



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001**

July 1, 2015

MEMORANDUM TO:           ACRS Members

FROM:                        Quynh Nguyen, Senior Staff Engineer */RA/*  
                                  Technical Support Branch, ACRS

SUBJECT:                    CERTIFIED MINUTES OF THE ACRS REGULATORY  
                                  POLICIES AND PRACTICES SUBCOMMITTEE MEETING ON  
                                  JUNE 9, 2015

The minutes of the subject meeting were certified on June 25, 2015, as the official record of the proceedings of that meeting. Copies of the certification letter and minutes are attached.

Attachments: As stated

cc:    E. Hackett  
       M. Banks



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001**

**MEMORANDUM TO:** Quynh Nguyen, Senior Staff Engineer  
Technical Support Branch, ACRS

**FROM:** Dana A. Powers, Chairman  
Early Site Permit Subcommittee

**SUBJECT:** CERTIFICATION OF THE MINUTES OF THE REGULATORY  
POLICIES AND PRACTICES SUBCOMMITTEE MEETING ON  
JUNE 9, 2015

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting are an accurate record of the proceedings for that meeting.

***/RA/***

***June 25, 2015***

---

Dana A. Powers, Chairman  
Regulatory Policies & Practices Subcommittee

Date

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
MINUTES OF THE ACRS REGULATORY POLICIES AND PRACTICES SUBCOMMITTEE  
MEETING  
JUNE 9, 2015

The ACRS Regulatory Policies and Practices Subcommittee held a meeting on June 9, 2015 in T2-B3, 11545 Rockville Pike, Rockville, Maryland. The meeting convened at 8:29 am on June 9 and adjourned at 10:34 am.

The entire meeting was open to the public.

No written comments or requests for time to make oral statements were received from members of the public related to this meeting.

ATTENDEES

ACRS Members/Consultants/Staff:

DANA A. POWERS, Subcommittee Chairman  
DENNIS C. BLEY, Member  
GORDON R. SKILLMAN, Member  
MICHAEL T. RYAN, Member

NRC Staff:

QUYNH NGUYEN, ACRS (Designated Federal Official)  
ANDY CAMPBELL, NRO  
PROSANTA CHOWDHURY, NRO  
KEN ERWIN, NRO  
JOSEPH GIACINTO, NRO  
HENRY JONES, NRO  
ANDREA KEIM, NRO  
DAVENDRA PIMPALE, NRO  
GEORGE WUNDER, NRO  
ALDO RIVERA, NRO

Other Attendees:

CHRISTOPHER BENDER, Taylor Engineering  
DANIEL BLOUNT, PSEG  
NELSON BRETON, PSEG  
STEPHEN CRISCENTO, PSEG  
DAVID HARRIS, PSEG  
PAUL JENSEN, PSEG  
JAIME MALLON, PSEG  
MEHRDAD SALEHI, PSEG  
DAVE ROBILLARD, PSEG  
GARY RUF, PSEG  
MICHAEL SALISBURY, PSEG  
MICHAEL SHERVIN, PSEG

MICHAEL WIWEL, PSEG

SUMMARY

The purpose of the meeting is to review of selected chapters, the safety evaluation report associated with the early site permit for the PSEG site. The meeting transcripts are attached and contain an accurate description of each matter discussed during the meeting. The presentation slides and handouts used during the meeting are attached to these transcripts.

SIGNIFICANT ISSUES	
Issue	Reference Pages in Transcript
Regarding the proposed site, Member Skillman asked about the effects of an event from La Palma (Canary Islands).	19-23
Member Skillman questioned the applicability of a Category IV hurricane in the modeling. As part of their response, the applicant cited that a Category I has never made landfall at the site.	27-30
Member Bley asked how the models were validated. PSEG responded that the models included data from Hurricane Isabel and Northeaster Ida.	33
Member Skillman asked how maximum still water is established.	37-39
Chairman Powers wanted clarification regarding the differences between the one-dimensional screening modeling and the two-dimensional modeling.	49-58
Member Skillman wanted clarification about the Taylor engineering high-performance computing cluster.	58-60
Chairman Powers wanted more clarification regarding the radioactive liquid effluent analyses.	64-67
Mr. Chowdhury summarizes the staff efforts regarding the early site permit safety evaluation.	67-75

Documents provided to the Subcommittee

1. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.27, Revision 2, "Ultimate Heat Sink for Nuclear Power Plants," January 1976.
2. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.29, Revision 4, "Seismic Design Classification," March 2007.
3. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.59, Revision 2, "Design Basis Floods for Nuclear Power Plants," August 1977,
4. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.102, "Flood Protection for Nuclear Power Plants," September 1976.

**Official Transcript of Proceedings**  
**NUCLEAR REGULATORY COMMISSION**

Title:                   Advisory Committee on Reactor Safeguards  
                                  Regulatory Policies and Practices

Docket Number:     (n/a)

Location:             Rockville, Maryland

Date:                 Tuesday, June 9, 2015

Work Order No.:     NRC-1640

Pages 1-79

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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

REGULATORY POLICIES AND PRACTICES SUBCOMMITTEE

+ + + + +

TUESDAY

JUNE 9, 2015

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear  
Regulatory Commission, Two White Flint North, Room  
T2B3, 11545 Rockville Pike, at 8:30 a.m., Dana A.  
Powers, Chairman, presiding.

COMMITTEE MEMBERS:

DANA A. POWERS, Chairman

HAROLD B. RAY, Member

DENNIS C. BLEY, Member

MICHAEL T. RYAN, Member

GORDON R. SKILLMAN, Member

DESIGNATED FEDERAL OFFICIAL:

QUYNH NGUYEN

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## ALSO PRESENT:

CHRISTOPHER BENDER, Taylor Engineering

DANIEL BLOUNT, PSEG

NELSON BRETON, PSEG

ANDY CAMPBELL, NRO

PROSANTA CHOWDHURY, NRO

STEPHEN CRISCENTO, PSEG

KEN ERWIN, NRO

JOSEPH GIACINTO, NRO

DAVID HARRIS, PSEG

PAUL JENSEN, PSEG

HENRY JONES, NRO

ANDREA KEIM, NRO

JAIME MELLON, PSEG

DAVENDRA PIMPALE, NRO

MEHRDAD SALEHI, PSEG

ALDO RIVERA, NRO

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GARY RUF, PSEG

MICHAEL SALISBURY, PSEG

MICHAEL SHERVIN, PSEG

MICHAEL WIWEL, PSEG

GEORGE WUNDER, NRO

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## P R O C E E D I N G S

(8:29 a.m.)

CHAIRMAN POWERS: Let's come into session here. This is a meeting of the Regulatory Policies and Practice Subcommittee, and Advisory Committee on Reactor Safeguards. I'm Dana Powers, Chairman of the Subcommittee. The ACRS Members in attendance today include Dick Skillman, Mike Ryan, myself, Dennis Bley may join us as his Vice Chairman duties permit.

As announced in the Federal Register on May 22, 2015, the subject of today's briefing is a review of hydrologic engineering of the safety evaluation report associated with the early site permit application for the PSEG site. This is the third, and we certainly hope the final, Subcommittee briefing on this particular application.

The rules for participation in today's meeting were also announced in the Federal Register Notice. We do have a bridge line, I'm told, for the public and stakeholders to hear the deliberations. This line will not carry any signal from this end. I need to tell who you are. You want to introduce yourself?

MR. NGUYEN: Go ahead.

CHAIRMAN POWERS: Mr. Quynh Nguyen is the

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1 designated federal official for this meeting and he  
2 will ably assist me as required, right?

3 MR. NGUYEN: Right.

4 CHAIRMAN POWERS: Okay. Well, there's a  
5 lot of stuff about the fact that we have a phone line  
6 here. Also, to minimize disturbance, the line will be  
7 kept on the listen-in-only mode until the end of the  
8 meeting when ten minutes are allocated for public  
9 comments. At that time, any member of the public  
10 attending this meeting in-person or through the bridge  
11 line can make a statement or provide comments if they  
12 so desire.

13 As the meeting is being transcribed, I  
14 request the participants in the meeting use the  
15 microphones located throughout this room when  
16 addressing the Subcommittee, and certainly, do not  
17 follow my poor example of you need to tap your thing  
18 to get it to activate and you need to tap it again to  
19 get it to deactivate so the young lady sitting to my  
20 left can hear us.

21 If she doesn't hear us, she gets to write  
22 what you said, and she's vindictive, I'm told.  
23 Participation in all cases, first, identify themselves  
24 and speak with sufficient clarity and volume so that  
25 they can be readily heard. I'm cautioned to please

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1 silence all cellphones. We have a special room for  
2 those people that don't do that. It is unpleasant, I'm  
3 told.

4 We will now proceed with the meeting and  
5 I guess we'll start the meeting off with an introductory  
6 and overview status report from Prosanta.

7 MR. CHOWDHURY: Right.

8 CHAIRMAN POWERS: The floor is yours, sir.

9 MR. CHOWDHURY: Okay. Good morning,  
10 Chairman, and good morning, Committee Members, and --

11 CHAIRMAN POWERS: See, I give you  
12 instructions.

13 MR. CHOWDHURY: It's now turned on. I'll  
14 repeat what I said. Good morning, Mr. Chairman and  
15 Members of the ACRS Subcommittee, and good morning all  
16 present this morning at this ACRS Subcommittee meeting  
17 on PSEG site, early site, permit hydrologic engineering  
18 review by the NRC staff.

19 My name is Prosanta Chowdhury. I'm the  
20 lead project manager for this project and I have been  
21 involved with this project since May 2010, when the  
22 application was tendered. As for my background, I was  
23 a state government employee in Louisiana at the  
24 Department of Environmental Quality and Radiation  
25 Protection for 18 years.

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1           And then I moved to the NRC in 2005, so I  
2           have been at the NRC a little over ten years now, and  
3           as far as the project manager position goes, I moved  
4           from the Security and Instant Response Office to Office  
5           of New Reactors in 2008. Since then, I have been  
6           project manager, so it has been almost seven years as  
7           a project manager.

8           I have a Master's Degree in Electrical  
9           Engineering from Moscow, Russia, and I have a Master's  
10          Degree in Nuclear Engineering from Louisiana State  
11          University. And I have been managing this project  
12          since May 2010 and the project, when we came to today's  
13          meeting, which is the last Subcommittee meeting on the  
14          last piece of the application, so I'm going down to the  
15          next slide.

16          The purpose of today's meeting is to brief  
17          the Subcommittee on the status of the staff safety  
18          review and also support the Subcommittee's review of  
19          the application and subsequent letter from the ACRS to  
20          the Commission, and address the Subcommittee's  
21          questions.

22          On this agenda, on my part of the agenda,  
23          I have the introduction, schedule milestone, status of  
24          safety evaluations, and today's key review area is  
25          hydrologic engineering. Okay. I'm being helped

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1 here. Just bear with me. Thank you so much. And then  
2 we will present the advanced safety evaluation with  
3 open items conclusions presentation, conclusions, and  
4 I will briefly go over and recap what has been completed  
5 by the staff and also what has been presented so far  
6 to the Subcommittee, and then any discussions and  
7 questions thereafter.

8 So the Applicants, once again, are PSEG  
9 Power, LLC, and PSEG Nuclear, LLC. The Applicants'  
10 proposed ESP site is located in Lower Alloways Creek  
11 Township, Salem County, New Jersey, 30 miles southwest  
12 of Philadelphia, Pennsylvania, and 7-1/2 miles  
13 southwest of Salem, New Jersey.

14 It's located on the upper Delaware Bay  
15 adjacent to and north to the Hope Creek Generating  
16 Station. The two-unit Salem Generating Station is  
17 co-located on this site to the south of Hope Creek  
18 Station. PSEG, just to refresh everybody's memory,  
19 PSEG developed Plant Parameter Envelope using one-unit  
20 U.S. EPR, one-unit ABWR, and one-unit U.S. APWR, and  
21 two-unit passive AP1000 technologies.

22 PSEG requests permit approval, early site  
23 permit approval, for a 20-year term. Does not seek a  
24 limited work authorization approval for activities,  
25 and then seeks approval for complete and integrated

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1 emergency plans with ITAAC as part of ESP.

2 So the milestones that have been completed  
3 so far is, the application we received on 25th of May  
4 2010, acceptance review completed, and the application  
5 docketed on 4th of August 2010. We issued a schedule  
6 and completed Phase A, which is all REIs to be issued  
7 in September of 2013. This is a four-phase schedule  
8 and Phase B is advanced safety evaluations with no open  
9 items to be issued by end of June 2015, that was the  
10 public milestone, and we achieved that 45 days in  
11 advance.

12 And I must thank to all technical staff and  
13 technical branches for that achievement. Chapters  
14 presented to ACRS on March 19, 2014. As Dr. Powers  
15 mentioned, there have been two Subcommittee meetings  
16 already, so first one on March 19, 2014, we presented  
17 Chapters 3.5.1.6, has to do with aircraft hazards, 11.2  
18 and 11.3 combined, 13.3, 15.0.3, and 17.5.

19 Chapters presented to ACRS on September 29  
20 and 30, 2014 is 2.1 and 2.2 combined, and 2.3, and 2.5.  
21 Now, one thing I would like to mention here is that,  
22 we recently issued, publicly, Chapter 20, which has to  
23 do with the implementation of the Fukushima  
24 recommendations. And this Chapter 20, for the PSEG  
25 early site permit, simply points to other safety

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1 evaluations where applicable, Fukushima NTTF,  
2 Near-Term Task Force recommendations, are evaluated.

3 Chapter 20 does not contain the staff's  
4 evaluation as such, because the staff evaluation for  
5 the only recommendation, which is 9.3, has to do with  
6 emergency planning, staffing, and communications, has  
7 been addressed in the ASE, and then the seismic and  
8 flood hazard related to the recommendation 2.1 have  
9 been already addressed in the respective SE chapters,  
10 so the Chapter 20 points to those areas.

11 There are no surprised in Chapter 20, by  
12 the way. It has a long background and regulatory  
13 basis. So the remaining milestones, Chapter 2.4,  
14 hydrologic engineering, which is being presented  
15 today, and then the ACRS Full Committee meeting, it was  
16 a challenge for me, I took it, and I think we will be  
17 ready tomorrow at 8:30, and the conclusion of ACRS  
18 meetings, as well as ACRS letter, Phase C will be  
19 completed, and the public milestone is July 31, 2015.

20 And then the Final Safety Evaluation  
21 Report, FSER, completion date is September 30, 2015,  
22 which is Phase D, the last phase of this review before  
23 hearing. Just to --

24 CHAIRMAN POWERS: I hasten to point out  
25 that it will be up to the ACRS Full Committee itself

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1 to decide whether a letter is -- the Subcommittee only  
2 collects information and makes hints and  
3 recommendations to them. They make the decision.  
4 Okay. Well-known to be pig-headed and hard to get  
5 along with.

6 MR. CHOWDHURY: Understand. Just to  
7 remind everybody once again that, the staff had a  
8 pre-application site visit in 2008, January 2008,  
9 another PM was involved at that time. We had emergency  
10 planning site visit. Folks actually went around the  
11 site, looked at all the elements that pertain to  
12 emergency planning and preparedness. That was May of  
13 2010.

14 Hydrologic engineering site visit and  
15 audit was in 2011, February of 2011, that was an  
16 elaborate site visit and audit. Quality assurance  
17 audit was done in May -- end of May, early June of 2011.  
18 Geology site visit and audit was done in September of  
19 2011, and that was quite an adventure because of the  
20 rain the night before, but we took it and we made  
21 through.

22 And there's a meteorology site visit in May  
23 of 2012. Seismic software audit was done in September  
24 of 2013. This is a list of acronyms for the record and  
25 with that, are there any questions on the introductory

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1 remarks? Okay. If none, then I think by the agenda,  
2 PSEG is going to --

3 CHAIRMAN POWERS: Yes, we'll now turn to  
4 a presentation from PSEG. The staff will come back  
5 later this morning to discuss their view on the material  
6 that's presented. And so, Jaime, I think you're on.

7 MR. MELLON: Okay. My name's Jaime  
8 Mellon. I have over 30 years of experience in the  
9 nuclear power industry. I've worked in licensing, reg  
10 assurance, training, and radiation protection. I've  
11 worked at operating reactors, decommissioning  
12 reactors, and also in the construction of some  
13 facilities.

14 I have a Bachelor's Degree in Physics from  
15 Franklin and Marshall College in Lancaster, PA, and I  
16 have a SRO Cert from Peach Bottom. And with that, we're  
17 going to get started and I will -- okay. Going to move  
18 down here and hit Page Down? There we go. Is that the  
19 mouse? There it is. And I'd like to introduce Dan  
20 Blount. Dan has over 12 years of experience in the  
21 nuclear power industry, design engineering,  
22 engineering support of regulatory and licensing  
23 actions.

24 His design engineering experience  
25 includes major mods to both primary and secondary

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1 portions of the power plants. Dan is a qualified 5059  
2 evaluator at our nuclear facilities, PSEG's  
3 facilities. He has a Bachelor of Science Degree in  
4 Mechanical Engineering from York College of PA, and is  
5 a registered PE in the State of Delaware.

6 MR. BLOUNT: All right. Good morning,  
7 everyone. Thank you, Jaime. Today our presentation  
8 will be divided into three areas. We're going to go  
9 over a general hydrological background and talk about  
10 some of the smaller floods that we evaluated, then we'll  
11 move to discuss our design basis flood, which is the  
12 problem, maximum hurricane, for this site, and finally,  
13 we'll talk about our ground water analyses and  
14 accidental releases analyses.

15 This slide lists the regulatory guidance  
16 that we used in developing the early site permit  
17 application. Reg Guide 159 was used to establish the  
18 floods considered for the design basis flood. NUREG  
19 CR 7046 was issued after the early site permit  
20 application was submitted, however, that captures much  
21 of the ANC 2.8 guidance that we used in our application  
22 related to combined events that we'll discuss later.

23 This slide presents the PSEG site and its  
24 location within the Delaware River Basin. This site  
25 is located about 52 miles upstream of the mouth of the

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1 bay. I'll try to, I don't know if the mouse is -- there  
2 we go.

3 MR. MELLON: So there's the mouth of the  
4 bay, right?

5 MR. BLOUNT: The site is the pink dot  
6 there. Seven miles north of this site is the Reedy  
7 Point NOAA Tidal Gauge, and that is the closest tidal  
8 gauge to the site, and the gauge we used for a lot of  
9 our data at the site location.

10 This slide depicts a picture of the current  
11 site. We have Salem Unit 1 and 2 in the foreground,  
12 Hope Creek to the north, and then further to the north  
13 there is our location for the new plant, just to the,  
14 excuse me, west of the cooling tower, north of Hope  
15 Creek. This slide is effectively looking northwest  
16 across the site.

17 The river at the site is about two and a  
18 half miles wide. Next slide. All right. In this  
19 slide we show the actual, the reaches of the Delaware  
20 River Basin itself. It goes from the Catskill  
21 Mountains in New York to the north, and all the way  
22 drains to the Atlantic Ocean in the south.

23 The site's located at the transition zone  
24 between the Delaware Bay and the Delaware River. The  
25 tidal flows at the site greatly dominate the freshwater

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1 flows. And the river's actually tidally influenced  
2 all the way up to Trenton, New Jersey. There are no  
3 dams on the main branch of the Delaware River. The  
4 reservoirs that you see on this slide are all on  
5 tributaries that feed the Delaware River.

6 Next slide. Historically, storm surge  
7 events have dominated the flood causing mechanisms and  
8 in the vicinity of the site, the hurricane of 1933  
9 produced the highest recorded water level at Reedy  
10 Point, which is our closest tidal gauge. The design  
11 basis flood determination is made by obtaining a number  
12 of different flood-causing mechanisms, which we've  
13 listed on this slide, and also, the applicable combined  
14 events criteria associated with these events that we'll  
15 talk about as we go through the various floods.

16 First off, we have the local intense  
17 precipitation event, which is local just to PSEG's site  
18 itself. We used NOAA's hydrometeorological reports  
19 number 51 and 52 to develop the rainfall intensities  
20 over a one-square-mile area at varying durations.  
21 We've built an Army Corps HEC-HMS Model and divided the  
22 site up into subbasins to determine the peak flow rates  
23 between the various subbasins in the model.

24 At the ESP stage, that's, effectively, as  
25 far as we can take the analyses because we don't have

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1 a finalized site grading plan with a final site  
2 technology selected, so this analysis will be revisited  
3 at the COLA stage to assure and refine that the local  
4 intense precipitation flooding does not impact  
5 safety-related structures.

6 MEMBER RAY: Do you do these calcs into the  
7 probable maximum or do you get the Corps to do this for  
8 you?

9 MR. BLOUNT: For these analyses, we used  
10 a NOAA HMR 51 and 52 are the publications that are  
11 regionalized and show you per a certain amount of area  
12 what the rainfall intensity is over a certain duration,  
13 so it's from an existing analysis.

14 MEMBER RAY: Okay.

15 MR. BLOUNT: Yes. Section 2.4.3 of the  
16 SAR is the first of the river floods we'll discuss here.  
17 For all of the river floods within the Delaware River  
18 Basin, we developed a U.S. Army Corps HEC-HMS and  
19 HEC-RAS model system that supported our analyses for  
20 the rivering environment. The model was validated  
21 against historical events and also the tidal aspects  
22 that are seen continuously at the site.

23 We used, once again, NOAA HMR 51 to  
24 establish our two possible probable maximum  
25 precipitation events. One is a larger lower intensity

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1 event that's centered over Doylestown, Pennsylvania,  
2 and the second is a smaller higher intensity event  
3 that's centered over Philadelphia.

4 We simulated those events in our model,  
5 combined that with the ANS 2.8 combined events  
6 criteria, and ultimately, arrived at a total water  
7 surface elevation of 21 feet NAVD at the PSEG site. The  
8 water surface elevation from the PMP, the probable  
9 maximum precipitation, event itself was actually less  
10 than three feet at the site. So the significant  
11 drivers are the combined events.

12 Section 2.4.4 of the SAR discussed  
13 potential dam failures. Our first step in this  
14 analysis was to screen the U.S. Army Corps national  
15 inventory of dams. We identified four 6000-acre-foot  
16 reservoirs near the site within a 70-mile vicinity of  
17 the site, and we also identified seven greater than  
18 60,000-acre-foot reservoirs, really, in the upper  
19 Delaware River Basin, in the Catskill Mountains and the  
20 Pocono Mountains of Pennsylvania.

21 With those reservoirs identified, we  
22 develop four scenarios where we combined the dams  
23 regionally in those various areas, and then assumed a  
24 seismic event would instantaneously break the dams,  
25 release the reservoirs contents to the main branch of

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1 the Delaware River at exactly the same time to maximize  
2 the potential flooding at the site.

3 The failure of the two largest reservoirs  
4 in the Catskills produced the highest water surface  
5 elevation. You can see here is only 3/10 of a foot from  
6 the dam -- or the reservoir inventory versus the  
7 combined events value of 9.4 feet.

8 MEMBER RAY: Just a question.

9 MR. BLOUNT: Sure.

10 MEMBER RAY: That's not something to write  
11 home about, but you said if they all fail  
12 simultaneously, that's the highest water? I would  
13 have thought a cascading effect would have led to a  
14 higher water level.

15 MR. BLOUNT: Probably should have  
16 mentioned that. There are no cascading dams within the  
17 Delaware Water Basin.

18 MEMBER RAY: Okay. So these are all --

19 MR. BLOUNT: Yes. So they're all on  
20 different branches and then they merge together, and  
21 we timed them, kind of, artificially, actually timed  
22 them burst together.

23 MEMBER RAY: So they all come together.  
24 Okay.

25 MR. BLOUNT: Yes. Section 2.4.6

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1 discussed the probable maximum tsunami analysis. Our  
2 analysis followed the guidance of NUREG CR 6966.  
3 First, we reviewed the historical record of the  
4 tsunamis affecting the East Coast to establish our  
5 source characteristics for modeling the probable  
6 maximum tsunami. We next used NOAA's MOST model to  
7 simulate the PMT event and how it impacted the site  
8 through the Delaware Bay to our site location.

9 Next slide. The La Palma event in the  
10 eastern Atlantic Ocean and the Hispaniola trench  
11 subduction event in the Caribbean Sea were both  
12 modeled. Neither of these events represent the  
13 probable maximum tsunami at the site. The results were  
14 approximately half of a foot of elevation change in the  
15 water level, drawdown and runup, so very minor impacts  
16 at the site from these two events.

17 MEMBER SKILLMAN: Dan, before you change  
18 that slide, the text of the safety evaluation, 124  
19 pages, indicate that at least early calcs showed a wall  
20 of water of about 88 feet from La Palma.

21 MR. BLOUNT: The --

22 MEMBER SKILLMAN: Okay. And you just  
23 mentioned a very minor effect on the bay. Speak to that  
24 in terms of reconciling that difference.

25 MR. BLOUNT: The 88 feet of water, I

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1 believe, is in Europe, so the effects of the tsunami  
2 as it went to the East and into Europe versus the effects  
3 of the tsunami as it propagated to the West, towards  
4 the Atlantic, or our East Coast of the United States,  
5 the value -- I apologize. I don't have that here.  
6 I'll have to get that for you, but I believe we had  
7 presented that in our SAR. I can't speak specifically  
8 to the SER text. I apologize.

9 MEMBER SKILLMAN: I read it very  
10 carefully.

11 MR. BLOUNT: Okay.

12 MEMBER SKILLMAN: I think you will find  
13 that the text essentially says, some predictions could  
14 be as great as 88 feet at the site. Now, if you've  
15 sailed across the Atlantic a number of times you know  
16 she's a wide ocean and it's hard to believe that if there  
17 were that event in the Canary Islands that 88 feet could  
18 find its way 2500 miles to the West, and if it did, I  
19 would think what happens at Salem Hope Creek site may  
20 pale compared to what is happening elsewhere on the East  
21 Coast. That's a different issue.

22 But I think you need to take a look at the  
23 way the text is presented in the safety evaluation  
24 because it's quite clear that early calcs showed 88 feet  
25 arriving at the site, then there are some words in there

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1 that indicate later calculations suggest it's a  
2 fraction of a meter, which is approximately what you  
3 just mentioned.

4 MR. BLOUNT: We'll certainly take a look  
5 at that, yes.

6 MEMBER SKILLMAN: Thank you.

7 MEMBER RAY: I've seen other calculations  
8 of La Palma that generate very high water on the East  
9 Coast. I can't remember the details, but I think,  
10 somehow, they left out the effects of superposition on  
11 that with the multiple waves canceling out each other,  
12 but there might be a hint there if you dig at it.

13 MR. BLOUNT: We'll take a look. Okay.  
14 In the SAR analysis, the Currituck landslide event  
15 ultimately represented our probable maximum tsunami  
16 event. The runup and drawdown without considering the  
17 tidal effects was just slightly over one-foot elevation  
18 at the site. With tide, as you can see there, it's  
19 approximately six-feet positive and negative NAVD.

20 2.4.7 of the SAR discussed ice effects and  
21 to evaluate ice effects, we reviewed the historical ice  
22 jam data and actually found no ice jams downstream of  
23 Trenton, so no ice jams in the tidal portions of the  
24 Delaware River. To simulate a flood from an ice jam,  
25 we took a historical 1904 event at Trenton, modeled that

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1 in our HEC-HMS, HEC-RAS software, combined that with  
2 the effects of tide, the spring river flood, and then  
3 waves to establish 8.1 feet NAVD.

4 A new intake structure at the site will be  
5 designed to address both surface and frazil ice, as both  
6 are possible at the PSEG site.

7 MEMBER BLEY: Have you ever had frazil ice  
8 there?

9 MR. BLOUNT: Yes.

10 MEMBER BLEY: You have.

11 MR. BLOUNT: Yes.

12 MEMBER BLEY: Did it affect any of the  
13 cooling systems?

14 MR. BLOUNT: It caused some blockages on  
15 the circulating water intake structure, so the  
16 non-safety-related streams for --

17 (Simultaneous speaking)

18 MR. BLOUNT: Yes, it's kind of like grass  
19 or something that builds up.

20 MEMBER BLEY: I've seen it further north.  
21 I didn't realize we got it down in this area.

22 MR. BLOUNT: It's certainly not common,  
23 but it has happened once or twice. Section 2.4.8  
24 discusses cooling water canals and reservoirs, which  
25 are actually features that we do not have at the PSEG

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1 site, so it's not really applicable. 2.4.9 goes into  
2 channel diversions.

3 As we saw on the picture previously, the  
4 site is a very flat, very open area. There's no recent  
5 historical evidence of the Delaware River or bay  
6 changing course in any significant manner to either  
7 cause a lack of cooling water to the site or cause a  
8 flooding condition on the site, so there's really no  
9 seismic or severe weather event that might cause those  
10 types of issues.

11 Section 2.4.11 was low water  
12 considerations and there were three primary events we  
13 considered for low water. First is low flow conditions  
14 in the Delaware River, second, we've already discussed,  
15 was the drawdown from tsunami events, and third was  
16 drawdown from a severe windstorm, which, in our case,  
17 is a hurricane event.

18 The negative surge from the hurricane  
19 could produce drawdowns as low as -15.9 feet NAVD when  
20 we consider the combined effects of a very low tide as  
21 well. A safety-related intake structure will be  
22 designed such that the low water does not cause any  
23 operational problems for the plant.

24 MEMBER SKILLMAN: Explain that last  
25 phrase that you communicated.

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1 MR. BLOUNT: So the lower invert of the  
2 intake structure would be set such that the pumps would  
3 have sufficient NPSH to, basically, continue pumping  
4 water through the duration of a low-water event if one  
5 were to occur.

6 MEMBER SKILLMAN: What would that  
7 duration be?

8 MR. BLOUNT: We've estimated  
9 approximately six hours and that is related, of course,  
10 to the tidal cycle at the site, combined with the  
11 hurricane passing by.

12 MEMBER SKILLMAN: Okay. Thank you.

13 MR. MELLON: And with that, I'm going to  
14 ask Mike Salisbury to come up and he's going to talk  
15 to us about the probable maximum hurricane storm surge.  
16 And, Mike, your cord is right there. So Mike has served  
17 as the project manager and lead modeler for a number  
18 of tide and storm surge modeling related projects  
19 throughout the United States and abroad.

20 He has over ten years of experience working  
21 on coastal related projects, including expertise in  
22 developing storm surge models for risk assessment,  
23 floodplain mapping, and long-term climatology studies.  
24 He's published several peer-reviewed articles  
25 detailing the development and validation of various

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1 numerical models, and is chair of the Coastal and  
2 Estuarian Hydrosociences Committee for the Coasts,  
3 Oceans, Ports, and Rivers Institute of the American  
4 Society of Civil Engineers.

5 Mike has his Bachelor's and Master's  
6 Degree in Civil Engineering from the University of  
7 Central Florida and is a PE in the State of Florida.

8 MR. SALISBURY: Thank you, Jaime. Good  
9 morning, Committee Members. Thank you for taking the  
10 time for this presentation today. So for probable  
11 maximum surge, the basis methodology that we used is  
12 the probable maximum hurricane and it's based off of  
13 the NWS 23 technical publication. And the root of this  
14 methodology is it looks at various combinations of the  
15 important parameters necessary for hurricane formation  
16 and propagation.

17 With that, and so some of these important  
18 parameters are central pressure, radius of maximum  
19 winds, forward speed, et cetera. Using the  
20 information in this technical document, we performed  
21 a storm surge screening assessment and what this  
22 assessment did is it looked at the different  
23 combinations. You know, some of the parameters gave  
24 a range of possible possibilities, such as forward  
25 speed, radius of maximum winds, so what we wanted to

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1 do is look at all possible reasonable combinations of  
2 these parameters using a screening methodology, and  
3 that screening methodology is use the Bodine storm  
4 surge model to bring the surge from the open deep water  
5 ocean to the open coast at the mouth of the Delaware  
6 Bay.

7 From the mouth of the Delaware Bay, we  
8 relied on the HEC-RAS model that was developed for  
9 Delaware Bay, Delaware River to propagate the surge  
10 from the mouth of the Delaware Bay up to the site. With  
11 that, it was also superimposed on top of that is wind  
12 setup from the Kamphius wind setup methodology, and  
13 then lastly, getting local to the site, wave runup was  
14 calculated based on these conditions using Coastal  
15 Engineering Manual methodologies.

16 Using that screening assessment, like I  
17 said, we looked at a number of different combinations  
18 and arrived at the peak water surface elevation at site  
19 resulting from a storm that had a radius of maximum  
20 winds of 28 nautical miles, and a forward speed of 26  
21 knots. And this resulted in a total water surface  
22 elevation of the site of 42.4 feet.

23 Now, just to give you a frame of reference  
24 for this probable maximum hurricane event, it had a  
25 central pressure of 902 millibars. This is

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1 approximately a strong Category 4 storm, on the  
2 Saffir-Simpson scale, and further with that, along New  
3 Jersey, they've only ever had a Category 1 storm make  
4 direct landfall, so to give you a frame of reference  
5 of how intense and big of a storm this is that we're  
6 dealing with.

7 MEMBER SKILLMAN: Let me challenge you  
8 there, Michael, why would we find any comfort that the  
9 greatest storm has been a Cat 1 when you say the design  
10 envelope is a Cat 4? Why shouldn't we think, one of  
11 these days there might be a Cat 4 that comes that far  
12 north?

13 MR. SALISBURY: Well, to the point I  
14 think, you know, that that's why we're wanting to look  
15 at a storm of this magnitude, you know, there is some  
16 literature out there that suggests the sea surface  
17 temperatures in the mid-Atlantic region of the ocean  
18 won't allow a storm to get that intense or that strong  
19 in this area, but, you know, to be conservative, you  
20 know, we decided since it's possible, according to that  
21 technical literature for an NWS 23 method, that a storm  
22 could be this intense.

23 MR. MELLON: So this is a deterministic  
24 model and we're plugging it into the NWS 23 methodology,  
25 and we're just following it, even though reality looks

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1 very different. So we're accepting that conservatism,  
2 especially post-Fukushima, it's appropriate to  
3 overdesign in this area because the impacts would be  
4 significant of a flooding event, so we'll get into what  
5 site grade is, and as we go, how we use the screening  
6 to perform a more refined two-dimensional model,  
7 because HEC-RAS is a one-dimensional model, and it is  
8 overly conservative when modeling what happens in the  
9 Delaware Bay.

10 MEMBER SKILLMAN: Let me ask this, for a  
11 storm that's not a Cat 4, it's a Cat 2, he said the worst  
12 appears to have been a Cat 1, for a Cat 2 or Cat 3 that's  
13 sitting either due east with that anti-cyclic rotation,  
14 or particularly, sitting to the southeast, where the  
15 northern cusp would drive up the bay, what is the  
16 approximate variation in the water level for those  
17 scenarios; for a slightly higher than a Cat 1, not a  
18 Cat 4, but the center of the storm, the eye of the storm,  
19 is sitting at that location that causes the site to be  
20 most vulnerable?

21 MR. SALISBURY: I guess, let me answer  
22 that in two parts. One, that scenario you're talking  
23 about, the orientation, is exactly what the orientation  
24 we're modeling in this probable maximum hurricane  
25 analysis. The second part is to your question of the

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1           relativity of Category 2 or 3, et cetera, we -- I don't  
2           have those numbers on me, I'd have to get back to you  
3           on that.

4                       MR. MELLON:   So to the path of the storm,  
5           we took a storm out in the open ocean, starts a parallel  
6           to the bay path to the south, and it makes landfall,  
7           roughly, Ocean City, Maryland, to drive the water up  
8           the bay, so again, deterministic, this path is chosen  
9           to maximize that storm surge at the site.

10                      A 2 or a 1 would be less water and so we  
11           will raise the site grade to be above the flood height,  
12           but it would be less water, even if it was on that same  
13           path.

14                      MEMBER BLEY:   And you overlaid the high  
15           tide.

16                      MR. SALISBURY:   Yes.   Sorry, some of  
17           these details are coming up in other slides, but if all  
18           other parameters are the same, according to scientific  
19           literature, from that point, it's just a ratio of  
20           central pressure difference.   You can scale the surge  
21           almost directly associated with that correlation.   So  
22           it would be less, but I can't speak to what that exact  
23           number is right now.   I'd have to look that up.

24                      MEMBER SKILLMAN:   Off the top of your  
25           head, what did Sandy do to the site?

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1           MR. SALISBURY:     Sandy, at the site,  
2           produced a water level of 7.7 feet NAVD. And, you know,  
3           some of that had to do with it was occurring on a  
4           downward timing with the tide when it reached the site,  
5           but when it got to the site, it was, I want to say --  
6           was it still a Cat 1 or wasn't it a Category 1 at that  
7           point?

8           MR. MELLON:     It wasn't even Cat 1. It  
9           dropped out of Cat 1 before it made landfall. Sandy  
10          made landfall north of Atlantic City. It did not --  
11          there was no flooding on site. The existing site grade  
12          is about 10 to 12 feet NAVD, so we did see higher water  
13          levels. Most significant was the wave action at the  
14          circ water, the non-safety-related intake structure  
15          for Salem, which caused them to have to trip the unit.  
16          One unit was in a refuel outage. The other unit tripped  
17          and Hope Creek remained online through Sandy.

18          MEMBER SKILLMAN:    Okay. And a trick  
19          question, I don't know if anybody will remember it, I  
20          certainly do, Camille, 1969, walloped the East Coast.  
21          I mean, really, really pummeled the East Coast. Any  
22          history or any information? It doesn't show up on your  
23          data.

24          MR. SALISBURY:     We looked at the whole  
25          record at every tide gauge in Delaware Bay, not the

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1 Delaware River, and looked at all the historical water  
2 levels and --

3 MEMBER SKILLMAN: That one didn't show up?

4 MR. MELLON: Wasn't Camille a rain event,  
5 basically, in the Susquehanna River Basin?

6 MEMBER SKILLMAN: Well, it moved off to  
7 the east because I was stuck in Newark on an airplane  
8 and I remember it was one of the baddest days I've ever  
9 had in an airplane. All you can see was elbows and  
10 rearends with people getting off that plane. I will  
11 tell you, it was deadly. It was really bad.

12 MR. SALISBURY: Yes, like I said, we did  
13 look at all the historical water level data that was  
14 available in the Delaware Bay region. The exact number  
15 for that time period, I don't recall off the top of my  
16 head.

17 MEMBER SKILLMAN: Fair enough. That was  
18 a trick question. I didn't expect any answer.

19 MEMBER BLEY: And if I remember right,  
20 that's the one that really hit Wilkes-Barre, and then  
21 got even up into Elmira, New York. It was a tremendous  
22 rain.

23 MR. MELLON: I remember the Governor's  
24 Mansion in Harrisburg flooded and was not habitable for  
25 years. They didn't open it back up for, you know, five,

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1 six years.

2 MEMBER SKILLMAN: Thank you.

3 MR. SALISBURY: So like I said, the first  
4 step that was presented on the previous slide was the  
5 screening methodology. Once we arrived at the  
6 conditions that produced the peak surge at the site,  
7 we moved to a two-dimensional model, storm surge model,  
8 and with that, it's widely regarded in technical  
9 literature that two-dimensional models are much more  
10 accurate for these types of simulations.

11 They much better describe the nuances of  
12 the bathymetry and topography in the area, the  
13 two-dimensional structure of the wind fields of the  
14 hurricane event, so because we organized that, we were  
15 able to get the recently completed ADCIRC and SWAN model  
16 that was developed for FEMA Region III, they're coastal  
17 flood study updates that they have done in the last few  
18 years.

19 This mesh, ADCIRC mesh, has about 1.8  
20 million computational nodes, so each vertex of the  
21 triangles on that image you see is a computational point  
22 of interest. The advantage of these large-scale  
23 models such as this is it better describes propagation  
24 of the surge when it's out in the deep ocean, Western  
25 North Atlantic Region, propagates up onto the shelf,

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1 and then into the coastal flood plain, and spreads out  
2 in the coastal flood plain.

3 It provides a much more accurate and  
4 realistic assessment of that surge flooding in a  
5 spatial two-dimensional sense.

6 MEMBER BLEY: Just to help me understand  
7 that, if you'll draw a distinction between accuracy and  
8 precision for me, I can see you getting very precise  
9 with this type of model, but when you compare it  
10 against, have you run it against historical or have you  
11 read reports of running it against historical storms  
12 and it more accurately portrays the kinds of things  
13 we're interested in?

14 MR. SALISBURY: Yes, so on the validation  
15 side, there's actually two fronts. One was done before  
16 we obtained the model. It was thoroughly validated by  
17 FEMA. They looked at a number, I want to say it was  
18 three or four historical events, Isabel, they looked  
19 at nor'easters, Nor'easter Ida was one of them, and they  
20 compared that to historical water level data to  
21 validate it.

22 MR. MELLON: Those three were for the  
23 Delaware Bay, as opposed to other hurricanes that FEMA  
24 validated this model against across the Eastern U.S.

25 MR. SALISBURY: Correct. And then once

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1 we got it and refined it locally, which, I'm going to  
2 get to that refinement here in a little bit, we also  
3 then re-validated it to make sure we're still comparing  
4 well to historical tide gauge records. And I forget  
5 what the delta is, but on the order of, you know, 1/10  
6 or two of a foot, I think, is the difference between  
7 model results and measured data.

8 And so, you know, what this is modeling,  
9 this coupled system, it's modeling a storm surge  
10 coupled with -- storm surge, which is the ADCIRC model,  
11 which simulates tides and storm surge, or can simulate  
12 tides, then it's coupled with SWAN, which is a wave  
13 model, so as it's going through the simulation, those  
14 two processes are intertwined with each other, you  
15 know, wave model simulates the waves, communicates that  
16 information back to the surge model, surge model  
17 calculates the water levels and currents, and feeds  
18 that back to the wave model.

19 And what that does is it, like I said,  
20 further represents reality in the physics involved with  
21 the surge flow around the site.

22 So as I alluded to before, once we obtained  
23 this storm surge model from FEMA, we recognized that  
24 it wasn't quite as resolved around the site as we'd  
25 like. There were site-specific features that weren't

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1 represented in the FEMA data that were pertinent to  
2 really locally describing the flow around the site.

3 So some of these features are things like  
4 sea walls, you know, sheet pile sea walls. At a few  
5 locations, there's berms along the site, and, you know,  
6 just to the south of the image you see here on the screen  
7 there's a line of sunken barges to act as breakwater  
8 for incoming waves. And, you know, so taking that  
9 understanding, coupling it with the latest data sources  
10 we had available, such LIDAR, but, you know, even as  
11 accurate as LIDAR is, it doesn't pick up things like,  
12 you know, sheet pile sea walls, so we also relied on  
13 as-built construction drawings to supplement those  
14 site-specific information.

15 With that, we also refined the resolution  
16 of the node spacing in the area. In the FEMA Region  
17 III mesh, node spacing was on the order of 75 to 100  
18 meters in the area, with this refinement, we went down  
19 to 30 to 50-meter resolution in the area to really  
20 describe the flow around the site.

21 So that was the surge aspect. You know,  
22 moving on to the next variable in the equation, wave  
23 runup. Wave runup is dependent on significant wave  
24 height, wave period, wave direction, it's also  
25 dependent on site-specific information such as what's

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1 the slope of the embankment that it's running up on,  
2 what's the material of the embankment that the wave is  
3 running up on?

4 So as you see here in this schematic on the  
5 upper right, at this juncture, the side slopes of the  
6 proposed site are 1 to 3, so every foot up vertical,  
7 it goes three-feet horizontal. You'll also note the  
8 site grade on this schematic of 36.9 feet, just keep  
9 that number in mind when we get to the next slide, but  
10 using that information, that localized information,  
11 you know, the embankment is, at this point, proposed  
12 is concrete riprap material.

13 Using that information and then with the  
14 output from the ADCIRC and SWAN models, the ADCIRC and  
15 SWAN model produces time series information of water  
16 levels, and also, time series information of wave data,  
17 so time series of significant wave heights, wave  
18 periods, et cetera.

19 And using that wave information and the  
20 local site characteristics of the proposed site, we  
21 were able to calculate the wave runup throughout each  
22 simulation at the site using Coastal Engineering Manual  
23 methodologies.

24 And so one last note, if you see the four  
25 green points surrounding the proposed site there,

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1 basically what that is is to factor in directionality  
2 of the waves. We look at representative points on each  
3 side of the structure and by doing so, you know, like,  
4 we are able to look at any potential variability in,  
5 you know, is the eastern side the worst case scenario,  
6 the western point, et cetera, so we're able to look at,  
7 sort of, the spatial distribution of what that wave  
8 runup and total water level would be around the site  
9 as opposed to just one representative location.

10 So with that, when you factor in the  
11 two-dimensional surge model, the wave runup, the surge  
12 modeling had an antecedent in water level condition of  
13 1.35 feet, which represents the project 100-year sea  
14 level rise in the area. That produces a still water  
15 level of 20.2 feet, and when you couple on top of that,  
16 superimpose, the wave runup, and then 10 percent  
17 exceedance high tide, that represents a total surface  
18 elevation of 32.1 feet, which is the design basis flood  
19 total water surface elevation at the site.

20 And if you compare that to the proposed  
21 site grade of 36.9 feet that was on the previous slide,  
22 you'll see that we're well underneath the top of the  
23 site relative to the design basis flood level.

24 MEMBER SKILLMAN: Michael, what  
25 establishes the maximum still water level?

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1 MR. SALISBURY: Is the peak surge level at  
2 the site that's recorded throughout the simulation.

3 MR. MELLON: That's the SWAN output?

4 MR. SALISBURY: Still water, that's the  
5 ADCIRC component of the output, but yes. So we  
6 simulated, produced time series information at these  
7 points around the site and then with that, you know,  
8 if you look at the hydrograph at the time variant data,  
9 it's the peak point associated with that.

10 And in this particular case it's, you know,  
11 worth noting that, you know, we're concerned more about  
12 the total water level side of things, so it's really  
13 the superposition of the time variant wave runup with  
14 time variant surge, and, you know, the peak wave runup  
15 doesn't necessarily coincide with the peak still water,  
16 so we calculated the total water level, which is more  
17 important to understand that dynamic that's at play  
18 there.

19 MEMBER SKILLMAN: Okay. So for this  
20 slide, antecedent is the night before the quiescent  
21 level at the site, then there are a series of events  
22 that drive the bay elevation, and that is the series  
23 of events that you've just described. And the  
24 consequence of that is approximately a rise of 18-1/2  
25 feet. It goes from 1.35 to 20.2, and then you put on

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1 that, the wave runup, and you've added margin on that  
2 exceedance for the height for the tide, that gives you  
3 32.1.

4 MR. SALISBURY: Yes.

5 MEMBER SKILLMAN: So 24 hours later, if  
6 all is calm, you're back to 1.35 feet, or 36 hours,  
7 whatever it is.

8 MR. SALISBURY: Yes.

9 MEMBER SKILLMAN: Now I understand.  
10 Thank you.

11 MR. SALISBURY: Okay.

12 MR. MELLON: And this is just to note that  
13 we don't know if we have a passive system, then the  
14 intake structure is not safety related. If we have an  
15 active, you know, emergency cooling systems, then we  
16 need a safety related intake structure, then that will  
17 have to be designed for this flood. The new plant grade  
18 is above that flood level, so we remain a dry site.

19 A lot of this is driven because the design  
20 certs assume that the plant grade is one-foot above your  
21 maximum flood, so as opposed to Salem and Hope Creek,  
22 which have flood protection at their current site  
23 grade, they have water-tight doors, and they take the  
24 actions, which they did at Sandy, to close them, and  
25 make ready for that.

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1           We have to raise this site or else take a  
2 departure from the design cert, but for the purposes  
3 of our ESP, we're describing raising the site. And the  
4 riprap protection is part of what we would have to do  
5 on the site to maintain those slopes so that the wave  
6 actually would keep the site grade intact.

7           And with that, we're going to move on to  
8 ground water and accidental releases of liquid  
9 effluents. Thank you, Mike.

10           MR. SALISBURY: Thank you.

11           MR. MELLON: And Nelson Breton is going to  
12 talk to us. Nelson has over 28 years of experience  
13 conducting environmental, geologic, and hydrogeologic  
14 site investigations. He's led a number of  
15 environmental field investigations, including  
16 multimedia environmental and radiological site  
17 characterization at sites under both state and federal  
18 regulatory review.

19           Nelson's a Connecticut licensed  
20 environmental professional in the State of Connecticut  
21 and he's a certified geologist in the State of Maine.  
22 Nelson has a Bachelor's Degree in Geology from the  
23 University of Maine. Thanks.

24           MR. BRETON: Thank you very much, Jaime,  
25 and thanks for having us. Good morning. The

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1 groundwater section, we'll talk about the regional  
2 hydrogeology groundwater use and effects on your water  
3 when you're doing construction. This slide here, we  
4 talk about the regional hydrogeology locally and in the  
5 region. Characterize the hydrogeology as  
6 water-bearing coarse-grained units intervened with  
7 finer grain confining units.

8 The thickness of these is approximately  
9 over 1000, 1500 feet total over bedrock units. The PRM  
10 aquifer system is important to water supply, both in  
11 the region and at the site, and --

12 MR. MELLON: PRM stands for?

13 MR. BRETON: Potomac, Raritan, and  
14 Magothy. The next slide will show the position of  
15 these units; relative position. And the nearest  
16 public water supply is approximately 3-1/2 miles from  
17 the site. In this slide, we took out the relative  
18 position of the various hydrogeologic units. The  
19 upper units, shown here, local hydrologic fill,  
20 alluvium, and the deeper units below that are regional  
21 units, blue representing the water-bearing zones, and  
22 the white representing the confining thickness of these  
23 units; relative thickness.

24 Again, the confining units between the  
25 upper zones, locally, and the deeper PRM lower units

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1 is approximately 400 feet, so you have about 400 feet  
2 of confining unit thickness of relatively impermeable  
3 units.

4 MEMBER RYAN: Just out of curiosity,  
5 what's the depth of all of these individual units  
6 combined?

7 MR. BRETON: Just over 1000 feet.

8 MEMBER RYAN: Thousand feet?

9 MR. BRETON: Yes. And the upper units,  
10 that are saline, are 100, 150 feet in depth.

11 MEMBER RYAN: Thank you.

12 MR. BRETON: Again, we talk about the PRM,  
13 the Potomac, Raritan, Magothy aquifer. Based on prior  
14 studies, there's sufficient capacity for future use.  
15 Investigations were completed in around 2009 to  
16 evaluate the local hydrogeology to support  
17 construction and accidental release scenarios.  
18 Again, the shallow aquifers are saline, not suitable  
19 for potable use.

20 The plant area information was collected,  
21 including ground levels that helped us with evaluating  
22 groundwater flow. In the shallow units, that being the  
23 Alluvium and Vincentown aquifers. The next slide will  
24 depict that. This is an average flow condition in the  
25 shallow water-bearing zone, the alluvium. A similar

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1 characterization is arrived at for the next deeper  
2 unit, the Vincentown.

3 MEMBER SKILLMAN: Let me ask, what forces  
4 that flow? What is the hydrology behind the drift to  
5 the west? Is there an elevated aquifer further to the  
6 east that is draining to the west or what causes that  
7 flow?

8 MR. BRETON: Mostly precipitation. It's  
9 imposing on top of the alluvial material and the  
10 overlying hydrologic field. So accretion of  
11 infiltration from precipitation drives that flow  
12 direction.

13 MEMBER SKILLMAN: Okay. Thank you.

14 MR. BRETON: A groundwater model was  
15 developed to support the dewatering during  
16 construction as well as evaluating post-construction  
17 hydrostatic loading, which fed into the geotechnical  
18 evaluation. Modeling results show dewatering  
19 requirements that consistent with Hope Creek's station  
20 nearby. Post-construction, local mounding was  
21 possible, so that was revealed in the results of the  
22 modeling as well, in the shallow units, that is, again,  
23 the Alluvium and the Vincentown.

24 We talked about accidental release,  
25 previous slide, two release scenarios were envisioned.

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1 From the prior slides, we show the predominant flow  
2 direction to the west. One scenario, release  
3 occurring on the western edge of the power block and  
4 migrating towards the Delaware River, and as a result  
5 of placement of silt retention barriers, relative  
6 mounding, another release scenario was envisioned  
7 towards the northeast, towards the Fishing Creek, water  
8 body that discharges into the Delaware River.

9 For each scenario, the shortest transport  
10 pathway was chosen as the Alluvium, the shallowest  
11 water-bearing zone, higher permeability than the  
12 hydrologic fill, and the underlying Kirkwood Unit.  
13 Next slide. In this here, we depict each location of  
14 the releases, on the west side towards the Delaware and  
15 to the northeast towards Fishing Creek.

16 MR. MELLON: So the pink block is the power  
17 block.

18 MR. BRETON: That's it.

19 MR. MELLON: It would be the 36.9-foot  
20 elevation that we've built the plant up on. And the  
21 two, then, release pathways.

22 MR. BRETON: That's right. In each case,  
23 in each flow, we considered the effects of mounding,  
24 which is important, because you have pre-construction  
25 water levels measured, and we looked at the effects of

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1 mounding effects post-construction, again, due to the  
2 placement of retention walls. Concentrations for each  
3 compared to the ECLs, again, we assume maximum  
4 groundwater velocities in each case with maximum  
5 hydrologic conductivity values, which is a property of  
6 each of the aquifers.

7 And when you're factoring in dilution, in  
8 each situation we beat the Unity Rule. Surface water,  
9 and there are no potable surface water supplies down  
10 gradient of the site, and control measures will be in  
11 place to prevent accidental releases, and those  
12 measures will be further described in the COLA stage.

13 MR. MELLON: That's the conclusion of our  
14 presentation. Do you have any questions?

15 CHAIRMAN POWERS: Members have any  
16 additional questions? Okay. In that case, we will  
17 take a respite of 15 minutes in order to allow the staff  
18 to setup and make their presentation, and --

19 MR. MELLON: Just me.

20 CHAIRMAN POWERS: Yes, and the rest of  
21 your staff's free. You have to work. And we will  
22 resume in 15 minutes.

23 (Whereupon, the above-entitled matter went off the record at 9:31 a.m.  
24 and resumed at 9:45 a.m.)

25 CHAIRMAN POWERS: Let's get back into

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1 session. I think Mr. Mellon wants to make an amendment  
2 to some of his comments.

3 MR. MELLON: We did, to your question,  
4 Dick, about other hurricanes and as part of Fukushima  
5 response for Salem and Hope Creek, we evaluated other  
6 hurricanes to understand the probability, how possible  
7 it is that a hurricane would break grade. A Cat 1  
8 hurricane results in a 6.35 feet of NAVD surge, so there  
9 would be additional wind setup, wave runup on top of  
10 that, a Cat 2 was 11 feet NAVD, and again, also wind  
11 setup, wave runup on top of it, and a Cat 3 was about  
12 14-1/2 feet NAVD.

13 And if you remember from our slide, I think  
14 our still water level from just the surge alone was  
15 about 20 feet, so these would be less significant  
16 events.

17 MEMBER SKILLMAN: Thank you.

18 MR. MELLON: Sure.

19 MEMBER SKILLMAN: Thank you.

20 CHAIRMAN POWERS: Good. Now we turn to  
21 the staff, and, Prosanta, you'll --

22 MR. CHOWDHURY: Yes. I'll introduce.  
23 Thank you. On this slide, you will see that we are  
24 presenting Chapter 2 Section 2.4, hydrologic  
25 engineering safety evaluation. The publicly

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1 available advanced safety evaluation with no open items  
2 was issued on April 22, 2015, and the Adams Session  
3 Number is listed here. And two principle contributors  
4 are present with me today, Joe Giacinto and Dr. Henry  
5 Jones.

6 So with that, I will flip the slides and,  
7 Joe, you can go first.

8 MR. GIACINTO: Okay.

9 MR. CHOWDHURY: You do this yourself.

10 MR. GIACINTO: All right. I'm Joe  
11 Giacinto. I'm the hydrologic engineering lead for the  
12 PSEG project. I've been with the  
13 hydrology/meteorology branch for six years, with 25  
14 years of industry and regulatory experience. I'm a  
15 certified professional geologist and I'd like to  
16 introduce Henry, my colleague.

17 DR. JONES: I'm Dr. Henry Jones. I've had  
18 eight years here in the hydrology, meteorology,  
19 oceanography branch. Prior to that, 28 years in the  
20 United States Navy, 26 years of that as a geophysicist  
21 and meteorologist. I have degrees from the United  
22 States Naval Academy, a Master's in Meteorology,  
23 Oceanography, and a Doctorate in Oceanography, with a  
24 specific specialty in ocean waves from the Naval  
25 Post-Graduate School.

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1                   MR. GIACINTO: Okay. Thank you. We'll  
2 start out with some background. The hydrologic  
3 engineering staff conducted a visit at the PSEG site  
4 in February of 2011. The topics include the site  
5 setting, hydrologic site characteristics and  
6 associated document reviews and calc packages. The  
7 staff coordinated the review with state and federal  
8 agencies, including the New Jersey Department of  
9 Environmental Protection, U.S. Geological Survey for  
10 Surface Water and Tsunami, the U.S. Army Corps of  
11 Engineers, and NOAA.

12                   The staff performed independent review and  
13 confirmatory analysis, as explained in the upcoming  
14 slides. Before you go to the next slide, I'd like just  
15 to point out the proposed PSEG site layout. As PSEG  
16 pointed out, the rectangle there in red is the power  
17 block area. It's approximately 70 acres. And to the  
18 left of that is a light-blue rectangle, which is the  
19 intake structure area, and various other areas around  
20 the site as well, but those two areas are where we'd  
21 have our safety-related SSCs. Okay. Next slide.

22                   As far overview, as you've heard, the PSEG  
23 site is located on the eastern shore of the lower  
24 Delaware River, the upper Delaware Bay. The watershed  
25 for the Delaware River is approximately 13,600 square

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1 miles and about 11,500 of that is upstream of the PSEG  
2 site.

3 As expected, the tidal flow dominates the  
4 freshwater flow at the site and there's a wide and open  
5 connection to the Atlantic Ocean. The existing site  
6 grade is about 5 to 15 feet and proposed site grade is  
7 36.9 feet. The storm surge is the design basis flood  
8 level determining event at 32.1 feet. And to the right  
9 is an image of the Salem, Hope Creek operating plants,  
10 and the location of the PSEG site alongside the Delaware  
11 River.

12 CHAIRMAN POWERS: They arrived at this  
13 storm surge level using a fairly elaborate  
14 two-dimensional computer code that they subsequently  
15 did a bunch of refinement. Will you discuss what the  
16 staff did in connection with that computational  
17 vehicle?

18 MR. GIACINTO: Yes, at the storm surge, we  
19 have a slide coming up on that.

20 CHAIRMAN POWERS: I'd like to understand  
21 because they made the point in their presentation that  
22 two-dimensional modeling was widely viewed as more  
23 accurate than is the one-dimensional screening  
24 modeling. And one can certainly believe that. The  
25 trouble is that two-dimensional modeling requires more

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1 input and more skill from the user and user inputs than  
2 does the one-dimensional screening modeling.

3 And I'd like to understand how the staff  
4 looked at that and quite frankly, I would have enjoyed  
5 understanding better how they validated that modeling  
6 in a more quantitative sense. I mean, they made  
7 statements to the effect that they looked at various  
8 data points and they got close. Well, this is not  
9 either horseshoes or hand grenades, so close doesn't  
10 necessarily mean good.

11 DR. JONES: We'll get to that one --

12 MR. GIACINTO: Yes, and we'll talk about  
13 that when we get to the storm and surge slides coming  
14 up shortly. Thank you. For the flood analysis  
15 summary, in terms of local intense precipitation, as  
16 was mentioned, the site drainage design is dependent  
17 on reactor technology selected. So the local intense  
18 precipitation review will be deferred to the COL stage,  
19 and as a result, we have COL Action Item 2.4-1, whereas  
20 a COL or a construction permit applicant referencing  
21 the ESP should design the site grading to provide  
22 flooding protection to safety-related structures at  
23 the ESP site based on a comprehensive flood water  
24 routing analysis for a local PMP event, or LMP, without  
25 relying on any active surface drainage systems that may

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1 be blocked during this event.

2 CHAIRMAN POWERS: Assuredly, the draining  
3 analysis does require the technology to be in place to  
4 evaluate, but how did you feel about their source term?

5 MR. GIACINTO: They did analysis all the  
6 way up to the point, a standard analysis, which was  
7 adequate up to the point of evaluating the site  
8 drainage. I mean, we have a plant grade of 36.9 feet,  
9 but we don't know how the site's going to be configured  
10 in terms of drainage ditches, culverts, and that sort  
11 of thing.

12 CHAIRMAN POWERS: But you didn't have any  
13 trouble for the amount of rain that they got?

14 MR. GIACINTO: No, the PMP derived was  
15 through standard methods, HMR 51 to 52, and so on, to  
16 the routing. For the flood analysis summary for  
17 probable maximum flood, that resulted in a value of 21  
18 feet per ANSI/ANS 2.8 combinatory events, which  
19 included the probable maximum precipitation, runoff  
20 and infiltration conservatively estimated, and surge  
21 and seiche from the worst regional historical  
22 hurricane, which was Hazel, and 10 percent exceedance  
23 high tide.

24 I would say that the probable maximum  
25 precipitation was actually very conservative and they

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1       could have used a 500-year flood, but this was actually  
2       greater than the 500-year flood, and they used this.  
3       And the result was that, the maximum calculated water  
4       level is actually 15.9 feet below the proposed site  
5       grade.

6                 Okay.  And here's where we get into the  
7       probable maximum surge and seiche, which, Henry can  
8       talk to in terms of the details that went in.  I'll just  
9       give you a quick overview and hand it off to Henry.  The  
10      initial screening method, which was a one-dimensional  
11      model of HEC-RAS, and integrating the wind model, it  
12      resulted in an extremely conservative, beyond the world  
13      record surge of 42.4 feet.  Never been seen before.

14                So at that point, we move to a more  
15      realistic approach, which incorporates physics, and  
16      which is the two-dimensional model, and incorporates  
17      conservatism as well, with the resulting design basis  
18      flood of 32.1 feet.  And at this point, I'll hand it  
19      off to Henry and let Henry and Chris explain some of  
20      the particulars about the physics and what went into  
21      the --

22                DR. JONES:  You asked about the details,  
23      what I have here, who I have here, is Dr. Chris Bender.  
24      He's from Taylor Engineering, who performed the  
25      analysis and the review of the storm surge.  I'll let

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1 him speak to this.

2 MR. BENDER: Hello. As Henry mentioned.  
3 I'm Christopher Bender. I work with Taylor  
4 Engineering. We've been working with the NRC on this  
5 project. I have a Master's Degree in Coastal  
6 Engineering from the University of Florida and a PhD  
7 in Coastal Engineering from the University of Florida  
8 as well. I worked with Henry to review the analysis  
9 that was conducted for the ESP application and also to  
10 do an independent confirmatory analysis as well.

11 And I guess stepping through, the first  
12 step was to review the model that was applied by the  
13 licensee, and that was the FEMA Region III model.  
14 Taylor Engineering has worked on several of the recent  
15 FEMA re-analysis studies in the southeast U.S.,  
16 starting in South Carolina and working down through  
17 Florida, including the Gulf of Mexico, and Louisiana,  
18 and Texas.

19 And the SWAN plus ADCIRC model is the model  
20 of choice right now that is being used in those studies.  
21 And having worked on those studies, there's a  
22 significant quality control and validation that goes  
23 through the DEM development, the digital elevation  
24 model, the model mesh is, Dr. Salisbury mentioned, the  
25 1.6 million nodes. There's a significant review that

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1 goes in there. And then there's a review of the model  
2 settings and then the model validation.

3 And FEMA is very specific in their  
4 guideline so you don't calibrate the model. You don't  
5 just change the model parameters however you feel in  
6 order to get good results. It's called a validation,  
7 not a calibration, so you keep those model parameters  
8 within an acceptable range and try to show over a series  
9 of, you know, three to five storms that your model  
10 reproduces the measured water levels for the historical  
11 events.

12 And one thing that, you know, I spoke with  
13 Henry about and you're limited by is, you can't create  
14 historical events. The historical record is what it  
15 is, so you have to find the storms that have data, both  
16 meteorological, and water level, and wave, and then  
17 those are what you can validate to.

18 So we reviewed the validation that was done  
19 for the FEMA Region III model and it showed good, you  
20 know, unbiased results for the historical data that was  
21 available and, you know, the validation looked similar  
22 to the other FEMA studies that we worked on.

23 MEMBER SKILLMAN: Can you please explain  
24 how many samples?

25 MR. BENDER: There were, as was mentioned,

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1 I believe, five storms. There were, I believe, two  
2 nor'easters and three tropical storms that were looked  
3 at as part of that FEMA study, and that's pretty typical  
4 for a FEMA study. There's between three and five  
5 storms that are looked at. And southeast, there's no  
6 extra tropical storm, so northeast, you might have a  
7 couple extra. There would be extra tropical.

8 MEMBER SKILLMAN: Yes, sir. Thank you.

9 MR. BENDER: The next part of our analysis  
10 that I worked with with Dr. Jones was to re-validate  
11 the model that was developed by the Applicant. As was  
12 mentioned, there was resolution added near the site,  
13 which makes sense. The FEMA studies are looking over  
14 hundreds of miles over, in some cases, multiple states,  
15 or large portions of states, so they're not focused in  
16 on one specific plant.

17 So it does make sense to add in this extra  
18 resolution and we were able to, on a separate computer  
19 cluster, reproduce within 1/10 of a foot, the water  
20 levels that were produced by the Applicant's model that  
21 included the additional resolution, so Henry and I  
22 discussed that. It gave us comfort that their model  
23 changes didn't introduce any different model results,  
24 or any instabilities, or anything that was of concern.

25 And, you know, with the extra resolution,

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1 provided a better tool to actually look at the results  
2 at the site. And then as was mentioned earlier, the  
3 screening was done by the Applicant where they apply  
4 this one-dimensional approach based on the NWS 23  
5 results, and they came up with a set of storms that were  
6 run through the very refined SWAN plus ADCIRC model.

7 And what we did is, we were able to, on a  
8 separate cluster, replicate their PMH results after  
9 reviewing the NWS 23 guidance to document that they had  
10 chosen the correct ranges of parameters that are listed  
11 within NWS 23, so Henry and I, you know, went through  
12 the documentation, confirmed that they were using the  
13 right values, and then were able to replicate those  
14 values on the Taylor Engineering high-performance  
15 computing cluster.

16 And then the next step was, since they had  
17 applied a screening tool that was a one-dimensional  
18 model that, as has been stated, doesn't included,  
19 necessarily, all the physics. You know, for part of  
20 it, it doesn't account for the shape of Delaware Bay,  
21 or some of the nuances that a two-dimensional model can.

22 We did a sensitivity study where we varied  
23 the storm track that they applied, we varied the storm's  
24 forward speed, then we looked at some of the model  
25 settings that they had applied to just evaluate the

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1 sensitivity to see if there would be large changes in  
2 the maximum surge level that was produced in their  
3 model. And there were some small changes, one foot or  
4 so, but no really large changes in the still water  
5 levels that were created by shifting the storm, or  
6 speeding the storm up, or applying some of those  
7 changes.

8 So that got us to the still water  
9 elevation. That doesn't include the wave runup. Then  
10 we looked at their wave runup methodology, and what they  
11 applied, Corps of Engineers, Coastal Engineering  
12 Manual, a standard that is used by our firm and by many  
13 other firms in terms of wave runup analysis.

14 And using their wave results and comparing  
15 those to the wave results from our model, we got very  
16 similar runup levels for their PMH storm to where, you  
17 know, the final water levels were within a foot for our  
18 completely independent analysis using our cluster and  
19 our wave results in those models.

20 So that, you know, Henry and I discussed,  
21 gave us comfort in those values, and it should be noted  
22 that not only is there conservatism in the  
23 two-dimensional modeling, but within runup, you have  
24 choices too about how the riprap will affect the waves  
25 and what wave height to even apply. And there were

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1 noted, and, you know, we agreed, conservative  
2 approaches even within the runup analysis as well that  
3 led to the final value that they had, so that was the  
4 process that we took to verify the modeling that was  
5 conducted.

6 I know it was a lot. I'm open to any  
7 questions if any of that was unclear.

8 CHAIRMAN POWERS: Well, I'm going to just  
9 inject, Prosanta, this is excellent. This is the kind  
10 of stuff that many people don't see. It's high quality  
11 confirmatory analysis and that's what I was looking  
12 for. Thank you very much.

13 MR. CHOWDHURY: Thank you.

14 CHAIRMAN POWERS: Henry, I think you're  
15 responsible for this and it sounds like you did a good  
16 job there.

17 DR. JONES: Well, thank you, sir.

18 MEMBER SKILLMAN: I would like to ask,  
19 you've used the term Taylor Engineering  
20 high-performance computer cluster several times.

21 MR. BENDER: Yes.

22 MEMBER SKILLMAN: Would you explain what  
23 you mean by cluster?

24 MR. BENDER: That is the ADCIRC model and  
25 the SWAN model are written in a way that allows it to

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1 run in a parallelized mode, which means that the domain  
2 is split-up into different regions that all run at the  
3 same time, and it greatly improves the efficiency of  
4 the numerical model so that it runs --

5 CHAIRMAN POWERS: And with 1.6 million  
6 nodes, you better --

7 MR. BENDER: Might run a little faster.  
8 So the Applicant had the random model in a parallel mode  
9 on their cluster, which, I'm not sure which one it was,  
10 but they had a high-performance computing resource that  
11 they used, and Taylor Engineering has their own  
12 cluster. It's got 200 and -- well, it's got 512 nodes  
13 if we run it in a certain way, and what that means is  
14 we could take that 1.6 million node domain, which  
15 includes the Carribean, the Gulf of Mexico, and the  
16 Eastern Coast, and separate that into 512 little models  
17 that are all running at the same time and communicating  
18 at the boundaries.

19 So instead of it running on, you know, a  
20 single computer like that, ours should rung, you know,  
21 hundreds of times faster by running it in a parallelized  
22 mode, and that's what's important for -- it's used for  
23 these FEMA studies where they're running hundreds of  
24 these models on these very refined meshes in order to  
25 meet the schedule for the FEMA studies.

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1           They're using these high-performance  
2 computing resources and Taylor Engineering has its own  
3 cluster, relatively small compared to a research  
4 institution or a university, but still, you know,  
5 greatly improves the efficiency over a single computer.

6           DR. JONES: And the other thing too, is  
7 that, you could also have computer errors, depending  
8 on what the cluster you have, so by them both having  
9 independent separate clusters and reaching,  
10 essentially, the same result, actually reinforces it.

11           MEMBER SKILLMAN: Thank you.

12           CHAIRMAN POWERS: Now, that's the kind of  
13 stuff that people don't see in summary presentations  
14 that I think needs to get highlighted, and especially  
15 when it's done, as you say, independent cluster, or  
16 independent examination, and the input review of the  
17 methodologies get, kind of, the same results, maybe not  
18 after the third significant figure, but reasonably  
19 close, gives confidence to what the staff does.

20           And I think many people don't appreciate  
21 this because it doesn't get highlighted and I  
22 appreciate it very much.

23           MEMBER SKILLMAN: I do too, thanks.

24           DR. JONES: Another slide.

25           MR. GIACINTO: Well, we have a few more.

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1 Yes.

2 MR. CHOWDHURY: Anything else with this  
3 one?

4 DR. JONES: Not really. No.

5 MR. CHOWDHURY: Okay.

6 MR. GIACINTO: We talked a little bit  
7 about the intake structure and for flood protection,  
8 the site created 36.9 with a design basis flood of 32.1.  
9 There's obviously sufficient margin for safety-related  
10 site grade structure, system, and components. At the  
11 intake structure design associated with flood  
12 protection would be considered at the COL stage simply  
13 because it's dependent on the technology.

14 And as a result, we have a COL Action Item  
15 2.4-2, whereas, a COL or CP Applicant referencing this  
16 ESP should address whether the intake structure of the  
17 selected design is a safety-related SSC. If so, the  
18 Applicant should address the necessary flooding  
19 protection for a safety-related intake structure at the  
20 ESP site based on the design basis flooding event and  
21 associated effects.

22 As for groundwater, the maximum  
23 groundwater level taken was ten feet, with a proposed  
24 site grade of 36.9 feet. There will be a monitoring  
25 program implemented during construction and operation.

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1 As a result, we have COL Action Item 2.4-3, whereas a  
2 COL or CP Applicant referencing this ESP should refine  
3 hydrogeologic parameters and model estimates of  
4 dewatering rates and drawdowns beneath the existing  
5 site structures after determination of the final  
6 excavation geometry, consistent with the selected  
7 reactor technology.

8 So at the COL stage, there'll be  
9 significant changes to the site, obviously, and  
10 additional data gathered during that time will help us  
11 characterize the response to the site and refine our  
12 understanding of the hydrogeology.

13 Oh, and to the right, just to mention that,  
14 that's the site-wide September water levels for the  
15 Alluvial aquifer, and you can see around the operating  
16 plants, there's somewhat of a mound there, it's only  
17 three feet maximum, but as their Applicant's modeling  
18 showed, there may be a mound at the new site after the  
19 COL stage, and that was accounted for in terms of the  
20 release scenarios as well.

21 Okay. As for the plant parameter envelop,  
22 our bounding maximum flood level would be one foot below  
23 site grade and our maximum groundwater level bounding  
24 value would be 3.3 feet below site grade for the  
25 technologies selected. Okay. Next slide.

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1           And just to summarize our water levels and  
2 the PSEG site grade, we have our site grade at 36.9,  
3 our screening, one-dimensional storm surge analysis,  
4 at 42.4 feet, the design basis flood at 32.1 feet, the  
5 PMF at 21 feet, maximum groundwater at 10 feet, probable  
6 maximum tsunami at 5.6 feet, and for comparison, we've  
7 listed two hurricanes to compare to the water levels  
8 at the site.

9           The U.S. record, of course, is Hurricane  
10 Katrina at 29 feet measured at the Gulf Coast.  
11 Hurricane Sandy is measured at Oyster Creek, which is  
12 about 75 miles east, northeast of the PSEG site. As  
13 for the accidental release of radioactive  
14 radionuclides, the scenarios account for potential  
15 post-construction flow directions, both towards the  
16 Delaware River towards the west and the marshlands  
17 towards the northeast, which in effect, drain into the  
18 Delaware River.

19           The bounding PPE and conservative  
20 hydrologic characteristics were incorporated in the  
21 simulations and the results, concentrations of each  
22 radionuclide were less than the associated limits in  
23 10 CFR 20, and the sum of the ratios for all the  
24 radionuclides in the mixture was less than Unity.

25           Conclusions from the hydrogeologic

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1 engineering review is that the Applicant has provided  
2 sufficient information about the site, description,  
3 satisfied the requirements, and considered the most  
4 severe natural phenomena that have been historically  
5 reported for the site and surrounding area, and  
6 appropriately estimated the design basis flood  
7 elevation. And that concludes our slides. I think  
8 you have one more.

9 MR. CHOWDHURY: Yes, I have, but let's see  
10 if there are any questions.

11 CHAIRMAN POWERS: If I can come back a  
12 little to these radioactive liquid effluent analysis.  
13 The Applicant indicated on his Slide 23 and assuming  
14 maximum groundwater velocities, and solely a vector  
15 transported decay, some radionuclides would exceed  
16 ECLs for each release scenario. Then he says,  
17 factoring in dilution results and levels up to several  
18 orders of magnitude below ECLs, Unity Rule is met for  
19 each release scenario. Can you explain more what he  
20 did and what you did to review that?

21 MR. GIACINTO: Sure. What was done is,  
22 being conservative, the maximum groundwater velocities  
23 were taken towards the Delaware River, which is the  
24 short pathway to the west, and the marshlands towards  
25 the northeast, so the release was conservative on

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1 several levels, in terms of the fastest pathways  
2 possible towards these locations.

3 Now, these pathways are considered through  
4 brackish water aquifers, which would not be used for,  
5 obviously, drinking water or anything else. So what  
6 was done is, when the release points are assumed to be  
7 the river, which, the alluviglock (phonetic) for  
8 subcrops into the river. And after the site is built,  
9 obviously, they'll have a bulkhead along the river,  
10 which would impede flow, which is another conservative.

11 But in addition to those pathways, the  
12 maximum gradient assumes that you take the water level  
13 that's measured in a well and then the river level, but  
14 the thing is, with the Delaware River, it's tidal, so  
15 it's going in and out, so the groundwater isn't actually  
16 moving to the river and then back in. It's moving back  
17 and forth, back and forth, so those travel times that  
18 are calculated are actually very, very conservative.

19 In reality, they'd be much, much longer  
20 than they actually are in both directions because this  
21 marshland is also tidally influenced. But at the  
22 point, assuming it goes through the alluvial aquifer,  
23 which is the fastest path, there's no credit taken for  
24 what's called retardation, in terms of absorption by  
25 the radionuclide metals onto sediment, which will

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1 typically happen to have very high absorption  
2 retardation values, but no credit is taken for that.

3 What is taken is that when it reaches these  
4 locations, there's a very minimal amount of dilution  
5 that would be necessary in order to meet the ECLs,  
6 whereas, at Marsh Creek, I mean, we're talking cubic  
7 feet per day magnitude. And the Delaware River, as you  
8 saw, the tidal flow is on the order of hundreds of  
9 thousands of feet per day, whereas, to meet ECLs, they  
10 would only need, like, 112 cubic feet per second, which  
11 is less than 1 percent of the tidal flow.

12 And then towards Fishing Creek, which is  
13 the marshland, that transport would have to go through  
14 layers of organic sediments, which would, again, retard  
15 that. And then at Fishing Creek, there's a very  
16 minimal amount of flow that's needed to reach ECLs,  
17 which is on the order of a fraction of a cubic foot per  
18 day, or maybe a foot, or I forget the number, but I can  
19 get that for you, but a few cubic feet per day of water.

20 Now, this all assumes that the tank is  
21 released in the concentrations that are in the tank to  
22 the aquifer. In reality, for the tank to leak, you'd  
23 have to have water coming into the containment, and then  
24 it would leak out, and you'd have more dilution before  
25 it even started. So those are the things we looked at

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1 in terms of the transport and the conservatives built  
2 into that.

3 CHAIRMAN POWERS: Okay. Your slide  
4 wasn't very clear. You didn't explain it very well.  
5 He did a good job.

6 MR. CHOWDHURY: Any other questions  
7 before I move to the next slide?

8 CHAIRMAN POWERS: Any other questions on  
9 this subject? Let's continue.

10 MR. CHOWDHURY: Okay. Now I take over  
11 from Dr. Jones and Joe. This is a standard sample that  
12 we used before for the first general regulatory and  
13 conclusion regarding the site safety and suitability  
14 to the final safety evaluation because that will  
15 include ACRS findings too. That's in Phase D, which,  
16 by the way, has September 30, 2015 public milestone.

17 So today, we presented advanced safety  
18 evaluation with no open items on Chapter 2 Section 2.4,  
19 which is hydrologic engineering. And just to recap  
20 that this SE does not contain any permit conditions and  
21 it does contain three action items that have to be  
22 addressed by a COL or CP Applicant referencing these  
23 early site permit.

24 Now, I'd like to recap, because this is the  
25 last Subcommittee meeting, for the benefit of the

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1 Members and the audience-at-large, and members of the  
2 public, for that matter, the summary of what we have  
3 done so far, and I'll be brief. And if you have any  
4 specific questions on subject areas, we do not have  
5 those subject area experts or technical staff present  
6 today.

7           However, it's just a summary. We have  
8 already presented to you and we answer your questions.  
9 So I'll verbalize. One of the important things I would  
10 like to mention is our interaction with other agencies.  
11 We have mentioned that, but we have taken significant  
12 effort, made significant effort, to interact with other  
13 agencies very closely to the extent we needed. That  
14 includes the Federal Emergency Management Agency, who  
15 is a partner with the NRC in terms of the emergency  
16 planning review for offsite emergency plans.

17           United States Army Corps of Engineers, as  
18 Joe mentioned, Coast Guard, U.S. Coast Guard, NOAA,  
19 National Oceanic and Atmospheric Administration, New  
20 Jersey Department of Environmental Protection, the  
21 hydrology folks, interacted with them, and then the  
22 U.S. Geological Survey.

23           So although these are just a few names, but  
24 the interaction made our independent analyses, getting  
25 insight, discussing with them, matters of interest, was

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1 significant in reaching the conclusion that the staff  
2 did in various aspect of review.

3 I already mentioned on March 19th, we  
4 presented several pieces of the safety evaluation with  
5 no open items, aircraft hazards, radiological effluent  
6 release, those consequences from normal operations,  
7 which is 11.2 and 11.3. We presented emergency  
8 planning, which is Section 13.3. Included in there was  
9 14.3.10, which is emergency planning, the ITAAC. And  
10 it's a long list of ITAAC that has been presented also.

11 Chapter 15, we presented 15.0.3, which is  
12 radiological consequences of design basis accidents.  
13 Chapter 17, 17.5 in particular, quality assurance  
14 program description. And in September 2014,  
15 specifically on the 29th and 30th, we presented  
16 geography and demographic, nearby industrial  
17 transportation and military facilities. That's 2.1  
18 and 2.2 combined, and then meteorology, which was a big  
19 chunk of our review, Section 2.3.

20 And on that same timeframe, we also  
21 presented Chapter 2.5, which is a significant chapter  
22 also, geology, seismology, and geotechnical  
23 engineering. On June 9, which is today, we presented  
24 to you the last piece of our advanced safety evaluation  
25 with no open items, that's on hydrologic engineering,

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1 2.4.

2 Site location and description of some of  
3 the areas I'm going to mention that had no action items  
4 or permit conditions, they were clean to the extent that  
5 the ESP scope allows. The Applicant met requirements  
6 in describing site location description. In the  
7 exclusion area, or third gamm (phonetic) control, with  
8 respect to ownership and control of arrangements of 85  
9 acres of land from the U.S. Army Corps of Engineers,  
10 there is a permit condition, it's quite detailed, and  
11 that permit condition is -- they are in the SE, because  
12 the arrangement has not been finalized when the SE was  
13 published and presented.

14 So population distribution, the Applicant  
15 met the requirements that the staff found.  
16 Identification of potential hazards in the site  
17 vicinity, all requirements for the ESP have been met.  
18 Now, evaluation of potential accidents. There is a  
19 permit condition, which is Permit Condition 2, we  
20 presented to you earlier in March, I believe, or  
21 September, September, it has to do with the effects of  
22 potential explosions associated with the new located  
23 gasoline storage tanks and gasoline delivery tanker  
24 truck on the nearest SSEs, structure systems, and  
25 component with regard to safety.

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1           So that permit condition is there. For  
2 the meteorology, there are no permit conditions and  
3 there is, for regional, local, meteorology and onsite  
4 meteorological measurement program, all requirements  
5 for the ESP have been met.

6           Short-term diffusion, the Applicant met  
7 the requirements, as the staff found out. Long-term  
8 atmospheric dispersion estimates for routine release,  
9 the staff proposed a COL Action Item, which is 2.3-1.  
10 Regarding identification and condition of any  
11 difference in exported factors and most susceptible  
12 locations, including those in sectors adjacent to the  
13 Delaware River.

14           I don't need to go over the hydrologic  
15 engineering because we already covered it today. Once  
16 again, there are no permit conditions, three COL Action  
17 Items. The site grade is 4.8 feet -- the proposed site  
18 grade is 4.8 feet above the design basis flood of 32.1  
19 feet NAVD.

20           Overall, for hydrologic engineering, the  
21 Applicant has provided sufficient information,  
22 satisfied the requirements, and appropriately  
23 estimated the design basis flood elevation, less the  
24 staff's findings. Geology, seismology, and  
25 geotechnical areas, there are two permit conditions.

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1 One is related to the geological mapping for  
2 documenting the presence or absence of fault and shear  
3 zones in dam foundation materials.

4 Migratory ground motion that now this  
5 includes aspects of Virginia earthquake evaluation as  
6 well as the Fukushima Near Term Task Force 2.1 seismic  
7 evaluation that has been done. The staff did not need  
8 a separate question and evaluation for that matter.  
9 And stability of subsurface materials and foundations,  
10 there is a permit condition concerning the need for  
11 additional geotechnical investigations and leak  
12 protection assessments.

13 That will be done once the Applicant  
14 chooses the reactor technology. And then the staff,  
15 in geology, seismology, and geotechnical engineering,  
16 has identified several COL Action Items, quite a few,  
17 in various areas that we presented to you. Stability  
18 of slope will be evaluated after selecting a reactor  
19 technology, so that evaluation is not stated.

20 The aircraft hazard has the COL Action Item  
21 that concerns compliance with the design basis. I'm  
22 reading this part, or all of this, taken from the public  
23 development safety evaluation, so there's no surprises  
24 here, except, I will not be able to explain if you have  
25 a question on some specific pieces, but I can try my

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1 best.

2 Radiological effluence release dose  
3 consequences from normal operations, that's Chapter  
4 11.23, there is a COL Action Item concerning effluent  
5 dose calculation based on site-specific information,  
6 specific details, and those will be available at the  
7 COL stage, and the Applicant will have to address.

8 Emergency planning has five permit  
9 conditions, okay? Two of those, if I'm not mistaken,  
10 are related to how the Applicant will address certain  
11 aspects of Fukushima Recommendation 9.3. So those two  
12 permit conditions are there and there are others, so  
13 permit conditions, some of them, at least two of them,  
14 have to do with emergency action levels which are not  
15 the details and parameters are not available at this  
16 stage.

17 MEMBER BLEY: Just a process question.  
18 With a permit condition, I'm assuming what that means  
19 is, when there's a COL, they'll have to just show that  
20 they meet those conditions, and they will review it.

21 MR. CHOWDHURY: That is correct.

22 MEMBER BLEY: Okay.

23 MR. CHOWDHURY: And those conditions will  
24 be part of the permit even when issued.

25 MEMBER BLEY: Oh, they will.

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1 MR. CHOWDHURY: Yes. And then the reg  
2 provides adequate guidance for the Applicant,  
3 otherwise, there is guidance for establishing a quality  
4 assurance program that complies to 10 CFR Part 50. By  
5 following the guidance in our ASME Standard,  
6 NQA-1-1994.

7 The bottom-line is that the staff  
8 completed advanced safety evaluation for all chapters  
9 and sections associated with PSEG site, early site  
10 permit application, and there are no open items. With  
11 that, does the staff have any concluding remarks? Any  
12 questions?

13 CHAIRMAN POWERS: Members have any  
14 additional questions to pose? At this point, I will  
15 --

16 MR. CHOWDHURY: One other thing, Dr.  
17 Powers, just to mention to complete my slide is that  
18 our next interaction is tomorrow with the Full  
19 Committee on this project.

20 CHAIRMAN POWERS: And I believe you and  
21 Quynh have discussed which will present there and I  
22 would not hesitate at all to highlight where you have  
23 done independent confirmatory analyses so that the Full  
24 Committee can understand that. Jamie, you too, I  
25 think, have discussed with Quynh what will be cited for

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1 Full Committee?

2 MR. MELLON: Yes.

3 CHAIRMAN POWERS: It's a little late to  
4 make changes so I'm not going to ask the Subcommittee  
5 to give you any advice. And, Prosanta, I would not  
6 hesitate, also, in your presentation to the Full  
7 Committee to highlight your interaction with other  
8 agencies. The ACRS has been positively impressed with  
9 the ability of the staff to coordinate and I'm quite  
10 certain that the Applicant appreciates that as well,  
11 since it gives him one point of contact rather than  
12 multiple points of contact.

13 So I would not hesitate to at least orally  
14 highlight your interactions with FEMA, USGS, the Army  
15 Corps of Engineers, and other agencies, both state and  
16 local, because I think that's -- I know how difficult  
17 interagency interactions are, and when you do it well,  
18 it's a real service to the public.

19 Okay. At that point, I will ask that the  
20 line be opened, but before I solicit comments on the  
21 telephone line, I'll ask if there's anyone in the public  
22 that wants to make comment. I don't see a flock of  
23 people streaming to the microphones. Disappointing as  
24 that may be, I will now ask if there is anyone on the  
25 telephone line that wants to make a comment or other

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1 contributions.

2 You have obviously not drawn a crowd. A  
3 little more outrageousness on your part might have. I  
4 hear no additional comments and hear none, we have no  
5 advice to offer you for tomorrow. You're on your own.

6 MEMBER BLEY: Are you going to come around  
7 to us or not?

8 CHAIRMAN POWERS: I asked if there were  
9 other comments from the Members.

10 MEMBER BLEY: Well, questions, but  
11 comments, despite your words, I'm going to offer just  
12 a little advice, and you don't need -- you would never  
13 need to touch a slide for this and you're probably  
14 already doing it. I was just looking back over my notes  
15 and I think for the Full Committee, there'd be some  
16 interest in your organizational arrangement that you  
17 explained to us at the first meeting, I think, with the  
18 PSEG Power and the eventual shift over to PSEG Nuclear,  
19 and the development of the plant parameter envelope and  
20 how that works.

21 You're probably already planning to do  
22 that, but just in case you weren't, I wanted to throw  
23 that on the table. And I wanted to second what Dana  
24 said about the independent review stuff. That was very  
25 good.

**NEAL R. GROSS**

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1 CHAIRMAN POWERS: Dick, do you have any --

2 MEMBER SKILLMAN: I do. I reviewed the  
3 2.4 safety evaluation very, very closely, 124 pages,  
4 I think that that was very well done. I compliment you.  
5 There's some things that are in that document that you  
6 didn't talk about today. For instance, the  
7 oscillatory seiche and how you determined that there  
8 will not be an additional runup or additional increase  
9 in water level.

10 How you calculated the impact on the lower  
11 Delaware for the Doylestown heavy precipitation and the  
12 Greater Philadelphia heavy precipitation, how you  
13 determined that the last conduit on the Delaware is  
14 really up in Trenton, and that once the water is below  
15 Trenton, it opens up into this vast reservoir and there  
16 is no real increase in elevation for whatever might have  
17 happened upstream.

18 And so the thoroughness of the safety  
19 evaluation is commendable. Thank you.

20 CHAIRMAN POWERS: Mike, do you have  
21 anything that you wanted to add?

22 MEMBER RYAN: Well, I'm sure you probably  
23 counted it, but I appreciate the --

24 COURT REPORTER: Sir, is your microphone  
25 on?

**NEAL R. GROSS**

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WASHINGTON, D.C. 20005-3701

1 MEMBER RYAN: I'm sorry?

2 CHAIRMAN POWERS: You've got to turn your  
3 microphone on.

4 MEMBER RYAN: Oh, I'm sorry.

5 CHAIRMAN POWERS: Otherwise, she puts  
6 your words in.

7 MEMBER RYAN: I'd just like to comment  
8 that I think the staff's done a terrific job on bringing  
9 this all together and all the speakers today did a nice  
10 job in presenting the details. It's clear you've got  
11 a good understanding of how things work and I'll look  
12 forward to your next briefing. Thank you.

13 CHAIRMAN POWERS: All right. So no  
14 further comments, I think we can bring this  
15 Subcommittee to a close. We are adjourned.

16 (Whereupon, the above-entitled matter was concluded at 10:34 a.m.)

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**NEAL R. GROSS**

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PSEG Early Site Permit  
Advisory Committee on Reactor Safeguards  
Subcommittee Meeting  
SSAR Section 2.4

June 9, 2015



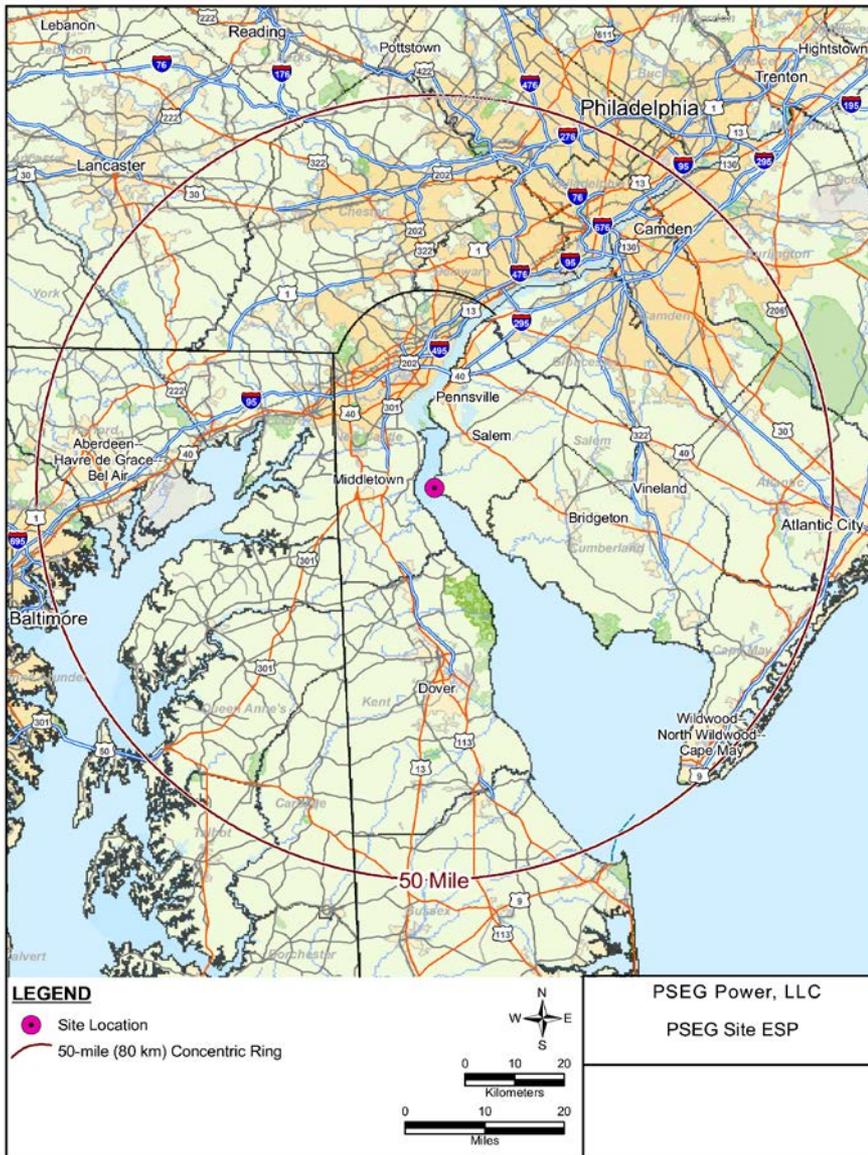
# Chapter 2 – Section 2.4 Hydrologic Engineering

## 2.4 Hydrologic Engineering

### Areas covered in ESP same as for COLA

- RS-002 outlines NRC review approach
- Regulatory Guidance
  - RG 1.27
  - RG 1.29
  - RG 1.59
  - RG 1.102
  - RG 1.206
- NUREG/CR-7046
- NUREG/CR-6966
- QA requirements apply – 10 CFR 50 Appendix B

## 2.4.1 Hydrologic Description



### PSEG Site

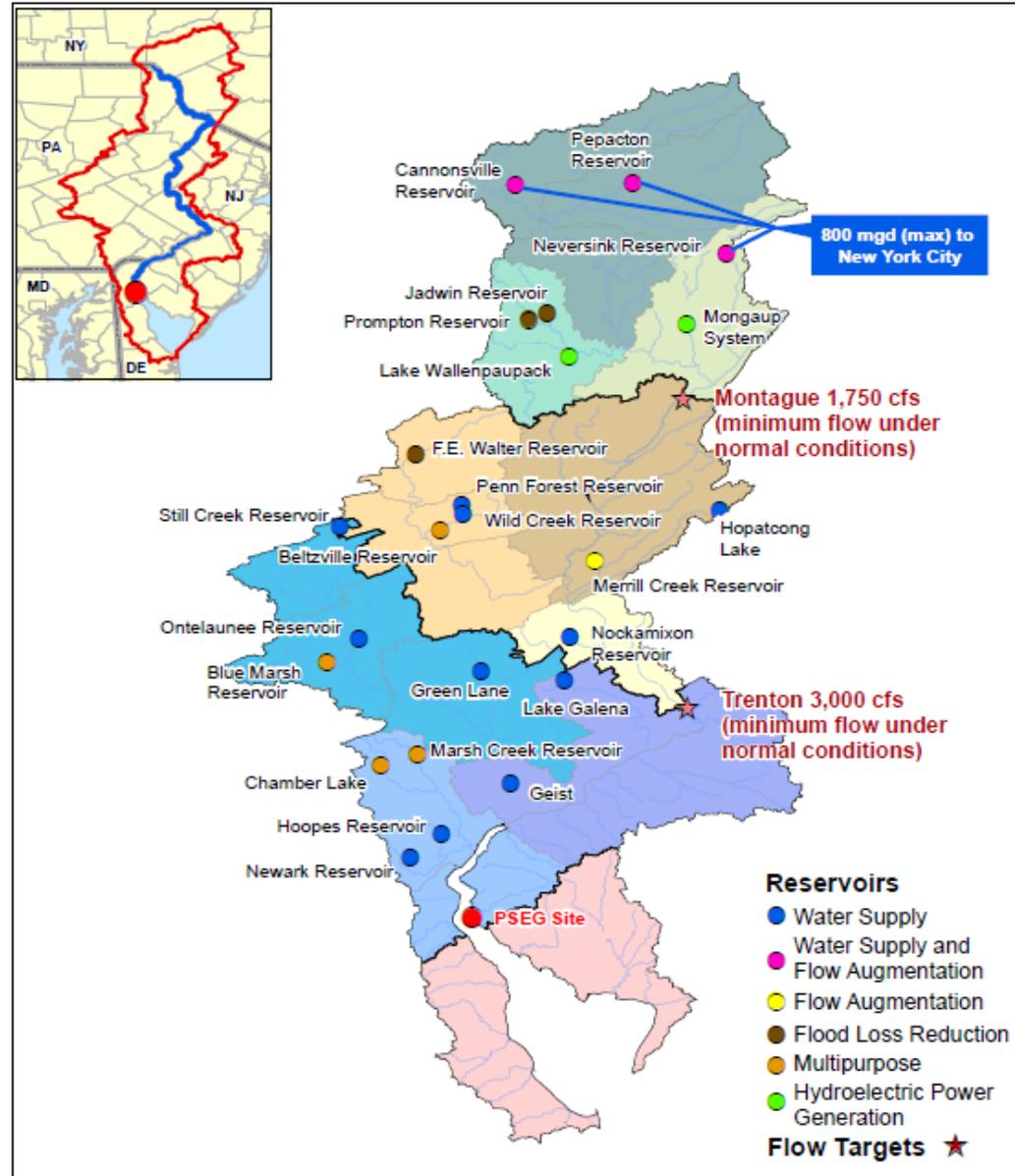
- 52 river miles (RM) upstream of the mouth of Delaware Bay.
  - 17 RM downstream of the Delaware Memorial Bridge (RM69)
  - 40 RM southwest of Philadelphia, Pennsylvania (RM 92)
- Head of the Delaware Bay (RM 48)
- Chesapeake and Delaware (C&D) Canal channel entrance (RM 59).

## 2.4.1 Hydrologic Description



## 2.4.1 Hydrologic Description

- Delaware River Basin covers 13,600 square miles (sq. mi.)
- Tidal flow ranges from 400,000 cubic feet per second (cfs) to 472,000 cfs
- Freshwater flow is approximately 15,000 cfs
- Delaware River is the longest undammed river east of the Mississippi River



## 2.4.2 Floods

Historical records show highest flood events recorded near mouth of Delaware River and within Delaware Bay are caused by storm surge

### Events Resulting in Storm Surges in the Delaware River near the PSEG Site

Storm Event	Year	Estimated Storm Surge, ft. <sup>(a)</sup>	
		Reedy Point	Philadelphia
Hurricane of 1878	1878	5 to 8	5 to 8
Chesapeake-Potomac Hurricane	1933	7.7	7.1
Hurricane Hazel	1954	n.a. <sup>(b)</sup>	9.4
Hurricane Connie	1955	n.a. <sup>(b)</sup>	5.0
Hurricane Floyd	1999	2.9	4.0
Hurricane Isabel	2003	5.0	5.4

a) surge above predicted tide

b) n.a. = not available

## 2.4.2 Floods

Flooding scenarios investigated for the site include:

- Local Intense Precipitation
- PMF on rivers and streams
- Potential dam failures
- Maximum surge and seiche flooding
- Probable maximum tsunami
- Ice effect flooding
- Channel diversions

## 2.4.2 Floods (Cont.)

### Local Intense Precipitation

- NOAA Hydrometeorological Reports
- HEC-HMS is used to simulate the precipitation-runoff processes in watershed systems to determine peak discharge
- The resulting peak flows are used to determine the maximum WSEL resulting from the PMP event
- Analysis can be refined once a technology is selected and site grading and drainage systems are designed
- Site will be designed to ensure PMP event will not cause flooding events or operational problems

## 2.4.3 Probable Maximum Flood on Streams and Rivers

### Methodology and Inputs

- USACE HEC-HMS and HEC-RAS Model developed and validated for the Delaware River System upstream of the PSEG Site
- Two probable maximum precipitation events considered
  - 15,000 sq. mi. storm centered over Doylestown, PA
  - 2150 sq. mi. storm centered over Philadelphia, PA

### Results

- Maximum WSEL is 21.0 ft. NAVD due to PMF combined with 10% exceedance high tide, worst regional surge, and wave runup
- PMF at site is not expected to cause flooding events or operational problems

## 2.4.4 Potential Dam Failures

### Methodology and Inputs

- Screening of dams and regional combinations developed for failure scenarios
- Seismic failure of dams assumed for immediate breach
  - Dam failures are sequenced, such that flood waters converged at the DE River at the same time

### Results

- Failure of Cannonsville and Pepacton Reservoirs produces greatest WSEL of 0.3 ft. NAVD
- Combined events of 10% exceedance high tide, 500 year flood, and wave runup produces a WSEL of 9.4 ft. NAVD
- Dam failure runup at site is not expected to cause flooding events or operational problems

## 2.4.6 Probable Maximum Tsunami Flooding

### Historical Tsunami Record

- Documented seismic events (Puerto Rico, Lisbon 1755)
- Documented landslide events (Grand Banks, 1929)
- Landslide events in geologic record (Currituck, Cape Fear, other sites along east coast continental margin)
- Volcanic cone collapse events in geologic record (Canary Islands)

### Modeling Approach MOST (Method of Splitting Tsunami)

- Solves nonlinear shallow water equations
- Used extensively in tsunami forecasting and inundation studies

### Probable Maximum Tsunami events

- La Palma Landslide in Canary Islands
- Hispaniola Trench
- Currituck Landslide

## 2.4.6 Probable Maximum Tsunami Flooding (Cont.)

### La Palma Landslide in Canary Islands

- Usual worst case scenario for most coastal areas in the Northeast
- Impact inside Delaware Bay reduced by refraction of incident waves to areas north and south of bay entrance

### Hispaniola Trench

- Largest subduction zone in Atlantic Ocean
- Plausible tsunamigenic region based on geological processes and history of events
- Results show slightly larger impact than La Palma case, with more wave penetration into Bay

## 2.4.6 Probable Maximum Tsunami Flooding (Cont.)

### Currituck Landslide

- Representative of large East Coast slide events found in geological record
- Sensitivity tests show wave conditions in Delaware bay are largely insensitive to shifts in assumed slide location along continental shelf margin
- Represents the PMT event for the PSEG site

### Model results:

- All tsunami-generated runups and drawdowns at site are not expected to cause flooding events or operational problems
- Maximum runup with 10% exceedance high tide is 1.15 ft. (5.65 ft. NAVD)
- Maximum drawdown with 90% exceedance low tide is -1.16 ft. (-6.16 ft. NAVD)
- Tsunami-induced velocities at site are not large compared to maximum observed tidal currents

## 2.4.7 Ice Effects

### 2.4.7 Ice Effects

- Historical ice jam information review and model simulation of a major historic ice jam event
  - Flooding potential from historic ice jam discharge is elevation 8.1 ft. NAVD
- Intake structure will be designed to address ice effects, including surface ice, frazil ice, and other dynamic forces and blockages associated with ice effects
- Ice effects at site are not expected to cause flooding events or operational problems

## 2.4.8 Cooling Water Canals and Reservoirs and 2.4.9 Channel Diversions

### 2.4.8 Cooling Water Canals and Reservoirs

- These features are not present at PSEG Site

### 2.4.9 Channel Diversions

- Shoreline near PSEG Site is flat and low and neither a seismic nor severe weather event result in a major shoreline collapse

## 2.4.11 Low Water Considerations

### 2.4.11 Low Water Considerations

- 20-year low flow conditions with 90% exceedance low tide simulated in HEC-RAS model result in a WSEL of -5.0 ft. NAVD
- Negative surge from hurricane reduces WSEL in vicinity of the PSEG Site by 10.9 ft.
- Coincident with a 20-year low flow in the Delaware River at Trenton and 90% exceedance low tide, WSEL could be as low as -15.9 ft. NAVD
- A safety-related intake structure designed to operate during low water conditions identified
- Low water conditions at site are not expected to cause operational problems

## Chapter 2 – Section 2.4.5 Probable Maximum Surge and Seiche Flooding

## 2.4.5 Probable Maximum Surge and Seiche Flooding

### Probable Maximum Hurricane (PMH) Storm Meteorological Parameters based on NWS 23

- Central pressure,  $P_0 = 26.65$  inches of mercury (Hg)
- Pressure drop,  $\Delta P = 3.5$  in. of Hg
- Radius of maximum winds,  $R =$  from 11 to 28 nautical miles (NM)
- Forward speed,  $T =$  from 26 to 42 knots (kt)
- Coefficient related to density of air,  $K = 68$
- Track direction, from 138 degrees (moving northwest)

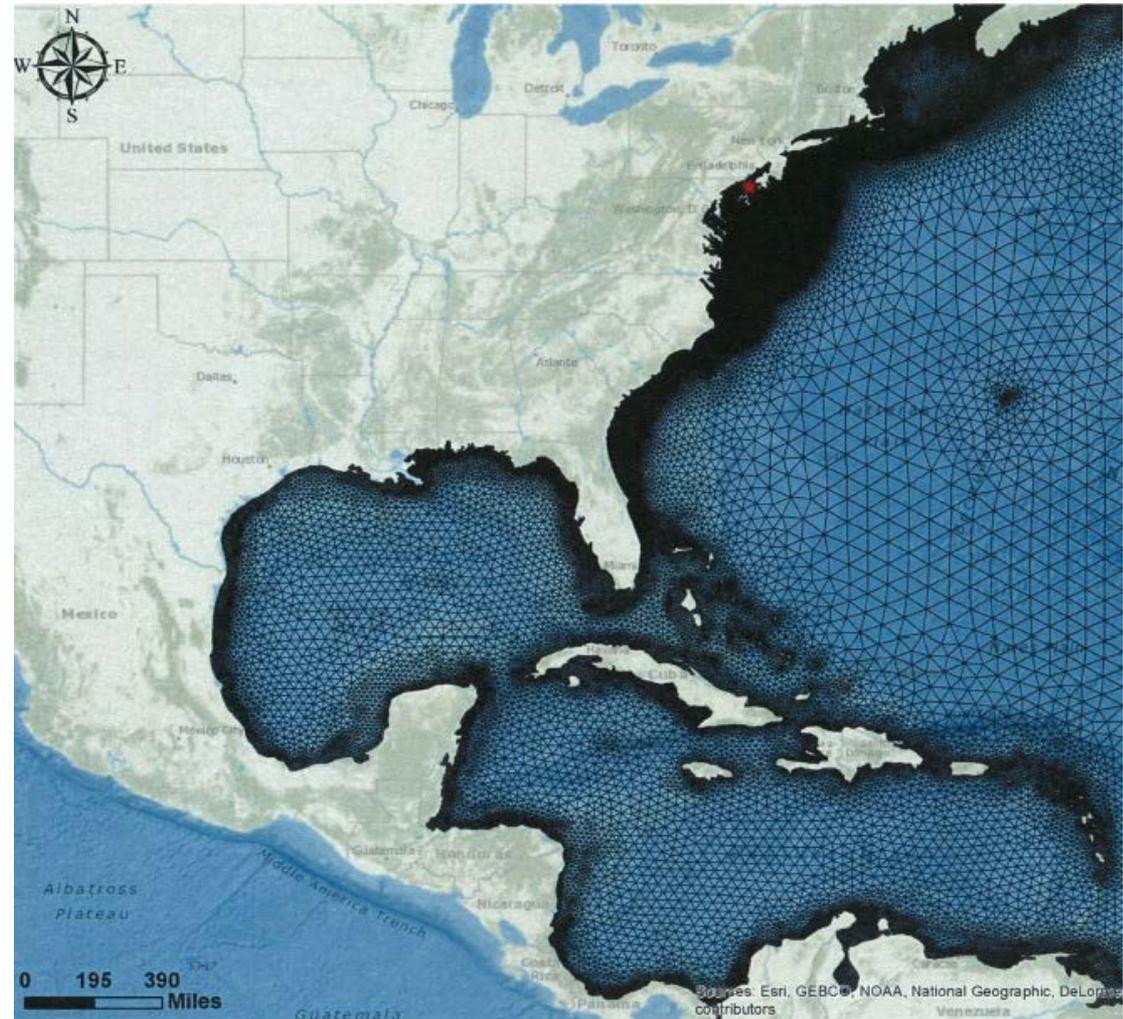
### PSEG ESPA Storm Surge Screening

- Modeled with Bodine storm surge method
- Coupled with HEC-RAS; Kamphuis wind setup method; and Coastal Engineering Manual wave runup method
- Parameters Resulting from Screening:  $R = 28$  NM;  $T = 26$  kt
- Produces total Water Surface Elevation (WSEL) of 42.4 ft. NAVD

## 2.4.5 Probable Maximum Surge and Seiche Flooding (Cont.)

PSEG developed a high resolution 2-D storm surge model (ADCIRC+SWAN) to support development of the response to RAI No. 67

- 2-D models are recognized as a more accurate storm surge modeling tool
- FEMA Region III coastal flood study



## 2.4.5 Probable Maximum Surge and Seiche Flooding (Cont.)

Use high resolution  
ADCIRC+SWAN  
Model to determine  
total design basis  
WSEL for the  
selected PMH storm

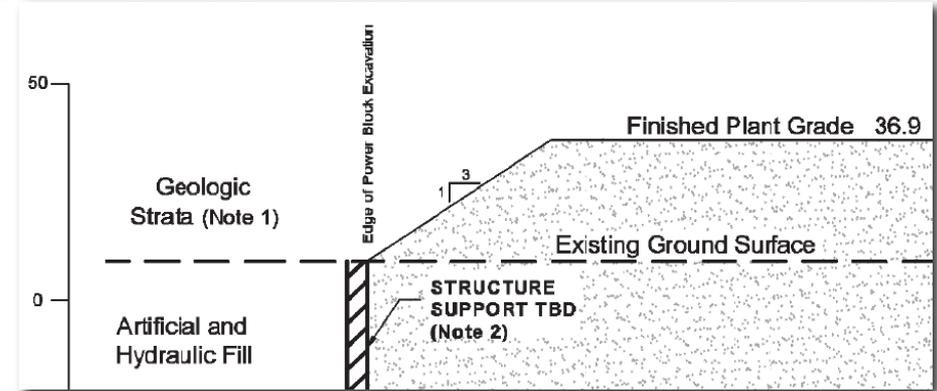
Finite element  
mesh refined at  
project site



## 2.4.5 Probable Maximum Surge and Seiche Flooding (Cont.)

Wave runup determined using USACE Coastal Engineering Manual (CEM) Methodologies

Output from ADCIRC+SWAN Model evaluated at four points around powerblock



## 2.4.5 Probable Maximum Surge and Seiche Flooding (Cont.)

### PMH Maximum Total Water Surface Elevation

- **2-D ADCIRC+SWAN Model Results:**
  - Antecedent Water Level 1.35 ft.
  - Maximum Still Water Level 20.2 ft. NAVD
  - Wave Runup 7.4 ft.
  - 10% Exceedance High Tide 4.5 ft.
  - Maximum Total Water Surface Elevation 32.1 ft. NAVD

**Design Basis Flood Total WSEL is 32.1 ft. NAVD**

## 2.4.10 Flooding Protection Requirements

### 2.4.10 Flooding Protection Requirements

- All safety-related SSC (with exception of intake structure) for new plant will be constructed at least one foot higher than DBF
- New plant site grade is established at 36.9 ft. NAVD. This meets requirements of a dry site as defined in NRC RG 1.102
- Riprap protection will be provided on the slopes of the site to provide protection from wave runup

Section 2.4.12 Groundwater and  
Section 2.4.13 Accidental Release of  
Radioactive Liquid Effluents

### Regional Hydrogeology and Groundwater Use

- Regional hydrogeologic units are characterized as permeable coarse-grained materials separated by less permeable fine-grained materials within NJ Coastal Plain
- PSEG Site lies outside two Critical Water-Supply Management Areas designated in NJ
- PRM aquifer system (about 400 to over 1000 ft. below grade) provides majority of potable water for region and PSEG site
- Nearest off-site public water supply well is located more than 3.5 miles west of PSEG Site, across Delaware River, in DE

## 2.4.12 Groundwater (Cont.)

### Regional Hydrogeology- Hydrostratigraphic Classification

Site Stratigraphic Unit	Hydrogeological Characteristics
Artificial & Hydraulic Fill	Leaky confining units.
Alluvium	Upper portion is a water-bearing zone; lower silts and clays, when present, act as a leaky confining unit.
Kirkwood Formation (upper)	Leaky confining unit.
Kirkwood Formation (lower)	Water-bearing zone; part of the Vincentown Aquifer.
Vincentown Formation	Water-bearing zone.
Hornerstown Formation (upper)	Upper portion is a water-bearing zone and part of the Vincentown Aquifer.
Hornerstown Formation (lower)	Lower portion, along with the Navesink Formation act as a leaky confining unit.
Navesink Formation	Leaky confining unit.
Mount Laurel Formation	Water-bearing zone, with the Wenonah Formation comprises the Wenonah-Mt. Laurel Aquifer.
Wenonah Formation	Water-bearing zone.
Marshalltown Formation	Confining unit.
Englishtown Formation	Water-bearing zone.
Woodbury Formation	Confining unit.
Merchantville Formation	Confining unit.
Magothy Formation	Water-bearing zone.
Raritan Formation	Confining unit.
Potomac Formation	Water Bearing Unit.

## 2.4.12 Groundwater (Cont.)

### Local Hydrogeology and Groundwater Use

- The deeper PRM aquifer has sufficient capacity to provide potable groundwater to support new plant construction and future operations without inducing saline intrusion
- Investigations characterized shallower hydrogeologic units at new plant location to support construction and accidental release evaluations
- Shallow aquifers in vicinity of site are saline and tidally-influenced and not potable water sources
- In new plant area, predominant groundwater flow direction in shallower units (Alluvium and Vincentown aquifers) is westerly toward Delaware River

## 2.4.12 Groundwater (Cont.)

### Local Hydrogeology

Average Groundwater Elevations (ft. NAVD) in Alluvium



## 2.4.12 Groundwater (Cont.)

### Site Groundwater Modeling

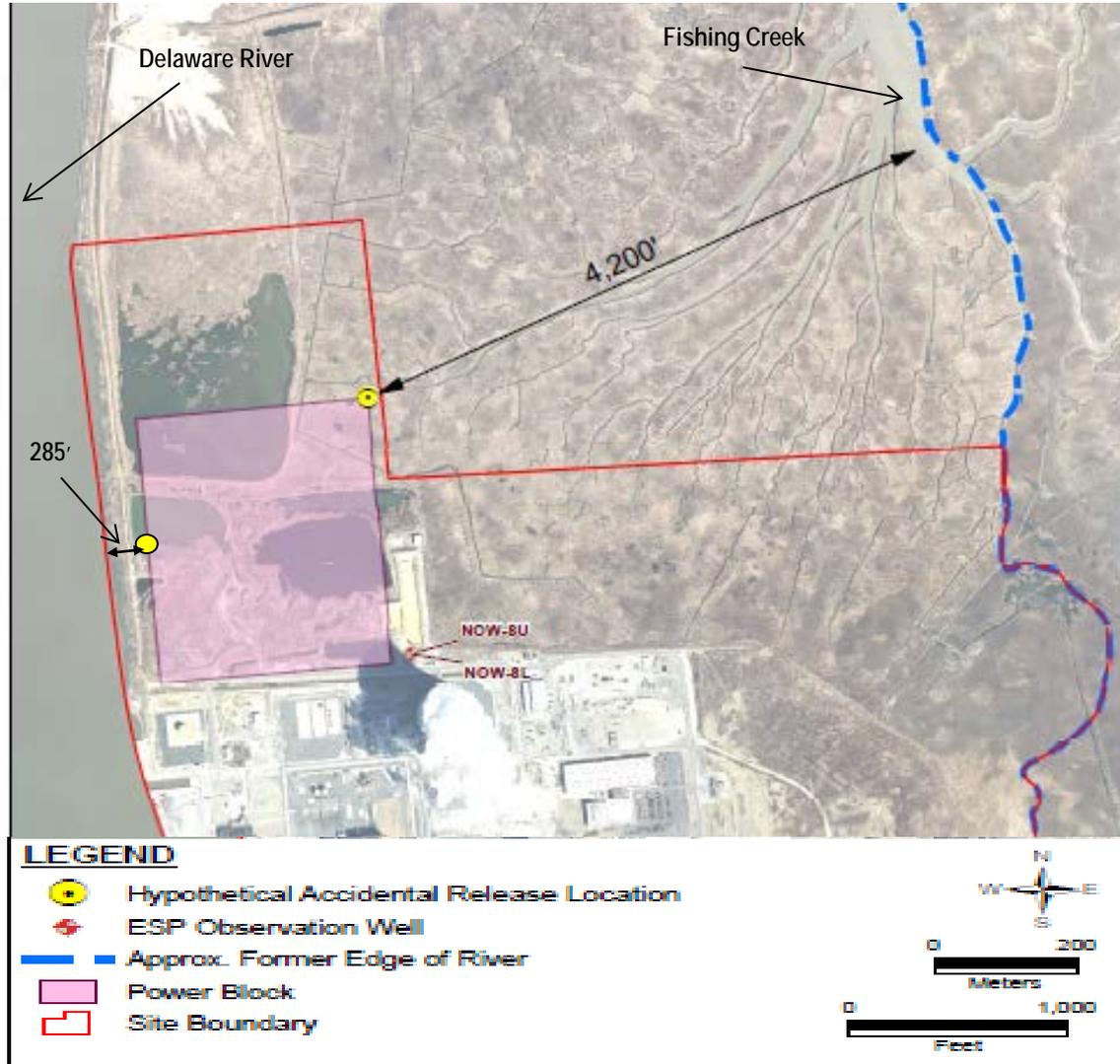
- Site-wide groundwater model developed, based on the PPE, to assess:
  - Dewatering requirements during construction
  - Effects of dewatering on shallow aquifers
  - Post-construction hydrostatic loading
- Site Groundwater modeling results:
  - Dewatering requirements consistent with HCGS construction
  - Groundwater levels in the shallow aquifer will return to a natural condition, which will be only slightly higher than preconstruction
  - Local mounding in shallow aquifers is possible due to soil retention wall placement
- Groundwater model will be refined once a reactor technology has been selected

### Accidental Release in Groundwater

- Two accidental release locations are hypothesized at the edge of Power Block:
  - At western edge of Power Block assuming migration west toward the Delaware River
  - At northeast corner of Power Block, assuming migration northeast toward a Delaware River tributary named Fishing Creek
- Conservative hydrogeologic parameter values are used in the evaluation, as are minimum distances to two potential receptor locations
- Shortest transport pathway is taken as through shallowest unit (Alluvium)

## 2.4.13 Accidental Release of Radioactive Liquid Effluents in Groundwater and Surface Water (Cont.)

### Accidental Release in Groundwater – Hypothetical Flow Paths



### Accidental Release in Groundwater

- Exposure point concentrations compared to Effluent Concentration Levels (ECLs) defined in 10 CFR Part 20
- Assuming maximum groundwater velocities, and solely advective transport with decay, some radionuclides would exceed ECLs for each release scenario
- Factoring in dilution results in levels up to several orders of magnitude below ECLs and Unity Rule is met for each release scenario

### Accidental Release to Surface Water

- No potable surface water bodies located downgradient of the PSEG Site
- Outdoor tanks containing radionuclides will have secondary containment to prevent catastrophic release of liquid effluent directly to surface water
- Controlled release points will be established for systems that could be in contact with radioactive liquids to prevent unmonitored discharges to surface water



# Presentation to the ACRS Subcommittee

## **Safety Review of the PSEG Site Early Site Permit Application**

Presented by

Prosanta Chowdhury, Project Manager

NRO/DNRL/LB1

June 9, 2015

# Purpose

- Brief the Subcommittee on the status of the staff's safety review of the PSEG Site early site permit (ESP) application
- Support the Subcommittee's review of the application and subsequent interim letter from the ACRS to the Commission
- Address the Subcommittee's questions

# Meeting Agenda

- Introduction, Schedule Milestones, Status of Safety Evaluations (SEs)
- Key Review Area:
  - ◆ Hydrologic Engineering
- Advanced Safety Evaluation (ASE) with no Open Items (OIs) Conclusions
- Presentation Conclusions
- Summary of Safety Evaluations
- Discussion / Questions

# PSEG Site ESP Application

- ESP applicants: PSEG Power, LLC and PSEG Nuclear, LLC (PSEG)
- Proposed ESP Site located in Lower Alloways Creek Township, Salem County, NJ (30 miles southwest of Philadelphia, PA, 7.5 miles southwest of Salem, NJ)
- Located on the upper Delaware Bay adjacent to and north of Hope Creek Generating Station (HCGS). The two-unit Salem Generating Station (SGS) is co-located on this site to the south of HCGS

# PSEG Site ESP Application

- PSEG developed Plant Parameter Envelope (PPE) using 1-Unit U.S. EPR, 1-Unit ABWR, 1-Unit US-APWR, and 2-Unit Passive AP1000
- PSEG requests permit approval for a 20-year term
- PSEG does not seek approval for limited work authorization (LWA) activities
- PSEG seeks approval for complete and integrated emergency plans with ITAAC as part of ESP

# Schedule Milestones

## Completed

- PSEG Site ESP Application Received - 5/25/2010
- Acceptance Review Completed - 8/4/2010
- **Phase A** - RAIs Issued - 9/2013
- **Phase B** - Advanced Safety Evaluation (SE) with no Open Items Issued – 5/2015
- Chapters **Presented to ACRS** on March 19, 2014 -
  - ♦ 3.5.1.6, 11.2&11.3 (combined), 13.3, 15.0.3, 17.5
- Chapters **Presented to ACRS** on Sept. 29 & 30, 2014 -
  - ♦ 2.1&2.2 (combined), 2.3, 2.5
- Chapter 20 (Fukushima) points to other SEs where applicable Fukushima NTTF recommendations are evaluated

# Schedule Milestones

## Remaining

- Chapter 2.4 (Hydrologic Engineering) - Being Presented to ACRS Today (June 9, 2015)
- ACRS Full Committee Meeting - Scheduled for June 10, 2015
- **Phase C** - ACRS Meetings - Completion by 07/31/2015
- **Phase D** - Final Safety Evaluation Report (FSER) - Completion by 09/30/2015

# Inspections / Site Visits/ Audits

- Inspections / Site Visits/ Audits:
  - ◆ Pre-application Site Visit – 1/2008
  - ◆ Emergency Planning Site Visit - 5/2010
  - ◆ Hydrologic Engineering Site Visit and Audit - 2/2011
  - ◆ Quality Assurance Audit - 5, 6/2011
  - ◆ Geology Site Visit and Audit - 9/2011
  - ◆ Meteorology Site Visit - 5/2012
  - ◆ Seismic Software Audit – 9/2013

# Acronyms

- ANS/ANSII – American Nuclear Society / American National Standards Institute
- COL – Combined License
- CP – Construction Permit
- DC – Design Certification
- ESP – Early Site Permit
- HCGS – Hope Creek generating Station
- NAVD88 – North American Vertical Datum 1988
- NJDEP – New Jersey Department of Environmental Protection
- PPE – Plant Parameter Envelope
- SER – Safety Evaluation Report
- SGC – Salem Generating Station
- SSAR – Site Safety Analysis Report
- SSC – Structures, Systems, and Components
- USACE – United States Army Corps of Engineers

# Key Review Area

## Chapter 2, Section 2.4

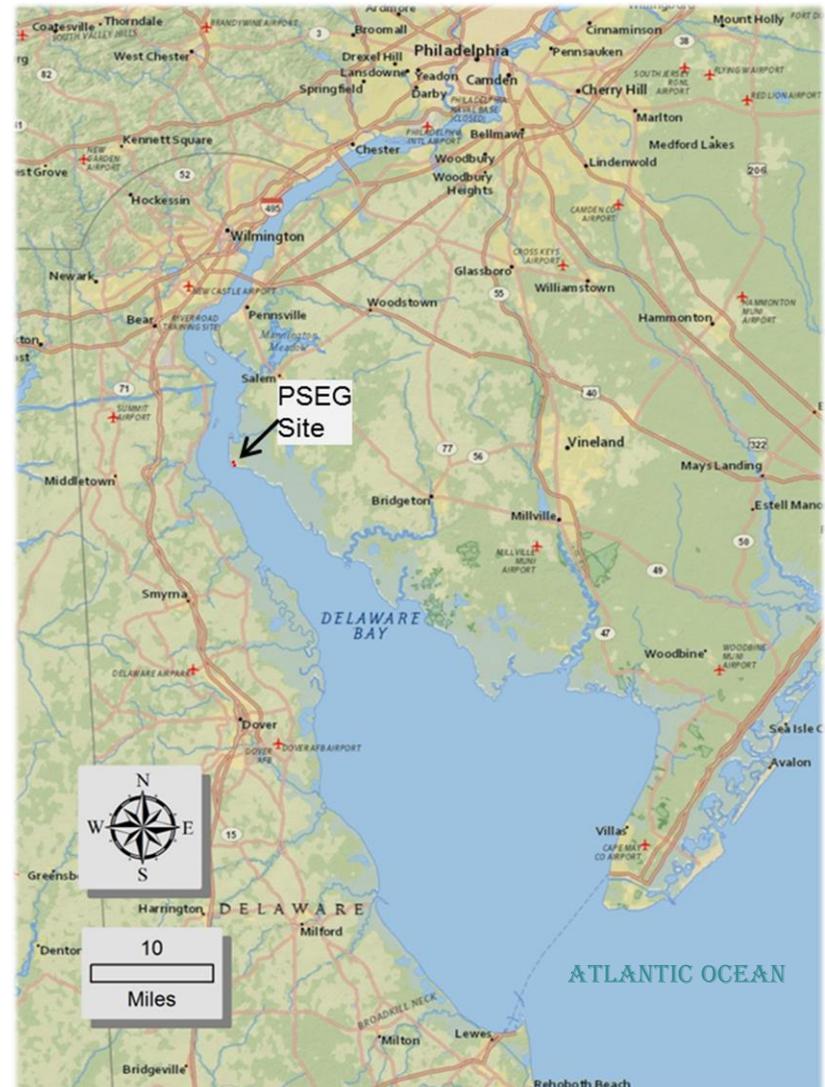
### “Hydrologic Engineering”

*(ASE Issued April 22, 2015; ADAMS Accession No. ML13211A144)*

## Principal Contributors

**Joseph Giacinto, PG**

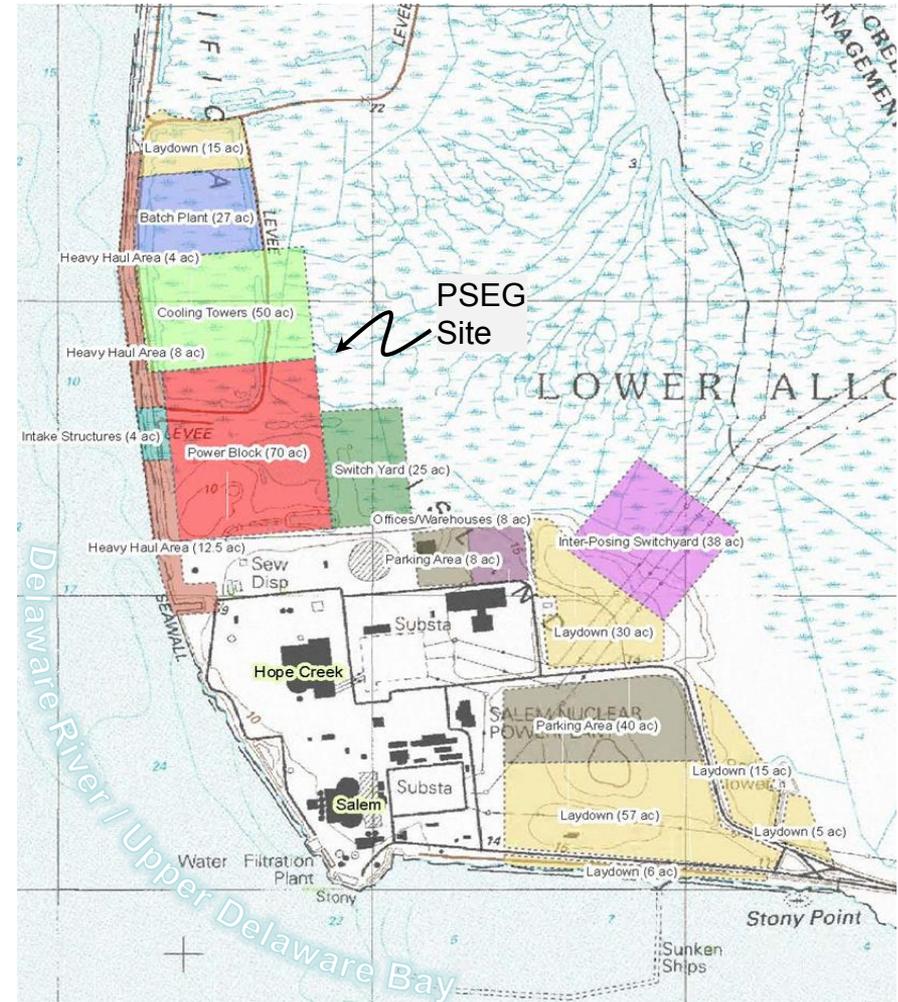
**Henry Jones, Ph.D.**



PSEG Site - Regional Setting.

# Background

- Hydrologic engineering staff conducted a visit at the PSEG site February 2011
  - ♦ Topics included site setting, hydrologic site characteristics and associated document reviews
- Staff coordinated review with state and federal agencies
  - ♦ NJDEP, USGS (surface water / tsunami), USACE, NOAA
- Performed independent review and confirmatory analyses as explained in upcoming slides



Proposed PSEG Site Layout (from SSAR Rev 0 Figure 1.2-3).

# Overview

- PSEG ESP Site located on eastern shore of lower Delaware River / upper Delaware Bay
- Approximately 13,600 mi<sup>2</sup> watershed
- Tidal flow dominates fresh water flow at the Site
  - ♦ Wide & open connection to Atlantic
- Existing site grade 5-15 ft
- Proposed site grade 36.9 ft
- Storm surge is DBF determining event at 32.1 ft



Looking north over Salem/Hope Creek.

# Flood Analysis Summary

## – Local Intense Precipitation

- Site drainage design dependent on reactor technology selected
- Local intense precipitation review deferred to COL stage
  - ♦ **COL Action Item 2.4-1:**

COL or Construction Permit (CP) applicant referencing this ESP should design the site grading to provide flooding protection to safety-related structures at the ESP site based on a comprehensive flood water routing analysis for a local PMP event without relying on any active surface drainage systems that may be blocked during this event.

# Flood Analysis Summary

## – Probable Maximum Flood

- **Probable maximum flood (PMF) 21.0 ft per ANSI/ANS-2.8-1992 combinatory events**
  - ♦ Probable maximum precipitation
  - ♦ Runoff and infiltration conservatively estimated
  - ♦ Surge/seiche from worst regional historical hurricane and 10 percent exceedance high tide
- **Results**
  - ♦ Maximum calculated riverine water level 15.9 ft below proposed site grade

# Probable Maximum Surge and Seiche

- Initial screening method (1D with wind model)
  - ◆ Results extremely conservative (42.4 ft NAVD88)
- Moved to current best practice approach
  - ◆ Physics-based 2D model added realism / incorporated conservatism
  - ◆ Resulting design basis flood (DBF) 32.1 ft NAVD88

<b>100-yr Sea Level Rise<sup>1</sup> (ft)</b>	<b>1.35 ft</b>
<b>Ten Percent Astronomical High Tide<sup>2</sup> (ft)</b>	<b>4.5 ft</b>
<b>Maximum Still Water Level (ft-NAVD88)</b>	<b>20.2 ft</b>
<b>Wave Runup<sup>2</sup> (ft)</b>	<b>7.4 ft</b>
<b>Maximum Total Water Surface Elevation (ft. NAVD88)</b>	<b>32.1 ft</b>

<sup>1</sup>Added prior to model simulation for initial sea level

<sup>2</sup>Added after model simulation to maximum still water level at site

# Flood Protection

## - Intake Structure

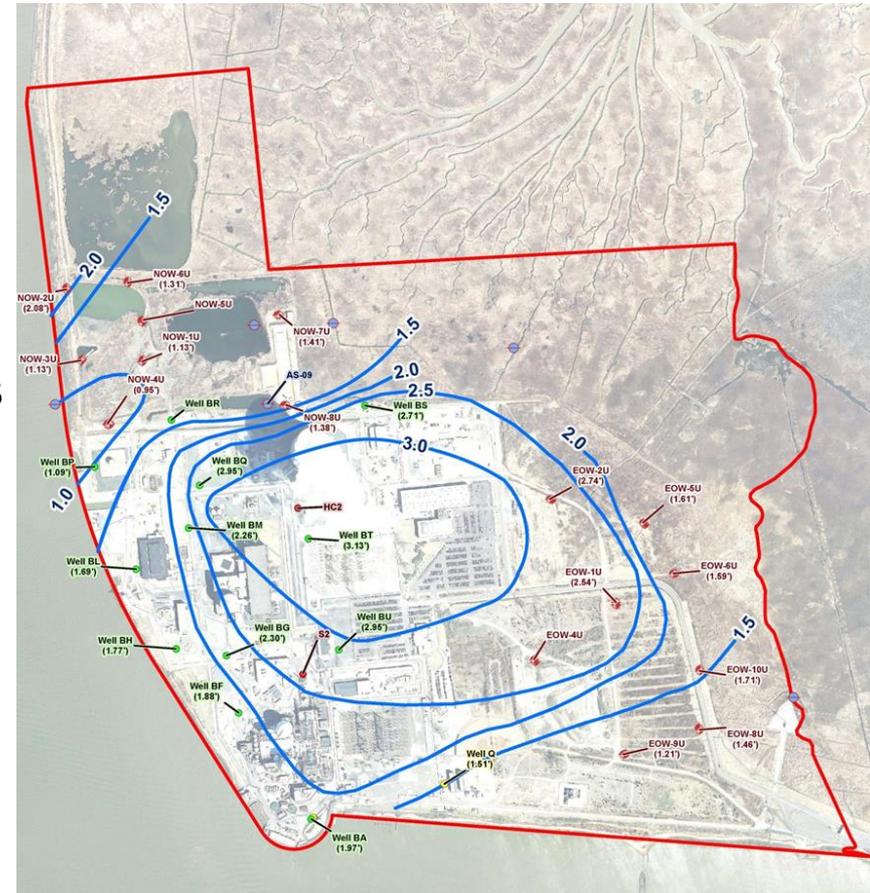
- Site grade of 36.9 ft
- DBF of 32.1 ft
- Sufficient margin for safety related site grade SSCs
- Intake structure design and associated flood protection considered at COL stage
  - ♦ **COL Action Item 2.4-2:**

COL or CP applicant referencing this ESP should address whether the intake structure of the selected design is a safety-related SSC. If so, the applicant should address necessary flooding protection for a safety-related intake structure at the ESP site based on the design basis flooding event and associated effects.

# Groundwater

- **Proposed site grade 36.9 ft**
  - ◆ Maximum groundwater level 10 ft
- **Monitoring program implemented during construction and operation**
  - ◆ **COL Action Item 2.4-3:**

COL or CP applicant referencing this ESP should refine hydrogeologic parameters and model estimates of dewatering rates and drawdowns beneath existing site structures after determination of the final excavation geometry consistent with a selected reactor technology.



PSEG Site September 2009 Potentiometric Contours.  
(from SSAR Rev 0, Figure 2.4.12-4).

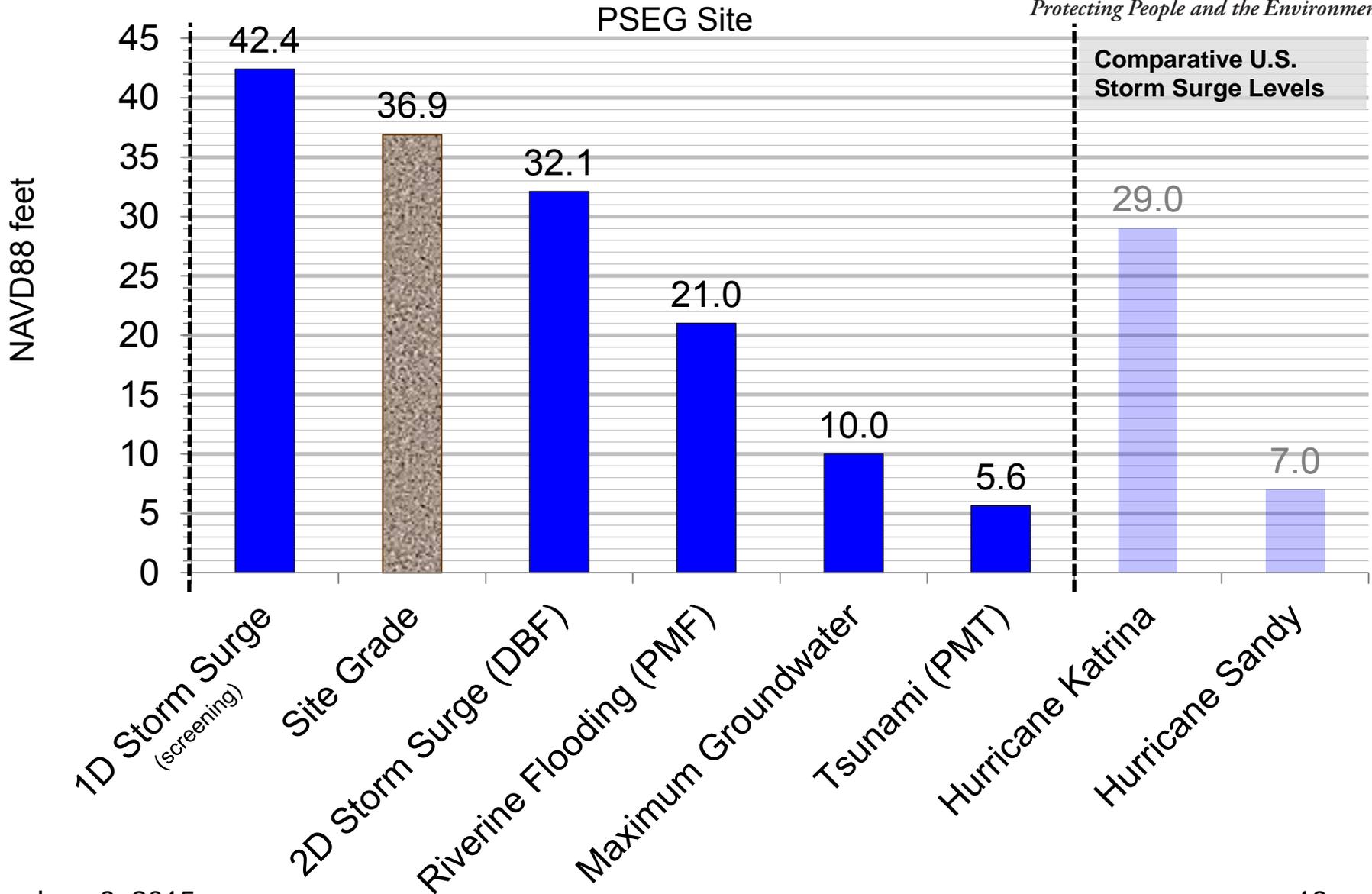
# Plant Parameter Envelope

## - Site parameters



<b>Technology</b>	<b>Max Flood Level</b> (ft below grade)	<b>Max Groundwater Level</b> (ft below grade)
U.S. EPR	1.0	3.3
ABWR	1.0	2.0
APWR	1.0	1.0
AP1000	0.0	2.0

# Water Levels and PSEG ESP Site Grade



# Accidental Releases of Radioactive Liquid Effluents

- Scenarios account for potential post-construction flow directions:
  - ♦ Delaware River towards west
  - ♦ Marshland towards northeast
- Incorporated bounding PPE and conservative hydrologic characteristics
- Results
  - ♦ Concentration of each radionuclide is less than associated limit in 10 CFR 20.
  - ♦ Sum of the ratios (predicted concentration vs. 10 CFR 20 limit) for all radionuclides in the mixture is less than unity

# SE Conclusions

- Conclusions from the Hydrologic Engineering review:

The applicant has provided sufficient information about the site description, satisfied the requirements, and considered the most severe natural phenomena that have been historically reported for the site and surrounding area and appropriately estimated the design-basis flood (DBF) elevation.

# Presentation Conclusions

- ASER defers general regulatory conclusion regarding site safety and suitability to FSER in Phase D
- ASE with no Open Items on Chapter 2, Section 2.4 –
  - Contains no permit conditions
  - Contains three (3) Action Items to be addressed by a COL or CP applicant referencing the PSEG Site Early Site Permit
- Summary of Safety Evaluations
- Next Interaction with ACRS – June 10, 2015