6.2 RADIOLOGICAL MONITORING

This section describes the objectives, basis, content, reporting and quality assurance aspects of the site area Radiological Environmental Monitoring Program (REMP) which includes Susquehanna Steam Electric Station (SSES) Units 1 and 2 and the new Bell Bend Nuclear Power Plant (BBNPP). The BBNPP REMP will build upon the existing SSES program where sample types, locations, collection frequencies, and analysis requirements are consistent with satisfying the program requirements (such as objectives, basis, and reporting) that are identified for BBNPP. The BBNPP REMP is considered a separate program from that administered by SSES, even though many of the program elements are shared between operating entities on the SSES units and the BBNPP. The existing REMP for the SSES site covers the entire Susquehanna and BBNPP site and environs surrounding the site and will be used to provide baseline information in support of the pre-operational phase of BBNPP (SSES, 2005) (SSES, 2007).

The pre-operational monitoring program for SSES Units 1 and 2 was implemented in April 1972 (SSES, 2007). SSES Unit 1 achieved criticality on September 10, 1982. SSES Unit 2 achieved criticality on May 4, 1984 (SSES, 1984). Results of the existing monitoring program for both the pre-operational and operational periods to date have been reported to the Nuclear Regulatory Commission (NRC) in a series of annual reports. Annual reporting of REMP activities, detected radioactivity, trends, and plant related impacts will continue through the construction and operation of BBNPP and will cover the influence of all three units in a series of annual reports entitled "Annual Radiological Environmental Operating Report (AREOR)". BBNPP will prepare its own AREOR, which will cover the licensing commitments specific to its operations. The BBNPP REMP will be initiated at least two years prior to the plant's first criticality.

The objectives of the REMP for the existing SSES Units 1 & 2 are (SSES, 2007):

a. To implement the REMP in accordance with Technical Specifications, Technical Requirements Manual, and the Offsite Dose Calculation Manual, which are based on the design objectives in 10 CFR Part 50 Appendix I, Sections IV.B.2, IV.B.3, and IV.C (CFR, 2008). The REMP supplements the results of the radioactive effluent-monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation in the environment are not higher than expected on the basis of the effluent measurements and modeling of the environment in the vicinity of the site.

b. Document compliance with REMP Technical Requirements for radiological environmental surveillances.

c. Verify proper implementation of station radiological effluent controls.

d. Identify, measure, and evaluate trends of radionuciide concentrations in environmental pathways near the station.

e. Assess the impact of station effluents on the environment and the public.

These same objectives are applied to the design and operation of the BBNPP Radiological Environmental Monitoring program which provides for a site area wide compatibility between the existing SSES program and the addition of BBNPP.

The SSES monitoring program was originally developed based on the guidance from the NRC's Radiological Assessment Branch Technical Position on radiological environmental monitoring, as described in Revision 1, November 1979 (NRC, 1979b). The current environmental

monitoring sampling program is consistent with the guidance provided in standard radiological effluent technical specifications as described in NUREG-1301 (NRC, 1991) and Regulatory Guide 4.1 (NRC, 1975). The Radiological Environmental Monitoring Program (REMP) for BBNPP was designed following the same guidance criteria in NUREG-1301, Table 3.12-1, including, when consistent with the guidance criteria, the current REMP sampling conducted by SSES Units 1 and 2. The justification for the selection of sample media, locations and collection frequencies that make up the REMP is based on the need to provide representative measurements of radiation and radioactive materials in those exposure pathways and for those radionuclides that could lead to radiation exposure of Members of the Public resulting from plant operations. The REMP implements Section IV.B.2 of Appendix I to 10 CFR Part 50 (CFR, 2008) and thereby supplements the Radiological Effluent Monitoring Program by verifying that measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of effluent measurements and modeling of the environmental exposure pathways. Table 6.2-1 identifies the exposure pathways to be sampled and the types of radiological monitoring and sample media that are included in the REMP. The exposure pathways to be sampled along with the sampling frequency or collection duration and a description of the sampling location requirements are provided in Table 6.2-2 for the existing SSES Units 1 and 2 REMP and Table 6.2-4 for BBNPP. Table 6.2-3 and Table 6.2-5 give specific sampling locations for both the existing REMP (i.e., SSES Units 1 and 2) and for BBNPP. On-site ground water monitoring locations near BBNPP are provided for early detection of liquid leaks from plant systems, structures, and components that contain radioactive liquids. Sample sizes for the different types of environmental media are based on commercial counting laboratory standard collection protocols which insure that Lower Limits of Detection (LLD) requirements as shown on Table 6.2-7 can be routinely achieved. Table 6.2-6 indicates the detection levels for different environmental media which if reached will result in a report to the NRC of high radioactivity detected in the environs near the facility. Table 6.2-8 provides typical sample sizes for various environmental media.

Expected changes to the existing SSES Unit 1 and 2 REMP to reflect the addition of BBNPP and changing monitoring requirements are noted in Sections 6.2.7 and Section 6.2.10.

6.2.1 Pathways Monitored

Environmental exposure pathways to man resulting from BBNPP radiological effluents are described in Section 5.4.1. These are the same environmental pathways that apply to effluents from SSES Units 1 and 2. Radioactive liquid pathways include internal exposure due to the ingestion of aquatic foods (fish) and external exposure due to recreational activities on the shoreline and in the water (boating, and swimming if it occurs). Radioactive gaseous pathways include external exposure due to immersion in airborne effluents and exposure to a deposited material on the ground plane. Internal exposures result from the ingestion of food products grown in areas under the influence of atmospheric releases, and inhalation from airborne effluents. In addition, direct radiation exposure from the facility structures is also considered a potential pathway. The REMP for all three units will be designed to evaluate detectable levels of radioactive materials in environmental media associated with these exposure pathways.

The relationship between exposure pathways and environmental media included in the existing SSES Units sampling program are shown in Table 6.2-1 and are applicable to BBNPP.

The exposure pathways being monitored are listed in Table 6.2-2 and Table 6.2-3 for the existing REMP. These same pathways and monitoring locations will be applied to the BBNPP REMP for sample locations identified in Table 6.2-5. Changes to the program from the existing site REMP are noted in Section 6.2.7.

6.2.2 Land Use Census

A Land Use Census for the BBNPP site area is conducted during the growing season at least once every 12 months as committed to in the Offsite Dose Calculation Manual (ODCM). The Land Use Census is conducted to identify the following within five (5) miles of the plant in each of the sixteen (16) meteorological sectors:

- The nearest milk animal,
- The nearest residence, and
- The nearest garden of greater than 500 ft^2 (50 m^2) producing broad leaf vegetation.

The purpose of the Land Use Census is to identify needed changes in the Radiological Environmental Monitoring Program. This ensures that sampling locations associated with media that have the highest dose potential are included in the REMP as changes in land use patterns occur over time. The implementation of the land use census satisfies the requirement of 10 CFR Part 50, Appendix I (CFR, 2008).

6.2.3 Environmental Monitoring Program Sample Types

6.2.3.1 Direct Radiation Monitoring

Radiation exposure occurs by immersion in radionuclides present in the atmosphere, deposited on the ground, or via direct shine from fixed sources such as an Independent Spent Fuel Storage Installation (ISFSI). Thermoluminescent dosimeters (TLDs) are used to measure ambient gamma radiation levels at many locations surrounding the existing units and will be extended to include locations near the BBNPP Owner Controlled Area boundary for each of the 16 compass sectors. Current locations for SSES Units 1 and 2 are shown in Table 6.2-3 and Figure 6.2-1 through Figure 6.2-3. Table 6.2-4 describes the direct radiation measurement criteria applied to both the pre-operational and operational REMP specific to BBNPP. BBNPP TLD Monitoring locations are identified in Table 6.2-5 and Figure 6.2-7 through Figure 6.2-9. Data collected as part of the existing SSES environmental TLD program will be included as part of the Bell Bend REMP as indicated in Table 6.2-4 and Table 6.2-5.

TLDs are crystalline devices that store energy when they are exposed to radiation. They are processed after their exposure periods, with minimal loss of information, to read the amount of stored energy, or radiation, that they had accumulated during their exposure period in the field. This makes them well suited for quarterly environmental radiation measurements.

During TLD processing, stored energy is released as light, and is measured by a TLD reader. The light intensity is proportional to the radiation dose to which the TLD was exposed.

6.2.3.2 Airborne Activity Monitoring

Radioiodine and particulate samples are currently collected with continuously operating air pumps, particulate filters, and iodine collection charcoal cartridges at six sample collection points (12S1, 12E1, 3S2, 13S6, 6G1, 8G1). Sampling frequencies are shown in Table 6.2-2 for the existing SSES REMP. Filter elements and iodine cartridges are changed out on a weekly basis. Airborne activity monitoring data collected as part of the existing SSES REMP will be included in the assessment of the BBNPP REMP. Additions to the airborne monitoring program that are related directly to the BBNPP REMP are identified in Section 6.2.7. These include four new air samplers near the BBNPP Owner Controlled Area boundary with high ranked D/Q values, as well as one new air sampler near Nescopeck, PA as a nearby community with high D/Q estimate. Table 6.2-4 describes the air sampling criteria applied to both the pre-operational

and operational REMP specific to BBNPP. Table 6.2-5 and Figure 6.2-10 through Figure 6.2-12 provides the locations of air particulate and radioiodine sampling locations for the BBNPP REMP.

6.2.3.3 Waterborne Monitoring

Waterborne and sediment samples for the SSES program are currently collected at 18 locations (6 surface waters, 1 drinking water, and 11 ground waters) as shown in Table 6.2-3 and Figure 6.2-4 through Figure 6.2-6. Sampling frequencies are shown in Table 6.2-2 for the existing SSES REMP. Waterborne activity monitoring data collected as part of SSES Units 1 and 2 REMP will be included as appropriate in the assessment the BBNPP REMP. Additions to the waterborne monitoring program that are related directly to the BBNPP REMP are identified in Section 6.2.7 and Section 6.2.8. These include new surface water sampling locations in the Susquehanna River near the BBNPP liquid effluent discharge point, its cooling water intake location, and at an upstream control site. Eight ground water well sampling locations specific to the Bell Bend plant facilities are also added to BBNPP REMP to monitor for potential liquid leaks to ground water as a result of BBNPP operations. Table 6.2-4 describes the surface and ground water sampling criteria applied to both the pre-operational and operational REMP specific to BBNPP. Table 6.2-4, Table 6.2-5 and Figure 6.2-10 and Figure 6.2-13 provide the locations of additional waterborne sampling locations for the BBNPP REMP.

6.2.3.4 Ingestion Pathway Monitoring

For liquid effluent pathways, fish have been collected as part of the SSES program at off-site locations IND and 2H and from an on-site (SSES) surface water body, Lake Took-A-While (LTAW) as shown in Table 6.2-2, Table 6.2-3, Figure 6.2-4, and Figure 6.2-5.

Food products (fruits / vegetables) are sampled from as many as six locations (11D1, 11D2, 11F2, 12F7, 5S10, 5S11) also shown in Table 6.2-2 and Table 6.2-3, Figure 6.2-4 through Figure 6.2-6. Milk samples have been collected in the recent past, as needed to meet the minimum sample requirements of the SSES program listed in Table 6.2-2, from as many as seven different locations (5E2, 6E3, 10D2, 10D3, 13E3, 10G1, 12B2) depending on dose potential ranking and availability of milk from locations in business at the time.

Drinking water is currently collected from one municipal water supply which draws water from the Susquehanna River (location 12H2, Danville Water company, 26 mi (42 km) downstream.

Environmental ingestion pathway data collected as part of SSES Units 1 and 2 REMP as shown on Table 6.2-2 and Table 6.2-3 will be included in the assessment of the BBNPP REMP. The same ingestion pathway sample sites will be utilized to satisfy the BBNPP ingestion pathway requirements as listed in Table 6.2-4. Table 6.2-5 provides the locations of ingestion sampling locations for the BBNPP REMP.

6.2.4 Sample Size

Table 6.2-8 is an estimate of typical sample sizes for radiological analyses as performed by commercial laboratories. These are approximations and may vary depending on such things as laboratory procedures and methods, available media obtained during sampling, lower limits of detection (LLDs), and split sampling, if applicable.

6.2.5 Radiological Environmental Monitoring Program Reports

Annual REMP reports are submitted to the NRC. The annual REMP reports for BBNPP will include summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period. The reports also include

comparisons with preoperational studies and with operational controls, as appropriate, and with previous environmental surveillance reports, and an assessment of any observed impacts of the plant operation on the environment. The reports also include the results of the land use census for BBNPP. SSES Units 1 and 2 and one for BBNPP, will be submitted annually. The BBNPP Report will include all data collected and shared between operating companies.

6.2.6 Quality Assurance program

The REMP quality assurance program for BBNPP will be conducted in accordance with Regulatory Guide 4.15, Revision 2 (NRC, 2007).

The REMP quality assurance program for SSES Units 1 and 2, prior to BBNPP has been conducted in accordance with Regulatory Guide 4.15, Revision 1 (NRC, 1979a). For site area environmental samples results that are to be shared between all three units, the most limiting QA requirements of either revision of Regulatory Guide 4.15 will be applied, or independent sampling and analyses for SSES Units 1 and 2 and BBNPP will be performed in accordance with their respective versions of the Regulatory Guide 4.15 guidance document.

The QA program also involves the use of "Inter-laboratory Comparison Program" samples as discussed in the ODCM and split samples for all parameters listed in Table 6.2-7 to verify the accuracy of laboratory techniques. The performance of these samples is reported in each AREOR. Because there are no NRC approved laboratory that supply TLDs as part of a comparison program, no TLDs are analyzed as part of the "Inter-laboratory Comparison Program". The nature of TLDs precludes their use in the split sample program.

6.2.7 REMP Modifications for BBNPP

Table 6.2-5 lists the location of the operational BBNPP radiological environmental sampling locations. The BBNPP operational program shares many of the same sampling locations with those used for SSES Units 1 and 2, along with several additional locations specific to BBNPP.

Changes to the existing SSES Unit 1 and 2 REMP may result from the location of BBNPP near the SSES units and the inner ring of on-site sample locations. BBNPP is centered approximately 1 mi (1.6 km) west-southwest from the centerline between SSES Units 1 and 2. The BBNPP creates the potential need to re-locate existing SSES sample sites if interferences during plant construction of BBNPP are identified.

In addition to the relocation of some existing SSES sample sites, the BBNPP REMP includes the addition of several new sampling locations in order to meet the sampling criteria of Table 6.2-4 as related to the specific location of the BBNPP facilities and its effluent release points (the main vent stack located directly next to the BBNPP Containment, and the BBNPP liquid effluent discharge line to the Susquehanna River located down stream from the SSES liquid discharge to the river). The following items identify specific sample additions to the BBNPP REMP:

- The addition of four new air particulate / charcoal filter samplers (AP's) close to the BBNPP Owner Controlled Area boundary in four sectors with high ranked annual average D/Q values. These samplers are designated AP1, AP2, AP3, and AP4 with their locations listed on Table 6.2-5.

- The addition of one new air particulate / charcoal filter sampler (AP) close to a community with high ranked annual average D/Q. This sampler is designated AP5 and is situated near Nescopeck, PA, approximately 3 mi (4.8 km) SW of BBNPP. This

supplements the existing SSES community sampler at location 12E1 in Berwick, PA, 3.6 mi (5.8 km) WSW of BBNPP.

- The addition of 16 new TLD locations, one in each of the 16 compass directions near the BBNPP Owner Controlled Area boundary designated as TL1 through TL16. This provides indications of radiation field near the plant boundary perimeter, including those sectors which border the SSES site and their ISFSI located approximately 0.4 mi (0.7 km) ENE of BBNPP Containment Building.

- The addition of 12 new TLD locations, designated TL17 through TL28, each in a different compass sector. These, along with 4 additional existing SSES TLD locations constitute the outer ring of TLD locations between 4 and 5 miles from the plant, as required by Table 6.2-4.

- The addition of three new surface water (Susquehanna River) sample locations designated WS1, WS2 and WS3 that cover the BBNPP liquid effluent discharge point to the river, the BBNPP cooling water intake, and an upstream control location beyond the influence of both SSES and BBNPP.

- The addition of eight new on-site well water sampling locations to monitor for potential leaks from plant facilities which could impact ground water. Six of these wells (designated WG1 through WG6) are to be located near those plant building containing significant radioactive liquid inventory, as well as sampling two locations (WG7 and WG8) down gradient from the ESWEMS Retention Pond and the Combined Waste Water Retention Pond. Section 6.2.8 describes the basis for this ground water protection program.

6.2.8 Ground Water Protection Program

Prior to fuel load, Bell Bend will develop a written Ground Water Protection Initiative (GPI) Program describing the approach to assure timely detection and effective response to situations involving inadvertent radiological releases to ground water following the guidance provided in NEI 07-07, "Industry Ground Water Protection Initiative – Final Guidance Document." (NEI, 2007) This program will include the following:

- Analysis of site hydrology and geology to determine predominant ground water flow characteristics and gradients and potential pathways for ground water migration from on-site locations to off-site locations including periodic reviews to identify possible changes in site hydrology.

- Performance of a site risk assessment that evaluates all Systems, Structures, or Components (SSCs) that contain or could contain licensed material and for which there is a credible mechanism for the licensed material to reach ground water along with work practices involving licensed material for which there is a credible mechanism for the licensed material to reach ground water.

- Establishment of on-site ground water monitoring to ensure timely detection of inadvertent radiological releases to ground water. Sampling and analysis protocols will be established, including analytical sensitivity requirements, for ground water and soil. The establishment of on-site ground water monitoring requirements is intended to address one of the findings of the NRC Liquid Radioactive Release Lessons Learned Task Force Final Report (NRC, 2006), which concluded there had been no past requirements to monitor ground water for potential leaks from plant systems.

- Establishment of a remediation protocol to prevent migration of licensed material off-site and to minimize decommissioning impacts.
- Establishment of a recordkeeping program to record leaks, spills, and remediation, efforts to meet the requirements of 10CFR 50.75(g).
- Communication with state/local officials, with follow-up notification to the NRC, regarding significant on-site leaks/spills into ground water and on-site or off-site water sample results exceeding the criteria given in Table 6.2-6 (NRC, 1991).

The predominant ground water flow characteristics and gradients around the plant facilities are described in BBNPP FSAR Sections 2.4.12 and 2.4.13. Preliminary ground water monitoring locations have been developed based upon current site hydrological characteristics along with review of buildings containing a considerable volume of radioactive liquid. These preliminary ground water sampling locations are given in Table 6.2-5 and Figure 6.2-13. The placement of these groundwater monitoring locations may change based upon future (post construction) site hydrological studies. The sampling and analysis protocol associated with these ground water monitoring locations will be established after on-site construction is complete.

6.2.9 Preoperational (Units 1 & 2) Site Area Background Radiation

The background sources of radiation at the Susquehanna site were characterized during the preoperational radiological environmental monitoring program (REMP) for Units 1 & 2 from 1972 through 1976 for all environmental sample media, and from 1978 through 1981 for direct radiation monitoring (TLD). Table 6.2-9 gives a summary of background radiation and radioactivity levels found in these media (SSES, 1978). The average pre-operational ambient direct radiation level was measured to be approximately 76 mR/year by indicator (on-site or near-site) TLDs, and 65 mR/year by control (off-site) TLDs. This is consistent with the terrestrial and cosmic radiation dose rate calculated for the Wilkes- Barre area by the EPA, i.e., 82 mrem/year, neglecting any neutron contribution, as cited in the 1981 annual Radiological Environmental Monitoring Program report for SSES (SSES, 1982). The difference between these values is not unexpected and could be explained by differences in the makeup of the terrestrial environment between the SSES site and those used by the EPA in the determination of their value.

The operational REMP at SSES has detected iodine-131 in many surface (river) water samples taken both from locations upstream and downstream of the discharge outfall. Investigations have attributed these concentrations to the discharge of medical wastes into the Susquehanna River through sewage treatment plants upstream of SSES. The downstream iodine-131 concentrations tend to be elevated, relative to the upstream concentrations, due to the intake of the river water into the cooling tower basins by way of the River Water Intake Structure. There, due to the evaporation of water in the basins, the iodine-131 (like other suspended and dissolved materials) is concentrated by a factor of 4 to 5 times that detected in river water entering the basins. (SSES, 2007)

During the pre-operational period at SSES, and to a lesser extent through the operational years, radioactive fallout from atmospheric nuclear weapons tests has been detected in various sample media, as reported in annual Radiological Environmental Operating Reports. Since the last atmospheric nuclear weapons test in 1980, environmental fallout concentrations have steadily decreased, with a small increase noticed after the 1986 Chernobyl event. In 2007, the operational REMP at SSES detected residual fallout cesium-137 in soil and sediment. (SSES, 2007)

Radionuclide concentrations from fallout deposited on or near the SSES site during the pre-operational period are reflected in Table 6.2-9. Such data are similar to that found during this time period by other environmental monitoring programs in the Middle Atlantic states. These data include short-lived radionuclides that were attributed to specific fallout events, and should not be considered typical environmental levels. Several examples of this are iodine-131 in milk and iodine-131, iodine-132, iodine-133, and Mo-99 in vegetation samples. (SSES, 1978)

6.2.10 References

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Table 6.2-1— Effluent Exposure Pathways and Environmental Sampling Media

Effluent Exposure Pathways	REMP Sampling Media
Liquid Effluents:	
Ingestion Fish	Recreational fish species
Ingestion of water	Potable water from the Susquehanna River
Shoreline Exposure (external direct)	Sediments from River shoreline / bottom
Swimming & boating (external direct)	Susquehanna River surface waters
Gaseous Effluents	
Cloud Immersion (external direct)	TLDs
Ground Plane (external direct)	TLDs
Inhalation	Continuous operation air samplers (particulate filter and charcoal cartridge for Iodine)
Ingestion of agricultural products	Broadleaf vegetation and/or food crops
Ingestion of dairy products	Milk

Table 6.2-2— The Existing Radiological Environmental Monitoring Program for SSES Units 1 and 2

(Page 1 of 3)

Exposure Pathway and\or Sample	Number of Representative Samples(a) and Sample Locations	Sampling and Collection Frequency[a]	Type and Frequency of Analysis
Direct Radiation[e]	40 routine monitoring stations with two or more dosimeters or with one instrument for measuring and recording dose rate continuously placed as follows: ♦ an inner ring of at least one station in each of the 16 meteorological sectors, in the general area of the site boundary ♦ an outer ring of at least one station in each of the 16 meteorological sectors, in the 3 to 9 mi (4.8 to 14.4 km) range from the site. ♦ the balance of the stations placed in special interest areas such as population centers, nearby residences, schools, and in one or two areas to serve as control stations.	Once per 3 months	Gamma dose once per 3 months
Airborne Radioiodine & Particulates [i]	Samples from at least 5 locations ♦ 1 sample from close to each of the three site boundary locations (in different sectors) with the highest calculated annual average ground level X/Q. ♦ One sample from the vicinity of the community having one of the highest calculated annual ground level X/Q. ♦ One sample from a control location between 9.4 mi and 18.8 mi (15 and 30 km) and in the least prevalent wind direction of wind blowing from the plant.	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent	♦ Radioiodine canisters: analyze once/week for I-131 ♦ Particulate Samplers: Gross beta radioactivity following filter change[b],composite (by location) for gamma-isotopic analysis[c] once per 3 months (as a minimum)
Waterborne	Surface[f] ♦ 1 sample upstream ♦ 1 sample downstream	Composite sample over one-month period[g]	Gamma isotopic analysis[c] once per bi-weekly period or monthly. Composite for H-3 analysis at least quarterly.
	Ground Water ♦ Samples from one or two sources only if likely to be affected	Quarterly	Gamma isotopic analysis and tritium analysis quarterly

Table 6.2-2— The Existing Radiological Environmental Monitoring Program for SSES Units 1 and 2

(Page 2 of 3)

Exposure Pathway and\or Sample	Number of Representative Samples(a) and Sample Locations	Sampling and Collection Frequency[a]	Type and Frequency of Analysis
Waterborne	Drinking Water ♦ One sample from each of one to three of the nearest water supplies that could be affected by its discharge ♦ Once sample from a control location	Composite samples over a two week period when I-131 analysis is performed. Monthly composite otherwise.	I-131 analysis on each composite when the dose calculated for the consumption of water is greater than 1 mrem per year. Composite for gross beta and gamma-isotopic analyses monthly. Composite for tritium analysis quarterly.
Sediment from Shoreline	1 sample from a downstream area with existing or potential recreational value	Semi-annually	Gamma isotopic analysis semi-annually[c]
Soil	2 Samples each from one of the air sampling locations	Annually	Gamma isotopic analysis semi-annually[c]
Ingestion - Milk	♦ Samples from milking animals in three locations within 5km from the plant having the highest dose potential. If there are none, then one sample from milking animals in each of three areas 3.2 to 5 mi (5 to 8 km) distance where doses are calculated to be greater than 1 mrem per year. ♦ One sample from milking animals at a control location (between 9.4 and 18.8 mi) (15 and 30 km) from the plant preferably in the least prevalent wind direction from the plant)[d]	Semi-monthly when animals are on pasture, monthly otherwise	Gamma isotopic[c] and I-131 analysis of each sample.
Ingestion - Fish and Invertebrates	♦ One sample of each of two recreational important species in the vicinity of the plant discharge area ♦ One sample of the same species in areas not influenced by plant discharge	Sample in season, or semi-annually if they are not seasonal.	Gamma isotopic analysis[c] on edible portions.
Ingestion - Food Products	♦ One sample of each principal class of food products from any area which is irrigated by water in which liquid plant wastes have been discharged. ♦ Samples of three different kinds of broad leaf vegetation grown nearest to each of two different off-site locations of highest predicted annual average ground level D/Q if milking sampling is not performed. ♦ One sample of each of the similar broad leaf vegetation grown between 9.4 and 18.8 mi (15 to 30 km) from the plant, preferably in the least prevalent wind direction from the plant if milk sampling is not performed.	At harvest time	Gamma isotopic analysis[c] of edible portions

Table 6.2-2— The Existing Radiological Environmental Monitoring Program for SSES Units 1 and 2

Exposure Pathway and\or Sample	Number of Representative Samples(a) and Sample Locations	Sampling and Collection Frequency[(a)]	Type and Frequency of Analysis

Notes:

(a) It is recognized that, at times, it may not be possible or practical to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question and may be substituted. Actual locations (distance and directions) from the site will be provided in the Annual Radiological Environmental Operating Report. Highest D/Q locations are based on historical meteorological data for all site licensed reactors.

(b) Particulate sample filters should be analyzed for gross beta 24 hours or more after sampling to allow for radon and thoron daughter decay. If the gross beta activity in air is greater than 10 times a historical yearly mean of control samples, gamma isotopic analysis will be performed on the individual samples.

(c) Gamma isotopic analysis means the identification and quantification of gamma emitting radionuclides that may be attributable to the effluents from the facitlity.

(d) The purpose of these samples is to obtain background information. If it is not practical to establish control locations in accordance with the distance and wind direction criteria, other sites, such as historical control locations which provide valid background data may be substituted.

(e) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purpose of this table, a thermoluminesecent dosimeter may be considered to be one phosphor and two or more phosphors in a packet may be considered as two or more dosimeters. Film badges will not be used to measure direct radiation.

(f) The "upstream sample" should be taken at a distance beyond significant influence of the discharge. The "downstream sample" should taken in an area beyond but near the mixing zone, if possible.

(g) Composite samples should be collected with equipment (or equivalent) which is capable of collecting an aliquot at time intervals which are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining representative samples.

(h) In the event commercial or recreational important species are not available as result of three attempts, then other species may be utilized as available.

(i) In 2007, SSES actually collected air particulate and charcoal cartridge from four indicator locations and two control locations.

Table 6.2-3— Existing Environmental Monitoring Sites for SSES Units 1 and 2

(Page 1 of 5)

SampleSite*	SSESSector*	Distance*		Location
		miles	km	
Airborne (Radioiodine[a] & Air Particulates[b]				
12S1	WSW	0.4	0.6	SSES West Building Laboratory
12E1	WSW	4.7	7.6	Berwick Hospital
3S2	NE	0.5	0.8	SSES Backup Met Tower
13S6	W	0.4	0.6	Former Laydown Area, West of Confer's Lane
6G1	ESE	13.5	21.7	Freeland Substation [c]
8G1	SSE	12.2	19.3	PPL System Facilities Central, Humboldt Industrial Park [c]
Direct Radiation (TLD)				
1D5	N	4	6.4	Shickshinny/Mocanaqua Sewage Treatment Plant [e]
1S2	N	0.2	0.3	Perimeter Fence [e]
2S2	NNE	0.9	1.4	Thomas Road
2S3	NNE	0.2	0.3	Perimeter Fence [e]
2F1	NNE	5.9	9.5	St. Adalberts Cemetery [e]
3E1	NE	4.7	7.6	Residence - Lilly Lakee
3G4	NE	17	27.4	Wilkes Barre Service Center [ce]
3S2	NE	0.5	0.8	SSES Backup Met Tower
3S3	NE	0.9	1.4	ANSP Riverlands Garden
4S3	ENE	0.2	0.3	Post, West of SSES APF [e]
4E2	ENE	4.7	7.6	Ruckles Hill/Pond Hill Roads Intersection [e]
4G1	ENE	14	22.5	Mountaintop - Crestwood Industrial Park [ce]
4S6	ENE	0.7	1.1	Riverlands
5E2	E	4.5	7.2	Farm [e]
5S7	E	0.3	0.5	Perimeter Fence [e]
5S4	E	0.8	1.3	West of Environmental Laboratory
6S4	ESE	0.2	0.3	Perimeter Fence (north) [e]
6A4	ESE	0.6	1.0	Restaurant (U. S. Route 11) [s]
6E1	ESE	4.7	7.6	St. James Church [e]
6S9	ESE	0.2	0.3	Perimeter Fence (south) [e]

Table 6.2-3— Existing Environmental Monitoring Sites for SSES Units 1 and 2

(Page 2 of 5)

SampleSite*	SSESSector*	Distance*		Location
		miles	km	
7S6	SE	0.2	0.3	Perimeter Fence [e]
7E1	SE	4.2	6.8	Harwood Transmission Line Pole #2 [e]
7G1	SE	14	22.5	Hazleton PP&L Complex [ce]
7S7	SE	0.4	0.6	End of Kline's Road
8A3	SSE	0.9	1.4	PPL Wetlands Sign (U. S. Route 11)
8S2	SSE	0.2	0.3	Perimeter Fence [e]
8B2	SSE	1.4	2.3	Residence [s]
8D3	SSE	4	6.4	Residence [e]
9B1	S	1.3	2.1	Transmission Line - east of Route 11
9S2	S	0.2	0.3	Security Fence [e]
9D4	S	3.6	5.8	Country Folk Store [e]
10B3	SSW	1.7	2.7	Castek Inc.[s]
10S1	SSW	0.4	0.6	Post - south of switching station
10S2	SSW	0.2	0.3	Security Fence [e]
10D1	SSW	3	4.8	Farm [e]
11E1	SW	4.7	7.6	Residence [e]
11S7	SW	0.4	0.6	SSES Access Road Gate #50
12D2	WSW	3.7	6.0	Residence
12S3	WSW	0.5	0.8	Confers Lane (east side) at "12 WSW" white sign [e]
12E1	WSW	4.7	7.6	Berwick Hospital [s e]
12G1	WSW	15	24.1	PPL Service Center, Bloomsburg [c e]
12G4	WSW	10	16.1	Residence [e]
12S1	WSW	0.4	0.6	SSES West Building
12S7	WSW	1.1	1.8	Former Kisner Property
13S2	W	0.4	0.6	Perimeter Fence [e]
13S5	W	0.4	0.6	Perimeter Fence
13S6	W	0.4	0.6	Former Laydown Area - West of Confer's Lane
13E4	W	4.1	6.6	Farm [e]
14D1	WNW	3.6	5.8	Moore's Hill/Mingle Inn Roads Intersection
14S5	WNW	0.5	0.8	Beach Grove Rd./Confer's Lane Intersection [e]
15A3	NW	0.9	1.4	Residence [s]

Table 6.2-3— Existing Environmental Monitoring Sites for SSES Units 1 and 2

(Page 3 of 5)

SampleSite*	SSESSector*	Distance*		Location
		miles	km	
15F1	NW	5.4	8.7	Farm [e]
15S5	NW	0.4	0.6	Perimeter Fence [e]
16A2	NNW	0.8	1.3	Residence [s]
16S1	NNW	0.3	0.5	Perimeter Fence (east)
16S2	NNW	0.3	0.5	Perimeter Fence (west) [e]
16F1	NNW	7.8	12.6	Residence [e]
Surface Water				
2S7	NNE	0.1	0.2	Cooling Tower Blowdown Line
5S9	E	0.8	1.3	Environmental Lab Boat Ramp [c g]
6S6	ESE	0.8	1.3	River Water Intake Line [c]
6S5	ESE	0.9	1.4	SSES Susquehanna River below discharge line
LTAW	NE	0.7	1.1	Lake Took-A-While (on site)
4S7	ENE	0.4	0.6	Peach Stand Pond
Drinking Water				
12H2	WSW	26	41.8	Danville Water Co. (treated) [d]
Ground Water				
1S3	N	0.1	0.2	MW-1, N of RW Bldg.
2S2	NNE	0.9	1.4	SSES Energy Information Center
4S4	ENE	0.5	0.8	SSES Learning Center
4S8	ENE	0.1	0.2	MW-2, SE of E. Diesel Bldg.
4S9	ENE	0.3	0.5	MW-3, NW corner of APF parking lot
6S10	ESE	0.4	0.6	SSES Sewage Treatment Plant
7S10	SE	0.3	0.5	MW-5, N of S-2 Pond
8S4	SSE	0.1	0.2	MW-4, E of U-2 CST
11S2	SW	0.4	0.6	Tower's Club

Table 6.2-3— Existing Environmental Monitoring Sites for SSES Units 1 and 2

(Page 4 of 5)

SampleSite*	SSESSector*	Distance*		Location
		miles	km	
12F3	WSW	5.2	8.4	Berwick Water Company [c]
13S7	W	0.2	0.3	MW-6, Laydown Area W of cooling towers
Sediment from Shoreline				
2B	NNE	1.6	2.6	Gould Island [c h]
7B	SE	1.2	1.9	Bell Bend [h]
12F	WSW	6.9	11.1	Old Berwick Test Track
Milk**				
5E2	E	4.5	7.2	Farm
6E3	ESE	4.2	6.8	Farm
10D2	SSW	3.1	5.0	Farm
10D3	SSW	3.5	5.6	Farm
13E3	W	5	8.0	Farm
10G1	SSW	14	22.5	Farm [c]
12B2	WSW	1.7	2.7	Farm
Fish				
IND	ESE	0.9-1.4	1.4-2.3	Outfall Area [f]
2H	NNE	30	48.3	Near Falls, PA [c f]
LTAW	NE-ESE	0.7	1.1	On-site lake
Food Products				
11D1	SW	3.3	5.3	Farm (vegetable)
11D2	SW	3.5	5.6	Farm - Route 93 Field (vegetable)
11F2	SW	5.5	8.9	Field (vegetable)
12F7	WSW	8.3	13.4	Farm (vegetable)
5S10	E	0.7	1.1	PPL Riverlands Parcel 30 (vegetable) [c]
5S11	E	1.1	1.8	PPL East Side Parcel 25 (vegetable) [c]

Table 6.2-3— Existing Environmental Monitoring Sites for SSES Units 1 and 2

(Page 5 of 5)

SampleSite*	SSESSector*	Distance*		Location
		miles	km	

Notes:

* The location of samples and equipment were designed using the guidance in the Branch Technical Position to NRC Reg. Guide 4.8, Rev. 1, Nov, 1979, Reg. Guide 4.8 1975, and ORP/SID 72-2 Environmental Radioactivity Surveillance Guide. Therefore, the airborne sampler locations were based upon χ/Q and/or D/Q.

** All potential dairy farms are listed. Samples from 3 indicator locations (dairy farms within 5 miles) are collected based on highest dose potential. If a milk sample is unavailable for more than two sampling periods from one or more of the locations, a vegetation sample shall be substituted until a suitable milk location is evaluated. Such an occurrence will be documented in the REMP annual report.

a The charcoal sampler cartridges used in the airborne radioiodine-sampling program are designed and tested by the manufacturer to assure a high quality of radioiodine capture. A certificate from the manufacturer is supplied and retained with each batch of cartridges certifying the percent reduction of radioiodine versus air flow rate through the cartridge.

b Gross beta activity calculations will be performed in accordance with the procedures of the designated REMP analysis laboratory.

c Control sample location.

d Two-week composite if calculated doses due to consumption of water exceed one millirem per year. In these cases, I-131 analyses will be performed.

e Emergency Plan TLD located at this location in addition to REMP TLD.

f The sample collector will determine the species based upon availability, which may vary seasonally and yearly.

g Alternate sample location for 6S6 to be collected and analyzed according to the required frequencies.

h Station code is omitted because no permanent location exist; sample are taken based on availability.

s Special Interest Area sample location

SSES Sample Sites Naming Convention:

All distances from the SSES to monitoring locations are measured from the standby gas treatment vent. The location codes are based on both distance and direction from the SSES. The letters in the location codes indicate if the monitoring locations are on site (within the site boundary) or, if they are not on site, the approximate distances of the locations from the SSES as described below:

S - on site
A - <1 mile
B - 1-2 miles
C - 2-3 miles
D - 3-4 miles
E - 4-5 miles
F - 5-10 miles
G - 10-20 miles
H - >20 miles

The numbers preceding the letters in the location codes provide the directions of the monitoring locations from the SSES by indicating the sectors in which they are located. A total of 16 sectors (numbered 1 through 16) equally divide an imaginary circle on a map of the SSES and its vicinity, with the SSES at the center of the circle. The middle of sector 1 is directed due north (N). Moving clockwise from sector 1, the sector immediately adjacent to sector 1 is sector 2, the middle of which is directed due north , northeast (NNE). Continuing to move clockwise, the sector numbers increase to 16, which is the north, northwest sector. The numbers following the letters in the location codes are used to differentiate sampling locations found in the same sectors at approximately the same distances from the SSES.

Table 6.2-4— BBNPP Radiological Environmental Monitoring Program

(Page 1 of 3)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. Direct Radiation[b]	40 routine monitoring stations either with two or more dosimeters or with one instrument for measuring and recording dose rate continuously, placed as follows: An inner ring of stations, one in each meteorological sector in the general area of the Owner Controlled Area Boundary. An outer ring of stations, one in each meteorological sector in the 4 to 5 mi (6 to 8 km) range from the site. The remaining stations to be placed in special interest areas such as population centers, nearby residences, schools, and in one area to serve as a control station.	Quarterly	Gamma Dose Quarterly
2. Airborne Radioiodine and Particulates	Samples from 5 locations[c]: 3 samples from close to the 3 Owner Controlled Area Boundary locations, in different sectors, of high calculated annual average ground-level D/Q. 1 sample from the vicinity of a community having a high calculated annual average ground-level D/Q. 1 sample from a control location, as for example 9 to 19 mi (15 to 30 km) distance and in a non-prevalent wind direction.	Continuous sampler operation with sample collection weekly - or more frequently if required by dust loading.	Radioiodine Canister: I-131 analysis weekly Particulate Sampler: Gross beta radioactivity analysis following filter change[d] Gamma isotopic analysis[e] of composite (by location) quarterly.
3. Waterborne a. Surface	1 sample at intake area 1 sample at discharge area	Composite Sample[f] over 1month period	Gamma Isotopic Analysis[e] monthly. Composite for tritium analysis quarterly
b. Sediment from shoreline	1 sample from downstream area with existing or potential recreational value	Semiannually	Gamma Isotopic Analysis[e] semiannually
c. Ground Water	1 sample from 8 on-site locations near plant facilities with liquid radioactive inventory that could influence ground water.	Quarterly	Gamma Isotopic and tritium analysis quarterly

Table 6.2-4— BBNPP Radiological Environmental Monitoring Program

(Page 2 of 3)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
4. Ingestion a. Milk(i)	Samples from milking animals in three locations within 3 mi (5 km) distance having the highest dose potential. If there are none, then one sample from milking animals in each of three areas between 3 to 8 mi (5 to 8 km) distances where doses are calculated to be greater than 1 mrem/yr.[j] One sample from milking animals at a control location 9 to 19 mi (15 to 30 km) distance and in a non-prevalent wind direction.	Semimonthly when animals are on pasture; monthly at other times	Gamma Isotopic Analysis [e] and I-131 analysis semimonthly when animals are on pasture; monthly at other times.
b. Fish	One sample from each of two recreationally important species in vicinity of plant discharge area. 3 samples of same species in areas not influenced by plant discharge.	Sample in season, or semiannually if they are not seasonal	Gamma Isotopic Analysis[e] on edible portions.
c. Food Products	Samples of 3 different kinds of broad leaf vegetation[g] grown near the Site Boundary at 2 different locations of high predicted annual average ground level D/Q[h](i). 1 sample of each of the similar-broad leaf vegetation grown 9 to 19 mi (15-30 km) distant in a non-prevalent wind direction.	Monthly during growing season	Gamma Isotopic[e] and 1-131 analysis .

Table 6.2-4— BBNPP Radiological Environmental Monitoring Program

(Page 3 of 3)

Exposure Pathway and/or Sample	Number of Representative Samples and Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
(a) Deviations are permitted from the required sampling schedule if specimens are unobtainable due to circumstances such as hazardous conditions, seasonal unavailability and malfunction of automatic sampling equipment. If specimens are unobtainable due to sampling equipment malfunction, effort shall be made to complete corrective action prior to the end of the next sampling period. (b) One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a thermoluminescent dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.) (c) Optimal air sampling locations are based not only on D/Q but on factors such as population in the area, year round access to the site, and availability of power. (d) Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, Gamma Isotopic Analysis shall be performed on the individual samples. (e) Gamma Isotopic Analysis is an analytical method of measurement used for the identification and quantification of gamma emitting radionuclides which may be attributable to the effluents from the facility. (f) A composite sample is one in which the quantity (aliquot) of liquid is proportional to the quantity of flowing liquid and in which the method of sampling employed results in a specimen that is representative of the liquid flow. In this program, COMPOSITE SAMPLE aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure a representative sample is obtained. (g) If broad leaf vegetation is unavailable, other vegetation will be sampled. Attention shall be paid to including samples of tuberous and root food products. (h) Broad leaf vegetation sampling of at least three different kinds of vegetation may be performed at the site boundary in each of two different direction sectors with high predicted D/Qs in lieu of the garden census. (i) Broad leaf vegetation sampling is performed in lieu of milk sampling if the required minimum number of milk locations is not available in the site area. Milk samples need be collected and analyzed if the milk is commercially available in quantities greater than 130 liters (34.3.gal) per year. (j) The dose shall be calculated for the maximum organ and age group, using the methodology and parameters in the ODCM.			

Table 6.2-5— Operational BBNPP Radiological Environmental Monitoring Program Locations[d]

(Page 1 of 4)

SampleSite	Required for Minimum REMP[i]	BBNPP Sector	BBNPP Distance[a]		Location
			miles	km	
Airborne (Radioiodine & Air Particulates)					
12S1	No	E	0.6	1.0	SSES West Building Laboratory
12E1	Yes	WSW	3.6	5.8	Berwick Hospital
3S2	No	ENE	1.6	2.5	SSES Backup Met Tower
13S6	No	ENE	0.7	1.1	Former Laydown Area, West of Confer's Lane
6G1	Yes	ESE	14.3	22.9	Freeland Substation[j]
8G1	No	SSE	12.3	19.8	PPL System Facilities Central, Humboldt Industrial Park[j]
AP1	Yes	NE	0.3	0.5	BBNPP Owner Controlled Area boundary
AP2	Yes	SSE	0.2	0.3	BBNPP Owner Controlled Area boundary
AP3	Yes	SSW	0.2	0.3	BBNPP Owner Controlled Area boundary
AP4	No	NNE	0.3	0.4	BBNPP Owner Controlled Area boundary
AP5	No	SW	3.0	4.8	Nescopeck, PA
Direct Radiation (TLD)[c]					
TL1	Yes	N	0.3	0.4	BBNPP Owner Controlled Area boundary[e]
TL2	Yes	NNE	0.3	0.4	BBNPP Owner Controlled Area boundary[e]
TL3	Yes	NE	0.3	0.5	BBNPP Owner Controlled Area boundary[e]
TL4	Yes	ENE	0.3	0.5	BBNPP Owner Controlled Area boundary[e]
TL5	Yes	E	0.3	0.5	BBNPP Owner Controlled Area boundary[e]
TL6	Yes	ESE	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL7	Yes	SE	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL8	Yes	SSE	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL9	Yes	S	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL10	Yes	SSW	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL11	Yes	SW	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL12	Yes	WSW	0.2	0.3	BBNPP Owner Controlled Area boundary[e]
TL13	Yes	W	0.1	0.2	BBNPP Owner Controlled Area boundary[e]
TL14	Yes	WNW	0.1	0.2	BBNPP Owner Controlled Area boundary[e]
TL15	Yes	NW	0.2	0.2	BBNPP Owner Controlled Area boundary[e]
TL16	Yes	NNW	0.2	0.4	BBNPP Owner Controlled Area boundary[e]
TL17	Yes	N	4.0	6.4	Shickshinny Valley Road [f]
TL18	Yes	NE	4.6	7.3	Pond Hill Mountain Road [f]
TL19	Yes	ENE	4.9	7.9	Ruckle Hill Road and Cemetary Road [f]
TL20	Yes	E	4.9	7.9	St. Mary's Road and Church Road [f]
TL21	Yes	SSE	4.4	7.0	Berwick Hazleton Highway [f]
TL22	Yes	S	4.6	7.3	Overlook Road [f]
TL23	Yes	SSW	5.0	8.0	Black Creek Road at bridge [f]
TL24	Yes	WSW	4.9	7.9	Intersection Orange Street and West Fron Street [f]
TL25	Yes	W	4.4	7.2	Dairy Road and Valley Road [f]
TL26	Yes	WNW	4.6	7.3	Shickshinny Valley Road at power line right-of-way [f]

Table 6.2-5— Operational BBNPP Radiological Environmental Monitoring Program Locations[d]
(Page 2 of 4)

SampleSite	Required for Minimum REMP[i]	BBNPP Sector	BBNPP Distance[a]		Location
			miles	km	
TL27	Yes	NW	3.8	6.1	Intersection S. Mountain Rd and Shickshinny Valley Rd [f]
TL28	Yes	NNW	3.9	6.3	Shickshinny Valley Road [f]
1D5	Yes	NNE	4.4	7.2	Shickshinny/Mocanaqua Sewage Treatment Plant
2S2	No	NE	1.9	3.0	Thomas Road
2F1	No	NNE	6.8	10.9	St. Adalberts Cemetery
3E1	No	NE	5.6	9.1	Residence - Lilly Lake
3G4	Yes	NE	18.5	29.8	Wilkes Barre Service Center[j]
3S3	No	ENE	2.1	3.4	ANSP Riverlands Garden (Abandoned)
4E2	No	ENE	5.8	9.3	Ruckles Hill/Pond Hill Roads Intersection
4G1	Yes	ENE	15.0	24.2	Mountaintop - Crestwood Industrial Park [j]
4S6	No	ENE	1.9	3.0	Riverlands[g]
5E2	No	E	5.4	8.8	Farm
5S4	No	ENE	1.9	3.0	West of Environmental Laboratory
6A4	No	E	1.6	2.5	Restaurant (U.S. Route 11)
6E1	Yes	E	5.6	9.0	St. James Church [g]
7E1	Yes	ESE	4.7	7.5	Harwood Transmission Line Pole #2 [f]
7G1	Yes	SE	13.9	22.3	Hazleton PP&L Complex[j]
8A3	No	ESE	1.7	2.7	PPL Wetlands Sign (U. S. Route 11)
8B2	Yes	ESE	2.1	3.4	Residence [g]
8D3	Yes	SE	4.0	6.4	Residence [f]
9B1	No	SE	1.6	2.5	Transmission Line - east of Route 11 [g]
9S2	No	E	1.1	1.8	SSES Security Fence [h]
9D4	No	SSE	3.3	5.4	Country Folk Store
10B3	Yes	S	1.4	2.3	Castek Inc.[g]
10S1	No	E	0.9	1.4	Post - south of switching station
10S2	No	E	0.9	1.4	SSES Security Fence
10D1	Yes	SSW	2.3	3.8	Farm[g]
11E1	Yes	SW	3.7	5.9	Residence [f]
11S7	No	E	0.7	1.1	SSES Access Road Gate #50 [h]
12D2	Yes	WSW	2.7	4.3	Residence [g]
12S3	No	ENE	0.7	1.1	Confers Lane (east side) at -12 WSW-white sign
12E1	No	WSW	3.6	5.8	Berwick Hospital
12G1	No	WSW	14.0	22.5	PPL Service Center, Bloomsburg[j]
12G4	Yes	WSW	9.4	15.1	Residence [g]
12S1	Yes	E	0.6	1.0	SSES West Building [h]
13S2	No	ENE	0.7	1.2	SSES Perimeter Fence [h]
13S5	Yes	ENE	0.7	1.2	SSES Perimeter Fence [h]
13S6	Yes	ENE	0.7	1.1	Former Laydown Area - West of Confer's Lane [h]
13E4	No	W	3.0	4.8	Farm
14D1	No	WNW	2.8	4.5	Moore's Hill/Mingle Inn Roads Intersection
14S5	Yes	ENE	0.8	1.3	Beach Grove Rd./Confer's Lane Intersection [h]
15A3	Yes	NNE	0.9	1.4	Residence [g]
15F1	No	NNW	5.1	8.2	Farm
15S5	Yes	ENE	1.0	1.5	SSES Perimeter Fence [h]

Table 6.2-5— Operational BBNPP Radiological Environmental Monitoring Program Locations[d]
(Page 3 of 4)

SampleSite	Required for Minimum REMP[i]	BBNPP Sector	BBNPP Distance[a]		Location
			miles	km	
16A2	Yes	NE	1.3	2.1	Residence [g]
16S1	Yes	NE	1.2	1.9	SSES Perimeter Fence (east) [h]
16S2	Yes	ENE	1.1	1.8	SSES Perimeter Fence (west) [h]
16F1	No	NNW	8.4	13.5	Residence
Surface Water					
5S9	No	E	1.9	3.0	Environmental Lab Boat Ramp (alternate for 6S6)
6S6	No	E	1.9	3.0	SSES River Water Intake Line[j]
6S5	No	E	2.0	3.2	SSES Susquehanna River below discharge line
WS1	Yes	E	2.0	3.2	Surface Water Below BBNPP Discharge
WS2	Yes	E	1.9	3.0	BBNPP River Water Intake Line
WS3	No	NE	2.4	3.9	Gould Island Surface Water [j]
Drinking Water					
12H2	Yes	WSW	25.4	40.9	Danville Water Co. (treated)
Ground Water					
WG1	Yes	NE	0.07	0.11	Ground Water Sampling Well N of Demin Water Tanks
WG2	Yes	SE	0.06	0.10	Ground Water Sampling Well NW of 3URB (UHS)
WG3	Yes	S	0.09	0.14	Ground Water Sampling Well S of Radwaste Processing Bldg
WG4	Yes	SW	0.08	0.13	Ground Water Sampling Well SW of Radwaste Processing Bldg
WG5	Yes	W	0.06	0.10	Ground Water Sampling Well WSW of SFP Bldg
WG6	Yes	N	0.06	0.10	Ground Water Sampling Well E of 1URB & 2URB
WG7	Yes	ESE	0.4	0.6	Ground Water Sampling Well S of ESWEMS Retention Pond
WG8	Yes	ESE	0.5	0.8	Ground Water Sampling Well S of the Combined Waste Water Retention Pond
Sediment from Shoreline					
2B	No	NE	2.3	3.8	Gould Island[j]
7B	No	ESE	2.0	3.2	Bell Bend
12F	Yes	WSW	5.7	9.1	Old Berwick Test Track
Milk					
5E2	Note b	E	5.5	8.8	Farm
6E3	Note b	ESE	5.1	8.2	Farm
10D2	Note b	S	2.7	4.3	Farm
10D3	Note b	S	2.9	4.7	Farm
13E3	Note b	W	4.0	6.4	Farm
10G1	Note b	SSW	12.2	19.6	Farm[j]
12B2	Note b	SW	0.9	1.5	Farm

Table 6.2-5— Operational BBNPP Radiological Environmental Monitoring Program Locations[(d)]

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SampleSite	Required for Minimum REMP[i]	BBNPP Sector	BBNPP Distance[a]		Location
			miles	km	
Fish					
IND	Yes	E	2.0	3.2	Outfall Area
2H	Yes	NNE	30.5	49.0	Near Falls, PA [j]
Food Products					
11D1	No	SSW	2.6	4.1	Farm (vegetable)
11D2	No	SW	3.1	5.0	Farm - Route 93 Field (vegetable)
11F2	No	SW	4.9	7.9	Farm (vegetable)
12F7	Yes	WSW	7.2	11.6	Farm (vegetable)
5S10	Yes	ENE	1.8	2.9	PPL Riverlands Parcel 30 (vegetable)
5S11	Yes	E	2.1	3.4	PPL East Side Parcel 25 (vegetable)[j]

Notes:

a. Distance and direction are from the BBNPP Rx vent

b. All available dairy farms are listed. Samples from 3 indicator locations (dairy farms within 5 miles) are collected based on highest dose potential. If a milk sample is unavailable for more than two sampling periods from one or more of the locations, a vegetation sample will be substituted until a suitable milk location is evaluated. Such an occurrence will be documented in the REMP annual report.

c. For the SSES TLD program locations which are not included as a formal part of the BBNPP REMP, will be included in the BBNPP REMP reporting when data from these locations is available.

Key: # The sequential number of the sampling station for BBNPP.

TL# Direct Radiation, TLD Station specific to BBNPP

AP# Airborne Sampling Station specific to BBNPP

WS# Surface Water Sampling Station specific to BBNPP

WG# Ground Water Sampling Station specific to BBNPP

All other sampling stations are SSES stations used by the BBNPP program (See Table 6.2-3).

d. The same requirements as indicated for the operational program also apply to the BBNPP pre-operational period for 2 years prior to plant first criticality.

e. TLD placements per Table 6.2-4 for "inner ring" near to Owner Controlled Area boundary.

f. TLD placements per Table 6.2-4 for "outer ring".

g. TLD placements per Table 6.2-4 for special interest locations.

h. Additional TLDs in areas potentially impacted by SSES ISFSI.

i. Minimum BBNPP program requirements indicated as "Yes" refer to the requirements of . Other locations indicated as "No" are also included in the BBNPP REMP as non-required locations.

j. Control sample location.

Table 6.2-6— The Reporting Levels for Radioactivity Concentrations in Environmental Samples[a]

Analysis	Water (pCi/L)	Airborne Particulate of Gases (pCi/m^3)	Fish (pCi/kg, wet)	Milk (pCi/L)	Food Products (pCi/kg, wet)
H-3[b]	2×10^4				
Mn-54	1×10^3		3×10^4		
Fe-59	4×10^2		1×10^4		
Co-58	1×10^3		3×10^4		
Co-60	3×10^2		1×10^4		
Zn-65	3×10^2		2×10^4		
Zr-Nb-95	4×10^2				
I-131	2 [c]	0.9		3	1×10^2
Cs-134	30	10	1×10^3	60	1×10^3
Cs-137	50	20	2×10^3	70	2×10^3
Ba-La-140	2×10^2			3×10^2	

(a) The limits are for samples that have only one radionuclide detected. When a sample contains more than one radionuclide, the total level of radioactivity limit is:

$$\frac{\text{Concentration (1)}}{\text{Reporting Level (1)}} + \frac{\text{Concentration (2)}}{\text{Reporting Level (2)}} + \ldots \leq 1.0$$

(b) For drinking water samples. The value given is the 40 CFR Part 141 value. If no drinking water pathway exists, a value of 30,000 pCi/L may be used.
(c) If no drinking water pathway exists, a value of 20 pCi/L may be used.

Table 6.2-7— Lower Limits of Detection (LLD) for Environmental Media

Measurement Type	Analysis Parameter	Required LLD	Measurement Units
Direct Radiation	Gamma Dose	Note: (a)	mR
Airborne Activity-Radioiodine Cannister	I-131	0.07	pCi/m^3
Airborne Radioactivity - Particulate Filter	Gross Beta	0.01	pCi/m^3
	Cs-134	0.05	pCi/m^3
	Cs-137	0.06	
Waterborne Activity - Surface Water- Drinking Water- Ground Water	Gross Beta	4	pCi/L
	H-3[(b)]	2000	
	Mn-54	15	
	Fe-59	30	
	Co-58	15	
	Co-60	15	
	Zn-65	30	
	Zr-95	30	
	Nb-95	15	
	I-131[(c)]	1	
	Cs-134	15	
	Cs-137	18	
	Ba-140	60	
	La-140	15	
Shoreline Sediment	Cs-134	150	pCi/kg-dry
	Cs-137	180	
Ingestible Activity-Fish and Invertebrates	Mn-54	130	pCi/kg-wet
	Fe-59	260	
	Co-58	130	
	Co-60	130	
	Zn-65	260	
	Cs-134	130	
	Cs-137	150	
Ingestible Activity-Milk[(d)]	I-131	1	pCi/L
	Cs-134	15	
	Cs-137	18	
	Ba-140	60	
	La-140	15	
Food Products	I-131	60	pCi/kg-wet
	Cs-134	60	
	Cs-137	80	

Notes:
(a) LLD for TLDs used for environmental measurements will be in accordance with the recommendations of Regulatory Guide 4.13.
(b) If no drinking water pathway exists, a value of 3000 pCi/L may be used.
(c) If no drinking water pathway exists, a value of 15 pCi/L may be used.

Table 6.2-8— Typical Sample Sizes for Environmental Media

Media	Approximate Weight/Volume [Note: (c)]
Air Particulate	100 m^3 (3,531 ft^3)
Algae	2 kg (4.4 lb)
Aquatic (Special)	2 kg (4.4 lb)
Aquatic Vegetation	2 kg (4.4 lb)
Benthic Organisms	2 kg (4.4 lb)
Biological Organisms	2 kg (4.4 lb)
Cattle Feed	1 - 2 kg (2.2-4.4 lb)
Charcoal Filter	100 m^3 (3,531 ft^3)
Fish	2 kg (4.4 lb)
Food Crop	0.5 - 1 kg (1.1-2.2 lb)
Fresh Water	1 quart (0.95 liters) [Note: (a)]
Green Leafy Vegetation	0.5 - 1 kg (1.1-2.2 lb)
Ground Water	1 gallon (3.8 liters) [Note: (a)]
Mixed Vegetation	0.5 - 1 kg (1.1-2.2 lb)
Sediment	Cores as Required [Note: (b)]

Notes:

(a) One gallon (3.8 liters) is needed for gamma spectrometry/tritium analysis ONLY. An additional gallon (3.8 liters) is required for a gross beta analysis.

(b) Six core sections having a minimum depth of 6 in (15.2 cm) by means of a 2 in (5.1 cm) ID coring device.

(c) The sample sizes in this table should only be used as representative of approximate sizes needed. These may vary significantly depending on the LLD of the isotopes being measured.

Table 6.2-9— Background Radiation and Radioactivity Concentrations Measured Pre-Operationally* at SSES

(Page 1 of 3)

Sample Type	Nuclide or Analysis Type	Average Concentration***	Concentration Range***
TLDs (Indicators)	Exposure	18.9 mR/std qtr	18.5 - 19.2 mR/std qtr
TLDs (Controls)	Exposure	16.3 mR/std qtr	15.0 - 17.9 mR/std qtr
Air Iodine	I-131	0.004 ± 0.0048 pCi/m^3	<.0013 - 0.015 pCi/m^3
Air Particulates	Alpha	0.0014 ± 0.0013 pCi/m^3	<0.0001 - 0.0052 pCi/m^3
	Beta	0.074 ± 0.180 pCi/m^3	0.0045 - 0.535 pCi/m^3
	Be-7**	0.151 ± 0.133 pCi/m^3	0.089 - 0.360 pCi/m^3
	Co-58**	-	0.0002 pCi/m^3
	Zr-95**	0.012 ± 0.032 pCi/m^3	0.0005 - 0.068 pCi/m^3
	Nb-95**	0.043 ± 0.155 pCi/m^3	0.0005 - 0.340 pCi/m^3
	Ru-103**	0.0042 ± 0.0072 pCi/m^3	0.0011 - 0.017 pCi/m^3
	Ru-106**	0.021 ± 0.042 pCi/m^3	0.0023 - 0.071 pCi/m^3
	Sb-125**	0.0066 ± 0.016 pCi/m^3	0.0006 - 0.027 pCi/m^3
	Cs-137**	0.0028 ± 0.0068 pCi/m^3	0.0003 - 0.016 pCi/m^3
	Ce-141**	0.0042 ± 0.0044 pCi/m^3	0.0015 - 0.0089 pCi/m^3
	Ce-144**	0.041 ± 0.110 pCi/m^3	0.0014 - 0.220 pCi/m^3
	Ra-226**	0.013 ± 0.050 pCi/m^3	0.0021 - 0.079 pCi/m^3
	Th-232**	0.0037 ± 0.0030 pCi/m^3	0.0015 - 0.0069 pCi/m^3
Precipitation	H-3	-	212 pCi/l
	Sr-89	-	48 pCi/l
	Sr-90	-	<7.5 pCi/l
Well Water	H-3	370 ± 310 pCi/l	<80 - 1100 pCi/l
	Alpha-Total	1.6 ± 0.5 pCi/l	<1.5 - 3.2 pCi/l
	Beta-Total	3.3 ± 3.2 pCi/l	<3.0 - 20 pCi/l
	Sr-90	0.6 ± 0.4 pCi/l	<0.1 - <1.0 pCi/l
	K-40	0.9 ± 0.5 pCi/l	0.5 - 1.6 pCi/l
	K-40**	-	24 pCi/l
Milk	Sr-89	33 ± 68 pCi/l	<6.1 - 83 pCi/l
	Sr-90	4.9 ± 4.2 pCi/l	<0.5 - 9.0 pCi/l
	I-131	210 ± 368 pCi/l	1.0 - 370 pCi/l
	I-131**	61 ± 32 pCi/l	49 - 79 pCi/l
	K-40**	1490 ± 631 pCi/l	1100 - 2600 pCi/l
	Cs-137**	3.8 ± 5.4 pCi/l	2.0 - 11 pCi/l
	Ba/La-140**	31 ± 29 pCi/l	22 - 48 pCi/l
Food Products	Sr-90	-	<10 - <100 pCi/kg
	K-40**	2900 ± 4200 pCi/kg	920 - 7600 pCi/kg
	Cs-137**	-	240 pCi/kg
	Ra-226**	9.7 ± 15 pCi/kg	4.4 - 15 pCi/kg
Squirrels	K-40**	3029 ± 2477 pCi/kg(wet)	420 - 4500 pCi/kg(wet)
	Cs-137**	4994 ± 10,959 pCi/kg(wet)	830 - 20,000 pCi/kg(wet)
Other Game	Sr-90	-	8.0 pCi/kg
	K-40**	3250 ± 1291 pCi/kg(wet)	2300 - 4800 pCi/kg(wet)
	Cs-137**	141 ± 305 pCi/kg(wet)	8.0 - 480 pCi/kg(wet)
	Be-7**	136 pCi/kg(wet)	136 - 136 pCi/kg(wet)

Table 6.2-9— Background Radiation and Radioactivity Concentrations Measured Pre-Operationally* at SSES

(Page 2 of 3)

Sample Type	Nuclide or Analysis Type	Average Concentration***	Concentration Range***
Vegetation	Sr-89	1125 ± 710 pCi/kg	715 - 1340 pCi/kg
	Sr-90	-	136 pCi/kg
Vegetation (wet weight)	K-40**	5.4 ± 5.5 pCi/g(wet)	3.5 - 7.4 pCi/g(wet)
	Cs-137**	0.4 ± 0.4 pCi/g(wet)	0.3 - 0.6 pCi/g(wet)
Vegetation (dry weight)	K-40**	25 ± 101 pCi/g(dry)	2.0 - 230 pCi/g(dry)
	Be-7**	2.1 ± 3.9 pCi/g(dry)	0.08 - 7.2 pCi/g(dry)
	Cs-137**	1.7 ± 8.2 pCi/g(dry)	0.06 - 17 pCi/g(dry)
	ZrNb-95**	0.26 ± 0.56 pCi/g(dry)	0.07 - 1.0 pCi/g(dry)
	Ra-226**	0.8 ± 0.1 pCi/g(dry)	0.8 - 0.9 pCi/g(dry)
	Th-232**	0.8 ± 0.3 pCi/g(dry)	0.7 - 1.0 pCi/g(dry)
Vegetation (Chinese fallout samples)	Be-7**	2.3 ± 3.3 pCi/g(dry)	0.8 - 4.6 pCi/g(dry)
	K-40**	6.1 ± 1.3 pCi/g(dry)	5.5 - 7.0 pCi/g(dry)
	Nb-95**	4.4 ± 8.3 pCi/g(dry)	0.3 - 10 pCi/g(dry)
	Zr-95**	7.0 ± 7.2 pCi/g(dry)	1.0 - 10 pCi/g(dry)
	Mo-99**	5.3 ± 11 pCi/g(dry)	0.2 - 11 pCi/g(dry)
	Ru-103**	1.9 ± 2.6 pCi/g(dry)	0.6 - 3.4 pCi/g(dry)
	I-131**	8.4 ± 1.1 pCi/g(dry)	8.0 - 9.0 pCi/g(dry)
	I-132**	2.6 ± 4.3 pCi/g(dry)	0.2 - 4.2 pCi/g(dry)
	I-133**	0.9 ± 1.1 pCi/g(dry)	0.3 - 1.3 pCi/g(dry)
	Te-132**	4.5 ± 3.7 pCi/g(dry)	2.4 - 5.8 pCi/g(dry)
	Ba-140**	9.8 ± 13 pCi/g(dry)	2.2 - 14 pCi/g(dry)
	La-140**	11 ± 16 pCi/g(dry)	2.2 - 16 pCi/g(dry)
	BaLa-140**	1.7 pCi/g(dry)	1.7 - 1.7 pCi/g(dry)
	Ce-141**	5.0 ± 6.0 pCi/g(dry)	1.1 - 7.7 pCi/g(dry)
	Ce-144**	1.7 pCi/g(dry)	1.7 - 1.7 pCi/g(dry)
	Np-239**	6.9 pCi/g(dry)	6.9 - 6.9 pCi/g(dry)
Surface Water	H-3	300 ± 317 pCi/l	<80 - 1200 pCi/l
	Alpha-soluble	1.9 ± 1.5 pCi/l	<1.5 - 3.4 pCi/l
	Alpha-insoluble	1.5 ± 0.2 pCi/l	<1.5 - 2.5 pCi/l
	Beta-soluble	3.2 ± 1.2 pCi/l	<3.0 - 7.3 pCi/l
	Beta-insoluble	3.1 ± 1.4 pCi/l	<3.0 - 9.0 pCi/l
	Beta-total	3.8 ± 3.8 pCi/l	<3.0 - 18 pCi/l
	Sr-90	0.7 ± 0.4 pCi/l	<0.5 - <1.0 pCi/l
	K-40	1.2 ± 0.8 pCi/l	0.3 - 1.8 pCi/l
	K-40**	18 ± 35 pCi/l	3 - 42 pCi/l
	Ra-226**	-	1.5 pCi/l

Table 6.2-9— Background Radiation and Radioactivity Concentrations Measured Pre-Operationally* at SSES

(Page 3 of 3)

Sample Type	Nuclide or Analysis Type	Average Concentration***	Concentration Range***
Sediment	Alpha	30 ± 38 pCi/g(dry)	7.0 - 48 pCi/g(dry)
	Be-7**	0.89 ± 0.88 pCi/g(dry)	0.58 - 1.2 pCi/g(dry)
	K-40**	11 ± 9 pCi/g(dry)	0.88 - 18 pCi/g(dry)
	Zr-95**	0.18 ± 0.35 pCi/g(dry)	0.05 - 0.3 pCi/g(dry)
	Nb-95**	0.22 ± 0.76 pCi/g(dry)	0.03 - 0.9 pCi/g(dry)
	Ru-106**	-	0.6 pCi/g(dry)
	Sb-125**	0.05 ± 0.09 pCi/g(dry)	0.07 - 0.1 pCi/g(dry)
	Cs-137**	0.23 ± 0.22 pCi/g(dry)	0.03 - 0.38 pCi/g(dry)
	Ce-141**	-	0.2 pCi/g(dry)
	Ce-144**	0.5 ± 0.8 pCi/g(dry)	0.2 - 0.8 pCi/g(dry)
	Ra-226**	0.78 ± 0.56 pCi/g(dry)	0.08 - 1.1 pCi/g(dry)
	Th-232**	0.83 ± 0.68 pCi/g(dry)	0.08 - 1.3 pCi/g(dry)
Fish	Sr-90	7.8 ± 10.9 pCi/kg(wet)	3.0 - 13 pCi/kg(wet)
	K-40**	2.4 ± 4.4 pCi/g(wet)	0.02 - 5.9 pCi/g(wet)
	Cs-137**	0.004 ± 0.189 pCi/g(wet)	0.001 - 0.61 pCi/g(wet)
Aquatic Invertebrates	K-40**	-	5.3 pCi/g(dry)
	Cs-137**	-	0.25 pCi/g(dry)

* TLD exposure rates are based on a pre-operational period of 1978 to 1981. All other radionuclide concentration data are based on a pre-operational period of 1972 to 1976.

** Indicates concentration was determined by gamma spectrometry.

*** The minimum detectable level (MDL) was used as the detection limit during this period, and is defined as the level at which the result exceeds background by three times the standard deviation of that background. For gamma spectrometry results, only the results exceeding the MDL are included in the "Average Concentration" and "Concentration Range" of the table. For all other results, "less than MDL" values were reported in the table as being equal to the MDL value. Where MDL values are used in the table they are preceded by a "less than" symbol. For all non-gamma spectrometry results, the MDL value was used in the calculation of average values, which are reported with the associated error of two standard deviations . Each such average is reported with an associated error of two standard deviations. When only a single analysis was performed, the result of that analysis appears as the "Concentration Range" value.

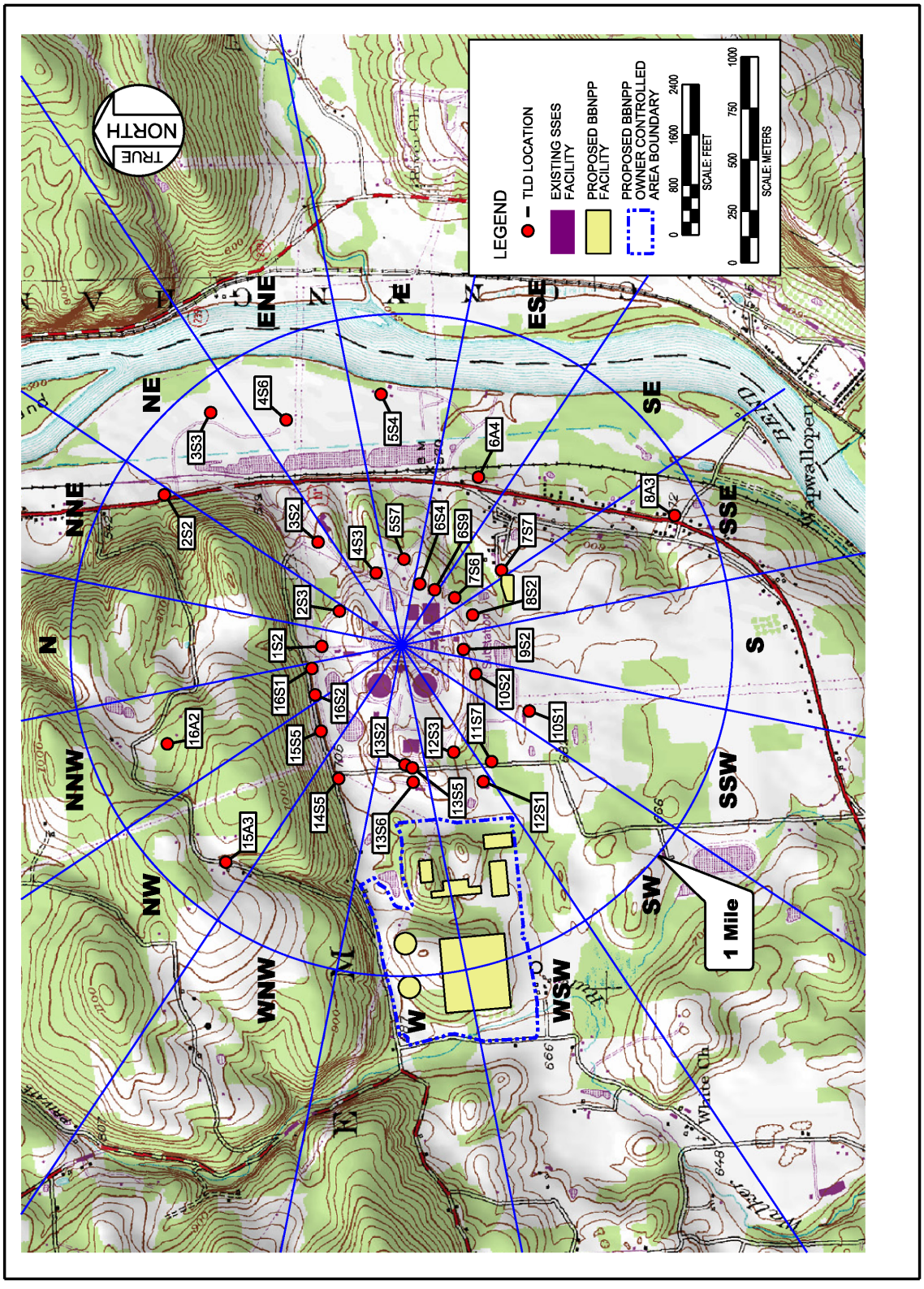


Figure 6.2-1— Existing SSES TLD Monitoring Locations within One Mile of Plant

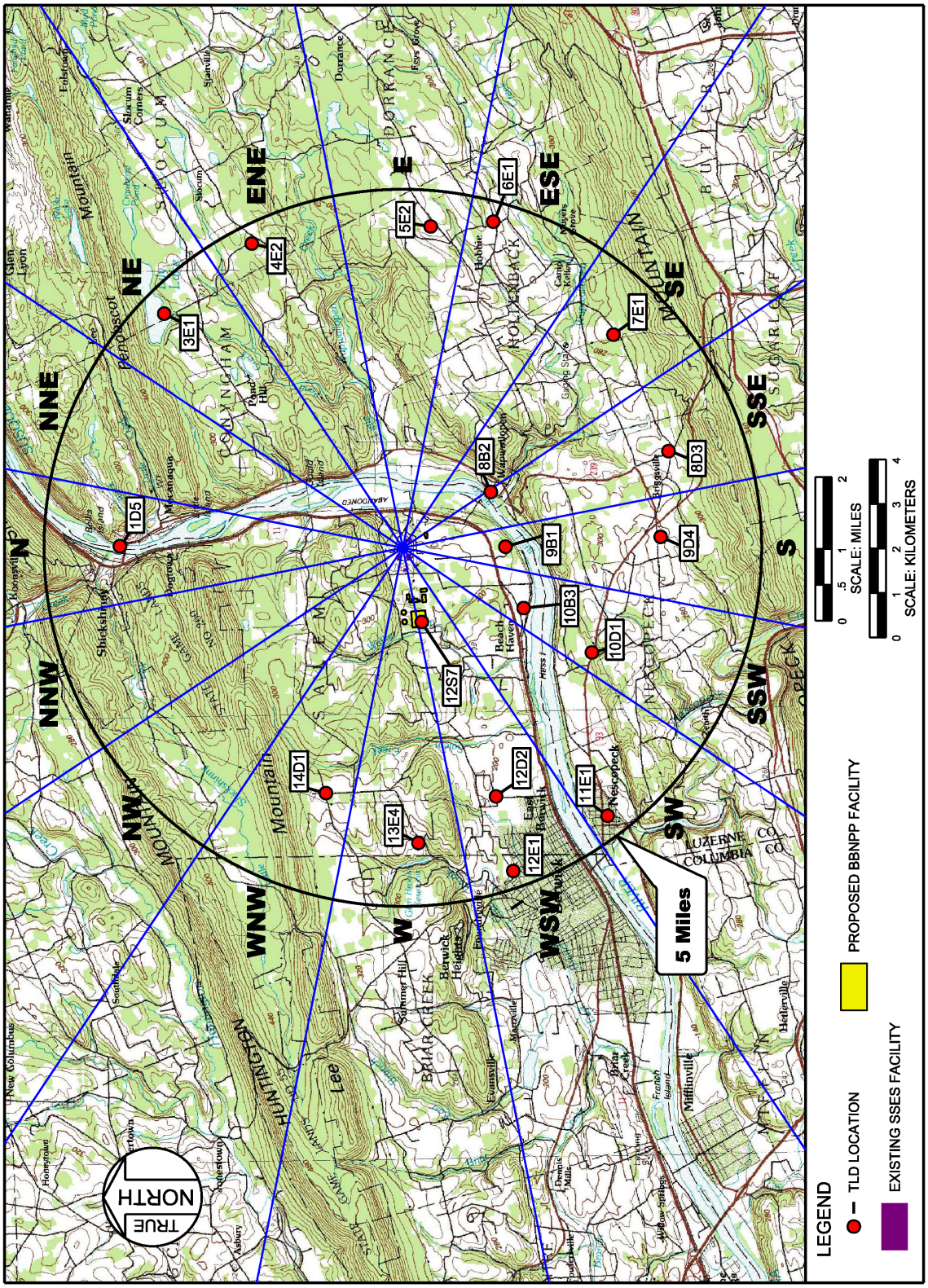
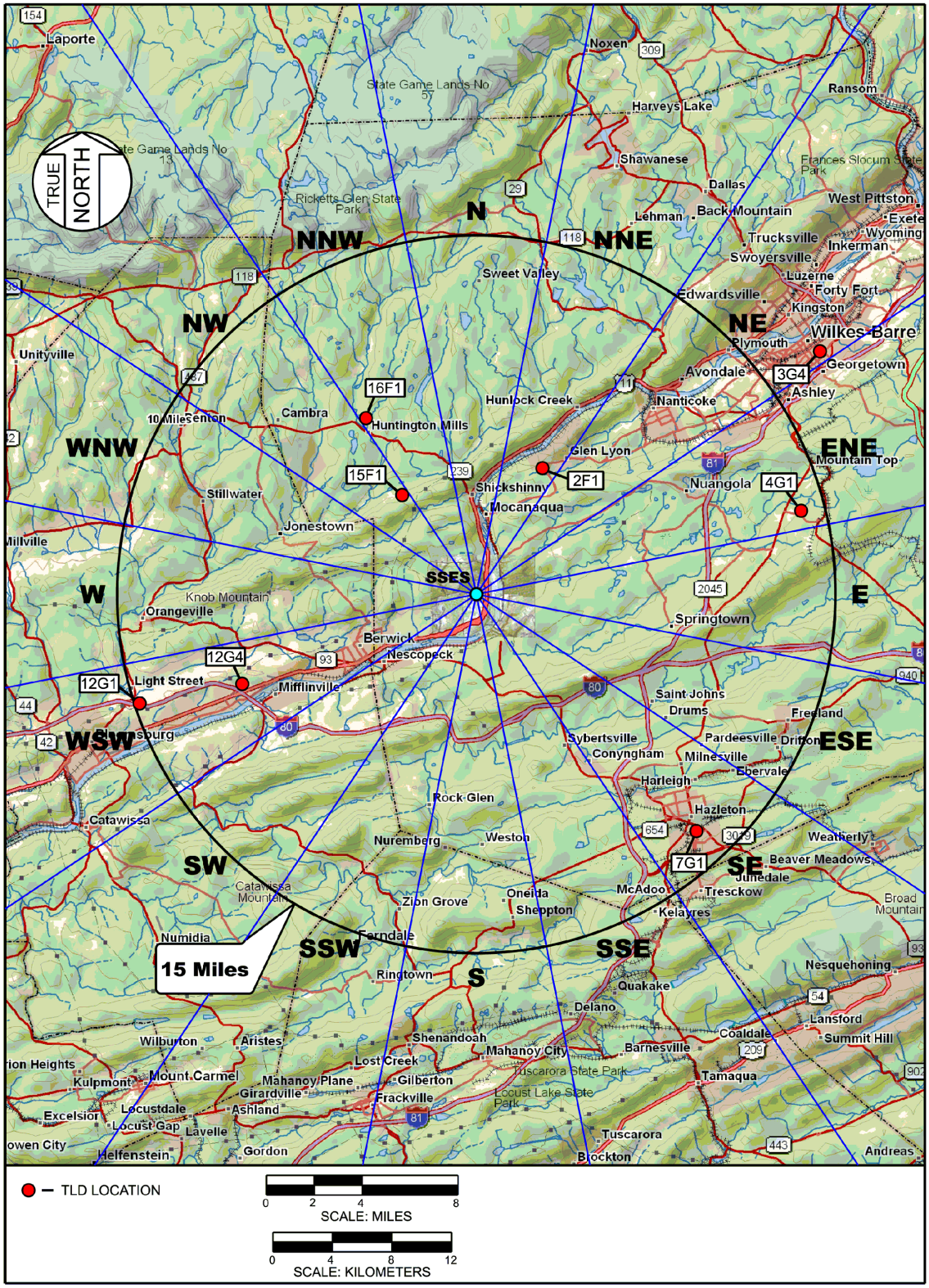


Figure 6.2-2— Existing SSES TLD Monitoring Locations that are One to Five Miles from the Plant

Figure 6.2-3— Existing SSES TLD Monitoring Locations that are Greater than Five Miles from the Plant



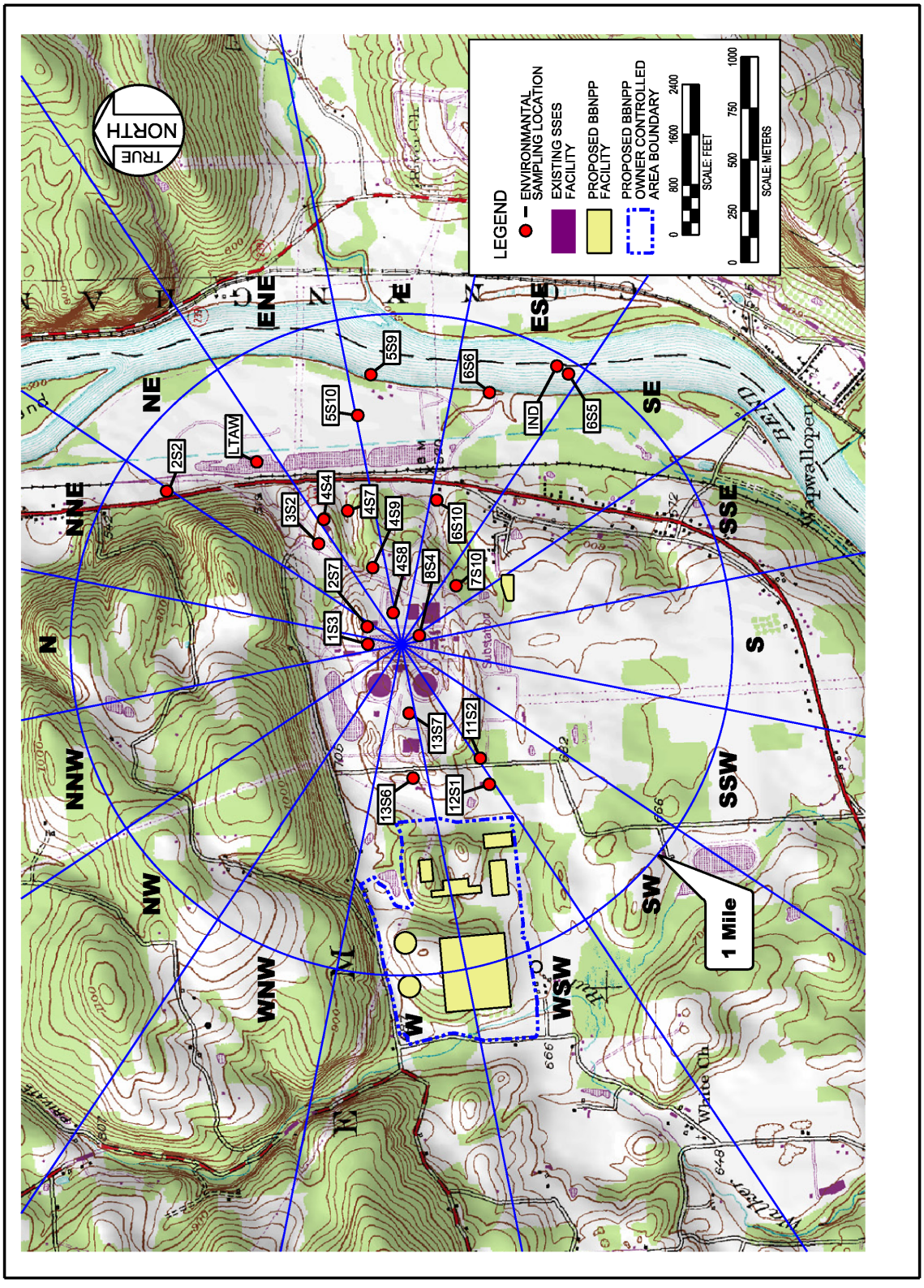


Figure 6.2-4— Existing SSES Environmental Sampling Locations that are within One Mile of the Plant