Nuclear Development
244 Chestnut Street, Salem, NJ 08079

PSEG
Power LLC

ND-2011-0048
June 30, 2011

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Subject: **PSEG Early Site Permit Application**
Docket No. 52-043
Response to Request for Additional Information, RAI No. 31, Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

References:
1) PSEG Power, LLC letter to USNRC, Application for Early Site Permit for the PSEG Site, dated May 25, 2010
2) RAI No. 31, SRP Subsection: 02.04.13 - Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters, dated June 1, 2011 (eRAI 5720)
3) PSEG Power, LLC letter to USNRC, ND-2011-0014, PSEG Power, LLC, Response to Request for Additional Information, RAI No. 13, Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters, dated March 31, 2011

The purpose of this letter is to respond to the request for additional information (RAI) identified in Reference 2 above. This RAI addresses Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters, as described in Subsection 2.4.13 of the Site Safety Analysis Report (SSAR), as submitted in Part 2 of the PSEG Site Early Site Permit Application, Revision 0.

Enclosure 1 provides our response for RAI No. 31, Question Nos. 02.04.13-3 through 02.04.13-13. Enclosure 2 includes the new regulatory commitments established in this submittal.

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Our response to RAI No. 31 will result in a revision to the SSAR. These revisions will be provided under separate cover no later than July 29, 2011. The digital files requested in Question No. 02.04.13-13 will also be provided under separate cover no later than July 29, 2011.

If any additional information is needed, please contact David Robillard, PSEG Nuclear Development Licensing Engineer, at (856) 339-7914.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 30th day of June, 2011.

Sincerely,

David P. Lewis
Director, Nuclear Development
PSEG Power, LLC

Enclosure 1: Response to NRC Request for Additional Information, RAI No. 31, Question No. 02.04.13-9, SRP Subsection: 02.04.13 - Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

Enclosure 2: Summary of Regulatory Commitments

cc: USNRC Project Manager, Division of New Reactor Licensing, PSEG Site (w/enclosures)
USNRC, Environmental Project Manager, Division of Site and Environmental Reviews (w/enclosures)
USNRC Region I, Regional Administrator (w/enclosures)

PSEG Letter ND-2011-0048, dated June 30, 2011

ENCLOSURE 1

RESPONSE TO RAI NO. 31

QUESTION NOs. 02.04.13-3 THROUGH 02.04.13-13

Response to RAI No. 31, Question 02.04.13-3:

In Reference 2, the NRC staff asked PSEG for information regarding Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters, as described in Subsection 2.4.13 of the Site Safety Analysis Report (SSAR). The specific request for Question 02.04.13-3 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to identifying and evaluating hydrological features of the site relating to hydrology and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain how tidal influences from the Delaware River have been taken into account and the rationale to support the premise that the predominant groundwater flows in the Alluvium and the Vincentown are westward towards the Delaware River.*

PSEG Response to NRC RAI:

Data collected monthly in the new plant area indicate predominant groundwater flow toward the Delaware River. Exceptions are noted during high tides which affect interpreted groundwater flow near the river bank in both the Alluvium (at and near where the underlying Kirkwood aquitard is absent and the Alluvium is in direct contact with the Vincentown) and in the Vincentown, which is more hydraulically connected to the river and displays tidal effects generally in proportion to the distance from the river. Groundwater flow in the Alluvium reflects infiltration of precipitation through the overlying hydraulic and structural fills and lateral flow above the Kirkwood aquitard moving mostly toward the Delaware River through the area of the proposed expansion, while flow in the Vincentown reflects more regional movement toward the west and northwest. The potentiometric contour maps are shown on Figures 2.4.12-11 through 2.4.12-13 for the Alluvium and Figures 2.4.12-16 through 2.4.12-19 for the Vincentown Formation.

Associated PSEG Site ESP Application Revisions:

Discussions related to groundwater flow impacts from tidal influence, currently in SSAR Subsection 2.4.13.1.4, will also be moved into Subsection 2.4.13.1.3 to support the conceptual model.

Response to RAI No. 31, Question 02.04.13-4:

In Reference 2, the specific request for Question 02.04.13-4 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to identifying and evaluating hydrological features of the site relating to hydrology and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain the hydrologic basis for the apparent groundwater divide in the marshes that result in the predominant groundwater flow towards the east in the eastern portions of the site over the period of record.*

PSEG Response to NRC RAI:

Recharge of precipitation to the Alluvium over the site occurs in relatively small amounts through the hydraulic and structural fill creating a mounded piezometric surface that directs groundwater movement in the Alluvium toward natural sinks for groundwater, mainly the Delaware River to the west and south for site groundwater in the western portion of the facility, and to the east and south for groundwater in the eastern portion of the facility. The mounding is a function of the hydrogeologic properties of the Alluvium, the distribution of recharge across the site, and distances and directions to groundwater sinks, i.e., places where groundwater would discharge to surface water. Groundwater flow is generally radial outward from the middle area of the facility, an area located approximately 2000 feet southeast of the new plant site. This pattern has been presented as part of the response to RAI No. 29, Question 02.04.12-2, which includes a plot (new SSAR Figure 2.4.12-30) of interpreted average groundwater contours in the Alluvium along with contours output from the groundwater model developed to support dewatering during construction.

Associated PSEG Site ESP Application Revisions:

The text in SSAR Subsection 2.4.13.1.3, *Conceptual Model and Hydrogeologic Inputs*, will be revised to provide additional description of the mounded piezometric surface observed and cite Figure 2.4.12-30 to characterize this condition.

Response to RAI No. 31, Question 02.04.13-5:

In Reference 2, the specific request for Question 02.04.13-5 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to factors important to hydrological radionuclide transport (such as soil, sediment, and rock characteristics, adsorption and retention coefficients, ground water velocity, and distances to the nearest surface body of water) and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain why a release to the Delaware River at western edge of the site is considered the most conservative scenario, while it appears that a release to the marsh in the east would receive less dilution than western release to the river and therefore would be a more conservative scenario.*

PSEG Response to NRC RAI:

The calculation for potential effects of an accidental release to groundwater has conservatively assumed no retardation or dispersion attenuation. The radioactive decay of radionuclides considered in the calculation occurs in response to the time of travel determined by the groundwater velocity (average and maximum) and the distance of the release from the receiving surface water. The groundwater velocity has been estimated as presented in SSAR section 2.4.12.1.3.5, and the distance is determined as that between the westerly extent of the power block excavation and the Delaware River. Westerly migration to the Delaware River is taken as the probable migration pathway based on the predominant interpreted groundwater flow direction from groundwater level data taken monthly over the period January 2009 to December 2009 (refer to new SSAR Figure 2.4.12-30 developed in response to RAI 29 Question 02.04-2). While an easterly groundwater flow component is indicated in some instances due to diurnal tidal effects, the predominant and sustained direction of flow across the proposed PSEG Site area is toward the Delaware River. Migration to the marshy areas to the east, if it were to occur, would require migration upward through approximately 30 to 40 feet of low permeability hydraulic fill or natural marsh sediments before discharging to surface water. This would greatly increase the travel time along this migration route as the hydraulic conductivity of the Alluvium is reported to be 1000 to 10,000 times more than that of the overlying hydraulic fill (SSAR Reference 2.4.12-1). This longer duration for the easterly flow path would therefore present a pathway with greater potential for decay, sorption and retardation (see responses to Questions 02.04.13-10 and 02.04.13-11) than the westerly flow path which is taken as more conservative.

Associated PSEG Site ESP Application Revisions:

SSAR Subsection 2.4.13.1.4, *Radionuclide Transport Analysis*, will be revised to include additional discussion described above to support conclusion that a release on the western edge of the power block is the more conservative release scenario despite the greater potential of dilution provided by the Delaware River.

Response to RAI No. 31, Question 02.04.13-6:

In Reference 2, the specific request for Question 02.04.13-6 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to factors important to hydrological radionuclide transport (such as soil, sediment, and rock characteristics, adsorption and retention coefficients, ground water velocity, and distances to the nearest surface body of water) and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain the impact of Delaware River dredging next to the shoreline on the net groundwater discharge to the river and associated gradient in the Alluvium, and the potential for enhanced tidal influence on groundwater levels in the Alluvium due to the dredging.*

PSEG Response to NRC RAI:

Dredging of the Delaware River along the proposed expansion location is not expected to affect the results of the Accidental Release scenario. No resistance to discharge of the groundwater is included in the calculations, while actually it might be slowed by upward discharge to the river through the existing low permeability river bottom sediments while radionuclides would also undergo additional retardation and decay due to the relatively high organic content sediments. The assumptions for the evaluation include immediate discharge of groundwater to the river right at the river edge (285 feet from the western edge of the proposed power block area and the assumed conservative release location), but due to the shallow river depth along the proposed expansion, and the greater depth of the Alluvium, the discharge of groundwater would likely occur at a greater distance from the shoreline where the river is deeper and overlying sediments are likely to be thinner. While some greater additional tidal response in the Alluvium might occur due to an improved connection with the river after dredging, the tidal effects are manifest more as a hydrostatic pressure response in the confined alluvial aquifer rather than actual intrusion of water from the river into the Alluvium for any significant distance toward the site. Any intrusion that might occur would set up a narrow mixing zone for the groundwater and river water prior to discharge to the surface water that would result in further decreases in concentration at the river. The net tidal effects in the Alluvium due to dredging will be minimal as the river is the sink for alluvial groundwater and the total discharge of groundwater would remain the same despite any noticeable and diurnal tidal cycle effects. Local gradients, as reflected by piezometric heads or groundwater levels in monitoring wells, could be inward toward the site on the high tide, but these would be counterbalanced by heightened outward local gradients at low tide.

Associated PSEG Site ESP Application Revisions:

SSAR Subsection 2.4.13.1.4, *Radionuclide Transport Analysis*, will be revised to provide further discussion of the potential impacts of dredging on groundwater levels as it relates to transport of radionuclides.

Response to RAI No. 31, Question 02.04.13-7:

In Reference 2, the specific request for Question 02.04.13-7 was:

> *In accordance with the requirements of 10 CFR Part 100 as they relate to identifying and evaluating effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users in the vicinity of the site and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#3 Characteristics that Affect Transport), please explain the release scenario assuming direct discharge to the Alluvium and why the discharge is to the Alluvium rather than the construction fill, and the potential for tidal action to significantly enhance a release discharge volume within the fill and Alluvium.*

PSEG Response to NRC RAI:

While a hypothetical release within the power block would more likely occur in the structural fill replacing the excavated hydraulic fill and Alluvium, the sequence of materials immediately exterior to the power block cut-off wall would still be the low permeable hydraulic fill over the Alluvium over the Kirkwood aquitard. A release within the power block area would result in percolation down through a greater volume of material than assumed in the conservative evaluation of a release directly into the Alluvium. The added material and saturated thickness within the structural fill above or replacing the Alluvium would afford a longer migration pathway, longer time of travel, and greater opportunity for sorption and decay effects to occur than assumed in the conservative approach taken. If the surface tank leakage occurred at the top of the structural fill embankment, the discharge would have to migrate down through the structural fill and then horizontally to the limit of the power block. Once beyond the extent of the power block, the pathway (with a conservatively low assumed path distance as explained in the response to the previous Question 02.04.13-6) to the river would still remain through the Alluvium. This is the assumption made in the calculations supporting SSAR Section 2.4.13. Further, the soil retention barrier constructed to improve dewatering efficiency and stability during excavation may remain in-place post-construction. If so, it would present an added constraint to the rate of movement of the hypothetical release-affected groundwater to the river. The fact that no flow impediment credit is given to the soil retention barrier adds yet another layer of conservatism to the analysis.

Tidal effects in the Alluvium are relatively small. Net effects over a tidal cycle are even less significant as, due to the bi-directional nature of the tidal cycle, the same flow through the Alluvium will occur over a complete tidal cycle as would occur had there been no tidal effects. A relatively narrow tidally influenced mixing zone may develop just prior to groundwater discharge to the river which would result in further decreases in concentration just prior to discharge to the river. No credit was taken for this added dilution factor in the analysis.

Associated PSEG Site ESP Application Revisions:

SSAR Subsection 2.4.13.1.3 will be revised to further clarify the assumption for the release scenario described above.

Response to RAI No. 31, Question 02.04.13-8:

In Reference 2, the specific request for Question 02.04.13-8 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to factors important to hydrological radionuclide transport and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain the level of confidence and conservatism regarding the maximum groundwater velocity given the length of the data record.*

PSEG Response to NRC RAI:

The calculation of the average and maximum groundwater velocity in the Alluvium is based on the evaluation and calculation of hydraulic gradients for each of twelve monthly measurement events. These events covered a variety of seasonal and tidal conditions, yielding a reasonable annual average condition, and a reasonable maximum gradient. These average and maximum gradients were coupled with estimates of average and maximum hydraulic conductivity through the performance of slug tests in alluvial monitoring wells in the proposed power block area, and the assumption of a reasonable value of effective porosity of 0.2. Historical available groundwater level data on the Alluvium throughout the site (SSAR References 2.4.12-1 and 2.4.12-2), when compared with twelve months of water levels (January 2009 to December 2009), and the later more geographically extensive water level measurement readings in September 2009, suggest that the water levels within the Alluvium are relatively stable across the site and over time. The minimum travel time, for a hypothetical release of radionuclides to groundwater to arrive at the receptor location is based on the shortest pathway distance, the maximum hydraulic gradient, and the maximum hydraulic conductivity. The groundwater flow velocity developed from these site hydrologic parameters, results in a travel time calculated at greater than 3000 days (> 8 years) which is considered a reasonable and sufficiently conservative estimate.

Associated PSEG Site ESP Application Revisions:

Elements from the discussion provided in the above response will be inserted into SSAR Subsection 2.4.13.1.4. The text and associated SSAR Tables 2.4.13-2 thru 2.4.13-5 will be revised to present various cases for average and maximum hydrogeologic parameters as well as assumptions for concentrations.

Response to RAI No. 31, Question 02.04.13-9:

In Reference 2, the specific request for Question 02.04.13-9 was:

> *In accordance with the requirements of 10 CFR Part 100 as they relate to identifying and evaluating effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users in the vicinity of the site and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#3 Characteristics that Affect Transport), please explain why some of the radionuclide fractions generated do not need to be considered.*

PSEG Response to NRC RAI:

The list of radionuclides released in an accidental release of liquid effluents is discussed in SSAR Subsection 2.4.13 and provided in SSAR Table 2.4.13-1. Since the submittal of Revision 0 of the SSAR, this table has been updated as discussed in Reference 3 of the cover letter. The content of the revised table provided in Reference 3 is provided in Table RAI 31-1. Per Reference 3, this information will be incorporated into SSAR Table 2.4.13-1 in a future revision of the SSAR. Table RAI 31-1 contains the bounding activity concentrations for all the radionuclides initially considered, and identifies the radionuclides eliminated due to short half-life or low activity concentration.

The radionuclides eliminated due to a short half-life are radionuclides with a half-life of less than one year. The analysis to support SSAR Subsection 2.4.13.1.6 determined that the transport time of the radionuclides from the point of release to the Delaware River is at least 8.3 years. Any radionuclide with a half-life of less than one year would be eliminated by radioactive decay in this time period.

The radionuclides eliminated due to low activity concentration are radionuclides with activity concentrations below the limits established in 10 CFR Part 20 (prior to release). The activity concentrations will further decrease due to decay as the radionuclides travel from the release point to the receptor.

Associated PSEG Site ESP Application Revisions:

None.

Table RAI-31-1
Initial Concentrations of Radionuclides
Sheet 1 of 4

Nuclide	Half-life[6] (days)	GE-ABWR[1] (MBq)	GE-ABWR[1] (µCi/cc[7])	AP-1000[2] (µCi/cc)	US-APWR[3] (µCi/cc)	U.S. EPR[4] (µCi/cc)	Bounding (µCi/cc)	ECL[5] (µCi/cc)	Analysis (µCi/cc)
Br-82	1.47E+00				3.50E-03		3.50E-03	4.00E-05	*
Br-83	9.96E-02				2.40E-02	3.20E-02	3.20E-02	9.00E-04	*
Br-84	2.21E-02				1.10E-02	1.70E-02	1.70E-02	4.00E-04	*
Br-85	1.99E-03					2.00E-03	2.00E-03		*
Rb-86m	6.94E-04					3.00E-07	3.00E-07		*
Rb-86	1.87E+01				1.10E-02	1.90E-03	1.10E-02	7.00E-06	*
Rb-88	1.24E-02			1.50E+00	1.40E+00	1.00E+00	1.50E+00	4.00E-04	*
Rb-89	1.06E-02	2.80E+02	8.41E-05	6.90E-02	2.50E-02	4.70E-02	6.90E-02	9.00E-04	*
Sr-89	5.05E+01	5.10E+03	1.53E-03	1.10E-04	8.30E-04	6.40E-04	1.53E-03	8.00E-06	*
Sr-90	1.06E+04	4.20E+02	1.26E-04		5.40E-05	3.30E-05	1.26E-04	5.00E-07	1.26E-04
Sr-91	3.96E-01	7.00E+03	2.10E-03		4.70E-04	1.00E-03	2.10E-03	2.00E-05	*
Sr-92	1.13E-01	5.30E+03	1.59E-03		2.20E-04	1.70E-04	1.59E-03	4.00E-05	*
Y-90	2.67E+00	4.20E+02	1.26E-04		1.80E-04	7.70E-06	1.80E-04	7.00E-06	*
Y-91m	3.45E-02				2.70E-04	5.20E-04	5.20E-04	2.00E-03	*
Y-91	5.85E+01	2.00E+03	6.01E-04		1.30E-04	8.10E-05	6.01E-04	8.00E-06	*
Y-92	1.48E-01	4.10E+03	1.23E-03		2.10E-04	1.40E-04	1.23E-03	4.00E-05	*
Y-93	4.21E-01	6.80E+03	2.04E-03		9.00E-05	6.50E-05	2.04E-03	2.00E-05	*
Zr-95	6.40E+01	4.10E+02	1.23E-04		1.60E-04	9.30E-05	1.60E-04	2.00E-05	*
Zr-97	7.04E-01					6.70E-05	6.70E-05	9.00E-06	*
Nb-95	3.52E+01	3.70E+02	1.11E-04		1.80E-04	9.40E-05	1.80E-04	3.00E-05	*
Mo-99	2.75E+00	2.00E+04	6.01E-03	2.10E-01	1.80E-01	1.10E-01	2.10E-01	2.00E-05	*
Mo-101	1.01E-02				5.00E-03		5.00E-03	7.00E-04	*
Tc-99m	2.51E-01	2.00E+04	6.01E-03		1.10E-01	4.60E-02	1.10E-01	1.00E-03	*
Ru-103	3.93E+01	9.70E+02	2.91E-04		1.30E-04	7.80E-05	2.91E-04	3.00E-05	*
Ru-105	1.85E-01					9.50E-05	9.50E-05	7.00E-05	*
Ru-106	3.68E+02	1.80E+02	5.41E-05		4.70E-05	2.70E-05	5.41E-05	3.00E-06	5.41E-05
Rh-103m	3.90E-02	9.70E+02	2.91E-04			6.80E-05	2.91E-04	6.00E-03	*
Rh-105	1.47E+00					4.40E-05	4.40E-05	5.00E-05	*
Rh-106	3.46E-04	1.80E+02	5.41E-05			2.70E-05	5.41E-05		*

Table RAI-31-1
Initial Concentrations of Radionuclides
Sheet 2 of 4

Nuclide	Half-life[6] (days)	GE-ABWR[1] (MBq)	GE-ABWR[1] (µCi/cc[7])	AP-1000[2] (µCi/cc)	US-APWR[3] (µCi/cc)	U.S. EPR[4] (µCi/cc)	Bounding (µCi/cc)	ECL[5] (µCi/cc)	Analysis (µCi/cc)
Ag-110m	2.50E+02	5.80E+01	1.74E-05		4.30E-07	2.00E-07	1.74E-05	6.00E-06	*
Ag-110	2.85E-04					1.10E-08	1.10E-08		*
Sb-125	1.01E+03					8.00E-07	8.00E-07	3.00E-05	**
Sb-127	3.85E+00					5.00E-06	5.00E-06	1.00E-05	*,**
Sb-129	1.85E-01					6.80E-06	6.80E-06	4.00E-05	*
Te-125m	5.80E+01				1.90E-04		1.90E-04	2.00E-05	*
Te-127m	1.09E+02				7.50E-04	4.40E-04	7.50E-04	9.00E-06	*
Te-127	3.90E-01					2.20E-03	2.20E-03	1.00E-04	*
Te-129m	3.36E+01	1.80E+03	5.41E-04		2.50E-03	1.50E-03	2.50E-03	7.00E-06	*
Te-129	4.83E-02				2.00E-03	2.40E-03	2.40E-03	4.00E-04	*
Te-131m	1.25E+00	4.60E+02	1.38E-04		6.30E-03	3.70E-03	6.30E-03	8.00E-06	*
Te-131	1.74E-02				2.20E-03	2.60E-03	2.60E-03	8.00E-05	*
Te-132	3.26E+00	1.10E+02	3.30E-05		7.00E-02	4.10E-02	7.00E-02	9.00E-06	*
Te-133m	3.85E-02				4.30E-03		4.30E-03	9.00E-05	*
Te-134	2.90E-02				7.60E-03	6.70E-03	7.60E-03	3.00E-04	*
I-129	5.73E+09					4.60E-08	4.60E-08	2.00E-07	**
I-130	5.15E-01				2.70E-02	5.00E-02	5.00E-02	2.00E-05	*
I-131	8.04E+00	1.20E+05	3.60E-02	7.10E-02	6.70E-01	7.40E-01	7.40E-01	1.00E-06	*
I-132	9.58E-02	1.70E+04	5.11E-03	9.30E-02	2.90E-01	3.70E-01	3.70E-01	1.00E-04	*
I-133	8.67E-01	1.10E+05	3.30E-02	1.30E-01	1.10E+00	1.30E+00	1.30E+00	7.00E-06	*
I-134	3.65E-02	1.10E+04	3.30E-03	2.20E-02	1.50E-01	2.40E-01	2.40E-01	4.00E-04	*
I-135	2.75E-01	5.20E+04	1.56E-02	7.80E-02	6.40E-01	7.90E-01	7.90E-01	3.00E-05	*
Cs-132	6.48E+00				2.20E-03		2.20E-03	4.00E-05	*
Cs-134	7.53E+02	1.60E+03	4.80E-04	6.90E-01	2.00E+00	1.70E-01	2.00E+00	9.00E-07	2.00E+00
Cs-135m	3.68E-02				2.40E-03		2.40E-03	1.00E-03	*
Cs-136	1.31E+01	6.00E+02	1.80E-04	1.00E+00	2.50E-01	5.30E-02	1.00E+00	6.00E-06	*
Cs-137	1.10E+04	4.40E+03	1.32E-03	5.00E-01	1.20E+00	1.10E-01	1.20E+00	1.00E-06	1.20E+00
Cs-138	2.24E-02	1.20E+03	3.60E-04	3.70E-01	2.60E-01	2.20E-01	3.70E-01	4.00E-04	*
Ba-137m	1.77E-03			5.00E-01	8.00E+00	1.00E-01	8.00E+00		*

Table RAI-31-1
Initial Concentrations of Radionuclides
Sheet 3 of 4

Nuclide	Half-life[6] (days)	GE-ABWR[1] (MBq)	GE-ABWR[1] (µCi/cc[7])	AP-1000[2] (µCi/cc)	US-APWR[3] (µCi/cc)	U.S. EPR[4] (µCi/cc)	Bounding (µCi/cc)	ECL[5] (µCi/cc)	Analysis (µCi/cc)
Ba-139	5.74E-02					2.20E-02	2.20E-02	2.00E-04	*
Ba-140	1.27E+01	1.30E+04	3.90E-03		9.80E-04	6.20E-04	3.90E-03	8.00E-06	*
La-140	1.68E+00	1.30E+04	3.90E-03		4.20E-04	1.60E-04	3.90E-03	9.00E-06	*
La-141	1.64E-01					5.30E-05	5.30E-05	5.00E-05	*
La-142	6.42E-02					3.10E-05	3.10E-05	1.00E-04	*
Ce-141	3.25E+01	1.40E+03	4.20E-04		1.50E-04	8.90E-05	4.20E-04	3.00E-05	*
Ce-143	1.38E+00				1.20E-04	7.60E-05	1.20E-04	2.00E-05	*
Ce-144	2.84E+02	1.70E+02	5.11E-05		1.20E-04	6.90E-05	1.20E-04	3.00E-06	*
Pr-143	1.36E+01	1.00E+02	3.00E-05			8.80E-05	8.80E-05	2.00E-05	*
Pr-144	1.20E-02				2.90E-03	6.90E-05	2.90E-03	6.00E-04	*
Pm-147	9.58E+02				1.30E-05		1.30E-05	7.00E-05	**
Nd-147	1.10E+01					3.40E-05	3.40E-05	2.00E-05	*
Eu-154	3.21E+03				1.20E-06		1.20E-06	7.00E-06	**
Np-239	2.36E+00	6.80E+04	2.04E-02			8.70E-04	2.04E-02	2.00E-05	*
Pu-238	3.20E+04					2.00E-07	2.00E-07	2.00E-08	2.00E-07
Pu-239	8.79E+06					2.00E-08	2.00E-08	2.00E-08	*
Pu-240	2.39E+06					2.80E-08	2.80E-08	2.00E-08	2.80E-08
Pu-241	5.26E+03					6.90E-06	6.90E-06	1.00E-06	6.90E-06
Am-241	1.58E+05					7.80E-09	7.80E-09	2.00E-08	**
Cm-242	1.63E+02					1.90E-06	1.90E-06	7.00E-07	1.90E-06
Cm-244	6.61E+03					1.00E-07	1.00E-07	3.00E-08	1.00E-07
Na-24	6.25E-01	2.50E+04	7.51E-03		1.50E-02	3.70E-02	3.70E-02	5.00E-05	*
P-32	1.43E+01	6.90E+03	2.07E-03				2.07E-03	9.00E-06	*
Cr-51	2.77E+01	2.70E+05	8.11E-02		1.60E-03	2.00E-03	8.11E-02	5.00E-04	*
Mn-54	3.13E+02	4.10E+03	1.23E-03		1.10E-03	1.00E-03	1.23E-03	3.00E-05	*
Mn-56	1.07E-01	2.50E+04	7.51E-03	1.70E-02	4.00E-02		4.00E-02	7.00E-05	*
Fe-55	9.86E+02	6.00E+04	1.80E-02		1.10E-03	7.60E-04	1.80E-02	1.00E-04	1.80E-02
Fe-59	4.45E+01	1.50E+03	4.50E-04		1.90E-04	1.90E-04	4.50E-04	1.00E-05	*

Table RAI-31-1
Initial Concentrations of Radionuclides
Sheet 4 of 4

Nuclide	Half-life[6] (days)	GE-ABWR[1] (MBq)	GE-ABWR[1] (µCi/cc[7])	AP-1000[2] (µCi/cc)	US-APWR[3] (µCi/cc)	U.S. EPR[4] (µCi/cc)	Bounding (µCi/cc)	ECL[5] (µCi/cc)	Analysis (µCi/cc)
Co-58	7.08E+01	1.10E+04	3.30E-03		2.60E-03	2.90E-03	3.30E-03	2.00E-05	*
Co-60	1.93E+03	2.40E+04	7.21E-03		3.90E-04	3.40E-04	7.21E-03	3.00E-06	7.21E-03
Ni-63	3.51E+04	6.00E+01	1.80E-05				1.80E-05	1.00E-04	**
Cu-64	5.29E-01	6.40E+04	1.92E-02				1.92E-02	2.00E-04	*
Zn-65	2.44E+02	1.20E+04	3.60E-03		3.20E-04	3.20E-04	3.60E-03	5.00E-06	*
W-187	9.96E-01	1.10E+03	3.30E-04			1.80E-03	1.80E-03	3.00E-05	*
H-3	4.51E+03		1.00E-02	3.50E+00	1.00E+00	1.00E+00	3.50E+00	1.00E-03	3.50E+00

Notes:
* Eliminated because half-life is less than one year.
** Eliminated because activity is below ECL.
(1) Data is based on ABWR DCD (Rev. 4) Table 12.2-13a and Subsection 11.1.2.3.
(2) Data is based on AP1000 DCD (Rev. 18) Table 12.2-9 and Subsection 11.1.1.3.
(3) Data is based on US-APWR DCD (Rev. 2) Table 12.2-37 and Subsection 11.1.1.3.
(4) Data is based on U.S. EPR DCD (Rev. 1) Table 11.1-2.
(5) Data is based on 10CFR20 Appendix B, Table 2.
(6) Data for half-lives are based on Table E.1 NUREG/CR-5512 or a Chart of Nuclides.
(7) A conversion factor between MBq (in a 90m^3 tank) and µCi/cc is:
10^6Bq / 1MBq x 1µCi / 3.7x10^4Bq x 1m^3 / 10^6cc x 1 / 90m^3 = 3x10^{-7}µCi/cc x m^3/MBq.

Response to RAI No. 31, Question 02.04.13-10:

In Reference 2, the specific request for Question 02.04.13-10 was:

> *In accordance with the requirements of 10 CFR Part 100 as they relate to identifying and evaluating effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users in the vicinity of the site and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#3 Characteristics that Affect Transport), please explain the assumptions used in the analysis presented in Sections 2.4.13.1.6 through 2.4.13.1.9 and how the analysis incorporates conservatism of assumptions and parameters with respect to estimated receptor concentrations.*

PSEG Response to NRC RAI:

The PSEG Site is remotely located relative to any users of groundwater. The nearest public supply well in any direction is located over 3.5 miles away, across the Delaware River, in Delaware. The nearest private water well receptor is over a mile away. However, due to the brackish nature of both the Alluvium and the Vincentown, nearby water supply wells would not be completed in these aquifers and therefore would not be susceptible to releases in these aquifers. Concentration attenuation factors in the accidental release scenario include sorption, decay, dilution, and dispersion vertically through migration into a lower, thicker aquifer. The release into the Alluvium spans a relatively thin aquifer, whereas any further vertical migration into the next lower aquifer (the Vincentown) toward potential private well receptors, as well as the Delaware River, would be moderated by a longer flow path, additional dilution by dispersion, sorption, and added time for decay to occur, indicating that migration through the Alluvium is the more conservative pathway.

Associated PSEG Site ESP Application Revisions:

No change to the SSAR is anticipated in response to this RAI.

Response to RAI No. 31, Question 02.04.13-11:

In Reference 2, the specific request for Question 02.04.13-11 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to factors important to hydrological radionuclide transport and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain dilution factor derivations, and the specific factor by which the concentration of each radionuclide would be lessened due to the retardation.*

PSEG Response to NRC RAI:

The conservative analysis of the hypothetical accidental release scenario indicates that activity concentrations of several radionuclides are greater than their respective Effluent Concentration Limits (ECLs) at the point of discharge (prior to dilution in the Delaware River). The principal contributors to the sum of ratios (the ratio of the activity concentration for each radionuclide to its ECL) were Cs-134, Cs-137, Fe-55, Co-60, Sr-90, and tritium. However, due to the great dilution capacity in the tidal Delaware River, fully diluted radionuclide flux into the river would result in a sum of ratios orders of magnitude less than unity. A sensitivity calculation indicated that the required mixing flow in the river to achieve unity would be on the order of 112 cubic feet per second (cfs) as compared to a tidal flow in the river that ranges from 400,000 cfs to 472,000 cfs.

Although retardation was not credited in the original analysis, an analysis was performed to demonstrate that the potential effects of retardation could be an important factor in further reducing the activity concentrations reaching the river and lowering even further the relatively small portion of the river flow needed to achieve a sum of ratios of unity. The estimated maximum groundwater velocity through the Alluvium was conservatively used to assess retardation effects. Site-specific soil-water partition coefficients (K_d) for the radionuclides included in the analysis were not determined for the PSEG Site, NUREG/CR-5512 provides typical partition coefficient values. These values were used in the analysis of potential retardation effects. The results of the analysis demonstrate that all major contributors to the sum of ratios, as identified above, were insignificant in the sum, except for tritium, which is not retarded along the migration pathway. Tritium, the major contributor to the sum of ratios, represents over 99.99 percent of the sum. The sum of ratios still exceeds unity, but the estimated mixing flow in the river needed to achieve unity dropped to about 0.2 cfs.

In summary, the analysis demonstrates that the qualitative statements made regarding the potential effects of retardation are valid, and that the inclusion of typical retardation effects for the subject radionuclides (using NUREG/CR-5512 presented K_d values) result in only tritium as a significant contributor to the unity rule. While estimated tritium concentrations at the river under conservative assumptions would still exceed the unity rule, subsequent dilution in a minimal fraction of the available flow in the Delaware River would reduce the ratio to below unity.

Associated PSEG Site ESP Application Revisions:

No changes to the SSAR are anticipated in response to this RAI.

Response to RAI No. 31, Question 02.04.13-12:

In Reference 2, the specific request for Question 02.04.13-12 was:

> *In accordance with the requirements of 10 CFR 100.20(c) (3) as it relates to factors important to hydrological radionuclide transport and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#2 Pathways), please explain the following:*
>
> *(1) Section 2.4.13.1.9 (Potential Migration to Deeper Aquifers) and the assumptions that radionuclides enter the Vincentown Formation and travel towards the Delaware River, flow in the Vincentown was determined to be toward the river even from a potential release on the east side of the power block, and easterly migration is not expected.*
> *(2) Why the entire Vincentown Formation thickness would be available for infiltration from the overlying Alluvium. In short, clarify assumptions used for discussion of release in Vincentown Formation.*
> *(3) Why one part of the text narrative says the Vincentown outcrops in the river and another part says that contaminants would need to migrate through the Kirkwood Aquitard and Alluvium to reach the river, i.e., clarify alternative pathway description for migration through the Vincentown to the Delaware River.*
> *(4) Why the analysis for the Alluvium is considered more conservative than for the Vincentown and if this conclusion based on the nominal travel times.*
> *(5) In more detail, explain the statement that the rate of induced downward migration would slow in the event of a release and clarify the factors that would slow downward migration.*
> *(6) Justification for why dilution of radionuclide concentrations in a pumping well to less than detectable levels is compliant with requirements, and clarify the conservative assumptions in the downward and then horizontal migration in the PRM Formation.*

PSEG Response to NRC RAI:

(1) While the potential for migration to the deeper Vincentown exists from a release on either side of the power block, groundwater flow in the Vincentown is expected to be to the west or northwest in the direction of the Delaware River, where the Vincentown unit outcrops at its closest point to the site, approximately 1 to 2 miles northwest in the Delaware River. See SSAR Figures 2.4.12-16 through 2.4.12-18.

As discussed in response to Question 02.04.13-3, data collected monthly in the new plant area indicate predominant groundwater flow toward the Delaware River. Exceptions are noted during high tides which affect interpreted groundwater flow near the river bank in both the Alluvium (at and near where the underlying Kirkwood aquitard is absent and the Alluvium is in direct contact with the Vincentown) and in the Vincentown, which is more hydraulically connected to the river and displays tidal effects generally in proportion to the distance from the river. Groundwater flow in the Alluvium reflects infiltration of precipitation through the overlying hydraulic and structural fills and lateral flow above the Kirkwood aquitard moving mostly toward the Delaware River through the area of the proposed expansion, while flow in the Vincentown reflects more regional movement toward the west and northwest.

Additionally, as discussed in response to Question 02.04.13-5, westerly migration to the Delaware River is taken as the probable migration pathway based on the predominant interpreted groundwater flow direction from groundwater level data taken monthly over the period January 2009 to December 2009 (refer to new SSAR Figure 2.4.12-30 developed in response to RAI 29 Question 02.04-2). While an easterly groundwater flow component is indicated in some instances due to diurnal tidal effects, the predominant and sustained direction of flow across the proposed PSEG Site area is toward the Delaware River. Migration to the marshy areas to the east, if it were to occur, would require migration upward through approximately 30 to 40 feet of low permeability hydraulic fill or natural marsh sediments before discharging to surface water. This would greatly increase the travel time along this migration route as the hydraulic conductivity of the Alluvium is reported to be 1000 to 10,000 times more than that of the overlying hydraulic fill (SSAR Reference 2.4.12-1). This longer duration for the easterly flow path would therefore present a pathway with greater potential for decay, sorption and retardation than the westerly flow path which is taken as more conservative.

(2) While it is expected that the Vincentown unit would provide for additional dilution due to its thickness, PSEG agrees that the entire thickness of the Vincentown, described as 10 times thicker than that of the Alluvium, may not provide for dilution at 10 times greater than that in the Alluvium. However, the available dilution in the Vincentown is greater than in the Alluvium, particularly when considering a release at the western edge of the proposed power block area would be flowing and dispersing through both structural fill and Alluvium before reaching the thicker Vincentown. See also the response to item (4) of this Question. SSAR Subsection 2.4.13.1.9 will be revised to clarify the assumptions inherent in a release that could reach and migrate through the Vincentown.

(3) SSAR Subsection 2.4.13.1.3 presents two extremes of possible routes of migration through the Vincentown to the Delaware River. Subsection 2.4.13.1.3 will be expanded to provide a clearer description of the migration routes, and provide a distinction between potential migration pathways, i.e., migration upward through overlying materials into the river near the shoreline or more likely over a mile away where the Vincentown outcrops to the river

(4) The pathway through the Alluvium is considered more conservative than through the Vincentown due to longer migration pathways in the Vincentown Formation and similar groundwater velocities in both materials. The potential migration pathways for the Vincentown are either following the Vincentown to the point where it outcrops to the river, or migration up through the Kirkwood aquitard and/or river bottom

sediments closer to the site. These migration pathways require additional travel time, thereby enabling further radioactive decay to occur. Subsection 2.4.13.1.3 will be revised to describe in greater detail why the pathway through the Alluvium is more conservative than through the Vincentown.

(5) Migration to deeper aquifers will be slowed by the lack of significant vertical gradients in the shallow aquifers and the presence of significant aquitard units that would slow or prevent migration to deeper aquifers. SSAR Subsection 2.4.13.1.9 will be revised to clarify the factors that would slow downward migration of a release.

(6) The discussion regarding dilution of radionuclide concentrations in a pumping well was meant to be a qualitative statement of what could happen if radionuclide migration were to reach a supply well. This is now shown to be virtually impossible due to probable retardation and decay, lack of significant vertical gradients, presence of aquitards protecting deeper aquifers that could be used for supply, the brackish nature of the shallow aquifers (Alluvium and Vincentown), and the remote location of the site which is miles from any supply well. SSAR Subsection 2.4.13.1.9 will be revised to remove the discussion on dilution.

Associated PSEG Site ESP Application Revisions:

Changes to the SSAR are described in the above responses.

Response to RAI No. 31, Question 02.04.13-13:

In Reference 2, the specific request for Question 02.04.13-13 was:

In accordance with the requirements of 10 CFR Part 100, as they relate to identifying and evaluating effects of accidental releases of radioactive liquid effluents in ground and surface waters on existing users and known and likely future users in the vicinity of the site, and as recommended in Standard Review Plan 2.4.13 SRP Acceptance Criteria (#3 Characteristics that Affect Transport), please provide the following calculation packages:

- Digital copies of groundwater flow model input and output files in native formats with explanations of data and formats
- Digital copies of files used for radionuclide transport analysis in native formats with explanations of data and formats
- Digital copies of input and output files used for the aquifer test analysis in native formats with explanations of data and formats

PSEG Response to NRC RAI:

The files in native format will be provided as requested. The text below provides additional description of the file and calculation contents.

A) The Groundwater Model

Groundwater model input and output files in support of the model calibration and subsequent use in providing estimates of expected dewatering rates will be provided. Units of length and time for aquifer parameters and model domain dimensions are in feet and days. The model code used is the USGS MODFLOW-96, version 3.3, and modeling was accomplished and interpreted using the Groundwater Vistas modeling platform. The Groundwater Vistas files for the runs provided contain all this information, or the input files may be imported to other modeling platforms to run or used simply as model viewers.

The model files to be provided are identified by file name, and by additional information provided in the two comment lines in the .bas input file. The model input/output files will be provided in electronic format for each run. Model runs included will consist of base model steady-state calibration and transient dewatering simulations of the proposed power block area. Also included are sensitivity runs for the dewatering simulation that form the basis of the range of estimated dewatering rates that may be encountered during construction. As the reactor technology had not been selected at the time of these simulation runs, a bounding area approach was used in the model simulations.

A file that contains base maps of the facility and model domain in Groundwater Vistas .map format will also be provided.

B) The Accidental Release Evaluation

Spreadsheets for the calculations of anticipated concentrations at the receptor location (at the river, 285 feet from the point of release) in Excel format will be provided along with an explanation of how the data were processed. Where applicable, reference will be made to the accidental release calculation package.

C) Slug Test Analyses

Slug test data were collected using transducers that translated pressure readings and time in feet of drawdown (in hundredths) and seconds. These data were processed using Aqtesolv Version 4.5 (HydroSOLVE, Inc. 2007) software using additional input data concerning the well screen placement, aquifer saturation thickness, aquifer thickness, and well and boring radius information. The slug test data and the Aqtesolv data and output sheets will be provided in electronic format along with an explanation of how the data was processed.

Associated PSEG Site ESP Application Revisions:

None.

PSEG Letter ND-2011-0049, dated June 30, 2011

ENCLOSURE 2

Summary of Regulatory Commitments

ENCLOSURE 2

SUMMARY OF REGULATORY COMMITMENTS

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	Programmatic (Yes/No)
PSEG will provide the marked up SSAR pages indicating the proposed revisions to SSAR Subsection 2.4.13.	July 29, 2011	Yes	No
PSEG will provide the digital files requested by NRC RAI No. 31, Question 02.04.13-13.	July 29, 2011	Yes	No
PSEG will revise SSAR Subsection 2.4.13 to incorporate the changes discussed in Enclosure 1 in response to NRC RAI No. 31, Questions .02.04.13-3 – 8, 10, and 12	This revision will be included in the next update of the PSEG Site ESP Application SSAR	Yes	No