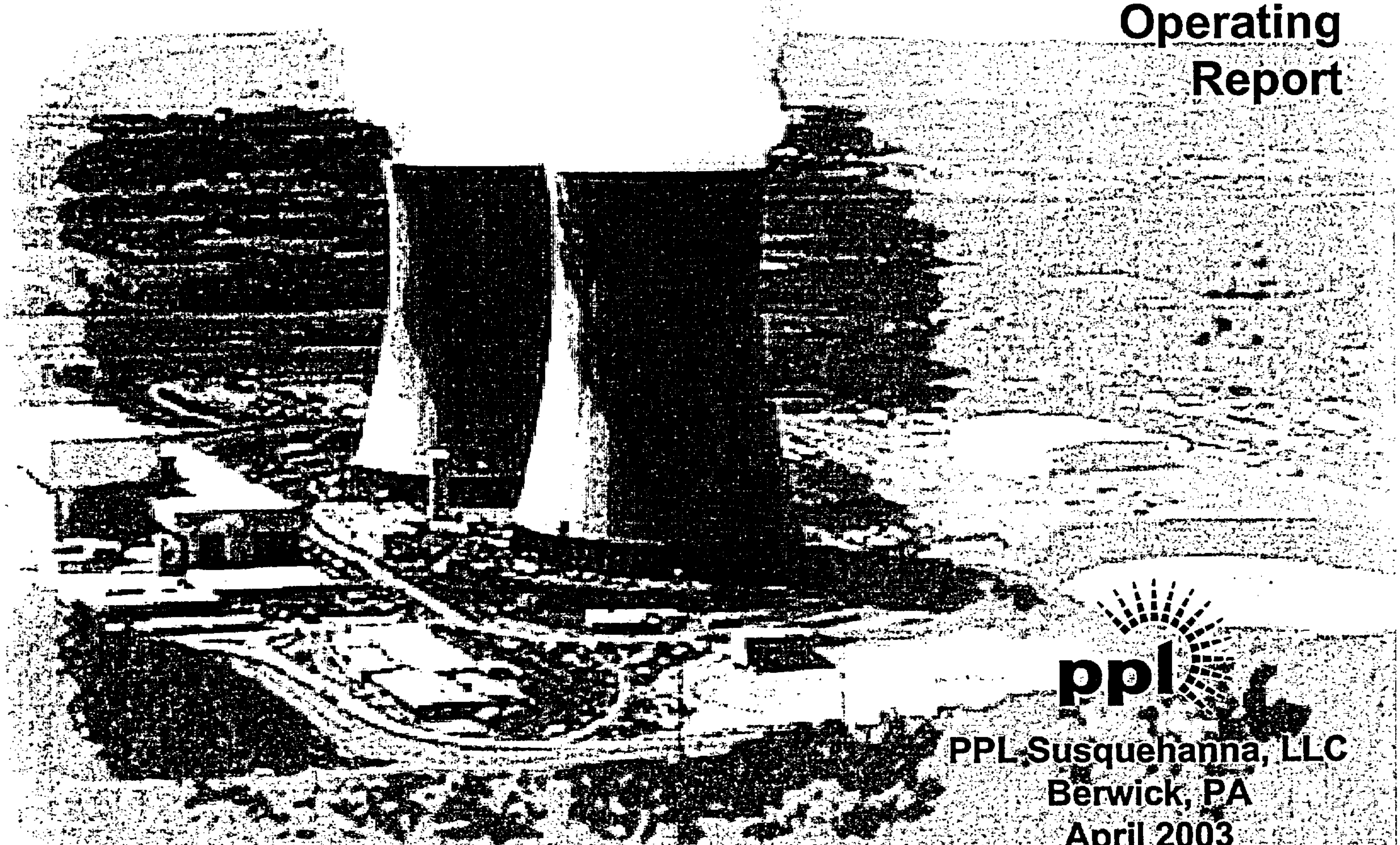
Susquehanna Steam Electric Station

Units 1 & 2

2002 ANNUAL REPORT

Annual
Radiological
Environmental
Operating
Report



PPL Susquehanna, LLC
Berwick, PA
April 2003

SUSQUEHANNA STEAM ELECTRIC STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

REPORT PERIOD: 12/26/01 – 1/31/03

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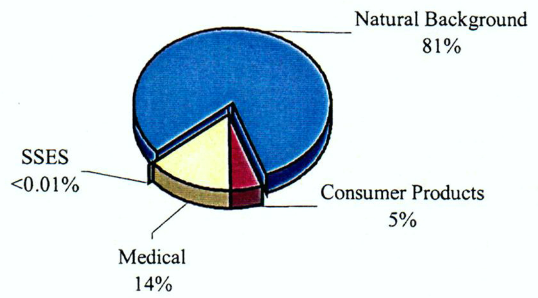
SUMMARY AND CONCLUSIONS

Radiological Dose Impact

The extent of the 2002 Radiological Environmental Monitoring Program (REMP) sampling met or exceeded the requirements of the Susquehanna Steam Electric Station (SSES) Technical Requirements. The types of analyses that were performed on these samples for the identification and quantification of radioactivity also met or exceeded the SSES Technical Requirements. The result of this effort was the verification of the SSES Effluent Monitoring Program data that indicate that the SSES operation has no deleterious effect on the health and safety of the public or the environment.

The amounts of the radionuclides detected in environmental samples during 2002 were very small, as in past years. Based on the radionuclide levels measured by the REMP, the maximum whole body dose or maximum organ dose to a member of the public from SSES operation is estimated to be less than one-tenth of one percent of the per unit dose guidelines established by the Nuclear Regulatory Commission (NRC) as stated in 10 CFR 50, Appendix I. The maximum hypothetical off-site whole body and organ doses from radionuclides detected by the REMP and attributable to the SSES operations were calculated to be approximately 0.0014 mrem/year.
By contrast, potassium-40, a very long-

COMPARISON OF PERCENT OF AVERAGE ANNUAL PUBLIC EFFECTIVE DOSE-EQUIVALENT FROM OTHER SOURCES WITH THAT FROM THE SSES



Sources for the values provided, with the exception of Susquehanna, are the following from NCRP Report #93 (1987): Tables 2.4 (Natural Background), 5.1 (Consumer Products), and 7.4 (Medical).

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lived, naturally occurring radionuclide found in the human body, is estimated to deliver an average annual dose to the blood forming organs of individuals in the United States of about 27 millirem. While a small portion of the background dose from natural radiation sources, the potassium-40 dose is still more than 19,300 times the estimated maximum whole body and organ doses to a hypothetical member of the public from ingestion of radionuclides attributable to the SSES.

The maximum direct radiation dose from SSES operation to a member of the public was determined to be approximately 0.030 millirem/year. The total whole body dose from both ingested radionuclides and direct radiation is negligible compared to the public's exposure from natural background radiation, medical irradiation, and radiation from consumer products of more than 300 millirem/year effective dose-equivalent.

Identified Radionuclides and Their Dose Contributions

Naturally Occurring Radionuclides

In 2002, the SSES REMP reported the naturally occurring radionuclides beryllium-7, potassium-40, radium-226, and thorium-228 in the environment at levels exceeding the minimum detectable concentrations (MDCs) for their respective gamma spectroscopic analyses. Beryllium-7 was identified in air and sediment. Potassium-40 was observed in fish, sediment, surface water, ground water, milk, soil, and fruit and vegetables. Thorium-228 and radium-226 were reported in surface water, sediment, and soil. These radionuclides are not related to the operation of the SSES. Doses from the presence of these radionuclides were not included in the estimate of the dose from SSES attributable radionuclides.

Man-made Radionuclides

Although not all due to SSES operation, the following man-made radionuclides were reported at levels in the environment in excess of the MDCs for their respective analyses: tritium, iodine-131, cesium-137, and Mn-54. These radionuclides, with the exception of cesium-137 and Mn-54, were identified in surface and drinking water. Tritium was measured above minimum detectable concentrations in some surface water, drinking water, and ground water analyzed. Iodine-131 was identified in surface water and drinking water. Cesium-137 was observed in sediment and soil. Mn-54 was identified in a fourth quarter air particulate composite

Tritium and Mn-54 were the only man-made radionuclides attributed to SSES operation. Tritium in media other than Susquehanna River water downstream of the SSES was attributed to both natural production by the interaction of cosmic radiation with the upper atmosphere and previous atmospheric testing of nuclear weapons. The presence of cesium-137 was attributed to non-SSES sources. Cesium-137 was considered to be present only as residual fallout from atmospheric weapons testing. Iodine-131 was found in the aquatic pathway. Evidence indicates that it is there only as the result of the discharge of medical waste to the Susquehanna or Lackawanna Rivers through sewage treatment plants upstream of the SSES.

All of the man-made radionuclides mentioned above were not analyzed for in all media. For example, no analyses were performed in an effort to determine iodine-131 levels in ground water. When selecting the types of analyses that would be performed, consideration was given to the potential importance of different radionuclides in the pathways to man and the regulatory analysis requirements for various environmental media.

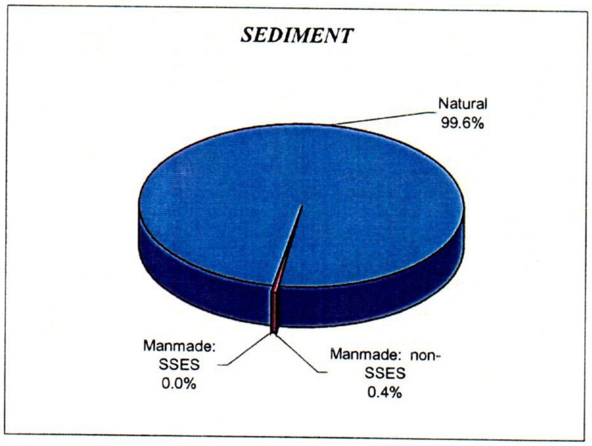
Relative Radionuclide Activity Levels in Selected Media

Some media monitored in the environment are significant for the numbers of gamma-emitting radionuclides routinely measured at levels exceeding analysis MDCs. Sediment in the aquatic pathway and soil in the terrestrial pathway are two such media.

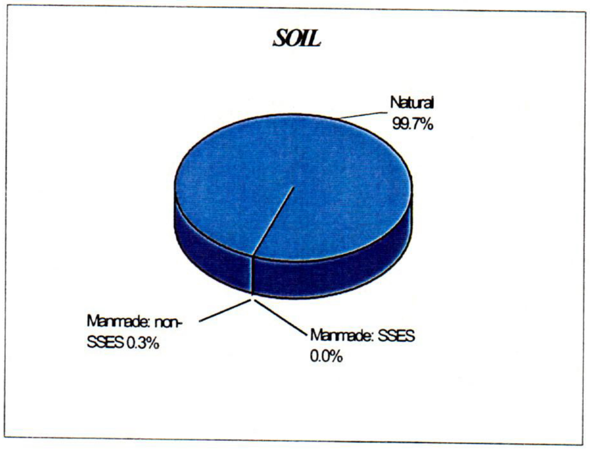
The following pie graphs show the relative activity contributions for the types of gamma-emitting radionuclides reported at levels above the analysis MDCs in sediment and soil at indicator locations during 2002.

AQUATIC PATHWAY

PERCENT TOTAL GAMMA ACTIVITY



TERRESTRIAL PATHWAY PERCENT TOTAL GAMMA ACTIVITY



Naturally occurring radionuclides account for 99.6% and 99.7 % of the gamma-emitting activity in sediment and in soil, respectively, in 2002. Man-made radionuclides of non-SSES origin

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account for most of the rest of the gamma-emitting activity in sediment and all of the rest in soil during 2002. Generally, the activity for naturally occurring radionuclides reported in sediment and soil dwarfs the activity of the man-made radionuclides also reported, especially those originating from the SSES.

Radionuclides Contributing to Dose from SSES Operation

Of the four man-made radionuclides reported in the environment by the SSES REMP, tritium and Mn-54 are the only radionuclides attributable to SSES operation.

The dose to members of the public attributable to the identified Tritium was 0.0014 mrem.

The dose to members of the public attributable to the identified Mn-54 was 9.10E-5 mrem.

Mn-54 was included in the dose calculation because it was identified in a fourth quarter air particulate composite sample.

The presumed exposure pathway to the public from this radionuclide is inhalation. The calculated inhalation pathway is based on 100% occupancy at the air sample location.

Tritium was included in the dose calculation because it was identified in the REMP samples of water being discharged to the river. The concentration of tritium in the water and the volume of water discharged were used to determine the amount of tritium released. The presumed exposure pathways to the public from this radionuclide were drinking water taken from the Susquehanna River at Danville, PA, and eating fish caught near the SSES discharge to the river. This assumption is based on the fact that tritium does not emit gamma radiation and the beta radiation emitted by tritium is not sufficiently penetrating to reach an individual on the shore.

INTRODUCTION

Radiological Environmental Monitoring

The enclosed information is consistent with the objectives outlined in the SSES ODCM and in 10CFR50 Appendix I, Section IV.B.2, IV.B.3 and IV.C.

In addition to the steps taken to control and to monitor radioactive effluents from the SSES, the SSES Technical Specifications also require a program for the radiological monitoring of the environment in the vicinity of the SSES. The objectives of the SSES REMP are as follows:

- Fulfillment of SSES Technical Requirements' radiological environmental surveillance obligations,
- Verification of no detrimental effects on public health and safety and the environment from SSES operations,
- Assessment of dose impacts to the public, if any,
- Verification of adequate SSES radiological effluent controls, and
- Identification, measurement, trending, and evaluation of radionuclides and their concentrations in critical environmental pathways near the SSES.

PPL has maintained a Radiological Environmental Monitoring Program (REMP) in the vicinity of the existing Susquehanna Steam Electric Station

Units 1 and 2 since April, 1972, prior to construction of both units and ten years prior to the initial operation of Unit 1 in September, 1982. The SSES is located on an approximately 1500 acre tract along the Susquehanna River, five miles northeast of Berwick in Salem Township, Luzerne County, Pennsylvania. The area around the site is primarily rural, consisting predominately of forest and agricultural lands. (More specific information on the demography, hydrology, meteorology, and land use characteristics of the area in the vicinity of the SSES can be found in the Environmental Report (14), the Final Safety Analysis Report (15), and the Final Environmental Statement (16) for the SSES.) The purpose of the preoperational REMP (April, 1972 to September, 1982) was to establish a baseline for radioactivity in the local environment that could be compared with the radioactivity levels observed in various environmental media throughout the operational lifetime of the SSES. This comparison facilitates assessments of the radiological impact of the SSES operation.

The SSES REMP was designed on the basis of the NRC's Radiological Assessment Branch Technical Position on radiological environmental monitoring, as described in Revision 1, November 1979.(17) However, the

REMP conducted by PPL for the SSES exceeds the monitoring suggested by the NRC's branch technical position, as well as the SSES Technical Requirements in terms of the number of monitoring locations, the frequency of certain monitoring, the types of analyses required for the samples, and the achievable analysis sensitivities.

Potential Exposure Pathways

The three pathways through which radioactive material may reach the public from nuclear power plants are the atmospheric, terrestrial, and aquatic pathways. (Figure 1 depicts these pathways for the intake of radioactive materials.) Comprehensive radiological environmental monitoring must sample media from all of these pathways.

Mechanisms by which people may be exposed to radioactivity and radiation in the environment vary with the pathway. Three mechanisms by which a member of the public has the potential to be exposed to radioactivity or radiation from nuclear power plants such as the SSES are as follows:

- inhalation (breathing)
- ingestion (eating and drinking), and
- whole body irradiation directly from a plant or from immersion in the radioactive effluents.

REMP Scope

During the operational period of the SSES, it has been important to establish two different categories of monitoring locations, called control and indicator locations, to further assist in assessing the impact of the station operation.

Control locations have been situated at sites where it is considered unlikely that radiation or radioactive material from normal station operation would be detected. Indicator locations are sited where it is expected that radiation and radioactive material that might originate from the station would be most readily detectable.

Control locations for the atmospheric and terrestrial pathways are more than 10 miles from the station. Preferably, the controls also are in directions from the station less likely to be exposed to wind blowing from the station than are the indicator locations. Control locations for the aquatic pathway, the Susquehanna River, are upstream of the station's discharge to the river.

Indicator locations are selected primarily on the basis of proximity to the station, although factors such as meteorology, topography, and sampling practicality also are considered. Indicator locations for the atmospheric and terrestrial pathways are typically less than 10 miles from the station. Most often, they are within 5 miles of the station. Indicator locations in the Susquehanna River are downstream of the station's discharge. Monitoring results from indicator locations are compared with results from control locations. These comparisons are made to discern any differences in the levels and/or types of radioactive material and/or radiation that might exist between indicators and controls and that could be attributable to the station.

In 2002, the SSES REMP collected more than 730 samples at more than 40 locations and performed more than

1,400 analyses. In addition, the REMP monitors ambient radiation levels using thermoluminescent dosimeters (TLDs) at 84 indicator and control locations, making as many as 336 radiation level measurements each year. The media monitored and analyses performed are summarized in the table below. Figures 2 through 7 display the REMP TLDs and sampling locations in the vicinity of the SSES. Appendix C provides directions, distances, and a brief description of each of the locations in Figures 2 through 7.

Regulatory agencies also participate in monitoring the SSES environment and also oversee PPL's monitoring efforts. The State of Pennsylvania's Department of Environmental Protection (PADEP) monitors air for radioactive particulates and radioactive iodine. It also monitors milk, fruits and vegetables, surface and drinking water, fish, river sediments, and ambient radiation levels. PADEP makes this data available to the NRC. Inspectors from the NRC regularly visit both PPL's Corporate Office and the SSES to review procedures and records, conduct personnel interviews, observe activities first-hand, and generally examine the programs supporting the effluent and environmental monitoring for the SSES.

REMP Monitoring Sensitivity

The sensitivity of the SSES REMP was demonstrated in 1986, following the problem with the Chernobyl reactor in the former Soviet Union. When the Chernobyl incident occurred, the SSES REMP was able to detect a relatively small increase in the level of gross beta activity in air samples at both control and indicator locations, as well as the presence of some specific radioactive materials that are not normally observed.

Detection of radiation and radioactive material from the SSES in the environment is complicated by the presence of naturally occurring radiation and radioactive materials from both terrestrial and cosmic sources. Man-made radiation and radioactive material from non-SSES sources, such as nuclear fallout from previous nuclear weapons tests and medical wastes, also can make identification of SSES radiation and radioactive material difficult. Together, this radiation and radioactive material present background levels from which an attempt is made to distinguish

SSES REMP	
Type of Monitoring	**Media Monitored**
Gross Alpha Activity	Drinking Water
Gross Beta Activity	All Waters, except Ground Water, and Air Particulates
Gamma-Emitting Radionuclide Activities	All Media
Tritium Activity	All Waters
Iodine-131 Activity	Surface Water, Drinking Water, Air & Milk
Exposure Rates (by TLD)	Ambient Radiation Levels

relatively small contributions from the SSES. This effort is further complicated by the natural variations that typically occur from both monitoring location to location and with time at the same locations.

The naturally occurring radionuclides potassium-40, beryllium-7, radium-226, and thorium-228 are routinely observed in certain environmental media. Potassium-40 has been observed in all monitored media and is routinely seen at readily detectable levels in such media as milk, meat, fish, and fruits and vegetables. Seasonal variations in beryllium-7 in air samples are regularly observed. Man-made radionuclides, such as cesium-137 and strontium-90 left over from nuclear weapons testing are often observed as well. In addition, the radionuclide tritium, produced by both cosmic radiation interactions in the upper atmosphere as well as man-made (nuclear weapons), is another radionuclide typically observed.

Radioactivity levels in environmental media are usually so low that their measurements, even with state-of-the-art measurement methods, typically have significant degrees of uncertainty associated with them.(18) As a result, expressions are often used when referring to these measurements that convey information about the levels being measured relative to the measurement sensitivities. Terms such as "minimum detectable concentration" (MDC) are used for this purpose. The formulas used to calculate MDCs may be found in Appendix E.

The methods of measurement for sample radioactivity levels used by PPL's contracted REMP radioanalytical laboratories are capable of meeting the analysis sensitivity requirements found in the SSES Technical Requirements. Summary descriptions of the analytical procedures and the accompanying calculational methods used by the laboratories can be found in Appendix E.

Additional terrestrial and aquatic environmental monitoring is performed independent of the SSES REMP by the Academy of Natural Sciences of Philadelphia, Pennsylvania. The monitoring program is titled "Safety Net" and an annual report is provided to PPL Susquehanna , LLC. Although the Safety Net program is not part of the SSES REMP, the data has provided additional information relative to the environmental impact of the operation of the SSES.

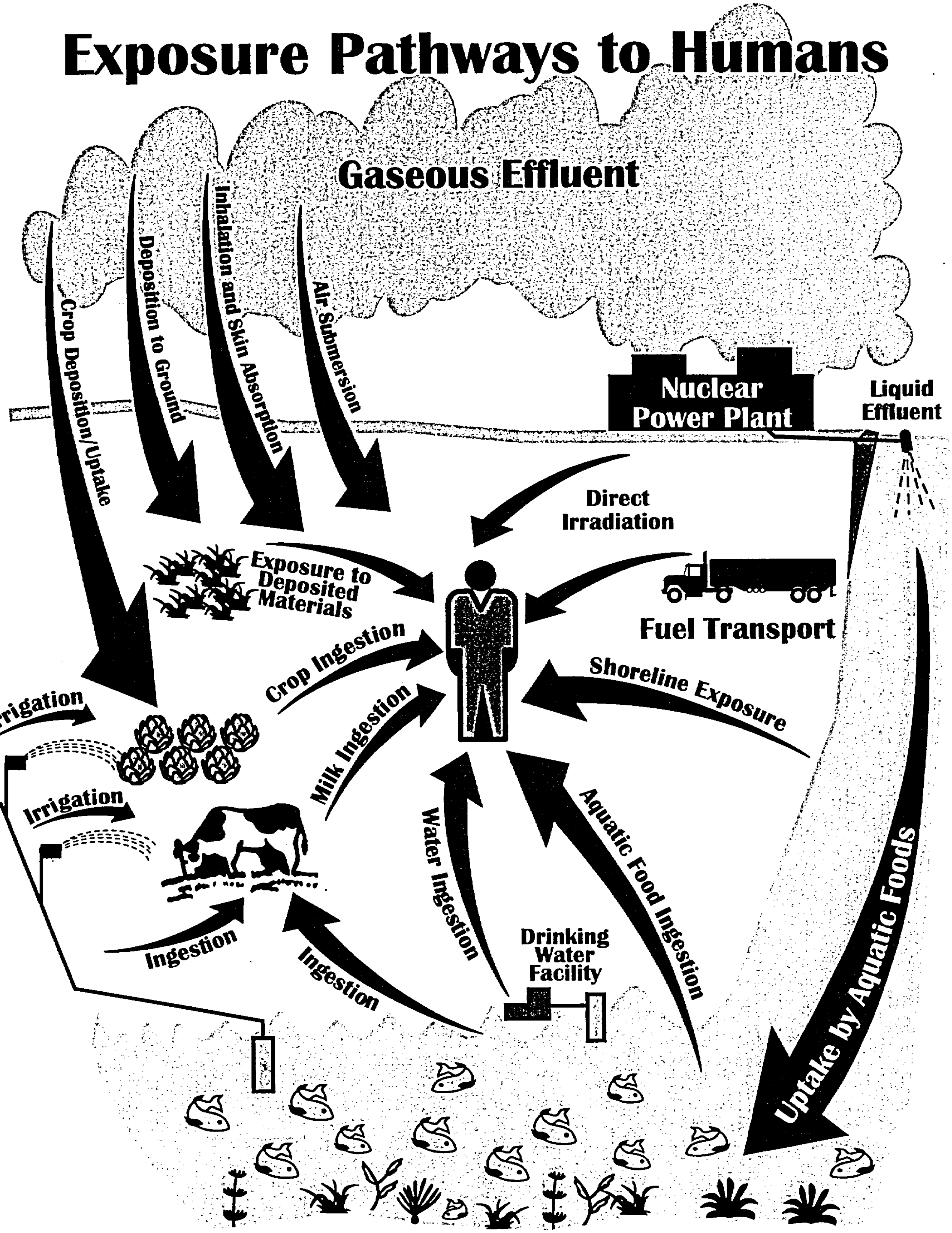
Exposure Pathways to Humans
Gaseous Effluent
Crop Deposition/Uptake
Deposition to Ground
Inhalation and Skin Absorption
Air Submersion
Nuclear Power Plant
Liquid Effluent
Direct Irradiation
Exposure to Deposited Materials
Fuel Transport
Crop Ingestion
Shoreline Exposure
Irrigation
Milk Ingestion
Irrigation
Water Ingestion
Aquatic Food Ingestion
Uptake by Aquatic Foods
Drinking Water Facility
Ingestion
Ingestion

Figure 1

FIGURE 2
2002 TLD MONITORING LOCATIONS WITHIN ONE MILE OF THE SSES

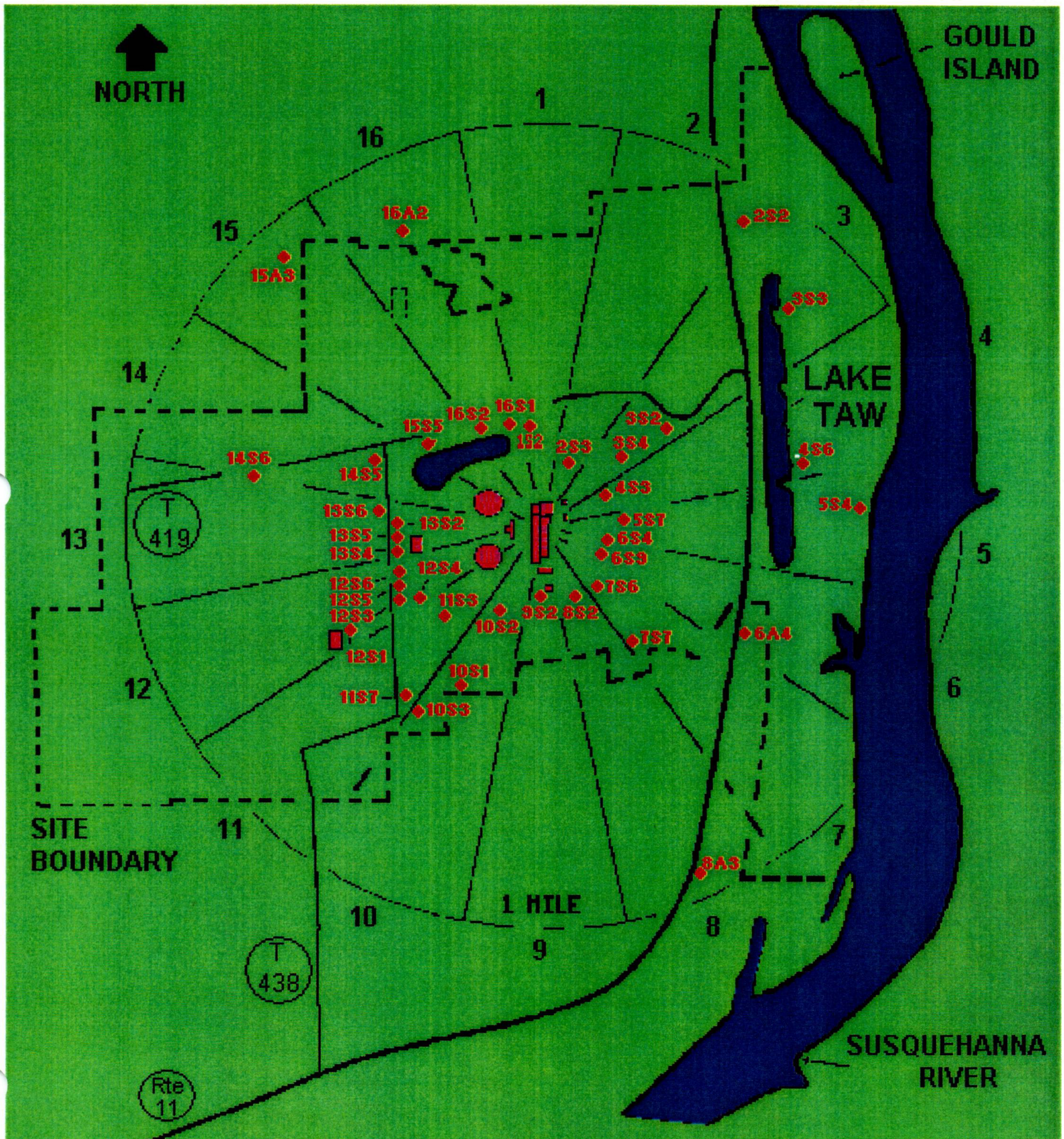

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FIGURE 3
2002 TLD MONITORING LOCATIONS
FROM ONE TO FIVE MILES FROM THE SSES

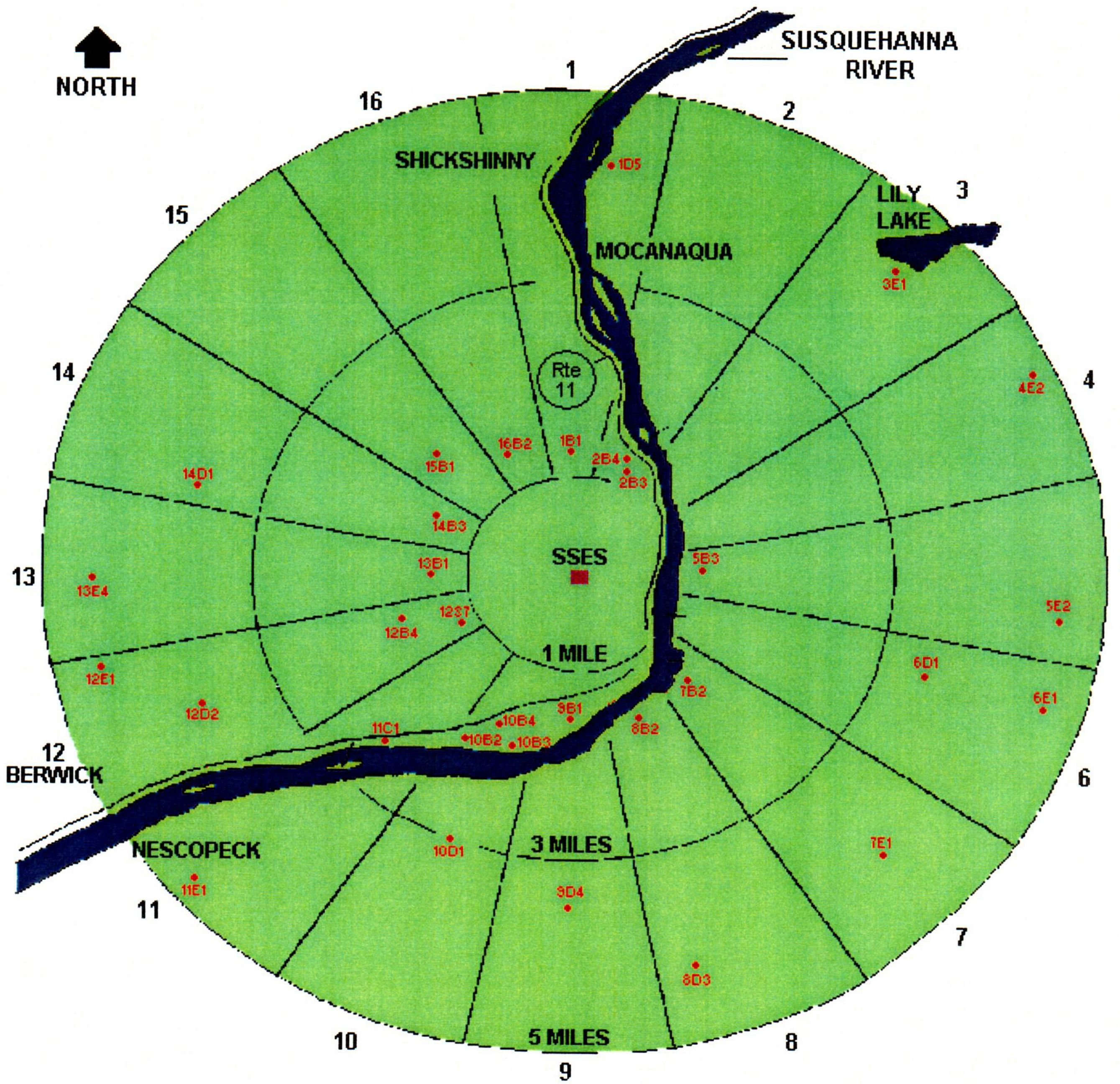

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FIGURE 4
2002 TLD MONITORING LOCATIONS
GREATER THAN FIVE MILES FROM THE SSES

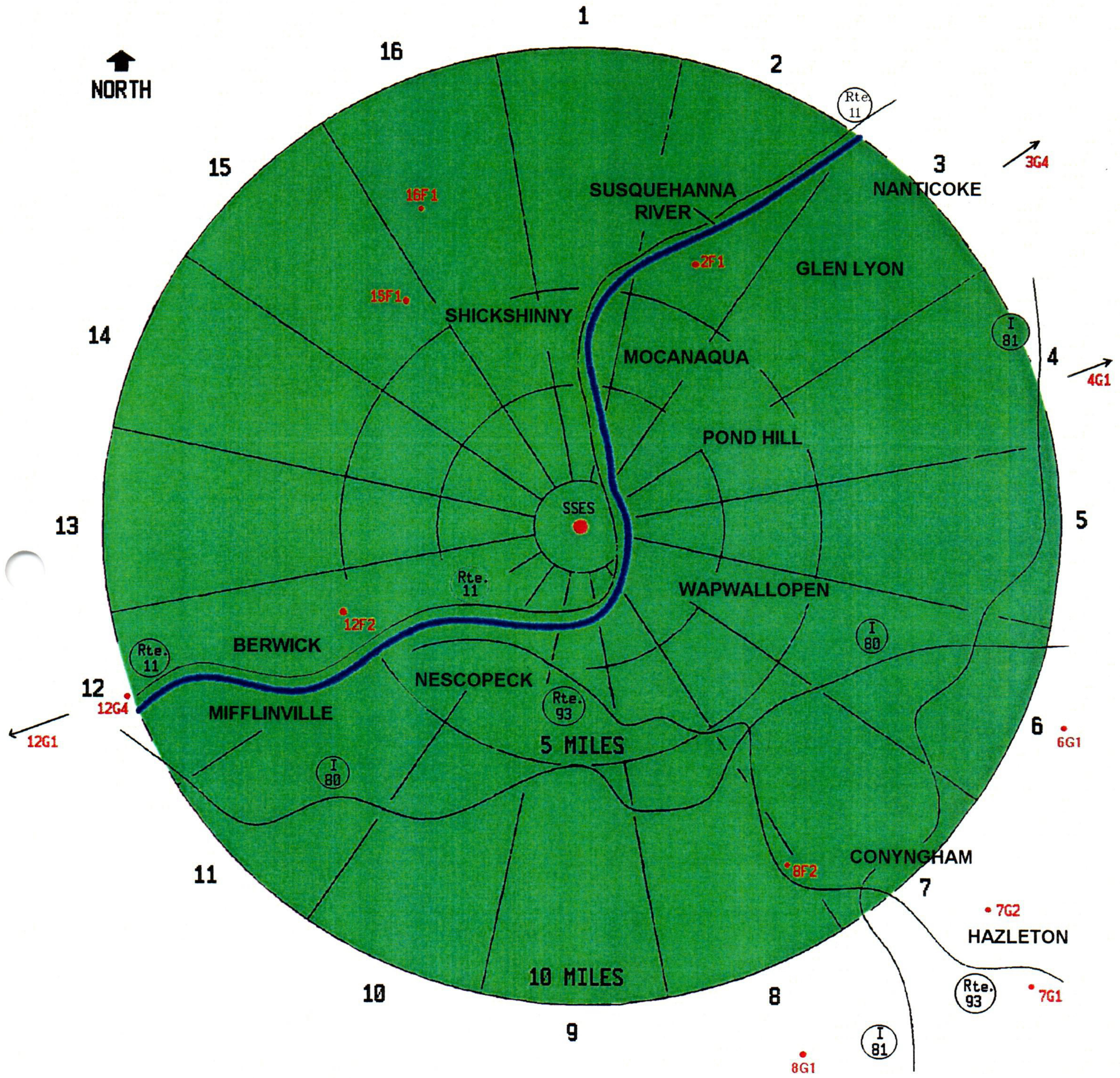

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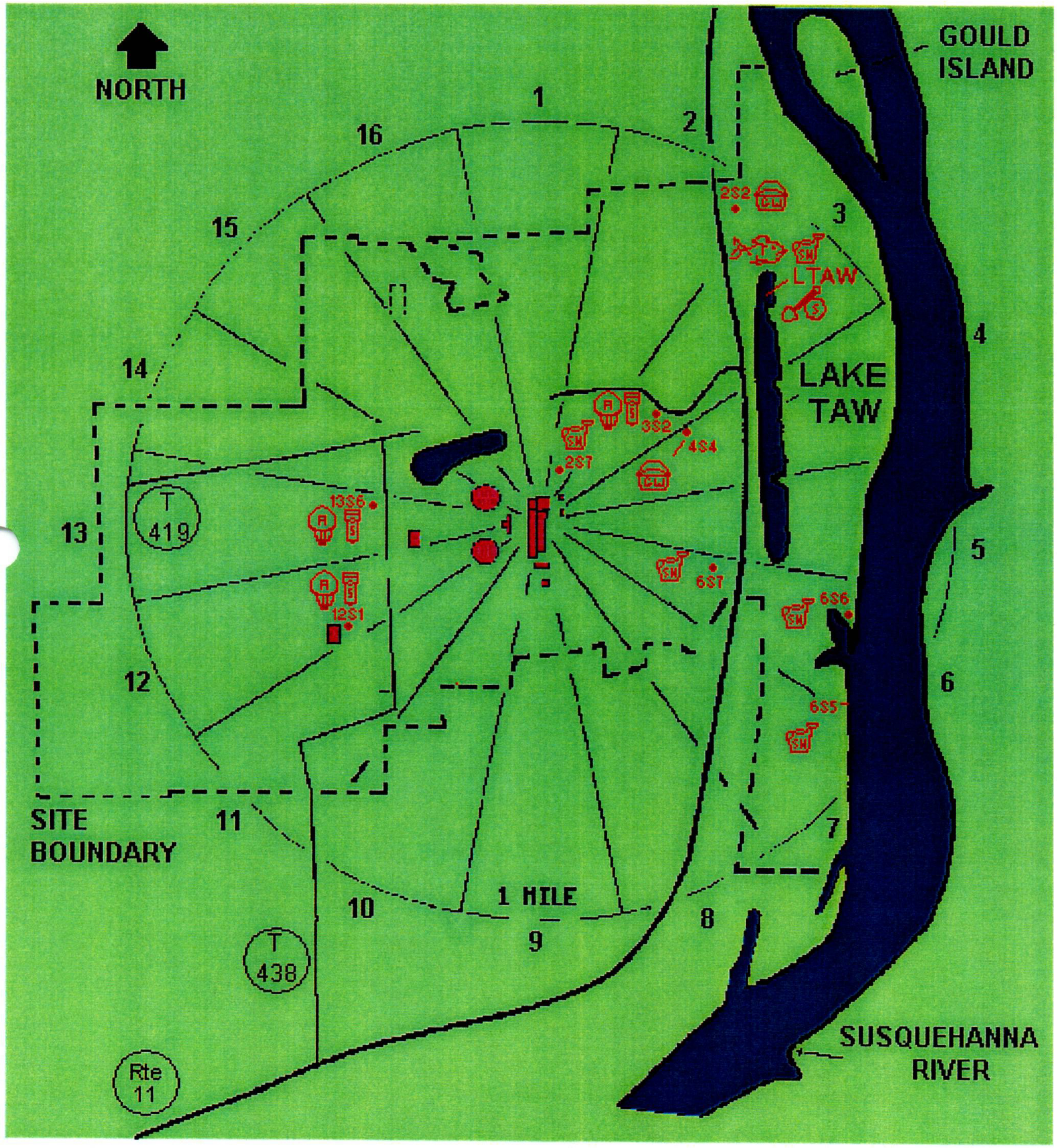
FIGURE 5
2002 ENVIRONMENTAL SAMPLING LOCATIONS WITHIN ONE MILE OF THE SSES



SURFACE WATER
SEDIMENT
FISH
GROUND WATER
AIR
MILK
FRUITS / VEGETABLES
SOIL

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FIGURE 6
2002 ENVIRONMENTAL SAMPLING LOCATIONS FROM ONE TO FIVE MILES FROM THE SSES

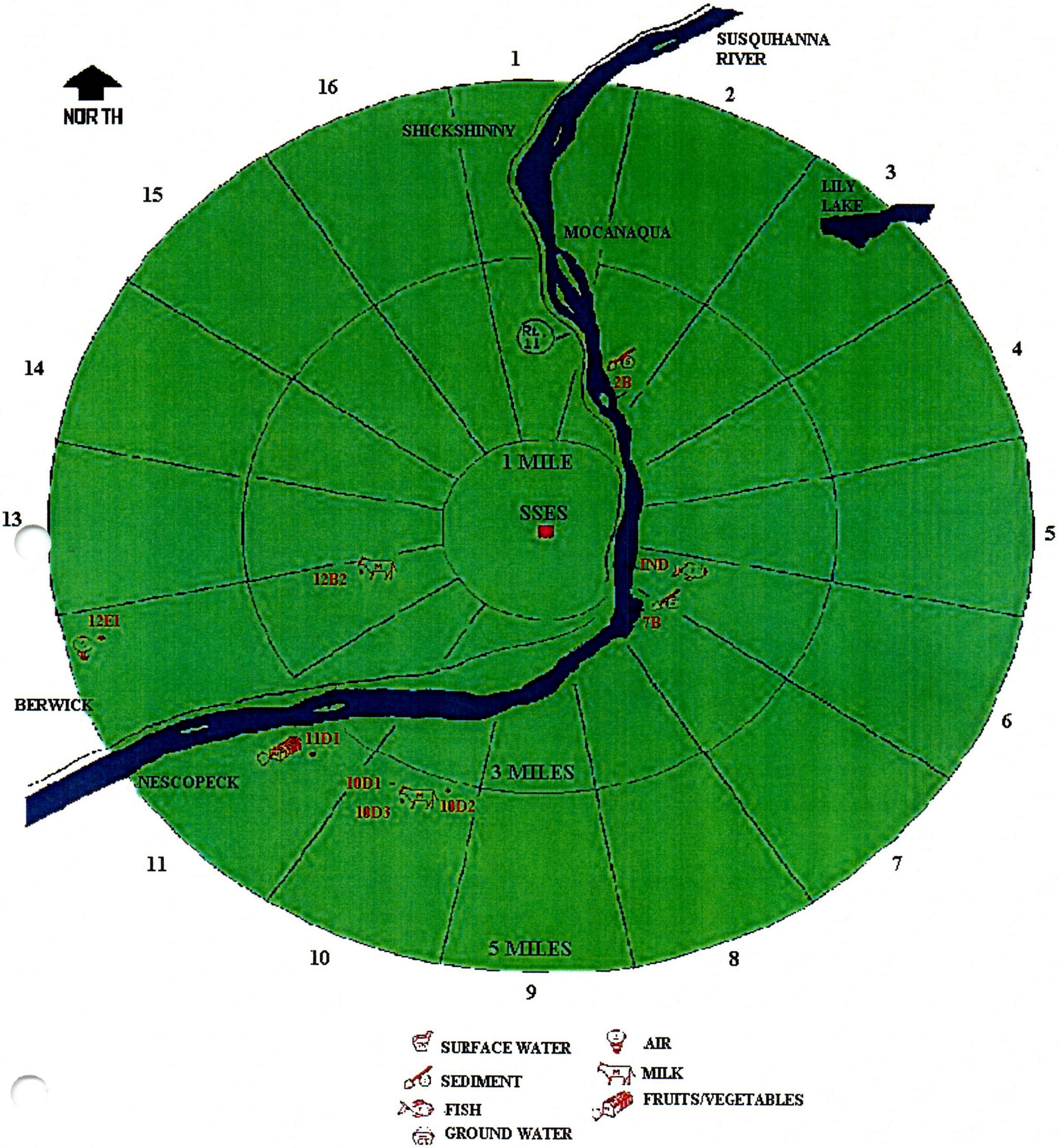

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FIGURE 7
2002 ENVIRONMENTAL SAMPLING LOCATIONS
GREATER THAN FIVE MILES FROM THE SSES