at Westwood NJ, the peak flow at the gauging station was 4,630 cfs. The flow at the Hillsdale Substation would be less than at the gauging station. However, flows in excess of this amount would be required to obtain a modeled water surface at the site equal to 66 ft. Therefore, it is believed that substantial debris was in the channel and blockage of bridge structures may have caused the water surface to rise to the observed elevation. There is not enough information to accurately model the hurricane flow and elevation at the site. However, because an elevation of approximately 66 ft was observed during this time, it is advisable to design the flood protection for the observed Hurricane Irene level plus one foot of freeboard.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are equivalent to those of the Effective Model. However, the Existing Conditions Model, which includes additional cross-sections in the vicinity of the site, modification to two existing cross-sections, and updated increased flows, yielded flood levels that are higher than those in the Duplicate Effective Model. It is our belief that our Existing Conditions Model more accurately describes the potential for flooding upstream of the Hillsdale Substation than the NJDEP model. Table 1 presents the results from the four models considered. River stations in bold indicate the additional cross-section added to the model at the site.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels

(Duplicate Effective Flow 2,745 cfs and Existing and Proposed Conditions Flow 3,647 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
30500	65.60	65.60	66.22	66.22	0
30490	65.55	65.55	66.16	66.16	0
30448	65.46	65.46	66.01	66.01	0
30030	64.93	64.93	65.48	65.48	0
29555	63.09	63.09	64.07	64.07	0
***28830**	**61.88**	**61.88**	**62.93**	**62.93**	**0**
28792	**n/a**	**n/a**	**62.76**	**62.76**	**0**
28706	**n/a**	**n/a**	**62.63**	**62.63**	**0**
***28620**	**61.70**	**61.70**	**62.66**	**62.67**	**0.01**
28575	**n/a**	**n/a**	**62.63**	**62.63**	**0**
28290	61.12	61.12	62.18	62.18	0
28030	60.69	60.69	61.80	61.80	0
27715	60.37	60.37	61.46	61.46	0
27145	59.98	59.98	61.06	61.06	0
26615	59.24	59.24	60.25	60.25	0
26595	59.25	59.24	60.25	60.25	0
26575	Hillsdale Avenue Bridge				
26555	59.18	59.18	60.23	60.23	0
26495	58.97	58.96	59.99	59.99	0
26150	58.86	58.86	59.90	59.90	0
25765	58.57	58.57	59.60	59.60	0
*Modifications made to this cross-section in the Existing Conditions Model					

The Existing Conditions Model yields WSEs that are in the range of 1 ft higher than the Effective and Duplicate Effective Models, with the maximum increase being 1.11 ft. higher at cross-section 28030, which is approximately 500 ft downstream from the Hillsdale Substation. This increase is largely due to the increase in flows taken from the FEMA study (document 5) but also partially due to updated survey information used at the Hillsdale Substation site.

The Proposed Conditions Model includes the flood protection on the east bank of the model. As discussed above, the updated topography in the Existing Conditions model places the flood protection wall almost entirely outside of the effective 100-year floodplain. As a result there is only a 0.01 ft rise at cross section 28620 for the 100-year flood WSEs due to the proposed flood protection wall.

Modeling results indicate that the 100-year flood does not reach elevations in excess of 63 ft and under existing conditions; the site should be safe from flooding during a 100-year event, since the most recent survey puts the general site elevation at 63 ft. This finding contradicts what is shown on the FEMA map. The intent of this project is to use the updated 2012 survey data to supplement and refine the model development. The proposed flood protection wall has no impact on upstream water surface elevations for events less than or equal to the 100-year flood.

However, under existing conditions the Flood Hazard flow water surface elevation will overtop the 63 ft contour and flow across the site unless flood protection measures are taken. In this case, the eastern portion of cross-section 28830 will effectively convey flow and the entire site will experience flooding.

Table 2 presents the results for the NJDEP Flood Hazard Criteria with the Duplicate Effective flow of 3,341 cfs and the updated increased flow of 4,556 cfs for the Existing and Proposed Conditions Models. River stations in bold indicate the additional cross-sections added to the model at the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows

(Duplicate Effective Flow 3,431 cfs and Existing and Proposed Conditions Flow 4,556 cfs)

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
30500	66.08	66.78	66.81	0.03
30490	66.02	66.71	66.74	0.03
30448	65.88	66.51	66.54	0.03
30030	65.34	65.98	66.03	0.05
29555	63.67	64.52	64.79	0.27
28830	**62.61**	**63.92**	**63.84**	**-0.08**
28792	**n/a**	**63.64**	**63.66**	**0.02**
28706	**n/a**	**63.54**	**63.54**	**0**
28620	**62.44**	**63.58**	**63.59**	**0.01**
28575	**n/a**	**63.55**	**63.55**	**0**
28290	61.94	63.14	63.14	0
28030	61.55	62.80	62.80	0
27715	61.21	62.44	62.44	0
27145	60.82	62.04	62.04	0
26615	60.02	61.19	61.19	0
26595	60.02	61.19	61.19	0
26575	Hillsdale Avenue Bridge			
26555	59.99	61.16	61.16	0
26495	59.75	60.91	60.91	0

26150	59.66	60.84	60.84	0
25765	59.36	60.53	60.53	0

Based on model results, the proposed sheetpile flood wall around the Hillsdale Substation will have a maximum impact of a 0.27 ft rise on the water surface elevation in the Pascack Brook Floodplain under Flood Hazard Flow Conditions. This occurs approximately 750 ft upstream from the site at cross-section 29555. The next cross-section 500 ft further upstream shows an increase of only 0.05 ft. An increase of 0.03 ft continues upstream until it reaches the Woodcliff Lake Dam spillway.

The average difference in WSE, for the Flood Hazard flow, between the Duplicate Effective model and the updated Existing Conditions model is approximately 1.2 ft with a maximum of 1.31 ft occurring at the northern edge of the substation site. To reiterate, this rise is primarily due to updated flows but is partially due to updated existing conditions per the 2012 site survey.

3.0 Conclusions and Recommendations

The proposed flood protection facilities will have a maximum impact of 0.27 ft on the updated Existing Conditions occurring approximately 750 ft upstream from the Hillsdale Substation. This increase occurs for the Flood Hazard flow condition. There is only a 0.01 ft rise from the sheetpile floodwall protection for the 100-year event. If PSE&G proceeds with the design and construction of the proposed flood mitigation measures for the Hillsdale Substation, there should be minimal impact to upstream existing structures. Hydraulically and based on the model results, there are no impacts to downstream structures.

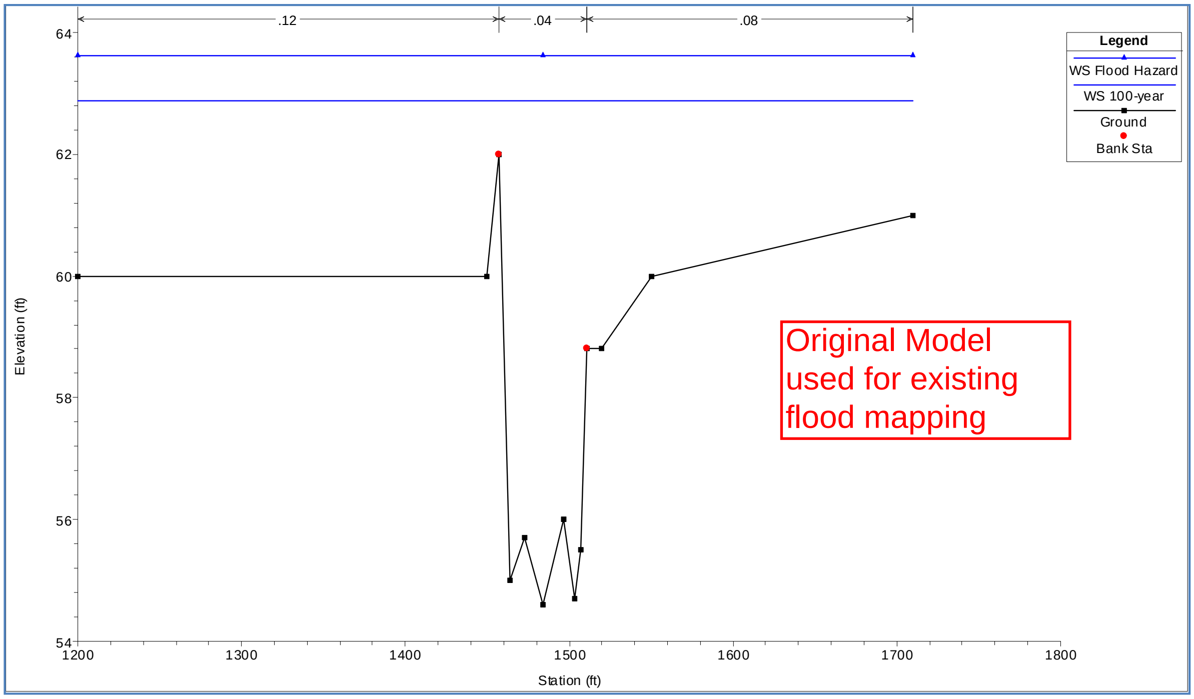
The existing conditions model prepared for this study was based on the NJDEP model but was modified to more accurately describe the Hillsdale Substation site based on recent survey data and an updated flow study by FEMA (document 5). The updates to the Existing Conditions model increased water surface elevations above levels from the Duplicate Effective model by a maximum of 1.11 ft for the 100-year event, and 1.31 ft for the Flood Hazard flow. These updates to flows and topography will be addressed during the permitting process and will require approval of the NJDEP and FEMA.

The inundation from Hurricane Irene was greater than the required FEMA 100-year, and the NJDEP Flood Hazard elevations. The site has an approximate elevation of 63 ft. The estimated Flood Hazard elevation in the vicinity of the site is 63.8 ft. However an elevation of approximately 66.0 feet was observed at the site during Hurricane Irene. Hurricane Irene produced a higher water surface elevation than the Flood Hazard model; therefore the Hurricane Irene event is even more conservative than the Flood Hazard event. A one foot of freeboard was applied to the maximum observed flood level occurring during Hurricane Irene for the design of the top of the flood protection wall. This places the top of wall elevation at 67 ft (NAVD 88).

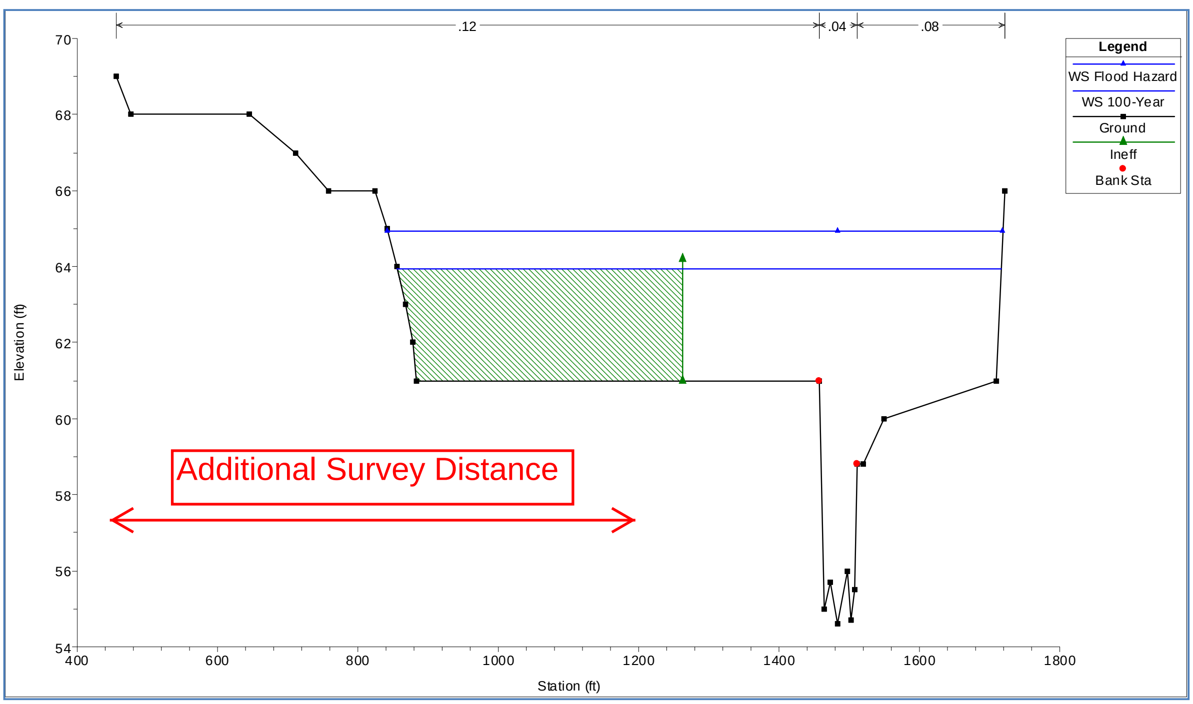
ELEVATION SUMMARY (FEET NAVD 88)				
Site	Minimum Site EL.	Maximum Observed Flood EL. (PSE&G)	NJDEP Updated Flood Hazard EL.	Proposed Flood Protection EL.
Hillsdale	63	66.0	63.8	67.0

The site survey prepared by Dresdner Robin indicates FEMA 100-year and NJDEP Flood Hazard limits that are not in agreement with our analyses. The survey plot references Document 2 listed above, but there is a discrepancy in the resulting values. Black & veatch will contact Dresdner Robin to clarify the issue.

[redacted]

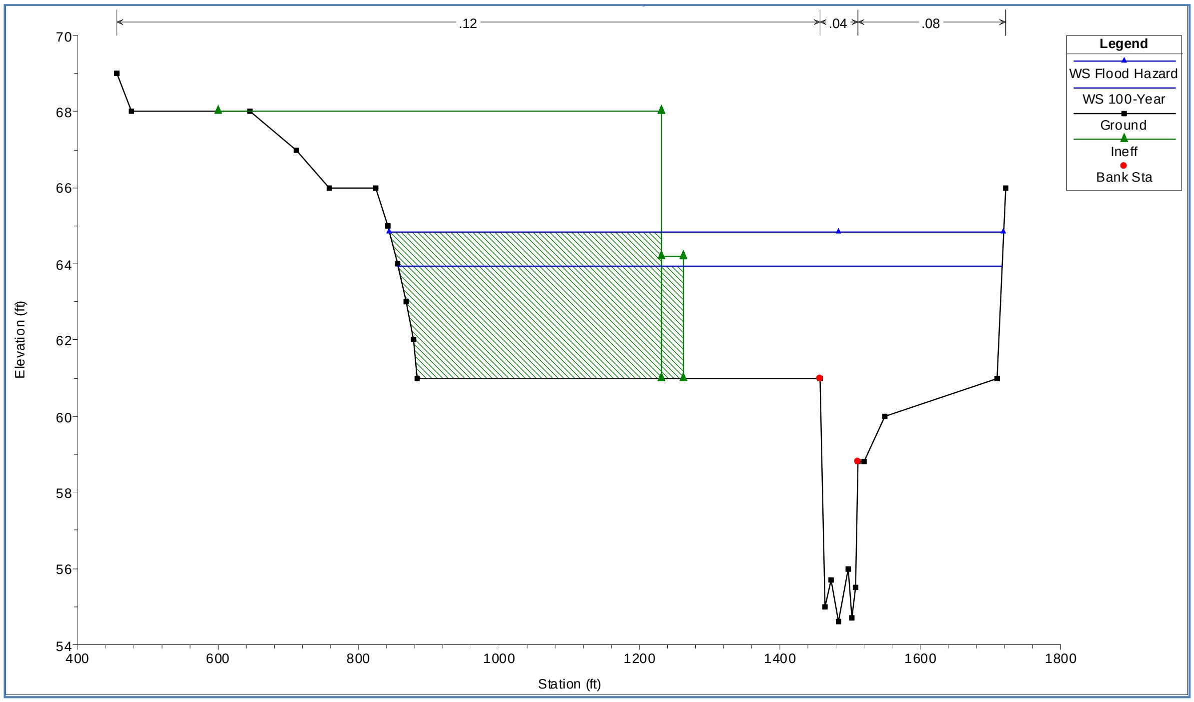


NJDEP XS 28830 – Upstream of northern edge of Hillsdale Substation as modeled in Effective and Duplicate Effective Models. Elevations are in NGVD 29.



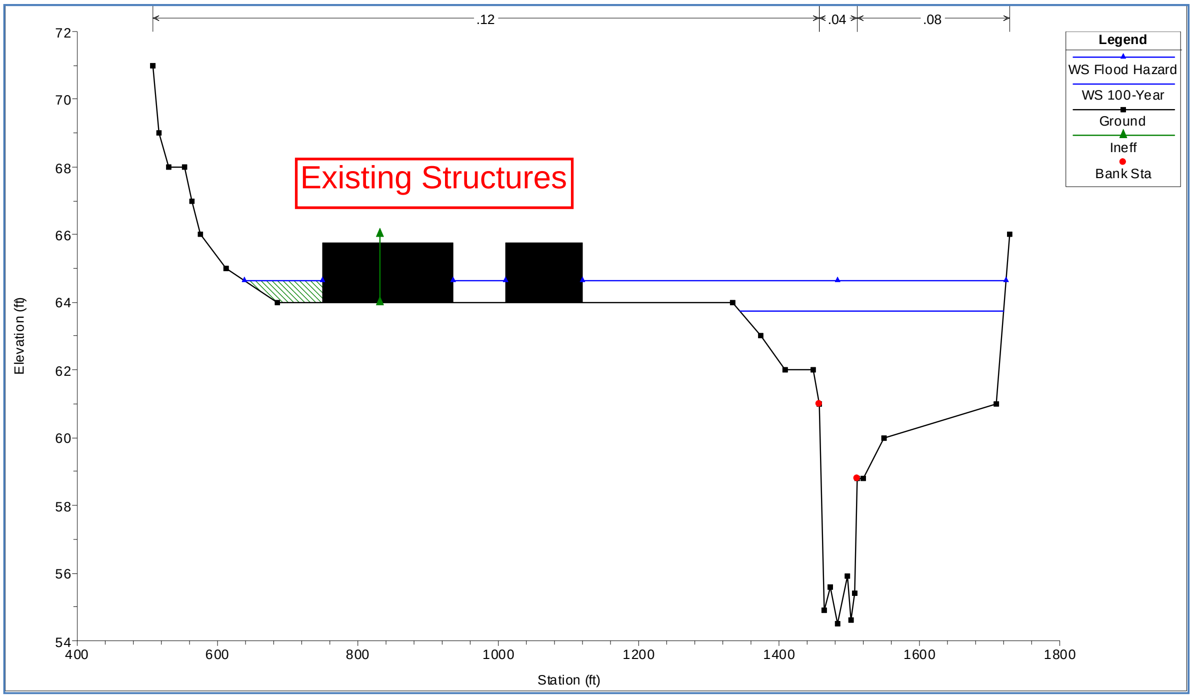
NJDEP XS 28830 – Upstream of northern edge of Hillsdale Substation as modeled in Existing Conditions Model. Elevations are in NGVD 29.

Figure 2a: Cross-sectional views (looking downstream) of cross-section 28830 as modeled in NJDEP Effective and Duplicate Effective Models and updated Existing Conditions Model.
PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.

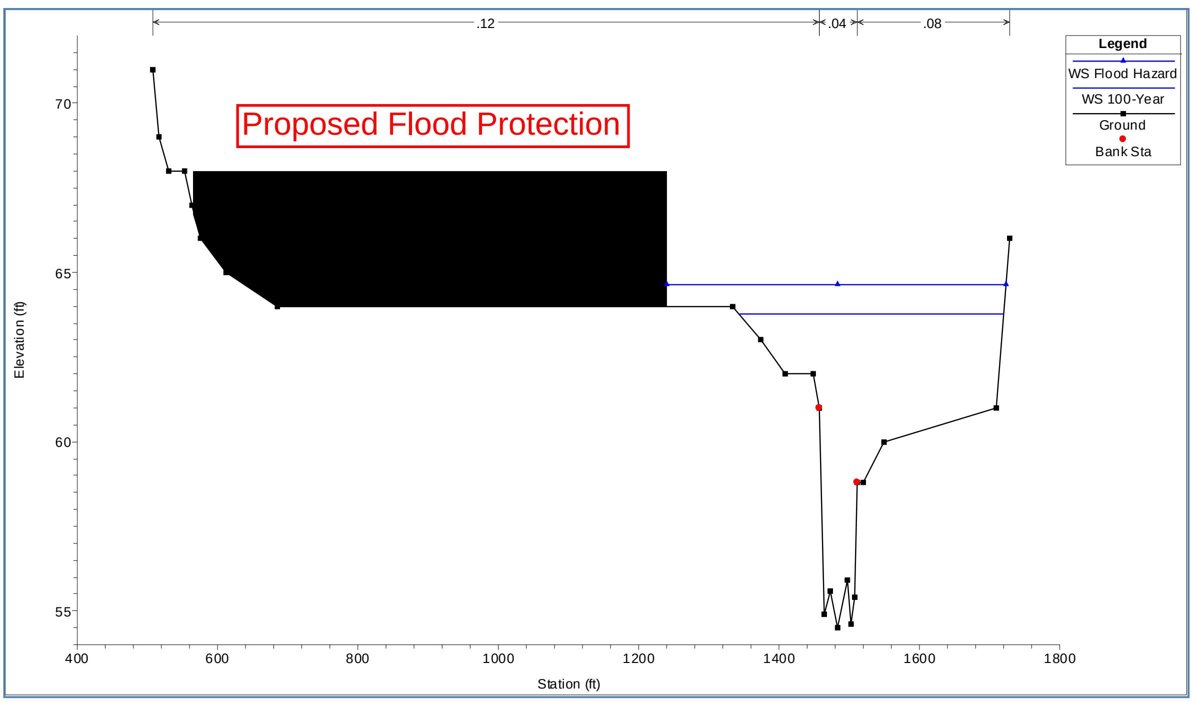


NJDEP XS 28830 – Upstream of northern edge of Hillsdale Substation as modeled in Proposed Conditions Model. Elevations are in NGVD 29.

Figure 2b: Cross-sectional view (looking downstream) of cross-section 28830
as modeled in Proposed Conditions Model.
PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.

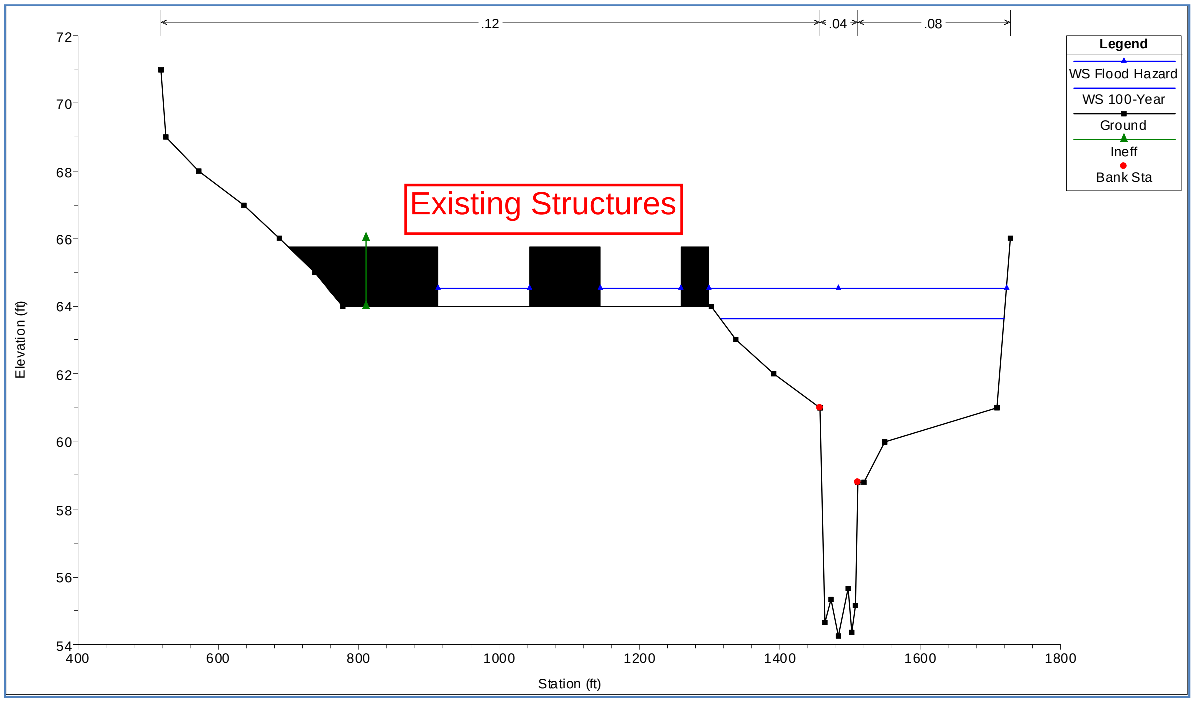


Added XS 28792 – North end of Hillsdale Substation as modeled in Existing Conditions Model.
Elevations are in NGVD 29.

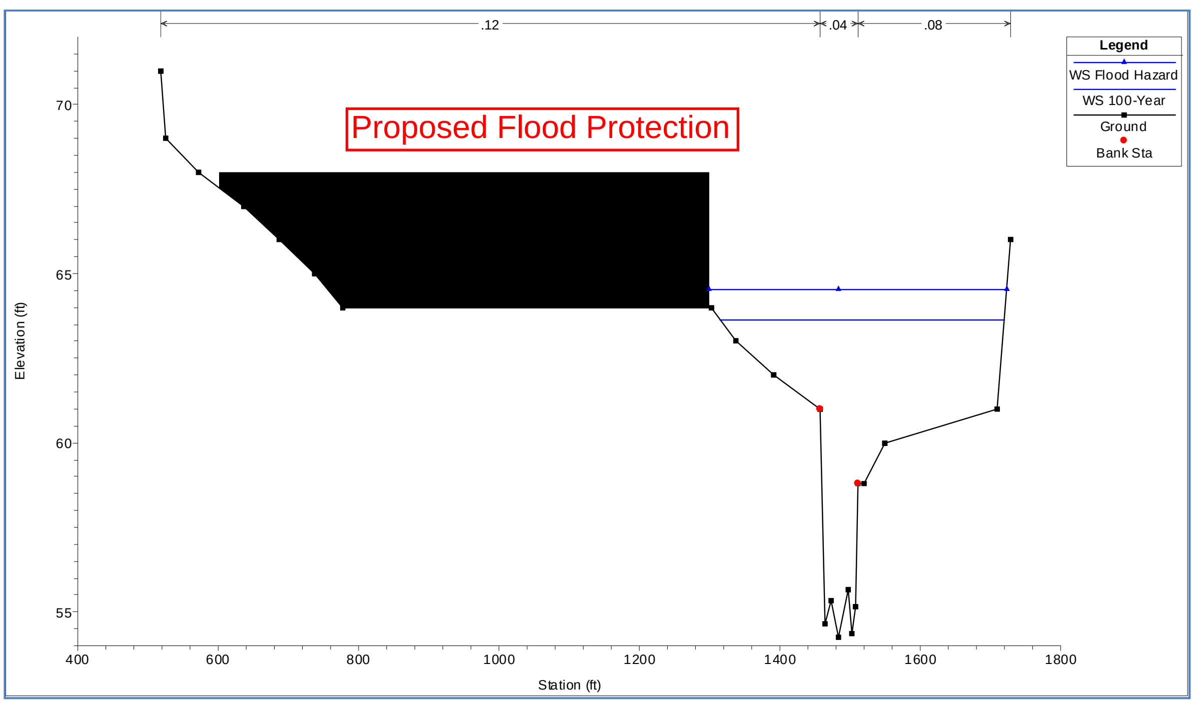


Added XS 28792 – North end of Hillsdale Substation as modeled in Proposed Conditions Model.
Elevations are in NGVD 29.

Figure 3: Cross-sectional views (looking downstream) of north end of Hillsdale Substation as modeled in Existing and Proposed Conditions Models and based on 2012 survey.
PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.

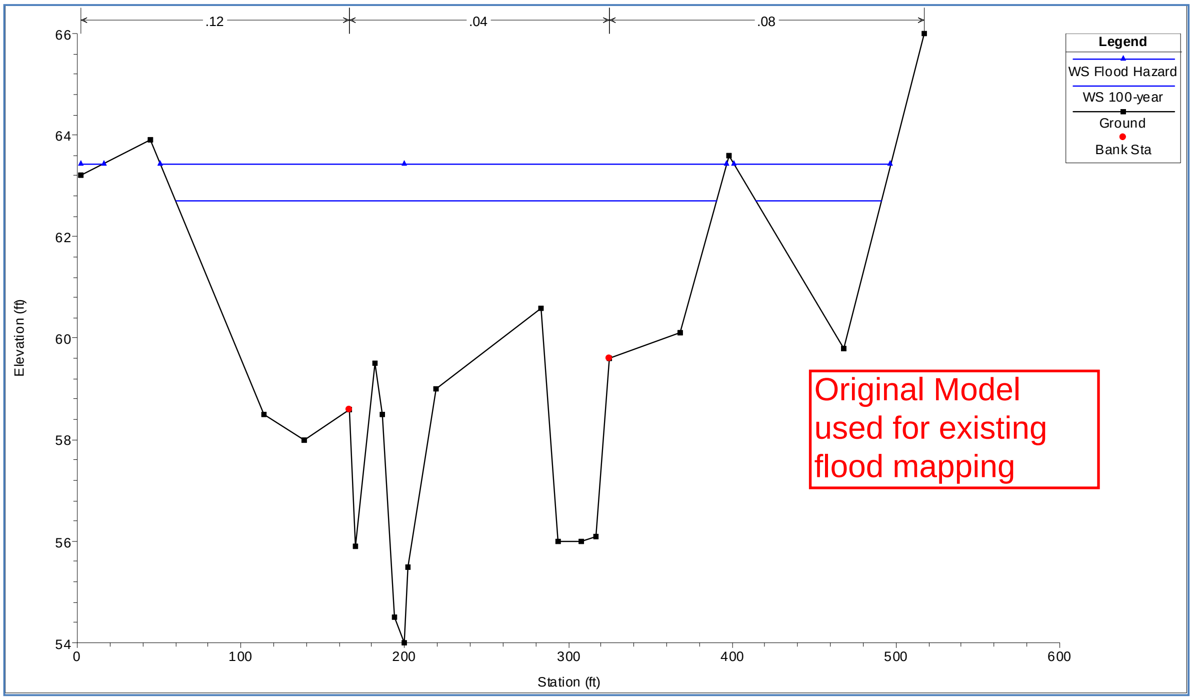


Added XS 28706 – Center portion of Hillsdale Substation as modeled in Existing Conditions Model. Elevations are in NGVD 29.

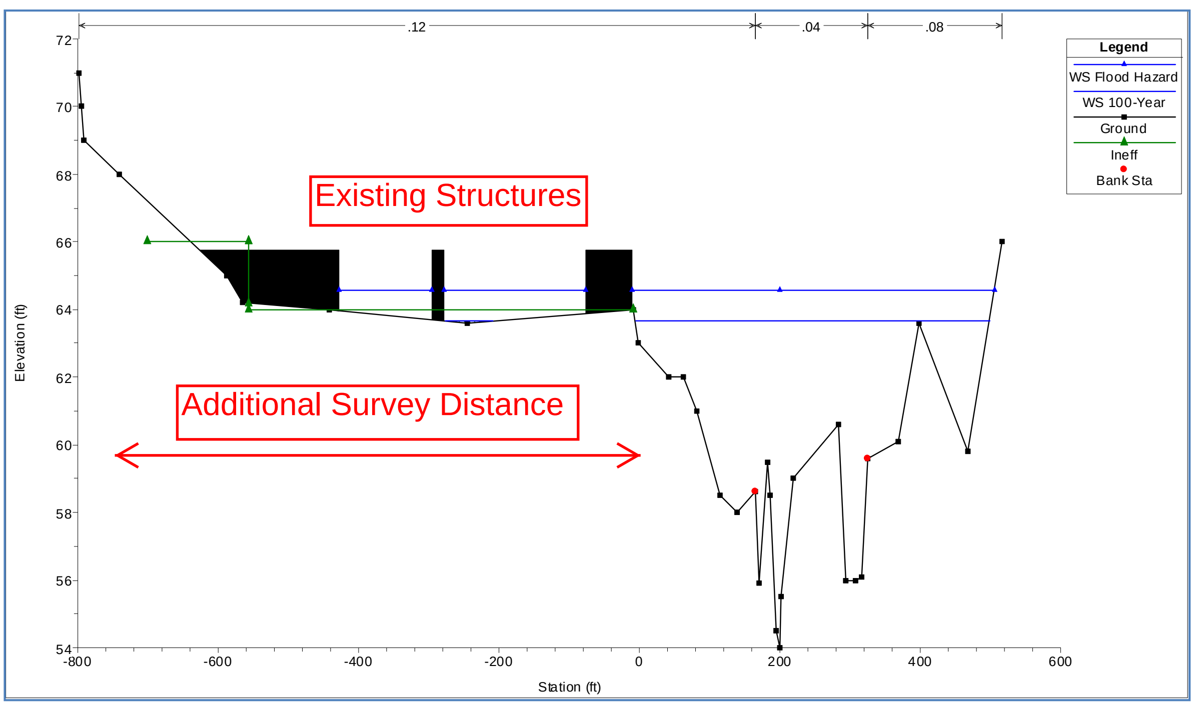


Added XS 28706 – Center portion of Hillsdale Substation as modeled in Proposed Conditions Model. Elevations are in NGVD 29.

Figure 4: Cross-sectional views (looking downstream) of center portion of Hillsdale Substation as modeled in Existing and Proposed Conditions Models and based on 2012 survey.
PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.

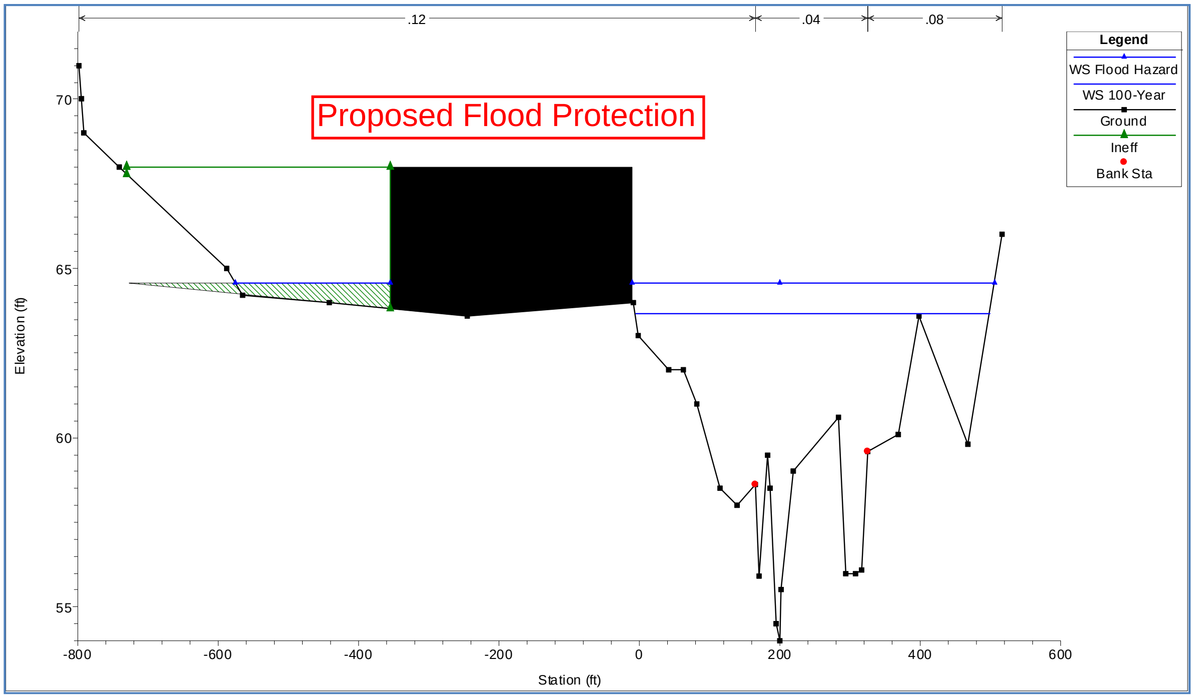


NJDEP XS 28620 – Southern portion of Hillsdale Substation as modeled in Effective and Duplicate Conditions Models. Elevations are in NGVD 29.



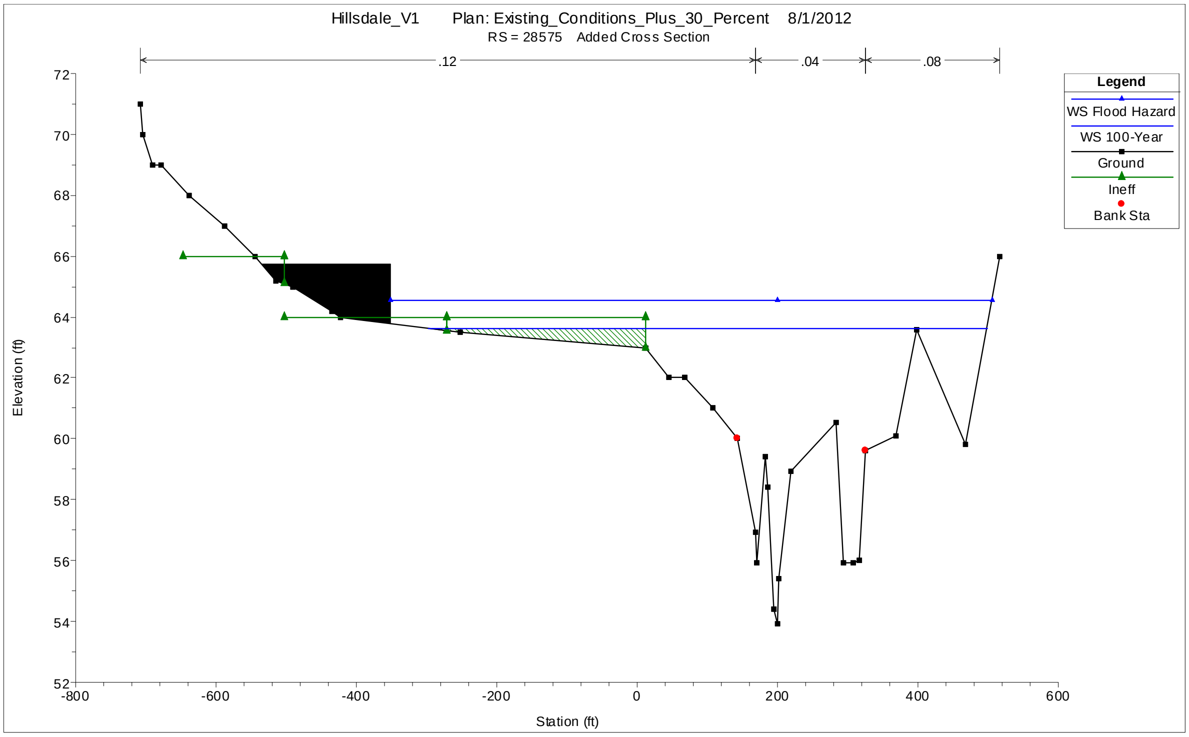
NJDEP XS 28620 – Southern portion of Hillsdale Substation as modeled in Existing Conditions Model. Elevations are in NGVD 29.

Figure 5a: Cross-sectional views (looking downstream) of southern portion of Hillsdale Substation as modeled in Effective, Duplicate Effective, and Existing Conditions Models and based on 2012 survey. PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.

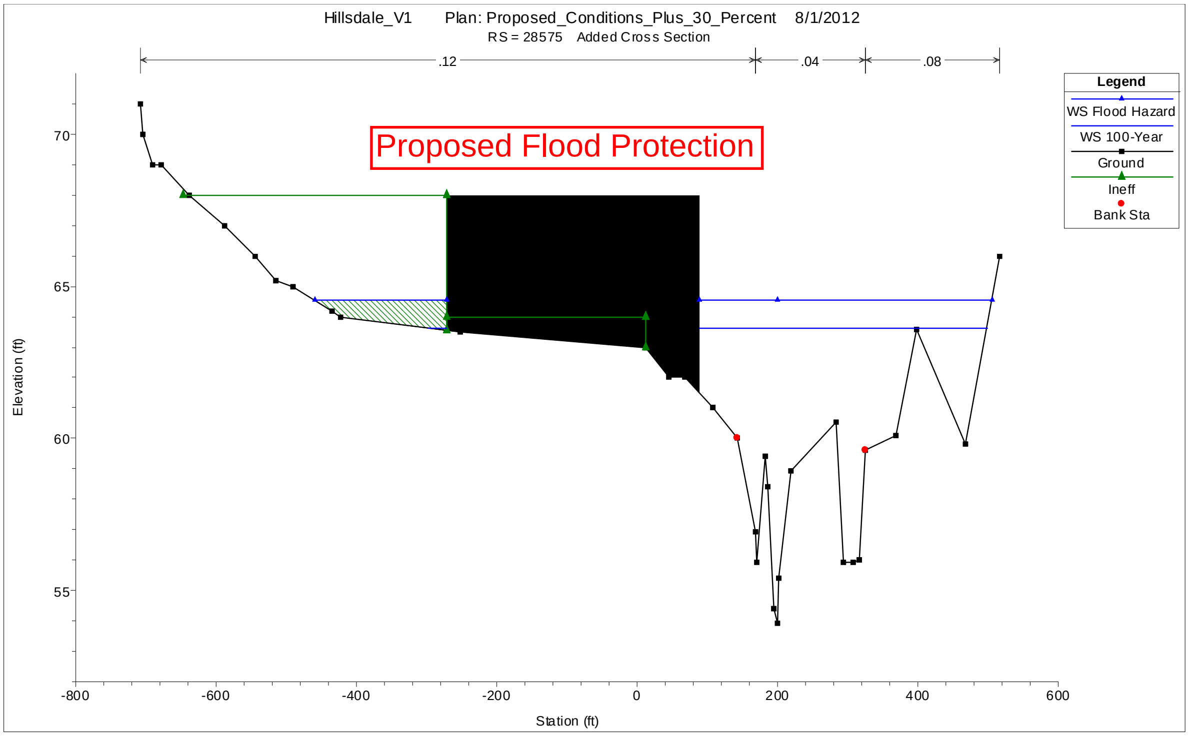


NJDEP XS 28620 – Southern portion of Hillsdale Substation as modeled in Proposed Conditions Model. Elevations are in NGVD 29.

Figure 5b: Cross-sectional views (looking downstream) of southern portion of Hillsdale Substation as modeled in Proposed Conditions Model and based on 2012 survey.
PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.



Added XS 28575 – Southern edge of Hillsdale Substation as modeled in Existing Conditions Model. Elevations are in NGVD 29.



Added XS 28575 – Southern Edge of Hillsdale Substation as modeled in Proposed Conditions Model. Elevations are in NGVD 29.

Figure 6: Cross-sectional views (looking downstream) of southern edge of Hillsdale Substation as modeled in Existing and Proposed Conditions Models and based on 2012 survey.
PF1 = FEMA 100-yr flow 3,647 cfs; PF2 = NJDEP Flood Hazard flow 4,556 cfs.

FLOOD IMPACT STUDY FOR RIVER EDGE SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing significant impact to electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Bayway) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the River Edge Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The River Edge Substation is located at the end of Main Street East of Hackensack Avenue. There is gated access to the site from Main Street, the only accessible side of the site. The site covers approximately 0.5 acres, and has no existing flood protection. The site is located at the confluence of the Hackensack River and the small tributary of Coles Brook.

A portion of the River Edge site is located within the floodway, which comprises the river channel and adjacent floodplain that should be kept free of encroachment in accordance with FEMA recommendations. The site is also located within the NJDEP Riparian Buffer Zone.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

1) Heritage Plaza Improved Encroachment: HEC-2 Input and Output Printouts from 22 July 1982 (Coles_Brook_Heritage_Plaza_Improved_7-22-82_FW.pdf)
2) River Edge Flood Insurance Study: HEC-2 Input and Output Printouts (Coles_Brook_FW.pdf)
3) HEC-2 Input and Output Printouts from 9 April 1981 (Hackensack_River_Amended_Run_FW.pdf)
4) HEC-2 Input and Output Printouts from 22 September 2006 (Hackensack_River_New_Milford_FW_Hacknmfy3.pdf)
5) Kennon Surveying Services Inc (KSS). Boundary and Topographic Survey – River Edge Substation (29 May 2012)
6) NJDEP. Delineation of Floodway and Flood Hazard Area – Hackensack River (Sta. 1002+00 to Sta. 1065+00). March 1980.
7) Black & Veatch. 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

Since the River Edge Substation is located just at the confluence of the Hackensack River with Coles Brook, two separate models of each of these river systems are necessary. The HEC-2 Input and Output printouts, presented as documents 1 and 2 were the basis for development for the Coles Brook model, while the HEC-2 input and output of documents 3 and 4 were the basis for the development of the Hackensack River model. Cross-sectional characteristics were obtained directly from these documents. The site survey (document 5) assisted in determining ground elevations at the site and distances to the river. The delineation map of the floodway (document 6) assisted in locating the cross-sections in the Hackensack Model relative to the substation. The Substation Flood Protection Report (document 7) provided the required height for flood protection measures. The vertical datum for all elevations reported in the HEC-2 files (documents 1 through 4) is NGVD 29, while the vertical datum for documents 5 and 7 is NAVD 88. NAVD 88 is one foot below NGVD 29 levels. All elevations presented in this report unless otherwise noted are NAVD 88, (i.e. cross-section profile views which were taken directly from the HEC-RAS model are in NGVD 29, See Figures 3-7).

The Substation Flood Protection – Summary Evaluation report (document 4), recommends a top elevation for the flood protection wall at the River Edge Substation 2 feet above the 100-year flood level. Based on references 1 and 2, the 100-year flood level in the vicinity of the site is 6.4 ft (NAVD 88) near its northern edge. This recommendation would yield a top of the wall at 8.4 ft (NAVD 88). Final recommendations for the flood protection height are based on the findings of this hydraulic study and are presented in the Conclusions and Recommendations (Section 3.0).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S Army Corps of Engineers Hydraulic Engineering Center, to develop hydraulic models for both Coles Brook and the Hackensack River in the vicinity of the River Edge Substation. The hydraulic models used for this study were developed from NJDEP's HEC-2 input data.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. These are the water surface elevations (WSEs) as presented in the results of the HEC-2 printouts. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were developed from the Effective model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is the input data from the HEC-2 files, input into a HEC-RAS model and run to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

As previously indicated, River Edge Substation is located at the confluence of two water bodies: Coles Brook and the Hackensack River. As such, two separate models were required in order to adequately estimate potential flood impacts associated with the proposed improvements. See Figure 1 for site location.

COLES BROOK MODEL DEVELOPMENT

A profile of Coles Brook indicating exact cross-section locations was not provided. Hence, the cross-section locations had to be estimated based on available information within HEC-2 input files. The HEC-2 files indicate that cross-section 1498 is just downstream of the New Bridge Road bridge, while cross-section 145 is the most downstream cross-section in the model and assumed to be 145 feet upstream of the confluence with the Hackensack River.

The distance between the bridge and last cross-section is approximately 1,350 feet. The cross-sections modeled in the NJDEP HEC-2 model are shown in white in Figure 1.

In development of the Existing Conditions Model for Coles Brook (Coles Brook Model 3), cross-sections were added at the site. Three additional cross-sections transecting the River Edge site were added to the Existing Conditions Model. These were based on the KSS site survey (KSS, 2012). The additional cross-sections are shown in yellow on Figure 1.

In development of the Proposed Conditions Model for Coles Brook (Coles Brook Model 4), the proposed flood protection was inserted on the north bank in each of the three added cross-sections.

The following flows were considered:

- 1,900 cfs – Coles Brook FEMA 100-year flood flow in the vicinity of the River Edge Site.
- 2,375 cfs – NJDEP Flood Hazard Limit Criterion = 125% of Coles Brook 100-year flood flow

HACKENSACK RIVER MODEL DEVELOPMENT

A profile of the river indicating several cross-section locations on the Hackensack River in the vicinity of the River Edge site was provided (document 6). Additional information regarding cross-section locations was available within NJDEP's HEC-2 files, including distances between cross-sections and hydraulic structures (bridges). The floodway map (document 6) indicates that cross-section 99600 is just downstream of the confluence with Coles Brook. Cross-section 99860 is just downstream of the Main Street bridge, while cross-section 100150 is just downstream of the New Bridge Road bridge. These cross-sections as well as others from the HEC-2 data files are shown in white in Figure 2.

In development of the Hackensack Existing Conditions Model (Hackensack Model 3), cross-sections were added at the site. Two additional cross-sections transecting the River Edge site were added to the Hackensack Existing Conditions Model. These were based on the KSS site survey (KSS, 2012). The additional cross-sections are shown in yellow on Figure 2.

In development of the Hackensack Proposed Conditions Model (Hackensack Model 4), the proposed flood protection was inserted on the west bank in each of the added cross-sections. The proposed flood protection was modeled as blocked obstructions to flow in the HEC-RAS model.

The following flows were considered:

- 6,900 cfs - The Hackensack River's FEMA 100-year flood flow in the vicinity of the River Edge Site upstream of the confluence with Coles Brook.
- 7,410 cfs - The Hackensack River's FEMA 100-year flood flow in the vicinity of the River Edge Site downstream of the confluence with Coles Brook.
- 8,625 cfs - NJDEP Flood Hazard Limit Criterion = 125% of the Hackensack River, 100-year flood flow upstream of the confluence with Coles Brook

- 9,263 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the Hackensack River, 100-year flood flow downstream of the confluence with Coles Brook

During Hurricane Irene, the River Edge Substation was flooded up to an approximate WSEL of 8 ft. Based on the HEC-RAS model; this would correspond with a Hackensack River flow of approximately 10,200 cfs in the vicinity of the substation just upstream of the confluence and a flow of 11,000 cfs in the vicinity of the substation just downstream of the confluence.

PRELIMINARY FLOOD IMPACTS

COLES BROOK MODEL RESULTS

The Coles Brook Duplicate Effective Model yields results that are equivalent to those of the Effective Model. However, the Existing Conditions Model, which includes additional cross-sections in the vicinity of the site, yielded flood levels that are slightly higher (0.02 feet) than those in the Duplicate Effective Model. Table 1 presents the results for the 100-year flood from the four models considered. River stations in bold indicate the cross-sections added to the model at the site.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (1,900 cfs)

Model #	1	2	3	4	(4-3)
	Effective Model	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
River Station	(ft)	(ft)	(ft)	(ft)	(ft)
1498	5.47	5.46	5.48	5.48	0.00
1448	4.88	4.93	4.95	4.95	0.00
1415	4.62	4.65	4.67	4.67	0.00
1348	4.72	4.72	4.74	4.74	0.00
810	4.50	4.50	4.52	4.52	0.00
508	**n/a**	**n/a**	**4.37**	**4.37**	**0.00**
337	**n/a**	**n/a**	**4.02**	**4.02**	**0.00**
196	**n/a**	**n/a**	**3.93**	**3.93**	**0.00**
145	3.84	3.84	3.84	3.84	0.00

The Proposed Conditions Model includes the flood protection along the north bank of the Coles Brook model. A rise in WSEL is not predicted in the vicinity of the site nor further upstream due to the flood protection installation. The River Edge Site has a curb running the majority of the site's perimeter. This curb is approximately at elevation 7.0 feet, while 100-year flood levels near the site in Coles Brook are approximately elevation 4.4 ft.

Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 2,375 cfs. River stations in bold indicate the additional cross-sections added to the model at the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (2,375 cfs)

Model #	2	3	4	(4-3)
	Duplicate Effective	**Existing Conditions**	**Proposed Conditions**	**Difference**
River Station	(ft)	(ft)	(ft)	(ft)
1498	6.29	6.32	6.32	0.00
1448	5.66	5.70	5.70	0.00
1415	5.30	5.35	5.35	0.00
1348	5.40	5.45	5.45	0.00
810	5.17	5.24	5.24	0.00
508	**n/a**	**5.06**	**5.06**	**0.00**
337	**n/a**	**4.65**	**4.65**	**0.00**
196	**n/a**	**4.58**	**4.58**	**0.00**
145	4.47	4.48	4.48	0.00

As presented in Table 2 and illustrated in Figures 3 through 5, the Flood Hazard flow for Coles Brook does not yield water levels that reach the River Edge site. While the curb around most of the site is at 7.0 feet, the maximum WSE in the vicinity of the site was estimated to be 5.0 feet for Flood Hazard Flows in Coles Brook. Thus the proposed flood protection wall does not impact water levels in Coles Brook.

HACKENSACK RIVER MODEL RESULTS

The Hackensack River Duplicate Effective Model yields results that are similar to those of the Effective Model. Differences in WSEs arise primarily at bridges (Main Street and New Bridge Road) and are in the range of 0.03 to 0.05 foot.

Table 3 presents the results from the four models considered. River stations in bold indicate the additional cross-sections added to the model at the site.

Table 3: Hydraulic Model Results – FEMA 100-year Flood Levels (6,900 – 7,410 cfs)

Model #	1	2	3	4	(4-3)
	Effective Model	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
River Station	(ft)	(ft)	(ft)	(ft)	(ft)
108930	9.08	9.10	9.10	9.10	0.00
108880	9.01	9.08	9.08	9.08	0.00
108580	8.99	9.03	9.03	9.03	0.00
108100	8.92	8.91	8.91	8.91	0.00
107625	8.82	8.83	8.83	8.83	0.00
106850	8.64	8.66	8.66	8.66	0.00
106560	8.55	8.58	8.58	8.58	0.00
106100	8.41	8.44	8.44	8.44	0.00

105700	8.39	8.41	8.41	8.41	0.00
105080	8.25	8.26	8.26	8.26	0.00
104500	8.12	8.13	8.13	8.13	0.00
104000	8.03	8.03	8.03	8.03	0.00
103365	7.75	7.74	7.74	7.74	0.00
102920	7.61	7.60	7.60	7.60	0.00
102500	7.43	7.41	7.41	7.41	0.00
102050	7.41	7.39	7.39	7.39	0.00
101400	7.24	7.23	7.23	7.23	0.00
100910	7.17	7.15	7.15	7.15	0.00
100490	7.12	7.10	7.10	7.10	0.00
100211		7.00	7.00	7.00	0.00
100210	New Bridge Road - Bridge				
100150	6.61	6.56	6.56	6.56	0.00
100040	6.60	6.55	6.55	6.55	0.00
99891		6.42	6.42	6.42	0.00
99890	Main Street - Bridge				
99860	6.35	6.35	6.35	6.35	0.00
99815	6.37	6.37	6.37	6.37	0.00
99760	**n/a**	**n/a**	**6.37**	**6.37**	**0.00**
99660	**n/a**	**n/a**	**6.32**	**6.32**	**0.00**
99600	6.26	6.26	6.26	6.26	0.00
99100	6.14	6.14	6.14	6.14	0.00
98900	6.18	6.19	6.19	6.19	0.00
98300	5.88	5.89	5.89	5.89	0.00
97900	5.88	5.88	5.88	5.88	0.00
97470	5.73	5.73	5.73	5.73	0.00
96900	5.70	5.70	5.70	5.70	0.00

The Existing Conditions Model, which includes additional cross-sections in the vicinity of the site, yielded water levels that are equivalent to those in the Duplicate Effective Model. The River Edge Site has a curb running the majority of the site's perimeter. This curb is approximately at elevation 7.0 feet, while 100-year flood levels near the site are approximately elevation 6.4 ft. The driveway entrance to the site is approximately elevation 6.5, and the road outside the site would be inundated.

The Proposed Conditions Model includes the flood protection on the west bank of the Hackensack River model. However, as presented in Table 3 and illustrated in Figures 6 and 7, the 100-year flood does not enter the site. Thus the addition of the flood protection wall does not impact 100-year flood levels.

Table 4 presents the results for the NJDEP Flood Hazard Criteria in the Hackensack River with flows at 8,625 cfs upstream of the confluence and 9,263 cfs downstream of the confluence with Coles Brook. River stations in bold indicate the additional cross-sections added to the model at the site.

Table4: Hydraulic Model Results – NJDEP Flood Hazard Levels (8,625 – 9,263 cfs)

Model #	2	3	4	(4-3)
	Duplicate Effective	**Existing Conditions**	**Proposed Conditions**	**Difference**
River Station	(ft)	(ft)	(ft)	(ft)
108930	10.05	10.05	10.05	0.00
108880	10.01	10.01	10.01	0.00
108580	9.96	9.96	9.96	0.00
108100	9.85	9.85	9.85	0.00
107625	9.75	9.75	9.75	0.00
106850	9.57	9.57	9.57	0.00
106560	9.49	9.49	9.49	0.00
106100	9.33	9.33	9.33	0.00
105700	9.31	9.31	9.31	0.00
105080	9.16	9.16	9.16	0.00
104500	9.03	9.03	9.03	0.00
104000	8.93	8.93	8.93	0.00
103365	8.67	8.67	8.67	0.00
102920	8.52	8.52	8.52	0.00
102500	8.34	8.34	8.34	0.00
102050	8.32	8.32	8.32	0.00
101400	8.14	8.13	8.14	0.01
100910	8.07	8.06	8.06	0.00
100490	8.02	8.02	8.02	0.00
100211	7.93	7.92	7.93	0.01
100210	New Bridge Road - Bridge			
100150	7.49	7.49	7.49	0.00
100040	7.48	7.48	7.48	0.00
99891	7.39	7.39	7.39	0.00
99890	Main Street - Bridge			
99860	7.36	7.35	7.35	0.00
99815	7.36	7.36	7.36	0.00
99760	**n/a**	**7.32**	**7.32**	**0.00**
99660	**n/a**	**7.28**	**7.29**	**0.01**
99600	7.20	7.20	7.20	0.00
99100	7.09	7.09	7.09	0.00
98900	7.14	7.14	7.14	0.00
98300	6.79	6.79	6.79	0.00
97900	6.80	6.80	6.80	0.00

97470	6.64	6.64	6.64	0.00
96900	6.61	6.61	6.61	0.00

Based on model results, the proposed sheetpile flood wall around the River Edge Substation will not impact water surface elevations in the Hackensack River Floodplain under Flood Hazard Flow Conditions. The maximum rise as a result of the sheetpile wall is 0.01 feet under Flood Hazard Flow Conditions.

Black & Veatch modeled the observed flooding condition of approximately EL. 8.0 feet reported by PSE&G during Hurricane Irene. Based on the HEC-RAS model; this would correspond with a Hackensack River flow of approximately 10,200 cfs in the vicinity of the substation just upstream of the confluence and a flow of 11,000 cfs in the vicinity of the substation just downstream of the confluence.

3.0 Conclusions and Recommendation

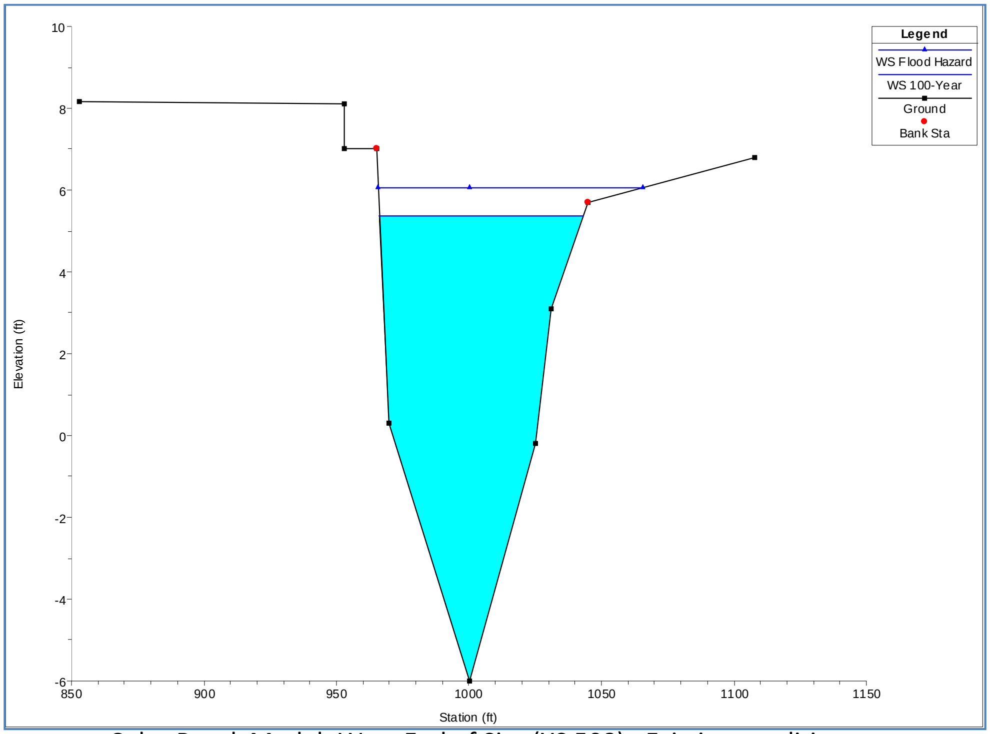
The proposed flood protection facilities will not impact flooding upstream of the River Edge Substation. If PSE&G proceeds with the design and construction of the proposed flood mitigation measures for the River Edge Substation, there should be little to no impact to upstream existing structures. Hydraulically and based on the model results, there are no impacts to downstream structures.

During Hurricane Irene, a maximum flood level of 8.0 feet was observed at the River Edge site. Based on the results of the hydraulic modeling, we assert that this flooding was due to large flows in the Hackensack River, rather than from Coles Brook. The flow and resulting inundation from Hurricane Irene were greater than the NJDEP Flood Hazard flows in the Hackensack River. An Elevation of 9.0 feet, which is approximately 1 foot above the maximum observed flood level and also over 2 feet above the Black & Veatch estimated Flood Hazard Elevation, was selected as the top of wall design level.

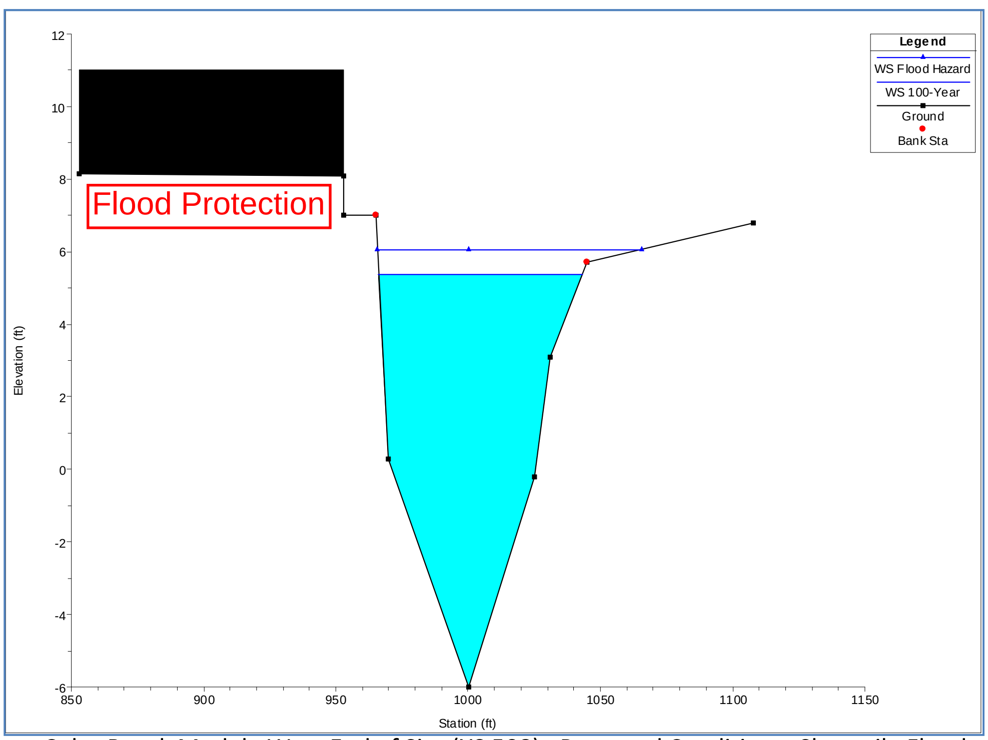
ELEVATION SUMMARY (FEET NAVD 88)				
Site	Minimum Site EL.	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL.	Proposed Flood Protection EL.
River Edge	6.5	8.0	7.3	9.0

[redacted]

[redacted]

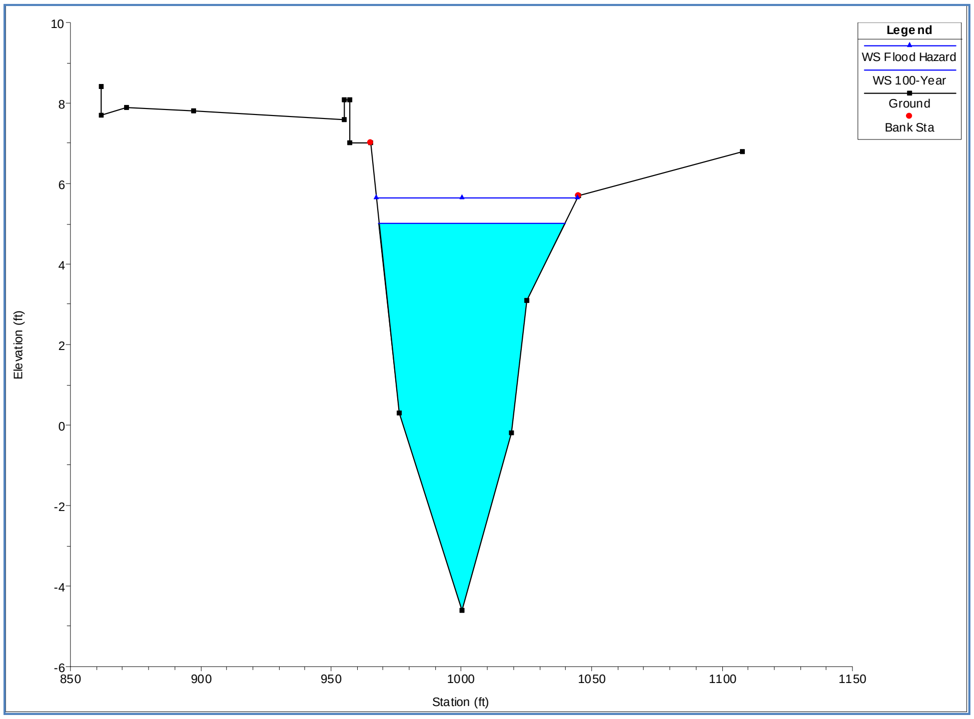


Coles Brook Model- West End of Site (XS 508): Existing conditions.

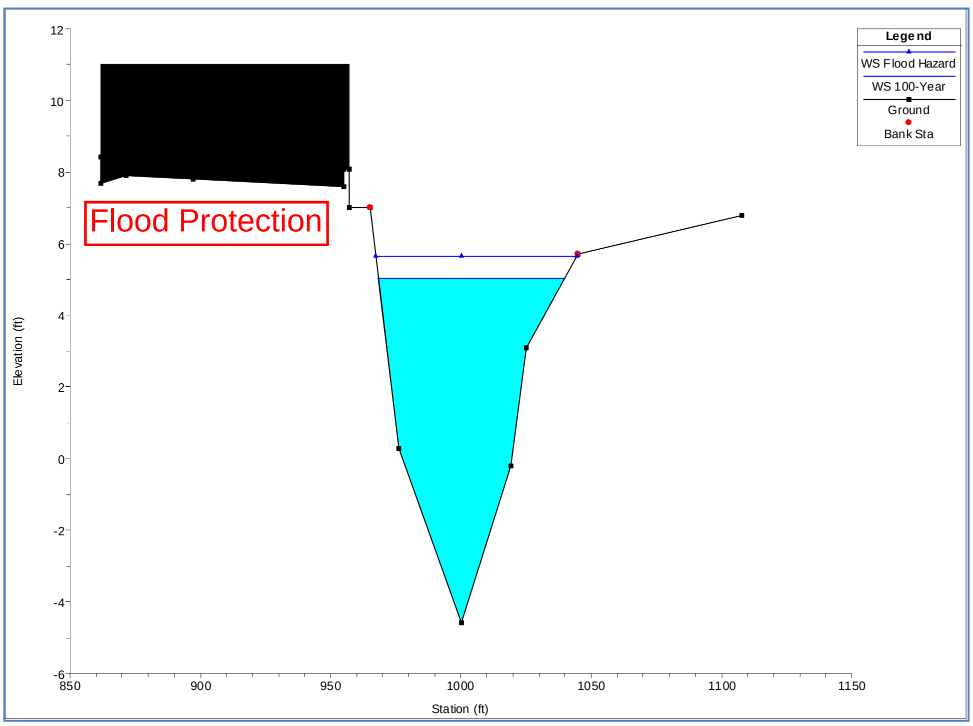


Coles Brook Model - West End of Site (XS 508): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 3: Cross-sectional view from upstream end of site looking downstream in Coles Brook. PF1 = FEMA 100-yr flow 1,900 cfs; PF2 = NJDEP Flood Hazard flow 2,375 cfs. (Model in NGVD 29)

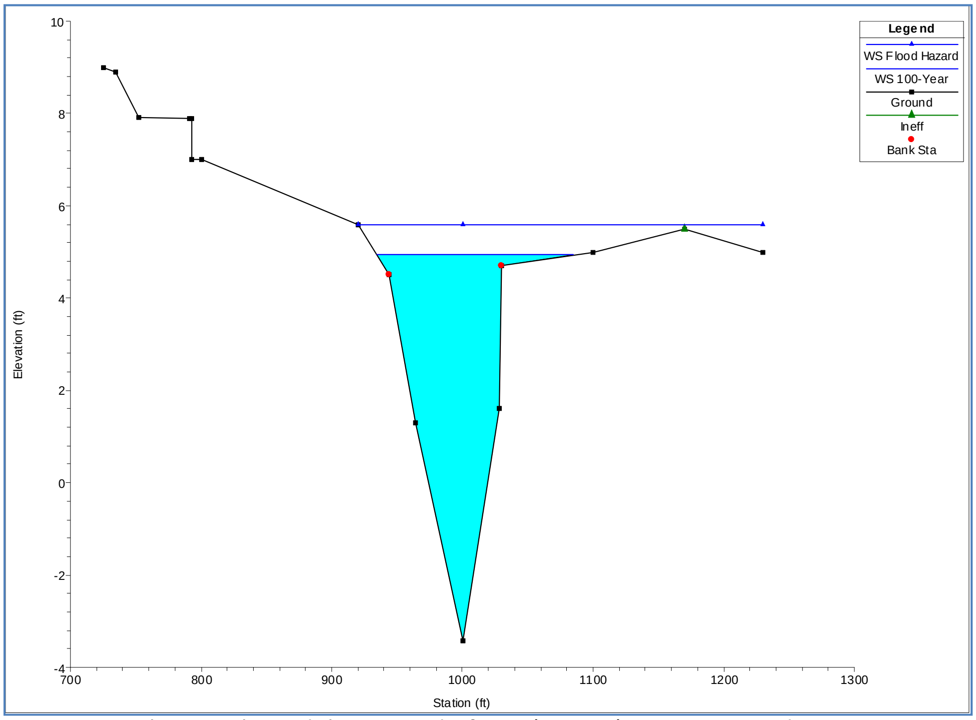


Coles Brook Model- Middle of Site (XS 337): Existing conditions.

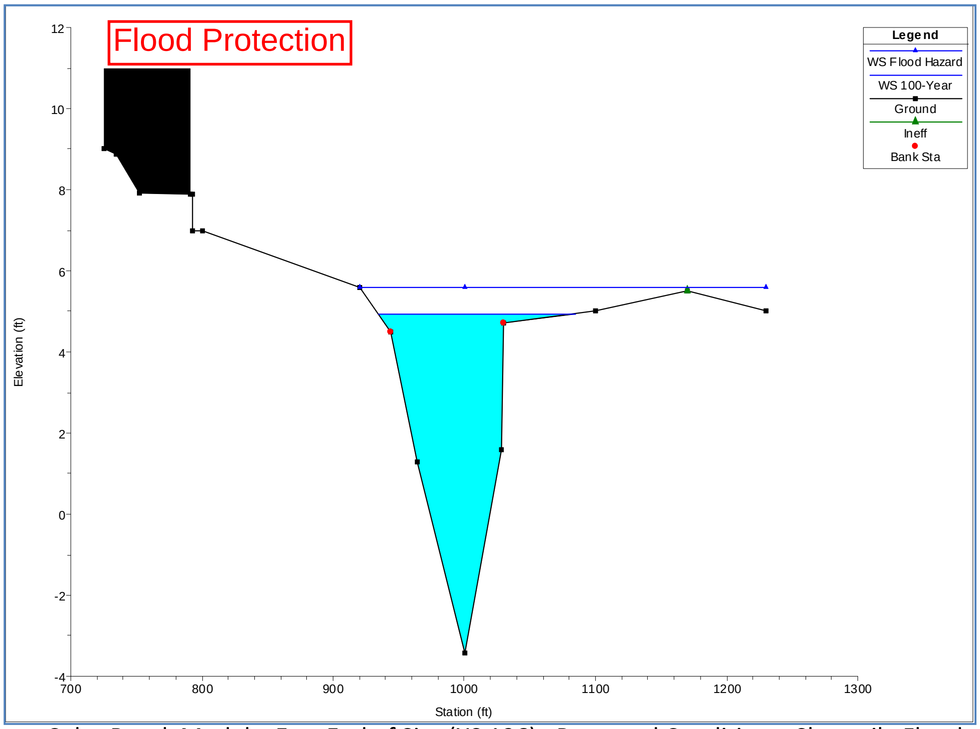


Coles Brook Model – Middle of Site (XS 337): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 4: Cross-sectional view from upstream end of site looking downstream in Coles Brook. PF1 = FEMA 100-yr flow 1,900 cfs; PF2 = NJDEP Flood Hazard flow 2,375 cfs. (Model in NGVD 29)

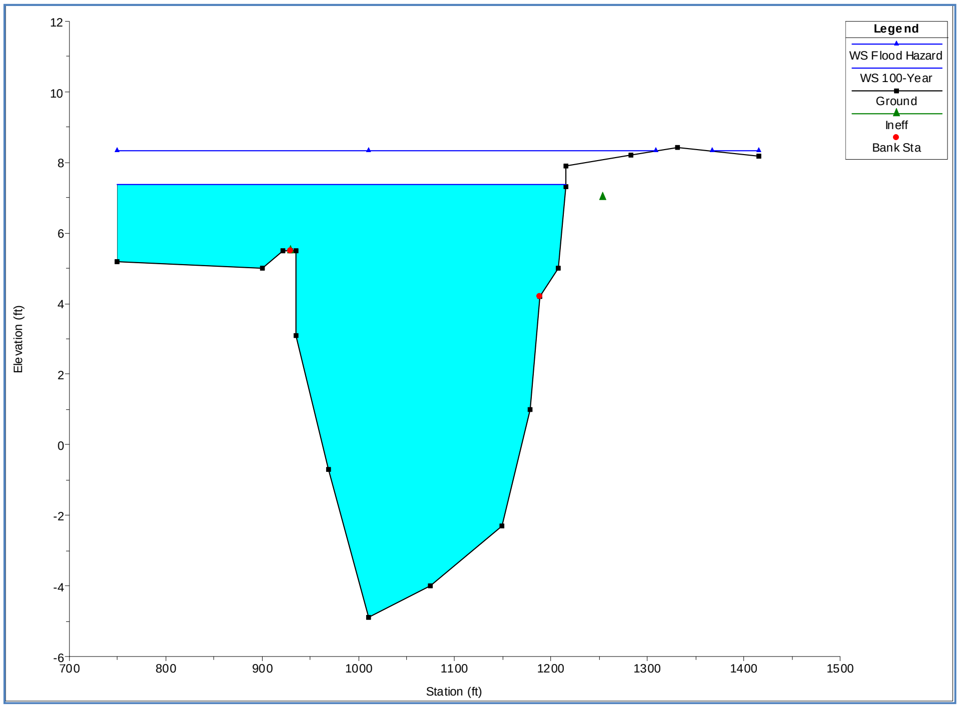


Coles Brook Model- East End of Site (XS 196): Existing conditions.

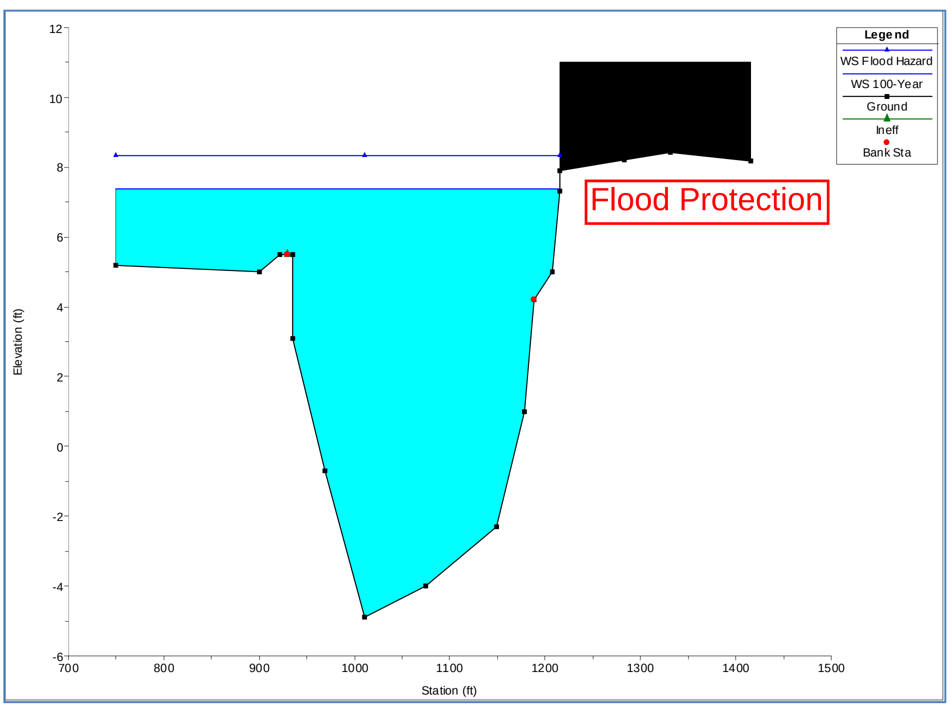


Coles Brook Model – East End of Site (XS 196): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 5: Cross-sectional view from upstream end of site looking downstream in Coles Brook. PF1 = FEMA 100-yr flow 1,900 cfs; PF2 = NJDEP Flood Hazard flow 2,375 cfs. (Model in NGVD 29)

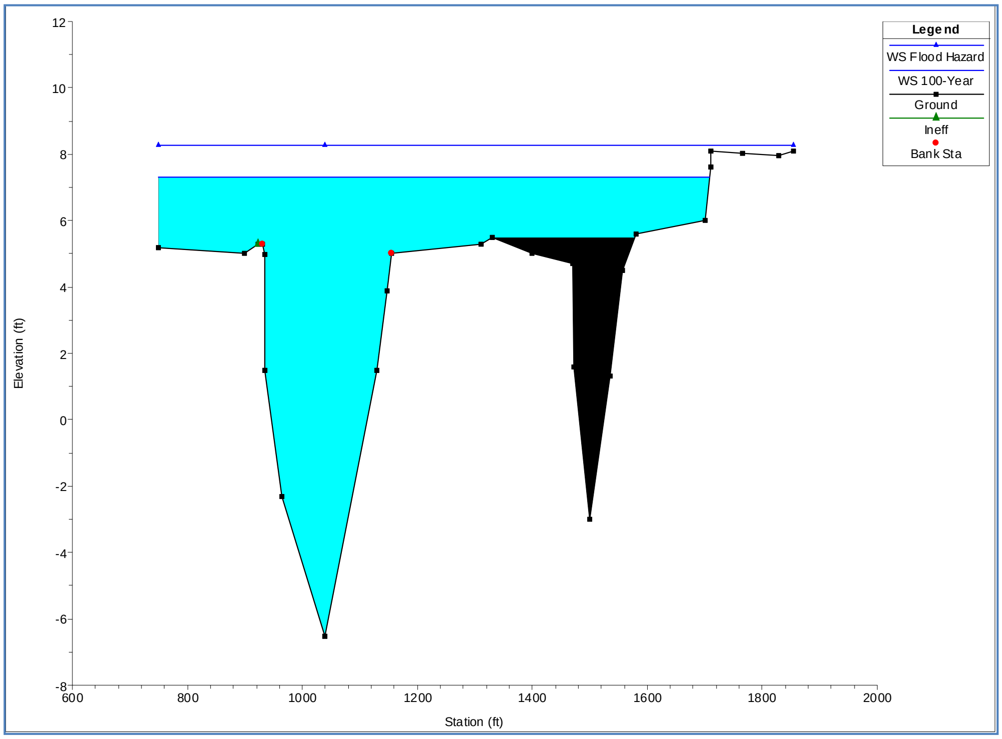


Hackensack River Model- North Side of Site (XS 99760): Existing conditions.

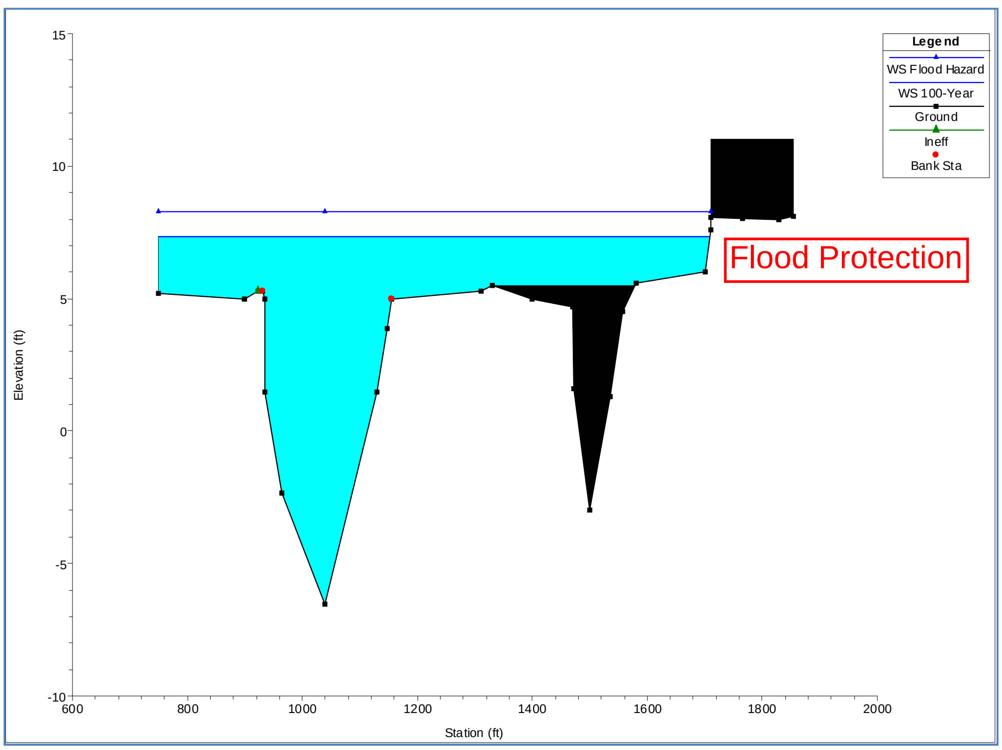


Hackensack River Model- North Side of Site (XS 99760): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 6: Cross-sectional view from upstream end of site looking downstream in the Hackensack River. PF1 = FEMA 100-yr flow 6,900 cfs; PF2 = NJDEP Flood Hazard flow 8,625 cfs. (Model in NGVD 29)



Hackensack River Model- South Side of Site (XS 99660): Existing conditions.



Hackensack River Model- South Side of Site (XS 99660): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 7: Cross-sectional view from upstream end of site looking downstream in the Hackensack River. PF1 = FEMA 100-yr flow 7,410 cfs; PF2 = NJDEP Flood Hazard flow 9,263 cfs. (Model in NGVD 29)

FLOOD IMPACT STUDY FOR RAHWAY SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing significant impact to electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Bayway) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Rahway Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The station is located across Clarkson Place from the Rahway River, in an urban residential/industrial area. The river in this area is well below the street elevation and has steep banks. The substation has two gated access points from Monroe Street, and access is generally open along Clarkson Place. The east side of the site is graded higher, at the same elevation as the station building, and the site has a total area of approximately 0.75 acres. The site is located within the NJDEP Riparian Buffer Zone.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Rahway Substation.

1) NJDEP. HEC-RAS model for the Rahway River from 13 November 2002 (111302Rahway.prj)
2) NJDEP. Delineation of Floodway and Flood Hazard Area: Plans – City of Rahway, NJ.
3) Kennon Surveying Services, Inc (KSS). Boundary and Topographic Survey - Rahway Substation (29 May 2012)
4) Black & Veatch (B&V). 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

NJDEP's Rahway HEC-RAS model (document 1) was the basis of the model development. The site survey (document 3) assisted in determining ground elevations at and around the site and distances to the river. The Substation Flood Protection Report (document 4) provided the estimated height for the flood protection measures. The vertical datum for all elevations reported in the HEC-RAS model (document 1) is NGVD 29, while the vertical datum for documents 3 and 4 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevations. All elevations presented in this report unless otherwise noted are NAVD 88, (i.e. cross section profile views which were taken directly from the HEC-RAS model are in NGVD 29. (See Figures 2-7).

The Substation Flood Protection – Summary Evaluation report (document 4), recommends a top elevation for the flood protection wall at the Rahway Substation 2 feet above the 100-year flood level. Based on references 1 and 2, the 100-year flood level in the vicinity of the site is 11.8 ft (NAVD 88) near its northern edge. This recommendation would yield a top of the wall at 14 ft (NAVD 88). Final recommendations for the flood protection height are based on the findings of this hydraulic study and are presented in the Conclusions and Recommendations (Section 3.0).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Rahway River in the vicinity of the Rahway Substation. The hydraulic model used for this study was a copy of NJDEP's HEC-RAS floodway model for the entire Rahway River.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. This model is the HEC-RAS model with its saved results as provided by NJDEP. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were copies of NJDEP's HEC-RAS model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is a copy of the NJDEP HEC-RAS model with no modifications, but rerun to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

A profile of the river indicating exact cross-section locations was not provided. Hence, the cross-section locations had to be estimated based on available information within NJDEP's HEC-RAS model. The existing NJDEP model indicates that cross-section 5.168 is just downstream of the Bridge Street Bridge, while cross-section 5.115 is at the upstream face of the Monroe Street Bridge. The distance between the two bridges is approximately 280 feet. Rahway Substation lies along the eastern bank (left bank) within this reach. These cross-sections and Rahway Substation are shown in white in Figure 1.

In development of the Existing Conditions Model (Rahway Model 3), cross-sections were added at the site and/or modifications were made to the NJDEP cross-sections. NJDEP cross-section 5.124 was extended on the east bank (left bank) based on recent site survey data (KSS, 2012). Modifications to XS 5.124 are illustrated on Figure 2.

Modified and added cross-sections are shown in yellow on Figure 1. Cross-section 5.154 was also added and runs north of the Rahway site. It was necessary to include this cross-section as there is an existing building that will impede flows onto the site, reducing the effective flow area upstream of the site. Figures 2 through 7 present the profiles of added cross-sections transecting the Rahway Substation site.

Ineffective flow areas are presented as the green hatched areas on the cross-sections. In some of the cross-sections, ineffective flow is indicated in areas which would likely experience flooding, however, the flow would have little to no velocity. In these instances, the green-hatched area experiences pooled water, which is typical at the edges of flood plains. Existing buildings are shown as obstructions in the cross-section profiles.

Although the bridge at Monroe Street was reconstructed in 2010, the bridge decking in the HEC-RAS model was not modified as drawings of the new bridge were not readily available.

However, the bridge cross-sections were extended along the east side to reflect recent survey data (KSS, 2012). Survey information did not extend to the west side of the bridge. In the Effective Model, the bridge decking was modeled at elevation 15.7 ft across the entire width of the cross-section. Thus flows in this model cannot weir over Monroe Street, unless they exceed an elevation of 15.7 feet. Rather all flow is forced through the bridge opening. This approach is a good conservative approach for determining floodplains where loss of life and property are at risk. However, based on 2012 survey data (KSS, 2012), the road deck is actually much lower than 15.7 feet and in reality, the City of Rahway could expect flooding over Monroe Street. This can also be seen on the NJDEP Delineation of Floodway and Flood Hazard Area Map, (Document 2). Additionally, during a site visit it was noted that the new bridge has only one pier, while the model indicates that it has two piers. Figure 3 presents the Monroe Street Bridge as modeled in the Duplicate Effective (NJDEP) and Existing Conditions Models, respectively.

In development of the Proposed Conditions Model (Rahway Model 4), the proposed flood protection was inserted on the east bank in each of the added cross-sections that transect the site. At the south end of the Rahway Substation Site, where the sheet piling would end, effective flow is allowed to expand out to Monroe Street at a 1:1 ratio.

The following flows were considered:

- 8,330 cfs - The Rahway River's FEMA 100-year flood flow in the vicinity of the Rahway Site.
- 10,413 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the Rahway River, 100-year flood flow

During Hurricane Irene, the Rahway Substation was flooded up to an approximate WSEL of 13.0 ft. Based on the HEC-RAS model; this would correspond with a Rahway River flow 11,800 cfs in the vicinity of the substation.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are nearly equivalent to those of the Effective Model. However, the Existing Conditions Model, which includes additional cross-sections in the vicinity of the site and modification to the road decking at Monroe Street, yielded flood levels that are lower than those in the Duplicate Effective Model. It is our belief that our Existing Conditions Model more accurately describes the potential for flooding upstream of Monroe Street Bridge than the NJDEP model. In the NJDEP model, the Monroe Street Bridge decking was set to an elevation of 15.7 feet across the entire cross-section. As a result, flood flows were only able to pass through the bridge opening under pressurized flow conditions. Thus the effective flow area was also restricted to the river banks.

As indicated, the Monroe Street Bridge was reconstructed in 2010. Recent survey information indicates that flood flows will overtop Monroe Street, around the bridge abutments rather than be confined to the river channel as indicated in the NJDEP model. The bridge itself is not overtopped. This change impacts flood levels in the vicinity of Rahway Substation.

Table 1 presents the results from the four models considered. River stations in bold indicate the additional cross-sections added to the model at the site.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (8,330 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
5.4185	West Grand Avenue - Bridge				
5.413	13.35	13.34	12.16	12.89	0.73
5.366	13.38	13.36	12.21	12.93	0.72
5.343	13.28	13.27	12.06	12.81	0.75
5.295	13.27	13.25	12.02	12.79	0.77
5.286	12.89	12.87	11.62	12.40	0.78
5.2795	Elizabeth Avenue - Bridge				
5.273	12.65	12.63	11.35	12.16	0.81
5.267	12.78	12.77	11.47	12.29	0.82
5.209	12.45	12.44	11.09	11.94	0.85
5.2	12.43	12.42	11.06	11.92	0.86
5.1895	Railroad Bridge				
5.179	12.34	12.32	10.93	11.81	0.88
5.173	12.39	12.37	11.00	11.87	0.87
5.1705	Bridge Street - Bridge				
5.168	11.90	11.88	10.94	11.40	0.46
5.165	11.81	11.84	10.95	11.42	0.47
5.154	**n/a**	**n/a**	**10.83**	**11.31**	**0.48**
5.145	**n/a**	**n/a**	**10.84**	**11.30**	**0.46**
5.132	**n/a**	**n/a**	**10.41**	**10.88**	**0.47**
*** 5.124**	**11.42**	**11.42**	**10.40**	**10.80**	**0.40**
5.117	**n/a**	**n/a**	**10.40**	**10.75**	**0.35**
***5.115**	**11.28**	**11.28**	**10.23**	**10.72**	**0.49**
*5.109	Monroe Street - Bridge				
5.103	9.10	9.09	9.39	9.10	-0.29
5.096	8.91	8.91	8.91	8.91	0.00
4.985	8.75	8.75	8.75	8.75	0.00
4.856	8.60	8.60	8.60	8.60	0.00
4.847	8.58	8.58	8.58	8.58	0.00
4.843	East Milton Avenue - Bridge				
4.839	8.37	8.36	8.36	8.36	0.00
4.835	8.34	8.34	8.34	8.34	0.00
4.73	8.36	8.35	8.35	8.35	0.00
4.616	8.29	8.28	8.28	8.28	0.00

4.547	8.20	8.19	8.19	8.19	0.00
*Indicates a modified cross-section					

The Existing Conditions Model yields WSEs that are approximately 1 foot lower than the Effective and Duplicate Effective models in the vicinity of Rahway Substation (at XS 5.124). Approximately ½ mile upstream, the Existing Conditions Model yields WSEs that are approximately 0.16 foot lower than the Duplicate Effective Model and 1 mile upstream, the Existing Conditions WSEs are 0.11 foot lower. There is no difference in WSEs upstream of the St. George's Avenue Bridge.

The Proposed Conditions Model includes the flood protection on the east bank of the model. A rise in WSEL is noted in the reach immediately adjacent to the site under 100-year flow conditions due to the flood protection installation. In the Rahway Substation reach, a maximum rise of 0.48 foot is noted at XS 5.154. However, further upstream, slightly larger rises are predicted. A rise of 0.88 feet is estimated for XS 5.179 which is just downstream of the Railroad Bridge. This increase in water rise moving upstream is due to the additional head losses at upstream bridges as a result of higher downstream WSEs. The water surface profile is under backwater control conditions.

Approximately ½ mile upstream of the Rahway site, the Proposed Conditions Model yields WSEs that are approximately 0.25 foot higher than the Existing Conditions Model. This rise of 0.25 foot is persistent further upstream until the St George's Avenue Bridge. There is no rise in WSEs upstream of the St George's Avenue Bridge.

Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 10,413 cfs. River stations in bold indicate the additional cross-sections added to the model at the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (10,413 cfs)

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
5.4185	West Grand Avenue - Bridge			
5.413	16.66	14.96	15.95	0.99
5.366	16.67	14.98	15.96	0.98
5.343	16.61	14.89	15.89	1.00
5.295	16.62	14.88	15.89	1.01
5.286	16.61	14.88	15.88	1.00
5.2795	Elizabeth Avenue - Bridge			
5.273	15.69	13.70	14.78	1.08
5.267	15.68	13.83	14.78	0.95
5.209	15.32	13.35	14.37	1.02
5.2	15.30	13.33	14.34	1.01
5.1895	Railroad Bridge			
5.179	15.22	13.20	14.24	1.04

5.173	15.28	13.28	14.31	1.03
5.1705	Bridge Street - Bridge			
5.168	14.34	12.44	13.41	0.97
5.165	14.31	12.47	13.45	0.98
5.154	**n/a**	**12.34**	**13.34**	**1.00**
5.145	**n/a**	**12.35**	**13.33**	**0.98**
5.132	**n/a**	**12.04**	**13.01**	**0.97**
*** 5.124**	**14.08**	**12.06**	**12.95**	**0.89**
5.117	**n/a**	**12.07**	**12.90**	**0.83**
***5.115**	**14.05**	**11.96**	**12.90**	**0.94**
*5.109	Monroe Street - Bridge			
5.103	10.23	10.98	10.40	-0.58
5.096	10.12	10.12	10.12	0.00
4.985	10.01	10.01	10.01	0.00
4.856	9.86	9.86	9.86	0.00
4.847	9.84	9.84	9.84	0.00
4.843	East Milton Avenue - Bridge			
4.839	9.41	9.41	9.41	0.00
4.835	9.38	9.38	9.38	0.00
4.73	9.43	9.43	9.43	0.00
4.616	9.36	9.36	9.36	0.00
4.547	9.28	9.28	9.28	0.00

Based on model results, the proposed sheetpile flood wall around the Rahway Substation will impact water surface elevations in the Rahway River Floodplain under Flood Hazard Flow Conditions. The maximum rise as a result of the sheetpile wall in the Rahway Substation reach is 1.00 feet under Flood Hazard Flow Conditions (XS 5.154). However, further upstream, slightly larger rises are predicted. A rise of 1.08 feet is estimated for XS 5.273 which is just downstream of the Elizabeth Avenue Bridge. This increase in water rise moving upstream is due to the additional head losses at upstream bridges as a result of higher downstream WSEs. The water surface profile is under backwater control conditions.

Approximately ½ mile upstream of the Rahway site, the Proposed Conditions Model yields WSEs that are approximately 0.5 foot higher than the Existing Conditions Model. At one mile upstream, WSEs are 0.25 foot higher in the Proposed Conditions Model. There is no difference in WSEs upstream of the Valley Road Bridge.

Black & Veatch modeled the observed flooding condition of EL. 13 feet reported by PSE&G during Hurricane Irene. In order to realize an inundation of that depth at the site, a flow of approximately 11,800 cfs would be necessary. A peak flow of 7,250 cfs was recorded at USGS gauge 01395000 (Rahway River at Rahway, NJ). This gauge is located 100 feet upstream of St George Avenue, approximately 1.1 miles upstream of the Rahway site. The flows and water surface elevations recorded during Hurricane Irene were the new peak of record (in excess of the 100 year storm event).

3.0 Conclusions and Recommendation

The proposed flood protection facilities will impact flooding upstream of the Rahway Substation. Should PSE&G proceed with the design and construction of the proposed flood mitigation measures for the Rahway Substation, upstream existing structures will be impacted. Hydraulically and based on the model results, there are no impacts to downstream structures.

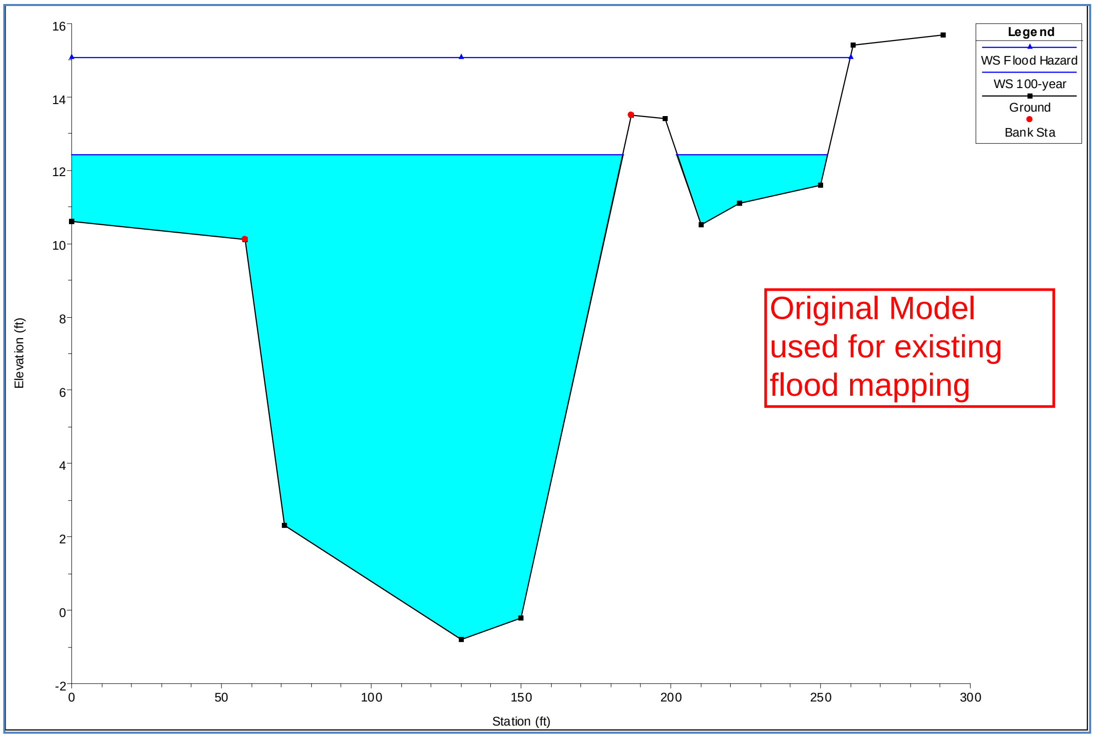
However, the proposed conditions WSELs are less than or equal to the most recent NJDEP models, that have not been applied to the flood mapping for the area. Further, we have concluded that those models do not accurately assess the effects of the Monroe Street Bridge on the river flow. The end result is that while there is an increase in WSEL with the addition of the flood protection, it is essentially the small WSEL that is currently mapped by the NJDEP.

The existing conditions model prepared for this study was based on the NJDEP model but was modified to more accurately describe Monroe Street based on recent survey data. The updates resulted in a decrease in predicted flood levels. For the 100-year flood, water surface elevations in the reach immediately adjacent to the Rahway Substation decreased by 1 foot. This finding will be addressed during the permitting process, if PSE&G proceed with design, and will require approval of the NJDEP and FEMA.

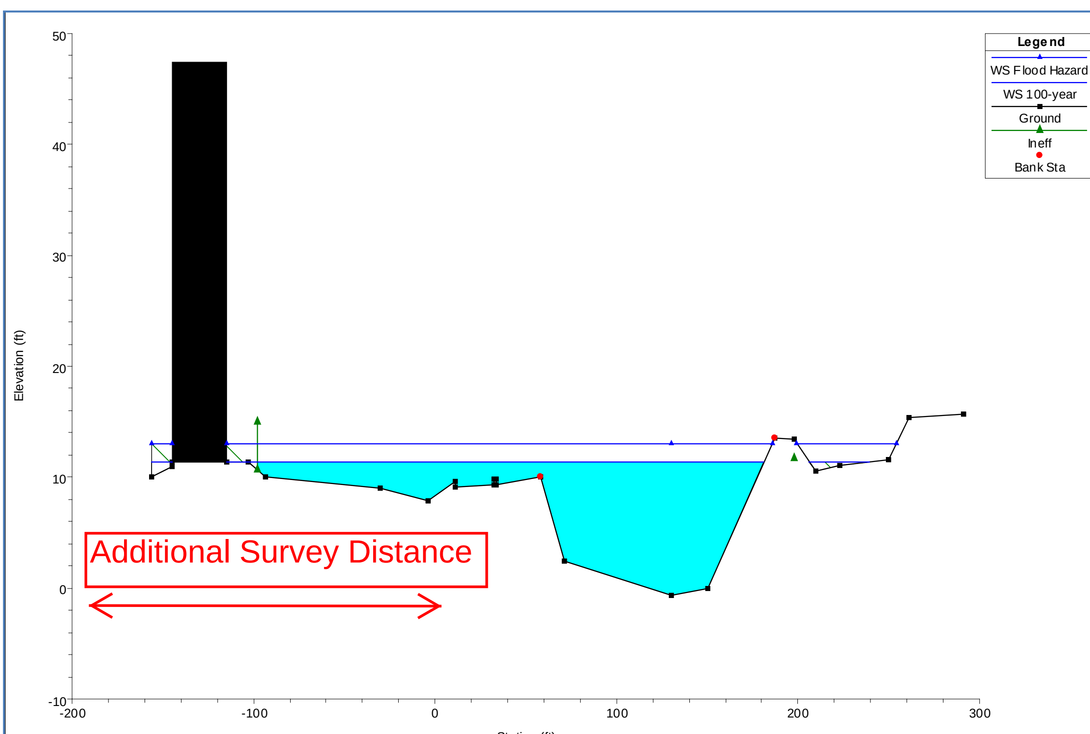
The flow and inundation from Hurricane Irene were greater than the required FEMA 100-year, and nearly equivalent to the NJDEP Flood Hazard flows. An elevation of 14.33 feet, which is approximately 1 foot above the NJDEP Flood Hazard Elevation, was selected as the top of wall design level.

ELEVATION SUMMARY (FEET NAVD 88)				
Site	Average Site EL.	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL.	Proposed Flood Protection EL.
Rahway	10	13.0	13.33	14.33

[redacted]

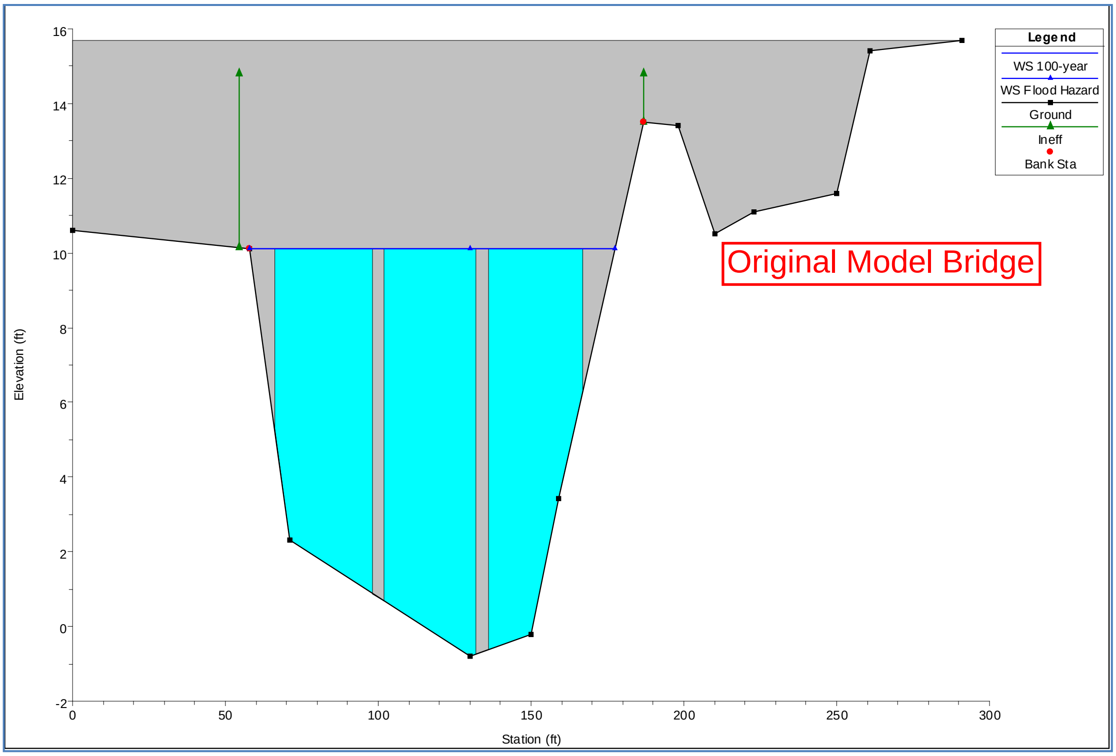


NJDEP Effective Model XS 5.124

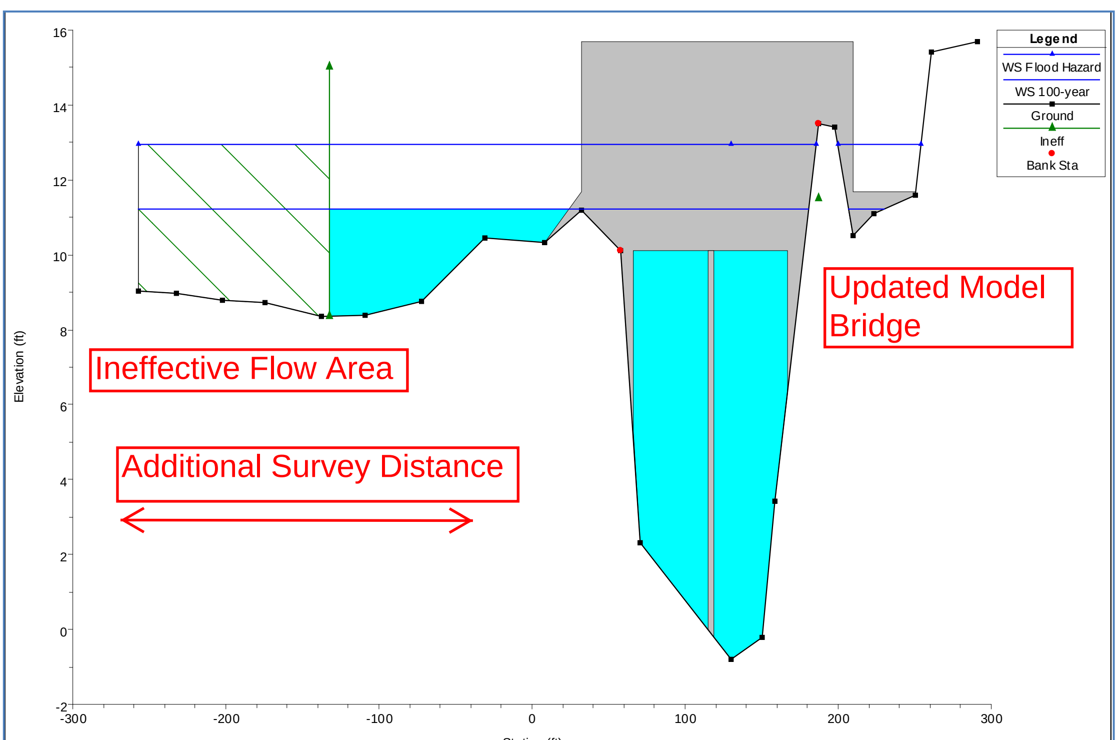


Existing Conditions Model XS 5.124

Figure 2: Cross-sectional views (looking downstream) at cross-section 5.124
PF1 = FEMA 100-yr flow 8,330 cfs; PF2 = NJDEP Flood Hazard flow 10,413 cfs.

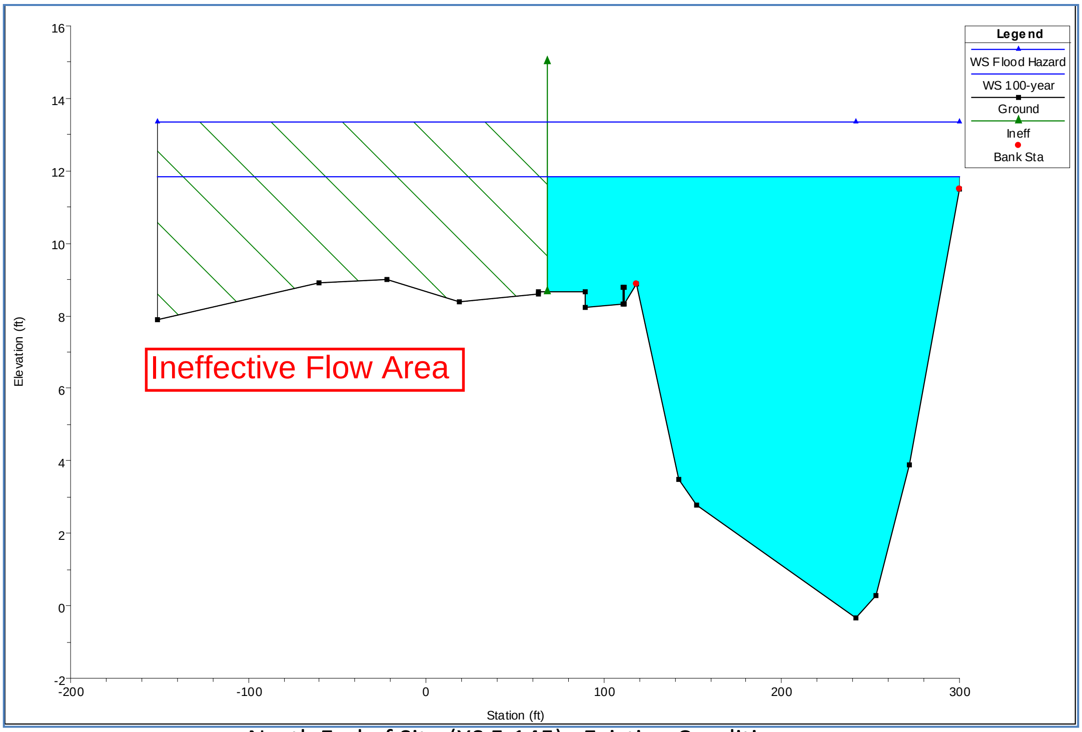


Monroe Street Bridge as modeled in Effective and Duplicate Effective Models

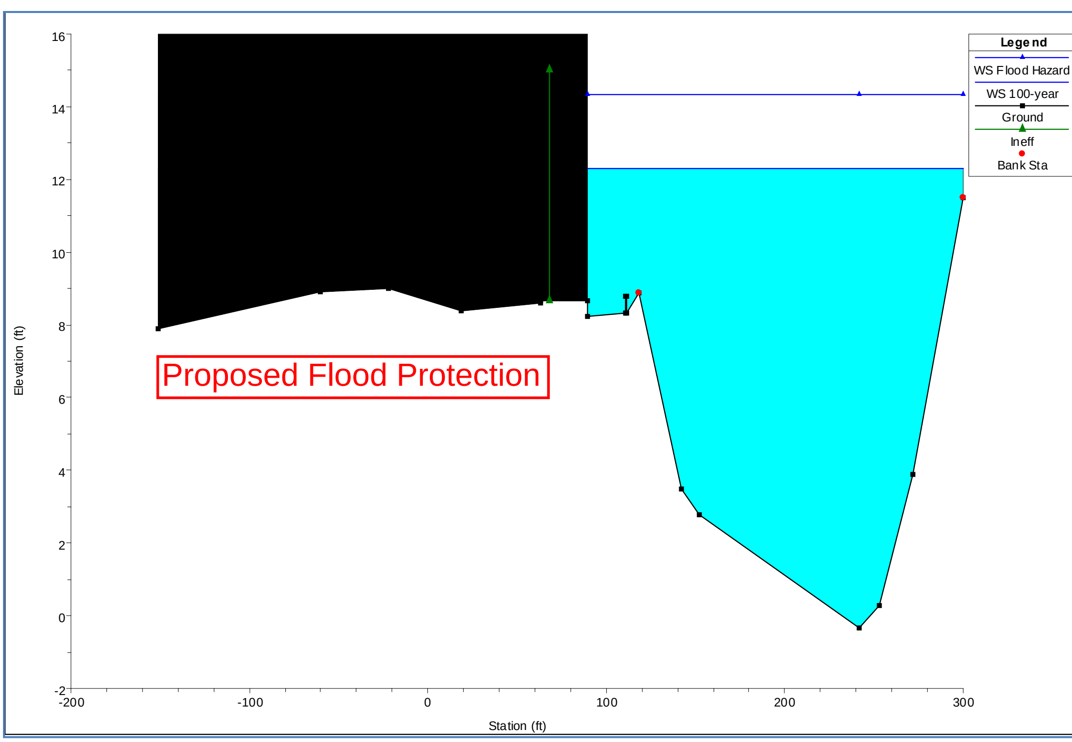


Monroe Street Bridge as modeled in Existing Conditions and Proposed Conditions Models

Figure 3: Cross-sectional views (looking downstream) of Monroe Street Bridge
PF1 = FEMA 100-yr flow 8,330 cfs; PF2 = NJDEP Flood Hazard flow 10,413 cfs.

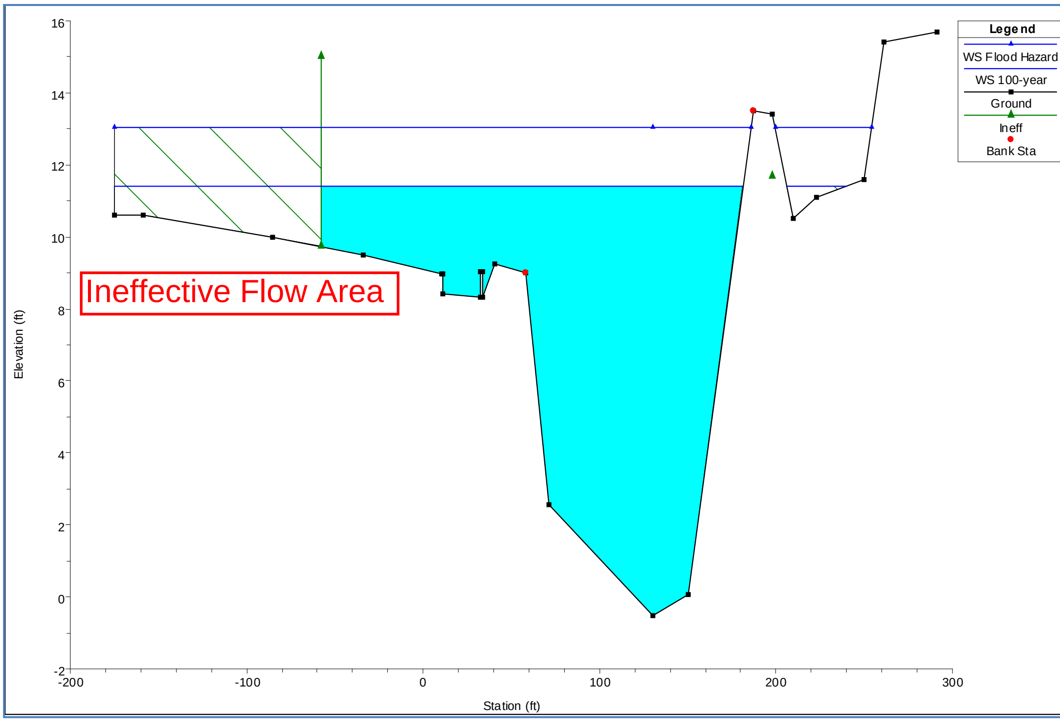


North End of Site (XS 5.145): Existing Conditions.

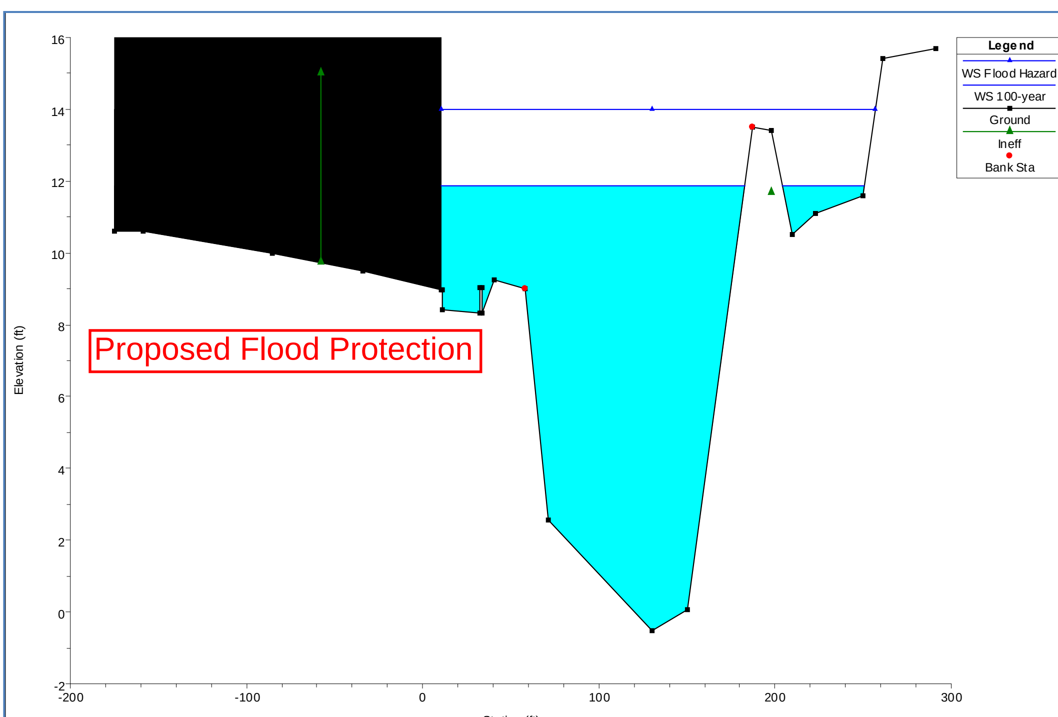


North End of Site (XS 5.145): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 4: Cross-sectional view from upstream (north) side of site looking downstream.
PF1 = FEMA 100-yr flow 8,330 cfs; PF2 = NJDEP Flood Hazard flow 10,413 cfs.

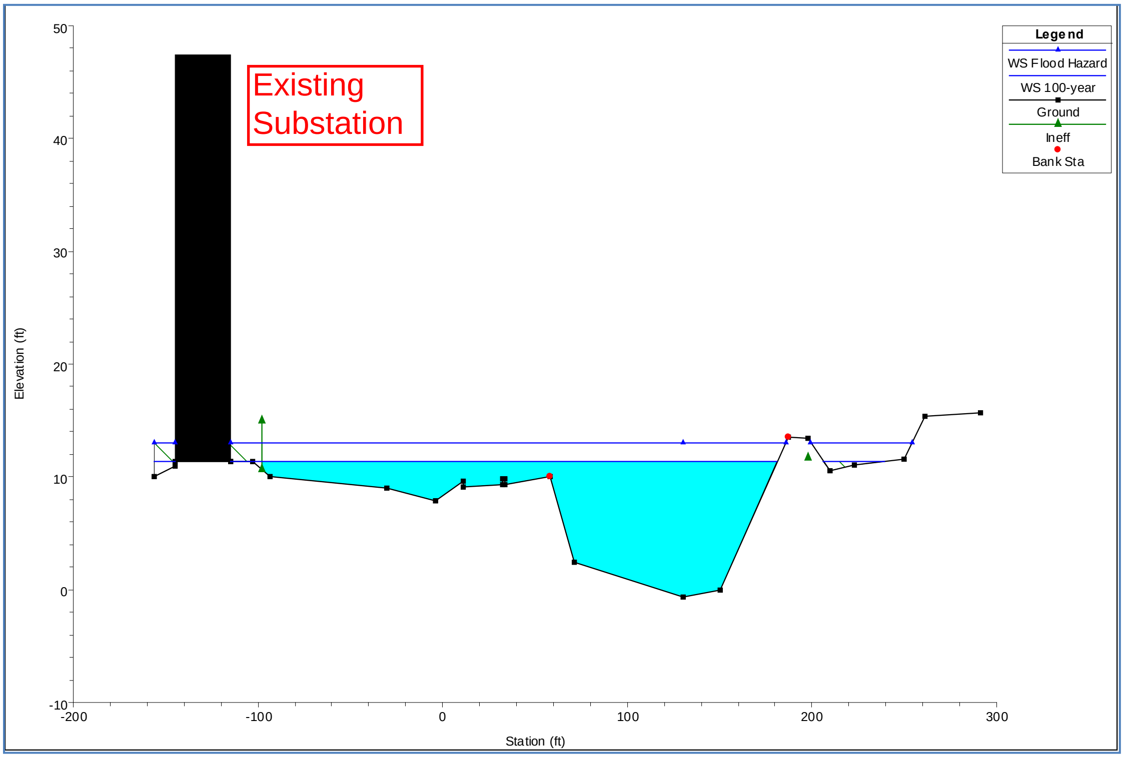


Middle of Site (XS 5.132): Existing Conditions.

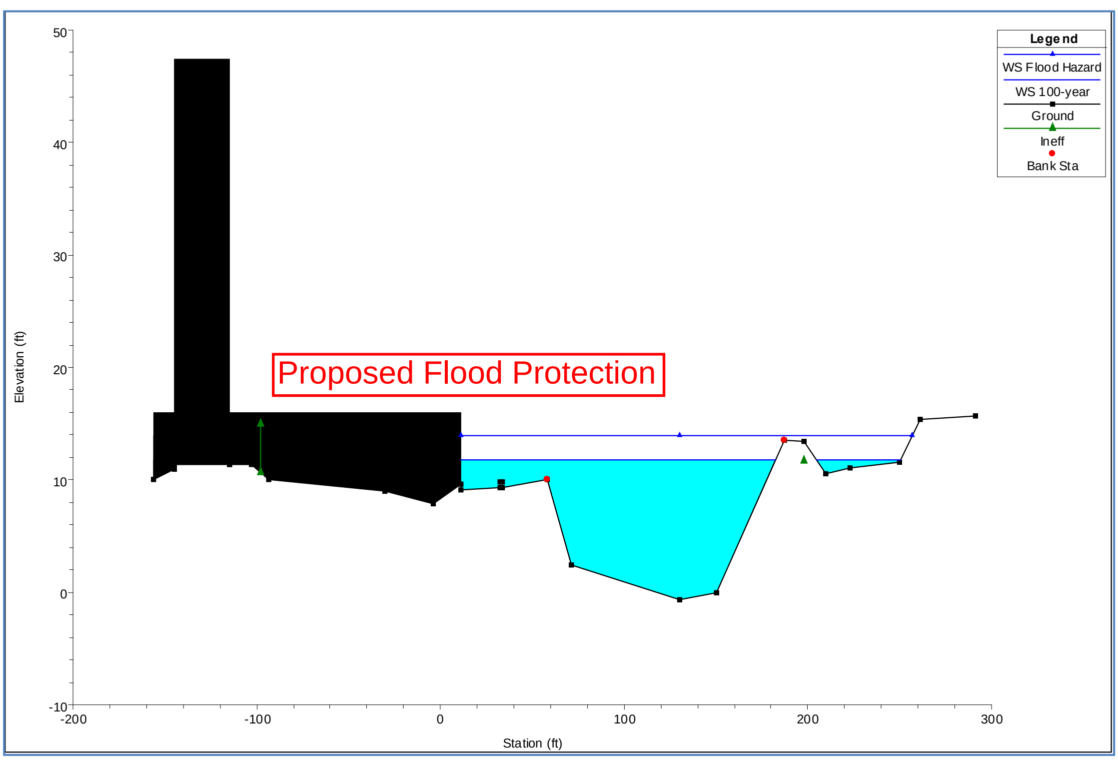


Middle of Site (XS 5.132): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 5: Cross-sectional view from middle of site (XS 5.132) looking downstream.
PF1 = FEMA 100-yr flow 8,330 cfs; PF2 = NJDEP Flood Hazard flow 10,413 cfs.

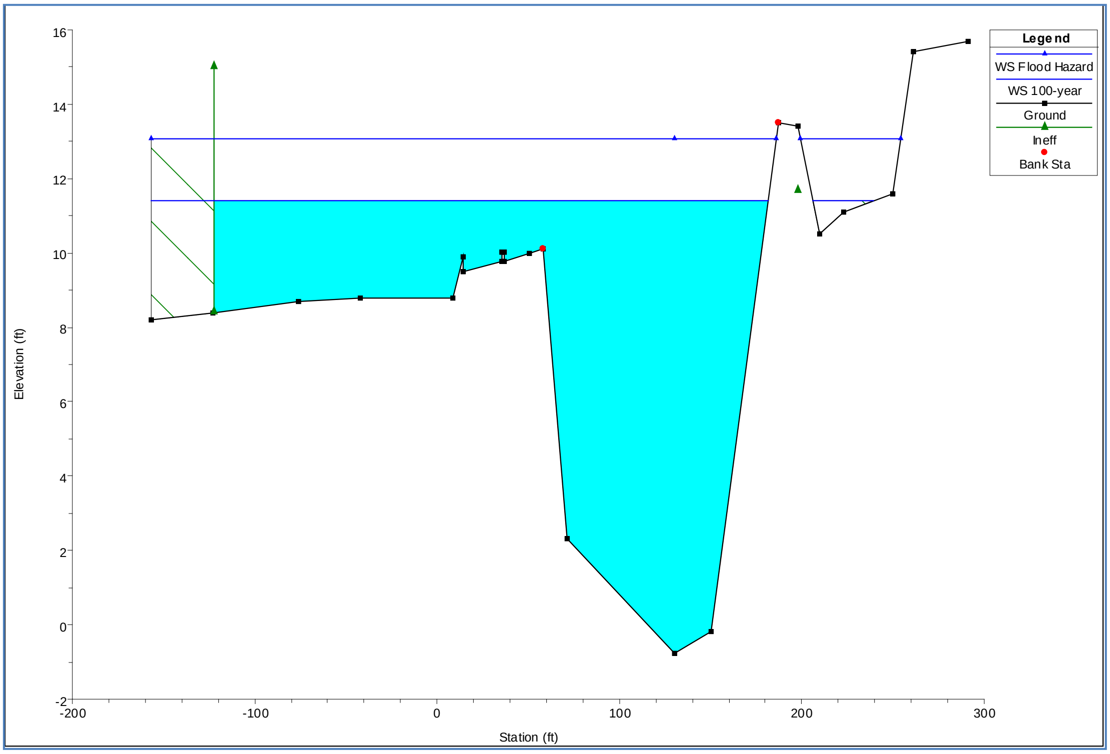


Middle of Site (XS 5.124): Existing Conditions.

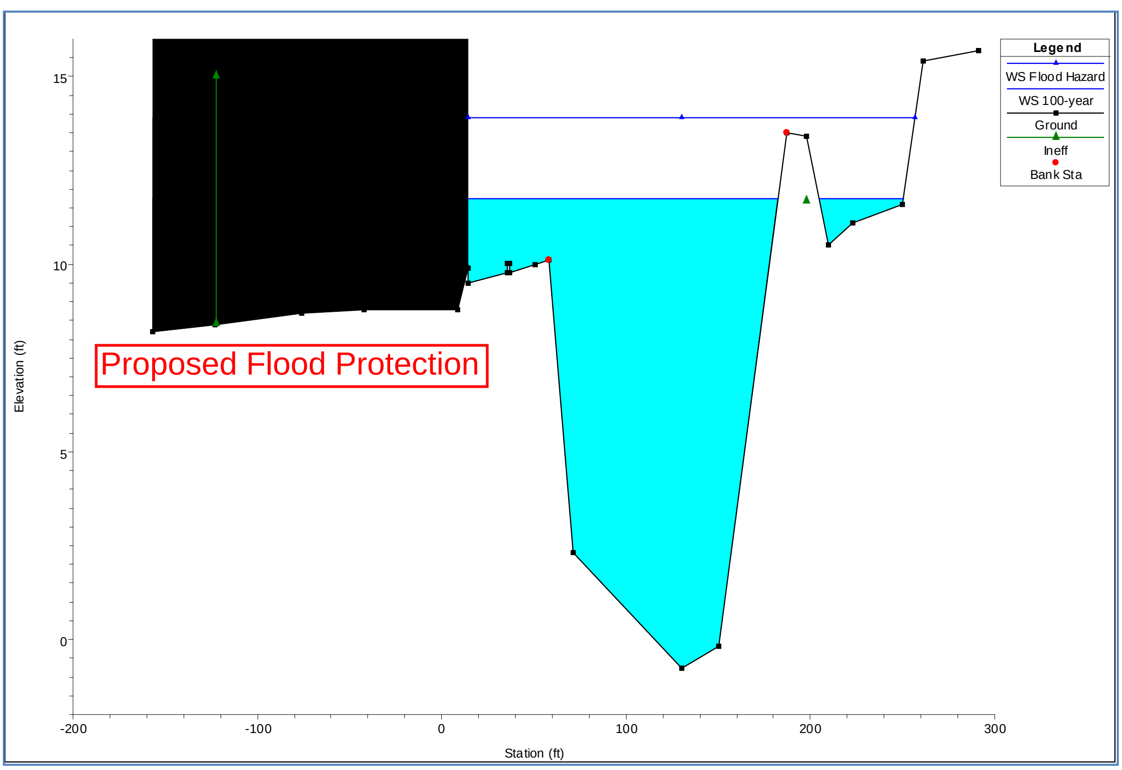


Middle of Site (5.124): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 6: Cross-sectional view from XS 5.124 looking downstream.
PF1 = FEMA 100-yr flow 8,330 cfs; PF2 = NJDEP Flood Hazard flow 10,413 cfs.



South End of Site (XS 5.117): Existing Conditions.



South End of Site (XS 5.117): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 7: Cross-sectional view from XS 5.117 looking downstream.
PF1 = FEMA 100-yr flow 8,330 cfs; PF2 = NJDEP Flood Hazard flow 10,413 cfs.

FLOOD IMPACT STUDY FOR SOMERVILLE SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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Table of Contents

1.0 Background

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5. Jackson Road Substation (7)

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7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Somerville Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The Somerville Substation is located about 700 feet north of the Route 206 and S. Bridge Street intersection, Somerville, NJ, 08876 and is approximately 2 acres. The site is bounded by SAS Medical Arts to the southwest; S. Bridge Street to the east; and a cemetery to the north. There are many overhead power lines in and around the site with the lowest point approximately 25-ft above grade. There is gated access to the site from S. Bridge St and it is generally open around the property. The Raritan River lies to the south of the site and flows from west to east. US Hwy 206 serves as an upstream barrier preventing flood flows from flowing across the site. However, flooding of the site is possible from flood flows in the Raritan River adjacent to and downstream of the site.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Somerville Substation.

1) USGS Computer Program E431 Input Printouts from 30 Jan 1997 (RARITAN_RIV_HILLSBOROUGH_USGS_INPUT.pdf)
2) USGS Computer Program E431 Output Printouts from 30 Jan 1997 (RARITAN_RIV_HILLSBOROUGH_USGS_RUN.pdf)
3) PSE&G Services Corporation – Surveys & Mapping. Boundary and Topographic Survey – Somerville Substation (23 April 2012)
4) NJDEP. Delineation of Floodway and Flood Hazard Area – Borough of Somerville: Raritan River. January 1986.
5) Black & Veatch. 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

The USGS Computer Program E431 input printout from the 1997 Raritan River model (document 1) was the basis of the model development, while the output printouts (document 2) provided model results for the NJDEP 100-year flood plain and floodway. The site survey (document 3) assisted in determining ground elevations at and around the site (see Figure 2). The Substation Flood Protection Report (document 5) provided the estimated height for the flood protection measures. The vertical datum for all elevations reported in the USGS Computer Program E431 model printouts (documents 1 and 2) is NGVD 29, while the vertical datum for documents 3 and 5 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevations. All elevations presented in this report are NAVD 88 unless otherwise noted (i.e. Figures 3 though 5, which are based on model data from documents 1 and 2).

The Substation Flood Protection – Summary Evaluation Report (document 5), recommends a top elevation for the flood protection wall at the Somerville Substation 2 feet above the 100-year flood level. Based on references 1 and 2, the 100-year flood level in the vicinity of the site is 46.5 ft (NAVD 88). This recommendation would yield a top of the wall at 48.5 ft (NAVD 88). Final recommendations for the flood protection height are based on the findings of this hydraulic study and are presented in the Conclusions and Recommendations (Section 3.0).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Raritan River in the vicinity of the Somerville Substation. The hydraulic model used for this study was a copy of NJDEP's HEC-RAS floodway model for the entire Raritan River.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. This model is the USGS E431 model and the corresponding reported results in the USGS E431 output file. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were prepared from information in the USGS E431 model printouts: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is the input data from the USGS E431 input file, input into a HEC-RAS model and run to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections and bridges.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

A profile of the river indicating exact cross-section locations was not provided to aid in the development of the HEC-RAS models relative to the Somerville Substation site. Hence, the cross-section locations had to be estimated based on available information within USGS E431 model printout (Effective Model), NJDEP Delineation of Floodway and Flood Hazard Area Map, (Document 4), and aerial imagery in Google Earth. Information in the Effective Model indicates that cross-section 136850 is just downstream of the US Hwy 206 Bridge. After estimating the location of this cross-section, all other cross-section locations in the model were estimated from distances between cross-sections as reported in the Effective Model. Somerville Substation lies along the northern bank (left bank) of the Raritan River just downstream of the US Hwy 206 Bridge. Somerville Substation and the estimated river model layout are shown in Figure 1.

In addition to the US Hwy 206 Bridge, the Effective Model also indicates that there is a railroad bridge approximately 1,500 feet upstream of the US Hwy 206 Bridge. In order to calibrate the Duplicate Effective Model to the Effective Model results, the expansion coefficients at the upstream cross-sections of the bridges was set to 0.1 and 0.24 for the railroad and US Hwy 206 bridges, respectively.

In development of the Existing Conditions Model (Somerville Model 3), the following changes were implemented:

- the US Hwy 206 bridge geometry was modified
- expansion and contraction coefficients at the US Hwy 206 bridge were modified
- the railroad bridge (1,500 feet upstream of US Hwy 206 bridge) was deleted
- cross-sections were added in the vicinity of the site

The bridge at US Hwy 206 was reconstructed in 2003. The bridge characteristics were modified based on available information. Figure 3 presents the US Hwy 206 Bridge as modeled in the Duplicate Effective (NJDEP) and Existing Conditions Models, respectively. As well, the contraction and expansion coefficients in the Existing Conditions Model were set to 0.3 and 0.5 respectively for the cross-sections immediately upstream and downstream of the US Hwy 206 Bridge. These values are in line with standard recommended values for most bridges.

The Effective Model indicates that there was a railroad bridge approximately 1,500 feet upstream of the US Hwy 206 Bridge; however, recent aerial imagery indicates that this bridge has been removed. The railroad bridge was deleted for the Existing Conditions Model.

Two additional cross-sections transecting the Somerville site were added to the Existing Conditions Model. These were based on the PSE&G site survey as shown in Figure 2 (PSEG, 2012). Added cross-sections are shown in yellow on Figure 1. Figures 4 and 5 present the profiles of the two added cross-sections transecting the Somerville Substation site.

In development of the Proposed Conditions Model (Somerville Model 4), the proposed flood protection was inserted on the east bank in each of the added cross-sections that transect the site. It is represented as a blocked obstruction in the HEC-RAS models and can be visualized in Figures 4 and 5.

The following flows were considered:

- 40,600 cfs - The Raritan River's FEMA 100-year flood flow in the vicinity of the Somerville Site.
- 50,750 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the Raritan River, 100-year flood flow.

During Hurricane Irene, the Somerville Substation was flooded up to an approximate WSEL of 49.0 ft. Based on the HEC-RAS model; this would correspond with a Raritan River flow of approximately 54,000 cfs in the vicinity of the substation.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are very similar to those of the Effective Model. The Existing Conditions Model yielded flood levels that are approximately 1 foot higher than those in the Duplicate Effective Model. However, it is our belief that our Existing Conditions Model more accurately describes the potential for flooding upstream of the US Hwy 206 Bridge than the Duplicate Effective Model. This belief is based on the fact that the Existing Conditions Model has updated bridge geometry, ineffective flow area on the north overbank east of US Hwy 206, and more realistic contraction and expansion loss coefficients.

Table 1 presents the results from the four models considered under 100-year flow flood conditions. River stations in bold indicate the additional cross-sections added to the model at the site.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (40,600 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
148600	51.85	51.86	52.11	52.11	0.00
147550	51.57	51.57	51.85	51.85	0.00
146460	51.02	51.02	51.35	51.35	0.00
145480	50.59	50.59	50.98	50.98	0.00
144060	49.76	49.77	50.27	50.27	0.00
144040	49.59	49.60	50.13	50.13	0.00
143855	49.53	49.53	50.08	50.08	0.00
143360	48.94	48.95	49.61	49.61	0.00
142310	48.61	48.62	49.35	49.35	0.00
141270	48.34	48.36	49.14	49.14	0.00
140200	48.09	48.10	48.94	48.94	0.00
139090	47.79	47.80	48.71	48.71	0.00
138600	47.42	47.43	48.39	48.39	0.00
138250	47.26	47.21	48.27	48.27	0.00
137750	46.95	46.90	48.01	48.01	0.00
136982	US HWY 206 - Bridge				
136850	46.57	46.57	46.57	46.57	0.00
136736	**n/a**	**n/a**	**46.52**	**46.52**	**0.00**
136297	**n/a**	**n/a**	**46.51**	**46.51**	**0.00**
136130	46.47	46.47	46.47	46.47	0.00
134800	46.05	46.05	46.05	46.05	0.00
133500	45.67	45.67	45.67	45.67	0.00
132400	45.31	45.31	45.31	45.31	0.00
131600	45.11	45.11	45.11	45.11	0.00

The Existing Conditions Model yields WSEs that are 1.11 feet higher than the Effective and Duplicate Effective models in the vicinity of US Hwy 206 (at XS 137750). Approximately 1 mile upstream, the Existing Conditions Model yields WSEs that are approximately 0.66 foot higher than the Duplicate Effective Model. Just over 2 miles upstream, the difference is only 0.25 foot.

The Proposed Conditions Model includes the flood protection on the north bank of the model. A rise in WSE due to the flood protection installation is not predicted in the vicinity of the site or further upstream under 100-year flow conditions.

Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 50,750 cfs. River stations in bold indicate the additional cross-sections added to the model at the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (50,750 cfs)

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
148600	53.45	53.81	53.81	0.00
147550	53.17	53.56	53.56	0.00
146460	52.65	53.09	53.09	0.00
145480	52.25	52.75	52.75	0.00
144060	51.51	52.13	52.13	0.00
144040	51.36	52.01	52.01	0.00
143855	51.32	51.97	51.97	0.00
143360	50.82	51.57	51.57	0.00
142310	50.53	51.33	51.33	0.00
141270	50.29	51.14	51.14	0.00
140200	50.05	50.95	50.95	0.00
139090	49.78	50.73	50.73	0.00
138600	49.41	50.44	50.44	0.00
138250	49.38	50.33	50.33	0.00
137750	49.02	50.03	50.03	0.00
136982	US HWY 206 - Bridge			
136850	48.43	48.43	48.43	0.00
136736	**n/a**	**48.37**	**48.37**	**0.00**
136297	**n/a**	**48.40**	**48.40**	**0.00**
136130	48.37	48.36	48.36	0.00
134800	47.97	47.97	47.97	0.00
133500	47.60	47.60	47.60	0.00
132400	47.22	47.22	47.22	0.00
131600	47.02	47.02	47.02	0.00

Based on model results, the proposed sheetpile flood wall around the Somerville Substation will not impact water surface elevations in the Raritan River Floodplain under Flood Hazard Flow Conditions. The model indicates that there will be no rise as a result of the sheetpile wall in the Raritan River under Flood Hazard Flow Conditions.

Black & Veatch modeled the observed flooding condition of EL. 49 feet reported by PSE&G during Hurricane Irene. In order to realize an inundation of that depth at the site, a flow of approximately 54,000 cfs would be necessary.

3.0 Conclusions and Recommendation

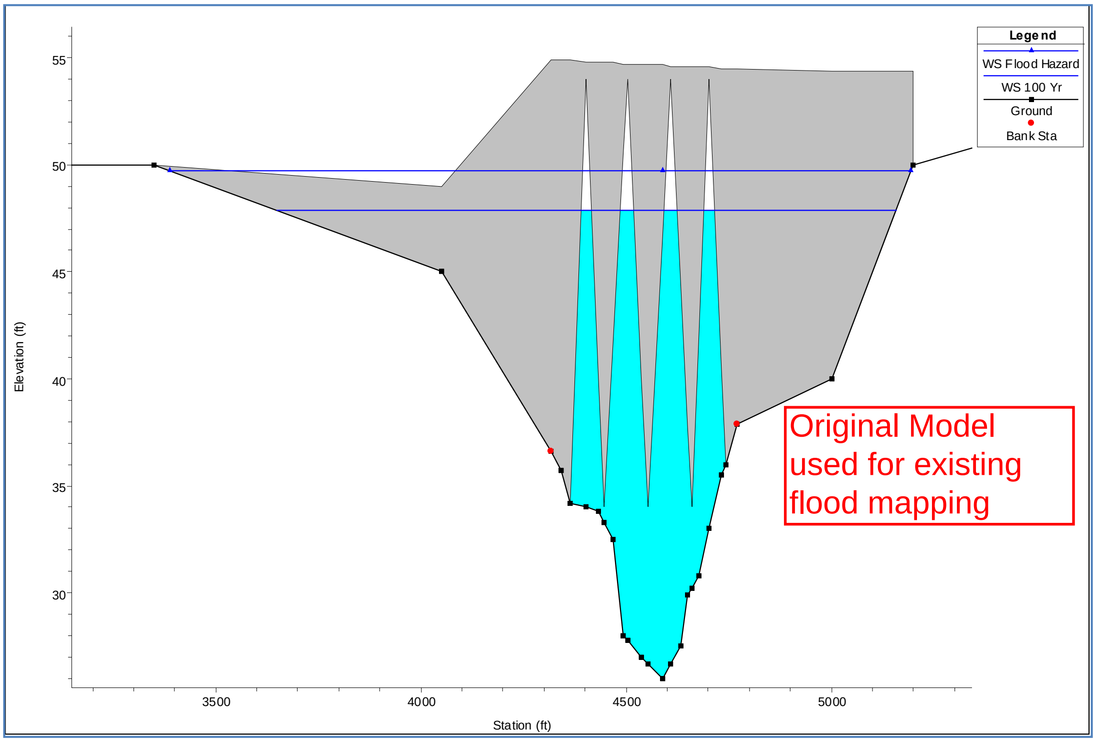
Although in the floodplain, the Somerville Substation site sits over 20 feet above the invert of the Raritan River and is protected from effective flow in the floodplain due to US Hwy 206 and SAS Medical Arts just south and west of the substation (see Figure 2 – Topographic Survey). The proposed flood protection facilities will not impact flooding upstream of the Somerville Substation. If PSE&G proceed with the design and construction of the proposed flood mitigation measures for the Somerville Substation, upstream existing structures will not be impacted. Hydraulically and based on the model results, there are no impacts to downstream structures.

The existing conditions model prepared for this study was based on the NJDEP model but was modified to more accurately describe the new US Hwy 206 Bridge, ineffective flow area on the north floodplain east of US Hwy 206, and the removal of the railroad bridge 1,500 feet upstream of US Hwy 206. The updates resulted in an increase in predicted flood levels for the existing conditions model. For the 100-year flood, water surface elevations in the reach immediately adjacent to the Somerville Substation increased by 1.11 feet. This finding will be addressed during the permitting process and will require approval of the NJDEP and FEMA.

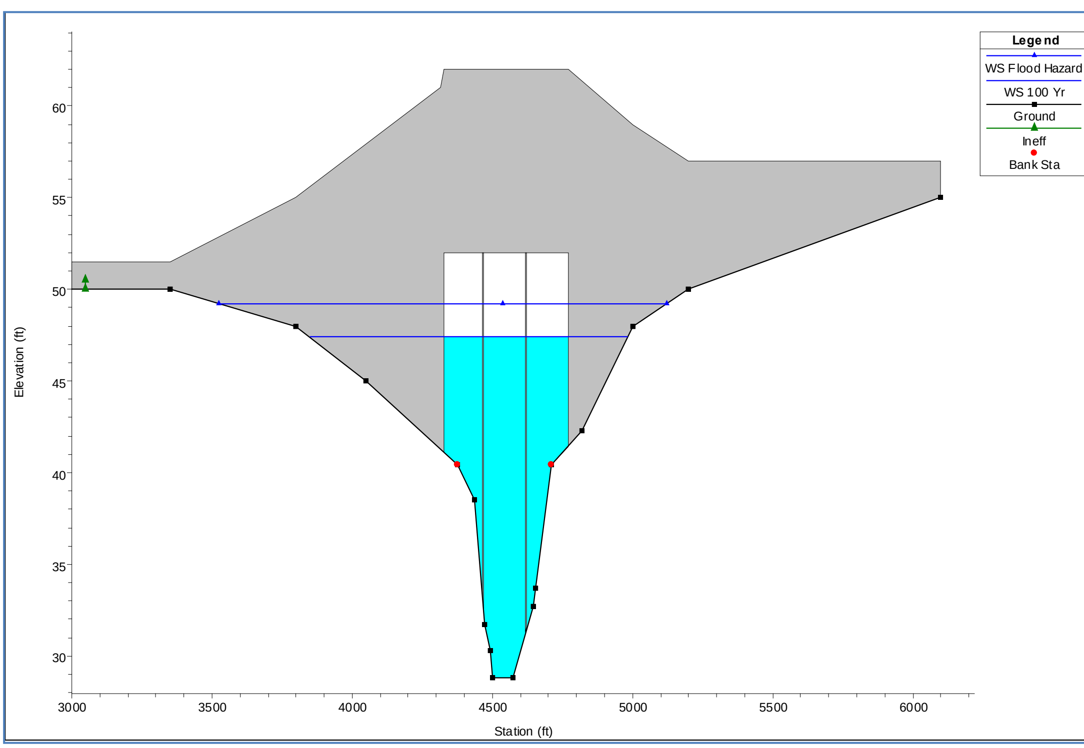
The flow and inundation from Hurricane Irene were greater than both the FEMA 100-year and NJDEP Flood Hazard flows. An elevation of 50.0 feet, which is approximately 1 foot above the maximum observed flood elevation, was selected as the top of wall design level.

ELEVATION SUMMARY (FEET NAVD 88)				
Site	Average Site EL.	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL.	Proposed Flood Protection EL.
Somerville	46	49.0	48.4	50.0

[redacted]

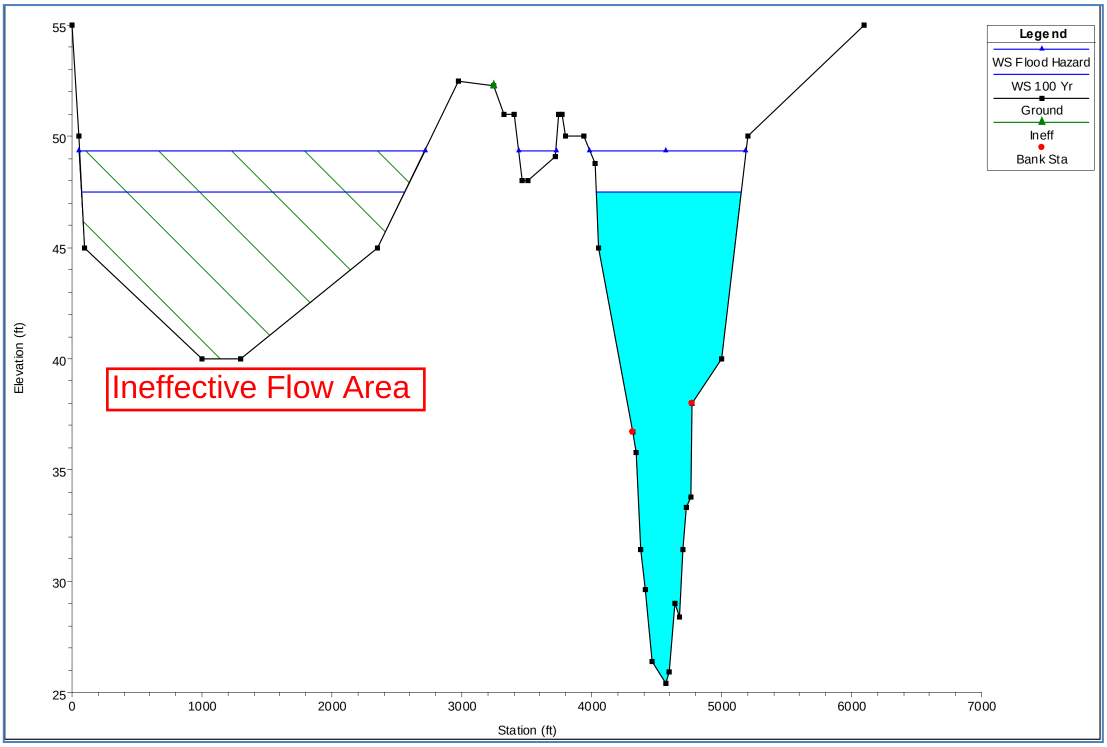


US Hwy 206 Bridge as modeled in Effective and Duplicate Effective Models



US Hwy 206 Bridge as modeled in Existing Conditions and Proposed Conditions Models

Figure 2: Cross-sectional views (looking downstream) of US Hwy 206 Bridge as modeled in Duplicate Effective Model and as modeled based on available information in Existing Conditions and Proposed Conditions Models.
PF1 = FEMA 100-yr flow 40,600 cfs; PF2 = NJDEP Flood Hazard flow 50,750 cfs.



West Side of Site (XS 136736): Existing conditions.

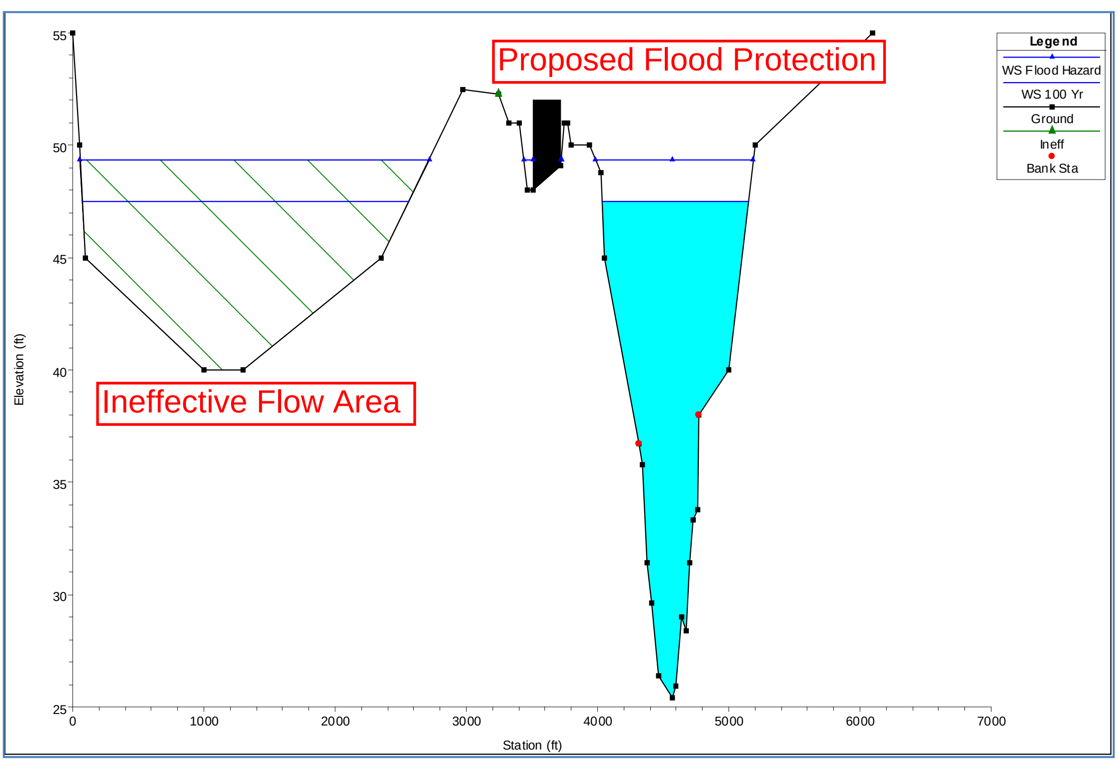
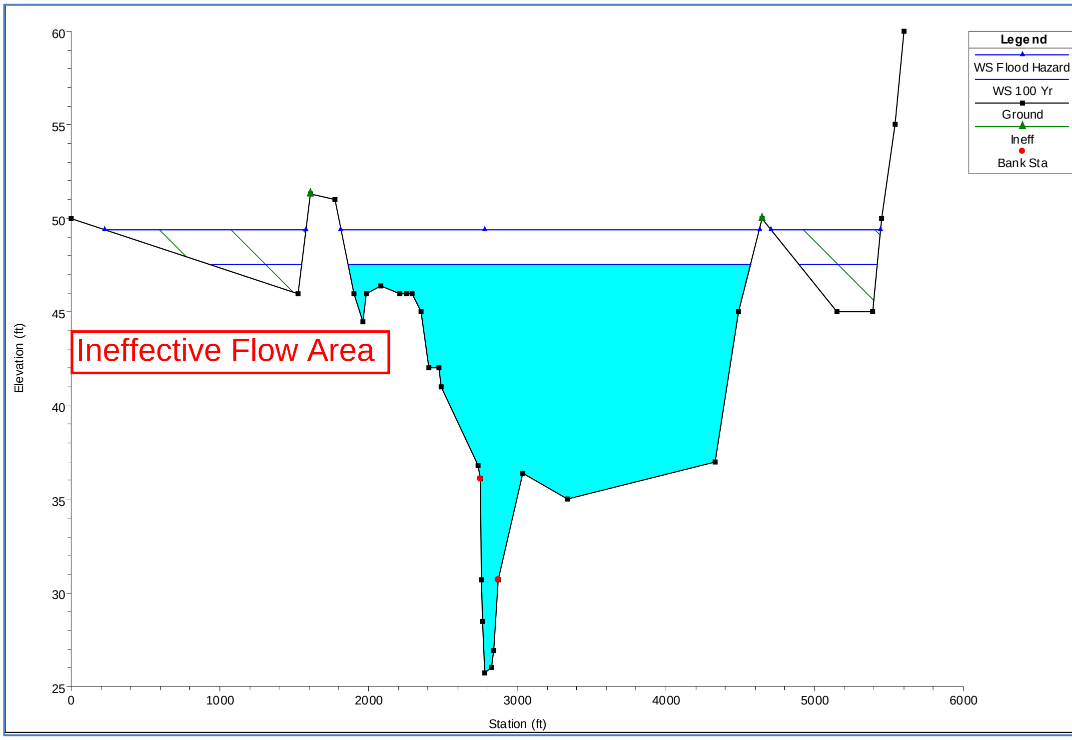
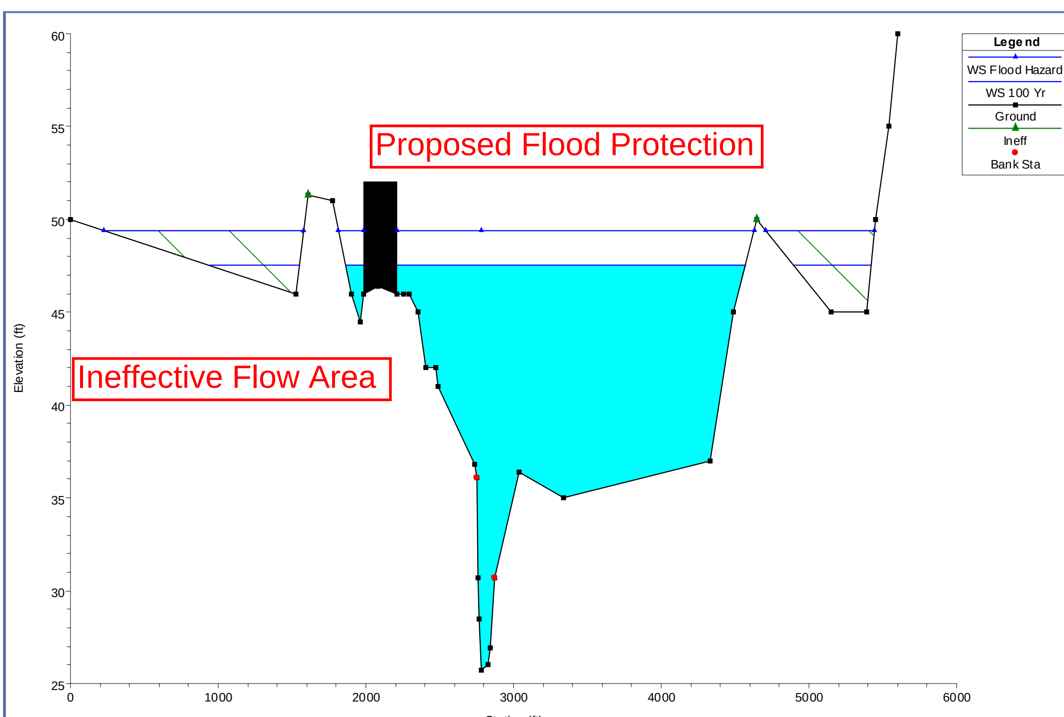


Figure 3: Cross-sectional view from upstream (north) side of site looking downstream.
PF1 = FEMA 100-yr flow 40,600 cfs; PF2 = NJDEP Flood Hazard flow 50,750 cfs.



East Side of Site (XS 136297): Existing conditions.



East Side of Site (XS 136297): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 4: Cross-sectional view from east side of site (XS 136297) looking downstream. PF1 = FEMA 100-yr flow 40,600 cfs; PF2 = NJDEP Flood Hazard flow 50,750 cfs.

FLOOD IMPACT STUDY FOR JACKSON ROAD SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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Building a world of difference.

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1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing substantial impact to some electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Bayway) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. <u>Jackson Road Substation (7)</u>

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Jackson Road Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The Jackson Road Substation is located at an approximate address of 11 Jackson Rd, Totowa, NJ, 07512 and is approximately three acres. The site is bounded by a forest/wetland to the west; Jackson Rd to the east; a warehouse to the north; and Madison Road and a Trucking Company's warehouse to the south. Overhead power lines, approximately 30-ft above grade at the lowest point, are all around and inside the site. There is an approximate 2.5-ft tall Jersey barrier wall that encompasses all but the eastern side of the substation. There is gated access to the site from Jackson Road. The site perimeter is located in close proximity to the limit of the 300 foot NJDEP Riparian buffer zone, and should be verified during design.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Jackson Road Substation.

1) NJDEP. HEC-2 Input and Output Printouts from 19 Oct 1983 (SINGAC_BR_TOTOWA_CED_83.pdf)
2) FEMA. Passaic County, NJ- Flood Profiles sheet 227. January 1986.
3) FEMA. Flood Insurance Rate Map (FIRM), Passaic County, NJ: Panels 194, 211 and 213. 28 SEP 2007.
4) NJDEP. Delineation of Floodway and Flood Hazard Area – Naachpunkt Brook. 18 DEC 1984.
5) Carroll Engineering. Boundary and Topographic Survey – PSE&G Co. Jackson Road Substation (01 June 2012)
6) Black & Veatch. 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

The NJDEP provided printouts of their HEC-2 Signac Brook Model dated from 1983 (document 1). This document was the basis of the model development, and its associated output provided model results for the NJDEP 100-year floodplain and floodway. The FEMA Flood Profile and FIRM, and the NJDEP Delineation of Floodway (documents 2, 3 and 4) assisted in locating the Jackson Road site within the HEC-2 model (see Figure 1). The site survey (document 5) was used to determine ground elevations at and around the site. The Substation Flood Protection Report (document 6) provided the estimated height for the flood protection measures. The vertical datum for all elevations reported in the NJDEP HEC-2 files (document 1) is NGVD 29, while the vertical datum for documents 2, 5 and 6 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevations. All elevations presented in this report are NAVD 88 unless otherwise noted (i.e., Figures 2 though 6, which are based on model data from document 1).

The Substation Flood Protection – Summary Evaluation report (document 6), recommends a top elevation for the flood protection wall at the Jackson Road Substation 2 feet above the 100-year flood level. Based on reference 1, the 100-year flood level in the vicinity of the site is 173.2 ft (NAVD 88). This recommendation would yield a top of the wall at 175.2 ft (NAVD 88). Final recommendations for the flood protection height are based on the findings of this hydraulic study and are presented in the Conclusions and Recommendations (Section 3.0).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Signac Brook in the vicinity of the Jackson Road Substation. The hydraulic model used for this study was developed from NJDEP's HEC-2 input data.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. These are the water surface elevations (WSEs) as presented in the results of the HEC-2 printouts. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels.

The remaining three other models were developed from the Effective model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is the input data from the HEC-2 files, input into a HEC-RAS model and run to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

A profile of the river indicating exact cross-section locations for cross-sections in the NJDEP HEC-2 model was not provided to aid in the development of the HEC-RAS models relative to the Jackson Road Substation site. Hence, the cross-section locations had to be estimated based on available information within the HEC-2 printout (Effective Model), river ground levels indicated in the flood profile sheet and aerial imagery in Google Earth. The Flood Profile Sheet indicates an inverted river slope at the Conrail Railroad Bridge. The inverted slope and bridge were then identified in the HEC-2 file. The location was further confirmed due to agreement in distances to upstream bridges. After estimating the location of the cross-section just upstream of the Conrail Railroad Bridge, all other cross-section locations in the model were estimated from distances between cross-sections as reported in the Effective Model. Jackson Road Substation lies along the eastern bank (left bank) of the Signac Brook downstream of Continental Road Bridge and upstream of the Conrail Railroad Bridge. Jackson Road Substation and the estimated river model layout are shown in Figure 1. Cross-sections taken from the HEC-2 model are shown in white.

Two cross-sections were modified and three cross-sections were added in the vicinity of the Jackson Road Substation site for the Existing Conditions Model. Elevations in the east (left) bank of cross-sections 2475 and 2135 were adjusted and the width of these cross-sections was broadened in order to transect the site. These modifications as well as the added cross-sections were based on the site survey (Carroll Engineering, 2012). Added cross-sections and modified cross-sections are shown in yellow on Figure 1. Figures 2 through 6 present the profiles of the modified and added cross-sections in the vicinity of the Jackson Road Substation site. Immediately upstream of the Jackson Road Substation is a warehouse which will block effective flow. The warehouse is indicated as a blocked obstruction in Figure 2. In Figures 3 and 4 – Existing Conditions, ineffective flow markers have been placed to further account for the warehouse. Ineffective flow markers are also placed in cross-sections 2135 and 2115 (see Figures 5 and 6) to account for the severe constriction to flow at the Conrail Railroad Bridge.

In development of the Proposed Conditions Model (Jackson Road Model 4), the proposed flood protection was inserted on the east bank in each of the added cross-sections that transect the site. It is represented as a blocked obstruction in the HEC-RAS models and can be visualized in Figures 2 through 6.

The following flows were considered:

- 2,000 cfs - The Signac Brook's FEMA 100-year flood flow in the vicinity of the Jackson Road Site.
- 2,500 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the Signac Brook, 100-year flood flow

During Hurricane Floyd, the Jackson Road Substation was flooded up to an approximate WSEL of 173.5 ft. Based on the HEC-RAS model this would correspond to a flow of 2,130 cfs. This flow is nearly equivalent to the 100-year flood flow for the Signac Brook flow of approximately 2,000 cfs in the vicinity of the substation. The site has not flooded since Hurricane Floyd in 1999 (Black & Veatch, 2012).

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are similar to those of the Effective Model.

The Existing Conditions Model, which includes additional and modified cross-sections, also yielded flood levels that are similar to those in the Effective and Duplicate Effective Models.

Table 1 presents the results from the four models considered under 100-year flow flood conditions. River stations in bold indicate cross-sections added to the model in the vicinity of the site.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (2,000 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
2915	173.72	173.73	173.63	173.67	0.04
2635	173.58	173.59	173.48	173.53	0.05
2634	Continental Road Bridge				
2595	173.30	173.39	173.24	173.30	0.06
2525	**-**	**-**	**173.06**	**173.13**	**0.07**
***2475**	**173.18**	**173.21**	**173.01**	**173.07**	**0.06**
2285	**-**	**-**	**173.00**	**172.95**	**-0.05**
***2135**	**172.62**	**172.63**	**172.93**	**172.89**	**-0.04**
2115	**-**	**-**	**172.93**	**172.90**	**-0.03**
1985	172.56	172.59	172.59	172.59	0.00
1984	Conrail Railroad Bridge				
1960	172.55	172.58	172.58	172.58	0.00
1560	172.51	172.53	172.53	172.53	0.00
1180	172.48	172.48	172.48	172.48	0.00
530	172.38	172.39	172.39	172.39	0.00
250	172.35	172.36	172.36	172.36	0.00
0	172.10	172.10	172.10	172.10	0.00
-300	172.22	172.22	172.22	172.22	0.00
-740	172.03	172.03	172.03	172.03	0.00
-1290	172.08	172.08	172.08	172.08	0.00
-1539	171.87	171.87	171.87	171.87	0.00
-1540	172.00	172.00	172.00	172.00	0.00
*Indicates a modified cross-section					

The Existing Conditions Model yields WSEs that are similar to the Effective and Duplicate Effective models in the vicinity of Jackson Road Substation.

The Proposed Conditions Model includes the flood protection on the east bank of the model. A slight rise of 0.07 feet is predicted in the vicinity of the site and further upstream due to the flood protection installation under 100-year flow conditions. However, no impact to water levels is seen 0.6 miles upstream at Passaic County Road 640 (also known as French Hill Road).

Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 2,500 cfs. River stations in bold indicate cross-sections added to the model in the vicinity of the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (2,500 cfs)

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
2915	175.60	175.37	175.56	0.19
2635	175.56	175.31	175.52	0.21
2634	Continental Road Bridge			
2595	175.41	175.29	175.35	0.06
2525	**-**	**175.23**	**175.29**	**0.06**
***2475**	**175.34**	**175.20**	**175.27**	**0.07**
2285	**-**	**175.19**	**175.16**	**-0.03**
***2135**	**174.88**	**175.17**	**175.14**	**-0.03**
2115	**-**	**175.16**	**175.14**	**-0.02**
1985	174.75	174.75	174.75	0.00
1984	Conrail Railroad Bridge			
1960	174.74	174.74	174.74	0.00
1560	174.81	174.81	174.81	0.00
1180	174.80	174.80	174.80	0.00
530	174.74	174.74	174.74	0.00
250	174.70	174.70	174.70	0.00
0	174.49	174.49	174.49	0.00
-300	174.60	174.60	174.60	0.00
-740	174.44	174.44	174.44	0.00
-1290	174.49	174.49	174.49	0.00
-1539	174.23	174.23	174.23	0.00
-1540	174.39	174.39	174.39	0.00
*Indicates a modified cross-section				

Based on model results, the proposed sheetpile flood wall around the Jackson Road Substation will impact water surface elevations in the Signac Brook Floodplain under Flood Hazard Flow Conditions. The model indicates that there will be a rise of 0.07 feet in the reach immediately adjacent to the Jackson Road Substation and a rise of 0.21 feet upstream of Continental Road Bridge as a result of the sheetpile wall in the Signac Brook floodplain under Flood Hazard Flow Conditions. However, a measurable rise in water levels is not predicted 0.6 miles upstream near Passaic County Road 640 (also known as French Hill Road).

3.0 Conclusions and Recommendation

The proposed flood protection facilities will have a slight impact on flooding levels upstream of the Jackson Road Substation. If PSE&G proceeds with the design and construction of the proposed flood mitigation measures for the Jackson Road Substation, there could be a minor impact to upstream existing structures. Hydraulically and based on the model results, there are no impacts to downstream structures.

Although the floodway does extend onto the PSE&G property, there is sufficient space on the site to accommodate proposed facility improvements without entering the floodway. PSE&G should ensure that the flood protection wall does not impose on the floodway when it is installed.

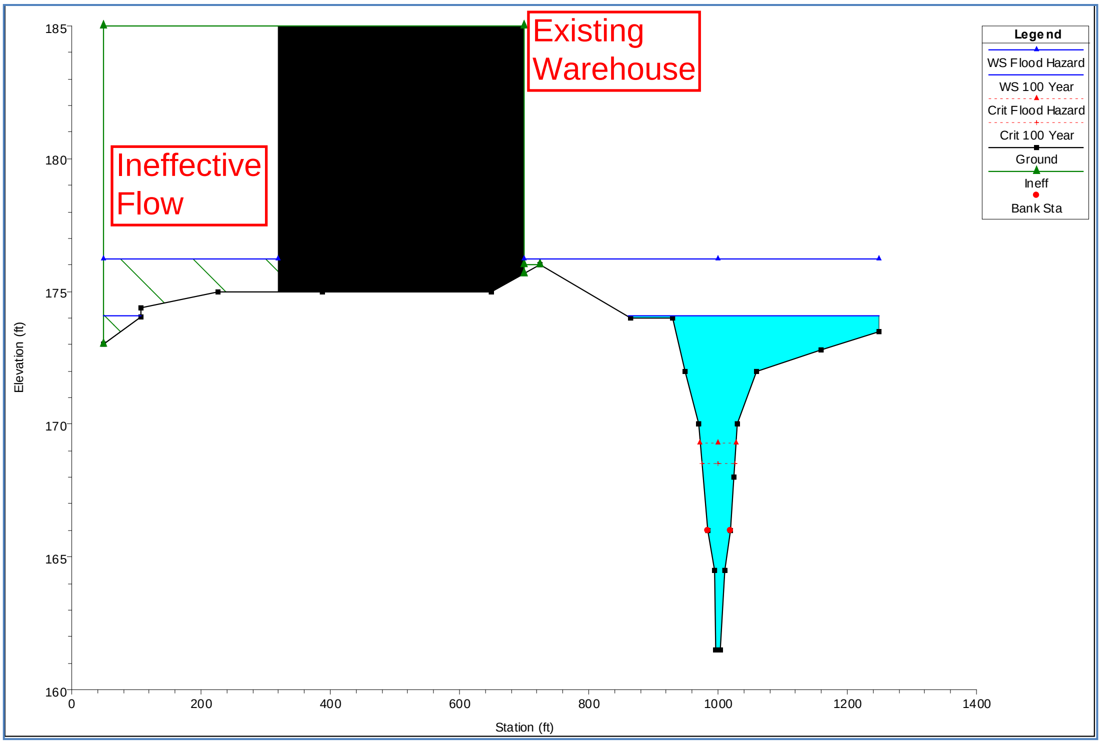
A maximum flood depth of 14 inches at the breaker was observed at the Jackson Road Substation during Hurricane Floyd in 1999. Based on modeling results, the flow during Hurricane Floyd was greater than both the NJDEP 100-year flow in the Signac Brook, and the NJDEP Flood Hazard Flow. An Elevation of 177.2 feet, which is 1 foot above the Black & Veatch estimated Flood Hazard Elevation and one foot above the maximum observed flood elevation, was selected as the top of wall design level.

ELEVATION SUMMARY (FEET NAVD 88)

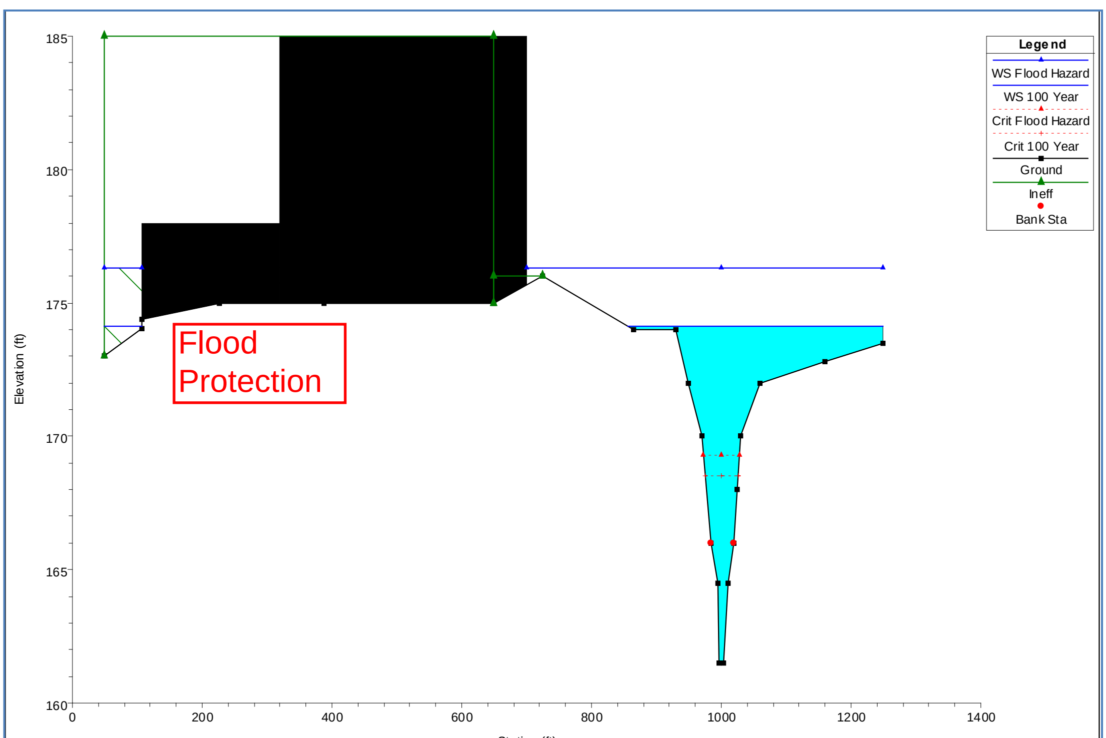
Site	Average Site EL.	Maximum Observed Flood EL. (PSE&G)	NJDEP Flood Hazard EL.	Proposed Flood Protection EL.
Jackson Road	175	176.2	175.3	177.2

[redacted]

[redacted]

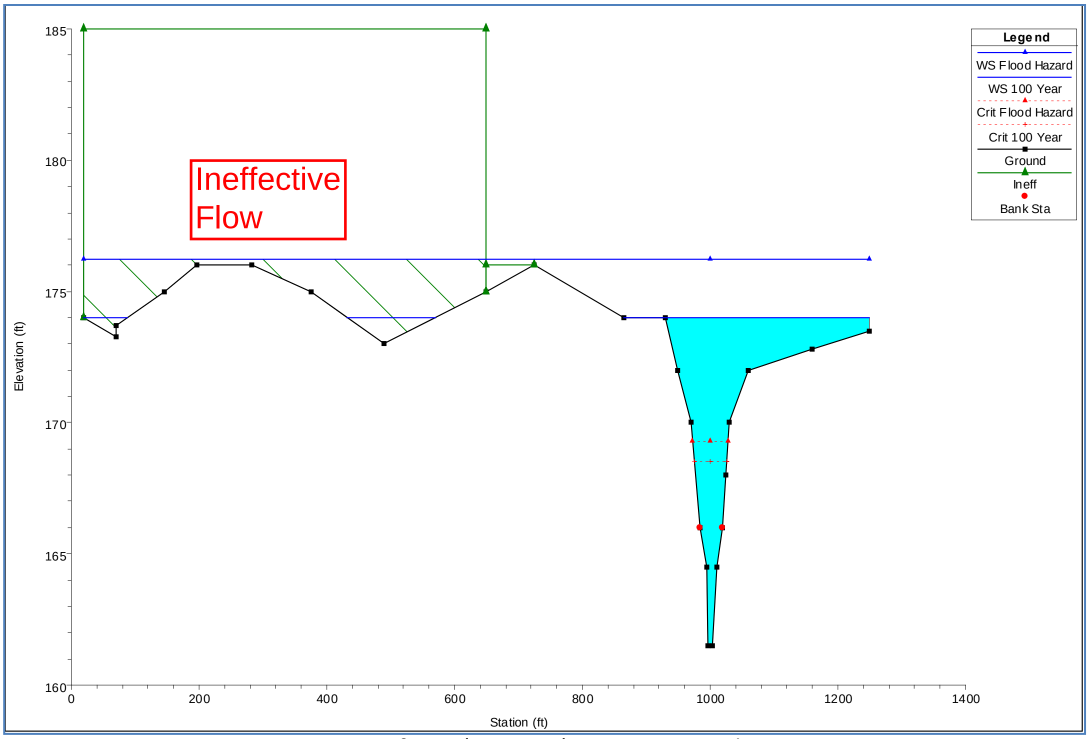


Upstream of Site (XS 2525): Existing Conditions.

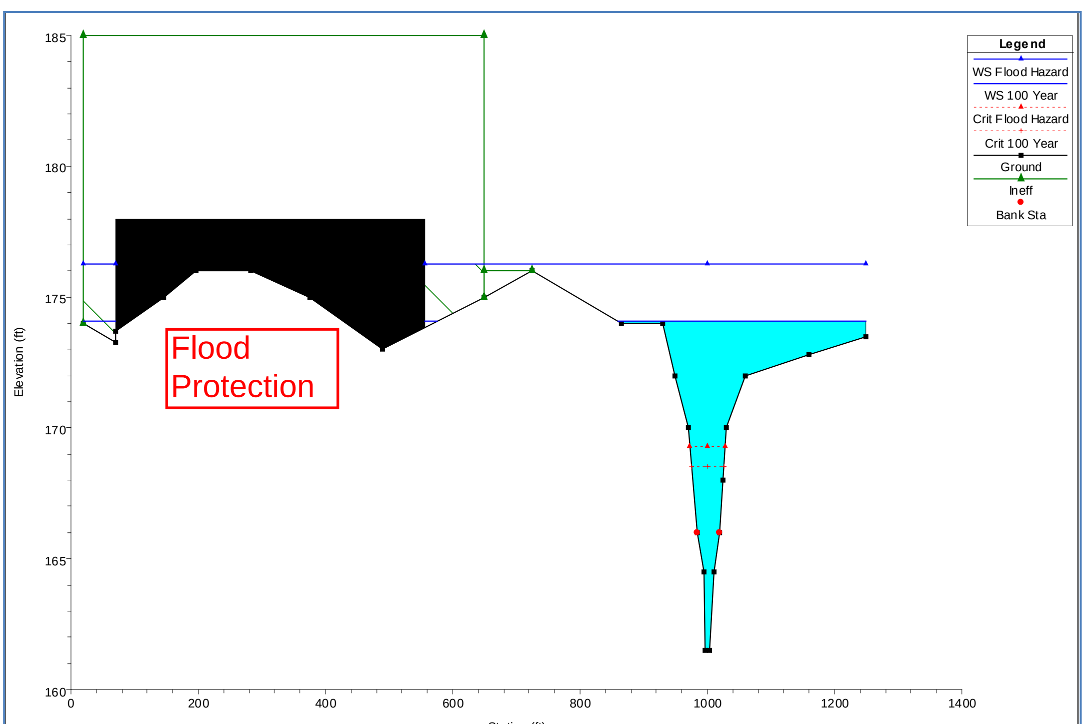


Upstream of Site (XS 2525): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 2: Cross-sectional view upstream of site (XS 2525) at warehouse looking downstream. PF1 = FEMA 100-yr flow 2,000 cfs; PF2 = NJDEP Flood Hazard flow 2,500 cfs.

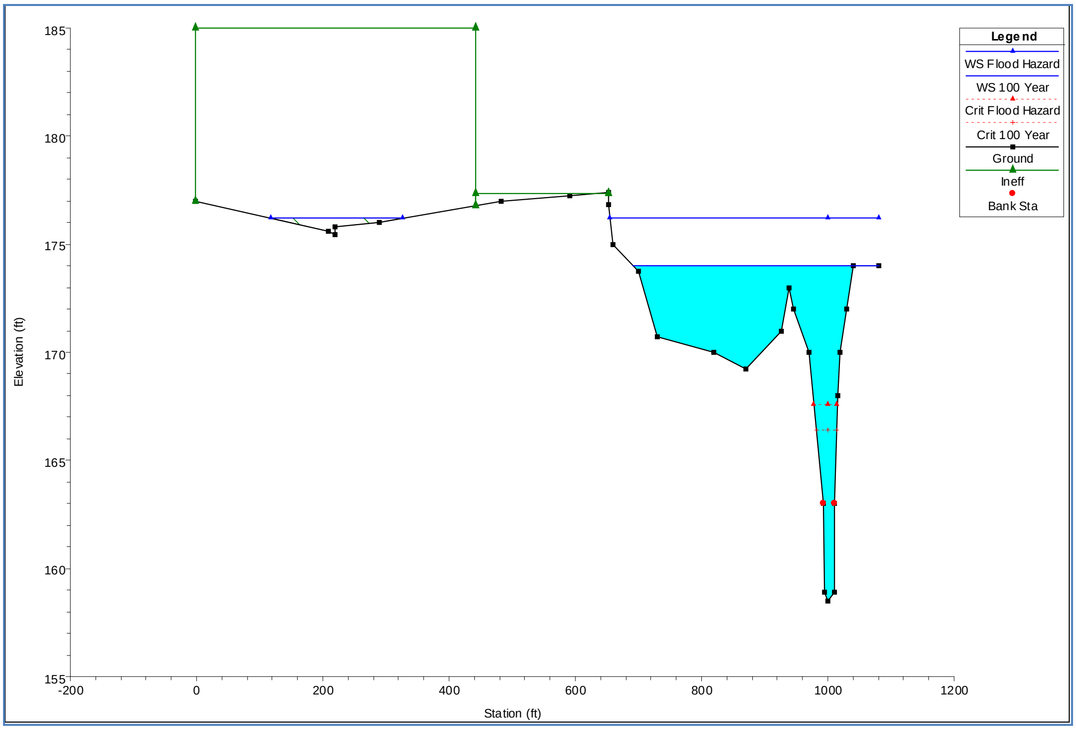


Upstream of Site (XS 2475): Existing Conditions.

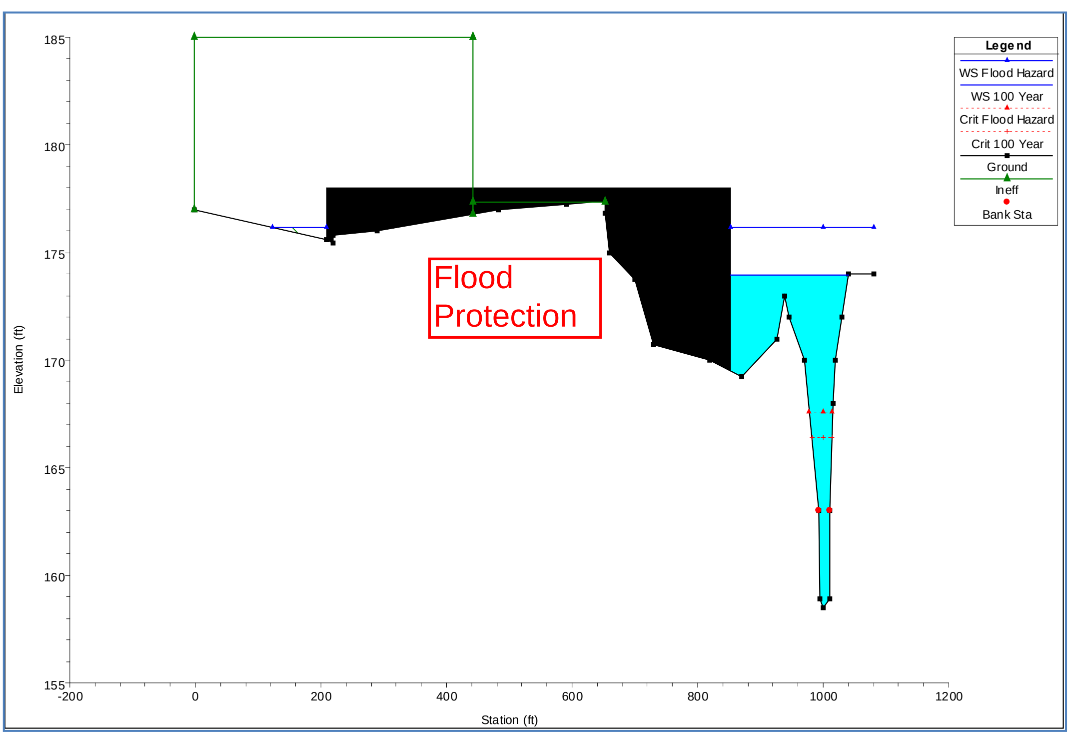


Upstream of Site (XS 2475): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 3: Cross-sectional view upstream of site (XS 2475) and downstream of warehouse looking downstream. PF1 = FEMA 100-yr flow 2,000 cfs; PF2 = NJDEP Flood Hazard flow 2,500 cfs.

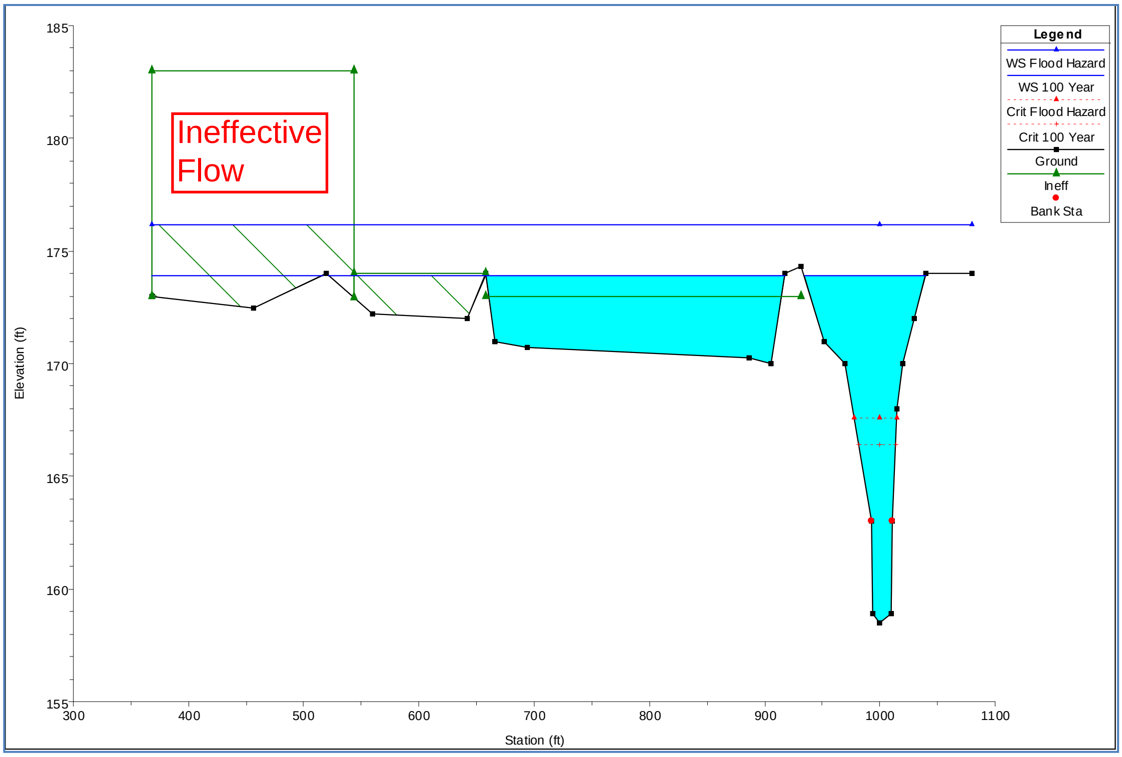


North Side of Site (XS 2285): Existing Conditions.

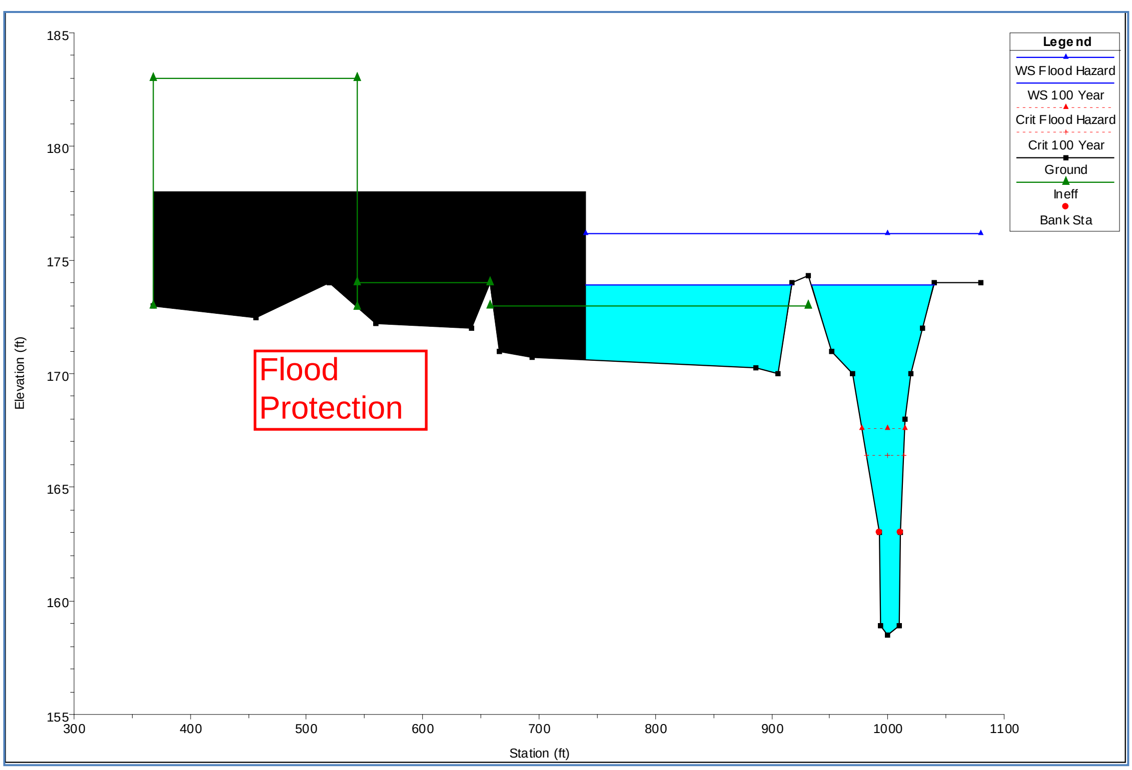


North Side of Site (XS 2285): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 4: Cross-sectional view from north side of site (XS 2285) looking downstream.
PF1 = FEMA 100-yr flow 2,000 cfs; PF2 = NJDEP Flood Hazard flow 2,500 cfs.

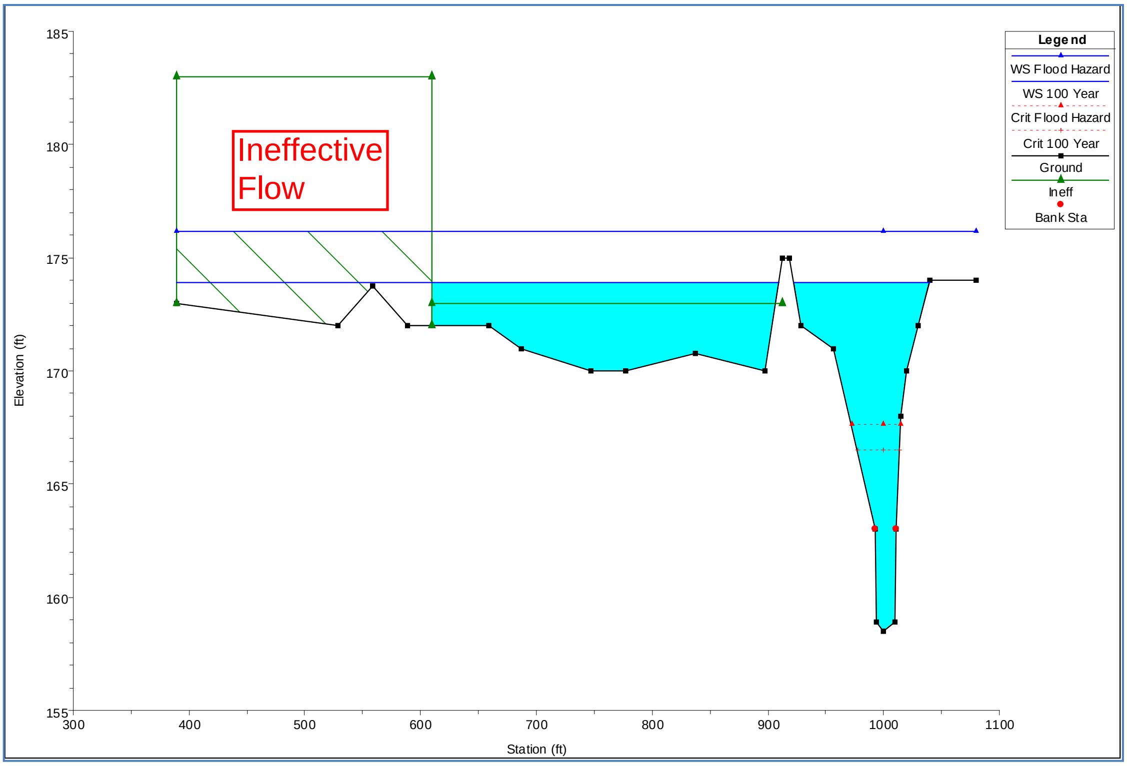


Middle of Site (XS 2135): Existing Conditions.

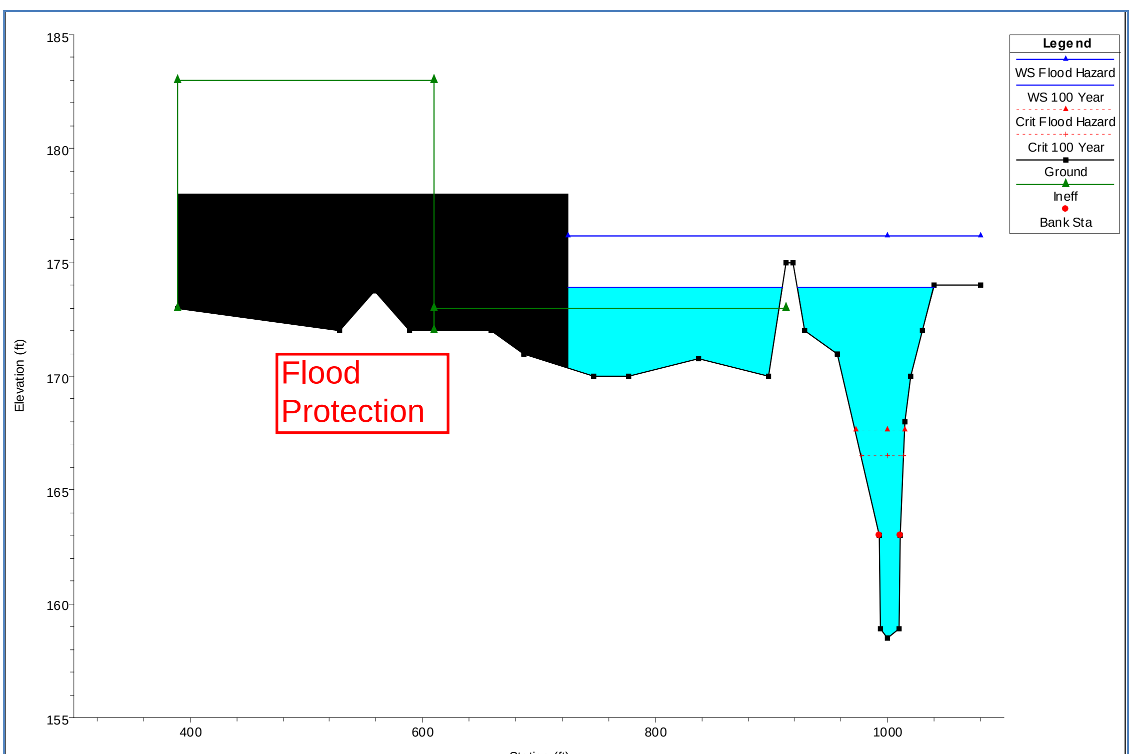


Middle of Site (XS 2135): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 5: Cross-sectional view through middle of site (XS 2135) looking downstream.
PF1 = FEMA 100-yr flow 2,000 cfs; PF2 = NJDEP Flood Hazard flow 2,500 cfs.



South Side of Site (XS 2115): Existing Conditions.



South Side of Site (XS 2115): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 6: Cross-sectional view from south side of site (XS 2115) looking downstream. PF1 = FEMA 100-yr flow 2,000 cfs; PF2 = NJDEP Flood Hazard flow 2,500 cfs.

FLOOD IMPACT STUDY FOR MARION SWITCHING STATION

Public Service Electric & Gas

11 OCTOBER 2012

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Building a world of difference.

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Table of Contents

1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing substantial impact to some electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Bayway) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. <u>Marion Switching Station (8)</u>

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Marion Switching Station. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The Marion Substation is located on West Side Avenue adjacent to the Hudson Generating Station. The substation is located on the larger station property, and occupies approximately 5 acres. There is gated access at the north end of the site. This is a large industrial site, with open access to the north and east along West Side Avenue. The west and south sides are adjacent to existing equipment with limited access. The Marion site is under the jurisdiction of the Hackensack Meadowlands Commission. The site is on the backside of the Hudson Generating Station. The topography of the site is concave in nature resulting in ponding from storm events.

The Hackensack River, which is west of the site, is under tidal influence and backwater control from Newark Bay. Water levels in the Hackensack River are a direct translation from levels in Newark Bay. The tidal influence and backwater control in the Hackensack River extends upstream over 18 miles. The FEMA FIS flood profile begins at approximate river station 959+50 and indicates that "Flood Elevations Downstream of this Point are Controlled by Newark Bay" (FEMA, 34003CV003A, 2005). NJDEP does not have flood mapping for the Hackensack Meadowlands Commission but FEMA does. Under New Jersey Law, the Flood Hazard Area in tidal areas, such as this, is equivalent to the FEMA 100-year (1%) flood area. Therefore, consideration of a separate Flood Hazard run is not necessary. Additionally, NJAC 7:13 (NJDEP Flood Hazard Area Control Act Rules) indicates in section 3.4(d) that: "*If no FEMA floodway map exists for the section of regulated water in question, the floodway limit shall be equal to the limits of the channel. The Atlantic Ocean and other non-linear tidal waters such as bays and inlets do not have a floodway*." Thus it is our understanding that the Hackensack River adjacent to the Marion site either does not have a floodway or it is limited to the limits of the river channel.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Marion Switching Station.

1) NJDEP. HEC-2 Input and Output Printouts (Hackensack_River_FW.pdf)
2) USACE. Hackensack Meadowlands Development Commission (HMDC) – Flood Control Study, New Jersey. September 2001
3) FEMA. FIS – Bergen County, New Jersey. September 2005.
4) PSE&G Services Corporation. Flood Study Base Survey – Marion Switching Station (06 April 2012)
5) Black & Veatch. 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

The NJDEP provided printouts of their HEC-2 Hackensack River Floodway Model beginning at river station 969+00 (document 1). This document was the basis of the model development for the reach of river outside of backwater control at Newark Bay. Its associated output provided model results for the NJDEP 100-year floodplain and floodway in this reach as well. The USACE study (document 2) provided cross-section profiles for the Hackensack River in the vicinity of the Marion Switching Station. These cross-sections were the basis for the model development for the reach of river under backwater control from Newark Bay. An existing HEC-2 or HEC-RAS model for the Hackensack River reach from station 0+00 to 959+50 was not available since flood levels downstream of station 959+50 are controlled by Newark Bay.

The FEMA FIS (document 3) provided the 100 year (1%) flood level at Newark Bay, and 100-year (1%) flood levels in the Hackensack River beginning at station 959+50. It also provided estimates for 100-year flows at cross-section 96900.

The PSE&G site survey (document 4) assisted in determining ground elevations at the site and distances to the river. The Substation Flood Protection Report (document 5) provided the estimated height for the flood protection measures.

The vertical datum for elevations reported in the NJDEP HEC-2 files (document 1), the USACE Flood Study (document 2), and the FEMA FIS (document 3) is NGVD 29, while the vertical datum for documents 4 and 5 is NAVD 88. NAVD 88 is approximately one foot below NGVD 29 elevations. All elevations presented in this report are NAVD 88 unless otherwise noted (i.e., Figures 2 and 3, which are based on model data from documents 1 and 2).

The Substation Flood Protection – Summary Evaluation Report (document 5), recommends a top elevation for the flood protection wall at the Marion Switching Station 2 feet above the 100-year flood level. Based on document 3, the 100-year (1%) water level in Newark Bay and the vicinity of the site is 8.9 ft (NAVD 88). This recommendation would yield a top of the wall at 10.9 ft (NAVD 88). Final recommendations for the flood protection height are based on the findings of this hydraulic study and are presented in the Conclusions and Recommendations (Section 3.0).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Hackensack River in the vicinity of the Marion Switching Station. The hydraulic model used for this study was developed from NJDEP's HEC-2 input data.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. These are the water surface elevations, (WSEs) as presented in the results of the HEC-2 printouts, for the Hackensack River reach beyond backwater control at Newark Bay (beyond river station 959+50). The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels and floodway levels.

The remaining three other models were developed from the Effective model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is the input data from the HEC-2 files, input into a HEC-RAS model along with the USACE cross-sections (document 2). This model was run to ensure similar results and proper calibration in the upstream reach.

- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

River profiles indicating exact cross-section locations for cross-sections in the USACE Flood study were available. Thus exact cross-section locations relative to the Marion site could be identified. Marion Switching Station lies on the eastern bank (left bank) of the Hackensack River approximately 3 miles upstream of Newark Bay. Marion Switching Station and the estimated river model layout in the vicinity of the Marion site are shown in Figure 1. Cross-sections taken from the USACE Flood Study are shown in white.

As previously indicated the Duplicate Effective model was developed from both the NJDEP Hackensack River model and the USACE Flood Study cross-sections. One cross-section was added to the Duplicate Effective model at the confluence with Newark Bay in order to set the downstream boundary condition to known water levels at Newark Bay.

For the Existing Conditions Model, two additional cross-sections were added in the vicinity of the Marion site: 16645 and 16195. Cross-section 16645 corresponds with the northern side of the Marion site, while cross-section 16195 runs along the southern side of the site. Station and elevation data for the left bank of the added cross-sections was established from survey information and available topographic data. The topographic survey is presented in Figure 2 (PSE&G, 2012). The added and modified cross-sections are shown in yellow on Figure 1. Figures 2 and 3 present the profiles for cross-sections 16645 and 16195 in the vicinity of the Marion Switching Station site. The Hudson Generating Station is also shown as a blocked obstruction on the two added cross sections in the Existing Conditions Model.

In development of the Proposed Conditions Model (Marion Model 4), the proposed flood protection was inserted on the east bank in each of the two cross-sections that border the site (16645 and 16195). It is represented as a blocked obstruction in the HEC-RAS models and can be visualized in Figures 2 and 3.

Two steady state flow conditions were considered; both have the same flow value but consider different starting water surface elevations in Newark Bay. The flow considered is the Hackensack River's 100-year flood flow of 7,410 cfs at river station 969+00. This was provided in the NJDEP HEC-2 model.

The first run considered a lower water level in Newark Bay in order to achieve the exact WSEL as predicted by the HEC-2 model at cross-section 96900. For this run, Newark Bay was set to a WSEL of 5.53 feet.

In the second run the water level in Newark Bay was based upon available information in the FEMA FIS and FIRM. The following information was considered:

- The FEMA FIS indicates that the Newark Bay 100-year (1%) water level is 8.9 feet (based on the historic record of northeasterly storm surges).
- The FIRM indicates a flood level of 7.9 feet at Marion Station when Newark Bay is experiencing the 100-year (1%) flood level of 8.9 feet.
- Based on Table 12 (Floodway Data) in the FIS, the backwater level in the Hackensack River at river station 969+00. is at 7.7 feet

The second run considered a downstream water level of 7.9 feet in order to achieve the WSEL indicated in the FIRM at the Marion site.

During Hurricane Irene, the Marion Switching Station experienced a maximum flood depth of 1.5 ft. The perimeter of the site is at approximate elevation 7.0 feet. Thus water in Newark Bay and the reach of the Hackensack River adjacent to the Marion site may have experienced water levels during Hurricane Irene of about 8 feet. Historic tide data are available for Bergen Point West Reach, NY and are archived by NOAA. Figure 4 presents the water levels in Newark Bay on the day when Hurricane Irene, as a tropical storm, passed over the Marion Switching Station.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are similar to those of the Effective Model at cross-section 96900 and further upstream.

Table 1 presents the results from the four models considered under 100-year flow flood conditions. River stations in bold indicate added cross-sections in the model.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (7,410 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model***	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
99600	6.16	6.18	6.18	6.18	0.00
99100	6.04	6.05	6.05	6.05	0.00
98900	6.08	6.10	6.10	6.10	0.00
98300	5.78	5.79	5.79	5.79	0.00
97900	5.78	5.78	5.78	5.78	0.00
97470	5.63	5.63	5.63	5.63	0.00
96900	5.60	5.60	5.60	5.60	0.00
20723	-	5.54	5.54	5.54	0.00
19292	-	5.54	5.54	5.54	0.00
17768	-	5.54	5.54	5.54	0.00
16911	-	5.53	5.53	5.53	0.00
16645	**-**	**-**	**5.54**	**5.54**	**0.00**

	1	2	3	4	(4-3)
River Station	**Effective Model***	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
16195	**-**	**-**	**5.53**	**5.53**	**0.00**
15997	-	5.53	5.53	5.53	0.00
13289	-	5.53	5.53	5.53	0.00
13120	-	5.53	5.53	5.53	0.00
0	-	5.53	5.53	5.53	0.00
*NJDEP HEC-2 Results					

The Existing Conditions Model, which includes additional cross-sections, yielded flood levels that are similar to those in the Effective and Duplicate Effective Models for both the upstream and downstream reaches.

The Proposed Conditions Model includes the flood protection on the east bank of the model. A rise in WSE due to the flood protection installation is not predicted in the vicinity of the site nor further upstream in the reach outside of the backwater control.

Black & Veatch also prepared a second run considering a 100-year (1%) water level at the Marion site with 100-year (1%) flood flows in the Hackensack River. Resulting flood levels from this run are presented in Table 2.

Table 2: Hydraulic Model Results – 100-year (1%) WSEL in Newark Bay and 100-Year Flows (7,410 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model***	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
99600	7.70	8.18	8.18	8.18	0.00
99100	7.70	8.14	8.14	8.14	0.00
98900	7.70	8.16	8.16	8.16	0.00
98300	7.70	8.01	8.01	8.01	0.00
97900	7.70	8.02	8.02	8.02	0.00
97470	7.70	7.97	7.97	7.97	0.00
96900	7.70	7.96	7.96	7.96	0.00
20723	7.9	7.90	7.90	7.90	0.00
19292	7.9	7.90	7.90	7.90	0.00
17768	7.9	7.90	7.90	7.90	0.00
16911	7.9	7.90	7.90	7.90	0.00
16645	**7.9**	**-**	**7.90**	**7.90**	**0.00**
16195	**7.9**	**-**	**7.90**	**7.90**	**0.00**
15997	7.9	7.90	7.90	7.90	0.00

	1	2	3	4	(4-3)
River Station	**Effective Model***	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
13289	8.9	7.90	7.90	7.90	0.00
13120	8.9	7.90	7.90	7.90	0.00
0	8.9	7.90	7.90	7.90	0.00
*FEMA FIS Results					

This run where Newark Bay experiences 100-year (1%) chance water levels due to storm surges with 100-year flows in the Hackensack River is probably a conservative approach, as it assumes the coincidence of separate independent events.

STORM SURGE FROM TROPICAL STORM IRENE

The National Hurricane Center website was examined for information on the effects of Tropical Storm Irene that made landfall in New Jersey on August 28, 2011 as a tropical storm and was moving in a north northeasterly direction. According to the Tropical Cyclone Report (http://www.nhc.noaa.gov/data/tcr/AL092011_Irene.pdf), observations of storm surge and storm tide were made at Bergen Point in Newark Bay, the nearest to Marion Switching Station. The storm surge is defined as the water height above the normal astronomical tide. The storm surge recorded at Bergen Point was 4.56 ft., resulting in a seawater elevation of 7.26 ft. (NAVD 1988).
(http://tidesandcurrents.noaa.gov/data_menu.shtml?bdate=20110827&edate=20110828&wl_sensor_hist=W1&relative=&datum=7&unit=1&shift=g&stn=8519483+Bergen+Point+West+Reach%2C+NY&type=Historic+Tide+Data&format=View+Plot)

The SLOSH (Sea, Lake, and Overland Surge from Hurricanes) model is used by the National Hurricane Center (NHC) and National Weather Service (NWS) to predict storm surges from Hurricanes (http://slosh.nws.noaa.gov/sloshPriv/). The NHC has used the model to predict the maximum storm surge that could occur at a given location for each category of hurricane. This is accomplished by running the model for each basin using a variety of storm directions, speeds and landfall locations. The maximum of all of these runs is then the maximum storm surge that could occur for any given category of hurricane. The Tropical Cyclone Report for Irene critiqued the predictions by NOAA for the storm. However, the critique focused on predictions of path and intensity and not on predicted storm surge. During Tropical Storm Irene NOAA predicted storm surge on a probability basis. For example, a prediction could be 50 percent probability that surge will be 2 ft and 30 percent probability that surge could be 5 feet. The SLOSH Display model cannot be used to simulate Irene because it does not simulate tropical storms.

The SLOSH display model is a tool that NOAA makes available so users can display or view the results of the model runs prepared by NOAA. The display model does not allow the user to run additional cases with inputs defined by the user.

Marion is included in the New York model basin. For this basin, NOAA modeled 288 different hurricane scenarios which included the following conditions:

- Hurricane moving in six directions: northeast (NE), north northeast (NNE), north (N), north northwest (NNW), northwest (NW) and west northwest WNW)
- Hurricane moving at six speeds (10, 20, 30, 40, 50 and 60 mph)
- Landfall during two tidal stages (mean and high tide)
- Categories 1, 2, 3, and 4 hurricane wind speeds

For each of these scenarios, several model runs were made with the hurricane moving along different parallel tracks to produce landfall at different points. Based on these results, a maximum envelop of water (MEOW) was defined. The MEOW represents the maximum height that water reaches, at any time during the storm, in each grid cell when running the model on storms with the same category, forward speed and direction of motion, but with tracks that are parallel to each other. After the MEOWs were defined, the Maximum of MEOWs (MOM) was calculated. The MOM represents the maximum height of water at every grid cell that is reached in any of the MEOWs, where the only constant is hurricane category.

A review of the results of the SLOSH modeling indicates that there are significant differences in the predicted surge heights for hurricanes depending on the speed and direction of the storm and tidal condition. In general, the highest surge is produced by storms moving at 40 mph. Faster moving storms produce approximately the same surge heights while slower moving storms produce less surge. Also, surge height increases as the movement of the storm shifts towards the west. The lowest surges were for storms moving towards the NE while the highest surges were for storms moving in the WNW direction. The recurrence interval for any Category 1 or 2 hurricane (i.e., sustained winds between 74 and 110 mph) impacting the New Jersey coast is about 19 years, while the recurrence interval for any major hurricane (i.e., Category 3 to 5, winds greater than 111 mph) impacting the New Jersey coast is about 74 years. The value of the recurrence intervals is based on, and extrapolated from, a statistical analysis of tropical cyclones.

It is not possible to model the impact of Irene at Marion because the SLOSH model only models hurricanes and not tropical storms. Irene was a tropical storm when it impacted the New Jersey coast. A summary of SLOSH model results showing the affect of Hurricane direction is presented in the following table.

Table 3 – Storm Tide (FT NAVD) and Hurricane Direction

Direction	**Category**	**Speed (mph)**	**Tidal Stage**	**Storm Tide (ft)**
NE	1	10	Mean	1.2
NNE	1	10	Mean	1.8
N	1	10	Mean	1.9
NNW	1	10	Mean	2.4
NW	1	10	Mean	2.7
WNW	1	10	Mean	3.1

Most hurricanes that impacted the New Jersey area traveled in a NNE to NE direction. A summary of SLOSH model results showing the effect of hurricane category, speed, and tidal stage is presented in the following table.

Table 3 – Storm Tide (FT NAVD) and Hurricane Direction and Speed Tidal Stage

Direction	Category	Speed (mph)	Tidal Stage	Storm Tide (ft)
NNE	1	10	Mean	1.2
NNE	2	10	Mean	4.0
NNE	3	10	Mean	6.0
NNE	4	10	Mean	8.2
NNE	1	20	Mean	2.3
NNE	1	30	Mean	2.9
NNE	1	40	Mean	3.6
NNE	1	50	Mean	3.6
NNE	1	10	High	3.7

To evaluate storm surge under conservative conditions, the SLOSH model was run for a Category 2 hurricane going to the NNE at 40 mph and high tide. The model results listed are below and also shown on the following figure.

Storm Tide (Ft NAVD 1988) for Conservative Conditions				
Direction	**Category**	**Speed (mph)**	**Tidal Stage**	**Storm Tide (ft)**
NNE	2	40	High	7.8

The storm tide of 7.8 ft determined from the SLOSH model is less than the flood level determined from the proposed conditions model of 7.9 ft.

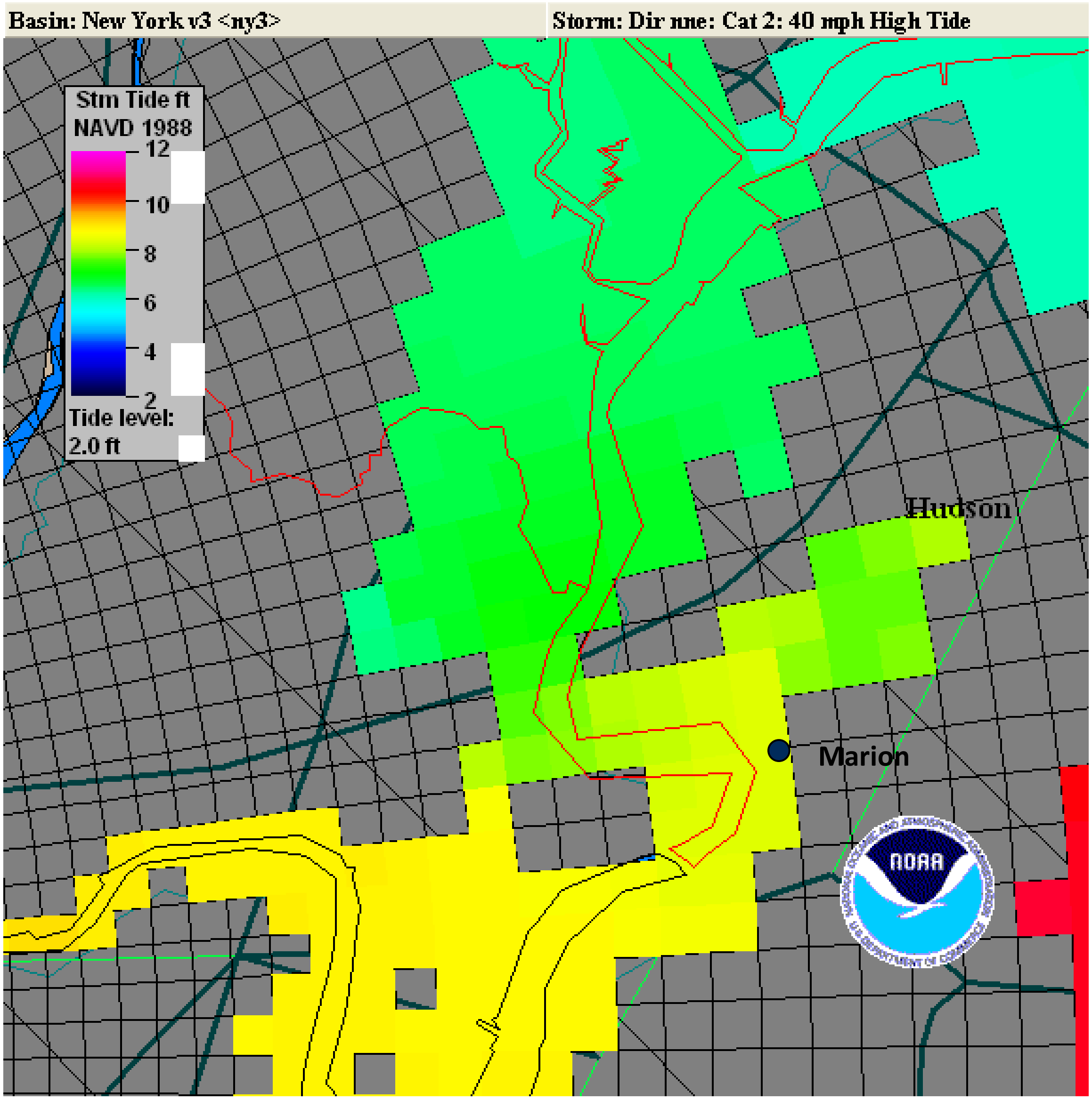


Figure 1 – SLOSH Model for Category 2 Hurricane

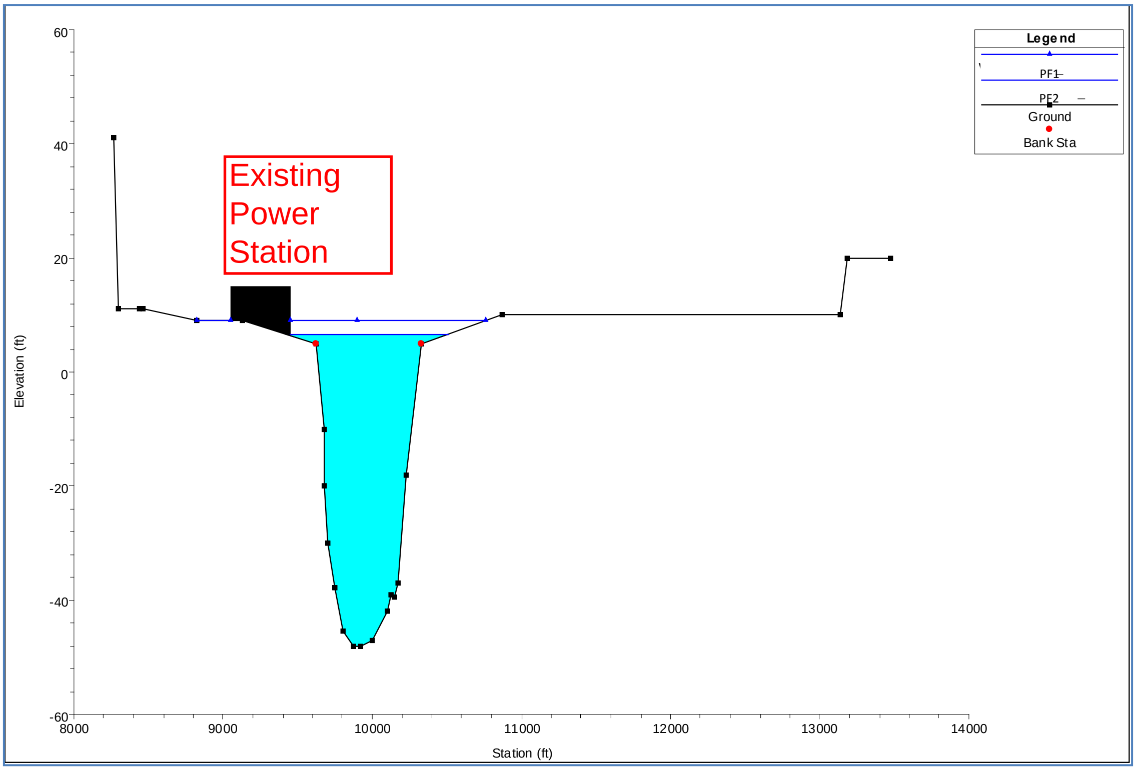
3.0 Conclusions and Recommendation

The proposed flood protection facilities will not impact flooding upstream of the Marion Switching Station. If PSE&G proceeds with the design and construction of the proposed flood mitigation measures for the Marion Switching Station, there should be no impact to upstream existing structures. Hydraulically and based on the model results, there are no impacts to downstream structures.

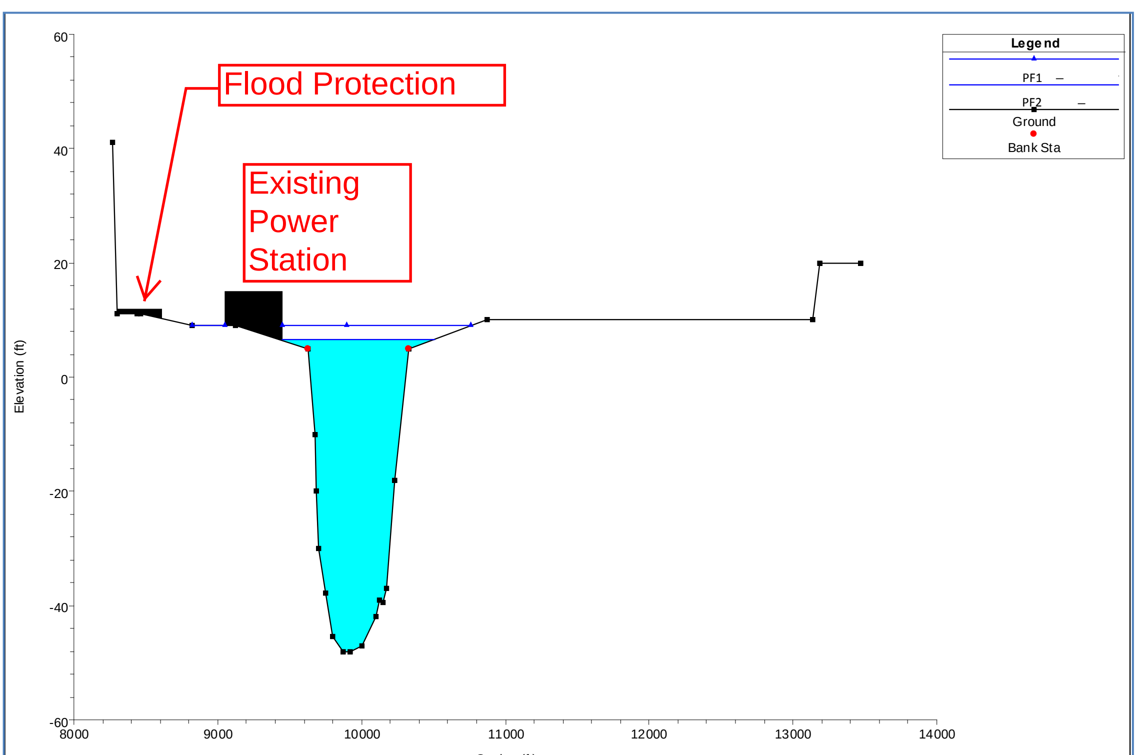
During Hurricane Irene, a maximum flood depth of 1.5 feet was observed at the Marion site. The flow and resulting inundation from Hurricane Irene were less than the 100-year (1%) flood level in Newark Bay. The FEMA FIS and FIRM indicate that when Newark Bay is at the 100-year (1%) flood level of 8.9 feet, the Hackensack River near the Marion site is at a WSEL of 7.9 feet. An elevation of 8.9 feet, which is 1 foot above the Hackensack River 100-year (1%) flood level in the reach adjacent to the Marion site, was selected as the top of wall design level.

ELEVATION SUMMARY (FEET NAVD 88)				
Site	Minimum Site EL.	Maximum Observed Flood EL. (PSE&G)	1% Flood Level	Proposed Flood Protection EL.
Marion	5.0	6.5	7.9	8.9

[redacted]

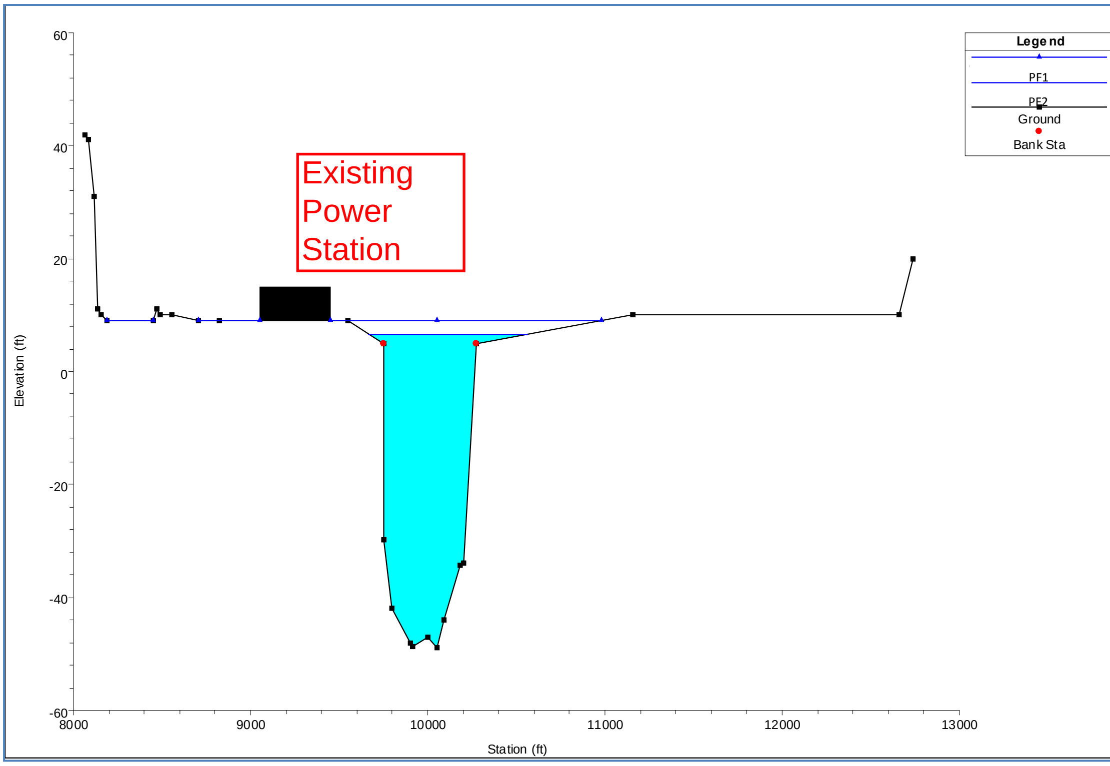


North Side of Site (XS 16645): Existing Conditions.

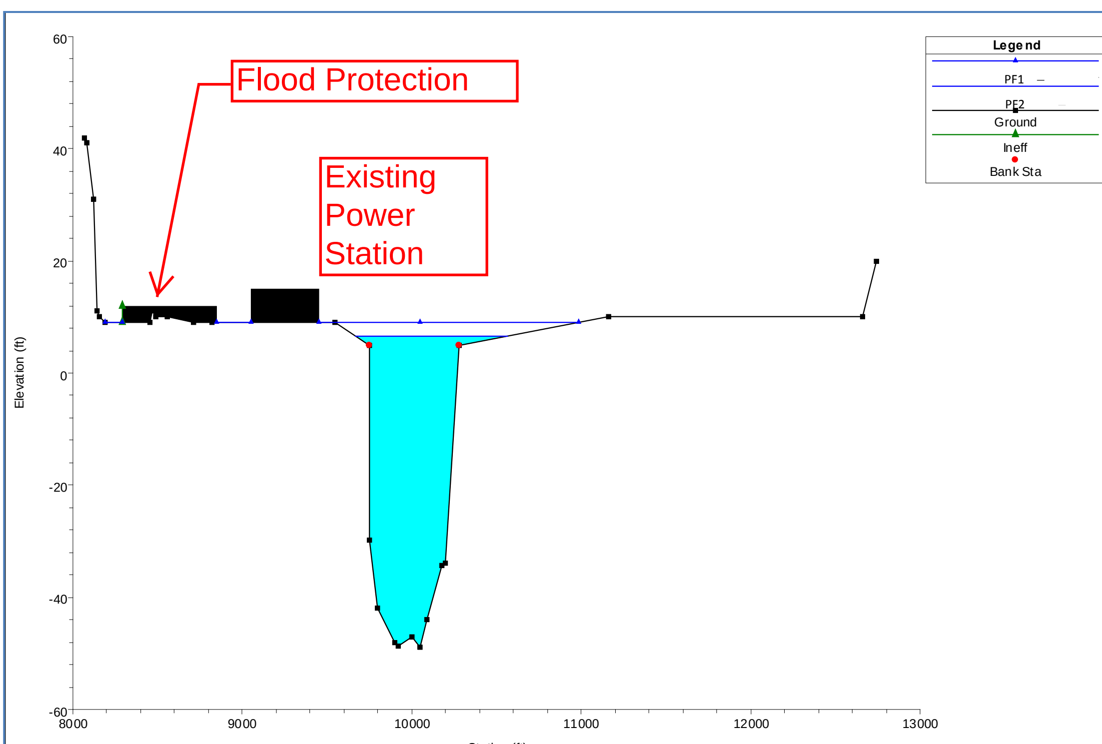


North Side of Site (XS 16645): Proposed Conditions – Sheetpile Flood Protection Installed.

Figure 2: Cross-sectional view from north side of site (XS 16645) looking downstream.
PF1 = Downstream WSEL = 7.9 ft; PF2 = Downstream WSEL = 5.53 ft



South Side of Site (XS 16195): Existing Conditions.



South Side of Site (XS 16195): Proposed Condition – Sheetpile Flood Protection Installed.

Figure 3: Cross-sectional view from south side of site (XS 16195) looking downstream.
PF1 = Downstream WSEL = 7.9 ft; PF2 = Downstream WSEL = 5.55 ft

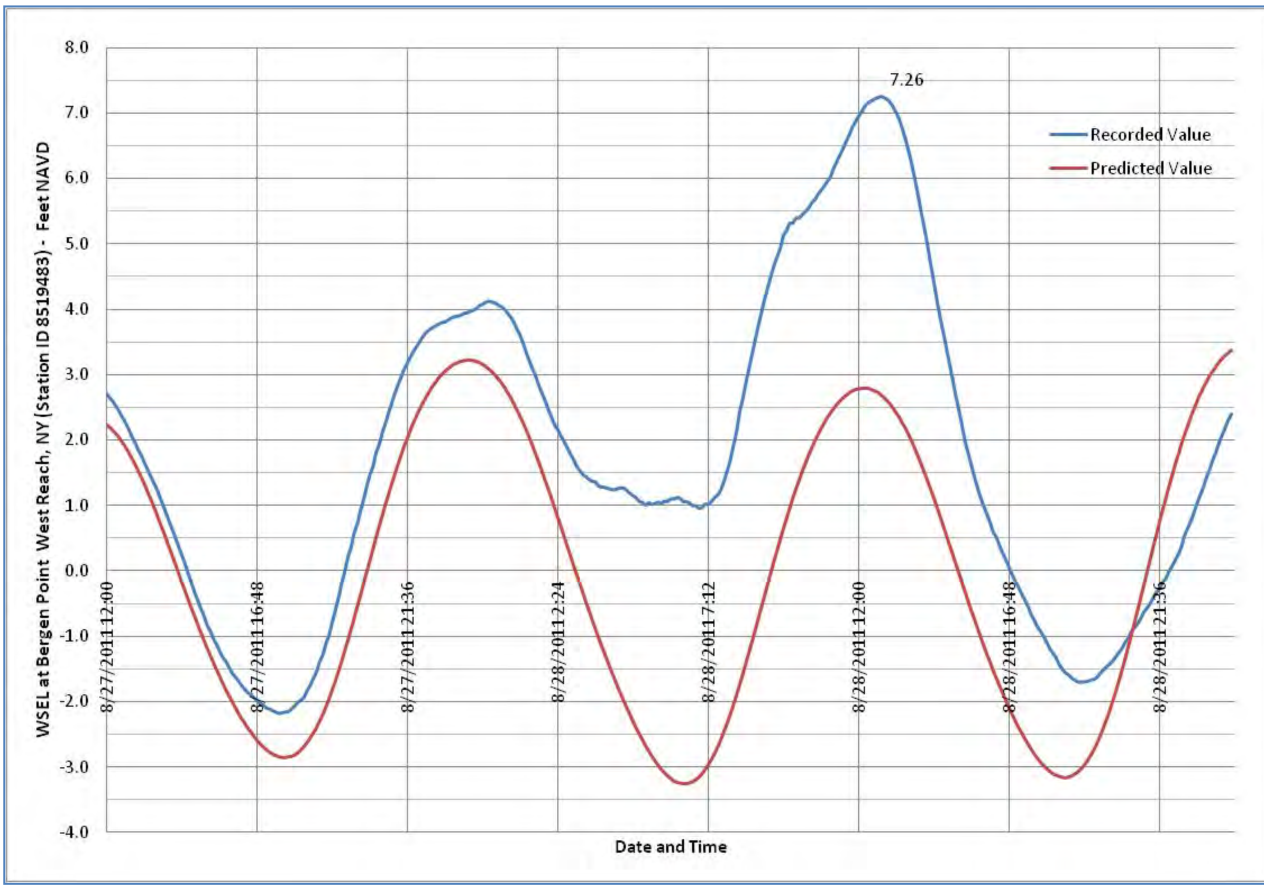


Figure 4: Historic Tide Data at Bergen Point West Reach, NY – Station ID 8519483 During Tropical StormIrene. Gage Datum is 0.00 feet NAVD 88.

FLOOD IMPACT STUDY FOR EWING SUBSTATION

Public Service Electric & Gas

11 OCTOBER 2012

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Table of Contents

1.0 Background

On August 28, 2011 Hurricane Irene moved through PSE&G's service territory leaving several thousand customers without power while causing substantial impact to some electric and gas facilities. This event flooded several PSE&G substations in North and Central New Jersey to varying depths. Based on this and prior flooding events a "Flood Protection Report" was completed for twelve of PSE&G's substations (Black & Veatch, Substation Flood Protection – Summary Evaluation Report, 2012). The Report defines the preliminary requirements to provide flood protection at the twelve flood prone substation sites. Since most of the substation sites are located within either the FEMA 100-year floodplain or the defined floodway area, construction of flood protection facilities at these sites could potentially impact upstream flood water elevations.

Flood Impact Studies will be performed for ten of the twelve substation sites, and will be based on the recommendations for flood protection measures included in the Flood Protection Report. Flood impact studies are not required for two of the twelve sites as they are either a) not in the FEMA 100-year floodplain (Bayway) or b) the proposed flood protection facilities will be located behind existing site floodwall protection (Garfield). PSE&G has provided guidance as to the order in which they would like the substations studied. This prioritization is denoted in the list below in parentheses after the substation name. The ten substations to be studied are as follows:

Central Division

1. Cranford Substation (2)
2. Rahway Substation (5)
3. Somerville Substation (6)

Metro Division

4. Belmont Substation (10)
5. Jackson Road Substation (7)

Palisades Division

6. New Milford Switching Station (1)
7. River Edge Substation (4)
8. Hillsdale Substation (3)
9. Marion Switching Station (8)

Southern Division

10. Ewing Substation (9)

This Flood Impact Study addresses the potential for flooding upstream of the Ewing Substation. It describes the upstream flood impacts resulting from construction of the recommended flood protection facilities. It is intended that the results of this study will be used by PSE&G in evaluating the implementation of the flood protection measures at this site. It is recognized that additional flood studies will likely be required to support the permitting process if the recommended mitigation methods are chosen.

The Ewing Substation is located about 700 ft south of the N. Olden Avenue and Prospect Street intersection, Ewing, NJ, 08638 and is approximately 0.75 acres. The site is bounded by an abandoned house and abandoned driving range to the west; Prospect St to the east; a warehouse to the north; and an abandoned miniature golf course to the south. There are no overhead power lines in the site boundary limits, but there are to the east, running parallel with Prospect St. There is a 3-ft tall concrete flood wall that encloses the feeder rows at the substation. There is a gate for access to the feeder rows from Prospect Street. The flood wall has 3 removable panels located along the south side of the wall. The control house and transformer are not protected by the floodwall. There is a 4 x 4 x 3.5 foot deep sump located in the western corner of the site with piping that conveys floodwaters to the eastern side boundary.

A portion of the Ewing site is located within the floodway, which comprises the river channel and adjacent floodplain that should be kept free of encroachment in accordance with FEMA recommendations.

2.0 Data Review and Hydraulic Modeling

DATA REVIEW

The following documents were utilized in the development of the hydraulic model for the Ewing Substation.

1) NJDEP. HEC-2 Input and Output Printouts from 21 DEC 1981 (West Br Shabakunk HEC 2 output.pdf)
2) NJDEP. Delineation of Floodway and Flood Hazard Area – West Branch Shabakunk Creek. 24 DEC 1980.
3) Kennon Surveying Services, Inc (KSS). Boundary and Topographic Survey – Ewing Substation (06 June 2012)
4) Black & Veatch. 2012 Substation Flood Protection – Summary Evaluation Report. 2 March 2012.

The NJDEP provided printouts of their HEC-2 West Branch Shabakunk Creek Model dated from 1981 (document 1). This document was the basis of the model development, and its associated output provided model results for the NJDEP 100-year flood plain and floodway. The site survey (document 3) was used to determine ground elevations at and around the site. The Substation Flood Protection Report (document 4) provided the estimated height for the flood protection measures. The vertical datum for elevations reported in the NJDEP HEC-2 files (document 1) and the NJDEP Floodway Delineation (document 2) is NGVD 29, while the vertical datum for documents 3 and 4 is NAVD 88. NAVD 88 is one foot below NGVD 29 elevations. All elevations presented in this report are NAVD 88 unless otherwise noted (i.e., Figures 3 and 4, which are based on model data from document 1).

The Substation Flood Protection – Summary Evaluation Report (document 4), recommends a top elevation for the flood protection wall at the Ewing Substation 2 feet above the 100-year flood level. Based on reference 1, the 100-year flood level in the vicinity of the site is 75.4 ft (NAVD 88). This recommendation would yield a top of the wall at 77.5 ft (NAVD 88). Final recommendations for the flood protection height are based on the findings of this hydraulic study and are presented in the Conclusions and Recommendations (Section 3.0).

HYDRAULIC MODEL SCENARIOS

Black & Veatch used the HEC-RAS one-dimensional hydraulic computer software program, as developed by the U.S. Army Corps of Engineers Hydraulic Engineering Center, to develop a hydraulic model for the Signac River in the vicinity of the Ewing Substation. The hydraulic model used for this study was developed from NJDEP's HEC-2 input data.

In order to achieve the goal of this study, four geometry models were considered.

- The first model was the Effective Model. These are the water surface elevations (WSEs) as presented in the results of the HEC-2 printouts. The results of the Effective Model provide the New Jersey Department of Environmental Protection (NJDEP) 100-year flood levels and floodway levels.

The remaining three other models were developed from the Effective model: the Duplicate Effective Model, the Existing Conditions Model, and the Proposed Conditions Model.

- The Duplicate Effective Model is the input data from the HEC-2 files, input into a HEC-RAS model and run to ensure similar results and proper calibration.
- The Existing Conditions Model was based on the Duplicate Effective Model, but includes additional cross-sections in the vicinity of the site and modifications to some cross-sections.
- The Proposed Conditions Model was based on the Existing Conditions Model and includes proposed flood protection.

The flood elevation differences between proposed conditions and existing conditions throughout the modeled length along the river will represent the potential flood impact associated with the proposed improvements.

HYDRAULIC MODEL DEVELOPMENT

A profile of the river indicating exact cross-section locations for cross-sections in the NJDEP HEC-2 model was not provided to aid in the development of the HEC-RAS models relative to the Ewing Substation site. Hence, the cross-section locations had to be estimated based on available information within the HEC-2 printout (Effective Model) and aerial imagery in Google Earth. After estimating the location of the cross-section just upstream of the Prospect Street Bridge, all other cross-section locations in the model were estimated from distances between cross-sections as reported in the Effective Model. Ewing Substation lies along the northern bank (left bank) of the West Branch Shabakunk Creek downstream of Parkside Avenue and just upstream of the Prospect Street Bridge. Ewing Substation and the estimated river model layout are shown in Figure 1. Cross-sections taken from the HEC-2 model are shown in white.

One cross-section was modified and one cross-section was added in the vicinity of the Ewing site for the Existing Conditions Model. The estimated location of cross-section 6330 corresponds with the eastern edge/border of the Ewing site. As such, this cross-section was modified to match available survey information. Cross-section 6500 was added. This cross-section runs along the western edge/border of the site. All modifications as well as the added cross-section were based on the updated site survey (KSS, 2012). The added and modified cross-sections are shown in yellow on Figure 1. Figures 2 and 3 present the profiles for cross-sections 6500 and 6330 in the vicinity of the Ewing Substation site.

In development of the Proposed Conditions Model (Ewing Model 4), the proposed flood protection was inserted on the north bank in each of the two cross-sections that transect the site (6500 and 6330). It is represented as a blocked obstruction in the HEC-RAS models and can be visualized in Figures 2 and 3.

The following flows were considered:

- 2,117 cfs - The West Branch Shabakunk Creek's FEMA 100-year flood flow in the vicinity of the Ewing Site.
- 2,646 cfs – NJDEP Flood Hazard Limit Criterion = 125% of the West Branch Shabakunk Creek, 100-year flood flow

Since a portion of the Ewing Site lies in the floodway, a floodway run which includes encroachments was also considered. A floodway is defined "as the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water-surface elevation by more than a designated height. Normally, the base flood is the one-percent change event (100-year recurrence interval), and the under New Jersey law the designated height is 0.2 foot for maximum rise. The floodway is usually determined by an encroachment analysis, using an equal loss of conveyance on opposite sides of the stream. For purposes of floodway analysis, the floodplain fringe removed by the encroachments is assumed to be completely blocked" (USACE, HEC-RAS User's Manuel).

During Hurricane Irene, the Ewing Substation was flooded up to an approximate WSEL of 75 ft. Based on the HEC-RAS model this would correspond to a flow of 1,700 cfs. This flow is 20 percent less than the 100-year flood flow of 2,117 cfs in the vicinity of the substation.

PRELIMINARY FLOOD IMPACTS

The Duplicate Effective Model yields results that are similar to those of the Effective Model.

The Existing Conditions Model, which includes additional and modified cross-sections, also yielded flood levels that are similar to those in the Effective and Duplicate Effective Models.

Table 1 presents the results from the four models considered under 100-year flow flood conditions. River stations in bold indicate added and modified cross-sections in the model.

Table 1: Hydraulic Model Results – FEMA 100-year Flood Levels (2,117 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
11360	85.44	85.58	85.58	85.58	0.00
10780	85.36	85.52	85.52	85.52	0.00
10370	84.96	85.14	85.14	85.14	0.00

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
10235	85.12	85.31	85.31	85.31	0.00
9770	85.05	85.23	85.23	85.23	0.00
9735	85.05	85.22	85.22	85.22	0.00
9734	Pennington Road Bridge				
9655	83.00	83.25	83.25	83.25	0.00
9605	82.20	82.22	82.22	82.22	0.00
9500	82.17	82.30	82.30	82.30	0.00
9395	82.40	82.43	82.43	82.43	0.00
9345	82.34	82.38	82.38	82.38	0.00
9344	N.J. National Bank Bridge				
9325	81.96	81.92	81.92	81.92	0.00
9275	81.96	82.00	82.00	82.00	0.00
8975	81.07	81.06	81.06	81.06	0.00
8927	81.21	81.21	81.21	81.21	0.00
8926	Culvert Under Mrs. G Store				
8725	81.10	81.08	81.08	81.08	0.00
8680	81.09	81.06	81.06	81.06	0.00
8675	81.11	81.06	81.06	81.06	0.00
8674	Parkside Avenue Bridge				
8605	81.08	80.98	80.98	80.98	0.00
8600	81.00	80.97	80.97	80.97	0.00
8555	80.89	80.79	80.79	80.79	0.00
8500	79.68	79.78	79.78	79.78	0.00
8080	78.10	78.27	78.26	78.26	0.00
7580	76.71	76.81	76.69	76.71	0.02
7280	76.34	76.42	76.23	76.27	0.03
6900	76.08	76.14	75.87	75.92	0.05
6500	**n/a**	**n/a**	**75.60**	**75.62**	**0.02**
6330	**75.34**	**75.39**	**75.48**	**75.45**	**-0.02**
6291	75.48	75.53	75.53	75.53	0.00
6290	75.38	75.53	75.53	75.53	0.00
6289	Prospect Street Bridge				
6235	75.21	75.29	75.29	75.29	0.00
6234	75.25	75.29	75.29	75.29	0.00
6195	74.98	75.01	75.01	75.01	0.00

The Existing Conditions Model yields WSEs that are very similar to the Effective and Duplicate Effective models in the vicinity of Ewing Substation.

The Proposed Conditions Model includes the flood protection on the north bank of the model. A slight rise in WSE due to the flood protection installation is predicted in the vicinity of the site. The model predicts a maximum rise of 0.05 feet; however, the slight rise does not propagate far upstream. At 1,580 feet upstream (XS 8080), there is no impact on 100-year flood levels.

Table 2 presents the results for the NJDEP Flood Hazard Criteria with flows at 2,646 cfs. River stations in bold indicate cross-sections added to the model in the vicinity of the site.

Table2: Hydraulic Model Results – NJDEP Flood Hazard Flows (2,646 cfs)

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
11360	86.02	86.02	86.02	0.00
10780	85.93	85.93	85.93	0.00
10370	85.38	85.38	85.38	0.00
10235	85.63	85.63	85.63	0.00
9770	85.52	85.52	85.52	0.00
9735	85.52	85.52	85.52	0.00
9734	Pennington Road Bridge			
9655	83.65	83.65	83.65	0.00
9605	82.62	82.62	82.62	0.00
9500	82.71	82.71	82.71	0.00
9395	82.92	82.92	82.92	0.00
9345	82.88	82.88	82.88	0.00
9344	N.J. National Bank Bridge			
9325	82.47	82.47	82.47	0.00
9275	82.55	82.55	82.55	0.00
8975	81.54	81.54	81.54	0.00
8927	81.66	81.66	81.66	0.00
8926	Culvert Under Mrs. G Store			
8725	81.52	81.52	81.52	0.00
8680	81.51	81.51	81.51	0.00
8675	81.51	81.51	81.51	0.00
8674	Parkside Avenue Bridge			
8605	81.41	81.41	81.41	0.00
8600	81.41	81.41	81.41	0.00
8555	81.18	81.18	81.18	0.00
8500	80.18	80.18	80.18	0.00
8080	78.95	78.93	78.94	0.00

	2	3	4	(4-3)
River Station	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)
7580	77.37	77.27	77.29	0.02
7280	76.93	76.76	76.80	0.03
6900	76.65	76.42	76.47	0.05
6500	**n/a**	**76.17**	**76.17**	**0.01**
6330	**75.98**	**76.04**	**76.03**	**-0.02**
6291	76.08	76.08	76.08	0.00
6290	76.08	76.08	76.08	0.00
6289	Prospect Street Bridge			
6235	75.92	75.92	75.92	0.00
6234	75.92	75.92	75.92	0.00
6195	75.69	75.69	75.69	0.00

Based on model results, the proposed sheetpile flood wall around the Ewing Substation will not significantly impact water surface elevations in the West Branch Shabakunk Creek Floodplain under Flood Hazard Flow Conditions. The model indicates that there will be a slight rise as a result of the sheetpile wall under Flood Hazard Flow Conditions. The model predicts a maximum rise of 0.05 feet; however, the slight rise does not propagate far upstream. At 1,580 feet upstream (XS 8080) of the site, there is no impact on Flood Hazard flood levels.

Black & Veatch also prepared a floodway run which includes encroachments since the Ewing Substation Site partially lies in the NJDEP designated floodway. Results are presented in Table 3.

Table 3: Hydraulic Model Results – Floodway Run Flood Levels (2,117 cfs)

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
11360	85.54	86.49	86.49	86.49	0.00
10780	85.43	86.42	86.42	86.42	0.00
10370	84.94	86.16	86.16	86.16	0.00
10235	85.18	86.28	86.28	86.28	0.00
9770	85.04	86.20	86.20	86.20	0.00
9735	85.04	86.18	86.18	86.18	0.00
9734	Pennington Road Bridge				
9655	83.11	83.33	83.33	83.33	0.00

	1	2	3	4	(4-3)
River Station	**Effective Model**	**Duplicate Effective**	**Existing Conditions**	**Proposed Conditions**	**Difference**
	(ft)	(ft)	(ft)	(ft)	(ft)
9605	82.33	82.20	82.20	82.20	0.00
9500	82.30	82.27	82.27	82.27	0.00
9395	82.52	82.48	82.48	82.48	0.00
9345	82.36	82.35	82.35	82.35	0.00
9344	N.J. National Bank Bridge				
9325	82.09	82.07	82.07	82.07	0.00
9275	82.05	82.08	82.08	82.08	0.00
8975	81.24	80.69	80.69	80.69	0.00
8927	81.38	81.03	81.03	81.03	0.00
8926	Culvert Under Mrs. G Store				
8725	81.27	81.23	81.23	81.23	0.00
8680	81.26	81.21	81.21	81.21	0.00
8675	81.27	81.21	81.21	81.21	0.00
8674	Parkside Avenue Bridge				
8605	81.22	81.12	81.12	81.12	0.00
8600	81.17	81.12	81.12	81.12	0.00
8555	81.10	80.97	80.97	80.97	0.00
8500	79.66	79.75	79.75	79.75	0.00
8080	78.20	78.38	78.36	78.37	0.00
7580	76.84	76.86	76.70	76.73	0.03
7280	76.49	76.58	76.38	76.42	0.03
6900	76.19	76.24	75.92	75.98	0.06
6500	**n/a**	**n/a**	**75.66**	**75.69**	**0.02**
6330	**75.44**	**75.45**	**75.54**	**75.51**	**-0.02**
6291	75.58	75.59	75.59	75.59	0.00
6290	75.51	75.57	75.57	75.57	0.00
6289	Prospect Street Bridge				
6235	75.37	75.40	75.40	75.40	0.00
6234	75.40	75.40	75.40	75.40	0.00
6195	75.22	75.22	75.22	75.22	0.00

The Proposed Conditions Model includes the flood protection on the north bank of the model. A slight rise in WSE due to the flood protection installation is predicted in the vicinity of the site. The model predicts a maximum rise of 0.06 feet; however, the slight rise does not propagate far upstream. At 1,580 feet upstream (XS 8080), there is no impact on floodway flood levels. This increase in the WSE due to construction in the Floodway will