U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

NUREG-1437
Supplement 37

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 37

Regarding Three Mile Island Nuclear Station, Unit 1

Draft Report for Comment

Office of Nuclear Reactor Regulation

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Office of Nuclear Reactor Regulation

Proposed Action	Issuance of a renewed operating license DPR-50 for Three Mile Island Nuclear Station, Unit 1, in Londonderry Township in Dauphin County, Pennsylvania.
Type of Statement	Draft Supplemental Environmental Impact Statement
Agency Contact	Sarah L. Lopas Mailstop O-11F1 U.S. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Phone: 301-415-1147 Email: sarah.lopas@nrc.gov
Comments	Any interested party may submit comments on this supplemental EIS. Please specify NUREG-1437, Supplement 37, draft, in your comments. Comments must be received by March 4, 2009. Comments received after the expiration of the comment period will be considered if it is practical to do so but assurance of consideration of late comments will not be given. Comments may be emailed to ThreeMileIslandEIS@nrc.gov or mailed to: Chief, Rulemaking, Directives and Editing Branch U.S. NRC Mail Stop T6-D59 Washington, D.C. 20555-0001

ABSTRACT

This draft supplemental environmental impact statement (EIS) has been prepared in response to an application submitted by AmerGen Energy Company, LLC to renew the operating license for Three Mile Island Nuclear Station, Unit 1 for an additional 20 years.

This draft supplemental EIS includes the preliminary analysis that evaluates the environmental impacts of the proposed action and alternatives to the proposed action. Alternatives considered include replacement power from new supercritical coal-fired generation and natural gas combined-cycle generation; energy conservation/energy efficiency; and a combination of alternatives that included natural gas combined-cycle generation, conservation/efficiency, and improvements to hydroelectric dams; and not renewing the license (the no-action alternative).

The preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for Three Mile Island Nuclear Station, Unit 1 are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable.

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Background

By letter dated January 8, 2008, AmerGen Energy Company, LLC (AmerGen) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) to issue a renewed operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1) for an additional 20-year period.

The following document and the review it encompasses are requirements of NRC regulations implementing Section 102 of the National Environmental Policy Act (NEPA), of the *United States Code* (42 U.S.C. 4321), in Title 10 of the *Code of Federal Regulations* (CFR), Part 51 (10 CFR Part 51). In 10 CFR 51.20(b)(2), the Commission indicates that issuing a renewed power reactor operating license requires preparation of an Environmental Impact Statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c) states that the EIS prepared at the operating license renewal stage will be a supplement to the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, Volumes 1 and 2 (NRC 1996, 1999).

Upon acceptance of AmerGen's application, we (the NRC staff) began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent to prepare an EIS and conduct scoping. We conducted a site audit at the plant in late April 2008 and held public scoping meetings on May 1, 2008, in Middletown, Pennsylvania. In the preparation of this draft supplemental EIS for TMI-1, we reviewed AmerGen's environmental report and compared it to the GEIS, consulted with other agencies, conducted a review of the issues following the guidance set forth in NUREG-1555, Supplement 1: *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000), and considered the public comments received during the scoping process.

Proposed Action

AmerGen initialized the proposed Federal action—issuing a renewed power reactor operating license—by submitting an application for license renewal of TMI-1, for which the existing license (DPR-50) expires April 19, 2014. NRC's Federal action is the decision whether to renew the license for an additional 20 years.

Purpose and Need for Action

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license, and to meet future system generating needs, as determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers. This definition of purpose and need for action reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954 or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, State regulatory agencies and AmerGen will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, April 19, 2014.

Environmental Impacts of License Renewal

The supplemental EIS evaluates the potential environmental impacts of the proposed action. The environmental impacts from the proposed action can be SMALL, MODERATE, or LARGE. AmerGen and the NRC staff established separate processes for identifying and evaluating the significance of any new and significant information on the environmental impacts of license renewal of TMI-1. Neither AmerGen nor the NRC identified information that is both new and significant related to Category 1 issues that would call into question the conclusions in the GEIS. Similarly, neither the scoping process nor the NRC has identified any new issue applicable to TMI-1 that has a significant environmental impact. Therefore, the NRC staff relies upon the conclusions of the GEIS for all the Category 1 issues applicable to TMI-1.

Land Use
SMALL. The NRC did not identify any Category 2 impact issues for land use, nor did the staff identify any new and significant information during the environmental review. Therefore, there would be no impacts beyond those discussed in the GEIS.

Air Quality
SMALL. The NRC did not identify any Category 2 issues for the impact of transmission lines on air quality, nor did the staff identify any new or significant information during the environmental review. Therefore, for plant operation during the license renewal term, there are no impacts beyond those discussed in the GEIS.

However, air quality during refurbishment (in nonattainment and maintenance areas) is a Category 2 issue. Emission calculations for refurbishment activities at TMI-1 indicate that emissions are not expected to exceed emission budgets specified in the Pennsylvania State Implementation Plan, and on this basis, the NRC staff concludes that the impact of vehicle exhaust emissions resulting from refurbishment activities would be SMALL. Potential mitigation measures include implementation of a dust control plan and the use of vans and workforce shift changes to reduce the number of vehicles on the road at any one given time.

Ground Water Use and Quality
SMALL. Ground water use conflicts: potable and service water—plants using greater than 100 gallons per minute; and plants using cooling towers withdrawing make-up water from a small river) are Category 2 issues related to license renewal at TMI-1. Information provided by AmerGen, including Susquehanna River Basin Commission (SRBC) pump test data, shows that TMI-1 ground water withdrawal has no effect on nearby ground water wells and ground water supplies. In addition, the withdrawal of surface water from the Susquehanna River is a small percentage of overall river flow and does not affect ground water levels in the area.

Surface Water Use and Quality
SMALL. Water use conflicts—plants with cooling ponds or cooling towers using make-up water from a small river with low flow—is a Category 2 issue related to license renewal at TMI-1.

Withdrawals of Susquehanna River water by TMI-1 are less than 1.6 percent of the lowest daily mean flow and less than 0.1 percent of the average annual flow of the river. TMI-1 also participates in the Cowanesque Lake water storage project, which releases water to the Susquehanna River during drought conditions.

Aquatic Resources

SMALL. With regard to operation of TMI-1 during the license renewal term, the NRC did not identify any Category 2 issues for aquatic resources, nor did the staff identify any new and significant information during the environmental review. Therefore, there are no impacts beyond those discussed in the GEIS.

For refurbishment, when the transportation route of the new steam generators to the TMI-1 site is determined, AmerGen will need to consult with the appropriate State and Federal agencies regarding potential impacts of the transportation plan on aquatic resources and threatened and endangered aquatic species.

Terrestrial Resources

SMALL. With regard to operation of TMI-1 during the license renewal term, the NRC did not identify any Category 2 issues for terrestrial resources, nor did the staff identify any new or significant information during the environmental review. Therefore, there are no impacts beyond those discussed in the GEIS.

However, impacts to terrestrial resources during refurbishment activities is a Category 2 issue. The majority of refurbishment activities will take place on existing facility grounds at TMI-1, and all new, permanent structures will be constructed on previously disturbed land. Although the exact transportation route of the replacement steam generators from Port Deposit, Maryland, to TMI-1, has not been determined at the time of this draft supplemental EIS's publication, AmerGen will be required to obtain all necessary Federal and State environmental and construction permits when the route is finalized. Potential mitigation measures to minimize impacts to terrestrial resources include installing silt fences to minimize sediment transport, the use of best management practices, and the restoration of cleared land upon completion of construction activities.

Threatened and Endangered Species

SMALL. Impacts to threatened and endangered species during the period of extended operation and during refurbishment activities are Category 2 issues. The U.S. Fish and Wildlife Service indicated that no known Federally-listed threatened and endangered species occur within the project area; therefore, the proposed project would not likely impact any Federally-listed species. The Pennsylvania Department of Natural Resources indicated that although several State-listed species of concern are known to occur in the vicinity of the TMI-1 project site, no impact to these species is anticipated. Furthermore, the Pennsylvania Fish and Boat Commission indicated that no adverse impacts to State-listed rare, candidate, threatened, or endangered aquatic species are expected from the proposed project.

Refurbishment activities will take place on existing facility grounds at the TMI-1 site, and all new, permanent structures will be constructed on previously disturbed land; therefore, no impact to these species is anticipated. However, when the transportation route of the new steam generators to the TMI-1 site is determined, AmerGen will need to consult with the appropriate State and Federal agencies regarding potential impacts of the transportation plan on threatened and endangered species.

Human Health

SMALL. With regard to Category 1 human health issues during the license renewal term—microbiological organisms (occupational health), noise, radiation exposures to public, occupational radiation exposures, and electromagnetic fields (chronic effects)—the NRC staff did not identify any new or significant information during the environmental review. Therefore, there are no impacts beyond those discussed in the GEIS. Slightly higher radiation doses to members of the public are expected from TMI-1 during the refurbishment period. However, based on past regulatory compliance, the dose to a maximally exposed individual in the vicinity of TMI-1 for the refurbishment period is expected to continue to be a small fraction of the limits and standards specified in 10 CFR Part 20, Appendix I to 10 CFR Part 50, and 40 CFR Part 190.

Microbiological organisms (public health) and electromagnetic fields— acute effects (electric shock) are Category 2 human health issues. When thermal discharge from TMI-1 is at its maximum temperature, and the Susquehanna River is at its maximum temperature, the resulting temperature of the mixed water in the vicinity of the TMI-1 discharge is approximately 91.3 degrees Fahrenheit, which is well outside the optimal growth temperature range of thermophilic microbiological organisms, therefore the impact is SMALL. Potential mitigation measures to reduce human health impacts include monitoring for thermophilic organisms in the water and sediments near the discharge, as well as prohibiting recreational use near the discharge plume. NRC staff reviewed AmerGen's analysis of electromagnetic fields—acute shock resulting from induced charges in metallic structures, and verified that none of TMI-1's in-scope transmission lines have the capability to induce greater than 5 milliamperes in a vehicle parked beneath the lines. This finding conforms with National Electric Safety Code provisions for preventing electric shock from induced current. Potential mitigation measures include limiting public access to transmission line structures, installing signs at road crossings, and increasing transmission line clearances. The NRC staff considers the GEIS finding of "uncertain" for electromagnetic fields—chronic effects still appropriate and will continue to follow developments on this issue.

Socioeconomics

SMALL. The NRC identified no Category 1 public services and aesthetic impacts, or new and significant information during the environmental review. Therefore, there would be no impacts beyond those discussed in the GEIS. Category 2 socioeconomic impacts include housing impacts, public services (public utilities), offsite land use, public services (public transportation), and historic and archaeological resources. Since TMI-1 is located in a high-density population area, and growth control measures are not in effect, any changes in TMI-1 employment would have little noticeable effect on housing availability in the surrounding area. AmerGen has indicated they have no plans to add non-outage employees during the license renewal period; therefore non-outage employment levels at TMI-1 would remain relatively unchanged with no additional demand for public water and sewer services. This also applies to offsite land use and transportation issues – because non-outage employment levels at TMI-1 would remain relatively unchanged during the license renewal period, there would be no land use impacts related to population or tax revenues, and no transportation impacts. Category 2 socioeconomic impacts related to refurbishment at TMI-1 would be SMALL, as the TMI-1 steam generator project is expected to require a one-time increase of outage workers for up to 70 days—a short duration of time.

No impacts to known historic and archaeological resources are expected from the continued operation of TMI-1 during the license renewal term. AmerGen has indicated no plans to change or modify the plant or transmission line structures. Based on the review of Pennsylvania Historical and Museum Commission files, archaeological surveys, assessments, and other information, the potential impacts on historic and archaeological resources at TMI-1 would be SMALL. Since TMI-1 is situated in an archaeologically sensitive area, development of a cultural resources management plan in addition to AmerGen's review procedures would serve to integrate cultural resource considerations with ongoing TMI-1 activities. Additionally, training of AmerGen staff in the Section 106 process would ensure that informed decisions are made when considering the effects of future projects on historic and archaeological resources. Lands that have not been surveyed should be investigated by a professional archaeologist prior to any ground disturbance. In addition, the historical farmstead site (36Da235) should be recorded and evaluated for eligibility. Because refurbishment activities will occur on previously disturbed land, the impacts associated with refurbishment are not expected to adversely affect historic or archaeological sites in the area of TMI-1 or TMI Unit 2. An analysis of minority and low-income populations residing within a 50-mile (80-kilometer) radius of TMI-1 indicated there would be no disproportionately high and adverse impacts to these populations from the continued operation of TMI-1 during the license renewal period. Based on recent monitoring results, concentrations of contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas surrounding TMI-1 have been low (at or near the threshold of detection) and seldom above background levels. Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

Severe Accident Mitigation Alternatives

Since TMI-1 had not previously considered alternatives to reduce the likelihood or potential consequences of a variety of highly uncommon but potentially serious accidents, NRC regulation 10 CFR 51.53(c)(3)(ii)(L) requires that TMI-1 evaluate Severe Accident Mitigation Alternatives (SAMAs) in the course of license renewal review. SAMAs are potential ways to reduce the risk or potential impacts of uncommon but potentially severe accidents, and may include changes to plant components, systems, procedures, and training.

Based on our review of potential SAMAs, we conclude that TMI-1 made a reasonable, comprehensive effort to identify and evaluate SAMAs. Based on the review of the SAMAs for TMI-1, and the plant improvements already made, we conclude that none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

Alternatives

We considered the environmental impacts associated with alternatives to license renewal. These alternatives include other methods of power generation and not renewing the TMI-1 operating license (the no-action alternative). Replacement power options considered were supercritical coal-fired generation, natural gas combined-cycle generation, and as part of the combination alternative, uprates to existing hydroelectric dams located in Pennsylvania. Wherever possible, we evaluated potential environmental impacts for these alternatives located both at the TMI-1 site and at some other unspecified alternate location. Energy conservation/energy efficiency, purchased power, and a combination alternative, which included natural gas combined-cycle generation, energy conservation/energy efficiency, and a series of uprates to hydroelectric dams, were also considered. We evaluated each alternative using the same impact areas that we used in evaluating impacts from license renewal. The results of this evaluation are summarized in the table on the following page.

Comparison of Alternatives

The coal-fired alternative is the least environmentally favorable alternative, due to: impacts to air quality from nitrogen oxides, sulfur oxides, particulate matter, polycyclic aromatic hydrocarbons, carbon monoxide, carbon dioxide, and mercury—and the corresponding human health impacts; construction impacts to aquatic, terrestrial, and potentially historic and archaeological resources are also factors that make the coal-fired alternative the least environmentally favorable alternative. The gas-fired alternative would have slightly lower air emissions, and impacts to aquatic, terrestrial, and historic and archaeological resources would vary depending upon location of the plant. Purchased power would likely have operational impacts that would include aspects of coal-fired, gas-fired, and existing nuclear generation.

The NRC notes that the energy conservation/energy efficiency alternative has SMALL impacts in all categories evaluated, and upon shut down of TMI-1, current operating impacts of TMI-1 would cease. Therefore, the energy conservation/energy efficiency alternative is the environmentally preferred alternative to license renewal. All other alternatives capable of meeting the needs currently served by TMI-1 entail potentially greater impacts than the proposed action of license renewal of TMI-1. The no-action alternative does not meet the purpose and need of this draft SEIS, though if it triggers the energy conservation/energy efficiency action to replace the capacity currently supplied by TMI-1, it could result in an overall SMALL impact, as well.

Recommendation

Our preliminary recommendation is that the Commission determines that the adverse environmental impacts of license renewal for TMI-1 are not so great that preserving the option of license renewal for energy planning decisionmakers would be unreasonable. This recommendation is based on (1) the analysis and findings in the GEIS; (2) information submitted in the AmerGen's Environmental Report; (3) consultation with other Federal, State, and local agencies; (4) a review of other pertinent studies and reports; and (5) a consideration of public comments received during the scoping process.

Alternative	Impact Area						
	Air Quality	Ground Water	Surface Water	Aquatic and Terrestrial Resources	Human Health	Socioeconomics	Waste Management
License Renewal	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	N/A
Supercritical coal-fired alternative at a new site	MODERATE	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	SMALL
Gas-fired alternative at the TMI-1 site	MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Gas-fired alternative at a new site	MODERATE	SMALL	SMALL	SMALL to LARGE	SMALL	SMALL to MODERATE	SMALL
Energy Conservation/ Energy Efficiency	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Combination of Alternatives	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
No Action Alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

ABBREVIATIONS AND ACRONYMS

ACC	averted cleanup and decontamination costs
AEA	Atomic Energy Act of 1954
AEC	U.S. Atomic Energy Commission
CDF	Core Damage Frequency
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CFS	cubic feet per second
COPC	chemicals of potential concern
CWA	Clean Water Act
DBA	design-basis accident
DCNR	Pennsylvania Department of Conservation and Natural Resources
DOE	U.S. Department of Energy
DPR	demonstration project reactor
DSM	demand-side management
EIA	Energy Information Administration (of DOE)
EIS	environmental impact statement
ELF-EMF	extremely low frequency-electromagnetic field
EMS	environmental management system
EOP	Emergency Operating Procedure
ER	environmental report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESRP	Environmental Standard Review Plan, NUREG-1555, Supplement 1, Operating License Renewal
FAA	Federal Aviation Administration
FES	Final Environmental Statement
FR	Federal Register
FSAR	Final Safety Analysis Report
FWS	U.S. Fish and Wildlife Service
GDC	general design criteria
GEIS	Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437
GPM	gallons per minute
HLW	high-level waste
Inc.	incorporated
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events
ISFSI	independent spent fuel storage installation

LLC	limited liability corporation
LLMW	low level mixed waste
LLW	low level waste
LNG	liquefied natural gas
LOCA	loss of coolant accident
LWR	light-water reactor
MSA	Magnuson-Stevens Fishery Conservation and Management Act of 1996
Msl	mean sea level
MW	megawatt
MWe	megawatt-electric
MWt	megawatt-thermal
NA	not applicable
NAAQS	National Ambient Air Quality Standards
NAS	National Academy of Sciences
NCI	National Cancer Institute
NEPA	National Environmental Policy Act of 1969
NESC	National Electric Safety Code
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Sciences
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxide(s)
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NWPPC	Northwest Power Planning Council
ODCM	Offsite Dose Calculation Manual
PADEP	Pennsylvania Department of Environmental Protection
pCi/L	picocuries per liter
PDS	plant damage state
PFBC	Pennsylvania Fish and Boat Commission
PGC	Pennsylvania Game Commission
PHMC	Pennsylvania Historical and Museum Commission
$PM_{2.5}$	particulate matter, 2.5 microns or less in diameter
PM_{10}	particulate matter, 10 microns or less in diameter
PRA	Probabilistic Risk Assessment
PSA	Probabilistic Safety Assessment
PSD	prevention of significant deterioration

PSW	plant service water
PWR	pressurized water reactor
RAB	reactor auxiliary building
RAI	request for additional information
RCP	reactor coolant pump
REMP	radiological environmental monitoring program
rms	root mean square
ROW(s)	right-of-way(s)
SAMA	Severe Accident Mitigation Alternative
SAR	Safety Analysis Report
SER	Safety Evaluation Report
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SRBC	Susquehanna River Basin Commission
TSCA	Toxic Substances Control Act
U	Uranium
UFSAR	Updated Final Safety Analysis Report
U.S.	United States
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
VOCs	Volatile Organic Compounds
WHO	World Health Organization

1.0 PURPOSE AND NEED FOR ACTION

Under the U.S. Nuclear Regulatory Commission's (NRC's) environmental protection regulations in Title 10, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," of the *Code of Federal Regulations* (10 CFR Part 51), which implement the National Environmental Policy Act (NEPA), issuance of a new nuclear power plant operating license requires the preparation of an environmental impact statement (EIS).

The Atomic Energy Act of 1954 originally specified that licenses for commercial power reactors be granted for up to 40 years with an option to renew for another 20 years. The 40-year licensing period was based on economic and antitrust considerations rather than on technical limitations of the nuclear facility.

The decision to seek a license renewal rests entirely with nuclear power facility owners and typically is based on the facility's economic viability and the investment necessary to continue to meet NRC safety and environmental requirements. The NRC makes the decision to grant or deny a license renewal application, based on whether the applicant has demonstrated that the environmental and safety requirements in the agency's regulations can be met during the period of extended operation.

1.1 Proposed Federal Action

AmerGen Energy Company, LLC (AmerGen) initialized the proposed Federal action by submitting an application for license renewal of Three Mile Island Nuclear Station, Unit 1 (TMI-1), for which the existing license, DPR-50, expires April 19, 2014. The NRC's Federal action is the decision whether to renew the license for an additional 20 years.

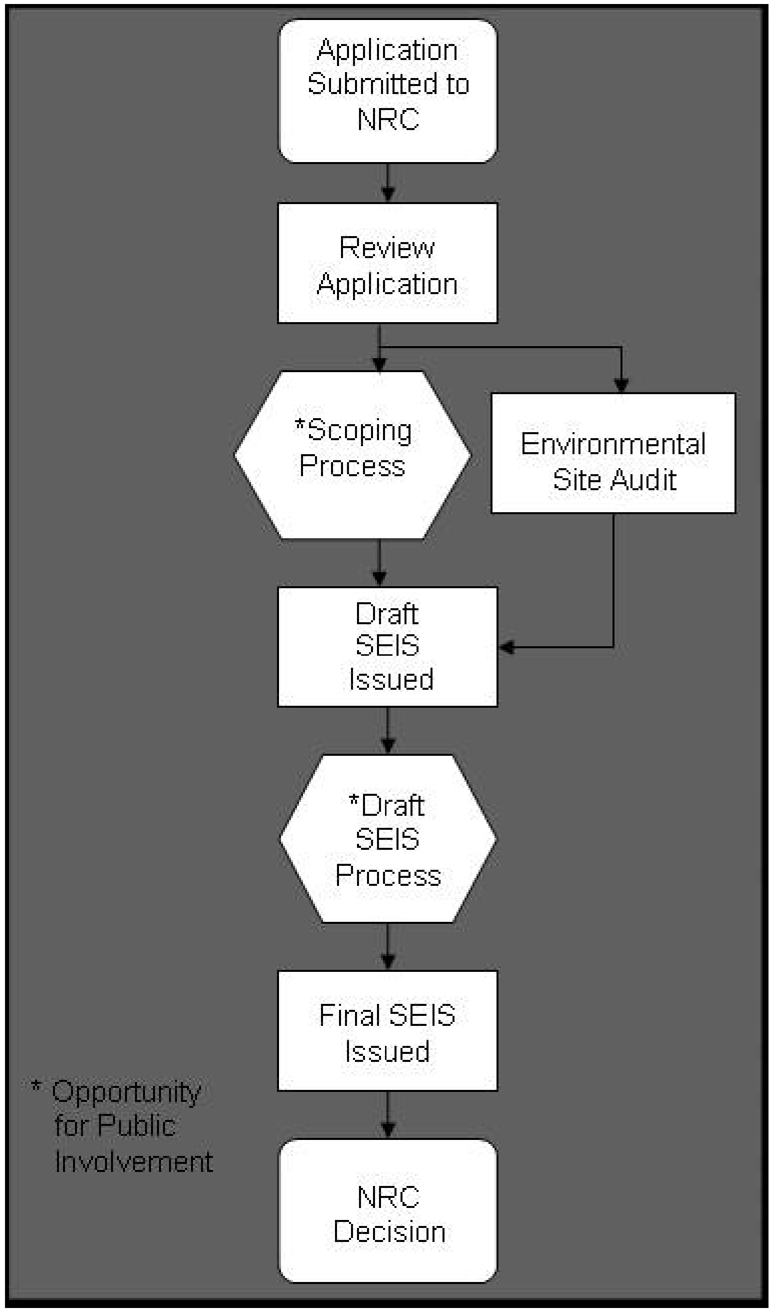
1.2 Purpose and Need for the Proposed Federal Action

The purpose and need for the proposed action (issuance of a renewed license) is to provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers. This definition of purpose and need reflects the Commission's recognition that, unless there are findings in the safety review required by the Atomic Energy Act or findings in the NEPA environmental analysis that would lead the NRC to reject a license renewal application, the NRC does not have a role in the energy-planning decisions of State regulators and utility officials as to whether a particular nuclear power plant should continue to operate.

If the renewed license is issued, State regulatory agencies and AmerGen will ultimately decide whether the plant will continue to operate based on factors such as the need for power or other matters within the State's jurisdiction or the purview of the owners. If the operating license is not renewed, then the facility must be shut down on or before the expiration date of the current operating license, April 19, 2014.

1.3 Major Environmental Review Milestones

Figure 1-1. **Environmental Review Process.** The environmental review provides opportunities for public involvement.



AmerGen submitted an environmental report (AmerGen 2008a) as part of its license renewal application (AmerGen 2008) in January 2008. After reviewing the application and the environmental report for sufficiency, the NRC staff published a Notice of Acceptability and Opportunity for Hearing on March 14, 2008, in the *Federal Register* (Volume 73, p. 13923, (73 FR 13923)). Then, on March 28, 2008, the NRC published another notice in the *Federal Register* (73 FR 16729) on its intent to conduct scoping, thereby beginning the 60-day scoping period.

The agency held two public scoping meetings on May 1, 2008, in Middletown, Pennsylvania. The NRC report entitled, "Environmental Impact Statement Scoping Process Summary Report for Three Mile Island Nuclear Station, Unit 1," dated August 8, 2008, presents the comments received during the scoping process in their entirety (NRC 2008b). Appendix A to this supplemental EIS presents the comments considered to be within the scope of the environmental license renewal review and the associated NRC responses.

To independently verify information provided in the environmental report, the NRC staff conducted a site audit at TMI-1 from April 28 through May 1, 2008. During the site audit, staff met with plant personnel, reviewed specific documentation, toured the facility, and met with interested Federal, State, and local agencies. The agency published a summary of that site audit and a list of the attendees in a report entitled, "Summary of Site Audit Related to the Review of the License Renewal Application for Three Mile Island Nuclear Station, Unit 1," dated August 5, 2008 (NRC 2008).

Upon completion of the scoping period and site audit, the staff compiled its findings in this document, the draft supplemental EIS (Figure 1-1). This document is made available for public comment for 75 days. During this time, NRC staff will host public meetings and collect public comments. Based on the information gathered, the staff will amend the draft supplemental EIS findings as necessary, and publish the final supplemental EIS.

The NRC has established a license renewal process that can be completed in a reasonable period of time with clear requirements to ensure safe plant operation for up to an additional 20 years of plant life. The safety review is conducted simultaneously with the environmental review. The staff documents the findings of the safety review in a safety evaluation report. The Commission considers the findings in both the supplemental EIS and the safety evaluation report in its decision to either grant or deny the issuance of a new license.

1.4 Generic Environmental Impact Statement

The NRC performed a generic assessment of the environmental impacts associated with license renewal to improve the efficiency of the license renewal. NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants*, documents the results of the NRC staff's systematic approach to evaluating the environmental consequences of renewing the licenses of individual nuclear power plants and operating them for an additional 20 years (NRC 1996, 1999)[1]. The NRC staff analyzed in detail and resolved those environmental issues that could be resolved generically in the Generic Environmental Impact Statement (GEIS).

The GEIS establishes 92 separate issues for the NRC staff to independently verify. Of these, the staff determined that 69 are generic to all plants (Category 1), while 21 issues do not lend themselves to generic consideration (Category 2). Two other issues remained uncategorized; environmental justice and the chronic effects of electromagnetic fields must be evaluated on a site-specific basis. Appendix B to this report lists all 92 issues.

For each potential environmental issue, the GEIS (1) describes the activity that affects the environment, (2) identifies the population or resource that is affected, (3) assesses the nature and magnitude of the impact on the affected population or resource, (4) characterizes the significance of the effect for both beneficial and adverse effects, (5) determines whether the results of the analysis apply to all plants, and (6) considers whether additional mitigation measures would be warranted for impacts that would have the same significance level for all plants.

The NRC's standard of significance for impacts was established using the Council on Environmental Quality terminology for "significant." The NRC established three levels of significance for potential impacts—SMALL, MODERATE, and LARGE, as defined below.

[1] The NRC originally issued the GEIS in 1996 and issued Addendum 1 to the GEIS in 1999. Hereafter, all references to the "GEIS" include the GEIS and Addendum 1.

SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Significance indicates the importance of likely environmental impacts and is determined by considering two variables: **context** and **intensity**.

Context is the geographic, biophysical, and social context in which the effects will occur.

Intensity refers to the severity of the impact, in whatever context it occurs.

The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted (Figure 1-2). Issues are assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

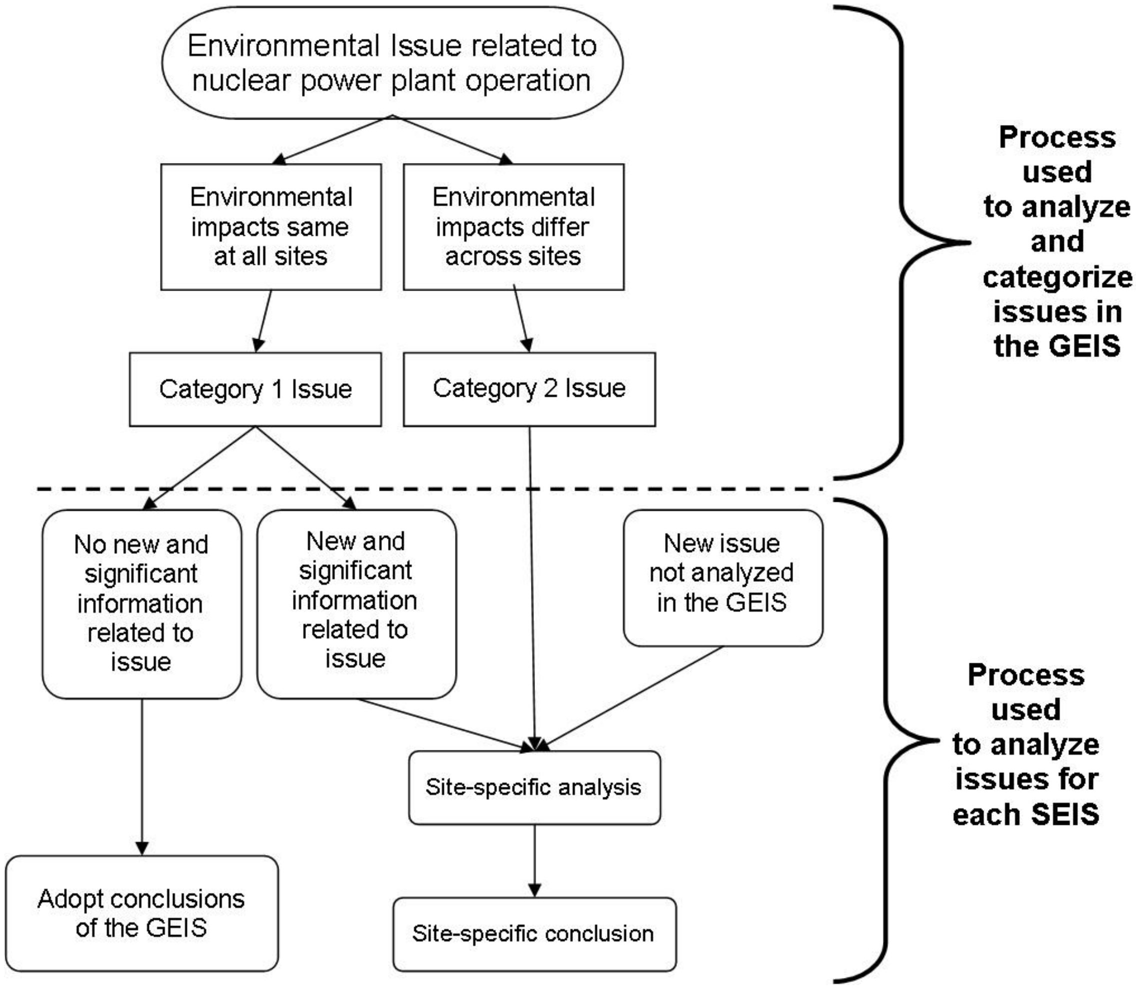
(1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics;

(2) A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts (except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal); and

(3) Mitigation of adverse impacts associated with the issue has been considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.

For generic issues (Category 1), no additional site-specific analysis is required in this supplemental EIS unless new and significant information is identified. Chapter 4 of this report presents the process for identifying new and significant information. Site-specific issues (Category 2) are those that do not meet one or more of the criterion for Category 1 issues, and therefore, additional site-specific review for these issues is required. The supplemental EIS documents the results of that site-specific review.

Figure 1-2. Environmental Issues Evaluated During License Renewal. 92 issues were initially evaluated in the Generic EIS. A site-specific analysis is required for 23 of those 92 issues.



1.5 Supplemental Environmental Impact Statement

The supplemental EIS presents an analysis that considers the environmental effects of the continued operation of TMI-1, alternatives to license renewal, and mitigation measures for minimizing adverse environmental impacts. Chapter 8 analyzes and compares the potential environmental impacts from alternatives, while Chapter 9 presents the preliminary recommendation to the Commission as to whether or not the environmental impacts of license renewal are so great that preserving the option of license renewal would be unreasonable. The recommendation will be made after consideration of comments received during the public scoping period and on the draft supplemental EIS.

In the preparation of this supplemental EIS for TMI-1, the staff undertook the following activities:

- reviewed the information provided in the AmerGen environmental report;
- consulted with other Federal, State, and local agencies;
- conducted an independent review of the issues during site audit; and
- considered the public comments received during the scoping process.

New information can be identified from a number of sources, including the applicant, the NRC, other agencies, or public comments. If a new issue is revealed, then it is first analyzed to determine whether it is within the scope of the license renewal evaluation. If it is not addressed in the GEIS then the NRC determines its significance and documents its analysis in the supplemental EIS.

New and significant information either: (1) identifies a significant environmental issue not covered in the GEIS, or (2) was not considered in the analysis in the GEIS and leads to an impact finding that is different from the finding presented in the GEIS.

1.6 Cooperating Agencies

During the scoping process, no Federal, State, or local agencies were identified as cooperating agencies in the preparation of this supplemental EIS.

1.7 Consultations

The Endangered Species Act of 1973, as amended; the Magnuson-Stevens Fisheries Conservation and Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 require that Federal agencies consult with applicable State and Federal agencies and groups before taking action that may affect endangered species, fisheries, or historic and archaeological resources, respectively. Below are the agencies and groups with whom the NRC consulted; Appendix D to this report includes copies of consultation documents.

Absentee-Shawnee Tribe of Oklahoma, Shawnee, Oklahoma
Advisory Council on Historic Preservation
Cayuga Nation, Versailles, New York
Delaware Nation, Anadarko, Oklahoma
Eastern Shawnee Tribe of Oklahoma, Seneca, Missouri
Oneida Indian Nation, Verona, New York
Oneida Nation of Wisconsin, Oneida, Wisconsin
Onondaga Nation, Nedrow, New York
Pennsylvania Historical and Museum Commission
Seneca-Cayuga Tribe of Oklahoma, Miami, Oklahoma
Seneca Nation of Indians, Salamanca, New York
Shawnee Tribe, Miami, Oklahoma
St. Regis Mohawk Tribe, Akwesasne, New York
Stockbridge-Munsee Band of the Mohican Nation – Wisconsin, Bowler, Wisconsin
Tonawanda Seneca Nation, Basom, New York

Tuscarora Nation, Lewiston, New York
U.S. Fish and Wildlife Service, Pennsylvania Field Office

1.8 Correspondence

During the course of the environmental review, the NRC staff contacted the following Federal, State, regional, local, and tribal agencies. Appendix E to this report contains a chronological list of all documents sent and received during the environmental review.

Absentee-Shawnee Tribe of Oklahoma, Shawnee, Oklahoma
Advisory Council on Historic Preservation, Washington, D.C.
Cayuga Nation, Versailles, New York
Delaware Nation, Anadarko, Oklahoma
Eastern Shawnee Tribe of Oklahoma, Seneca, Missouri
Oneida Indian Nation, Verona, New York
Oneida Nation of Wisconsin, Oneida, Wisconsin
Onondaga Nation, Nedrow, New York
Pennsylvania Department of Conservation and Natural Resources, Harrisburg, Pennsylvania
Pennsylvania Department of Environmental Protection, Harrisburg, Pennsylvania
Pennsylvania Department of Environmental Protection, South Central Regional Office, Harrisburg, Pennsylvania
Pennsylvania Fish and Boat Commission, Bellefonte, Pennsylvania
Pennsylvania Game Commission, Harrisburg, Pennsylvania
Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania
Seneca-Cayuga Tribe of Oklahoma, Miami, Oklahoma
Seneca Nation of Indians, Salamanca, New York
Shawnee Tribe, Miami, Oklahoma
St. Regis Mohawk Tribe, Akwesasne, New York
Stockbridge-Munsee Band of the Mohican Nation – Wisconsin, Bowler, Wisconsin
Susquehanna River Basin Commission, Harrisburg, Pennsylvania
Tonawanda Seneca Nation, Basom, New York
Tuscarora Nation, Lewiston, New York
U.S. Fish and Wildlife Service, Pennsylvania Field Office, State College, Pennsylvania

A list of persons who received a copy of this draft supplemental EIS is provided below:

TMI-1 Site Vice President, AmerGen	Senior Vice President—Operations, Mid-Atlantic, AmerGen	Vice President—Licensing and Regulatory Affairs, AmerGen
Regional Administrator, Region 1, NRC	Chairman, Board of County Commissioners of Dauphin County	Chairman, Board of Supervisors of Londonderry Township
David Kern, NRC	Director—Licensing and Regulatory Affairs, AmerGen	David Allard, Pennsylvania Department of Environmental Protection

Plant Manger – TMI-1, AmerGen	Regulatory Assurance Manager—TMI-1, AmerGen	Ronald Bellamy, NRC
Ronnie Gardner, AREVA NP Inc.	Judith Johnsrud, Sierra Club	Eric Epstein, TMI Alert
Correspondence Control Desk, AmerGen	Manager Licensing—TMI-1, Exelon Generation Company, LLC	Christopher Crane, AmerGen
Charles Pardee, AmerGen	Associate General Counsel, AmerGen	Chief Operating Officer, AmerGen
Senior Vice President—Operations Support, AmerGen	Frederic W. Polaski, Exelon Nuclear	Albert A. Fulvio, Exelon Nuclear
Rich Janati, Pennsylvania Department of Environmental Protection	Michael Murphy, Pennsylvania Department of Environmental Protection	Michael G. Brownell, Susquehanna River Basin Commission
Rachel Diamond, Pennsylvania Department of Environmental Protection	Nancy Ranek, Exelon Nuclear	Christopher Wilson, Exelon Nuclear
Michael P. Gallagher, Exelon Nuclear	Kathleen Yhip	William R. Geisel
Joseph Mirenzi	Anne Lovell, TetraTech NUS	James Oliver, TetraTech NUS
Larry Robbins	Mary Osborn	Michael R. Helfrich, Lower Susquehanna RiverKeeper
Linda Braasch, Harrisburg Diocesan Council of Catholic Women	Bradford S. Flynn	Douglas McLearen Pennsylvania Historical and Museum Commission
Anne Norton-Miller U.S. Environmental Protection Agency	Kimberly DePaul U.S. Environmental Protection Agency	William S. Arguto U.S. Environmental Protection Agency, Region 3

1.9 Status of Compliance

AmerGen is responsible for complying with all NRC regulations and other applicable Federal, State, and local requirements; Appendix H to the GEIS describes some of the major Federal statutes. Table 1-1 on the following page lists the numerous permits and licenses issued by Federal, State, and local authorities for activities at TMI-1.

Table 1-1. Licenses and Permits. *Existing environmental authorizations for TMI-1 Operations.*

Permit	Number	Dates	Responsible Agency
Operating License	DPR-50	Issued: 4/19/1974 Expires: 4/19/2014	U.S. NRC
Consumptive Water Use Permit	Docket 19950302	Issued: 3/14/1980 Expires: 3/14/2010	Susquehanna River Basin Commission
Ground Water Withdrawal Permit	Docket 19961102	Issued: 1/26/1999 Expires: 11/26/2021	Susquehanna River Basin Commission
Synthetic Minor Operating Permit	22-05029	Issued: 1/1/2007 Expires: 12/31/2011	Pennsylvania Department of Environmental Protection
National Pollutant Discharge Elimination System Permit	PA 0009920	Issued: 10/30/2007 Expires: 10/31/2012	Pennsylvania Department of Environmental Protection
Maintenance Dredging Permit	CENAB-OP-RPA (AmerGen 197500083-4)	Issued: 1/3/2006 Expires: 12/31/2015	U.S. Army Corps of Engineers
Maintenance Dredging Permit	21275724	Issued: 1/13/1976 Expires: Not Listed	Pennsylvania Department of Environmental Protection
Public Water Supply Permit	22296501-T1	Issued: 1/20/2000 Expires: Not Listed	Pennsylvania Department of Environmental Protection
Public Water Supply Permit	22296501-T2	Issued: 1/20/2000 Expires: Not Listed	Pennsylvania Department of Environmental Protection

Permit	Number	Dates	Responsible Agency
Acknowledgement of Notification of Regulated Waste Activity	PAR 000037861	Issued: 3/22/1999 Expires: Not Listed	U.S. Environmental Protection Agency
Storage Tank Registration/Permit Certificate	22-60170	Issued: 6/4/2007 Expires: 6/4/2008 (Annual Renewal)	Pennsylvania Department of Environmental Protection
Hazardous Materials Certificate of Registration	022307-701-002PR	Issued: 5/16/2007 Expires: 6/30/2010	U.S. Department of Transportation
Flammable and Combustible Liquid Storage Tank Approval	168,466	Issued: 6/12/1970 Expires: Not Listed	Pennsylvania Department of Labor and Industry
Flammable and Combustible Liquid Storage Tank Approval	168,465	Issued: 6/12/1970 Expires: Not Listed	Pennsylvania Department of Labor and Industry
Flammable and Combustible Liquid Storage Tank Approval	187,165	Issued: 11/17/1977 Expires: Not Listed	Pennsylvania Department of Labor and Industry
Flammable and Combustible Liquid Storage Tank Approval	203,271-B	Issued: 8/4/1989 Expires: Not Listed	Pennsylvania Department of Labor and Industry
Flammable and Combustible Liquid Storage Tank Approval	122-203,393	Issued: 9/22/1989 Expires: Not Listed	Pennsylvania Department of Labor and Industry
Sewage Disposal System Permit Modification	C179678 and C21434	Issued: 1/1/1995 Expires: Not Listed	Pennsylvania Department of Environmental Protection
Sewage Sludge Disposal Agreement	Letter Agreement	Issued: 6/20/2000 Expires: Not Listed	Pennsylvania Department of Environmental Protection
Environmental Laboratory Accreditation Certification	Reg. No. 22-00649	Issued: 4/17/2007	Pennsylvania Department of

Permit	Number	Dates	Responsible Agency
		Expires: 4/30/2008	Environmental Protection
On Lot Sewage Disposal System Permit	U003282	Issued: 8/10/2007 Expires: Not Listed	Pennsylvania Department of Environmental Protection

1.10 References

10 CFR Part 51. Code of Federal Regulations, *Title 10, Energy,* Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

73 FR 13923. U.S. Nuclear Regulatory Commission, Washington, D.C., "Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing; Regarding Renewal of Facility Operating License No. DPR-50 for an Additional 20-Year Period; AmerGen Energy Company, LLC Three Mile Island Nuclear Station, Unit 1." *Federal Register:* Vol. 73, No. 51, pp. 13923–13925. March 14, 2008.

73 FR 16729. U.S. Nuclear Regulatory Commission, Washington, D.C., "Three Mile Island Nuclear Station, Unit 1; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register:* Vol. 73, No. 61, pp. 16729–16731. March 28, 2008.

AmerGen (AmerGen Energy Company, LLC). 2008. "Three Mile Island Generating Station, Unit 1, License Renewal Application." ADAMS No. ML080220207.

AmerGen (AmerGen Energy Company, LLC). 2008a. "Three Mile Island Nuclear Station, Applicant's Environmental Report, License Renewal Operating Stage." Kennett Square, Pennsylvania. ADAMS Nos. ML080220255, ML080220257, ML080220261, and ML080220282.

Atomic Energy Act of 1954. 42 U.S.C. 2011, et seq.

Endangered Species Act of 1973. 16 U.S.C. 1531, et seq.

Magnuson-Stevens Fishery Conservation and Management Act, as amended by the *Sustainable Fisheries Act of 1996*. 16 U.S.C. 1855, et seq.

National Environmental Policy Act of 1969. 42 U.S.C. 4321, et seq.

National Historic Preservation Act. 16 U.S.C. 470, et seq.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C. ADAMS No. ML061770605.

NRC (U.S. Nuclear Regulatory Commission). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 – Transportation, Table 9.1, Summary of findings on NEPA issues for license renewal of nuclear power plants, Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 2008. "Summary of Site Audit Related to the Review of the License Renewal Application for Three Mile Island Nuclear Station, Unit 1*.*" ADAMS No. ML081420398.

NRC (U.S. Nuclear Regulatory Commission). 2008b. "Environmental Impact Statement Scoping Process Summary Report, Three Mile Island Nuclear Station, Unit 1." ADAMS No. ML081920230.

2.0 AFFECTED ENVIRONMENT

Three Mile Island Nuclear Station, Unit 1 (TMI-1) is located in Londonderry Township of Dauphin County about 3 miles (mi) (4.8 kilometers [km]) south of Middletown, Dauphin County, and about 1.25 mi (2 km) east of the community of Goldsboro, York County. The site is approximately 10 mi (16 km) southeast of Harrisburg, Pennsylvania (AEC 1972). Figures 2-1 and 2-2 present the 50-mi (80-km) and 6-mi (10-km) vicinity maps, respectively. For purposes of the evaluation in this report, the “affected environment” is the environment that currently exists at and around TMI-1. Because existing conditions are at least partially the result of past construction and operation at the plant, the impacts of these past and ongoing actions and how they have shaped the environment are presented here. Section 2.1 of this report describes the facility and its operation, and Section 2.2 discusses the affected environment.

2.1 Facility Description

This assessment of the affected environment begins with a description of TMI-1, the source of potential environmental effects. TMI-1 is a pressurized-water reactor (PWR) utilizing once-through steam generators and licensed to operate at a power level of 2568 megawatt-thermal (MWt). Certain buildings and structures associated with Three Mile Island, Unit 2 (TMI Unit 2), which is owned by FirstEnergy Corporation (FirstEnergy), are intermingled with TMI-1 and its associated structures. TMI Unit 2 has been shut down since the accident in March 1979. Since December 1993, it has been in a stable, safe storage mode called post defueling monitored storage (AmerGen 2008).

The most conspicuous structures on the TMI-1 site are the four, 370-foot, hyperbolic, natural draft cooling towers. The two cooling towers to the south are inactive and were formerly utilized by the TMI Unit 2 reactor system. The two northern cooling towers are associated with the TMI-1 reactor. Other salient buildings on the TMI-1 site include the reactor building, auxiliary building, fuel-handling building, station blackout diesel generator building, intake screen and pump house, and the turbine building(AmerGen 2008). Figure 2-3 provides a general layout of the TMI-1 site.

2.1.1 Reactor and Containment Systems

TMI-1 is a single-unit plant with a Babcock and Wilcox PWR. Gilbert Associates, Inc. was the architect-engineer for TMI-1 (AEC 1972). TMI-1 received its construction permit in 1968 and its operating license in 1974, and began commercial operation on September 2, 1974. The initial licensed core thermal power of TMI-1 was 2535 MWt. In July 1988, the NRC approved a measurement uncertainty recapture uprate that increased the core thermal power by 1.3 percent to 2568 MWt (NRC 1996).

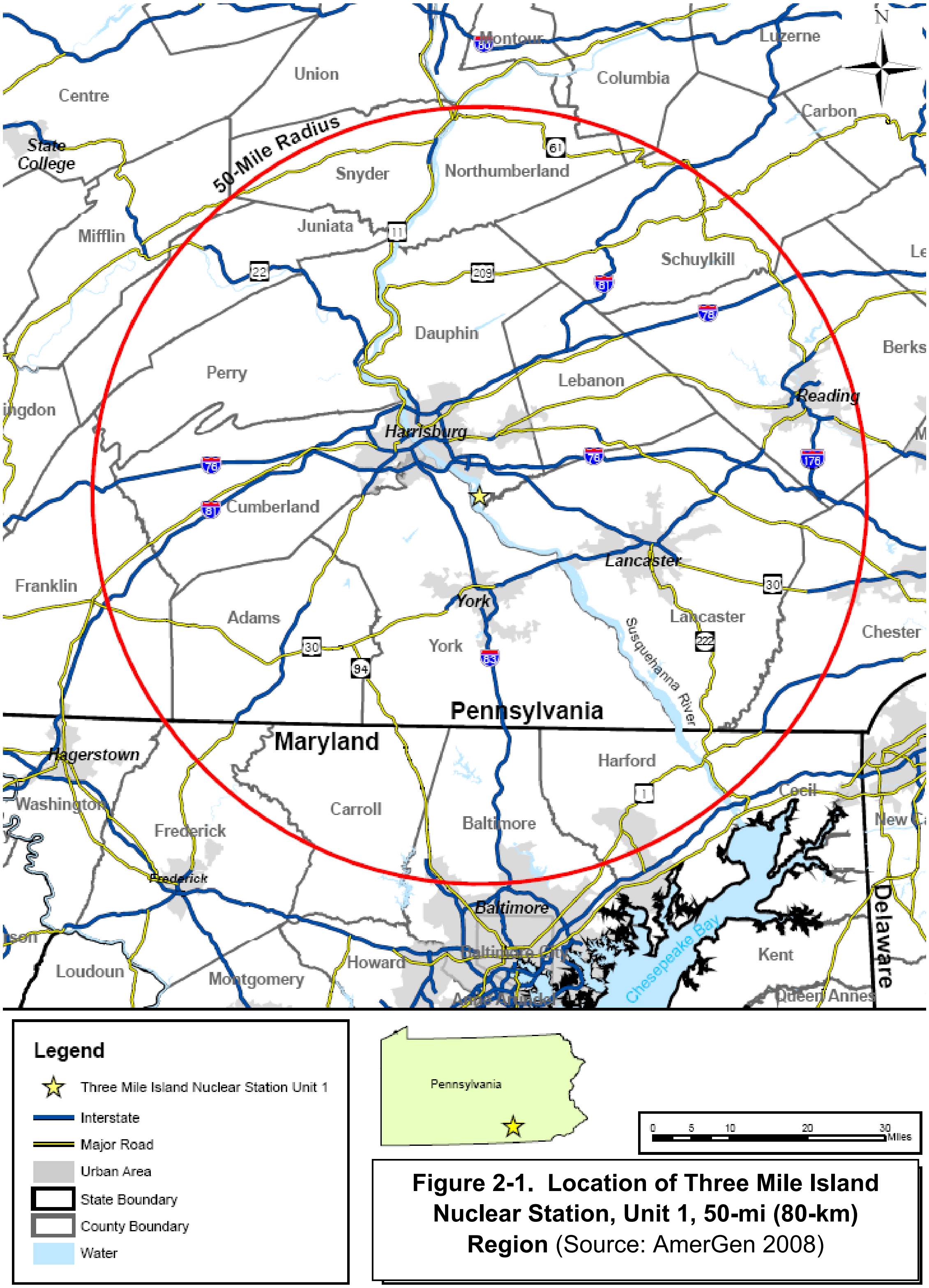


Figure 2-1. Location of Three Mile Island Nuclear Station, Unit 1, 50-mi (80-km) Region (Source: AmerGen 2008)

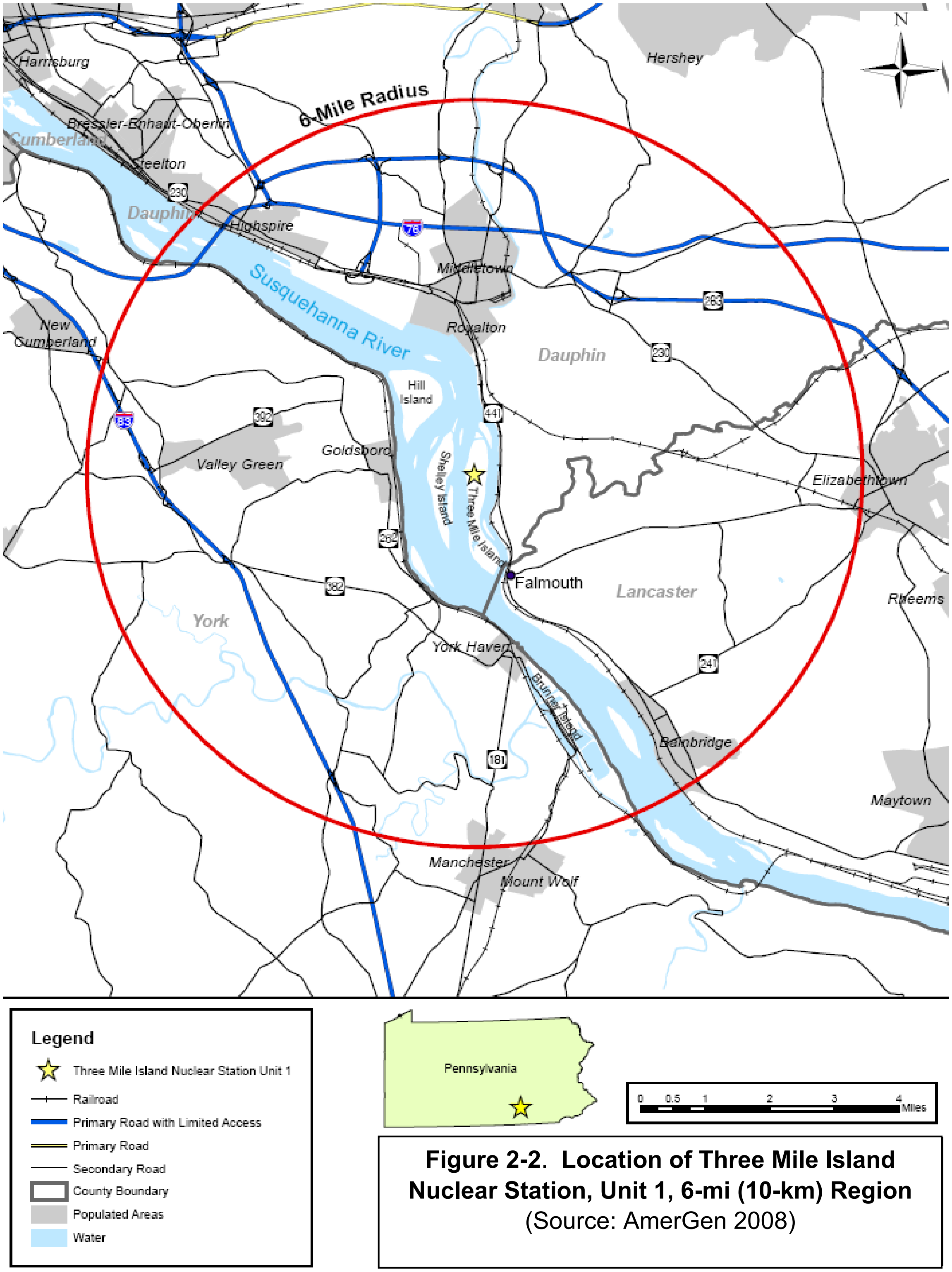


Figure 2-2. Location of Three Mile Island Nuclear Station, Unit 1, 6-mi (10-km) Region
(Source: AmerGen 2008)

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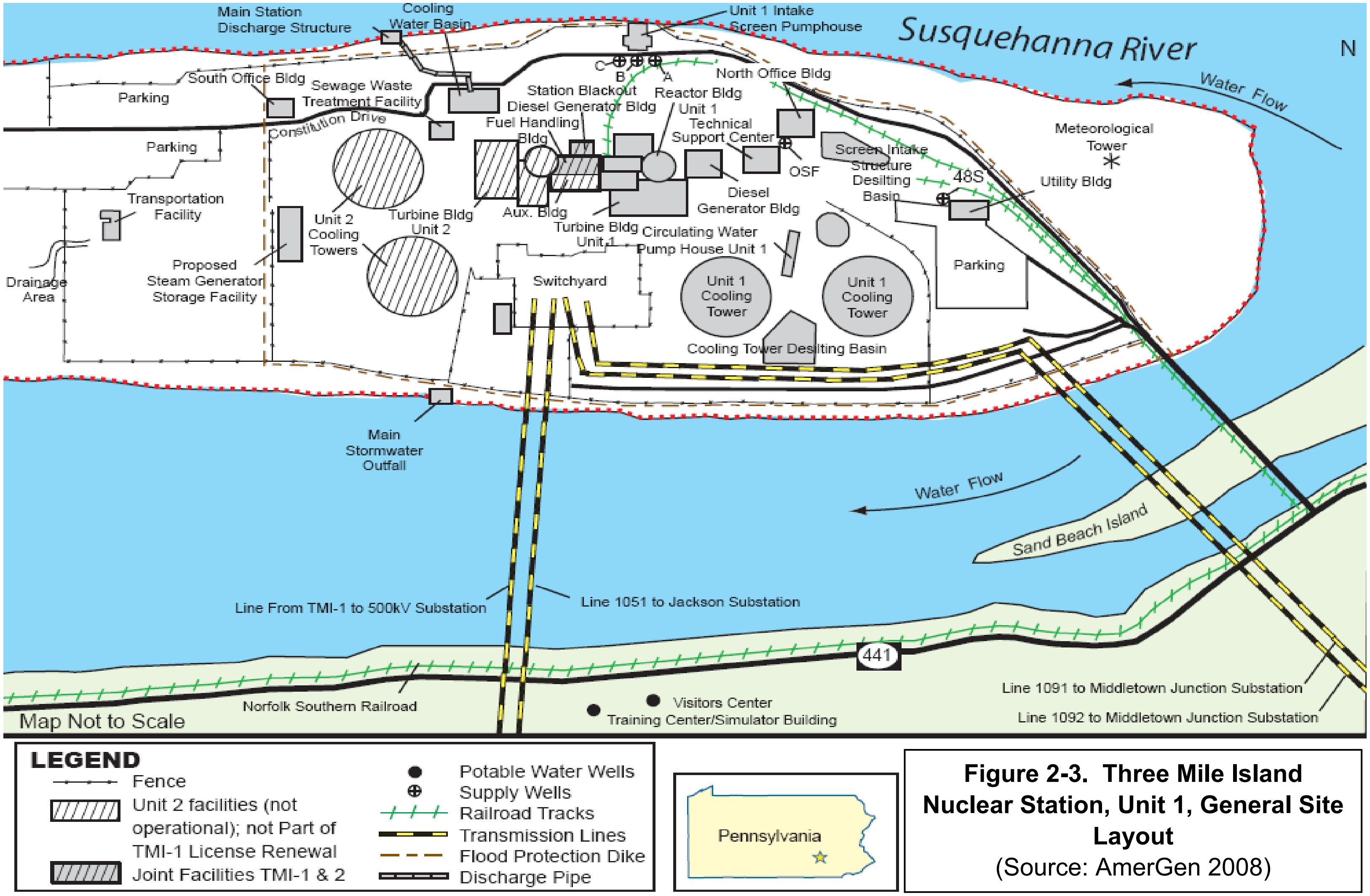

Figure 2-3. Three Mile Island Nuclear Station, Unit 1, General Site Layout
(Source: AmerGen 2008)

The reactor fuel is sintered low-enriched uranium dioxide pellets sealed in zirconium-based alloy tubing and caps (AmerGen 2008). Core reactivity is controlled by 69 movable control rod assemblies and borated water (boric acid is a neutron absorber). The control rods are silver-indium-cadmium alloy encapsulated in stainless steel. Control rods are used for short-term reactivity control associated with changes in power level and with changes in fuel burnup between adjustments in reactor coolant dissolved boron concentrations. If a reactor trip signal is received, all 69 control rod assemblies fall into the core by gravity (AEC 1972).

In the PWR power generation system, reactor heat is transferred from the primary coolant to a lower pressure secondary coolant loop, allowing steam to be generated in the steam supply system. The primary coolant loops each contain one steam generator, two centrifugal coolant pumps, and the interconnected piping. Reactor coolant is pumped from the reactor through the steam generators and back to the reactor inlet by two centrifugal coolant pumps located at the outlet of each steam generator. Each steam generator is a vertical straight tube-and-shell heat exchanger that produces superheated steam at a constant pressure over the reactor operating power range. Coolant flows downward through the tubes, and steam is generated on the lower pressure shell side. Steam then flows from the steam generators to the 1800-revolutions per minute, tandem compound, six-flow turbine generator, manufactured by General Electric (AEC 1972). NUREG/CR-5640, “Overview and Comparison of U.S. Commercial Nuclear Power Plant, Nuclear Power Plant System Source” (NRC 1990), provides a comprehensive overview and description of the PWR power generation system.

The primary containment is the reactor building and its associated isolation systems. The reactor building consists of a reinforced concrete slab and structure with cylindrical wall, a flat foundation mat, and a shallow dome roof. The 3-ft (1-meter [m]) concrete cylindrical wall is pre-stressed with a post-tensioning system in the vertical and horizontal directions. The dome roof is pre-stressed using a three way post-tensioning system. The inside surface of the reactor building is lined with a carbon steel liner 3/4-inch (1.9 centimeter [cm]) thick for the cylinder and dome and 1/4-inch (0.63 cm) thick for the base.

2.1.2 Radioactive Waste Management

TMI-1 radioactive waste systems are designed to collect, treat, and dispose of the radioactive and potentially radioactive wastes that are byproducts of plant operations. Byproducts include: activation products created from the irradiation of reactor water and impurities contained in that water (which are principally metallic corrosion products); and fission products created by defective fuel cladding or uranium contamination within the reactor coolant system (AmerGen 2008). Operating procedures for radioactive waste systems ensure that radioactive wastes are safely processed and discharged from the plant within the limits set forth in 10 CFR Part 20, “Standards for Protection against Radiation,” 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” the plant’s technical specifications, and the TMI-1 offsite dose calculation manual (ODCM) (AmerGen 2007a).

Radioactive wastes resulting from plant operations are classified as liquid, gaseous, or solid. Liquid radioactive wastes are generated from liquids received directly from portions of the reactor coolant system or were contaminated by contact with liquids from the reactor coolant system. Gaseous radioactive wastes are generated from gases or airborne particulates vented from reactor and turbine equipment containing radioactive material. Solid radioactive wastes are solids from the reactor coolant system, solids that came into contact with reactor coolant system liquids or gases, or solids used in the reactor coolant system or steam and power conversion system operation or maintenance (AmerGen 2006a).

Reactor fuel that has exhausted a certain percentage of its fissile uranium content is referred to as spent fuel. Spent fuel assemblies are removed from the reactor core and replaced with fresh fuel assemblies during routine refueling outages, typically every 24 months. Spent fuel assemblies are then stored for a period of time in the spent fuel pool in the reactor building.

The TMI-1 ODCM contains the methodology and parameters used to calculate offsite doses resulting from radioactive gaseous and liquid effluents, and the gaseous and liquid effluent monitoring alarm and trip setpoints used to verify the radioactive material being discharged meets regulatory limits (AmerGen 2007a). The ODCM also contains the radioactive effluent controls and radiological environmental monitoring activities and descriptions of the information that should be included in the annual radiological environmental operating report and annual radioactive effluent release report required by Appendix I, “Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion ‘As Low as is Reasonably Achievable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents,” to 10 CFR Part 50 and 10 CFR 50.36a, “Technical Specifications on Effluents from Nuclear Power Reactors,” respectively.

2.1.2.1 Radioactive Liquid Waste

The TMI-1 radioactive liquid waste disposal system collects, holds, treats, processes, and monitors all liquid radioactive wastes for reuse or disposal. The system is divided into several subsystems so liquid wastes from various sources can be segregated and processed separately. Cross-connections between the subsystems provide additional flexibility for processing the wastes by alternate methods. The wastes are collected, treated, and disposed of according to their conductivity and/or radioactivity (AmerGen 2006a).

Radioactive liquid waste from TMI-1 is collected in sumps and drainage tanks and transferred to the appropriate subsystem collection tanks for subsequent treatment, disposal, or recycle. The liquid wastes are processed by a series of components which employ various processes specifically designed to provide maximum decontamination factors. The processing methods used include filtration, reverse osmosis, and/or demineralization. Following treatment, the processed wastes in the waste evaporator condensate tank, waste monitor tanks, or secondary liquid waste monitor tanks are analyzed for chemical and radioactive content before being discharged. In addition, the system can handle effluent streams that typically do not contain radioactive material, but that may, on occasion, become radioactive. Liquid radioactive wastes released to the west channel of the Susquehanna River are limited to the maximum extent possible to satisfy the design objectives of Appendix I to 10 CFR Part 50. Liquid discharges occur when the radioactive material has been analyzed and the projected dose to members of the public has been calculated to be within the values specified in the ODCM, 10 CFR Part 20, and Appendix I to 10 CFR Part 50 (AmerGen 2006a).

The NRC staff reviewed the TMI-1 radioactive effluent release reports for 2003 through 2007 for liquid effluents (AmerGen 2004b, 2005b, 2006b, 2007a, 2008b). Based on the liquid waste processing systems and effluent controls and performance from 2003 through 2007, the liquid discharges for 2007 are consistent with the radioactive liquid effluents discharged from 2003 through 2006. Variations on the amount of radioactive effluents released from year to year are expected based on the overall performance of the plant and the number and scope of outages and maintenance activities. The liquid radioactive wastes reported by TMI-1 are reasonable and no unusual trends were noted.

AmerGen intends to replace the TMI-1 steam generators before the period of extended operation. Such an action is not likely to significantly increase the amount of liquid radioactive effluents above the amount discharged during normal plant operations. This is because any liquids generated, processed, and released during the outage will be offset by the amount of liquid waste that would not be generated, processed, and released during normal plant operations. Based on the historical evaluation and because a significant increase in liquid effluents from the potential repair or replacement of the TMI-1 steam generators is not expected, similar quantities of radioactive effluents are expected to be generated during normal operations and outages from TMI-1 during the period of extended operations. The liquid releases during refurbishment will still be controlled and limited to satisfy the dose objectives of Appendix I to 10 CFR Part 50. These releases would result in doses to members of the public that are well below the ALARA dose design objectives, as discussed in Section 4.8.1 of this report.

2.1.2.2 Radioactive Gaseous Waste

The TMI-1 radioactive gas waste disposal system processes and disposes of routine radioactive gaseous effluent to the atmosphere. The system comprises reactor coolant drain tanks, miscellaneous waste storage tanks, waste gas, decay tanks, waste gas compressors, and charcoal and high efficiency particulate filters, to accumulate, store, and process the waste fission product gases. Before gaseous radioactive waste is released to the atmosphere through the plant vents, the gas must be analyzed to determine and document the amount of radioactivity being released (AmerGen 2006a).

TMI-1 discharges gaseous waste in accordance with the procedures and methodology described in the ODCM. The gaseous radioactive waste system is used to reduce radioactive materials in gaseous effluents before discharge to meet the dose limits in 10 CFR Part 20 and the ALARA dose design objectives in Appendix I to 10 CFR Part 50.

The NRC staff reviewed the TMI-1 radioactive effluent release reports for 2003 through 2007 for liquid effluents (AmerGen 2004b, 2005b, 2006b, 2007a, 2008b). Based on the gaseous waste processing systems and effluent controls and performance from 2003 through 2007, the gaseous discharges for 2007 are consistent with the radioactive gaseous effluents discharged from 2003 through 2006. Variations on the amount of radioactive effluents released from year to year are expected based on the overall performance of the plant and the number and scope of outages and maintenance activities. The radioactive gaseous wastes reported by TMI-1 are reasonable and no unusual trends were noted.

AmerGen intends to replace the TMI-1 steam generators before the period of extended operation. This action is not likely to result in a significant increase in the amount of radioactive gaseous waste discharged over the amount discharged during normal plant operations, because any radioactive gaseous waste generated, processed, and released during the outage will be offset by the amount of radioactive gaseous waste that would not be generated, processed, and released during normal plant operations. Based on the historical evaluation and because no significant increase in radioactive gaseous effluents from the potential repair or replacement of the TMI-1 steam generators is anticipated, similar quantities of radioactive gaseous effluents are expected to be generated during normal operations and outages from TMI-1 during the period of extended operations. The radioactive gaseous waste releases to the environment during the refurbishment will still be controlled and limited to satisfy the dose objectives of Appendix I to10 CFR Part 50. These releases would result in doses to members of the public that are well below the ALARA dose design objectives, as discussed in Section 4.8.1.

2.1.2.3 Solid Radioactive Waste

The TMI-1 radioactive solid waste disposal system is designed to safely collect, process, store, and prepare wet and dry solid radioactive waste materials for onsite storage and offsite shipment. The system consists of a wet process stream used to collect, process, dewater, and solidify wet solid wastes, and a dry process stream used to collect and package dry solid wastes. Wet solid wastes include spent resins, filter cartridges, and filter crud. Dry solid wastes include contaminated rags, clothing, paper, outage equipment, and other radioactively contaminated equipment (AmerGen 2006a). Transportation of the radioactive solid waste is conducted in accordance with NRC and U.S Department of Transportation (DOT) regulations as specified in 10 CFR Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste,” and 10 CFR Part 71, “Packaging and Transportation of Radioactive Material.”

The NRC staff reviewed the TMI-1 solid radioactive waste reports for 2003 through 2007 (AmerGen 2004b, 2005b, 2006b, 2007a, 2008b). The solid waste volumes and radioactivity amounts generated in 2007 are typical of previous annual waste shipments made by TMI-1. Variations in the amount of solid radioactive waste generated and shipped from year to year are expected based on the overall performance of the plant and the number and scope of maintenance work outages. The volume and activity of solid radioactive wastes reported by TMI-1 are reasonable and no unusual trends were noted.

AmerGen intends to replace the TMI-1 steam generators before the period of extended operation. Such an action is likely to result in a small increase in the amount of solid radioactive waste generated. This is based on an increase in the number of personnel working at the plant which will result in the generation of more solid waste during the outage and any other associated related work. An outage of this type will also result in an increased use of protective clothing, safety equipment, and filters, as well as a general increase in the generation of debris that will have to be disposed of as radioactive waste. The increased volume is expected to be within the range of solid waste that can be safely handled by TMI-1 during the period of extended operations. The transportation of the radioactive solid wastes related to the refurbishment activities will be conducted in accordance with NRC and DOT regulations as specified in 10 CFR Part 61 and 10 CFR Part 71.

Low-level mixed waste (LLMW) is waste that exhibits hazardous characteristics and contains low levels of radioactivity. LLMW has been regulated under multiple authorities. The U.S. Environmental Protection Agency (EPA) or State agencies regulate the hazardous component of LLMW through the Resource Conservation and Recovery Act (RCRA), and either the U.S. Department of Energy (DOE) or the NRC regulates the radioactive component. TMI-1 has not had any LLMW stored on site for the past 5 years and does not expect to have to store any in the foreseeable future.

The State of South Carolina’s licensed low-level radioactive waste disposal facility, located in Barnwell, has limited the access from radioactive waste generators located in States that are not part of the Atlantic Low-Level Waste Compact. Pennsylvania is not a member of the Atlantic Low-Level Waste Compact. This has impacted the ability of TMI-1 to dispose of its low-level solid radioactive waste and necessitated the need for TMI-1 to store its low-level solid radioactive waste on site. TMI-1 has decided to store its low-level solid radioactive waste in the solid waste staging facility (SWSF). The NRC staff has reviewed the TMI-1 SWFS plant procedure and has found that the SWSF performs no active function and was used for temporary staging of low-level radioactive waste before preparation for shipment and disposal. Because the SWSF is located outside and is exposed to the weather, the concrete structure and individual cells utilize gaskets, slots and weep holes, a drainage piping system, and a common sump, with its associated equipment and instrumentations, to protect the waste containers and to control the disposal of any effluent that may collect in the sump. TMI-1 has a monitoring, inspection, and testing program, which includes periodic evaluation of the operability and functional performance of active components of the SWSF system. The SWSF was designed to provide a controlled but ready access for material handling operations, to ensure that worker radiation exposures are controlled in accordance with the ALARA criteria, and to ensure that the offsite dose does not exceed any of the Federal limits specified in 10 CFR Part 20, as well as the EPA radiation standards in 40 CFR Part 190, “Environmental Radiation Protection Standards for Nuclear Power Operations.”

2.1.3 Nonradiological Wastes

RCRA governs the disposal of solid and hazardous waste. RCRA regulations are contained in Title 40, “Protection of the Environment,” Parts 239 through 299 (40 CFR 239, et seq.), of the *Code of Federal Regulations*. Parts 239 through 259 of Title 40 contain regulations for solid (nonhazardous) waste, and Parts 260 through 279 contain regulations for hazardous waste. RCRA Subtitle C establishes a system for controlling hazardous waste from “cradle to grave,” and RCRA Subtitle D encourages States to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills (EPA 2007). Pennsylvania State RCRA regulations are administered by the Division of Hazardous Waste Management of the Pennsylvania Department of Environmental Protection (PADEP) and address the identification, generation, minimization, transportation, and final treatment, storage, or disposal of hazardous and nonhazardous wastes. TMI-1 generates nonradiological waste including oils, hazardous and nonhazardous solvents and degreasers, laboratory wastes, expired shelf-life chemicals and reagents, asbestos wastes, paints and paint thinners, antifreeze, non-routine (i.e., project-specific) wastes, point-source discharges regulated under the National Pollutant Discharge Elimination System (NPDES), sanitary waste (including sewage), and routine, daily refuse (AmerGen 2008).

2.1.3.1 Hazardous Waste

Hazardous waste means solid waste, or a combination of solid wastes, which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause or contribute to an increase in mortality or serious illness. Such waste may also pose a significant present or potential hazard to human health or the environment if it is not properly treated, stored, transported, disposed of, or otherwise handled (40 CFR Part 261, “Identification and Listing of Hazardous Waste”). TMI-1 generates a variety of hazardous waste including spent and off-specification chemicals, laboratory chemical wastes, hazardous solvents and degreasers, and occasional project-specific wastes. TMI-1 is classified as a “small quantity generator” of hazardous waste because the plant generates less than 1000 kilograms of hazardous waste in 1 month, and no more than 6000 kilograms of hazardous waste may be accumulated on site at any one time (EPA 2007a).

According to the EPA Envirofacts Warehouse, TMI-1 is classified as an active small quantity generator of hazardous wastes (EPA ID No. PAR000037861). The Envirofacts Warehouse database showed no violations for TMI-1 (EPA 2008a). During the site audit, the NRC viewed the TMI-1 waste storage building, which is a central facility designed for the safe and proper collection, sorting, packaging, and shipment of hazardous wastes. Also during the site audit, NRC staff reviewed AmerGen’s hazardous waste procedures and determined they complied with applicable RCRA regulations.

2.1.3.2 Residual Waste

TMI-1 generates solid waste, as defined by RCRA, as part of routine plant maintenance, cleaning activities, and plant operations. In Pennsylvania, solid waste is further classified as either municipal waste or residual waste by PA Code Article VIII and Article IX, respectively, based on its origin. TMI-1 nonhazardous solid waste is classified as residual waste. In Pennsylvania, residual waste is defined as nonhazardous industrial waste, including solid, liquid, or gaseous waste material produced by industrial, mining, or agricultural operations (PA Code Article IX). In addition to plant garbage, residual wastes generated at TMI-1 include nonhazardous waste oil and oily debris resulting from maintenance of oil-filled equipment; nonhazardous sludge from the industrial water supply treatment facility, waste water facility, or air pollution control facility; nonhazardous solvents and degreasers; asbestos; antifreeze; and occasional project-specific nonhazardous wastes. In 2007 TMI-1 generated approximately 26 tons (t) (24 MT) of residual waste, not including approximately 198 t (179 MT) of garbage, of which approximately 188 t (170 MT) was incinerated at a resource recovery facility (AmerGen 2008d).

2.1.3.3 Universal Waste

Universal waste is hazardous waste that is generated in a variety of settings and by a vast community and poses collection and management problems and often is not appropriately managed under existing hazardous waste regulations. EPA classifies several hazardous wastes as universal wastes including batteries, certain pesticides, mercury-containing devices, and fluorescent lamps (40 CFR Part 273, “Standards for Universal Waste Management”). Pennsylvania has incorporated by reference the EPA regulations regarding universal wastes. TMI-1 is a small quantity handler of universal waste (meaning the facility cannot accumulate more than 5000 kilograms (approximately 11,000 pounds) of universal waste at any one time), generating common operational wastes such as lighting ballasts containing polychlorinated biphenyls (PCBs), lamps, and batteries. In 2007 TMI-1 generated approximately 7,271 pounds (3,298 kilograms) of universal wastes (AmerGen 2008d).

2.1.3.4 Mixed Waste

As previously discussed in Section 2.1.2.3, LLMW contains both low-level radioactive waste and RCRA hazardous waste (40 CFR Part 266, “Storage, Treatment, Transportation, and Disposal of Mixed-Waste”). Pennsylvania has incorporated by reference Federal regulations exempting LLMW from RCRA storage and treatment regulations, provided the waste meets specific conditions (PADEP 2001). TMI-1 has not generated any mixed waste in the past five years (AmerGen 2008d).

2.1.3.5 Permitted Discharges

TMI-1 generates two types of wastewater—industrial effluents and sanitary liquid wastes, both of which are discharged to the Susquehanna River according to the TMI-1 Individual Wastewater Discharge NPDES Permit No. PA0009920, enforced by PADEP (radioactive liquid waste is addressed in Section 2.1.2.1 of this report). Normal operating processes used to control the pH of the reactor coolant prevent scale and erosion in the cooling system and clean and defoul the condenser of biological organisms that generate chemical and biocide wastes. Waste liquids containing chemicals from these processes are combined with cooling tower blowdown and are discharged to the Susquehanna River according to the limitations contained in the TMI-1 NPDES permit. The industrial waste treatment system provides treatment of secondary plant sumps and drains to meet NPDES permit effluent limitations. Treatment includes settling and filtration to remove solids, an air flotation unit to remove oil and grease, and pH adjustment. TMI-1 has an onsite sewage treatment plant to treat sanitary wastewater generated by the plant. The sewage treatment plant averages approximately 11,000–12,000 gallons (41,640-45,420 liters [L]) of effluent per day; approximately 7,000 gallons (26,500 L) are treated effluent and approximately 4,000 gallons (15,140 L) are filtered water used to deliver chlorine gas to the effluent for disinfection. Digested sanitary sludge from the sewage treatment plant is analyzed for radionuclides and transferred to a PADEP-approved agriculture utilization facility for disposal (AmerGen 2008d). Section 2.1.7.3 of this report provides more information on TMI-1 NPDES permit and effluent limitations.

2.1.3.6 Pollution Prevention and Waste Minimization

Currently, TMI-1 implements a waste minimization program which consists of steps such as segregating hazardous and nonhazardous wastes, choosing nonhazardous substitutes when possible, recycling or reclaiming appropriate waste materials, monitoring expired chemicals to determine minimum stocking requirements to reduce recurring excess, finding alternate uses for excess materials, or returning unused materials to the manufacturer. Currently TMI-1 does not recycle common waste materials such as paper, plastic, or aluminum.

In support of nonradiological waste minimization efforts, the EPA Office of Pollution Prevention and Toxics established a clearinghouse that provides information regarding waste management and technical and operational approaches to pollution prevention. The EPA clearinghouse can be used as a source for additional opportunities for waste minimization and pollution prevention at TMI-1, as appropriate (EPA 2008b).

EPA also encourages the use of environmental management systems (EMSs) for organizations to assess and manage the environmental impact associated with their activities, products, and services in an efficient and cost-effective manner. EPA defines an EMS as “a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.” EMSs help organizations fully integrate a wide range of environmental initiatives, establish environmental goals, and create a continuous monitoring process to help meet those goals. The EPA Office of Solid Waste especially advocates the use of EMSs at RCRA-regulated facilities to improve environmental performance, compliance, and pollution prevention (EPA 2008a). Introductory Web-based EMS training is available at the EPA Web site.[2]

2.1.4 Plant Operation and Maintenance

Maintenance activities conducted at TMI-1 include inspection, testing, and surveillance to maintain the current licensing basis of the facility and to ensure compliance with safety and environmental requirements. Various programs and activities currently exist at TMI-1 to maintain, inspect, test, and monitor the performance of facility equipment. These maintenance activities include inspection requirements for reactor vessel materials, boiler and pressure vessel in-service inspection and testing, a maintenance structures monitoring program, and maintenance of water chemistry (AmerGen 2008c).

Additional programs include those implemented to meet technical specification surveillance requirements, those implemented in response to NRC generic communications, and various periodic maintenance, testing, and inspection procedures. Certain program activities are performed during the operation of the unit, while others are performed during scheduled refueling outages. Nuclear power plants must periodically discontinue the production of electricity for refueling, periodic in-service inspection, and scheduled maintenance. TMI-1 refuels on a 24-month interval (AmerGen 2008c).

2.1.5 Power Transmission System

TMI-1 is connected to the regional grid via four, 230-kilovolt (kV) transmission lines, which total 5.6 mi (9.0 km) in length. These transmission lines are owned by AmerGen, who purchased TMI-1 from FirstEnergy in 1999; however, FirstEnergy continues to operate and maintain the transmission lines and their right-of-ways (ROWs) (AmerGen 2008). Transmission lines considered in scope for license renewal are those constructed to connect the facility to the transmission system (10 CFR 51.53(c)(3)(ii)(H)); therefore, the four lines, Line No. 1091, Line No. 1092, Line No. 1051, and the TMI-1 to TMI-1 500-kV substation line, are considered in scope and are discussed below in detail.

All four transmission lines originate at the TMI-1 switchyard and are shown in Figure 2-4. Line No. 1091 and Line No. 1092 extend 1.5 mi (2.4 km) northeast to the Middletown Junction Substation near Middletown, Pennsylvania. These lines share a 150-ft-wide (46-meter [m]) ROW. Line No. 1051 travels south for 4.1 mi (6.6 km) from the TMI-1 switchyard to the Jackson Substation, which is located near Jackson, Pennsylvania. The fourth line, unnumbered, travels from the TMI-1 switchyard 0.7 mi (1.1 km) to the TMI 500-kV substation. Line No. 1051 and the unnumbered line share a 150-ft-wide (46 m) ROW (AmerGen 2008).

In total, FirstEnergy operates and maintains 5.6 mi (9.0 km) of transmission lines and maintains 142 acres (ac) (57 hectares [ha]) of transmission line ROWs (AmerGen 2008). The four lines cross the Susquehanna River in three locations, as shown in Figure 2-4. The lines do not cross

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[2] Web-based EMS training available URL: http://www.epa.gov/epaoswer/ems/ems-101/ems101.htm

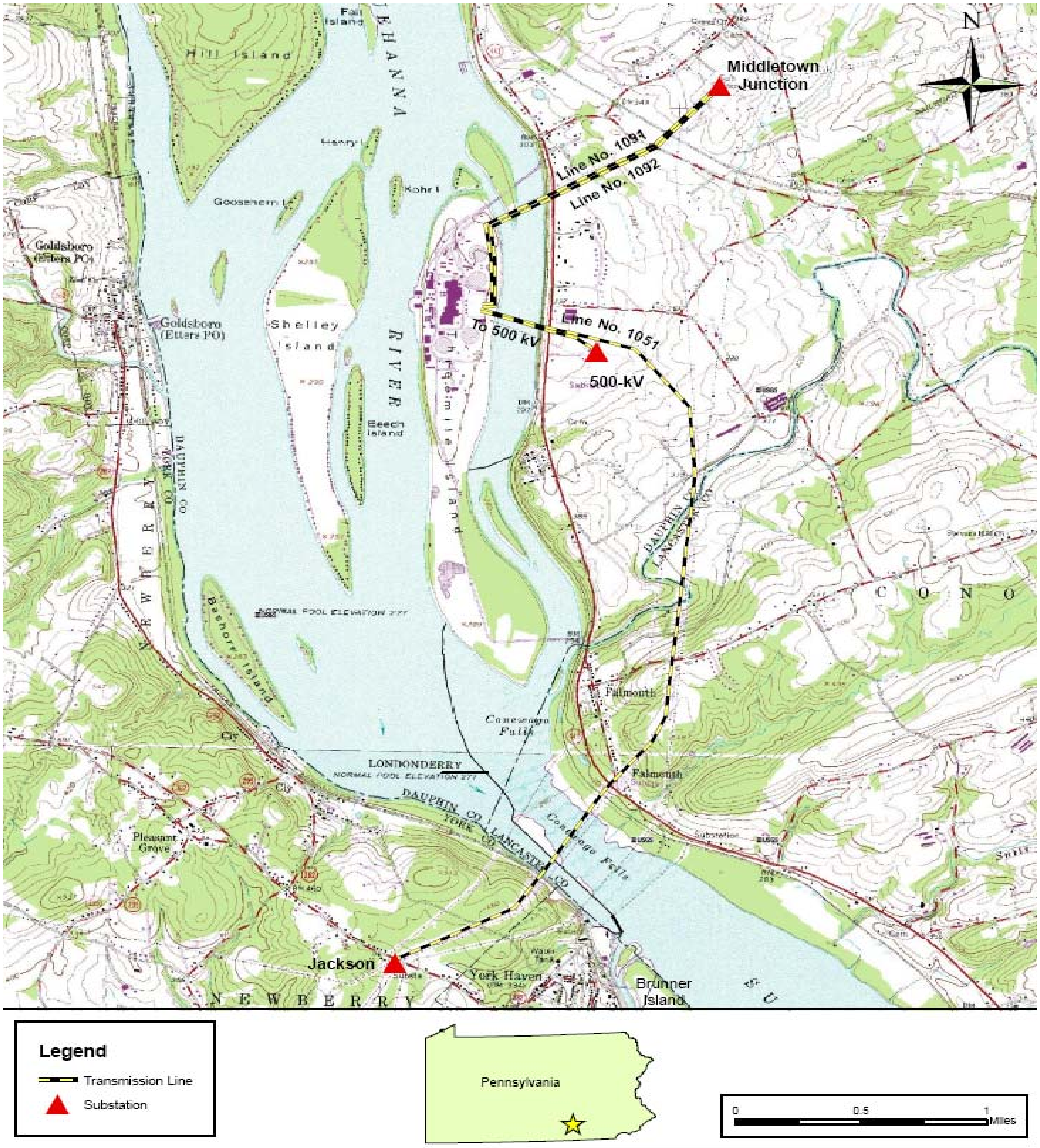

Figure 2-4. Three Mile Island Nuclear Station, Unit 1, Transmission System
(Source: AmerGen 2008)

any Federal, State, or local parks. FirstEnergy has vegetative maintenance procedures in place to prevent vegetation from interfering with the lines (FirstEnergy 2007). ROW vegetative maintenance practices use an integrated vegetation management approach that includes both mechanical and chemical control methods. Mechanical methods consist primarily of mowing, with supplementary pruning, felling, and hand trimming as needed. Chemical control methods consist of application of EPA-approved herbicides and tree-growth-regulating chemicals (FirstEnergy 2008). Procedures are in place to manage environmental incidents that might occur within the ROW, such as a chemical buildup in a wetland area. AmerGen, in conjunction with FirstEnergy staff, limits erosion around stream crossings and wetlands by using appropriate procedures and methods. ROWs that cross farmland or pastures are not maintained by FirstEnergy, as the land is cultivated by the local farmers. FirstEnergy will maintain the existing ROWs regardless of whether TMI-1 is granted a renewed operating license (AmerGen 2008).

2.1.6 Cooling and Auxiliary Water Systems

The TMI-1 circulating water system withdraws cooling water from, and discharges cooling tower blowdown to, the Susquehanna River. TMI-1 uses two hyperbolic natural draft cooling towers to dissipate heat from the plant's steam cycle to the atmosphere. Other systems that dissipate heat from the plant include the secondary services cooling system, the nuclear services cooling system, and the decay-heat cooling system (AEC 1972).

Water that is lost through cooling tower evaporation, wind, and as blowdown returned to the Susquehanna River is termed "makeup" water. Makeup water is obtained from the secondary services river water pumping system. The river intake structure is located on the shoreline of the Susquehanna River and is designed to pump under three river conditions—minimum river level of 271 ft (83 m) ("loss of the York Haven Dam"), normal river elevation of 278 ft (85 m), and flood levels. A deicing line operates during periods of subfreezing temperatures to prevent ice from forming and possibly blocking the intake structure. Under normal operation in subfreezing weather, condenser circulating water is the source of deicing water (AEC 1972).

River water enters the intake structure at a velocity of approximately 0.2 feet per second (ft/s) (0.06 m per second [m/s]), passes under a skimmer wall, travels through automated trash racks with 1-inch vertical bar spacing, through 3/8-inch mesh traveling screens, through the river water pumps, and lastly through 1/8-in mesh strainers before entering the heat exchangers. Once in the heat exchangers, river water mixes with the circulating water in the circulating pumps. The circulating water pump building contains six circulating water pumps—three pumps feed each of the two, 102-inch-diameter mains (AEC 1972). The circulating water system contains a chemical injection system for controlling bacterial and algae growth and metal corrosion (AmerGen 2008). The chemical injection to the circulating water comprises sodium hypochlorite, sulfuric acid, sodium bromide, scale inhibitor, dispersants, and other associated chemicals (AmerGen 2008c).

Under normal operation, maximum withdrawal of makeup water from the Susquehanna River for cooling tower losses is approximately 15,250 gallons per minute (gpm) (34 cubic ft per second [cfs], or 1 cubic meter per second [m^3/s]). Water is pumped to a high point on the site, and cooling tower blowdown is drained by gravity and discharged back to the Susquehanna River through a 48-inch-diameter river discharge line, which is located behind the natural shoreline downstream of the river intake structure. Cooling tower blowdown ranges from 3000 gpm (6.7

cfs, or 0.19 m^3/s) during normal operation to 6000 gpm (13.4 cfs, or 0.38 m^3/s) during maximum operation. Under normal conditions the discharge velocity is 2.7 ft/s (0.8 m/s) with a maximum value of 5.2 ft/s (1.6 m/s) (AEC 1972). The PADEP regulates plant discharges under NPDES Individual Wastewater Discharge Permit No. PA 0009920 (AmerGen 2008). Section 2.1.7.3 of this report discusses the discharges permitted from TMI-1.

The TMI-1 intake structure does not have a fish return system, therefore fish and other aquatic organisms that may become entrained in the TMI-1 intake structure and impinge on the trash racks, traveling screen, or mesh strainers are not returned to the river.

2.1.7 Facility Water Use and Quality

The TMI-1 circulating water system and the service water system both draw water from, and discharge to, the Susquehanna River. Onsite ground water wells also supply water for cooling water makeup, domestic water consumption, and other industrial uses. The following sections detail water use at TMI-1.

2.1.7.1 Ground Water Use

A portion of the water utilized by TMI-1 for its operation is ground water. Specifically, ground water is used for station fire service, makeup water to the demineralized water system, bearing lubrication for the screen house intake pumps, service water for onsite buildings and equipment, and drinking water. Onsite ground water is drawn from three service wells (installed in 1996) as well as two drinking water wells (one of which can also be used, when needed, to supply additional water to the service system). Drinking water is treated on site using a dilute orthophosphate solution, a zinc orthophosphate solution, and a sodium hypochlorite solution, as permitted by PADEP. The site also operates a sanitary wastewater treatment facility, with a capacity of up to 80,000 gallons per day (gpd) (302,833 liters per day [Lpd]) though the typical flow ranges from 10,000 gpd to 15,000 gpd (37,854 Lpd to 56,781 Lpd), with a maximum flow of 40,000 gpd (151,416 Lpd) during outages (AmerGen 2008).

2.1.7.2 Surface Water Use

Susquehanna River water is withdrawn for use in the circulating cooling water system through the intake structure located on the island's western bank. Under typical conditions the flow velocity at the intake structure is around 0.2 ft/s (0.06 m/sec), with a normal river elevation of 277 feet (84.4 m). Approximately 12,250 gpm (27.3 cfs, or 0.8 m^3/s) is withdrawn from the river under these conditions, and the maximum withdrawal of makeup water is approximately 15,250 gpm (34 cfs, or 1.0 m^3/s) (AmerGen 2008). The intake structure is designed to pump river water into the system during normal conditions and during extreme conditions such as the loss of the York Haven Dam and major flood levels (AmerGen 2008).

Cooling tower blowdown typically ranges from 3000 gpm to 6,000 gpm (6.68 to 13.4 cfs, or 0.2 to 0.4 m^3/s) at its maximum. Water not lost by evaporation or drift from the cooling towers is discharged at a rate ranging from 2.7 ft/s to 5.2 ft/s (0.82 m/s to 1.58 m/s) at its maximum, in a manner complying with the plant's NPDES Individual Wastewater Discharge Permit No. PA 0009920 issued by PADEP in October 2007 (AEC 1972; AmerGen 2008).

The primary sources of river water consumption are evaporation and drift losses, and TMI-1 has an SRBC (Susquehanna River Basin Commission) permit allowing for the consumptive use of river water of up to 18 million gpd (mgd) (68 million Lpd) (SRBC 1995). To abide by this permit, TMI-1 takes part in the Cowanesque Reservoir Water Allocation Project. This project keeps TMI-1 from having to shut down in the event of a severe drought in the Susquehanna River by allowing for water stored in the reservoir to be discharged downstream during such an emergency.

2.1.7.3 Surface Water Quality

Between the years 1974 and 1982, Metropolitan Edison and GPU Nuclear performed various studies on the water quality around Three Mile Island to evaluate the impacts of the plant on local water quality (Ichthyological Associates 1983). These studies utilized data on water chemistry, macroinvertebrates, larval and adult fishes, and thermal plume mapping. The last year with available data for both operating units is 1978 because of the accident at TMI Unit 2 in March 1979. During this period of combined operation of the two units, none of the water quality criteria violated the State requirements. The studies examined water quality parameters including turbidity, alkalinity, sulfate, total dissolved solids, total and dissolved copper, and total and dissolved zinc. The data were gathered near both the upstream and downstream discharge structures. Additional measurements of water temperature, pH, and dissolved oxygen were taken at various sampling locations (Ichthyological Associates 1983).

The studies concluded that mean levels for dissolved oxygen, turbidity, total copper, and total zinc peaked in April, whereas water temperature, alkalinity, sulfate, and total dissolved solids peaked in July. Dissolved zinc was highest in November. The data also showed that levels of alkalinity, sulfate, dissolved copper, and total zinc were generally higher values upstream, whereas levels of water temperature, dissolved oxygen, turbidity, total dissolved solids, and dissolved zinc were higher downstream (Ichthyological Associates 1979; 1983).

The Susquehanna River was tested for water temperature and showed a typical pattern of low temperatures in the winter, with highs in the late summer months. Water temperature data obtained immediately below the discharge indicated that the thermal effluent did not heat the surrounding water enough to exceed the temperatures mandated by the State. It also showed that the upstream and downstream temperatures did not differ by over 5 degrees Fahrenheit (°F) (Ichthyological Associates 1979; 1983). Water temperature data collected between March 1979 and 1982 represent ambient conditions because, following the TMI Unit 2 accident, both units were shut down, with TMI-1 not resuming operation until 1985.

In more recent years, AmerGen has collected water temperature data using an automatic temperature sensor located at the intake screen pump house and the discharge monitoring pit, which is before the discharge water is mixed with the river water. Figure 2–5 on the following page represents the recorded daily average discharge and intake temperatures between August 2005 and September 2007, with the 2006 maximum discharge recorded as 110.2°F (43.4 degrees Celsius [°C]) and the 2007 maximum as 101.1°F (38.4 °C) (recorded in August and September, respectively).

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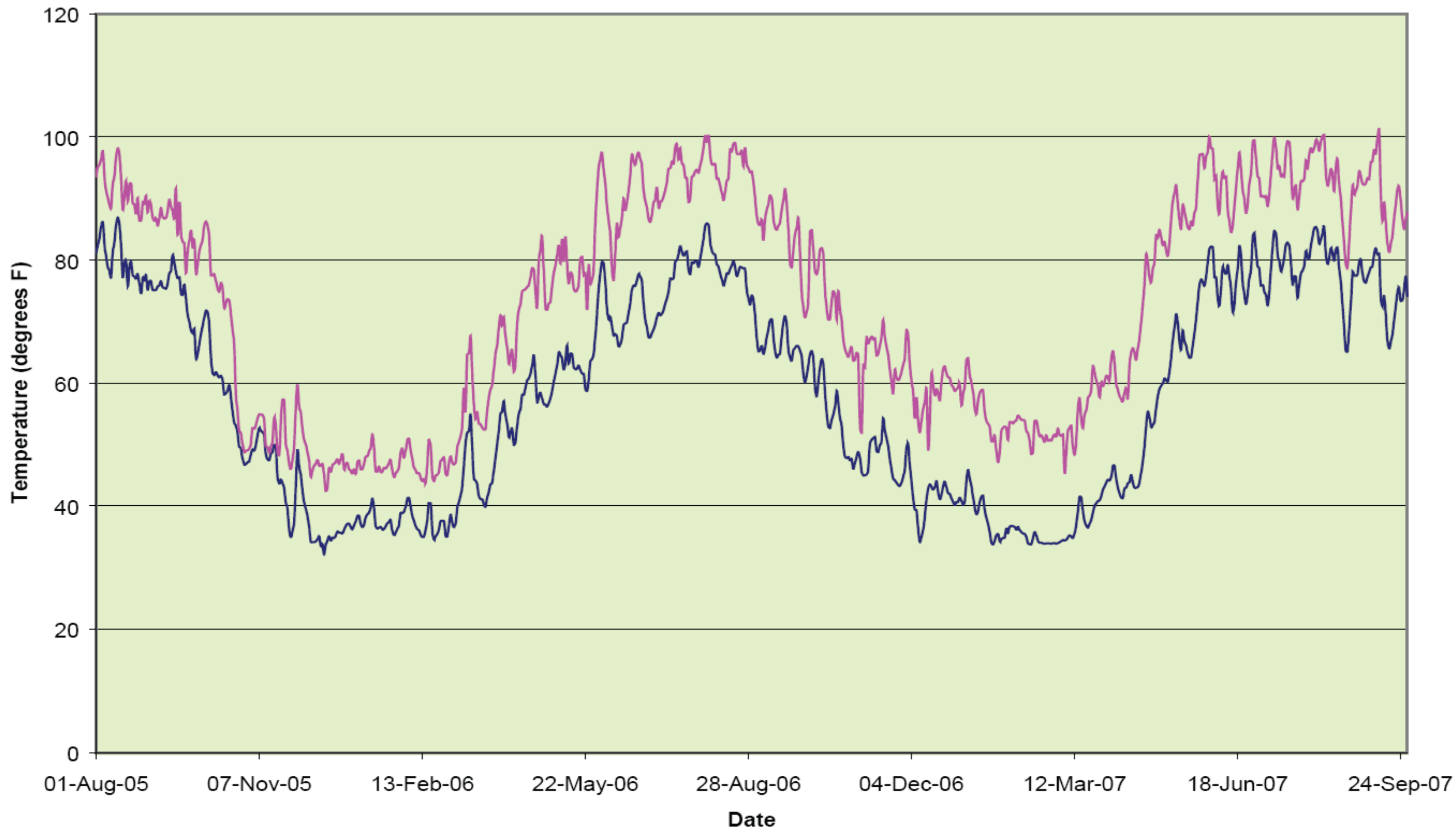


LEGEND

Daily Average Inlet
Daily Average Discharge

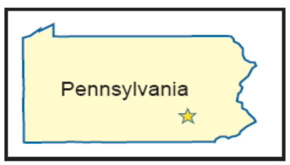


Figure 2-5. Three Mile Island Nuclear Station, Unit 1, Inlet and Discharge Temperatures
(Source: AmerGen 2007c)

Table 2-1 represents the calculated differences between discharge and intake temperature (ΔT) on a month-to-month basis recorded during the same time period. The maximum temperature difference recorded is 30.16 °F in April 2006 (AmerGen 2007c).

Table 2-1. Monthly Average, Minimum, and Maximum ΔT (°F) Based on Automatic Temperature Sensors at the Intake Screen Pump House

Year	Month	Average ΔT	Minimum ΔT	Maximum ΔT
2005	August	11.66	7.50	13.80
	September	11.04	2.76	16.46
	October	11.16	1.61	16.58
	November	5.98	0.78	14.67
	December	11.13	4.74	14.02
2006	January	9.47	6.30	10.77
	February	9.43	6.35	11.67
	March	12.23	5.32	17.04
	April	15.86	11.26	30.16
	May	16.10	7.13	20.61
	June	17.80	8.96	22.68
	July	16.59	9.72	21.17
	August	16.86	11.99	21.88
	September	18.84	10.26	21.56
	October	17.10	10.18	21.27
	November	16.04	4.83	22.41
	December	17.17	5.42	21.71
2007	January	16.88	11.35	20.22
	February	17.32	11.01	19.36
	March	17.35	9.64	24.37
	April	20.55	10.99	28.96
	May	21.01	15.97	27.08
	June	14.87	8.67	19.17
	July	15.01	11.62	18.04
	August	13.95	10.08	16.53
	September	15.56	8.74	20.95

Source: AmerGen 2007c

Historically, monitoring in the Susquehanna River has shown river flow to be a very influential parameter in determining water quality. Over the past few decades of recorded data, mean river flow fluctuated based on snow melt, spring runoff, rain, and periods of drought. A parameter analysis conducted using 17 years of water temperature, pH, and dissolved oxygen data, and 13 years of total dissolved solids data found that trends appear to relate more to meteorological cycles, river flows, and land and water uses than to operations at the TMI-1 site. In addition, the data showed no significant impact of TMI-1 discharge on water quality (Normandeau 2007).

The water quality of the Lower Susquehanna River Basin has considerably improved since the 1970s. Water quality issues in this area were historically dominated by acid mine drainage discharges upstream, which have been considerably reduced, as well as sewage-treatment plant improvements, a ban on phosphate detergents, and improvement of agricultural practices. The concentration of nitrate, however, has been shown to be increasing. A 2002 water quality study conducted by the SRBC collected data from 25 stations along the river, as well as at the mouths of its three major tributaries. Six of these stations were determined to be moderately impaired, and 19 were designated as slightly impaired. Out of the 950 tested water quality data points, 79 were found to exceed the tolerance levels for aquatic life. According to the SRBC report, this is an indication of fairly good water quality (SRBC 2006).

In accordance with the Federal Water Pollution Control Act (or the Clean Water Act (CWA)), TMI-1 effluent discharges are regulated by NPDES Individual Wastewater Discharge Permit No. PA 0009920 issued and enforced by PADEP. Section 402 of the CWA states that “NPDES prohibits [discharges] of pollutants from any point source into the nation’s waters except as allowed under an NPDES permit.” The purpose of this permit is to regulate wastewater discharge to preserve the water quality of the surrounding water bodies. As of the most recent permit issued, there have been no notices of violation for the TMI-1 site. Information in this section was obtained from the TMI-1 NDPES. The applicant’s license renewal environmental report includes a copy of the most recent TMI-1 NPDES permit (AmerGen 2008).

The most recent renewal of this permit occurred in October 2007. Table 2-2 on the following page shows the quantitative effluent limitations regulated under the NPDES permit. In addition to these effluent limitations, the permit also stipulates that during any 1-hour period, discharge may not affect the temperature of the receiving water body by more than 2 °F. No violations of this limit have been recorded.

The permit outlines the effluent limitations and monitoring requirements of 10 different discharge outfalls. In addition to the effluent limitations shown in Table 2–2, the permit also outlines the minimum number of sampling events that are required for each outfall, where necessary. Additionally, the discharge of “floating solids, visible foam, or other substances that produce color, tastes, odors, turbidity or settle to form deposits” are to be controlled, and pH is to be monitored, with the required levels being between 6.0 and 9.0.

Outfall 001 (by far the largest outfall on site) receives wastewater from the circulating cooling water, secondary service water, reactor building, emergency cooling, decay heat, nuclear service water, liquid radioactive waste treatment, station blackout diesel cooling water, and several other minor sources. Its discharge limitations were calculated based on a maximum discharge rate of 81.02 mgd (306.7 million Lpd). Outfall 003 is an emergency outfall, meant to receive discharge from TMI-1 in the event that Outfall 001 is blocked. Outfall 004 is another emergency outfall which receives discharge from TMI-1 in the event that the TMI-1 mechanical draft cooling tower is blocked. Both of these emergency outfalls are based on the same rate of 81.02 mgd (306.7 million Lpd) as Outfall 001. If either of these outfalls is used, the facility is required to notify PADEP within 2 days to explain the composition of the discharge and the reason for its use.

Outfall 101 receives wastewater from the sewage treatment plant, and its limitations are based on a discharge rate of 0.08 mgd (302,833 Lpd). In addition to the effluent limitations shown, the

Table 2-2. National Pollutant Discharge Elimination System Effluent Limitations for TMI-1

Outfall	Total Suspended Solids (mg/L)			Oil and Grease (mg/L)			CBOD-5 Day (mg/L)		Free Available Chlorine (mg/L)		Phosphorus (mg/L)		Total Residual Oxidants (mg/L)		Spectrus (mg/L)		Hydrazine (mg/L)	Temperature (°F)	
No.	Avg. Month	Max. Daily	Inst. Max.	Avg. Month	Max. Daily	Inst. Max.	Avg. Month	Inst. Max.	Max. Daily	Inst. Max.	Avg. Month	Inst. Max.	Max. Daily	Inst. Max.	Max. Daily	Inst. Max.	Instant Max.	10/1-3/31	4/1-9/30
001	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	0.2	0.5	NLR	NLR	0.14	0.17	0.1	0.3	Not Detectable	110	115
003	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	0.2	0.5	NLR	NLR	0.14	0.17	0.1	0.3	Not Detectable	110	115
004	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	0.2	0.5	NLR	NLR	0.14	0.17	0.1	0.3	Not Detectable	NLR	NLR
005A	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR
005B	30	100	NLR	15	20	30	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR
006	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR
101	30	NLR	60	NLR	NLR	NLR	25	50	NLR	NLR	2.0	4	NLR	NLR	NLR	NLR	NLR	NLR	NLR
401	30	100	NLR	15	20	30	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR
501	30	100	NLR	15	20	30	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR
701	30	100	NLR	15	20	30	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR	NLR

Source: NPDES No. PA 0009920

NLR = No Longer Regulated

permit requires this outfall to be monitored for fecal coliform levels, which are restricted to an average monthly concentration of 200 per 100 milliliters from May to September, and 2000 per 100 milliliters from October to April. Outfall 401 receives wastewater from the industrial waste filter system, and its limitations are based on a discharge rate of 0.3 mgd (1.1 million Lpd). Outfall 501 receives wastewater from the TMI-1 secondary neutralizer tank, and its limitations are based on a discharge rate of 0.3 mgd (1.1 million Lpd). Outfall 701 receives wastewater from the industrial waste treatment system, and its limitations are based on a discharge rate of 0.3 mgd (1.1 million Lpd).

Outfall 005B receives wastewater from screen house desilting, dewatering of the TMI-1 natural draft cooling towers, fire brigade training, the fuel oil offloading station, industrial cooler maintenance, emergency diesel generator building floor drains, and operation of the east dike settling basin drain valve. The discharge rates upon which these limitations are based are not specified by the permit. Outfall 006 receives wastewater from intake screen wash and sluice water, the intake pump strainer backwash, and the intake chlorinator building floor drain. No discharge limitations are put on this outfall, but it does require the collection of all debris found on the intake screens which is not discharged into the Susquehanna River. The stormwater outfalls are 005A, SO1, SO2, SO3, and SO4. They do not have specific effluent limitations, but are required to be monitored for biochemical oxygen demand (BOD-5 Day), chemical oxygen demand, total suspended solids, total phosphorus, total Kjeldahl nitrogen, dissolved iron, oil and grease, and pH levels.

Discharge of stormwater must also be monitored for pollutants to ensure that the discharge only consists of uncontaminated stormwater. TMI-1 is required to report these data to PADEP using discharge monitoring reports. TMI-1 is also required to report, within 24 hours of their occurrence, any unexpected diversions of wastewater that exceed any listed effluent limitation, upsets that exceed or threaten to exceed any limitations, and any violations of maximum daily discharge limitations.

Part C of the NPDES permit specifies that waterborne releases of radioactive material must conform to the guidelines in Appendix I to 10 CFR Part 50. The facility must provide reports which describe quantities of unrestricted radioactive material released in effluent discharge to the PADEP Bureau of Radiation Protection and the NRC.

2.2 Affected Environment

This section provides general descriptions of the environment near TMI-1 as background information. This section also provides detailed descriptions where needed to support the analysis of potential environmental impacts of refurbishment and operation during the renewal term, as discussed in Chapters 3 and 4. Section 2.2.9 describes historic and archaeological resources in the TMI-1 area, and Section 2.3 describes the possible impacts associated with other Federal project activities.

2.2.1 Land Use

Three Mile Island covers approximately 370 ac (150 ha), of which about 200 ac (81 ha) are occupied by the TMI-1 and TMI Unit 2 facilities. AmerGen owns the entire island except certain

TMI Unit 2 facilities. AmerGen also owns all or a portion of some of the smaller islands in the vicinity of Three Mile Island and a portion of the eastern bank of the Susquehanna River. TMI-1 is surrounded by fencing and contains few areas that have not been developed or previously disturbed. As can be seen in Figure 2-6, the undeveloped land on the island is found south of the TMI-1 and TMI Unit 2 facilities. The majority of this undeveloped land lies under the 10-year flood level and is subject to seasonal variations in water level. The southern part of the island contains a wetland that was formed when borrow pits created during construction of a flood dike system, which surrounds the TMI-1 and TMI Unit 2 facilities, filled with water. The southern portion of the island also contains fallow field areas that are surrounded by a woodland buffer (AmerGen 2008).

The TMI-1 site encompasses several properties that total approximately 440 ac (162 ha). Included are Three Mile Island; St. John's Island and Evergreen Island (also referred to as "Sand Beach Island"), which are situated north of Three Mile Island and together total approximately 31 ac (13 ha); a 6.4-ac (2.6-ha) section of Shelley Island, which is part of the western half of the TMI-1 exclusion area; and a 32-ac (13-ha) strip of land east of Three Mile Island along the eastern shore of the Susquehanna River (AmerGen 2008).

Three Mile Island is approximately 11,000 ft long and 1,700 ft wide with the long axis aligned north to south in the river. It lies approximately 900 ft from the east bank of the Susquehanna River and approximately 6500 ft from the west bank of the river (see Figure 2-6). The Susquehanna River makes a sharp change in directional flow from southeasterly to nearly due south just north of Three Mile Island where the river widens to approximately 1.5 mi (2.4 km). This widening resulted from the Red Hill and York Haven Dams, which transect the river on either side of the downstream end of Three Mile Island creating a barrier for the purpose of hydroelectric generation (AmerGen 2008). State Highway (SH)-441 parallels Three Mile Island to the east, and tracks of the Norfolk Southern Railroad parallel the Susquehanna River on the eastern and western banks. Shelley Island is located west of Three Mile Island in the middle of the river, and the borough of Goldsboro is located on the western bank of the river. The developed portion of the TMI-1 site is surrounded by a flood protection dike system. Access to the northern portion of Three Mile Island is by a bridge connecting the main entrance to the TMI-1 site and the mainland near the junction of SH-441 and Geyers Church Road. Another bridge connects the southern end of Three Mile Island with the east bank of the Susquehanna River near Falmouth on SH-441 in Lancaster County. The southern bridge serves as access to TMI-1 for some station operation personnel, refueling outage workers, and construction equipment. It also provides an alternate egress route.

2.2.2 Air and Meteorology

TMI-1 is located in Dauphin County, one of the four counties comprising the Harrisburg metropolitan area (AmerGen 2008). Pennsylvania is divided into 10 climate regions. Dauphin County belongs to Climate Region 5, along with Lycoming, Columbia, Montour, Union, Northumberland, Snyder, Mifflin, Juniata, and Perry Counties (PSC 2008). Data collected in the

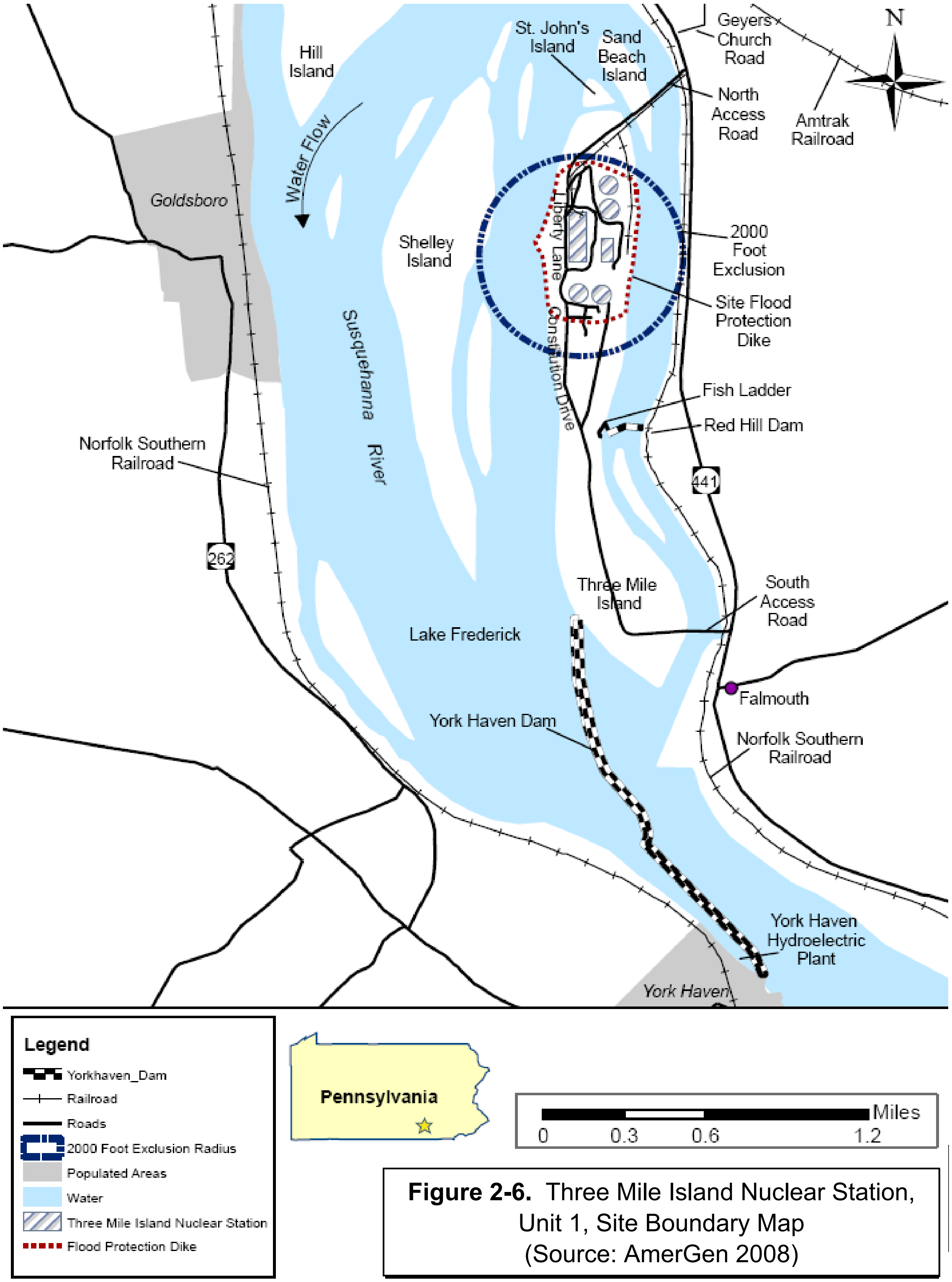


Figure 2-6. Three Mile Island Nuclear Station, Unit 1, Site Boundary Map (Source: AmerGen 2008)

region since 1899 show that average winter temperature is 29.9 °F (1.2 degrees Celsius [°C]), rarely dropping below 20 °F (-6.7 °C), while average summer temperature is 61.15 °F (16.39 °C), with July being the hottest month (PSC 2008a).

Precipitation is fairly evenly distributed throughout the year. Annual precipitation amounts generally range between 30 to 48 inches, with occasional amounts reaching 54 to 58 inches. The greatest amounts of precipitation usually occur in the spring and summer months, while February is the driest month, amounting to about 2 inches less than the wettest months (PSC 2008b). As documented by Pennsylvania State climatologists, average mean snowfall from 1957 through 2007 was 35.4 inches (PSC 2008c).

The dominant wind direction throughout the State of Pennsylvania is from the west, with some seasonal variation. TMI-1 historical meteorological reports show that yearly winds from the northwest prevail, with stronger winds in winter (windspeed varies from 4 to 10 knots) and calmer winds in summer (windspeed varies from 0 to 6 knots). The median annual windspeed as reported by the National Weather Service station located in Harrisburg (approximately 10 mi [16 km] northwest of TMI-1) is 7.5 mi per hour (mph) (4.1 knots) (NCDC 2008; PSC 2008b). While the prevailing westerly winds result in most of the air masses that affect Pennsylvania (those originating from the interior of the continent), the Atlantic Ocean does have a limited influence on the climate of the State. Coastal storms can affect the day-to-day weather, primarily in the eastern section of the State.

Severe weather events in Pennsylvania are generally uncommon. Severe snowstorms are infrequent, but when they do occur, they can approach blizzard conditions. High winds have been known to cause huge drifts that can disrupt normal routines for several days. While the incidence of tornadoes is very low, the region has occasionally been hit with storms that caused loss of life and property damage. June is the month of highest tornado frequency, followed closely by July and August. The National Climatic Data Center (NCDC 2008a) reported 13 tornadoes in Dauphin County from 1950 through February 2008—three at F0, six at F1, and four at F2 strengths.[3] The most destructive activity in Dauphin County occurred on April 5, 1977, and caused $2.5 million in property damage. (NCDC 2008b)

The TMI-1 meteorological data monitoring system consists of Alpha and Bravo systems. Alpha system allows it to measure windspeed and direction at 100 ft (30 m) and 150 ft (46 m), ambient temperature at 33 ft (10 m), and differential temperature at 150 ft (46 m). Measurement of windspeed and direction on Bravo system is conducted at 100 ft, while ambient temperature is measured at 33 ft (10 m) and differential temperature is measured at 150 ft (46 m). The meteorological data are collected via e-mail sent by the TMI-1 chemistry department. It is sampled once per hour and stored in the meteorological database which is edited once a week; invalid data are deleted during the data review process performed by a meteorologist. The

[3] The Fujita six-point scale (F0 to F5) is used to rate the intensity of a tornado based on the damage it inflicts to structures and vegetation. The lowest intensity is F0; the highest is F5. Fujita scale categories are based on estimated (not measured) sustained windspeeds compared against observed structural damage. An enhanced Fujita scale replaced the original Fujita scale in February 2007. The enhanced Fujita scale still uses six categories of tornado intensity (EF0 to EF5), but defines those categories differently. For additional information about the Fujita scale, see the following National Oceanic and Atmospheric Administration Web site and the hypertext links therein—http://www.spc.noaa.gov/faq/tornado/f-scale.html.

quality-assured meteorological data are then compiled into monthly, quarterly, and annual reports (AmerGen 2006).

2.2.2.1 Regional Air Quality Impacts

TMI-1 is located within the Mid-Atlantic Air Quality Control Region 3, as designated by the EPA. The Mid-Atlantic Air Protection Region 3 is represented by Delaware, the District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia. The Bureau of Air Quality of PADEP is responsible for regulating all air emission sources within the State. Pennsylvania's ambient air monitoring program is a result of the implementation of the Federal Clean Air Act on a State level. The State is divided into six air regions, and Dauphin County, where TMI-1 is located, belongs to the Southcentral Air Quality Region, which includes the counties of Adams, Bedford, Berks, Blair, Cumberland, Dauphin, Franklin, Fulton, Huntington, Juniata, Lancaster, Lebanon, Mifflin, Perry, and York. Dauphin County is a nonattainment area for fine particulate matter ($PM_{2.5}$) and a part of the Harrisburg-Lebanon-Carlisle $PM_{2.5}$ nonattainment area, which includes Cumberland, Dauphin, and Lebanon Counties. There are two monitoring sites in the Harrisburg-Lebanon-Carlisle $PM_{2.5}$ nonattainment area—one in Dauphin County (Harrisburg) and one in Cumberland County (Carlisle). PADEP also operates several types of $PM_{2.5}$ monitors in Carlisle and Harrisburg (PADEP 2004).

TMI-1 is recognized as a synthetic minor facility by Pennsylvania State regulators because of the quantities of emissions and restrictions on the hours of operation of its stationary sources of criteria pollutants; therefore operation of the sources is regulated by a State Only Operating Permit for Synthetic Minor Facility (AmerGen 2006d). TMI-1 has a number of stationary emission sources, including two auxiliary boilers, six standby emergency power supply diesel generators, two emergency power generators, a blackout emergency generator, a security system uninterruptible power generator, and two substation emergency power generators. A number of sources do not require any work practice standards, test monitoring, recordkeeping, or reporting requirements, as defined by the PADEP permit for TMI-1. Some of these sources include three air compressors, the turbine building, vents, turbine oil vapor extractor, a 15,000-gallon (56,781 L) turbine lubricating oil storage tank, water and waste water treatment chemical storage tanks, water and waste water treatment system, the two natural draft cooling towers, two mechanical draft industrial cooling towers, diesel fuel and fuel oil storage tanks, and an emergency warehouse diesel-fueled fire pump. The generators are tested periodically to ensure their continued ability to perform their intended function, and there are procedures in place to ensure continuous monitoring, sampling, and filtering of the oil.

2.2.3 Ground Water Resources

Three Mile Island is one of a sequence of Triassic lowland deposits in an area known as the Gettysburg Basin. The island itself formed during the later stages of glaciation as a result of fluvial deposition (materials deposited by river flow) of glacial melt-water by the slow-moving flow of the Susquehanna River and the resulting steady accumulation of sediments to form the island.

Two aquifers are located beneath the TMI-1 site. The shallowest aquifer consists of surficial alluvial deposits under unconfined conditions. The alluvial layer is made up of silty sand, with some gravels and clay, and ranges from 7–19 ft (2.1–5.8 m) in thickness. This layer overlies layers of glacial outwash, which range from 12–21 ft (3.7–6.4 m) in thickness and are composed of dense gravel and silt.

The second and underlying aquifer is the Gettysburg shale, which is the primary aquifer in the area of the site. Ground water in the Gettysburg shale is under semi-confined conditions, based on information gathered during drilling operations on the island. The shale is found 19–28 ft (5.8–8.5 m) below the surface (AmerGen 2008). It is described as a tabular aquifer, meaning some beds within the Gettysburg shale are able to transmit water, while others are not. The range of permeability within the bedrock is primarily caused by varying frequencies of fractures (Conestoga-Rovers 2006). Within the bedrock, which dips to the northwest, ground water is found within joints, fractures, and bedding separations. Two major joint sets occur on the island, with one dipping nearly 90 degrees, and the other dipping 50–60 degrees in the southwestern direction. The hydraulic conductivity of the aquifer ranges from 2,126 ft–4,208 ft/yr (648.0–1282.6 m/yr).

The ground water conditions found in the upper aquifer (the alluvial deposits) are directed by the river itself, with the water table's maximum elevation centered in the middle of the island and gently sloping toward the island's shores. The Susquehanna acts as a boundary for this aquifer as the ground water flows into the river. The lower aquifer (the Gettysburg shale) is unlikely to receive flow from the river because of its lower flow characteristics, but could occur if pumping from the surface is heavy enough to cause infiltration.

2.2.3.1 TMI-1 Water Supply Wells

Of the 54 water supply wells found in a specified 1-mile radius of the TMI-1 site, only 7 are associated with the plant. Five of these wells are on site, while the remaining two supply potable water to the Visitors Center and the Training Center/Simulator Building. The Visitors Center well is installed at a depth of 121 ft (36.8 m) and produces up to 10 gpm (0.02 cfs, or 0.001 m^3/s), while the Training Center/Simulator Building well is at 100 ft (30 m) and can yield up to 30 gpm (0.07 cfs, or 0.002 m^3/s) (Conestoga-Rovers 2006). From 2003–2005, these seven ground water wells yielded a combined total that averaged to about 95–115 gpm (0.21–0.25 cfs, or 0.006–0.007 m^3/s), or (AmerGen 2004; 2005; 2006e).

Of the five onsite wells, two (the Operations Support Facility/North Office Building [OSF] well and the Building 48 [48S] well) supply the plant's public water system. The 48S well is installed at a depth of 996 ft (303 m) and produces a maximum of 30 gpm (0.07 cfs, or 0.002 m^3/s). The OSF well, at 775 ft (236 m), can yield a maximum of 40 gpm (0.09 cfs, or 0.003 m^3/s) and can be used, if necessary, to supplement the water production of the three industrial makeup water wells (A, B, and C). These three service water wells are installed at 400 ft (122 m), 500 ft (152 m), and 400 ft (122 m), respectively. Their water is utilized for the fire service, makeup to the demineralized water system, bearing lubrication in the screen house pumps, and various other building and equipment uses. Table 2-3 shows the annual ground water withdrawal data for the three industrial wells (both individually and combined) for the years 2003–2005.

Table 2-3. Total Annual Ground Water Withdrawal (Gallons) and Average Daily Withdrawal Rate (Gallons) for Industrial Wells, A, B, and C and Combined for 2003–2005

	Well A		Well B		Well C		Total	
Year	Total Withdrawn (x1000)	Avg. Daily Withdrawal Rate	Total Withdrawn (x1000)	Avg. Daily Withdrawal Rate	Total Withdrawn (x1000)	Avg. Daily Withdrawal Rate	Total Withdrawn	Avg. Daily Withdrawal Rate
2003	20,648	55,805	12,895	34,851	15,664	42,335	49,207,000	132,992
2004	20,434	54,930	11,696	31,441	10,859	29,191	42,989,000	115,562
2005	19,080	51,429	6,229	16,790	6,787	18,294	32,096,000	86,512

Source: AmerGen 2004, AmerGen 2005, AmerGen 2006a

The SRBC originally approved the use of ground water by the TMI-1 site in 1996. Before doing so, two 48-hour pump tests were conducted at a rate of 168,750 gpd (638,788 Lpd), and no adverse impacts were determined (SRBC 1999). When TMI-1 applied to the SRBC in 1998 for an increase in ground water withdrawal from its three industrial wells (A, B, and C), the original pump test data were considered in addition to observations of plant operations. After deciding that there were no production impacts to any of the onsite wells (including OSF and 48S) or any wells along the eastern shore of the island, SRBC approved the increase. Currently, all three industrial wells may pump a maximum limit of 225,000 gpd (156 gpm, or 851,718 Lpd) on a 30-day average (SRBC 1999).

2.2.3.2 TMI-1 Monitoring Wells

The Three Mile Island Nuclear Station began installing ground water monitoring wells in 1980 to monitor for the ground water infiltration of radionuclides such as tritium. As tritium decays, it emits a low-energy beta particle that cannot travel far into either tissue or air. It is produced from man-made sources as well as natural processes. In 2006, the background concentration of tritium in the onsite ground water was said to be (at most) 200 picoCuries per liter (pCi/L) (Conestoga-Rovers 2006).

That same year, Exelon began a study to evaluate the possible impacts of plant operation on nearby ground water and surface water, leading to the installation of 31 new onsite ground water monitoring wells. The initiation of this Exelon project was considered Phase 1 of the ground water monitoring effort at TMI-1, with Phase 2 being the continuation of the ground water monitoring program that had been in place at the station for over 20 years. Samples were collected from up to 76 well locations and the concentration of tritium was not found to exceed the EPA drinking water standard of 20,000 pCi/L in any location, but was detected to be higher than the background concentration during both studies. Samples taken from offsite drinking water wells proved to have no detectable concentrations of tritium (AmerGen 2007).

As a result of these studies, AmerGen introduced the Radiological Ground Water Protection Program (RGPP) in 2007. The purpose of this program is to ensure the detection and adequate response to any possible radiological releases to ground water. The program includes 59 onsite monitoring wells (5 of which are the water supply wells mentioned in Section 2.2.3.1), which are sampled for tritium, strontium-90, and gamma-emitting radionuclides (Exelon 2007). Results from these samples are compared to the results of the 2006 studies, which now serve as the baseline monitoring round, to enable the use of trends, quickly identify contamination issues, and ensure that ground water quality is maintained.

In 2007 the RGPP successfully identified significantly elevated tritium levels in several monitoring wells from May–July, two of which were found to have exceeded the EPA standard of 20,000 pCi/L (peaking at 29,600 pCi/L in July). The facility was able to identify the problem and the source of the tritium leak, isolate the source, and then repair it. Once the problem was corrected, tritium levels returned to acceptable standards.

Conestoga-Rovers & Associates also calculated the rate and amount of tritiated ground water migrating to the Susquehanna River, and the results were confirmed again following the tritium leak incident (Conestoga-Rovers 2007). Table 2-4 below shows the rate of migration as affected by the pumping of onsite water supply wells, as well as with and without background levels. Conestoga-Rovers concluded that the migration of tritium to the Susquehanna River was negligible, and that the amount of tritium entering the river in ground water was "minimal" (Conestoga-Rovers 2006).

Table 2-4. Rate of Tritiated Ground Water Migration to the Susquehanna River as Affected by Onsite Pumping and Background Levels of Tritium (Curies Per Year)

	Total Mass Flux with Background (Ci/yr)	Background Contribution (Ci/yr)	Total Mass Flux without Background (Ci/yr)
No Pumping	0.32	0.09	0.23
Tritium Captured by Pumping	0.20	0.013	0.18
With Pumping	0.12	0.074	0.05

Source: Conestoga-Rovers 2006

2.2.4 Surface Water Resources

TMI-1 is located at approximately river mile 58 on the Susquehanna River, about 10 mi (16 km) south of the city of Harrisburg, PA, on the northern half of the 370-ac (150-ha) Three Mile Island (AmerGen 2008). Three Mile Island is almost 12,000 ft (3,700 m) long and up to 2200 ft (700 m) wide. The Susquehanna River ranges in width from 7,000 ft–8,400 ft(2,100-2600 m) at Three Mile Island, but narrows to less than 1,800 ft (500 m) wide within 3,500 ft (1,100 m) downstream of Three Mile Island (AmerGen 2008). Three Mile Island is the longest in a group of islands that divides the river into three channels (west, center, and east), as illustrated in Figure 2-6. The intake and discharge structures for TMI-1 are located along the western shore of Three Mile Island, in the center river channel (Ichthyological Associates 1983). As described in detail in Section 2.1.6, the Susquehanna River provides makeup water for and receives blowdown from the two TMI-1 cooling towers (AmerGen 2008).

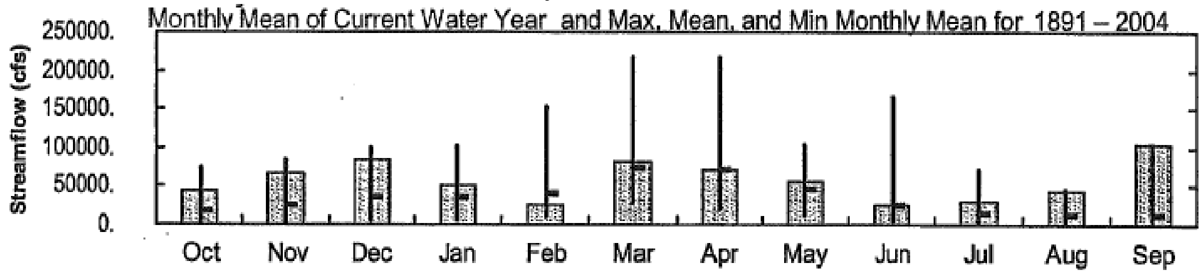
The Susquehanna River forms from two main branches, the North Branch Susquehanna River and the West Branch Susquehanna River. The source of the North Branch is Ostego Lake in Cooperstown, NY. The North Branch flows somewhat south in a meandering fashion through Sunbury, PA, where it joins with the shorter West Branch that begins in central-western Pennsylvania. The two branches combine to form the mainstem of the Susquehanna River, which is the largest tributary of the Chesapeake Bay. The Susquehanna River flows over 440 mi (708 km) from Ostego Lake to the Chesapeake Bay. Major tributaries of the Susquehanna River include the Juniata River, the West Branch Susquehanna River, and the Chemung River (SRBC 2006).

The Susquehanna River Basin includes portions of the Allegheny Plateau region of the Appalachian Mountains of Pennsylvania and New York, the rolling hills and farmland closer to Three Mile Island situated in the Piedmont Plateau of Pennsylvania, and the coastal plain to the Chesapeake Bay in Maryland. It drains over 27,500 square miles (mi^2) (71,200 km^2) of central Pennsylvania, south-central New York, and a small portion of northeastern Maryland, and is the second-largest watershed in the eastern United States (SRBC 1999; SRBC 2006).

The Susquehanna River Basin is divided into six major subbasins: (1) the Upper Susquehanna Subbasin, (2) the Chemung Subbasin, (3) the Middle Susquehanna Subbasin, (4) the West Branch Susquehanna Subbasin, (5) the Juniata Subbasin, and (6) the Lower Susquehanna Subbasin, which is the location of TMI-1 (SRBC 2006). The Lower Susquehanna Subbasin is located primarily south and downstream of the other five subbasins. This subbasin drains about 5,900 mi^2 (15,300 km^2) of urban and rural areas, ridges, and open valleys and empties into the Chesapeake Bay at Havre de Grace, MD. The ridges of this subbasin are primarily forested, and the valleys are predominantly used for agriculture. Other portions of this subbasin contain developed areas, with only limited abandoned mine lands. The cities of Harrisburg, Lancaster, and York are the largest populated areas in the Lower Susquehanna Subbasin (SRBC 2006a).

Susquehanna River flow is monitored by the United States Geological Survey (USGS) from a station located near Harrisburg, PA. The river supplies about 19 million gpm (42,000 cfs, or 1200 m^3/s) of freshwater to the Chesapeake Bay, which is about half of the Chesapeake Bay's flow of freshwater (SRBC 2006). Figure 2-7 shows that in 2004, a year with above-average flows, the daily mean flow of the Susquehanna River through Harrisburg was 56,400 cfs (25 million gpm or 1600 m^3/s), compared to the historic annual mean flow of 34,500 cfs (15 million gpm or 1000 m^3/s). Daily mean flow in 2004 ranged from 9600 cfs (4 million gpm or 300 m^3/s) to 500,000 cfs (224 million gpm or 14,000 m^3/s). The lowest average annual mean flow recorded at the Harrisburg gauging station is about 16,900 cfs (8 million gpm or 500 m^3/s), with the lowest daily mean recorded as 1700 cfs (1 million gpm or 50 m^3/s) (Durlin and Schaffstall 2005).

Figure 2-7. Monthly Mean Flow of the Susquehanna River in 2004 and the Maximum, Mean, and Minimum Monthly Mean Flow Date for 1891–2004



Source: Durlin and Schaffstall 2005

The Susquehanna River is well known for the flooding damage it has caused in the past, with over 40 serious floods recorded since 1736 (Alliance for the Chesapeake Bay undated). To protect the site and possible contamination of the river during a serious flood event, the developed area of TMI-1 is bordered by a flood protection dike system (AmerGen 2008).

Three Mile Island is located within a reservoir portion of the river adjacent to two dams, the run-of-the-river York Haven Dam and the smaller Red Hill Dam, as illustrated in Figure 2-6. The reservoir formed behind the two dams that includes part of Three Mile Island is known as York Haven Pond and Lake Frederick (AmerGen 2008). At normal levels Lake Frederick has a surface area of 2.3 mi^2 (596 ha) and extends 3.5 mi (5.6 km) upstream. The normal full pool elevation of Lake Frederick is 277 ft (84 m) above mean sea level, and the mean depth is 9 ft (2.7 m) (Ichthyological Associates 1983). Both dams are owned and operated by York Haven Power Company. The York Haven Dam runs diagonally downstream and southwest from the southern end of Three Mile Island and is over 9,200 ft (2,800 m) long. The dam connects Three Mile Island to the mainland on the western side of the river, and is the site of a 19–20 MWe hydroelectric plant, which controls river flow at Three Mile Island (AmerGen 2008). The dam is located at the Conewago Falls, where the river drops 19 ft (6 m) (Kapsch 2004). The 900-foot-long (290-m-long) Red Hill Dam is located at the midway point of Three Mile Island along the eastern side of the island and regulates the flow of the Susquehanna River in the eastern channel. Between the dam and Three Mile Island is a fish ladder where fish passage can be monitored (AmerGen 2008).

The larger water bodies that flow into the Susquehanna River near Three Mile Island include the Swatara Creek, East Conewago Creek, West Conewago Creek, and Fishing Creek. East Conewago Creek discharges into the Susquehanna River from the eastern shoreline adjacent to the southern access bridge to Three Mile Island (PADEP 2008).

The Susquehanna River Basin Commission (SRBC) performs bioassessments of the Susquehanna River, the six subbasins, and a number of streams within each subbasin to monitor water quality and the biological health of the river basin. As part of the Susquehanna Large River Assessment Project, the SRBC collected biological and water chemistry data at 25 stations in 2005 on the mainstem Susquehanna River and at the mouths of three tributaries. Nineteen of the stations were designated slightly impaired and six other stations were designated moderately impaired. However, less than 10 percent of the samples analyzed from the 25 stations exceeded levels of tolerance for aquatic life, indicating that the Susquehanna

River maintains fairly good water quality. Five of the twenty-five stations were located in the Lower Susquehanna Subbasin. Thirty-one of the forty-four samples obtained at these five stations in the Lower Susquehanna Subbasin were designated slightly impaired, and 12 of the samples were designated moderately impaired. Only one of the samples was rated non-impaired (SRBC 2006).

In a comparison of surveys conducted in the Lower Susquehanna Subbasin in 1996 and 2005, biological conditions improved slightly, while some parameters for water quality improved and others degraded. The SRBC has attributed high levels of nutrients, sediments, and toxins in some samples to the prevalence of agricultural lands in the Lower Susquehanna Subbasin, along with areas of residential, commercial, and industrial development, and to some areas in the subbasin containing abandoned mine lands. Data collected in 2005 during the Lower Susquehanna Subbasin Survey, near the confluence of the Swatara Creek with the Susquehanna River and 2 mi upstream of Three Mile Island, rated the habitat as partially supporting, with elevated nutrient levels, elevated sodium, and nonimpaired biological conditions. Further upstream on Swatara Creek, acid mine drainage and development affected the watershed (SRBC 2006a).

2.2.5 Description of Aquatic Resources

<u>Macroinvertebrates</u>

Sampling was performed for macroinvertebrates above and below the TMI-1 discharge pipes from 1974–1982 (Ichthyological Associates 1975; 1976; 1983) and from 1986–1990 (Normandeau 2007; RMC 1991), with the most taxa (165) collected in 1982. Dominant taxa were aquatic tube worms (*Limnodrilus hoffmeisteri*), the larvae of Diptera–midges (*Chironomus decorus*), and mollusks (*Pisidium* spp.). Virginia river snail (*Elimia virginica*) and *L. hoffmeisteri* had the greatest biomass. Distributions varied seasonally, as did relative abundance, density, and biomass, particularly after the 1980 drought in this region (Ichthyological Associates 1983). Biological data collected in 1996 by the SRBC at Conewago Falls, immediately downstream of Three Mile Island, indicated that Emphemeroptera (mayflies) and Trichoptera (caddisflies) were two of the four dominant taxa in the samples. These families are typically found in water bodies of better water quality. Coleoptera (beetle larvae) were also dominant in the sample, with Amphipoda (shrimp-like crustaceans) the most dominant of the four taxa, indicating less than ideal water quality (SRBC 1996).

Macroinvertebrate samples collected by the SRBC 12 mi (19 km) downstream of Three Mile Island (river mile 45) and 20 mi (32 km) upstream of Three Mile Island (river mile 77) during the 1996 Lower Susquehanna River Subbasin Survey contained *Corbicula fluminea*—invasive Asiatic clams. Macroinvertebrate samples collected on the Susquehanna River at the Conewago Falls boat launch (river mile 57) contained Corbicula as well as the native pea clam *(Pisidium* spp.) (SRBC 1996), characterized by its extremely small size (0.5 in.) (Pennsylvania Sea Grant 2008a). Several species of snails (Gastropoda) were also identified from the boat launch samples, including *Ferrissia* spp., *Lymnaea* spp., *Physa* spp., and *Viviparus* spp. (SRBC 1996). No Corbicula or pea clams were collected at the sampling stations located at river mile 45 and river mile 77 during the 2005 Lower Susquehanna Subbasin Survey, and the only snails that were collected were *Leptoxis* spp. and *Pleurocera* spp. (SRBC 2005).

The nonnative mollusk Asiatic clam (*C. fluminea*) is present in the Susquehanna River and has been observed attached to the intake structures at TMI-1. Corbicula is a small bivalve originally from eastern Asia and Africa that has spread into many estuarine habitats and river beds of the United States. The adults typically do not grow over 1.5 in. in size. Corbicula tolerates polluted environments better than native mussels, which allows it to colonize areas that would most likely not be inhabited by native mussels. Corbicula is inadvertently spread by boats transported from one waterway to another, and can cause biofouling of intake structures and irrigation systems (Pennsylvania Sea Grant 2008). At TMI-1, a biocide is applied to the intake water as it reaches the screens to prevent any infestations by Corbicula (AmerGen 2008).

Another common, nonnative invasive mollusk, the zebra mussel (*Dreissena polymorpha*), has not been observed in the Susquehanna River near Three Mile Island. The zebra mussel, originally from Europe, has spread through many States east of the Mississippi River, and was discovered on May 17, 2007, in Cowanesque Lake near the New York State line (Pennsylvania Sea Grant 2008b). This was the first time that the zebra mussel has been observed in a Pennsylvania waterway in the Susquehanna watershed (Alliance for the Chesapeake Bay 2007). In June 2007, zebra mussels were identified in the Susquehanna River mainstem in Oneonta, NY (Harman and Underwood 2008). While conducting the Upper Susquehanna Subbasin Survey in 2007, the SRBC discovered zebra mussels in the Susquehanna River around Great Bend, PA, which is the furthest point downstream in the Susquehanna River mainstem that zebra mussels have been identified (SRBC 2008; Pennsylvania Sea Grant 2008b).

Plankton

Phytoplankton and zooplankton were studied in 1974 and 1975 at the intake and discharge structures at TMI-1. A total of 95 genera of phytoplankton were identified in 1975, with the division Chlorophyta (green algae) the most common, followed by the division Bacillariophyta (diatoms). Also identified were genera from the division Cyanophtya (blue-green algae), Pyrophyta (dinoflagelltes), Euglenophyta (euglenoids), and Chrysophyta (yellow-green algae). A total of 85 taxa of zooplankton were identified in 1974 and 1975 at the TMI-1 intake and discharge structures. Cladocerans, rotifers, and copepods were the most abundant, and comprised 98.9 percent of the number of zooplankton that were identified (Ichthyological Associates 1975; 1976).

Fish

Several fish studies have been conducted by the facility in the vicinity of Three Mile Island from 1974–1982 using various sampling methods (trapnet, seine, and electrofishing), with a total of 58 different species captured. Flathead catfish (*Pylodictis olivaris*), channel catfish (*Ictalurus punctatus*), pumpkinseed (*Lepomis gibbosus*), smallmouth bass (*Micropterus dolomieui*), black crappie (*Pommoxis nigromaculatus*), and white crappie (*Pomoxis annularis*) dominated the catches, and the common carp (*Cyprinus carpio*) contained the greatest biomass in the catch (Ichthyological Associates 1983). A 1990 study that sampled fish in Lake Frederick found the most common fish collected, in descending order, were the mimic shiner (*Notropis volucellus*), the spotfin shiner (*Cyprinella spiloptera*), channel catfish, smallmouth bass, the tessellated darter (*Etheostoma olmstedi*), the spottail shiner (*Notropis hudsonius*), pumpkinseed, the white sucker (*Catostomus commersonii*), the bluntnose minnow (*Pimephales notatus*), and the common carp (RMC 1991). Fish sampling conducted from 2002–2005 in the vicinity of the Brunner Island steam electric station, located about 4 mi downstream from Three Mile Island, has demonstrated species composition similar to the fish sampled in the vicinity of York Haven Dam. Creel surveys in the vicinity of Lake Frederick from 2007 when compared to the 1974–1982 study indicated that similar taxa of sportfish dominated the catch as well as walleye (*Sander vitreus*)and muskellunge (*Esox masquinongy*) (Normandeau 2007).

The American shad (*Alosa sapidissima*) is an anadromous fish that historically numbered in the millions along the entire Susquehanna River, but have substantially dropped in the last 100 years. Before 1904, millions of American shad migrated up the Susquehanna River for spawning, and over 2.5 million lb (1.1 million kg) of shad were commercially harvested during the peak of this fishery in 1885 (PFBC undated). Between 1904 and 1930, four hydroelectric dams were constructed along the lower Susquehanna River between Three Mile Island and close to the mouth of the Susquehanna River in Maryland, resulting in a loss of river access for shad above each dam: York Haven Dam (1904); Holtwood Dam (1910), Conowingo Dam (1928); and Safe Harbor Dam (1930). Safe Harbor is approximately 26 mi (42 km) south of Three Mile Island, Holtwood is approximately 33 mi (53 km) south, and Conowingo is approximately 48 mi (77 km) south. Construction of the Conowingo Dam in Maryland near the mouth of the Chesapeake Bay resulted in the complete loss of accessibility to spawning habitat for American shad and other anadromous fishes on the Susquehanna River. It also led to the closure of the shad industry, since fish could no longer pass through this first dam on the Susquehanna River (The Native Fish Conservancy 2008).

A combination of fish passage restoration projects performed at the Red Hill Dam, Safe Harbor Dam, Holtwood Dam, and Conowingo Dam over the past several decades has returned migratory access to American shad and other migratory fishes of the Susquehanna River. The construction of fish lifts, fish ladders, low-flow fish passages, and the completion of a fish passage facility at the Red Hill dam in 2000 has potentially opened the Susquehanna River to American shad and other anadromous fishes as far upriver as Binghamton, NY. Fish passage facilities are also being constructed on the tributaries of the Susquehanna River and on smaller streams where impasses may exist. Millions of shad larvae, fry, and fingerlings are stocked annually within the Chesapeake Bay watershed, including the Susquehanna River and its tributaries, with over 455 million American shad stocked in the Chesapeake Bay watershed since 1986 (CBP 2008). Cooperative stocking efforts between New York, Pennsylvania, and Maryland are attempting to rebuild the population of American shad (Sadzinski and Jarzynski undated).

Since the opening of the fishway in 2000 at the Red Hill Dam, York Haven Power Company has monitored this fishway for passage of American shad, gizzard shad (*Dorosoma cepedianum*), walleye, smallmouth bass, and other species. The numbers of American shad, gizzard shad, walleye, and smallmouth bass passing the Red Hill Dam fishway have fluctuated since 2000 (York Haven Power Company 2008). American shad passage at all four dams has continued to decline since 2006, as shown in Table 2-5 below (PFBC 2008a). A number of factors can be causing the decrease in American shad numbers in the Susquehanna River, such as coast-wide declines in shad populations, low hatchery outputs, low wild juvenile survival, and fish passage effectiveness (PFBC 2008d). While predation on newly stocked American shad larvae may reduce the number that survive to adulthood (Johnson and Dropkin 1992), mortality at Susquehanna River stocking sites was less than 2 percent (PFBC 2008e).

Table 2-5. American Shad Passage at the Conowingo, Holtwood, Safe Harbor, and Red Hill Dams on the Susquehanna River

Year	Conowingo[(a)]	Holtwood[(b)]	Safe Harbor[(b)]	Red Hill
2008	19,914	2,795	1,252	21
2007	25,464	10,338	7,215	192
2006	56,899	35,968	24,929	1,913
2005	68,853	34,189	24,425	1,772
2004	109,360	3,482	2,109	219
2003	125,135	25,254	16,646	2,536
2002	108,001	17,522	11,705	1,555
2001	193,574	109,976	89,816	16,200
2000	153,546	29,421	21,079	4,675
1999	69,712	34,702	34,150	--
1998	39,904	8,235	6,054	--
1997	90,971	28,063	20,828	--

(a) The Conowingo Dam fish lift was built in 1991, but did not pass fish until 1997.
(b) The Holtwood Dam and Safe Harbor Dam fish lifts came online in 1997.
Source: PFBC 20008a

Other fish besides American and gizzard shad, walleye, and smallmouth bass use the Red Hill fish ladder. While monitoring for American shad passage during a 3-week period in 2008, data collected by the York Haven Power Company indicated that the gizzard shad was the species that most frequently passed up the ladder (15,930), followed by channel catfish (3,286), quillback (*Carpiodes cyprinus*) (2,045), walleye (905), carp (332), shorthead redhorse (*Moxostoma macrolepidotum*), and smallmouth bass (150). Several other species were also observed in lower numbers passing up the fish ladder (York Haven Power Company 2008).

The smallmouth bass is popular with recreational fishers on the Susquehanna River, but recent events have caused a concern with fisheries managers regarding the health of smallmouth bass and other fishes in the Susquehanna River. In the summers of 2005 and 2007, die-offs of mostly young smallmouth bass occurred in the Susquehanna River, Juniata River, and the West Branch Susquehanna River (PFBC 2008c). Mortality has been attributed to a bacterial infection caused by *Flavobacterium columnaris*, which results in large, visible lesions on infected fish. Greater than 50 percent of the young-of-the-year sampled in 2005 and 2007 in a study conducted by the Pennsylvania Fish and Boat Commission (PFBC) had visible external lesions. Scientists from the USGS suspect that stress from low rainfall and correspondingly low flows and low dissolved oxygen levels with high temperatures played a key role in making these fish susceptible to colonization by *F. columnaris* (USGS 2008). Research was conducted in 2008 by the USGS and PFBC to determine the cause of these outbreaks (USGS 2008).

The Susquehanna River in the vicinity of Three Mile Island is used for recreational fishing for a variety of species, such as the smallmouth bass, flathead catfish, channel catfish, and walleye (McNally 2008; PFBC 2008). To enhance recreational fishing, the PFBC annually stocks several species of fish on the Susquehanna River, typically above Lake Frederick. From 1991–2008, species stocked by the PFBC on the Susquehanna River within the Lower Susquehanna Subbasin included muskellunge and tiger muskellunge (*E. lucius* x *E. masquinongy*), walleye, striped bass (*Morone saxatilis)*, Hickory shad (*Alosa mediocris*), and American shad. The stocking of striped bass on the Susquehanna River was discontinued in 2006 (PFBC 2008f).

The cold-water tributaries of the Susquehanna River are home to several species of trout. A number of streams in the vicinity of Three Mile Island and Harrisburg are stocked with trout for recreational fishing and to enhance the naturally reproducing populations. Several streams near Three Mile Island—such as the headwaters of a tributary of Swatara Creek, located less than 2 mi upriver of Three Mile Island—also contain naturally reproducing trout populations. The Yellow Breeches, located along the west shoreline of the Susquehanna River and opposite Three Mile Island, also contains a naturally reproducing population of trout, (PFBC 2008b). No essential fish habitat has been designated for any species along the Susquehanna River upstream of Conowingo Dam (NOAA undated).

The EPA has outlined a nationwide program for the analysis of fish to establish fish consumption advisories. This program includes a listing of parameters for tissue analysis including PCBs, pesticides, and heavy metals. To comply with this program, Pennsylvania has conducted fish tissue contaminant monitoring throughout the Commonwealth since 1976. Public health advisories, based on fish tissue contaminant levels, are published annually in the PFBC annual summary of fishing regulations and laws. Since 2002, Pennsylvania has issued a general Statewide advisory recommending that people consume no more than one meal per week of recreationally caught sport fish. The Commonwealth issues more restrictive advisories for specific water bodies.

For the reach of the Susquehanna River within the vicinity of the TMI-1 facility and the nearest major water bodies—including Swatara Creek, East Conewago Creek, West Conewago Creek, and Fishing Creek—Pennsylvania issued a health advisory to limit the consumption of smallmouth bass to no more than two meals per month due to mercury contamination (PFBC 2008g).

2.2.6 Terrestrial Resources

The TMI-1 site and its associated transmission lines are located within the Lower Susquehanna River Subbasin and span Lancaster, York, and Dauphin Counties. Before construction, the entire TMI-1 site was within the 10-year floodplain; however, today, only the southern, undisturbed portion of the island remains in the 10-year floodplain. The TMI-1 site is approximately 370 ac (150 ha) and includes both the TMI-1 and TMI Unit 2 facilities. The buildings associated with plant generation and maintenance, parking lots, and onsite roads occupy 200 ac (81 ha) of the overall site (AmerGen 2008). The remaining 170 ac (69 ha) are covered by fields, forested land, and wetlands with several intermittent ponds. Natural areas

Figure 2-8. Three Mile Island Nuclear Station, Unit 1, Site Area Overview Map and Transmission Lines (Source: AmerGen 2008)

within the TMI-1 site and associated transmission line ROWs include upland; riparian; river floodplain forest communities; open fields; grasslands; and ponds, streams, and wetlands, whose primary water source is the Susquehanna River. Figure 2-8 is a map of Three Mile Island, the TMI-1 site, its associated transmission lines, and the surrounding area. Preconstruction habitat at the TMI-1 site consisted of open field habitats with upland and riparian forests as well as wetlands, while the transmission line ROWs consisted mostly of forested and agricultural land. After the construction of the plant facilities at the TMI-1 and TMI Unit 2 sites, much of the island became disturbed land. Continual maintenance of the transmission lines retains previously forested ROW land in an early successional state.

Upland areas at the TMI-1 site primarily support Virginia pine (*Pinus virginiana*), sweet birch (*Betula lenta*), flowering dogwood (*Cornus florida*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), and tuliptree (*Liriodendron tulipifera*). Common nonwoody species include fan-shaped clubmoss (*Lycopodium flabelliforme*), intermediate woodfern (*Dryopteris intermedia*), ground ivy (*Glechoma hederacea*), white avens (*Geum canadense*), common cinquefoil (*Potentilla simplex*), common blue violet (*Viola papilionacea*), and Swan's sedge (*Carex swanii*) (WHC 2005).

Forested riparian areas at the TMI-1 site support a mix of maples (*Acer* spp.), alders (*Alnus* spp.), birches (*Betula* spp.), and sycamores (*Platanus occidentalis*) (AmerGen 2008). Common tree species found in the river floodplain forests in and around the TMI-1 site are silver maple (*A. saccharinum*), river birch (*B. nigra*), and northern red oak (*Quercus rubra*). Nonwoody species found in river floodplain forests include ostrich fern (*Matteuccia struthiopteris*), mayapple (*Podophyllum peltatum*), dame's rocket (*Hesperis matronalis*), false mermaid (*Floerkea proserpinacoides*), Dutchman's breeches (*Dicentra cucullaria*), jumpseed (*Polygonum virginianum*), common blue violet (*Viola papilionacea*), and dogtooth violet (*Erythronium americanum*) (WHC 2005).

Open fields and grassland make up the predominant habitat on the southern end of Three Mile Island. Foxtail grasses (*Alopercurus* spp.) are the dominant genus; other grasses and sedges common to the TMI-1 site include Allegheny blackberry (*Rubus allegheniensis*), northern dewberry (*Rubus flagellaris*), white heath aster (*Symphyotrichum ericoides*), white panicle aster (*Symphyotrichum lanceolatum*), wrinkleleaf goldenrod (*Solidago rugosa*), common sheep sorrel (*Rumex acetosella*), common cinquefoil (*Potentilla simplex*), yellowfruit sedge (*Carex annectens*), creeping bentgrass (*Agrostis stolonifera*), little bluestem (*Andropogon scoparius*), poverty oatgrass (*Danthonia spicata*), and common timothy (*Phleum pretense*) (WHC 2005). Sycamores, sweetgum (*Liquidambar styraciflua*), basswood (*Tilia* spp.), and locust trees are found near the edges of the grasslands (AmerGen 2008).

The U.S. Fish and Wildlife Service (FWS) National Wetlands Inventory database indicates that wetlands, some of which are classified as significant habits, exist on the southern end of the TMI-1 site, as well as in the vicinity of the site along the Susquehanna River shoreline (FWS 2008). Figure 2-4 shows the location of the wetlands in proximity to the TMI-1 site. The onsite wetlands were formed when borrow pits were created during the construction of a dike system that surrounds the entire island (AmerGen 2008). The former borrow pits now have standing water approximately 7 months of the year (AmerGen 2008). Dragonflies, amphibians, frogs, and salamanders are all common species in the wetland ecosystems on the TMI-1 site (WHC 2005).

Invasive plant species common to Pennsylvania floodplain forests include tree-of-heaven (*Ailanthus altissima*), Oriental bittersweet (*Celastrus orbiculatus*), and garlic mustard (*Alliaria officinalis*), which encroach upon woodland areas, while purple loosestrife (*Lythrum salicaria*), wild hops (*Humulus japonicus*), and Japanese knotweed (*Polygonum cuspidatum*) are known to colonize areas along the Susquehanna River (TNC 2005). AmerGen is not required to keep records of known invasive species and does not have programs or procedures in place to control terrestrial plant or animal invasive populations on the TMI-1 site.

A variety of wildlife exists on and in the vicinity of the TMI-1 site. Mammals common to the TMI-1 site include white-tailed deer (*Odocoileus virginianus*); raccoon (*Procyon lotor*); gray squirrel (*Sciurus carolinensis*); red fox (*Vulpes vulpes*); striped skunk (*Mephitis mephitis*); small insectivores, such as moles, shrews, and bats; and rodents, such as mice and voles (AmerGen 2008). Reptiles and amphibians common to the TMI-1 site include snakes, turtles, lizards, salamanders, and toads.

The TMI-1 site provides habitat to a variety of songbirds, upland game birds, waterfowl, and raptors. AmerGen maintains onsite nests for osprey (*Pandion haliaetus*), peregrine falcon (*Falco peregrinus*), and mallard duck (*Anas platyrhynchos*), as well as boxes for wood duck (*Aix sponsa*) (AmerGen 2008). Twenty existing wood duck boxes will be replaced with new boxes in the next three years (WHC 2005).

AmerGen has several procedures for protecting wildlife at TMI-1, including environmental review checklists and environmental evaluation forms. Environmental review checklists are completed by qualified biologists and ensure that all appropriate procedures are followed, where applicable, to minimize the effects of plant operation on wildlife. Environmental evaluations are filled out when an item on the environmental review checklist is documented as disturbed or potentially affected. The environmental evaluation forms require the qualified biologist to describe and assess the impact, document possible ways to reduce or avoid the impact, and provide any applicable mitigation options.

2.2.7 Threatened and Endangered Species

Table 2-6, beginning on page 2-41 lists threatened, endangered, or candidate species known to occur in Dauphin County, in which TMI-1 is located, or York and Lancaster Counties, through which transmission line ROWs associated with TMI-1 traverse.

2.2.7.1 Aquatic Species

One Federally listed and State-listed endangered species, the dwarf wedgemussel (*Alasmidonta heterodon*), was recorded in Lancaster County, but not in the vicinity of TMI-1 or in the waterways along the transmission line corridors. The black bullhead (*Amerius melas*), a State-listed species, has been recorded in Dauphin County (PNHP 2008), but is not known to occur in the vicinity of TMI-1 or in the waterways along the transmission line corridors (AmerGen 2008).

The FWS indicated by letter dated April 23, 2008, that no Federally listed or proposed threatened or endangered species are known to occur within the project impact area, so no biological assessment or further consultation under the Endangered Species Act is required with the FWS (FWS 2008). PFBC indicated by letter dated June 7, 2008, that no adverse impacts to State-listed rare, candidate, threatened, or endangered aquatic species are expected from the proposed project (PFBC 2008h).

2.2.7.2 Terrestrial Species

Two Federally listed threatened or endangered terrestrial species, the bog turtle (*Glyptemys muhlenbergii*) and the northeastern bulrush (*Scirpus ancistrochaetus*), are potentially found in the vicinity of the TMI-1 site (FWS 2008). The bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon were formerly listed as Federally threatened and may also be found in the vicinity of the TMI-1 site. Eleven State-listed species were identified as species for consideration of the proposed license renewal of TMI-1, including the (1) osprey, (2) prothonotary warbler (*Protonotaria citrea*), (3) yellow-crowned night heron (*Nycticorax violacea*), (4) black-crowned night heron (*Nycticorax nycticorax*), (5) aster-like boltonia (*Boltonia asteroides*), (6) Short's sedge (*Carex shortiana*), (7) flat-stemmed spike-rush (*Eleocharis compressa*), (8) ellisia (*Ellisia nyctelea*), (9) bronze copper (*Lycaena hyllus*), and the formerly Federally listed (10) bald eagle, and (11) peregrine falcon (DCNR 2008a; PGC 2008; AmerGen 2008; PNHP 2008). The American Holly (*Ilex opaca*), State-listed as endangered, has been documented as occurring on the TMI-1 site; however, neither the Pennsylvania Department of Conservation and Natural Resources (DCNR) nor the Pennsylvania Game Commission (PGC) have identified the species for consideration of the proposed license renewal of TMI-1 (AmerGen 2008; DCNR 2008a; PGC 2008; PNHP 2008).

<u>Federally Protected and Formerly Protected Terrestrial Species</u>

The northeastern bulrush and the bog turtle have ranges that include the TMI-1 project area, but neither species is known to occur on the TMI-1 site or along its associated transmission line ROWs (AmerGen 2008). Additionally, neither species was identified in the April 23, 2008, letter from FWS as species requiring consideration for this proposed action (FWS 2008).

On July 9, 2007, the FWS issued a *Federal Register* notice announcing the delisting of the bald eagle from the Federal List of Endangered and Threatened Wildlife (72 FR 37346). Eagles continue to be protected at the national level by the Bald and Golden Eagle Protection Act, as well as the Migratory Bird Treaty Act, and at the State level as a Pennsylvania-listed threatened species. The bald eagle is a large bird, even among raptor species, and can reach a weight of more than 13 lb (6 kg). The eagle has a white head and tail, with brown body feathers. Bald eagles eat fish, small mammals, birds, and occasionally carrion. Bald eagles are known to occur in Dauphin, Lancaster, and York Counties, and are seen regularly along the Susquehanna River. The eagle is occasionally seen on Three Mile Island; however, the closest known nest is 20 mi (32 km) south of TMI-1, near the Holtwood Dam (AmerGen 2008).

The peregrine falcon was removed from Federal listing in August 1999, but continues to be listed as endangered at the State level. Adult birds have a bluish-black head and wings, are 14–19-in. (36–48 cm) tall, and have a 39–43-in (99-109 cm) wingspan (Cornell 2003). Peregrine falcons nest on high cliffs near river systems and on bridges and tall buildings (PGC 2006). The species was not observed nesting in Pennsylvania from 1959 to 1987, coinciding with the population depletion between 1950 and 1970 caused by the species' sensitivity to DDT (Cornell 2003). Reintroduction efforts in Pennsylvania and neighboring states have facilitated the growth of the population since the early 1990s (PGC 2006). A breeding pair has nested on the TMI-1 reactor building every year since 2002 (AmerGen 2008). In an effort to protect the nesting pair and their young, AmerGen regularly communicates with FWS, DCNR, and PADEP (AmerGen 2008).

State Protected Terrestrial Species

The Pennsylvania State-listed threatened osprey occurs on the Susquehanna River shoreline throughout the project area, and osprey nests are known to occur on the TMI-1 site (AmerGen 2008). The osprey is a fairly large bird of prey with a body length of about 21–24 in. (53–61 cm) and a wingspan of 4.5–5.5 ft (1.4–1.7 m). Osprey feed exclusively on live fish (FWS 2008a). Individuals are brown with a white belly and have distinctive patches on their wings. The osprey has long, sharp talons, which are used for gripping fish. Females are larger than males, which is true for most birds of prey. The osprey's habitat includes rivers, lakes, and shallow water estuaries. Since 2004, ospreys have nested on the TMI-1 meteorological tower, located on the north end of Three Mile Island (AmerGen 2008). AmerGen built a 55-ft (17-m) nesting platform in an attempt to relocate the nesting pair to a location more secluded from human activity, but relocation efforts have been unsuccessful (AmerGen 2008).

The Pennsylvania State-listed endangered aster-like boltonia, also a Pennsylvania species of special concern, grows on rocky shores and exposed, rocky river beds (DCNR 2008a). The boltonia is a tall, slender plant with stalks commonly growing to heights of 4–6 ft (1.2–1.8 m). The plant has white flowers with a yellow center, which appear between July and October (Fike 2008). The closest location of the boltonia to the TMI-1 site is the riverside outcrop community (Fike 1999).

Short's sedge, a species of special concern in Pennsylvania, occurs near wetlands along the Susquehanna River (PHNP 2008). Short's sedge is a grass-like plant, ranging in height from 8–35 in. (20–89 cm) (PNHP 2008b). The stems are light green, three-sided, and have no hairs (PNHP 2008b). Flowers, which grow on the top of each stem, are densely packed, brown cylindrical spikes and look like very small pinecones (PNHP 2008b). Short's sedge is known to occur near TMI-1 and its associated transmission line ROWs (PNHP 2008b; DCNR 2008a).

The flat-stemmed spike-rush, a grass-like plant in the sedge family, is listed as endangered in the Commonwealth of Pennsylvania (DCNR 2008a). DCNR also identifies the plant as a species of special concern (DCNR 2008a). The medium-to-dark green species grows 0.5–1.5 ft (15– 46 cm) in height and has a uniform diameter of 0.04 in. (1 mm) (Hilty 2006b). Generally one long, oval-shaped flower can be found per stalk. Flowers range in color from light-to-medium brown with small white spikes (Hilty 2006b).

The Pennsylvania-threatened ellisia is also a species of special concern for TMI-1 and the associated transmission line ROWs (DCNR 2008a). The 4–16-in. (10–41 cm) wildflower has pale green to pale purple stems and dark green, hairy leaves (Hilty 2006a). Individual flowers appear in May, span 0.25 in. (6.4 mm) in diameter, and have five small white petals surrounding a pale blue center (DCNR 2008a; Hilty 2006a). Ellisia is known to occur in the area of TMI-1 and its associated transmission line ROWs, and is generally found in damp, shady areas near stream banks with rich soils (DCNR 2008a; PNHP 2008a).

The bronze copper, a Pennsylvania species of special concern, is a butterfly that lives in wet meadowsand marshes (DCNR 2008a). The DCNR does not currently rank the species as endangered, threatened, or rare because of a lack of or conflicting information about population trends (DCNR 2008a). The male is brown and the female is yellow-orange with black spots. In both sexes, the underside is orange with black spots. The bronze copper likes to perch on low, nontree plants ranging less than 3–4 ft (1–1.2 m) in size. When in its caterpillar phase, the species eats green leaves from plants.

The prothonotary warbler, a Pennsylvania species of special concern, is known to nest and forage in proximity to the TMI-1 site, according to PGC (PGC 2008); however, the species is not identified by the FWS or DCNR as rare, threatened, or endangered for the TMI-1 site. The warbler is a very colorful bird, with a bright yellow-golden head and underside, olive body, blue-gray wings and tail, and white underwings. Prothonotary warblers live and breed in wooded swamps, bottomland, flooded forests, and alongside slow-moving rivers. The warbler feeds primarily on caterpillars, insects, fruit, and seeds (Audubon 2008). AmerGen has no known monitoring programs for the prothonotary warbler.

The Pennsylvania-endangered yellow-crowned night heron lives in proximity to the TMI-1 site (PGC 2008). Adult herons are approximately 2 ft (61 cm) tall with a long, slender appearance, have a 3–4-ft (1.0–1.2 m) wingspan, and are blue to gray in color. The species feeds mostly on fish. AmerGen has no known monitoring programs in place for the yellow-crowned night herons, therefore their population numbers within the vicinity of TMI-1 are unknown.

The black-crowned night heron, listed in Pennsylvania as endangered, is a medium-sized heron with a stocky body and short legs and neck (PNHP 2008). The heron has a black crown; a black and white face, chest, and belly; and blue-gray wings. It feeds primarily on aquatic invertebrates, fish, and frogs. The PGC identifies the species as one of special concern because it nests near the TMI-1 site (PGC 2008). AmerGen has no known monitoring programs in place for the black-crowned night heron; therefore, their population within the vicinity of TMI-1 is unknown.

Table 2-6. Listed Aquatic and Terrestrial Species. *The species listed are Federally-listed, Pennsylvania-listed, or both that are threatened, endangered, or candidate species. These species may occur on the TMI-1 site, within the Susquehanna River, or within the transmission line corridors.*

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
Fish				
Ameiurus melas	black bullhead		PE	Quiet backwaters
Reptiles and Amphibians				
Glyptemys muhlenbergii	bog turtle	T	PE	Wetlands, bogs, fens, meadows, and wet grassy areas
Opheodrys aestivus	rough green snake		PE	Hilly, forested, dry areas

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
Pseudemys rubriventris	redbelly turtle	SC	PT	Aquatic species found in lakes, rivers, ponds, and marshes
Insects				
Lycaena hyllus	bronze copper		SC	Low wet meadows and marshes, especially in river flood plains (DCNR 2008a)
Birds				
Bartramia longicauda	upland sandpiper		PT	Bogs, fens, grasslands, and pastures
Botaurus lentiginosus	American bittern		PE	Freshwater wetlands and shorelines
Casmerodius albus	great egret		PE	Aquatic and wetland habitats
Cistothorus platensis	sedge wren		PE	Wet meadows, freshwater marshes, and bogs
Falco peregrinus	peregrine falcon	E	PE	Cliffs, usually near riverine areas
Haliaeetus leucocephalus	bald eagle		PT	Forests near water bodies
Nyctanassa violacea	yellow-crowned night-heron		PE	Freshwater and saltwater marshes, wooded swamps, and shore areas
Nycticorax nycticorax	black-crowned night-heron		PE	Fresh and saltwater marshes, swamps, lakes, and wooded streams
Pandion haliaetus	osprey		PT	Close proximity to watery areas such as lakes, bogs, rivers, bay areas, and oceans
Rallus elegans	king rail		PE	Freshwater and brackish marshes
Mammals				
Cryptotis parva	least shrew		PE	Grasses, brushes, and weedy fields

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
Neotoma magister	Allegheny woodrat		PT	Rocky, forested areas
Plants				
Agalinis auriculata	eared false-foxglove		PE	Prairies, dry woods, and open fields
Ammannia coccinea	scarlet ammannia		PE	Moist, sandy shorelines
Arethusa bulbosa	swamp-pink		PE	Wetland areas
Aristida purpurascens	arrow-feathered three awned		PT	Moist areas, swamps, shores, and wetlands
Arnica acaulis	Leopard's-bane		PE	Wooded areas
Asplenium bradleyi	Bradley's spleenwort		PT	Exposed, barren areas; cliffs; and rocks
Boltonia asteroides	aster-like boltonia		PE,SC	Rocky shores and exposed rocky river beds (DCNR 2008a)
Bouteloua curtipendula	tall gramma		PT	Grasslands and barren areas
Carex aquatilis	water sedge		PT	Wetlands, ponds, marshes, and areas with standing water
Carex bullata	bull sedge		PE	Wetlands, ponds, marshes, and areas with standing water
Carex diandra	lesser panicled sedge		PT	Wetlands, ponds, marshes, and areas with standing water
Carex polymorpha	variable sedge		PE	Wetlands, ponds, marshes, and areas with standing water
Carex prairea	prairie sedge		PT	Wetlands, ponds, marshes, and areas with standing water
Carex shortiana	sedge		SC	Wet meadows, swamps, and wooded areas (DCNR 2008a)
Carex sterilis	sterile sedge		PT	Wetlands, ponds, marshes, and areas with

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
				standing water
Carex tetanica	sedge		PT	Wetlands, ponds, marshes, and areas with standing water
Carex typhina	cattail sedge		PE	Wetlands, ponds, marshes, and areas with standing water
Chrysopsis mariana	Maryland golden-aster		PT	Well-drained, open woods
Cirsium horridulum	horrible thistle		PE	Shores, marshes, or sandy fields
Cladium mariscoides	twig rush		PE	Wetlands, bogs, and freshwater shorelines
Clitoria mariana	butterfly-pea		PE	Dry, open areas on sandy soil
Cynanchum laeve	smooth swallow-wort		PE	Open areas or areas with slight ground cover
Cyperus diandrus	umbrella flatsedge		PE	Wetlands and wet meadows
Cyperus refractus	reflexed flatsedge		PE	Open dry fields, clearings, open forests, and sandy soils
Cyperus retrorsus	retrorse flatsedge		PE	Open dry fields, clearings, open forests, and sandy soils
Cypripedium reginae	showy lady's-slipper		PT	Bogs, swamps, wet meadows, and damp forests
Dodecatheon radicatum	jeweled shooting-star		PT	Moist, shaded areas and river bluffs
Eleocharis compressa	flat-stemmed spike-rush		PE,SC	River banks with sandy soils and usually wet areas (DCNR 2008a)
Eleocharis intermedia	matted spike-rush		PT	Marshes, wetlands, and muddy areas
Elephantopus carolinianus	elephant's foot		PE	Dry, open woods

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
Ellisia nyctelea	ellisia		PT,SC	River banks and alluvial woods (DCNR 2008a).
Epilobium strictum	downy willow-herb		PE	Bogs, swamps, and wetlands
Erigenia bulbosa	harbinger-of-spring		PT	Wet, wooded areas
Euphorbia purpurea	glade spurge		PE	Cool, moist woods, swamps, and alongside streambanks
Festuca paradoxa	cluster fescue		PE	Wet, wooded areas and wet meadows
Fimbristylis annua	annual fimbry		PT	Swampy, damp grasslands, and wetlands
Gaylussacia dumosa	dwarf huckleberry		PE	Open areas in forest habitats
Gymnopogon ambiguus	broad-leaved beardgrass		PE	Glades, prairies, and open fields
Helianthemum bicknellii	Bicknell's hoary rockrose		PE	Woodlands, prairies, and open rocky areas
Hypericum densiflorum	bushy St. John's-wort		PT	Stream banks, pond and lake edges, and wet meadows
Ilex opaca	American holly		PT	Moist, sandy woodlands
Iris cristata	crested dwarf iris		PE	Wooded areas and ravines
Iris prismatica	slender blue iris		PE	Saltwater and freshwater marshes, shores, and wet meadows
Iris verna	dwarf iris		PE	Grassy areas and shaded woody areas
Juncus arcticus var. littoralis	baltic rush		PT	Wetland areas, wet meadows, and wet grassy areas
Juncus brachycephalus	small-headed rush		PT	Wetland areas, wet meadows, and wet grassy areas
Juncus dichotomus	forked rush		PE	Wetland areas, wet meadows, and wet grassy

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
				areas
Juncus scirpoides	scirpus-like rush		PE	Wetland areas, wet meadows, and wet grassy areas
Linum intercursum	sandplain wild flax		PE	Dry, open grasslands
Linum sulcatum	grooved yellow flax		PE	Glades, prairies, and open fields
Lipocarpha micrantha	common hemicarpa		PE	Pond and stream edges and wetlands
Lobelia kalmii	brook lobelia		PE	Pond and stream edges, wetlands, and wet areas
Lobelia puberula	downy lobelia		PE	Wet, wooded areas, and wetlands
Ludwigia decurrens	upright primrose-willow		PE	Swampy, damp grasslands, and wetlands
Ludwigia polycarpa	false loosestrife seedbox		PE	Swamps, marshes, wet meadows, and wetlands
Lycopodiella appressa	southern bog clubmoss		PT	Bogs, wetlands, and sandy banks
Lyonia mariana	stagger-bush		PE	Moist, sandy, and wooded areas
Magnolia tripetala	umbrella magnolia		PT	Wooded areas and forests
Magnolia virginiana	sweet bay magnolia		PT	Wooded areas and forests
Matelea obliqua	oblique milkvine		PE	Open wooded areas, rocky slopes, and wooded edges
Melica nitens	three-flowered melic-grass		PT	Dry, rocky woods, and open areas along edges
Myriophyllum sibiricum	northern water-milfoil		PE	Lakes, ponds, and streams
Panicum scoparium	velvety panic-grass		PE	Prairies, glades, roadsides, and fields
Passiflora lutea	passion-flower		PE	Rich woods, rocky areas, and slopes

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
Phemeranthus teretifolius	round-leaved fame-flower		PT	Wooded areas
Phlox ovata	mountain phlox		PE	Sunny fields and open areas
Phyllanthus caroliniensis	Carolina leaf-flower		PE	Open fields
Poa paludigena	bog bluegrass		PT	Wet woods, bogs, and sedge meadows
Polygala cruciata	cross-leaved milkwort		PE	Wet, sandy meadows and marshes
Polygala incarnata	pink milkwort		PE	Open fields and semi-open forests
Polygonum setaceum var. interjectum	swamp smartweed		PE	Sandy wetlands and moist fields
Potamogeton hillii	Hill's pondweed		PE	Ponds, lakes, streams, and mostly submerged areas
Potamogeton obtusifolius	blunt-leaved pondweed		PE	Ponds, lakes, streams, and mostly submerged areas
Potamogeton richardsonii	red-head pondweed		PT	Ponds, lakes, streams, and mostly submerged areas
Pycnanthemum torrei	Torrey's mountain-mint		PE	Fields and open woods
Quercus shumardii	Shumard's oak		PE	Forest habitats
Ranunculus fascicularis	tufted buttercup		PE	Dry woods, glades, prairies, and roadsides
Rhexia mariana	Maryland meadow-beauty		PE	Wet meadows, freshwater marshes, bogs, and wetlands
Rhododendron atlanticum	dwarf azalea		PE	Wooded areas
Rhynchospora capillacea	capillary beaked-rush		PE	Open wetlands
Ruellia strepens	limestone petunia		PT	Moist, open woods and wetlands, and streambanks

Scientific Name	Common Name	Federal Status[(a)]	State Status[(b)]	Habitat
Scheuchzeria palustris	pod-grass		PE	Marshes and bogs
Schoenoplectus smithii	Smith's bulrush		PE	Wetlands, shores, mudflats, and beaches
Scirpus ancistrochaetus	northeastern bulrush	E	PE	Small wetlands
Scleria pauciflora	few flowered nutrush		PT	Moist, sandy soils, wetlands, wet meadows, and bogs
Scleria verticillata	whorled nutrush		PE	Marshes, bogs, wetlands, and wet meadows
Sericocarpus linifolius	narrow-leaved white-topped aster		PE	Dry fields and open woods
Sida hermaphrodita	sida		PE	Open areas, floodplains, and some wet areas
Sisyrinchium atlanticum	eastern blue-eyed grass		PE	Fields, open woods, meadows, and edges of salt marshes
Solidago simplex ssp. randii var. racemosa	sticky golden-rod		PE	Riverbanks, open areas, and water edges
Solidago speciosa var. erecta	slender golden-rod		PE	Dry, open fields, tall, grassy areas, and roadsides
Sparganium androcladum	branching bur-reed		PE	Swamps and shallows
Spiranthes vernalis	spring ladies'-tresses		PE	Wet or dry upland prairies, and roadsides
Sporobolus clandestinus	rough dropseed		PE	Prairies, glades, roadsides, fields, and rocky edges
Sporobolus heterolepis	prairie dropseed		PE	Open fields and prairies
Symphyotrichum depauperatum	serpentine aster		PT	Dry fields and open woods
Thalictrum coriaceum	thick-leaved meadow-rue		PE	Rocky, open, wooded areas, and with moist soils
Triphora trianthophora	nodding pogonia		PE	Dense forests

Scientific Name	Common Name	Federal Status(a)	State Status(b)	Habitat
Vernonia glauca	tawny ironweed		PE	Meadows and upland forests
Viburnum nudum	possum-haw		PE	Moist woods, wetlands, and swamps
Vittaria appalachiana	Appalachian gametophyte fern		PT	Rock outcrop areas in fields and forests

(a) E = Federally endangered; T = Federally threatened
(b) PE = Pennsylvania endangered; ST = Pennsylvania threatened; SC = State species of concern

2.2.8 Socioeconomic Factors

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected by changes in TMI-1 operations. TMI-1 and the communities that support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required by TMI-1 operations. TMI-1 operations, in turn, create the demand and pay for the people, goods, and services in the form of wages, salaries, and benefits for jobs and dollar expenditures for goods and services. The measure of the communities' ability to support the demands of TMI-1 depends on their ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomics region of influence (ROI) is defined by the areas where TMI-1 employees and their families reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The TMI-1 ROI consists of a two-county area (Dauphin and Lancaster Counties) where approximately 71 percent of TMI-1 employees reside. The following sections describe the housing, public services, offsite land use, visual aesthetics and noise, population demography, and the economy in the ROI surrounding TMI-1.

AmerGen employs a permanent workforce of approximately 525 employees (AmerGen 2008). Approximately 97 percent live in Dauphin, Lancaster, Lebanon, York, Cumberland, Perry, and Berks Counties, PA (Table 2-7). The remaining 3 percent of the workforce are divided among 12 counties in Pennsylvania, ranging from one to five employees per county. Given the residential locations of TMI-1 employees, the most significant impacts of plant operations are likely to occur in Dauphin and Lancaster Counties. The focus of the socioeconomic impact analysis in this draft supplemental environmental impact statement (EIS) is therefore on the impacts of TMI-1 on these two counties.

Table 2-7. TMI-1 Employee Residence by County

County	Number of Employees	Percentage of Total
Dauphin, PA	196	37
Lancaster, PA	176	34
Lebanon, PA	57	11
York, PA	41	8
Cumberland, PA	26	5
Perry, PA	7	1
Berks, PA	6	1
Other	16	3
Total	525	100

Source: AmerGen 2008

Refueling outages at TMI-1 occur at 24-month intervals. During refueling outages, site employment increases by as many as 1,400 workers for approximately 20 to 30 days (AmerGen 2008). Most of these workers are assumed to be located in the same geographic areas as the permanent TMI-1 staff.

2.2.8.1 Housing

Table 2-8 lists the total number of occupied and vacant housing units, vacancy rates, and median value in the two-county ROI. According to the 2000 census, there were over 291,000 housing units in the socioeconomic region, of which approximately 275,000 were occupied. The median value of owner-occupied units ranged from $99,900 in Dauphin County to $119,300 in Lancaster County. The vacancy rate was lower in Lancaster County (4.1 percent) than Dauphin County (7.6 percent).

By 2006, the number of housing units in Dauphin County grew to an estimated total of 115,896 units, an increase of more than 4,700 units, and the number of occupied units grew by more than 1,600 units to an estimated total of 104,336 units. As a result, the number of available vacant housing units in Dauphin County increased by more than 3,090 units to 11,560, or 10 percent of the available units. In addition, the estimated number of vacant housing units also increased in Lancaster County (USCB 2008).

Table 2-8. Housing in Dauphin and Lancaster Counties, Pennsylvania

	Dauphin	Lancaster	Region
2000			
Total	111,133	179,990	291,123
Occupied housing units	102,670	172,560	275,230
Vacant units	8,463	7,430	15,893
Vacancy rate (percent)	7.6	4.1	5.5
Median value (dollars)	99,900	119,300	109,600
2006*			
Total	115,896	192,351	308,247
Occupied housing units	104,336	184,581	288,917
Vacant units	11,560	7,770	19,330
Vacancy rate (percent)	10.0	4.0	6.3
Median value (dollars)	136,200	171,900	154,050

* Estimated

2.2.8.2 Public Services

This section presents a discussion of public services including water supply, education, and transportation.

<u>Water Supply</u>

Because TMI-1 is located in Londonderry Township (in Dauphin County) and most of the TMI-1 employees reside in Dauphin and Lancaster Counties, the discussion of public water supply systems is limited to Dauphin and Lancaster Counties.

Dauphin County

Dauphin County is currently served by fourteen public water systems. Public water systems serve approximately 240,000 persons with approximately 74,000 connections (Dauphin County 2008). The largest populations served are those receiving water from United Water Pennsylvania (94,000 persons served), the Harrisburg Municipal Water Authority (66,500 persons), and the Pennsylvania American Water Company-Hershey (42,000 persons) (PADEP 2008). The sources for these public water systems are primarily surface water (i.e. various creeks, streams and a reservoir), while the majority of the smaller systems are dependent upon ground water sources (Dauphin County 2008). County planners state that there is currently ample water to meet demand. Table 2-9 lists the largest municipal water suppliers in Dauphin County.

Lancaster County

Lancaster County has more than 30 major public water systems providing services for larger communities in the county. Although these systems draw from groundwater and surface water sources, they are becoming increasingly dependent on ground water to meet growing public demand. Over the last several decades, Lancaster County's population has grown at a faster rate than the Commonwealth of Pennsylvania, reflecting an increase in demand for water. Lancaster County currently has ample supply to meet the county's needs. However, county planning officials are concerned about future supplies. Table 2-9 lists some of the major community water supply systems in the two-county area.

Table 2-9. Major Public Water Supply Systems

Water Supplier [a]	Water Source [a, b]	Average Daily Production [c]	Design Capacity [c]	Population Served
Dauphin County				
Harrisburg Municipal Water Authority	SW	9	20	66,540
Pennsylvania American Water Company–Hershey	SW	6	9	42,398
United Water Pennsylvania	SW	11	16	94,000
Lancaster County				
City of Lancaster	SW	16	40	108,000
Columbia Water Company	SW	2	3	21,500
Elizabethtown Area Water	SW	1	2	15,000
Ephrata Area joint Authority	SW	3	4	17,937
East Hempfield Water Authority	GW	2	3	16,761

(a) GW = ground water; SW = surface water;
(b) EPA 2008c
(c) Million gallons per day
Source: PADEP 2008a

Education

TMI-1 is located in the Lower Dauphin School District (PDE 2004), Dauphin County, which had an enrollment of approximately 3,950 students in 2006-2007 school year (PDE 2007a). Including the Lower Dauphin School District, Dauphin County has 10 public school districts (PDE 2007a) with over 38,500 enrolled students (PDE 2007b). Lancaster County has a total of 16 public school districts (PDE 2007a). Total enrollment in Lancaster County public schools in the 2006-2007 school year was approximately 71,000 students (PDE 2007b).

Transportation

TMI-1 is located in the southwest corner of Dauphin County (near the northern border of Lancaster County), approximately 10 mi southeast of Harrisburg, Pennsylvania. Dauphin County is traversed by four interstate highways: 81, 83, 283, and 76. The nearest interstate, I-76, can be accessed approximately 7 mi north of TMI-1 (see Figures 2-1 and 2-2).

Road access to TMI-1 is via State Highway 441 (SH-441), which runs north to south on the east side of the Susquehanna River. There are two access roads to TMI-1, Liberty Lane to the north (North Access Road), and Constitution Drive to the south (South Access Road), and they both intersect with SH-441 (see Figure 2-6). The majority of the plant's operation workforce uses the northern entrance; a limited number of employees working on the southern portion of the station, as well as the outage and refurbishment workforces use the southern entrance (AmerGen 2008). Approximately 4-5 mi north of TMI-1, SH-441 intersects with I-76, which runs east to west (Figure 2–2). AmerGen and contractor employees traveling to TMI-1 from Harrisburg, Hummelstown, and Middletown from the north would use I-76, or a variety of interstate, State, and secondary roads to access SH-441. Workers traveling to TMI-1 from Elizabethtown, Mount Joy, and Lancaster from the south would also use a variety of State highways and secondary roads to access SH-441.

Employees traveling from the southwest would travel north to I-76, cross the Susquehanna River, and access SH-441 to reach TMI-1.

Table 2–10 on the following page lists commuting routes to TMI-1 and average annual daily traffic (AADT) volume values. The AADT values represent traffic volumes for a 24-hour period factored by both day of week and month of year.

2.2.8.3 Offsite Land Use

Offsite land use conditions in Dauphin and Lancaster Counties are described in this section, because the majority of TMI-1 employees live in these two counties. In addition to the real estate taxes paid by AmerGen to Dauphin County, Dauphin and other counties in the vicinity of TMI-1 receive revenue from the taxes and fees paid by AmerGen and long-term contract employees residing in the region. In addition, changes in the number of workers employed at TMI-1 and the amount of taxes paid to local jurisdictions could affect land use conditions in these counties. The TMI-1 facility is located in southwestern Dauphin County. Lancaster County is located southeast of Dauphin County along the Susquehanna River.

Dauphin County

Dauphin County is approximately 525 mi^2 (1360 km^2) and has 40 municipalities including the Pennsylvania State capital in Harrisburg (USCB 2008b). The county is located in south-central Pennsylvania, along the Susquehanna River. Dauphin County planners are concerned about future population growth and making growth decisions that will not overburden taxpayers. County planners are focused on revitalizing older developed areas of the county and managing growth that will not change its rural character.

Dauphin County planners are working to manage development within the county through the use of Planned Growth Areas. Dauphin County adopted the Regional Growth Management Plan produced by the Tri-County Regional Planning Commission (which includes Cumberland and Perry Counties). The goal is to focus development in and around Planned Growth Areas where

Table 2-10. Major Commuting Routes in the Vicinity of the Three Mile Island Nuclear Station and 2006 Average Annual Daily Traffic (AADT) Counts

Roadway and Location	AADT [(a)]
State Highway 230, south of Interstate 76, near Harrisburg International Airport to Middletown	13,000–17,000
State Highway 441, just north of Interstate 76	6,400
State Highway 441, south of Interstate 76, near Middletown	7,100
State Highway 441, south of Interstate 76, near Royalton	6,700
State Highway 441, near northern entrance to Three Mile Island	3,300
State Highway 441, between Dauphin County border and intersection with State Highway 241 (Lancaster County)	4,200
State Highway 441, between intersection with State Highway 241 and intersection with State Highway 743 (Lancaster County)	5,100 – 6,300
State Highway 441, between intersection with State Highway 743 and intersection with State Highway 772 (Lancaster County)	11,000
State Highway 441, between intersection with State Highway 772 and intersection with State Highway 23 (Lancaster County)	16,000
State Highway 441, between intersection with State Highway 23 and intersection with U.S. Route 30 (Lancaster County)	17,000
State Highway 441, between intersection with U.S. Route 30 and intersection with State Highway 462 Lancaster County)	12,000

Source: PennDOT 2008.
(a) All AADTs represent traffic volume during the average 24-hour day during 2006.

services such as sewer, water, transit, highway access, and community facilities exist to maximize the investment in existing infrastructure (Dauphin County 2008).

The recently adopted Dauphin County Comprehensive Plan describes the following land use:

- Residential: 15 percent
- Public and semi-public lands: 26 percent (two-thirds comprised of state game lands and forest)
- Agricultural and undeveloped lands: 55 percent
- Industrial: 2 percent
- Transportation: less than 1 percent

- Commercial and service: less than 1 percent each.

In 2000, 34.5 percent of the county's residents lived in Harrisburg and 16 boroughs while others made their homes in townships and villages. As part of the 2008 Comprehensive Plan, the county considered future land use by including geographic planning sections. Northern Dauphin County is characterized by low-density residential development. Southeastern Dauphin County is characterized by medium-density residential development. Southwestern Dauphin County and Harrisburg are characterized by high-density mixed urban development (Dauphin County 2008).

Throughout the county, non-residential development occurs in a scattered fashion adjacent to roadways. The greatest concentration of non-residential development occurs between the City of Harrisburg and Derry Township, adjacent to U.S. Routes 83, 322, and 422. Limited non-residential land use has occurred on limited access intersections of Interstates 81 and 83 and the Pennsylvania Turnpike. The portions of the county located in the heart of the Susquehanna Valley contain the majority of agricultural activity. The northeastern tier of the county is mountainous and forested (Dauphin County 2008).

The Land Needs Concept forecasts land use needs by considering regional population growth trends, employment needs resulting from population growth, and real estate market projections. Previously, most planning did not take this picture into account and relied solely on population projections. The future land use map identifies land needed to accommodate population projections through 2020. All other land is designated as Rural Reserve/Agriculture for future evaluation and use (Dauphin County 2008).

<u>Lancaster County</u>

Lancaster County is approximately 949 mi^2 (2458 km^2), nearly twice the size of Dauphin County in acreage and population, and has 60 municipalities (USCB 2008b). Farming plays a major role in Lancaster County, and land use planning focuses on preservation of agricultural areas. Farmland presently occupies 69 percent of the available land area in the county. Lancaster County and Municipal Planners are concerned about preserving the farming culture and heritage of the county, especially that of the Amish. Tourists visiting these areas add $1.6 billion annually to the county's economy.

In 1993, the county adopted a Growth Management element to its Comprehensive Plan. Future growth would be directed to Designated Growth Areas (similar to Dauphin County's Planned Growth Areas) or areas already impacted by development to emphasize reinvestment in previously developed areas. The plan defined two types of growth areas as Urban Growth Areas and Village Growth Areas to manage future land use in the county (Lancaster County 2006). The growth areas have defined boundaries around a city, borough, or village, and include developed portions of surrounding townships and enough buildable land to meet future land use needs over a 20-year period. Since 1993, 39 growth areas have been established in Lancaster County. Between 1994 and 2002, residential land use outside Designated Growth Areas occurred at a net density of 0.8 dwellings per acre, while growth inside Designated Growth Areas occurred at a net density of 5.5 dwellings per acre (Lancaster County 2006).

Currently, the largest residential, commercial and industrial development concentrations are found in the City of Lancaster and surrounding areas. Development can also be found along major road corridors heading north and northwest (Interstate 76, U.S. 30, U.S. 222, and PA 283) through the county (Lancaster County 2006).

The Lancaster County Planning Commission is updating the Growth Management Plan element of the Lancaster County Comprehensive Plan. The update will plan for growth throughout the county through 2030, and it will be guided by the Policy Element of the Comprehensive Plan.

The growth management plan will:

- Examine current and projected growth patterns and infrastructure needs
- Review urban and village growth areas
- Address issues of concern within rural areas
- Provide recommendations to achieve sustainable growth that balances development with the preservation of farmland and open space.

2.2.8.4 Visual Aesthetics and Noise

TMI-1 is located on an island in the middle of the Susquehanna River. TMI-1 as a whole can be seen from the river, but is shielded on the land side for the most part by surrounding vegetation due to its position along the river in the Susquehanna River Valley. The cooling towers, turbine buildings, and reactor containment structures dominate the site's landscape and can be seen from the Susquehanna River.

> The EPA generally uses 55 decibels (dBA) as the noise threshold level to protect against excess noise during outdoor activities. However, according to the EPA, this threshold does "not constitute a standard, specification, or regulation," but was intended to provide a basis for state and local governments establishing noise standards.

With natural draft cooling towers, the most obvious aesthetic impact is the visible plume in the sky. The plumes are most persistent under certain meteorological conditions when the capacity for the atmosphere to hold additional water vapor is lowest. This occurs when relative humidity is high or air temperatures are low. Observations of cooling towers in the same region suggest that under certain meteorological conditions the visible plume could extend 1–2 mi (1.6–3.2 km) (AEC 1972).

Noise from TMI-1 can be detected offsite. Sources of noise from station operation include the cooling towers, turbines, and large pumps and cooling water system motors. Given the industrial nature of the station, noise emissions from the station are generally nothing more than an intermittent minor nuisance. Noise levels may sometimes exceed the 55 dBA level that the EPA uses as a threshold level to protect against excess noise during outdoor activities. However, according to the EPA this threshold does "not constitute a standard, specification, or regulation," but was intended to provide a basis for State and local governments establishing noise standards.

2.2.8.5 Demography

According to the 2000 Census, approximately 787,800 people lived within 20 mi (32 km) of TMI-1, which equates to a population density of 627 persons per square mile (AmerGen 2008). This density translates to the least sparse Category 4 density level (greater than or equal to 120 persons per square mile within 20 mi). Approximately 2,546,500 people live within 50 mi (80 km) of TMI-1 (AmerGen 2008). This equates to a population density of 325 persons per square mile. Applying the GEIS proximity measures, TMI-1 is classified as proximity Category 4 (greater than or equal to 190 persons per square mile within 50 mi). Therefore, according to the sparseness and proximity matrix presented in the GEIS, TMI-1 rankings of sparseness Category 4 and proximity Category 4 result in the conclusion that TMI-1 is located in a high population area.

Table 2-11 shows population projections and growth rates from 1970 to 2050 in Dauphin and Lancaster Counties. The growth rate in Dauphin County showed an increase of 5.9 percent for the period of 1990 to 2000. County populations are expected to continue to grow in both counties in the next decades although Lancaster County's population is expected to increase at a higher rate through 2050.

Table 2-11. Population and Percent Growth in Dauphin County and Lancaster County, Pennsylvania, from 1970 to 2000, and Projected for 2010 and 2050

Year	Dauphin		Lancaster	
	Population	Percent Growth[(a)]	Population	Percent Growth[(a)]
1970	223,834	—	319,693	—
1980	232,317	3.8	362,346	13.3
1990	237,813	2.4	422,822	16.7
2000	251,798	5.9	470,658	11.3
2006	***254,176***	***0.9***	***494,486***	***5.1***
2010	256,478	1.9	499,261	6.1
2020	263,198	2.6	527,486	5.7
2030	270,543	2.8	554,611	5.1
2040	279,024	3.2	591,901	6.7
2050	286,710	2.7	623,536	5.3

— = No data available.

(a) Percent growth rate is calculated over the previous decade.

Sources: Population data for 1970–2000 (USCB 2008a); population data for 2006 (estimated) 2006 American Community Survey; population projections for 2010 – 2030 by Pennsylvania State Data Center, February 2008; population projections for 2040 and 2050 (calculated)

The 2000 and 2006 (estimate) demographic profiles of the two-county region of influence population are presented in Table 2-12 and Table 2-13. In 2000, minority individuals (both race and ethnicity) comprised 15.5 percent of the total two-county population. The minority population was comprised largely of Black or African American and Hispanic or Latino residents.

Table 2-12. Demographic Profile of the Population in the TMI-1 Two-County Socioeconomic Region of Influence in 2000

	Dauphin	Lancaster	Region of Influence
Total Population	251,798	470,658	722,456
Race (percent of total population, Not Hispanic or Latino)			
White	75.6	89.3	84.5
Black or African American	16.6	2.5	7.4
American Indian and Alaska Native	0.1	0.1	0.1
Asian	1.9	1.4	1.6
Native Hawaiian and Other Pacific Islander	0.0	0.0	0.0
Some other race	0.1	0.1	0.1
Two or more races	1.5	0.8	1.1
Ethnicity			
Hispanic or Latino	10,404	26,742	37,146
Percent of total population	4.1	5.7	5.1
Minority Population (including Hispanic or Latino ethnicity)			
Total minority population	61,451	50,292	111,743
Percent minority	24.4	10.7	15.5

Source: USCB 2008a

According to the U.S. Census Bureau's 2006 American Community Survey, minority populations in the two-county region were estimated to have increased by nearly 17,000 persons and comprised 17.2 percent of the total two-county population in 2006 (see Table 2-13). The largest increases in minority populations were estimated to occur in Hispanic or Latino and Asian populations. The Black or African American population increased by approximately 9.4 percent from 2000 to 2006, but remained relatively unchanged as a percentage of the total fourcounty population.

Table 2-13. Demographic Profile of the Population in the TMI-1 Two-County Socioeconomic Region of Influence in 2006 (Estimate)

	Dauphin	Lancaster	Region of Influence
Total Population	254,176	494,486	748,662
Race (percent of total population, Not-Hispanic or Latino)			
White	73.5	87.6	82.8
Black or African American	17.2	3.0	7.8
American Indian and Alaska Native	0.2	0.1	0.1
Asian	2.4	1.5	1.8
Native Hawaiian and Other Pacific Islander	0.0	0.0	0.0
Some other race	0.1	0.2	0.2
Two or more races	1.5	0.9	1.1
Ethnicity			
Hispanic or Latino	12,910	32,894	45,804
Percent of total population	5.1	6.7	6.1
Minority Population (including Hispanic or Latino ethnicity)			
Total minority population	67,434	61,435	128,869
Percent minority	26.5	12.4	17.2

Source: USCB 2008a

Transient Population

Within 50 mi (80 km) of TMI-1, colleges and recreational opportunities attract daily and seasonal visitors who create demand for temporary housing and services. In 2007, there were approximately 63,000 students attending colleges and universities within 50 mi (80 km) of TMI1 (IES 2008).

In 2000 in Dauphin County, 0.5 percent of all housing units were considered temporary housing for seasonal, recreational, or occasional use. By comparison, seasonal housing accounted for 0.4 percent and 2.8 percent of total housing units in Lancaster County and Pennsylvania, respectively (USCB 2008). Table 2-14 provides information on seasonal housing located within 50 mi of TMI-1.

Table 2-14. Seasonal Housing in Counties Located within 50 Miles of TMI-1

County [(a)]	Housing units	Vacant housing units: For seasonal, recreational, or occasional use	Percent
Pennsylvania	**5,249,750**	**148,230**	**2.8**
Adams	35,831	672	1.9
Berks	150,222	744	0.5
Chester	163,773	571	0.3
Columbia	27,733	1,304	4.7
Cumberland	86,951	379	0.4
Dauphin	*111,133*	*570*	*0.5*
Franklin	53,803	572	1.1

County [(a)]	Housing units	Vacant housing units: For seasonal, recreational, or occasional use	Percent	
Juniata	10,031	945	9.4	
Lancaster	*179,990*	*808*	*0.4*	
Lebanon	49,320	458	0.9	
Mifflin	20,745	1,082	5.2	
Northumberland	43,164	246	0.6	
Perry	18,941	1,270	6.7	
Schuylkill	67,806	865	1.3	
Snyder	14,890	495	3.3	
York	156,720	946	0.6	
County Subtotal	1,191,053	11,927	2.4	(avg.)
Maryland	**2,145,283**	**38,880**	**1.8**	
Baltimore	313,734	1,212	0.4	
Carroll	54,260	117	0.2	
Cecil	34,461	1,410	4.1	
Frederick	73,017	284	0.4	
Harford	83,146	299	0.4	
Washington	52,972	468	0.9	
County Subtotal	611,590	3,790	1.1	(avg.)
County Total	**1,802,643**	**15,717**	**2.0**	(avg.)

Source: USCB 2008
(a) Counties within 50 mi (80 km) of TMI-1 with at least one block group located within the 50-mile radius
avg. = percent average for counties within the TMI-1 50-mile radius and excludes state percentage

Migrant Farm Workers

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers may follow the harvesting of crops, particularly fruit, throughout the northeastern U.S. rural areas. Others may be permanent residents near TMI-1 who travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being residents, migrant workers may be unavailable for counting by census takers. If uncounted, these workers would be “underrepresented” in USCB minority and low-income population counts.

Information on migrant farm and temporary labor was collected in the 2002 Census of Agriculture. Table 2-15 provides information on migrant farm workers and temporary farm labor (less than 150 days) within 50 mi (80 km) of TMI-1. According to the 2002 Census of Agriculture, approximately 25,000 farm workers were hired to work for less than 150 days and were employed on 5,800 farms within 50 mi (80 km) of TMI-1. The county with the largest number of temporary farm workers (5,841 workers on 1,627 farms) was Lancaster County, Pennsylvania.

In the 2002 Census of Agriculture, farm operators were asked for the first time whether any hired migrant workers, defined as a farm worker whose employment required travel that prevented the migrant worker from returning to their permanent place of residence on the same day. A total of 648 farms in the 50-mile radius of TMI-1 reported hiring migrant workers. Chester County reported the most farms (158) with hired migrant workers, followed by Lancaster County (126). By comparison, the 10 farms in Dauphin County host relatively small numbers of migrant workers. According to 2002 Census of Agriculture estimates, 425 temporary farm laborers (those working fewer than 150 days per year) were employed on 147 farms in Dauphin County, and as previously discussed 5,841 temporary farm workers were employed on 1,627 farms in Lancaster County (USDA 2002 Census of Agriculture).

Table 2-15. Migrant Farm Worker and Temporary Farm Labor in Counties Located within 50 Miles of TMI-1

County[(a)]	Number of farm workers working for less than 150 days	Number of farms hiring workers for less than 150 days	Number of farms reporting migrant farm labor	Number of farms with hired farm labor
Pennsylvania	**13,512**	**10,232**	**41,606**	**745**
Adams	293	211	2,437	88
Berks	549	383	2,128	28
Chester	710	494	2,470	158
Columbia	252	196	1,408	8
Cumberland	189	130	420	4
Dauphin	*194*	*147*	*425*	*10*
Franklin	482	342	1,819	27
Juniata	172	158	304	2
Lancaster	*1,976*	*1,627*	*5,841*	*126*
Lebanon	325	180	547	6
Mifflin	250	106	249	1
Northumberland	204	156	595	27
Perry	150	112	392	7
Schuylkill	173	128	556	10
Snyder	242	189	534	16
York	404	327	1,104	23
County Subtotal	**6,565**	**4,886**	**21,229**	**541**
Maryland	**3,321**	**2,453**	**10,551**	**212**
Baltimore	273	201	762	47
Carroll	244	169	414	6
Cecil	162	123	713	7
Frederick	294	223	1,269	17
Harford	148	101	406	26
Washington	188	129	443	4
County Subtotal	**1,309**	**946**	**4,007**	**107**
County Total	**7,874**	**5,832**	**25,236**	**648**

(a)Counties within 50 mi (80 km) of TMI-1 with at least one block group located within the 50-mi (80-km) radius
Source: 2002 Census of Agriculture – County Data; Table 7. Hired Farm Labor – Workers and Payroll: 2002

2.2.8.6 Economy

This section contains a discussion of the economy, including employment and income, unemployment, and taxes.

Employment and Income

Between 2000 and 2006, the civilian labor force in Dauphin County increased 6 percent from 128,611 to 136,359. During the same time period, the civilian labor force in Lancaster County grew by nearly the same percentage (5.8 percent) (USCB 2008a).

In 2006, educational services, health care and social assistance represented the largest sector of employment in the two-county region followed closely by manufacturing and retail trade industry. The educational services, health care, and social assistance sector employed the most people in Dauphin County, followed by the retail trade and public administration sectors. A list of some of the major employers in Dauphin County in 2007 is provided in Table 2-16. As shown in the table, the largest private employer in Dauphin County was Hershey Foods Corporation.

Table 2-16. Major Employers in Dauphin County in 2007

Name	Name
Pennsylvania State Government	Harrisburg School District
Milton S Hershey	Giant Food Stores LLC
Hershey Foods Corporation	Wal-Mart Associates Inc.
HERCO Inc./ Hershey Entertainment and Resorts	Keystone Service Systems Inc.
Pinnacle Health System	Nationwide Mutual Insurance Company
Federal Government	United Concordia Companies Inc.
Pennsylvania Higher Education Assistance Agency	Diocese of Harrisburg
Tyco Electronics Corporation	DST Health Solutions Services
Central Dauphin School District	City of Harrisburg
United Parcel Service	ArcelorMittal Steelton LLC
Pennsylvania State University	D & H Distributing Company
Capital Blue Cross	Derry Township School District
Harrisburg Area Community College	ENERFAB Inc.
Dauphin County Government	Lower Dauphin School District
Milton S Hershey School and School Trust	C & S Wholesale Grocers

Source: Center for Workforce Information and Analysis 2008

Income information for the TMI-1 region of influence is presented in Table 2-17. In 1999, the date of the last economic census, the two counties each had median household incomes above the Pennsylvania Commonwealth average. Per capita income, with the exception of Lancaster County, was also above the average for all of Pennsylvania. In 1999, only 7.8 percent of the population in Lancaster County was living below the official poverty level, while in Dauphin County and the Commonwealth of Pennsylvania, 9.7 and 11 percent of the respective populations were living below poverty level. The percentage of families living below the poverty level was about the same for Dauphin County and Pennsylvania as a whole. Lancaster County had a smaller percentage of families living below the poverty level (USCB 2008a).

Table 2-17. Income Information for the TMI-1 Socioeconomic Region of Influence

	Dauphin	Lancaster	Pennsylvania
Median household income 1999 (dollars)	41,507	45,507	40,106
Per capita income 1999 (dollars)	22,134	20,398	20,880
Percent of families living below the poverty level (2000)	7.5	5.3	7.8
Percent of individuals living below the poverty level (2000)	9.7	7.8	11.0

Source: USCB 2008

Unemployment

In 2006, the annual unemployment average in Dauphin and Lancaster Counties were 4.8 and 3.6 percent, respectively, which were lower than the annual unemployment average of 6.2 percent for the Commonwealth of Pennsylvania (USCB 2008a).

Taxes

Currently, AmerGen pays annual property taxes on TMI-1 to Dauphin County, Londonderry Township, and the Lower Dauphin School District. Prior to 2000, real estate taxes were paid to the Commonwealth of Pennsylvania for power generation, transmission, and distribution facilities. During that time, under authority of the Pennsylvania Utility Realty Tax Act (PURTA), real estate taxes collected from all utilities (water, telephone, electric, and railroads) were redistributed to the taxing jurisdictions within the Commonwealth. In Pennsylvania, these jurisdictions included counties, cities, townships, boroughs, and school districts. The distribution of PURTA funds was determined by formula, and was not necessarily based on the individual utility's effect on a particular government entity.

Under 1999 Amendments to PURTA, the assessment methodology for utilities was revised from the depreciated book value to the market value of utility property. Additionally, as of January 1, 2000, the owners of TMI-1 were required to begin paying real estate taxes directly to local jurisdictions, ceasing payments to the Commonwealth's PURTA fund. Accordingly, since that time, the owner of TMI-1 has periodically negotiated with local taxing jurisdictions regarding market value assessments of the station and the amount of taxes that will be paid.

While maintaining open appeals of the assessments from 1998 through 2002, AmerGen and the previous owners of TMI-1 entered into a Stipulation and Interim Settlement agreement with the taxing authorities, dated December 22, 2000 (2000 Stipulation). Under the 2000 Stipulation, AmerGen paid Dauphin County approximately $146,900 annually in property taxes from 2000 through 2004. These payments represented approximately 0.2 to 0.3 percent of Dauphin County's total property tax revenues for that time period (see Table 2-18 on the following page).

Also from 2000 through 2004 under the 2000 Stipulation, AmerGen paid property taxes annually to Londonderry Township and Lower Dauphin School District in the amounts of $30,000 and $394,500, respectively. These payments represented approximately 0.5 to 0.7 percent of Londonderry Township's total property tax revenues and approximately 2.1 to 2.9 percent of total property tax revenues for the Lower Dauphin School District (see Table 2-18 on the following page).

In 2005, AmerGen and PECO signed a settlement with the local taxing bodies (the 2005 Settlement) that both acknowledged the 1999 PURTA Amendments' change in the way TMI-1's value would be assessed and reported a corresponding reduction in assessed value. As a result, the 2005 Settlement slightly decreased AmerGen's property tax payments to Dauphin County, Londonderry Township, and the Lower Dauphin School District in comparison with payments made under the 2000 Stipulation. For 2005, AmerGen's property tax payments represented approximately 0.2 percent of Dauphin County's total property tax revenues, and approximately 1.7 percent of the Lower Dauphin School District's total property tax revenues (see Table 2-18).

From 2000 to 2005, AmerGen's annual property tax payments to both Dauphin County and Londonderry Township for TMI-1 represented less than 1 percent of each of their total property tax revenues. Annual property tax payments to the Lower Dauphin School District during the same time period represented an average of approximately 2.4 percent of the school district's total property tax revenues (see Table 2-18).

In July of 2008, AmerGen negotiated a new agreement with the three taxing entities (2008 Agreement) that provides for an increase in the property taxes AmerGen currently pays. The 2008 Agreement obligates AmerGen to pay a total of $930,000 to the Lower Dauphin School District, Dauphin County and Londonderry Township. Annually, the school district will receive $637,000, the county will receive $254,634, and the township will receive $37,665. These payments will begin in 2008 and continue through 2017.

Dauphin County property taxes are used to pay for county operations, the judicial system, public safety, public works, cultural and recreational programs, human services and conservation and development programs. Londonderry Township property taxes pay the operating costs for libraries, hospitals, roads, school districts, and fire departments. The continued availability of TMI-1 and the associated tax base is an important feature in the ability of the Dauphin County and Londonderry Township to continue to invest in infrastructure and to draw industry and new residents.

2.2.9 Historic and Archaeological Resources

This section discusses the cultural background and the known historic and archaeological resources at the site of TMI-1 and in the surrounding area.

2.2.9.1 Cultural Background

The region around TMI-1, located on the northern end of Three Mile Island, contains prehistoric and historic Native American and Euro-American cultural resources. Three Mile Island was formed as a result of water deposited sands and gravels resting on deposits of sedimentary sandstones, siltstones, and clays (Smith 1977). TMI-1 lies within the Gettysburg Section of the Piedmont physiographic province, which is characterized by rolling low hills and valleys (DCNR 2008a). The Piedmont region contains some of the most agriculturally productive land in Pennsylvania both currently and historically, and is a favored area of settlement (Raber 1985). There are 369 properties in Dauphin, York, and Lancaster Counties that are listed on the *National Register of Historic Places* (NRHP), and 19 properties

Table 2-18. TMI-1 Property Tax Paid and Percentage of Dauphin County, Londonderry Township, and the Lower Dauphin School District from Property Tax Revenues, 2000 to 2005

Entity	Year	Total Property Tax Revenue (millions of dollars)	Property Tax Paid by AmerGen (thousands of dollars)	Percent of Total Revenue
Dauphin County	2000	58.0	146.9	0.3
	2001	60.1	146.9	0.2
	2002	60.5	146.9	0.2
	2003	61.5	146.9	0.2
	2004	73.9	146.9	0.2
	2005	89.3	141.6	0.2
Londonderry Township	2000	4.0	30.0	0.7
	2001	4.8	30.0	0.6
	2002	5.1	30.0	0.6
	2003	5.6	30.0	0.5
	2004	6.3	30.0	0.5
	2005	6.4	21.0	0.3
Lower Dauphin School District	2000	13.8	394.5	2.9
	2001	14.1	394.5	2.8
	2002	15.8	394.5	2.5
	2003	17.5	394.5	2.3
	2004	18.6	394.5	2.1
	2005	20.1	343.0	1.7

Source: AmerGen 2008

are located within 6 mi (10 km) of TMI-1 (USDOI 2008). No NRHP listed properties are affected by operation of TMI-1. Paleo-Indians occupied North America approximately 15,000–10,000 years ago, subsisting on hunted game and gathered plant material. In the Pennsylvania area, Paleo-Indians migrated into an environment changed by retreating glacial ice. The climate in Pennsylvania at the time was wetter and cooler than it is today. Large areas of grasslands mixed with coniferous and deciduous forests were characteristic of the region (Raber 1985). Paleo-Indian populations were highly mobile and hunted large animals such as mastodons, bison, caribou, mammoths, horse, deer, giant beaver, moose, and elk (Raber 1985; Funk 1972). The primary artifact associated with the Paleo-Indian period is the Clovis point, a distinctive, fluted, lanceolate point that is widely distributed throughout Pennsylvania, especially in the Susquehanna and Delaware River valleys (AmerGen 2008). Regional studies indicate that there is a high probability for Clovis points to be found in the Susquehanna River Valley (Kent et al. 1971). Other tools commonly found at Pennsylvania Paleo-Indian sites include scrapers; spurred-end scrapers; drills; cores; bifaces; microblades; and small uniface, biface, and flake knives (AmerGen 2008).

During the Archaic Period, from approximately 10,000 years ago until about 3,000 years ago, subsistence strategies underwent changes to adapt to resource availability. As the glaciers retreated northward and larger animals disappeared from the region, humans adapted to exploit modern plants and smaller game animals. Like Paleo-Indians, early Archaic foragers were highly mobile (Carr 1998). As resource quality and the cultural means to access resources improved, archaeologists find evidence of larger populations by the end of the Archaic Period, a time when climate reached its modern condition. As a result of diversification of prey species, a shift in the design of hunting technology occurred. Prehistoric megafauna were replaced by deer, elk, bear, turkey and other species common to deciduous forests (Raber 1985). Projectile points also changed to smaller, barbed points (Raber 1985). Archaic people collected, hunted, and gathered most of what they needed for survival in their home territory. Large base camps found near major water sources provided a focal point for groups during the winter months. During this period, Archaic peoples developed well-defined seasonal foraging activities.

The “Woodland” culture existed from 3,000 years ago until European contact around 1,500 A.D. This period is defined by the introduction of horticulture to augment subsistence hunting and gathering. A reliance on agriculture led to the establishment of more permanent settlements during this period. The earliest evidence of agriculture in Pennsylvania was found at the Meadowcroft rock shelter where evidence of squash and maize (corn) appear in the archaeological record (Adovasio and Johnson 1981). Other characteristics of Woodland culture include an increase in population, the emergence of social hierarchy, expanded interregional trade, more elaborate burial rituals, the introduction of the bow and arrow, and the use of ceramics for storage and cooking (Cowin 1985).

The area around TMI-1 was home to a number of prehistoric populations. Evidence from archaeological sites in the region reflect the influences of Laurentian, Lamoka, Piedmont and later Hopewell cultural traditions (AmerGen 2008). Native Americans used the Susquehanna River and several overland paths and trails as their primary transportation routes. Native American societies in the region shared several important characteristics at the time of first contact with Europeans. These characteristics included an economic base that combined hunting and gathering with domesticated plants and an annual settlement pattern that varied in population size between semi-permanent river-side villages in summer, large camps in winter, and population dispersal among scattered camps in the spring and fall.

In the 1600s, Europeans came to the Pennsylvania area and came into contact with Late Woodland peoples known as the Delaware, Shawnee, Iroquois, and Susquehannock (AmerGen 2008). The Susquehannocks were an Iroquoian-speaking tribe that lived along the Susquehanna River in Pennsylvania and Maryland (PGA Undated). Living in Algonkian-speaking tribes' territory, they engaged in many wars (AmerGen 2008). The Susquehannocks lived about 20 miles downstream from Three Mile Island in a town called Sasquesahanaugh, located on the eastern side of the Susquehanna River at Washington Boro (AEC 1972). Susquehannock populations were reduced by diseases brought by Europeans and by attacks from Marylanders and the Iroquois. By 1675, the Susquehannocks ceased to exist as a Nation (PGA Undated).

The rise of nation-states in Europe coincided with European land acquisition in North America. Wars in southern Germany caused many Germans to migrate to Pennsylvania. The struggle for religious freedom in England brought Quakers, Puritans, and Catholics to Pennsylvania (PHMC Undated-a). Captain John Smith was the first European to explore the region. In 1608, Smith journeyed from Virginia up the Susquehanna River and made contact with the Susquehannock Indians. Around this time, Henry Hudson's voyages document the relations between the European settlers and the Indian Nations occupying Pennsylvania (Raber 1985). Between 1609 and 1681, the Dutch, Swedes, and English inhabited and fought over the region that would later become eastern Pennsylvania. Ultimately, the English prevailed in Pennsylvania and the area fell under English rule (PHMC Undated-a). The effects of European contact upon Indian populations included death due to disease, increased inter-group warfare, and a dependence on European goods (Jennings 1968).

William Penn, a member of the Society of Friends, also known as Quakers, a persecuted religious sect in England petitioned the King of England for a haven in the New World. On March 4, 1681, the King granted the petition and named the new colony in honor of William Penn's father (PHMC Undated-a). Although William Penn was granted all of the land in Pennsylvania, he and his heirs chose not to grant or settle any part of it without first buying the claims of Native Americans who lived there. Most of Pennsylvania was purchased by 1768 and the remaining portion was purchased by the Commonwealth by 1789 (PHMC Undated-a). English, German, and Scotch-Irish immigrants eventually settled in the region.

As previously discussed, TMI-1 is located in Londonderry Township in Dauphin County, Pennsylvania. Dauphin County was created on March 4, 1785, from part of Lancaster County, and it was named for the French dauphin (prince), the king's eldest son (PHMC Undated-b). Harrisburg, the county seat, was named for its founder John Harris, and was incorporated as a borough in 1791 and chartered as a city in 1810 (PHMC Undated-b). John Harris, a native of Yorkshire, England, was one of the first emigrants to accompany William Penn (Harrisburg Websites Undated). In 1705, Harris secured a license to obtain land and around 1718, settled in the wilderness of what was to become Harrisburg (PHMC Undated-b). There are several islands within Londonderry Township, one of which is Three Mile Island, formerly called Elliot's Island and prior to that Conewago Island (Londonderry Township Undated).

Several historic canals were constructed on both sides of the Susquehanna River in the vicinity of TMI-1. The nearest canal, Pennsylvania Canal's Eastern Division (Eastern Division Canal) ran on the east side of the Susquehanna River for 43 mi (69 km) between Columbia, PA (Lancaster County) and Duncan's Island at the mouth of the Juniata River north of Harrisburg (Citizendium 2007). The Eastern Division Canal was originally owned and operated by the Commonwealth of Pennsylvania. Due to the cost of maintaining the canal and competition from railroads, the whole of Pennsylvania's Main Line canal system was sold to the Pennsylvania Railroad (PRR) in the 1850s. The PRR operated the canal until 1901, when it was replaced by the existing railroad, which is built on top of the old canal. Later, railroads became the predominant mode of freight transportation which resulted in the abandonment of the canals.

2.2.9.2 Historic and Archaeological Resources

The islands in the Susquehanna River Valley were heavily utilized by prehistoric and historic native populations, as well as European immigrants. Three Mile Island was first purchased in 1749 by Thomas Cookson who served as Thomas Penn's Deputy Surveyor for Lancaster County (Huber 1982). The island was passed down through Cookson's extended family and sold to James Duffy in 1879 (Huber 1982). Duffy's son rebuilt and transformed an existing farm on the island into a tobacco producing station (Huber 1982). In 1904, ice and elevated levels of water from the winter thaw flooded the island and ruined Duffy's tobacco station. Duffy unknowingly sold the island to the York Haven Water and Power Company, which in turn sold the land to Metropolitan Edison in 1924 (Huber 1982). Between 1957 and the start of construction, 270 acres on Three Mile Island were leased for farming (AEC 1972). At the time, there was no access to the island by bridge, so equipment and produce were transported by barge. In addition to farming, there were 70 cabins on the island that were also leased (53 on the west side and 17 on the east side), along with a picnic area, a boat dock, and a well for drinking water (AEC 1972).

A search of the PHMC site file records identified nine prehistoric sites and one historic site on Three Mile Island. One additional historic site was identified on the island during NRC's walkover survey. Of the nine previously recorded sites, two sites (36Da51 and 36Da98) are not associated with any cultural period. Sites 36Da96, 36Da97, 36Da99, and 36Da100 contain material from Late Archaic to the Late Woodland period. Dates for these sites were based upon collected lithics, points, and pottery. Site 36Da96 was situated in a cultivated area near TMI-1 and TMI Unit 2 and was assigned a cultural designation of Late Archaic to Early Woodland. It is unclear if any portions of the 36Da96 remain. Site 36Da97 was also located where TMI-1 and TMI Unit 2 are currently situated. The site form indicates that Woodland pottery was collected; however, no examples were available for study. 36Da97 was destroyed by construction of TMI-1 and TMI Unit 2. 36Da99 and 36Da100 are large multi-component campsites. On their respective site forms, 36Da99 is listed as Late Archaic and 36Da100 as a Late Woodland site.

Site 36Da52 is also listed as primarily an Archaic site, but some Woodland components were also recovered there. This site was recorded by the William Penn Memorial Museum in 1967 (now known as the State Museum of Pennsylvania) perhaps as part of Ira Smith's salvage excavation. It is unclear whether or not 36Da52 was destroyed during the construction of TMI-1 and 2.

In 1967, prior to construction of TMI-1 and TMI Unit 2, a cultural resource study was conducted by the Pennsylvania Historical and Museum Commission (PHMC) (AEC 1972). Five areas of the island were tested, and one multi-component site (36Da50) was selected as the most likely candidate to yield information about the island's cultural sequence. The site was excavated and yielded a rich inventory of lithic and ceramic information dating to the Early and Middle Woodland periods. The types and quantities of lithic and ceramic artifacts recovered suggests that Three Mile Island was intermittently occupied by small groups of Early and Middle Woodland peoples utilizing the area for hunting and fishing (Smith 1977). At the time, 36Da50 was the largest Early to Middle Woodland site excavated in the Lower Susquehanna River Valley of Pennsylvania. Previous research in the area had primarily focused on small campsites and rock shelters. In total, eight different ceramic types were recovered from the island along with eight categories of projectile points, ten types of flake tools, and four classes of bifacials and cleavers (Smith 1977). This suggests that Three Mile Island was used for securing and processing food (Smith 1977). In total, more than 1,000 artifacts were recovered spanning from 4,000 B.C. to 1,000+ A.D.

In 1987, a paper was presented by two archaeologists at the Mid Atlantic Archaeological Conference Annual Meeting in Lancaster Pennsylvania for archaeological work conducted at

Three Mile Island. The paper defined the cultural occupations of the island based on examining artifacts gathered by local collectors, reviewing previous archaeological reports, and performing limited testing on the island. Research and fieldwork (completed in 1986) indicated that the earliest occupation of Three Mile Island was during the Early Archaic period. Additionally, Early, Middle, and Late Woodland periods are also well represented. The continuous use of the island is surprising because experts believed that Late Woodland sites are comparatively infrequent on islands. To date, no Paleo-Indian artifacts have been found. While Three Mile Island was used continuously over the last 12,000 years, much of the cultural data, stratigraphy, and features relating to prehistoric occupations remain to be investigated (AmerGen 2008).

In 1988, the Curator of Archaeology from the State Museum of Pennsylvania performed an excavation of an historical burial site (36Da101) discovered eroding out of the river bank by a TMI-1 employee (Warfel 1988). According to PHMC survey records, 36Da101 is a large site that borders the riverbank and contains both Late Archaic and Late Woodland period artifacts in addition to the historic artifacts recovered during Warfel’s excavation. As previously discussed, the island was extensively farmed in the 18th and 19th centuries (Warfel 1988). Residents of the island built houses, barns, and other structures. Records verify that children were born and adults died on the island, so the likelihood of additional burials is high (Warfel 1988). Fragmentary remains were collected and analysis of the bones and artifacts determined the burial dates to be in the 1860s–1880s time period and the bones to have originated from an adult male aged 50-plus years (Warfel 1988). The remains were collected and later reburied in a location near the original burial site. Artifacts associated with the burial were donated to the State Museum of Pennsylvania (AmerGen2008).

Another archaeological survey was conducted in 1998 for a proposed fish passage to be located on the east side of Three Mile Island. Previous research indicated that site 36Da51 was located in the vicinity of the project. PHMC records for 36Da51 did not indicate site type or cultural affiliation. Test units from the survey yielded some lithic flakes, fire-cracked rock, two pottery shards, and some historic artifacts. Analyses of the materials recovered indicated that further testing was not warranted. The portion of site 36Da51 that would be impacted by the proposed fish ladder did not meet any of the criteria for listing on the National Register of Historic Places.

As noted earlier, during the walkover survey of Three Mile Island an additional historic site was identified. Remnants of an historic farmstead were found in the woods. This farmstead is a large complex complete with foundations for approximately 10 buildings (possibly a house, barns, and other outbuildings). There is also a standing silo made from ceramic bricks. Further examination of the silo revealed manufacturing information at the base of the structure indicating that it was a NATCO Imperishable Silo, patented by the National Fire Proofing Company of Pittsburg, Pennsylvania. The National Fire Proofing Company was purportedly established in 1889; however, financial records put the date of establishment closer to 1902 (University of Melbourne Undated). NATCO’s imperishable silo is constructed of curved, hollowed blocks in which the courses are staggered (University of Melbourne Undated). This dates the silo to the first quarter of the 20th century. As a result of this discovery, AmerGen submitted a Pennsylvania Archaeological Site Survey Form along with photographs to the PHMC and the site was assigned State number 36Da235.

Another potential historic site on Three Mile Island is TMI Unit 2. On March 28, 1979, TMI Unit 2 experienced a loss of coolant accident that resulted in a partial core meltdown, and is considered the nation's worst commercial nuclear accident (Walker 2004). Although the structure is under 40 years of age, it can be considered potentially eligible for listing on the National Register of Historic Places under Criterion A, as a site of exceptional importance. In 1999, a historical marker was placed on Pennsylvania State Highway 441, commemorating the 20th anniversary of the TMI Unit 2 accident (AmerGen 2008). All of the TMI Unit 2 buildings are standing and are currently in long-term monitored storage.

2.3 Related Federal and State Activities

The NRC staff reviewed the possibility that activities of other Federal agencies might impact the renewal of the operating license for TMI-1. Any such activity could result in cumulative environmental impacts and the possible need for a Federal agency to become a cooperating agency in the preparation of the TMI-1 SEIS.

The NRC staff has determined that there are no Federal projects that would make it desirable for another Federal agency to become a cooperating agency in the preparation of the SEIS. Federal facilities and National Parks within 50 mi (80 km) of TMI-1 are listed below. There are no known American Indian lands within 50 mi (80 km) of TMI-1.

- Fort Indiantown Gap Military Reservation, Annville (closed)
- Blue Marsh Lake (U.S. Army Corps of Engineers)
- New Cumberland General Depot (U.S. Military Reservation)
- Mechanicsburg Naval Ship Parts Control Center
- Letterkenny Army Depot
- Gettysburg National Military Park
- Eisenhower National Historic Site
- Fort Ritchie Raven Rock Site
- U.S. Army Chemical Center
- Appalachian National Scenic Trail (various areas)

NRC is required under Section 102(2)(c) of the National Environmental Policy Act of 1969 (NEPA) to consult with and obtain the comments of any Federal agency that has jurisdiction by law or special expertise with respect to any environmental impact involved. NRC has consulted with the American Council on Historic Preservation and the U.S. Fish and Wildlife Service. Federal Agency consultation correspondence and comments on the SEIS are presented in Appendix D.

2.4 References

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10 CFR 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, “Domestic Licensing of Production and Utilization Facilities.”

10 CFR 54. *Code of Federal Regulations*, Title 10, *Energy,* Part 54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

10 CFR 61. *Code of Federal Regulations*, Title 10, *Energy*, Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste.”

10 CFR 71. *Code of Federal Regulations*, Title 10, *Energy*, Part 71, “Packaging and Transportation of Radioactive Material.”

10 CFR 100. *Code of Federal Regulations*, Title 10, *Energy*, Part 100, “Reactor Site Criteria.”

25 PA Code VII § 262. *Pennsylvania Code*, Title 25, *Environmental Protection*, Article VII, *Hazardous Waste Management*, Section 262a, “Standards Applicable to Generators of Hazardous Waste.”

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40 CFR 81. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 81, “Designation of Areas for Air Quality Planning Purposes.”

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3.0 ENVIRONMENTAL IMPACTS OF REFURBISHMENT

Facility owners or operators may need to undertake or, for economic or safety reasons, may choose to perform refurbishment activities in anticipation of license renewal or during the license renewal term. The major refurbishment class of activities characterized in the generic environmental impact statement (GEIS) (NRC 1996, 1999) is intended to encompass actions that typically take place only once in the life of a nuclear plant, if at all. Examples of these activities include, but are not limited to, replacement of boiling-water reactor recirculation piping and pressurized-water reactor steam generators. As noted in the GEIS, refurbishment activities could result in environmental impacts beyond those that occur during normal plant operations. For issues that meet Category 1 criteria, no additional plant-specific analysis is required in this draft supplemental environmental impact statement (EIS) unless new and significant information is identified. Category 2 issues are those that do not meet criteria for Category 1 and, therefore, additional plant-specific review of these issues is required. Refurbishment activities may affect a variety of environmental issues as listed in Table 3-1 below.

Table 3-1. Issues Related to Refurbishment at TMI-1

Issues	Category
Surface Water Quality, Hydrology, and Use	
Impacts of refurbishment on surface water quality	1
Impacts of refurbishment on surface water use	1
Aquatic Ecology	
Refurbishment	1
Terrestrial Resources	
Refurbishment impacts	2
Threatened and Endangered Species	
Threatened and Endangered Species	2
Ground Water Use and Quality	
Impacts of refurbishment on ground water use and quality	1
Air Quality	
Air quality during refurbishment (nonattainment and maintenance areas)	2
Land Use	
Onsite land use	1

Table 3-1 (continued). Issues Related to Refurbishment at TMI-1

Human Health	
Radiation exposures to the public during refurbishment	1
Occupational radiation exposures during refurbishment	1
Socioeconomics	
Public Services: Public Safety, Social Services, and Tourism and Recreation	1
Aesthetic Impacts (refurbishment)	1
Housing Impacts	2
Public Services: Education (refurbishment)	2
Public Services: Public Utilities	2
Public Services: Transportation	2
Historic and Archaeological Resources	2
Environmental Justice	
Environmental Justice	Uncategorized

AmerGen Energy Company, LLC (AmerGen) plans to replace the two steam generators at Three Mile Island Nuclear Station, Unit 1 (TMI-1), with new, once-through, enhanced steam generators. As such, AmerGen and the NRC have analyzed steam generator replacement as a refurbishment activity, pursuant to Title 10, Section 51.53(c)(3)(ii), of the *Code of Federal Regulations* (10 CFR 51.53(c)(3)(ii)).

3.1 Refurbishment Activities at TMI-1

Steam generator replacement activities will take approximately 70 days to complete and will occur sometime between the refueling outage scheduled for October 2009 and the expiration of the original license period in April 2014. The original TMI-1 steam generators contain tubing made of alloy 600MA, which can degrade over time because of corrosion and mechanical stress from normal plant operation. AmerGen determined that both of the steam generators at TMI-1 are affected by degradation and should be replaced with new steam generators fitted with tubing made of alloy 690TT, which is more resistant to stress-corrosion cracking. AmerGen will also replace the hot-leg elbows, portions of the piping, and all existing steam generator insulation. AmerGen indicated that the steam generator refurbishment will allow TMI-1 to operate safely throughout the period of license extension and will increase the steam generator blowdown system capacity (AmerGen 2008).

The replacement steam generators will be manufactured in France and transported to the TMI-1 site. Transportation of these large components (each steam generator weighs approximately 500 tons [454 metric tons]) will be by a combination of boat, barge, rail, and road (AmerGen 2008). For transportation within the United States, AmerGen will be required to meet all Federal, State, and local requirements that may be applicable to dredge or fill activities, temporary or permanent removal of route interferences (such as narrow tunnels and low-hanging overhead wires), and movement of wide or heavy loads over rail and roadways. For example, if the overland route includes bridge crossings, weight-bearing modifications to those bridges could require temporary fill-in of these water bodies, temporary redirecting of streams, or construction of instream cofferdams. The U.S. Army Corps of Engineers (USACE) will regulate such work pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 if any of the work is performed in “navigable waters.”

AmerGen has contracted a vendor to conduct a detailed study of the steam generator transport process. The transportation study is scheduled to be completed in spring 2009, and, at the time of publication of this draft supplemental EIS, the study was unfinished. Until the study is complete, AmerGen cannot provide specific information regarding potential transportation routes for the replacement steam generators, work areas within the routes, or Federal, State, or local permits required for potential routes. However, AmerGen reported that the steam generators would likely be transferred to land at Port Deposit, Maryland, and that preliminary bathymetry studies provide reasonable assurance that dredging in the Susquehanna River will not be required to accommodate the transfer at that location. As details of the transportation study become available, the U.S. Nuclear Regulatory Commission (NRC) staff will include that information in the refurbishment analysis in the final supplemental EIS for TMI-1 (NRC 2008).

Once on site, the steam generators will be moved via a heavy-duty, self-propelled modular transporter to the steam generator storage facility that will be constructed on the power block (i.e., previously developed) portion of the site. To temporarily store the new steam generators until they are ready for installation, and to permanently store the original steam generators after removal, a 6000-square-foot (ft^2) (557 square meters [m^2]) steam generator storage building will be constructed on the power block within the flood protection dike. The building will be approximately 100-ft-long by 60-ft-wide (30-m-long by 18-m-wide) and 30-ft-high (9 m). Design specifications include a watertight roof membrane and reinforced concrete thick enough to provide radiological shielding to ensure that dose rates will remain within the limits set in 10 CFR Part 20, “Standards for Protection against Radiation” (AmerGen 2008).

The steam generator storage facility will be the only permanent structure built to support the refurbishment project. Temporary facilities will be used for offices, fabrication and welding activities, and laydown areas; however, the 4500-square-ft (418 m^2) fabrication/weld test shop will have a permanent concrete slab, which will remain after the building is removed. AmerGen estimates that the total area to be disturbed for refurbishment activities will be less than 10 acres (ac) (4 hectares [ha]), and disturbance will all take place on the power block, which is previously disturbed property (AmerGen 2008).

To remove the old steam generators and install the new ones, a 26 ft by 25 ft (8 m by 7.6 m) opening will be created in the 3-foot thick (0.9 m), reinforced concrete containment building by hydrodemolition (high-pressure water) and other mechanical methods. The process of creating this opening in the containment includes detensioning and removing tendons, removing concrete, cutting rebar, and cutting and removing a section of the steel liner. The original steam generators will be drained and cut away from their supports, and penetrations and openings will be welded closed. Loose radiological contamination will be removed, and a coating will be applied to the exterior of the original generators to seal any residual contamination in place (AmerGen 2008).

3.2 Environmental Impacts of Refurbishment

The following sections discuss the Category 2 issues associated with refurbishment activities at TMI-1. Any environmental impacts from refurbishment will be in addition to those associated with continued operation of TMI-1 for the period of license renewal; Chapter 4 of this report discusses those issues.

3.2.1 Terrestrial Resources – Refurbishment Impacts

Section 2.2.6 of this draft supplemental EIS describes the terrestrial resources on and in the vicinity of the TMI-1 site. Section 2.1.5 describes the transmission line right-of-ways (ROWs). For purposes of this analysis, Sections 2.1.5 and 2.2.6 describe the geographic area considered in this evaluation.

The majority of steam generator replacement activities for TMI-1 will take place on existing facility grounds at the TMI-1 site. The replacement project will likely require laydown areas, a permanent holding facility for the old steam generators, and several temporary buildings to support the steam generator replacement activities. All new, permanent structures will be constructed on previously disturbed land. Temporary and permanent facilities will use approximately 10 ac (4 ha) of land. Some minimal, short-term noise impacts from construction may occur. AmerGen will need to obtain all required State and Federal permits for construction of the facilities associated with refurbishment (AmerGen 2008).

The new steam generators will be delivered to TMI-1 from a port in Port Deposit, Maryland, and will travel over land primarily via flatbed vehicles. Although the exact route has not been decided upon, NRC staff can extrapolate potential impacts to terrestrial resources associated with transporting the steam generator. The most likely activity to occur during transport of the steam generator is increasing the height of telephone and electric power poles along the roadways to allow for clearance of the steam generators. Impacts to terrestrial resources from these activities are expected to be negligible.

On the basis of the information from the staff's review of AmerGen's environmental report for the TMI-1 proposed license renewal, the staff's site visit, the scoping process, and the evaluation of other reports and information, impacts to terrestrial resources during the proposed steam generator replacement will be SMALL. A few mitigation measures that could reduce impacts to the terrestrial environment during construction of the permanent storage building include silt fences to minimize sediment transport, the use of best management practices, and the restoration of cleared land remaining after completion of construction. These mitigation measures could reduce impacts by reducing erosion and minimizing the movement of sediment, nutrients, and pollutants to surface and ground water resources.

3.2.2 Threatened and Endangered Species

3.2.2.1 Terrestrial Species

As discussed in Section 2.2.7 of this report, State and Federal agencies have recognized two Federally listed and 11 State-listed threatened, endangered, or special concern terrestrial species as occurring in the vicinity of the TMI-1 site and its associated transmission line ROWs. Additional facilities associated with refurbishment is not likely to exceed 10 ac (4 ha) in total land use; therefore no additional impacts to threatened and endangered species within the TMI-1 site and its associated transmission line ROWs are expected (AmerGen 2008). The steam generators will be transported over land from Port Deposit, Maryland, to the TMI-1 site. Although the route is still unknown, over 100 mi (161 km) of road transport could be considered for passage of the steam generators. Because the exact route is unknown, the number of threatened or endangered species that may occur in proximity to the roads is also unknown. However, as mentioned in the project description above, the most likely activity to occur is increasing the height of power and telephone poles along roadways, with the possibility of road modification to bridges or weight-restricted areas in some locations. These activities are not likely to have additional impacts on the threatened or endangered species associated with the license renewal of TMI-1 because they will be confined to previously developed land.

On the basis of information from the staff's review of AmerGen's environmental report for the TMI-1 proposed license renewal (AmerGen 2008), the staff's site visit, the scoping process, and the evaluation of other reports and information, impacts to threatened or endangered species during the proposed steam generator replacement will be SMALL. Mitigation measures will be similar to those used to minimize the impacts to terrestrial resources.

3.2.2.2 Aquatic Species

As stated above, the implementation of best management practices, such as installing silt fences, would mitigate the impact of sediment-laden run-off to surface waters and aquatic species. Water used during hydrodemolition would be treated and monitored prior to discharge to the Susquehanna River. As such, refurbishment activities at the TMI-1 site will likely have a SMALL impact on aquatic species.

AmerGen intends to ship the two steam generators by barge to Port Deposit, Maryland, and then use ground transportation to reach Three Mile Island in Pennsylvania, which is located approximately 60 mi (96 km) from Port Deposit. Delivery of the two generators from Port Deposit to Three Mile Island will most likely require crossing numerous streams via State and county roadways. With each steam generator weighing approximately 500 tons (454 metric tons), small bridges at these stream crossings could require modifications to support the weight of the generators. These bridge modifications could include additional support structures, such as bridge abutments, or road widening and resurfacing, or possibly bridge replacement. Much of the bridge work may need to be performed within the stream itself such as the construction of a cofferdam, which requires work at the base of existing instream bridge support structures while remaining dry, and/or work in the adjacent riparian zone and associated wetlands. In some instances, the entire stream could be temporarily rerouted until the bridge modifications are completed or the old bridge is replaced. Such instream work can potentially disrupt various lifecycles of aquatic organisms. Sediment transported downstream as a result of construction can adversely impact spawning grounds for fish and invertebrates, including anadromous fish. The rerouting of a stream or replacement of stream-crossing infrastructure (e.g., culverts, abutments) may disrupt migration patterns for anadromous fish if they are unable to move upstream because of temporary construction-related impasses, including loud noises and instream equipment movement and vibrations.

The instream work related to bridge modifications may also impact Federally and State-listed endangered and threatened aquatic species. Aquatic species that are listed as threatened or endangered by the U.S. Fish and Wildlife Service (FWS), the Commonwealth of Pennsylvania, or the State of Maryland are known to occur in the counties in Pennsylvania and Maryland located between Port Deposit and Three Mile Island. Once AmerGen determines a final route for transportation of the stream generators, AmerGen will need to initiate discussions with FWS and Pennsylvania and Maryland natural resource agencies to determine if any State- or Federally listed aquatic species are in the vicinity of potential bridge construction and to evaluate whether the potential work will adversely affect any listed species or its designated critical habitat.

3.2.3 Air Quality During Refurbishment (Non-Attainment and Maintenance Areas)

Air quality during refurbishment (nonattainment and maintenance areas) is a Category 2 issue. Table B-1 of Appendix A to Subpart B, “Environmental Effect of Renewing the Operating License of a Nuclear Power Plant,” of 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions,” notes the following:

> Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance statues of each site and the numbers of workers expected to be employed during the outage.

Specifically, 10 CFR 51.53(c)(3)(ii)(F) requires the following:

> If the applicant’s plant is located in or near a nonattainment or maintenance area, an assessment of vehicle exhaust emissions anticipated at the time of peak refurbishment work force must be provided in accordance with the Clean Air Act as amended.

The GEIS states the following:

> The 1990 Clean Air Act amendments include a provision that no federal agency shall support any activity that does not conform to a state implementation plan designed to achieve the National Ambient Air Quality Standards (NAAQS) for criteria pollutants (sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead,

and particulate matter less than 10 µm in diameter). On November 30, 1993, the U.S. Environmental Protection Agency (EPA) issued a final rule (58 FR 63214) implementing the new statutory requirements, effective January 31, 1994. The final rule requires that federal agencies prepare a written conformity analysis and determination for each pollutant where the total of direct and indirect emissions caused by proposed federal action would exceed established threshold emission levels in a nonattainment[4] or maintenance area[5].

AmerGen is planning to replace the two TMI-1 steam generators with enhanced once-through steam generators. AmerGen stated that an additional 900 temporary employees will be needed for the duration of the project, which is estimated to be 70 days (AmerGen 2008).

During steam generator replacement project activities at the TMI-1 site some minor and short-duration air quality impacts are expected to occur. The main sources of these air quality impacts will be fugitive dust from construction activities associated with the project and exhaust emissions from the motorized equipment and vehicles of workers.

The majority of the refurbishment activities will be performed inside existing buildings and will not cause additional atmospheric emissions. However, a permanent steam generator building and several temporary facilities will be constructed and some land will be used for laydown areas. During construction activities, some minor air quality impacts are expected to occur as a result of equipment emissions and fugitive dust from the operation of earth-moving and material-handling equipment. The small size of disturbed area and AmerGen's commitment to use best management practices, such as watering, silt fences, covering soil piles, and hydrodemolition, will minimize the amount of fugitive dust generated during operation of earth-moving and debris-hauling equipment.

Refurbishment activities are known to cause localized temporary increases in atmospheric concentrations of nitrogen oxides (NOx), carbon monoxide, sulfur dioxide (SO_2), volatile organic compounds (VOCs), ammonia, and particulate matter (PM_{10} and $PM_{2.5}$) as a result of exhaust emissions from workers' vehicles, diesel generators, and construction equipment. Federal agencies are prohibited from issuing a license for any activity that does not conform to an applicable implementation plan (40 CFR Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans," and 40 CFR Part 93, "Determining Conformity of Federal Actions to State or Federal Implementation Plans"). TMI-1 is required to show conformity to the applicable Pennsylvania State Implementation Plans by analyzing vehicle exhaust emissions that will occur during the steam generator replacement project.

AmerGen stated, and the NRC staff has confirmed, that Dauphin County, where TMI-1 is located, is one of three counties located within the Harrisburg-Lebanon-Carlisle $PM_{2.5}$ nonattainment area (Cumberland, Dauphin, and Lebanon). Using an EPA-approved screening model, AmerGen estimated the impacts of direct and indirect ozone and particulate emissions

[4] An area is designated "nonattainment" for a criteria pollutant if it does not meet the National Ambient Air Quality Standard (NAAQS) for the pollutant.

[5] A maintenance area has been redesignated by a State from nonattainment to attainment; the State must submit to EPA a plan for maintaining the NAAQS as a revision to its State Implementation Plan.

related to refurbishment on air quality in the nonattainment areas. The results of model calculations indicate that the emissions associated with the refurbishment activities at TMI-1 will conform to the Pennsylvania State Implementation Plans for the nonattainment areas (72 FR 40749).

The results of the model calculations indicate that that the emissions associated with the proposed action conform to the implementation plans for the nonattainment areas. Total direct and indirect emissions as a result of the postulated TMI-1 steam generator replacement project are not expected to exceed emission budgets specified in the Pennsylvania State implementation plans and rates, established by EPA, for nonattainment and maintenance areas as defined in 40 CFR Part 51. On this basis, the NRC staff concludes that the impact of vehicle exhaust emissions attributable to the steam generator replacement project will be SMALL. The NRC staff acknowledges that the applicant will use best management practices that could mitigate potential air quality impacts resulting from the TMI-1 steam generator replacement project. Additionally, the NRC staff also identified the use of multiperson vans and workforce shift changes to reduce the number of vehicles on the road at any given time.

$PM_{2.5}$ emissions from mobile sources are generated from three general processes—(1) direct emissions from the tailpipes of cars, trucks, and other onroad vehicles, (2) reentrainment from materials found on the roadway (typically known as fugitive dust), and (3) secondary formation from precursor emissions such as SO_2, NOx, VOCs and ammonia. EPA requires that $PM_{2.5}$ conformity assessments consider NOx and SO_2 emissions, however, VOC and ammonia emissions need only be considered if they are significant. No such determination has been made for Dauphin County.

AmerGen performed a preliminary screening analysis (using an EPA-approved model) of the emissions during the construction and outage stages of the steam generator replacement project for a period of 70 days.

AmerGen estimated total annual emissions of NOx during the construction stage to be 21.27 tons per year (ton/yr), which is 0.16 percent of the total 2001 Dauphin County emissions and 21.27 percent of the EPA threshold level for this $PM_{2.5}$ precursor. Total NOx emissions during the outage stage were estimated to be 8.34 tons/yr, which is 0.06 percent of the total 2001 Dauphin County emissions and 8.34 percent of the EPA threshold level (AmerGen 2008a).

Total annual emissions of SO_2 during the construction stage were estimated to be 0.59 tons/yr, which is 0.01 percent of the total 2001 Dauphin County emissions. During the outage stage, total SO_2 emissions were estimated to be 0.12 tons/yr, which is less than 1 percent of the total 2001 Dauphin County emissions and 0.12 percent of the EPA threshold level (AmerGen 2008a).

AmerGen estimated total annual emissions of $PM_{2.5}$ during the construction stage to be 1.5 tons/yr, which is 0.06 percent of the total 2001 Dauphin County emissions and 1.5 percent of the EPA threshold level. During the outage stage, total $PM_{2.5}$ emissions were estimated to be 0.53 tons/yr, which is 0.02 percent of the total 2001 Dauphin County emissions and 0.53 percent of the EPA threshold level (AmerGen 2008a).

Dauphin County is part of the Harrisburg-Lebanon-Carlisle 8-hour ozone attainment area (basic maintenance area). Ground-level ozone is formed when NOx and VOCs react in the presence of heat and sunlight. AmerGen estimated total annual emissions of VOCs during the construction stage to be 2.78 tons/yr, which is 0.02 percent of the total 2001 Dauphin County emissions and 5.55 percent of the EPA threshold level. During the outage stage, total VOC emissions were estimated to be 4.04 tons/yr, which is 0.03 percent of the total 2001 Dauphin County emissions and 8.09 percent of the EPA threshold level (AmerGen 2008a).

The results of the model calculations indicate that the emissions associated with the proposed action conform to the implementation plans for the nonattainment areas. Total direct and indirect emissions resulting from the replacement of the two TMI-1 steam generators are not expected to exceed emission budgets specified in the Pennsylvania State implementation plans and rates, established by the EPA, for nonattainment and maintenance areas as described in 40 CFR Part 51. On this basis, the NRC staff concludes that the impact of vehicle exhaust emissions during the steam generator replacement project will be SMALL. There are a number of measures that could mitigate potential air quality impacts resulting from refurbishment activities, such as implementation of a dust control plan to minimize emissions from construction activities and the use of multiperson vans and workforce shift changes to reduce the number of vehicles on the road at any one given time.

3.2.4 Housing Impacts

Housing impacts during refurbishment is a Category 2 issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that:

> Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measure that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development.

AmerGen estimates that steam generator replacement would require a one-time increase in the number of refueling outage workers for up to 70 days at TMI-1. Approximately 900 workers would be needed to perform TMI-1 steam generator replacement project activities in addition to the normal number of refueling outage workers (AmerGen 2008).

The number of additional workers would cause a short-term increase in the demand for temporary (rental) housing units in the region beyond what is normally experienced during a refueling outage at TMI-1. Since TMI-1 is located in a high population area, and Dauphin and Lancaster Counties are not subject to growth control measures that would limit housing development, any changes in TMI-1 employment would have little noticeable effect on housing availability in these counties. In addition, the number of available housing units has kept pace with or exceeded the decrease in the county populations. However, the rental housing market in the region is very large and based on this information, employment-related housing impacts would be very SMALL.

3.2.5 Public Services – Education (Refurbishment)

Public services: education (refurbishment) is a Category 2 issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that "Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors."

As discussed in Section 3.2.4, AmerGen estimates that TMI-1 steam generator replacement would require a one-time increase in the number of refueling outage workers for up to 70 days at TMI-1 (AmerGen 2008). Due to the short amount of time needed to replace the steam generators, workers would not be expected to bring families and school-age children with them and therefore there would be no impact on educational services during this extended refueling outage.

3.2.6 Public Services – Public Utilities

Public services: public utilities is a Category 2 refurbishment issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that "An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability."

Since there is no water shortage in the TMI-1 region and the public water systems located in Dauphin and Lancaster Counties have excess capacity, any changes in TMI-1 and employee public water usage would have little noticeable affect on public water supply availability in these counties.

As discussed in Section 3.2.4, AmerGen estimates that steam generator replacement would require a one-time increase in the number of refueling outage workers for up to 70 days at TMI-1 (AmerGen 2008). The additional number of refueling outage workers needed to replace the steam generators would cause a short-term increase in the amount of public water and sewer services used in the immediate vicinity of TMI-1. Since the region has excess capacity water supply impacts would be very SMALL.

3.2.7 Public Services – Transportation

Public services: transportation is a Category 2 refurbishment issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that:

> Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

The additional number of refueling outage workers and truck material deliveries needed to support the replacement of the steam generators would cause a short-term level of service impact on access roads in the immediate vicinity of TMI-1. As previously discussed in Section 2.2.8.2, major commuting routes to TMI-1, including State Highway 441, are mostly rural and uncongested. Increased traffic volumes entering and leaving TMI-1 during refueling outages, which occur at intervals of approximately 24 months, has not degraded the level of service capacity on local roads. In addition, the TMI-1 site has two entrances. The entrance to the north is used by the operating work force. The entrance to the south is used by a limited number of operational employees working on the southern portion of the station and construction and outage workforces. According to AmerGen, during the refurbishment project, construction workers would use the southern entrance to the site. This could alleviate potential congestion problems at the northern site entrance.

Also, the delivery of the steam generators to TMI-1 would have an impact on the transportation infrastructure used to transport the steam generators to TMI-1 from the U.S. port of call (i.e., Baltimore, Philadelphia, or Newark) to the TMI-1 site. As detailed in Section 3.1, according to AmerGen, a final option has not been selected for the delivery of the steam generators. Some options being considered may require the temporary removal and replacement of interferences, such as low-hanging overhead telephone and power lines and narrow roadway obstructions. Such activities would be temporary and localized causing short-term traffic delays and detours. Permits and approvals would be obtained from the appropriate Federal, State, and local agencies prior to the movement of the steam generators.

As previously discussed, a combination of barge, rail, and/or road transport from the U.S. port of call to TMI-1 is being considered by AmerGen, using one of the following options:

- Barge from Baltimore, Maryland, through the Chesapeake Bay and up the Susquehanna River to Port Deposit, Maryland, then rail or road to TMI-1;
- Rail and/or road from Baltimore, Maryland, to TMI-1;
- Rail and/or road from Philadelphia, Pennsylvania, to TMI-1; or
- Rail and/or road from Newark, New Jersey, to TMI-1.

Based on this information and due to the short time duration (up to 70 days) for the steam generator replacement project after the arrival of the steam generators, transportation (level of service) impacts in the vicinity of TMI-1 would be SMALL and would only occur during shift changes.

3.2.8 Offsite Land Use (Refurbishment)

Offsite land use (refurbishment) is a Category 2 issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that “Impacts may be of moderate significance at plants in low population areas.”

Since TMI-1 is located in a high population area any changes in TMI-1 employment would have little noticeable affect on land use in the region. Due to the short amount of time needed to replace the steam generators, the additional number of refueling outage workers would not cause any permanent population- and tax revenue-related land use changes in the immediate vicinity of TMI-1.

3.2.9 Historic and Archaeological Resources

Historic and archaeological resources are a Category 2 refurbishment issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that

> Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection.

The area potentially affected by the steam generator replacement project is in an area that was previously disturbed by the construction of TMI-1 and TMI Unit 2. Ground disturbing activities associated with the project include the excavation of previously disturbed areas in the vicinity of TMI-1 and in several areas located south and west of the TMI Unit 2 cooling towers (AmerGen 2008 response to ENV-36). A 6,000 ft^2 (557 m^2) storage facility built to house the old steam generators and other temporary structures will be constructed within the existing industrial footprint of the site (AmerGen 2008b).

Should AmerGen proceed with the steam generator project, all activities would be reviewed in accordance with AmerGen's site procedures which are designed to ensure that site investigations and consultations with the Pennsylvania Historical and Museum (PHMC; Pennsylvania's State Historic Preservation Office, PA SHPO) are conducted as needed, and that existing and unknown cultural resources are adequately protected. AmerGen has consulted with the PHMC. The PHMC determined that the project would have no effect on known historic and archaeological resources. However, should the project include additional ground disturbing activities beyond what is currently planned, then further consultation and mitigation would be necessary.

The delivery of the steam generators from the eastern shore of the Susquehanna River to TMI-1 could impact remnants of the Pennsylvania Canal's Eastern Division (Eastern Division Canal) which ran on the east side of the Susquehanna River. Prehistoric and historic properties along the route could be affected by vibrations from the movement of the heavy transporter over roadways and bridges. However, most activities would be temporary and localized. Permits and approvals would be obtained from the appropriate Federal, State, and local agencies prior to the movement of the steam generators.

The impacts associated with this activity are not expected to adversely impact historic or archaeological sites located in the vicinity of TMI-1 and TMI Unit 2. Therefore, the potential impacts from this activity on historic or archaeological resources would be SMALL. However, should archaeological resources be encountered during construction, work would cease until AmerGen environmental personnel perform an evaluation and consider possible mitigation measures through consultation with the PHMC.

3.2.10 Environmental Justice

Environmental justice is a Category 2 refurbishment issue. Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, notes that "The need for and the content of an analysis of environmental justice will be addressed in plant specific reviews."

Since TMI-1 is located in a high population area any changes in TMI-1 employment would have little noticeable effect on minority and/or low-income populations in the region. Due to the short amount of time (up to 70 days) needed to replace the TMI-1 steam generators and based on the analysis of impacts for the other resource areas discussed in Section 3.2, there would be no disproportionately high and adverse impacts on minority and low-income populations located in the immediate vicinity of TMI-1.

3.3 Evaluation of New and Potentially Significant Information on Impacts of Refurbishment

For all Category 1 issues related to refurbishment, the NRC staff has not identified any new and significant information during its review of the TMI-1 ER, the staff's environmental site audit, the scoping process, or the evaluation of other available information, including the July 17, 2008 telephone conference call between NRC and AmerGen, during which AmerGen's refurbishment plans were discussed (NRC 2008). Therefore, the NRC staff adopts the findings in the GEIS for Category 1 issues associated with refurbishment, and concludes that there would be no environmental impacts during the renewal term beyond those discussed in the GEIS for these issues.

3.4 Summary of Impacts of Refurbishment

For the nine Category 2 issues and environmental justice, the impacts of refurbishment at TMI-1 range from no impact to SMALL. For the refurbishment issues Public Services: Education, Offsite Land Use, and Environmental Justice, the NRC staff concludes that there would be no noticeable impact. For the refurbishment issues Terrestrial Ecology, Threatened or Endangered Species, Air Quality (Nonattainment and Maintenance Areas), Housing Impacts, Public Services: Public Utilities, Public Services: Transportation, and Historic and Archeological Resources, the NRC staff concludes that the potential environmental effects are of SMALL significance.

3.5 References

10 CFR 51. *Code of Federal Regulations,* Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

40 CFR 51. *Code of Federal Regulations*, Title 40, *Protection of Environment,* Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

40 CRF 93. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 93, “Determining Conformity of Federal Actions to State or Federal Implementations Plans.”

72 FRN 40749. July 25, 2007. “Approval and Promulgation of Air Quality Implementation Plans; Pennsylvania; Redesignation of the Harrisburg-Lebanon-Carlisle Ozone Nonattainment Area to Attainment and Approval of the Area’s Maintenance Plan and 2002 Base Year Inventory.” *Federal Register.* Volume 72, No. 142, pp. 40749. Washington, D.C.

AmerGen (AmerGen Energy Company, LLC). 2008. *Three Mile Island Nuclear Station, Applicant’s Environmental Report, License Renewal Operating Stage.* Kennett Square, Pennsylvania. ADAMS Nos. ML080220255, ML080220257, ML080220261, and ML080220282.

AmerGen (AmerGen Energy Company, LLC). 2008a. *Three Mile Island, Unit 1, Enclosure A - Post Audit Environmental Information – Question ENV-070, Monthly Report on the Meteorological Monitoring Program, March 2007 through End (Non-Proprietary Version).* June 10. ADAMS No. ML082110253.

AmerGen (AmerGen Energy Company, LLC). 2008b. *Three Mile Island, Unit 1, Enclosure A – Post Audit Environmental Information – Index through Audit Question ENV-070, Monthly Report on the Meteorology Program, February 2007 (Non-Proprietary Version).* ADAMS No. ML082110252.

Clean Air Act. 42 U.S.C. 7401, et seq. *United States Code*, Title 42, *The Public Health and Welfare*, Chapter 85, “Air Pollution Prevention and Control.”

Clean Water Act. 33 U.S.C. 26. *United State Code*, Title 33, *Navigation and Navigable Waters*, Chapter 26, “Water Pollution Prevention and Control”

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C. ADAMS No. ML061770605.

NRC (U.S. Nuclear Regulatory Commission). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, “Section 6.3-Transportation, table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report.” NUREG-1437, Volume 1, Addendum 1, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 2008. Summary of Telephone Conference Call Held on July 17, 2008, Between the U.S. Nuclear Regulatory Commission and AmerGen Energy Company, LLC, Concerning Follow-Up Questions Pertaining to the Three Mile Island Nuclear Station, Unit 1 License Renewal Environmental Review and Site Audit. Washington, D.C. ADAMS No. ML082120727.

4.0 ENVIRONMENTAL IMPACTS OF OPERATION

This chapter addresses potential environmental impacts related to the period of extended operation of Three Mile Island Nuclear Station, Unit 1 (TMI-1). These impacts are grouped and presented according to resource. Generic issues (Category 1) rely on the analysis provided in the generic environmental impact statement (GEIS) prepared by the U.S. Nuclear Regulatory Commission (NRC) (NRC 1996, 1999) and are discussed briefly. NRC staff analyzed site-specific issues (Category 2) for TMI-1 and assigned them a significance level of SMALL, MODERATE, or LARGE. Some remaining issues are not applicable to TMI-1 because of site characteristics or plant features. Section 1.4 of this report explains the criteria for Category 1 and Category 2 issues and defines the impact designations of SMALL, MODERATE, and LARGE.

4.1 Land Use

Land use issues are listed in Table 4-1. The staff did not identify any Category 2 issues for land use. The staff also did not identify any new and significant information during the review of the environmental report (ER) (AmerGen 2008) prepared by AmerGen Energy Company, LLC (AmerGen), the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be warranted.

Table 4-1. Land Use Issues. *Section 2.2.1 of this report describes the land use around TMI-1.*

Issues	GEIS Section	Category
Onsite land use	4.5.3	1
Power line right-of-way	4.5.3	1

4.2 Air Quality

The air quality issue applicable to TMI-1 is listed in Table 4-2. The staff did not identify any Category 2 issues related to the effects of transmission lines on air quality. Staff also did not identify any new and significant information during the review of AmerGen's ER (AmerGen 2008), the site audit, or the scoping process. Therefore, there are no impacts related to this issue beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be warranted.

Table 4-2. Air Quality Issue. *Section 2.2.2 of this report describes air quality in the vicinity of TMI-1.*

Issue	GEIS Section	Category
Air quality effects of transmission lines	4.5.2	1

4.3 Ground Water

The following sections discuss the Category 2 ground water issues applicable to TMI-1, which are listed in Table 4-3.

Table 4-3. Ground Water Use and Quality Issues. *Section 2.2.3 of this report discussed ground water use and quality at TMI-1.*

Issues	GEIS Section	Category
Ground Water use conflicts (potable and service water, plants using >100 gpm)	4.8.1.1	2
Ground Water use conflicts (plants using cooling towers withdrawing make-up water from a small river)	4.8.1.3	2

4.3.1 Ground Water Use Conflicts (plants using >100 gpm)

The NRC specifies as issue 33 in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that, “if the applicant’s plant…pumps more than 100 gallons (total onsite) of ground water per minute (gpm), an assessment of the impact of the proposed action on ground water use must be provided.” The NRC further states that “plants that use more than 100 gpm may cause ground water use conflicts with nearby ground water users,” (10 CFR 51.53[c][3][ii][C]). This applies to TMI-1 because, as discussed in Section 2.2.3.1 of this report, TMI-1 used between 95 and 115 gallons per minute (gpm) of ground water pumped from seven onsite wells from 2003 to 2005.

A ground water withdrawal rate of over 100 gpm has the potential to create a cone of depression large enough to affect offsite wells and ground water supplies, limiting the amount of ground water available for the area surrounding the plant. The Susquehanna River Basin Commission (SRBC) originally approved ground water withdrawal at a rate of 168,750 gallons per day (gpd) (117 gpm) at TMI-1 from wells A, B, and C after a process of simultaneous pump tests in 1995. In 1998, TMI-1 applied to SRBC for a ground water withdrawal upgrade. Based on information gathered during the original pumping tests, and after observing that there had been no impacts on the operation of the onsite Operations Support Facility/North Office Building (OSF) well, the Building 48 (48S) well, or any other onsite wells, or along the eastern shore of the Susquehanna River, SRBC approved a new ground water withdrawal rate of 225,000 gpd.

After reviewing the information provided by the applicant, as well as the 1996 SRBC pump test data from wells A, B, and C, which showed no effect on nearby ground water wells, the NRC staff concludes that the impacts of TMI-1 ground water withdrawal on nearby ground water users would be SMALL.

4.3.2 Ground Water Use Conflicts (make-up from a small river)

The NRC specifies that, “if the applicant’s plant utilizes cooling towers or cooling ponds and withdraws makeup water from a river whose annual flow rate is less than 3.15×10^{12} cubic ft per year (ft^3/year) [(99,885 cubic ft per second (cfs)]…[t]he applicant shall also provide an assessment of the impacts of the withdrawal of water from the river on alluvial aquifers during low flow," (10 CFR 51.53[c][3][ii][A]). For water use conflicts, the NRC further states, as issue 34 in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 that, "water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground water or upstream surface water users come online before the time of license renewal…." This issue is applicable to TMI-1 because the plant uses cooling towers, and makeup water for its cooling systems is withdrawn from the Susquehanna River, which has an annual mean flow of approximately 1.09×10^{12} ft^3/yr (34,450 cfs), thus meeting the NRC's definition of a small river. Flow is monitored at the Harrisburg gauging station, about 11 miles (mi) (18 kilometers [km]) upstream of TMI-1.

Consumptive water losses at TMI-1 comprise a small fraction of the Susquehanna River flow at Lake Frederick (which is created by the damming of the Susquehanna River by the Red Hill Dam and the York Haven Dam), where TMI-1 is situated. The rate at which TMI-1 withdraws surface water is about 1.6 percent of the lowest daily mean flow of the Susquehanna River, which is less than 0.2 percent of the lowest annual mean flow and less than 0.1 percent of the average annual flow. TMI-1 is also part of the Cowanesque Lake water storage project, allowing the site 8,274 acre-feet of storage. During a period of severe drought, SRBC can direct the release of water and, of that 8,274 acre-feet, about 4,250 would alleviate any impacts to the Susquehanna River caused by the consumptive loss from plant operations, allowing for the continuation of TMI-1 operations.

Furthermore, the Commonwealth of Pennsylvania requires facilities that withdraw or use more than 10,000 gpd (378,541 liters per day [Lpd]) of surface or ground water, such as TMI-1, to register and periodically report their water usage for Commonwealth water planning purposes. Thus, the NRC staff concludes that the impacts from consumptive water use on ground water would be SMALL.

4.4 Surface Water

The following sections discuss the surface water quality issues applicable to TMI-1 which are listed in Table 4-4. The staff did not identify any new and significant information during the review of AmerGen's ER (AmerGen 2008), the site audit, or the scoping process. Therefore, no impacts are related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be warranted.

Table 4-4. Surface Water Quality Issues. *Section 2.2.4 of this report describes surface water quality conditions at TMI-1.*

Issues	GEIS Section	Category
Altered current patterns at intake and discharge structures	4.2.1.2.1	1
Altered salinity gradients	4.2.1.2.2	1
Temperature effects on sediment transport capacity	4.2.1.2.3	1
Scouring caused by discharged cooling water	4.2.1.2.3	1

Issues	GEIS Section	Category
Eutrophication	4.2.1.2.3	1
Discharge of chlorine or other biocides	4.2.1.2.4	1
Discharge of sanitary wastes and minor chemical spills	4.2.1.2.4	1
Discharge of other metals in wastewater	4.2.1.2.4	1
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	4.3.2.1; 4.4.2.1	2

4.4.1 Water Use Conflicts

The NRC specifies that, "if the applicant's plant uses cooling towers or cooling ponds and withdraws makeup water from a river whose annual flow rate is less than 3.15×10^{12} cubic feet per year (ft^3/year) [99,885 cubic feet per second (cfs)], an assessment of the impact of the proposed action on the flow of the river and related impacts on instream and riparian ecological communities must be provided" (10 CFR 51.53[c][3][ii][A]). For water use conflicts, the NRC further states as issue 13 in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51, "The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations." This issue is applicable to TMI-1 because the plant uses a cooling-tower-based heat dissipation system, and water to replace that lost to evaporation in the cooling system is withdrawn from the Susquehanna River, which has an annual mean flow of approximately 1.09×10^{12} ft^3/yr (34,450 cfs), thus meeting the NRC's definition of a small river. Flow is monitored at the Harrisburg gauging station, about 11 mi (18 km) upstream of TMI-1.

The GEIS considered surface water use conflicts to be a Category 2 issue for two reasons:

(1) Consumptive water use can adversely affect riparian vegetation and instream aquatic communities. Reducing the amount of water available to either the riparian zones or instream communities could result in impacts to threatened and endangered species, wildlife, and recreational uses of the water body. In addition, riparian vegetation performs several important ecological functions, included stabilizing channels and floodplains, influencing water temperature and quality, and providing habitat for aquatic and terrestrial wildlife.

(2) Continuing operation of these facilities depends on the availability of water within the river from which they are withdrawing water. For facilities that are located on small bodies of water, the volume of water available is expected to be susceptible to droughts and to competing water uses within the basin. In cases of extreme drought, these facilities may be required to curtail operations if the volume of water available is not sufficient.

An additional potential effect of the withdrawal of water from a small river is that the withdrawal may have an impact on ground water levels and, therefore, result in ground water use conflicts

(NRC 1996). The staff considers this to be a separate Category 2 issue, which is evaluated in Section 4.3 of this draft supplemental environmental impact statement (EIS).

The Susquehanna River meets the definition of a small river because, based on data taken 11 mi (18 km) upstream of TMI-1 at Harrisburg, the annual mean flow of the river is $1.09\text{x}10^{12}$ ft^3/yr (34,450 cfs). TMI-1 is permitted to withdraw up to 18 million gpd, with its average estimated rate of withdraw being 24,000 gpm. The withdraws from TMI-1 are less than 1.6 percent of the Susquehanna River flow under the conditions of a typical drought period, less than 0.2 percent of the lowest annual mean flow of the river, and less than 0.1 percent of the average annual flow. These consumptive losses are insignificant relative to the flow in the Susquehanna River and would not be expected to impact the river's aquatic and riparian ecological communities or the alluvial water-bearing material (aquifers).

Additionally, as detailed in Section 2.1.7.2 of this report, TMI-1 participates in the Cowanesque Lake water storage project and sponsors 8,274 acre-feet of water storage. SRBC monitors the flow of the Susquehanna River and, in the event of a drought emergency, it has the authority to signal the U.S. Army Corps of Engineers to release predetermined quantities of water from storage. In such a situation, only 4,250 of the 8,274 acre-feet sponsored by TMI-1 would be required to help offset the effects of water consumption from plant operations.

The staff has reviewed the available information, including that provided by the applicant, additional SRBC data, information gathered at the staff's site visit and the scoping process, and other available sources. Considering TMI-1's small consumptive water use relative to the flows in the Susquehanna River, as well as the potential for SRBC to release water into the river during periods of extreme drought, the NRC staff concludes that the impact of water use on the Susquehanna River at TMI-1 would be SMALL.

4.5 Aquatic Resources

Table 4-5 on the following page lists the issues related to aquatic resources applicable to TMI-1. No Category 2 issues are related to aquatic resource. The NRC staff did not identify any new and significant information during the review of the AmerGen environmental report (AmerGen 2008), the site audit, the scoping process, or the evaluation of other available information. Therefore, the staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to warrant implementation.

Table 4-5. Aquatic Resources Issues. Section 2.1.6 of this report describes the TMI-1 cooling water system; Section 2.2.5 describes the aquatic resources.

Issues	GEIS Section	Category
For All Plants		
Accumulation of contaminants in sediments or biota	4.2.1.2.4	1
Entrainment of phytoplankton and zooplankton	4.2.2.1.1	1
Cold shock	4.2.2.1.5	1
Thermal plume barrier to migrating fish	4.2.2.1.6	1
Distribution of aquatic organisms	4.2.2.1.6	1
Premature emergence of aquatic insects	4.2.2.1.7	1
Gas supersaturation (gas bubble disease)	4.2.2.1.8	1
Low dissolved oxygen in the discharge	4.2.2.1.9	1
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	4.2.2.1.10	1
For Plants with Cooling Tower-Based Heat Dissipation Systems		
Entrainment of fish and shellfish in early life stages	4.3.3	1
Impingement of fish and shellfish	4.3.3	1
Heat shock	4.3.3	1

4.5.1 Generic Aquatic Ecology Issues

The NRC staff did not identify any new and significant information during the review of the AmerGen environmental report (AmerGen 2008), the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

4.6 Terrestrial Resources

The issues related to terrestrial resources applicable to TMI-1 are discussed below and listed in Table 4-6. No Category 2 issues are related to terrestrial resources for license renewal. The NRC staff did not identify any new and significant information during the review of the AmerGen environmental report (AmerGen 2008), the site audit, the scoping process, or the evaluation of other available information. Therefore, the NRC staff concludes that there would be no impacts related to these issues beyond those discussed in the GEIS (NRC 1996). For these issues, the

GEIS concludes that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to implement.

Table 4-6. Terrestrial Resources Issues. *Section 2.2.6 provides a description of the terrestrial resources at TMI-1 and in the surrounding area.*

Issues	GEIS Section	Category
Cooling tower impacts on crops and ornamental vegetation	4.3.4	1
Cooling town impacts on native plants	4.3.5.1	1
Bird collisions with cooling towers	4.3.5.2	1
Power line right-of-way management (cutting herbicide application)	4.5.6.1	1
Bird collisions with power lines	4.5.6.1	1
Impacts of electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)	4.5.6.3	1
Floodplains and wetland on power line right-of-way	4.5.7	1

4.7 Threatened or Endangered Species

Table 4-7. Threatened or Endangered Species. *Section 2.2.7 describes the threatened or endangered species on or near TMI-1.*

Issue	GEIS Section	Category
Threatened or endangered species	4.1	2

4.7.1 Aquatic Species

One Federally- and State-listed endangered species, the dwarf wedgemussel (*Alasmidonta heterodon*), was recorded in Lancaster County, but not in the vicinity of TMI-1 or in the waterways along the transmission line corridors. The black bullhead (*Amerius melas*), a State-listed species, has been recorded in Dauphin County (PNHP 2008), but is not known to occur either in the vicinity of TMI-1 or in the waterways along the transmission line corridors (AmerGen 2008).

The U.S. Fish and Wildlife Service (FWS) indicated by letter dated April 23, 2008, that no Federally listed or proposed threatened or endangered species are known to occur within the project impact area; hence no biological assessment or further consultation with FWS, as required by the Endangered Species Act, is necessary (FWS 2008). The Pennsylvania Fish and Boat Commission (PFBC) indicated by letter dated June 7, 2007, that no adverse impacts to State-listed rare, candidate, threatened, or endangered aquatic species are expected from the proposed project (PFBC 2008).

4.7.2 Terrestrial Species

Impacts to threatened and endangered terrestrial species requires consultation with appropriate agencies to determine whether such species are present and whether they would be adversely affected by continued operation of the TMI-1 site during the license renewal term. Sections 2.2.6 and 2.2.7 of this draft supplemental EIS discuss the characteristics and habitat of threatened and endangered species in the vicinity of the TMI-1 site.

The NRC staff contacted FWS, the Pennsylvania Department of Conservation and Natural Resources (DCNR), and the Pennsylvania Game Commission (PGC) to request information that could assist in its assessment of the environmental impacts associated with license renewal. In response, on April 28, 2008, the FWS indicated that no known Federally-listed threatened or endangered species occur within the project area; therefore, the proposed project would not likely adversely affect any Federally-listed species (FWS 2008). In a May 2, 2008, letter to the NRC, DCNR stated that, although several species of concern are known to occur in the vicinity of the TMI-1 project site, no impact to these species is anticipated (DCNR 2008). In a May 14, 2008, letter to the NRC, PGC indicated that, "the renewal of the TMI Operating License is not anticipated to cause any adverse impacts to special concern species of birds and mammals that may be in the vicinity of the transmission line corridors associated with the electric generating station" (PGC 2008).

Two Federally-listed threatened or endangered species, the bog turtle (*Glyptemys muhlenbergii*) and the northeastern bulrush (*Scirpus ancistrochaetus*), are potentially found in the vicinity of the TMI-1 site (PNHP 2008). The bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon (*Falco peregrinus*) were formerly listed as Federally-threatened. Eleven State-listed threatened or endangered species have been determined to be species of special concern for the TMI-1 site, including the osprey (*Pandion haliaetus*), the prothonotary warbler (*Protonotaria citrea*), the yellow-crowned night heron (*Nycticorax violacea*), the black-crowned night heron (*Nycticorax nyticorax*), the aster-like boltonia (*Boltonia asteroides*), a sedge species (*Carex shortiana*), the flat-stemmed spike-rush (*Eleocharis compressa*), the ellisia (*Ellisia nyctelea*), the bronze copper (*Lycaena hyllus*), and the formerly Federally-listed birds, the bald eagle and peregrine falcon (DCNR 2008; PGC 2008; AmerGen 2008; PNHP 2008). Section 2.2.7 of this report describes these species in greater detail.

The NRC staff encourages AmerGen and FirstEnergy Corporation (FirstEnergy), who owns the transmission lines, to report the existence of any Federally- or State-listed endangered or threatened species within or near the transmission line right-of-ways (ROWs) to DCNR and/or FWS if any such species are identified during the license renewal term. In particular, if any evidence of injury to or mortality of migratory birds or threatened or endangered species is observed within the corridor during the license renewal period, the NRC staff encourages AmerGen and FirstEnergy to promptly report this to the appropriate wildlife management agencies. Additionally, the NRC staff encourages AmerGen to continue reporting information concerning the peregrine falcon pair and their young that nest on the reactor building to the Commonwealth of Pennsylvania.

Operation of the TMI-1 site and its associated transmission lines is not expected to adversely affect any threatened or endangered species during the license renewal term. Therefore, the NRC staff concludes that adverse impacts to threatened or endangered species during the license renewal term would be SMALL. Mitigation measures currently in place at the TMI-1 site include nest construction and placement for several species, including the peregrine falcon and osprey; environmental review checklists; environmental evaluation forms; and best management practices, all of which minimize the effects of plant operation on terrestrial species. These current mitigation measures are found to be adequate.

4.8 Human Health

The human health issues applicable to TMI-1 are discussed below and listed in Table 4-8 for Category 1, Category 2, and uncategorized issues.

Table 4-8. Human Health Issues. *Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 contains more information on these issues.*

Issues	GEIS Section	Category
Microbiological organisms (occupational health)	4.3.6	1
Microbiological organisms (public health, for plants using small rivers)	4.3.6	2
Noise	4.3.7	1
Radiation exposures to public (license renewal term)	4.6.1, 4.6.2	1
Occupation radiation exposures (license renewal term)	4.6.3	1
Electromagnetic fields – acute effects (electric shock)	4.5.4.1	2
Electromagnetic fields – chronic effects	4.5.4.2	Uncategorized

4.8.1 Generic Human Health Issues

The staff did not identify any new and significant information during its review of the AmerGen environmental report, the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these issues, the GEIS concluded that the impacts are SMALL, and additional site-specific mitigation measures are not likely to be sufficiently beneficial to be warranted.

TMI-1 conducts an annual Radiological Environmental Monitoring Program (REMP) in which radiological impacts to the employees, the public, and the environment in and around the TMI-1 site are monitored, documented, and compared to the appropriate standards. The objectives of the REMP include the following:

- Measure and evaluate the levels of radiation and radioactive material in the environs around the TMI-1 site to assess the radiological impacts, if any, of plant operation on the environment.
- Supplement the results of the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive material and levels of radiation are not higher than expected based on the measurement of radioactive effluents and modeling for the applicable exposure pathways.

- Demonstrate compliance with the requirements of applicable Federal regulatory agencies.

Two reports summarize radiological information about the TMI-1 site—the annual radiological environmental operating report and the annual radioactive effluent release report. The TMI-1 offsite dose calculation manual (ODCM) specifies limits for all radiological releases (AmerGen 2007). The ODCM is used to meet Federal standards and requirements. The TMI-1 REMP samples environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. The REMP measures the aquatic and atmospheric environment, as well as the ambient gamma radiation, for radioactivity in the vicinity of the TMI-1 site. Ambient gamma radiation pathways include radiation from buildings and plant structures and airborne material that may be released from the plant. In addition, the REMP also measures background radiation (i.e., cosmic sources, global fallout, and naturally occurring radioactive material, including radon). Thermoluminescent dosimeters (TLDs) are used to measure direct radiation. The atmospheric environmental monitoring consists of sampling the air for particulates and radioiodine. Terrestrial environmental monitoring consists of analyzing samples of milk and food products. The aquatic environmental monitoring consists of analyzing samples of surface water, drinking water, stormwater, ground water, and fish and sediment from the Susquehanna River.

The NRC staff reviewed the TMI-1 radioactive environmental operating reports for 2003 through 2007 to look for any significant impacts to the environment or any unusual trends in the data (AmerGen 2004, 2005, 2006b, 2007a, 2008a). During 2007, no plant-related activation or fission products were detected in airborne and foodborne samples. The only radionuclide attributable to plant operation detected in 2007 was tritium, which was measured in samples of surface, storm, effluent, and drinking water (AmerGen 2008a). No unusual trends were noted and all reported data on the radionuclides detected in environmental samples were below applicable NRC reporting levels and showed no significant or measurable impact from the operations at TMI-1 (AmerGen 2008a).

The Pennsylvania Department of Environmental Protection (PADEP), Bureau of Radiation Protection (BRP), also conducts a comprehensive environmental radiation monitoring program in Pennsylvania that routinely samples and analyzes selected environmental media in conjunction with TMI-1. The BRP environmental radiation monitoring program includes TLDs for monitoring direct radiation an samples of air, vegetation, milk, drinking water, fish, and river sediment. The results of the BRP 2003–2004 environmental radiation monitoring program showed detectable levels of radioactivity attributable to operation of TMI-1. In 2003, low levels of tritium were detected in drinking water samples near the plant site, but no reactor-produced radionuclides were detected in the fish, produce, air or milk samples. However, radioactivity from remnants of atomic weapons testing and the accident at Chernobyl was detected in water and milk samples. The report concluded, “The results of the 2003 and 2004 environmental sampling program indicate that Pennsylvanians have not been exposed to levels of radiation above normal background. This has been determined by comparing samples collected around nuclear facilities with those from locations that would not be influenced by such facilities.” (PADEP 2008).

In addition to the routine REMP, the applicant established an onsite ground water protection program in 2006. The program is designed to monitor the onsite environment for indication of leaks from plant systems and pipes carrying liquids with radioactive material. The results were reported as Appendix F to the TMI-1 2007 annual radiological environmental operating report. The results indicated that tritium was detected in 15 ground water samples at 3 locations at concentrations greater than the U.S. Environmental Protection Agency (EPA) drinking water standard (and the NRC reporting limit) of 20,000 picocuries per liter (pCi/L) (740,000 Becquerels per cubic meter [Bq/m^3]). Tritium was detected in 47 of 68 ground water monitoring locations. The tritium concentrations ranged from 206 pCi/L (7622 Bq/m^3) to 29,600 pCi/L (1,095,200 Bq/m^3). Tritium that was detected in ground water at the station is believed to be from a leak in the condensate de-ice line, historical releases, and/or background radiation. There were no known active releases at the end of 2007 into the ground water at the TMI-1 site. Based on the sample results, the applicant calculated that the potential dose to a member of the public from drinking this water was less than 0.008 millirems (mrem) (0.00008 milliSeiverts [mSv]). This dose is a very small fraction of the dose design objective specified in Appendix I to 10 CFR Part 50, "Numerical Guide for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents."

Historical data on releases from TMI-1 and the resultant dose calculations demonstrate that the amount of radiation received to a hypothetical maximally exposed individual in the vicinity of TMI-1 is a small fraction of the limits specified in 10 CFR Part 20, the as low as is reasonably achievable (ALARA) dose design objectives in Appendix I to 10 CFR Part 50, and EPA's radiation standards in 40 CFR Part 190, "Environmental Radiation Protection Standards for Nuclear Power Operations." For 2007, dose estimates were calculated based on actual liquid and gaseous effluent release data and conservative models to simulate the transport mechanisms. The TMI-1 2007 annual radioactive effluent release report (AmerGen 2008b) describes the results. The following summarizes the calculated hypothetical maximum dose to an individual located at the TMI-1 site boundary from liquid and gaseous effluents released during 2007:

- The maximum whole-body dose to an offsite member of the general public from liquid effluents was 0.056 mrem (0.00056 mSv), which is well below the 3-mrem dose criteria in Appendix I to 10 CFR 50.
- The maximum whole-body dose to the likely most-exposed member of the general public from gaseous effluents was 0.025 mrem (0.0025 mSv), which is below the 5-mrem dose criteria in Appendix I to 10 CFR 50.
- The maximum whole-body dose to the likely most-exposed member of the general public from all radioactive emissions (radioactive gaseous and liquid effluents and direct radiation shine) was 0.33 mrem (0.0033 mSv), which is below the 25-mrem limit in 40 CFR Part 190.

Based on the review and assessment of the TMI-1 radioactive waste system performance in controlling radioactive effluents and the resultant doses to members of the public in conformance with the ALARA criteria, the NRC staff found that the 2007 radiological data for TMI-1 are consistent, with reasonable variation attributable to operating conditions and outages, with the 5-year historical radiological effluent releases and resultant doses. These results demonstrate that TMI-1 is operating in compliance with Federal radiation protection standards contained in Appendix I to 10 CFR Part 50, 10 CFR Part 20, and 40 CFR Part 190. Continued compliance with regulatory requirements is expected during the license renewal term; therefore, the impacts from radioactive effluents are not expected to change.

Based on the applicant's assertion that refurbishment activities are planned, slightly higher doses to members of the public, and the resultant environmental impacts, are expected from TMI-1 during the refurbishment period. However, based on past regulatory compliance, the dose to a maximally exposed individual in the vicinity of TMI-1 for the refurbishment period is expected to continue to be a small fraction of the limits and standards specified in 10 CFR Part 20, Appendix I to 10 CFR Part 50, and 40 CFR Part 190.

4.8.2 Microbiological Organisms – Public Health

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 lists the effects of thermophilic microbiological organisms on human health as a Category 2 issue and requires the conduct of a plant-specific evaluation before license renewal for those plants using closed-cycle cooling that are located on a small river. The average annual flow of the Susquehanna River at the nearest measuring station to TMI-1 is approximately 1.09×10^{12} ft^3/yr (3.08×10^{10} cubic meters per year (m^3/yr)) (Durlin and Schaffstall 2005). This is less than the 3.15×10^{12} ft^3/yr (9×10^{10} m^3/yr), which is the threshold value in 10 CFR 51.53(c)(3)(ii)(G) for thermal discharge to a small river. Nevertheless, recreational uses of the Susquehanna River in the vicinity of TMI-1, which include boating, fishing, and swimming, create the potential for human exposure to thermophilic microbiological organisms. Consequently, the effects of its discharge on microbiological organisms must be addressed for TMI-1 license renewal.

The Category 2 designation is based on the magnitude of the potential public health impacts associated with thermal enhancement of enteric pathogens such as *Salmonella* spp. and *Shigella* spp., the *Pseudomonas aeruginosa* bacterium, the pathogenic strain of the free-living amoebae *Naegleria* spp., and a number of species from genus Legionella (NRC 1996). Thermophilic biological organisms generally occur at temperatures of 77 to 176 degrees Fahrenheit (°F) (25 to 80 degrees Celsius (°C)), with optimal growth occurring between 122 and 150 °F (50 and 66 °C) and minimum tolerance of 68°F (20 °C) (Joklik and Willett 1976). However, thermal preference and tolerances vary across the bacteria family.

P. aeruginosa is an opportunistic pathogen that causes serious and sometimes fatal infections in immunocompromised individuals by producing and releasing toxins. It has an optimal growth temperature of 99 °F (37 °C) (Todar 2007). *Legionella* spp. consists of at least 46 species and 70 serogroups and is responsible for Legionnaires' disease, with the onset of pneumonia in the first 2 weeks of exposure. Risk groups for *Legionella* spp. include the elderly, cigarette smokers, persons with chronic lung or immunocompromising disease, and persons receiving immunosuppressive drugs. *Legionella* spp. grows best at 90 to 105 °F (32 to 41 °C) (CDC 2007). *Salmonella typhimurium* and *Salmonella enteritidis* are two of the more common species of Enterobacteriaceae which cause fever, abdominal cramps, and diarrhea. *Salmonella* spp. can occasionally establish localized infection (e.g., septic arthritis) or can progress to sepsis. All ages can be affected, but groups at greatest risk for severe or complicated disease include infants, the elderly, and persons with compromised immune systems. *Salmonella* spp. occurs at temperatures between 50 and 120 °F (10 and 49 °C) (CDC 2007), with optimal growth occurring at 95 to 99 °F (35 to 37 °C) (ESR 2002). The pathogenic amoeba flagellate *Naegleria fowleri* is the causative agent of human primary amoebic meningioencephalitis. All ages can be affected, but groups at greatest risk for severe or complicated disease include infants, the elderly, and persons with compromised immune systems. *Naegleria* spp. is ubiquitous in nature and can be enhanced in thermally altered water bodies at temperatures ranging from 95 to 106 °F (35 to 41 °C) or higher, but this organism is rarely found in water cooler than 95 °F (35 °C), and infection rarely occurs at these water temperatures (Tyndall et al. 1989).

The maximum temperature of the discharge stream on September 11, 2007, was approximately 101.1 °F (38.4 °C), with a maximum ambient river temperature of 81.5 °F (27.5°C) (AmerGen 2008). As described in the GEIS (NRC 1996), nuclear power plants that discharge to "small rivers" have the greatest chance of affecting the public by increases in thermophilic microbiological organism populations. A small river is defined as one with a monthly average flow rate of less than 2,800 m^3/s (100,000 ft^3/s). The annual average flow rate of the Susquehanna River at the nearest measuring station to TMI-1 is approximately 1.09×10^{12} ft^3/yr (3.08×10^{10} m^3/yr), which equates to 978.1 cubic meters per second (m^3/s) (34,540 cubic feet per second (ft^3/s)) (Durlin and Schaffstall 2005). The average mechanical draft cooling tower basin flow rate from the current operation is about 5,000 gallons per minute (11.4 ft^3/s) per unit. This flow rate is less than 1 percent of the annual average flow rate of the Susquehanna River. Thus, at a given volume of the discharge stream with a maximal temperature of 101.1 °F (38.4 °C), there will be approximately 100 equivalent diluting volumes of the Susquehanna River water with a maximal temperature of 81.5 °F (27.5 °C). When a higher temperature system comes in physical contact with a lower temperature system, there will be a net transfer of heat from the higher temperature system to the lower temperature system, until the two systems reach thermal equilibrium (Adkins 1984). As such, when the plant discharge temperature is at its maximum and the ambient Susquehanna River water is at its maximum, the temperature range of the Susquehanna River (below the discharge outfall) would maximally be 91.3 °F (33.0 °C). This temperature range is well outside the optimal growth temperature range of thermophilic microbiological organisms, which is between 122 °F and 150 °F (50 and 66 °C) (Joklik and Willett 1976). Hence, such organisms are not expected to cause any significant public health risks.

During the year, ambient river temperatures average 33.8 °F (1 °C) with a maximum temperature of 81.5 °F (27.5 °C) (NRC 1976). The maximum temperature of the discharge stream (at the discharge monitoring pit and before the water mixes with the Susquehanna River) on September 11, 2007, was approximately 101.1 °F (38.4 °C) (AmerGen 2008). The ambient river temperature was 81.5 °F (27.5 °C). Assume the temperature of the heated effluent area or mixing zone is 101.1 °F (38.4 °C), the lowest daily mean river flows are 34,540 ft^3/s (978.1 m^3/s) (Durlin and Schaffstall 2005), and the mixing zone is located 16 feet (4.88 meters) offshore and 82 feet (25 meters) downstream of the discharge monitoring pit (AmerGen 2008). These thermophilic microbiological organisms would be entrained through this thermal plume for about 30 seconds to less than five minutes, based on a river flow rate of 34,540 ft^3/s (978.1 m^3/s). Because the growth rate for thermophilic microbiological organisms is measured in hours to days (Hendricks 1972), it is not expected that the short period of plume passage would notably affect growth rates of thermophilic microbiological organisms compared to ambient river temperatures. Therefore, thermophilic microbiological organisms are not expected to cause any significant public health risks.

The current National Pollutant Discharge Elimination System (NPDES) permit requires TMI-1 to monitor fecal coliform in the plant's sewage treatment effluent. Fecal coliform bacteria are classified within the family Enterobacteriaceae. The most common species of fecal coliform is *Escherichia coli*, a prokaryotic, gram-negative, rod-shaped bacteria. The value of determining fecal coliform concentrations is to establish the extent to which the Susquehanna River has been polluted with fecal wastes. Their presence in the water indicates the potential for other pathogenic microbes, including those that cause typhoid fever, bacterial or viral gastroenteritis, or hepatitis A (NAS 2004). TMI-1 has been collecting river water samples once per quarter for fecal coliform analysis and has been implementing a disinfection program of the TMI-1 sewage treatment plant effluent in compliance with TMI-1 NPDES permit requirements. In addition, the NPDES permit requires TMI-1 to control disease-producing organisms during the swimming season (May 1 through September 30) through "effective disinfection" and to impose a fecal coliform count limit of 200 cells per 100 milliliters.

AmerGen consulted the PADEP Water Management Program to determine whether there was any concern about the potential occurrence of thermophilic microbiological organisms in the Susquehanna River at the TMI-1 location (AmerGen 2008). PADEP indicated that it agrees with AmerGen's conclusion that the discharge of cooling water from the operation of TMI-1 over the license renewal term would not stimulate growth of thermophilic pathogens (AmerGen 2008).

Available data assembled by the U.S. Centers for Disease Control and Prevention (CDC) for the years 1999 to 2004 (CDC 2001, 2002, 2002a, 2003, 2003a, 2004, 2005, 2006, 2007b) report no occurrence of waterborne disease outbreaks in the Commonwealth of Pennsylvania resulting from exposure to the thermophilic microbiological organisms *Naegleria fowleri* and *Pseudomonas aeruginosa* from the operation of TMI-1. Outbreaks of legionellosis, samonellosis, or shigellosis that occurred in the Commonwealth of Pennsylvania were within the range of national trends (CDC 2001, 2002, 2002a, 2003, 2003a, 2004, 2005, 2006, 2007b) in terms of cases per 100,000 population or total cases per year, and the outbreaks were associated with hotel pools and spas.

The NRC staff independently reviewed the AmerGen environmental report and visited the TMI-1 site. Based on the evaluation presented above, thermophilic microbiological organisms are not likely to present a public health hazard as a result of TMI-1 discharges to the Susquehanna River. The NRC staff concludes that impacts on public health from thermophilic microbiological organisms from continued operation of TMI-1 in the license renewal period would be SMALL.

The staff identified a variety of measures that could mitigate the potential impacts of thermophilic microbiological organism resulting from continued operation of TMI-1. These mitigation measures include periodically monitoring for thermophilic microbiological organisms in the water and sediments near the discharge, as well as prohibiting recreational use near the discharge plume. These mitigation measures could reduce human health impacts by minimizing public exposures to thermophilic microbiological organisms. The staff did not identify any cost-benefit studies applicable to the mitigation measures mentioned above.

4.8.3 Electromagnetic Fields – Acute Shock

Based on the GEIS, the NRC found that electric shock resulting from direct access to energized conductors or from induced charges in metallic structures has not been a problem at most operating plants and generally is not expected to be a problem during the period of extended operation. However, a site-specific review is required to determine the significance of the electric shock potential along the portions of the transmission lines within the scope of the supplemental EIS.

The GEIS states that, without a review of the conformance of each nuclear plant transmission line with National Electrical Safety Code (NESC) (NESC 2007) rules, it is not possible to determine the significance of the electric shock potential. Evaluation of individual plant transmission lines is necessary because the issue of electric shock safety was not addressed in the licensing process for some plants. For other plants, land use in the vicinity of transmission lines may have changed, or power distribution companies may have chosen to upgrade line voltage. To comply with the requirements of 10 CFR 51.53(c)(3)(ii)(H), the applicant must provide an assessment of the potential shock hazard if the transmission lines that were constructed for the specific purpose of connecting the plant to the transmission system do not meet the recommendations of the NESC for preventing electric shock from induced currents.

An analysis of the conformance of the TMI-1 transmission lines with the NESC standard was conducted using computer-modeled data of induced current under the transmission lines. Objects located near the transmission lines can become electrically charged because of their immersion in the electromagnetic field surrounding the lines. This electrical charge results in a current that flows through the object to the ground. This current is called “induced” because there is no direct connection between the line and the object. The induced current can also flow to the ground through the body of a person who touches the electrically charged object. An object that is insulated from the ground can actually store an electrical charge, becoming what is called “capacitively charged.” A person standing on the ground and touching a vehicle or a fence receives an electrical shock from the sudden discharge of the capacitive charge through the person’s body to the ground. After the initial discharge, a steady-state current can develop, with the magnitude of the current depending upon several factors. These factors include the strength of the electric field (dependent on the voltage of the transmission line and its height and geometry), the size of the object on the ground, and the extent to which the object is grounded (AmerGen 2008).

As described above, four 230-kilovolt (kV) transmission lines were specifically constructed to distribute power from TMI-1 to the electrical grid. AmerGen began its analysis of these lines by identifying the limiting case for each line, that is, the configuration along each line where the potential for induced-current shock would be greatest. Once the limiting case was identified, the electric field strength for each transmission line was calculated, and the induced current was calculated. AmerGen calculated electric field strength and induced current using a computer code called ACDCLINE, produced by the Electric Power Research Institute. The results of this program have been field-verified through actual electrostatic field measurements by several utilities. The input parameters for the ACDCLINE program include the design features of the limiting-case scenario, the NESC requirement that line sag be determined at a conductor temperature of 120 °F, and the maximum vehicle size under the lines (a tractor-trailer). The analysis determined that none of the transmission lines have the capacity to induce greater than

5 milliamperes in a vehicle parked beneath the lines (Table 4-9). Therefore, the TMI-1 transmission lines conform to the NESC provisions for preventing electric shock from induced current (AmerGen 2008).

FirstEnergy has surveillance and maintenance procedures that provide assurance that design ground clearances will not change. These procedures include routine aerial inspections that check for evidence of clearance problems, including encroachments, broken conductors, broken or leaning structures, and signs of burning trees. In addition, ground-level inspections include examination of clearances at questionable locations, evaluation of the integrity of structures, and surveillance for dead or diseased trees that may fall on the lines. Problems noted during any inspection are identified for corrective action by the appropriate organization (AmerGen 2008).

Table 4-9. Results of Induced Current Analysis.

Transmission Line	Voltage (kilovolts)	Maximum Induced Current (milliamperes)
Line No. 1051-TMI-1 plant to Jackson	230	1.09
Line No. 1091-TMI-1 plant to Middletown Junction	230	1.38
Line No. 1092-TMI-1 plant to Middletown Junction	230	2.09
Line from TMI-1 plant to the 500-kV substation	230[a]	1.33

(a) Line from TMI-1 plant to the 500-kV substation was designed to operate at 500 kilovolts, but it currently operates at 230 kilovolts
Source: AmerGen 2008

The staff has reviewed the available information, including the applicant's evaluation and computational results, the site visit, the scoping process, and other public sources of information. Based on this information, the staff evaluated the potential impacts of electric shock resulting from operation of TMI-1 and its associated transmission lines. The staff concludes that the potential impacts of electric shock during the renewal term would be SMALL.

The staff identified a variety of measures that could mitigate potential acute electromagnetic field impacts resulting from continued operation of the TMI-1 transmission lines. These mitigation measures include limiting public access to transmission line structures, installing signs at road crossings, and increasing transmission line clearances.

These mitigation measures could reduce human health impacts by minimizing public exposures to electric shock hazards. NESC rules, as specified in Part 2, Rules 232C1c and 232D3c, contain provisions that are considered necessary for the protection of employees and the public from acute electromagnetic field hazards associated with transmission lines, which currently apply to TMI-1 and would apply during the license renewal period. AmerGen currently meets these rules. The staff did not identify any cost benefit studies applicable to the mitigation measures mentioned above.

4.8.4 Electromagnetic Fields – Chronic Effects

The GEIS did not designate the chronic effects of 60-hertz electromagnetic fields from power lines as either Category 1 or 2; such a designation will not occur until a scientific consensus is reached on the health implications of these fields.

The potential for chronic effects from these fields continues to be studied and is not known at this time. The National Institute of Environmental Health Sciences (NIEHS) directs related research through the U.S. Department of Energy (DOE). An NIEHS (1999) report contains the following conclusion which is supported by the recently published Environmental Health Criteria Monograph No. 238 (2007):

> The NIEHS concludes that ELF-EMF [extremely low frequency-electromagnetic field] exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of a risk to currently warrant concern.

This statement is not sufficient to cause the NRC staff to change its position with respect to the chronic effects of electromagnetic fields. This position is expressed in Footnote 5 to Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 as follows:

> If in the future, the Commission finds that, contrary to current indications, a consensus has been reached by appropriate Federal health agencies that there are adverse health effects from electromagnetic fields, the Commission will require applicants to submit plant-specific reviews of these health effects as part of their license renewal applications. Until such time, applicants for license renewal are not required to submit information on this issue.

The NRC staff considers the GEIS finding of “Uncertain” still appropriate and will continue to follow developments on this issue.

4.9 Socioeconomics

The socioeconomic issues applicable to TMI-1 are discussed below and listed in Table 4-10 on the following page for Category 1, Category 2, and uncategorized issues.

Table 4-10. Socioeconomic Issues. *Section 2.2.9 of this report describes the socioeconomic conditions near TMI-1.*

Issues	GEIS Section	Category
Housing Impacts	4.7.1	2
Public Services: public safety, social services, and tourism and recreation	4.7.3; 4.7.3.3; 4.7.3.4; 4.7.3.6	1
Public Services: public utilities	4.7.3.5	2
Public Services: education (license renewal)	4.7.3.1	1
Offsite Land Use (license renewal term)	4.7.4	2
Public Services: transportation	4.7.3.2	2
Historic and Archaeological Resources	4.7.7	2
Aesthetic Impacts (license renewal term)	4.7.6	1
Aesthetic impacts of transmission lines (license renewal term)	4.5.8	1
Environmental Justice	Not addressed[(a)]	Uncategorized[(a)]

(a) Guidance related to environmental justice was not in place at the time the GEIS and the associated revisions to 10 CFR Part 51 were prepared. Therefore, environmental justice must be addressed in plant-specific reviews.

4.9.1 Generic Socioeconomic Issues

The NRC staff reviewed and evaluated the TMI-1 Environmental Report, scoping comments, other available information, and visited TMI-1 in search of new and significant information that would change the conclusions presented in the GEIS. No new and significant information was identified during this review and evaluation. Therefore, it is expected that there would be no impacts related to these Category 1 issues during the renewal term beyond those discussed in the GEIS.

4.9.2 Housing Impacts

Appendix C to the GEIS presents a population characterization method based on two factors; sparseness and proximity (see Section C.1.4). Sparseness measures population density within 20 mi (32 km) of the site, and proximity measures population density and city size within 50 mi (80 km). Each factor has categories of density and size (see Table C.1). A matrix is used to rank the population category as low, medium, or high (see Figure C.1).

According to the 2000 Census, approximately 787,800 people lived within 20 mi (32 km) of TMI-1, which equates to a population density of 627 persons per square mile (AmerGen 2008). This density translates to the least sparse Category 4 (greater than or equal to 120 persons per square mile within 20 mi [32 km]). Approximately 2,546,500 people live within 50 mi (80 km) of TMI-1 (AmerGen 2008). This equates to a population density of 325 persons per square mile. Applying the GEIS proximity measures, TMI-1 is classified as proximity Category 4 (greater than or equal to 190 persons per square mile within 50 mi [80 km]). Therefore, according to the sparseness and proximity matrix presented in the GEIS, TMI-1 rankings of sparseness Category 4 and proximity Category 4 result in the conclusion that TMI-1 is located in a high population area.

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states that impacts on housing availability are expected to be of small significance in high-density population areas where growth control measures are not in effect. Since TMI-1 is located in a high population area, and Dauphin and Lancaster Counties are not subject to growth control measures that would limit housing development, any changes in TMI-1 employment would have little noticeable effect on housing availability in these counties. Since AmerGen has indicated that they have no plans to add non-outage employees during the license renewal period, non-outage employment levels at TMI-1 would remain relatively constant with no additional demand for permanent housing during the license renewal term. In addition, the number of available housing units has kept pace with or exceeded the increase in area population. Based on this information, there would be no impact on permanent housing during the license renewal term beyond what is currently being experienced.

However, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term. AmerGen estimates that steam generator replacement would require a one-time increase in the number of refueling outage workers for up to 70 days at TMI-1 (AmerGen 2008). These additional workers would create an additional demand for temporary (rental) housing in the immediate vicinity of TMI-1. The impacts of TMI-1 steam generator replacement are discussed in Chapter 3 of this draft supplemental EIS.

4.9.3 Public Services: Public Utility Impacts

Impacts on public utility services are considered SMALL if there is little or no change in the ability of the system to respond to demand and thus there is no need to add capital facilities. Impacts are considered MODERATE if service capabilities are overtaxed during periods of peak demand. Impacts are considered LARGE if services (e.g., water, sewer) are substantially degraded and additional capacity is needed to meet ongoing demand. The GEIS indicated that, in the absence of new and significant information to the contrary, the only impacts on public utilities that could be significant are impacts on public water supplies.

Analysis of the impacts on the public water and sewer systems considered both plant demand and plant-related population growth. Section 2.2.8 of this draft supplemental EIS describes the TMI-1 permitted withdrawal rate and actual use of water.

Since AmerGen has indicated that they have no plans to add non-outage employees during the license renewal period, non-outage employment levels at TMI-1 would remain relatively unchanged with no additional demand for public water and sewer services. Public water systems in the region would be adequate to meet the demands of residential and industrial customers in the area. Therefore, there would be no additional impact to public water and sewer services during the license renewal term beyond what is currently being experienced.

As discussed in Section 4.9.2, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term (AmerGen 2008). The additional number of refueling outage workers needed to replace the steam generators would cause a short-term increase in the amount of public water and sewer services used in the immediate vicinity of TMI-1. These impacts are discussed in Chapter 3 of this draft supplemental EIS.

4.9.4 Offsite Land Use – License Renewal Period

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 notes that “significant changes in land use may be associated with population and tax revenue changes resulting from license renewal.”

Section 4.7.4 of the GEIS defines the magnitude of land-use changes as a result of plant operation during the period of extended operation as follows:

SMALL - Little new development and minimal changes to an area's land-use pattern.

MODERATE - Considerable new development and some changes to the land-use pattern.

LARGE - Large-scale new development and major changes in the land-use pattern.

Tax revenue can affect land use because it enables local jurisdictions to provide the public services (e.g., transportation and utilities) necessary to support development. Section 4.7.4.1 of the GEIS states that the assessment of tax-driven land-use impacts during the license renewal term should consider (1) the size of the plant’s payments relative to the community’s total revenues, (2) the nature of the community’s existing land-use pattern, and (3) the extent to which the community already has public services in place to support and guide development. If the plant’s tax payments are projected to be small relative to the community’s total revenue, tax-driven land-use changes during the plant’s license renewal term would be SMALL, especially when the community has pre-established patterns of development and has provided adequate public services to support and guide development.

Section 4.7.2.1 of the GEIS states that if tax payments by the plant owner are less than 10 percent of the taxing jurisdiction’s revenue, the significance level would be SMALL. If the plant’s tax payments are projected to be medium to large relative to the community’s total revenue, new tax-driven land-use changes would be MODERATE. If the plant’s tax payments are projected to be a dominant source of the community’s total revenue, new tax-driven land-use changes would be LARGE. This would be especially true when the community has no pre-established pattern of development or has not provided adequate public services to support and guide development.

<u>Population-Related Impacts</u>

Since AmerGen has indicated that they have no plans to add non-outage employees during the license renewal period, there would be no noticeable change in land use conditions in the vicinity of TMI-1. Therefore, there would be no population-related land use impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.9.2, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term (AmerGen 2008). Due to the short amount of time needed to replace the steam generators, the additional number of refueling outage workers would not cause any permanent population-related land use changes in the immediate vicinity of TMI-1. These impacts are discussed in Chapter 3 of this draft supplemental EIS.

Tax Revenue-Related Impacts

As previously discussed in chapter 2, AmerGen pays annual real estate taxes to Dauphin County, Londonderry Township, and the Lower Dauphin School District. For the three-year period from 2003 through 2005, tax payments to Dauphin County represented 0.2 percent of the County's total annual property tax revenues, and payments to Londonderry Township represented approximately 0.3 to 0.5 percent of the Township's total annual property tax revenues. AmerGen's tax payments to the Lower Dauphin School District, for the period 2003 through 2005, represented 1.7 to 2.3 percent of the District's total annual property tax revenues.

Since AmerGen started making payments to local jurisdictions, population levels and land use conditions in Dauphin County and Londonderry Township have not changed significantly, which might indicate that these tax revenues have had little or no affect on land use activities within the county. However, discontinuing the current level of tax revenues could have a negative economic impact on these jurisdictions and the Lower Dauphin School District.

AmerGen has indicated that they have no plans to add non-outage employees during the license renewal period, non-outage employment levels at TMI-1 would remain relatively unchanged. Accordingly, there would be no increase in the assessed value of TMI-1, and annual property tax payments to Dauphin County, Londonderry Township, and the Lower Dauphin School District would be expected to remain relatively unchanged throughout the license renewal period. Based on this information, there would be no land use impacts related to tax revenue during the license renewal term beyond those already being experienced.

As discussed in Section 4.9.2, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term (AmerGen 2008). The replacement of the existing steam generators would not likely increase the assessed value of TMI-1, and property tax payments would remain unchanged. These impacts are discussed in Chapter 3 of this draft supplemental EIS.

4.9.5 Public Services: Transportation Impacts

Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 states the following:

> Transportation impacts (level of service) of highway traffic generated...during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites.

All applicants are required by 10 CFR 51.53(c)(3)(ii)(J) to assess the impacts of highway traffic generated by the proposed project on the level of service of local highways during the term of the renewed license.

Since AmerGen has no plans to add non-outage employees during the license renewal period; there would be no noticeable change in traffic volume and levels of service on roadways in the vicinity of TMI-1. Therefore, there would be no transportation impacts during the license renewal term beyond those already being experienced.

As discussed in Section 4.9.2, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term (AmerGen 2008). The additional number of refueling outage workers and truck material deliveries needed to support the replacement of the steam generators would cause a one-time short-term transportation impact on access roads in the immediate vicinity of TMI-1. These impacts are discussed in Chapter 3 of this draft supplemental EIS.

4.9.6 Historic and Archaeological Resources

The National Historic Preservation Act (NHPA) requires Federal agencies to consider the effects of their undertakings on historic properties. Historic properties are defined as resources that are eligible for listing on the National Register of Historic Places (NRHP). The criteria for eligibility are listed in Title 36, “Parks, Forests, and Public Property,” Part 60, Section 4, “Criteria for Evaluation,” of the *Code of Federal Regulations* (36 CFR Part 60.4) and include (1) association with significant events in history; (2) association with the lives of persons significant in the past; (3) embodies distinctive characteristics of type, period, or construction, and (4) or sites or places that have yielded or is likely to yield important information (ACHP 2008). The historic preservation review process (Section 106 of the NHPA) is outlined in regulations issued by the Advisory Council on Historic Preservation in Title 36, “Parks, Forests, and Public Property,” Part 800, “Protection of Historic Properties,” of the *Code of Federal Regulations* (36 CFR Part 800). The issuance of a renewed operating license for a nuclear power plant is a federal action that could possibly affect either known or undiscovered historic properties located on or near the plant site and its associated transmission lines. In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties in the area of potential effect. The area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs that may be impacted by post-license renewal land-disturbing operations or projected refurbishment activities associated with the proposed action. If no historic properties are present or affected, the NRC is required to notify the State Historic Preservation Office before proceeding. If it is determined that historic properties are present, the NRC is required to assess and resolve possible adverse effects of the undertaking. While AmerGen owns Three Mile Island, the APE is confined to the northern portion of the island where the plant is located. The following discussion summarizes the historic and archaeological research that has been conducted on the island.

AmerGen contacted the Pennsylvania Historical and Museum Commission (PHMC) on May 22, 2007, requesting information on historic and archaeological resources and describing the proposed action (AmerGen 2008). In a letter dated June 4, 2007, the PHMC stated that the activities described in the proposed action should have no effect on historic and archaeological resources (AmerGen 2008). The PHMC requested that if the applicant becomes aware of any unidentified historic buildings, structures, or archaeological resources located on site, or if the project could have an effect on historic properties, the PHMC should be contacted immediately (AmerGen 2008). In accordance with 36 CFR 800.8(c), the NRC contacted the PHMC (NRC 2008a), the Advisory Council on Historic Preservation (NRC 2008b), and the appropriate Federally-recognized Native American Tribes to initiate consultation. These letters are contained in Appendix D of this report.

As previously discussed in Section 2.2.9, a search of the PHMC site files identified nine prehistoric sites and one historic site on Three Mile Island. One of the sites, 36Da98 was a possible find spot reported by a local collector south of the powerblock. No time period was determined for the 36Da98 and portions of the site could still be intact and should be avoided. Sites 36Da96 and 36Da97 were located in a cultivated area which later became the construction site for TMI-1 and TMI Unit 2. Portions of the 36Da96 could also be intact due to its location on the edge of the construction zone. Site 36Da97 was destroyed by the construction of TMI-1 and TMI Unit 2. One additional site 36Da52 was recorded by the William Penn Memorial Museum in 1967. It is unclear whether 36Da52 was destroyed during the construction of TMI-1 and TMI Unit 2 because it was also situated on the edge of the construction area.

Site 36Da50 is a large multi-component occupation that was excavated prior to the construction of TMI-1 and TMI Unit 2. During the walkover survey, it was noted that the northernmost portions of 36Da50 remain and it is an area that should be avoided. Sites 36Da99, 36Da100, and 36Da101 are large multi-component occupation sites near the riverbank. 36Da101 also contains historic artifacts. Another prehistoric occupation site is 36Da51. While test units recovered a low concentration of artifacts, portions of this site may still be intact and should be avoided. These archaeological and historic sites have the potential to contribute a large amount of prehistoric information. Archaeological surveys and reports indicate that undisturbed portions of Three Mile Island could contribute to the archaeological record of the lower Susquehanna River valley. Archaeological investigations should be conducted if ground disturbing activities would occur in undisturbed areas of the island.

In addition to the prehistoric sites mentioned above, Three Mile Island also contains historic sites. As noted earlier, a historic farmstead was identified (36Da235) during NRC’s walkover survey of Three Mile Island. A preliminary Pennsylvania Archaeological Site Survey form was completed by AmerGen, however, documentation is incomplete. This site must be recorded and evaluated for eligibility to the National Register of Historic Places. Additionally, the remnants of Pennsylvania Canal's Eastern Division (Eastern Division Canal) are located on the eastern shore of the Susquehanna River next to AmerGen’s property. Another potential resource of historic significance on Three Mile Island is TMI Unit 2. TMI Unit 2 could be considered potentially eligible for listing on the NRHP under Criterion A, as a site of exceptional importance, but its eligibility has not yet been determined.

AmerGen has indicated no plans to change or modify the plant or transmission line structures. However, because of the high potential for the presence of historic and archaeological resources, AmerGen should take care during continued operations and maintenance activities to not affect these resources. AmerGen’s review procedures for onsite ground disturbing activities take into account the protection of historic and archaeological resources. AmerGen is currently revising its procedures to provide guidance regarding the protection of historic and archaeological resources, and to implement a stop work provision when these resources are inadvertently discovered. It should be noted in the procedures that previously disturbed lands are areas that were disturbed by the construction of TMI-1 and TMI Unit 2. Plow zone disturbance (farming) is not considered previously disturbed land because the depth of disturbance is minimal. If ground disturbing activities are planned that may adversely affect these resources, then AmerGen should hire a PHMC approved contractor to survey the proposed site prior to construction. To date, AmerGen has employed cultural resource management firms to ensure that ground disturbing activities would not adversely affect historic and archaeological resources.

As discussed in Chapter 3, AmerGen plans to replace the existing steam generators for TMI-1. A dedicated storage facility to house the replaced generators will be constructed within the existing industrial footprint of the site and will be located in and area that has been previously disturbed (AmerGen 2008). The NRC staff has reviewed the potential environmental impacts of this activity in Chapter 3 of this draft supplemental EIS.

No impacts to known historic and archaeological resources are expected from the continued operation of TMI-1 during the license renewal term. Based on the review of PHMC files, archaeological surveys, assessments, and other information, the potential impacts on historic and archaeological resources at TMI-1 would be SMALL. Since TMI-1 is situated in an archaeologically sensitive area, development of a cultural resources management plan in addition to AmerGen's review procedures would serve to integrate cultural resource considerations with ongoing TMI-1 activities. Additionally, training of AmerGen staff in the Section 106 process would ensure that informed decisions are made when considering the effects of future projects on historic and archaeological resources. As previously discussed, lands not previously surveyed should be investigated by a professional archaeologist prior to any ground disturbance. In addition, the historical farmstead site (36Da235) should be recorded and evaluated for eligibility.

4.9.7 Environmental Justice

Under Executive Order 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued a Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040), which states, "The Commission is committed to the general goals set forth in Executive Order 12898, and strives to meet those goals as part of its NEPA review process."

The Council of Environmental Quality (CEQ) provides the following information in its 1997 report entitled, "Environmental Justice: Guidance Under the National Environmental Policy Act":

> **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income

population is significant (as defined by NEPA [National Environmental Policy Act]) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ 1997).

Disproportionately High and Adverse Environmental Effects. A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the operation of TMI-1 during the renewal term. In assessing the impacts, the following CEQ (1997) definitions of minority individuals and populations and low-income population were used:

Minority individuals. Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races meaning individuals who identified themselves on a Census form as being a member of two or more races, for example, Hispanic and Asian.

Minority populations. Minority populations are identified when (1) the minority population of an affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

Low-income population. Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

Minority Population in 2000

According to 2000 census data, 11 percent of the population (approximately 2,536,000 individuals) residing with a 50 mi radius of TMI-1 identified themselves as minority individuals. The largest minority group was Black or African American (131,000 persons or 5.2 percent), followed by Hispanic or Latino of any race (107,000 or about 4.2 percent) (USCB 2003 – LandView 6). About 24.4 percent of the Dauphin County population identified themselves as minorities, with Black or African American the largest minority group (16.9 percent) followed by Hispanic or Latino (4.1 percent) (USCB 2008) (see Table 2-12).

The 50-mi (80 km) radius around TMI-1 includes 16 counties in Pennsylvania and six counties in Maryland. The geographic area includes any census block group with part of its area within the 50-mi (80 km) radius. Of the 1,931 census block groups located wholly or partly within the 50-mi (80 km) radius of TMI-1, 155 block groups were determined to have high density minority population percentages that exceeded the Pennsylvania average by 20 percentage points or more. The largest number of high density minority block groups was Black or African American, with 78 block groups that exceed the Pennsylvania average 20 percent or more. These block groups are concentrated in urban areas with high population densities. The greatest number of high density block groups with minority populations are located in four Pennsylvania counties (Berks, Dauphin, Lancaster, and York). The closest high density minority population to TMI-1 is located in Harrisburg, Pennsylvania.

Based on 2000 census data, Figure 4-1 shows the location of high density minority block groups within a 50-mi radius of TMI-1.

Low-Income Population in 2000

According to 2000 census data, approximately 36,000 families and 188,000 individuals (approximately 5.3 and 7.4 percent, respectively) residing within a 50-mi radius of TMI-1 were identified as living below the Federal poverty threshold in 1999 (USCB 2003 – LandView 6). The 1999 Federal poverty threshold was $17,029 for a family of four.

According to Census data, the median household income for Pennsylvania in 2006 was $46,259, while 12.1 percent of the State population was determined to be living below the Federal poverty threshold. Dauphin County had a higher median household incomes ($49,093) and a lower percentage (10.1 percent) of individuals living below the poverty level when compared to the State. Lancaster County had much higher median household income in 2006 ($52,064) and a lower percentage (9.2 percent) of individuals living below the poverty level when compared to the State and Dauphin County (USCB 2008). Census block groups were considered high density low-income block groups if the percentage of households below the Federal poverty threshold exceeded the Pennsylvania average by 20 percent or more. Based on 2000 Census data, there were 66 block groups within the 50-mi (80 km) radius of TMI-1 that exceeded the Pennsylvania average for low income households by 20 percent or more. The majority of census block groups with low-income populations were located in two counties, Berks County (16 block groups) and Dauphin County (12 block groups) in Pennsylvania. The nearest high density low-income population to TMI-1 is located in Harrisburg, Pennsylvania. Figure 4-2 shows the location of high density low-income census block groups within a 50-mi (80 km) radius of TMI-1.

Analysis of Impacts

Consistent with the impact analysis for the public and occupational health and safety, the affected populations are defined as minority and low-income populations who reside within a 50 mi (80 km) radius of TMI-1. Based on the analysis of environmental health and safety impacts presented in this draft supplemental EIS for other resource areas, there would be no

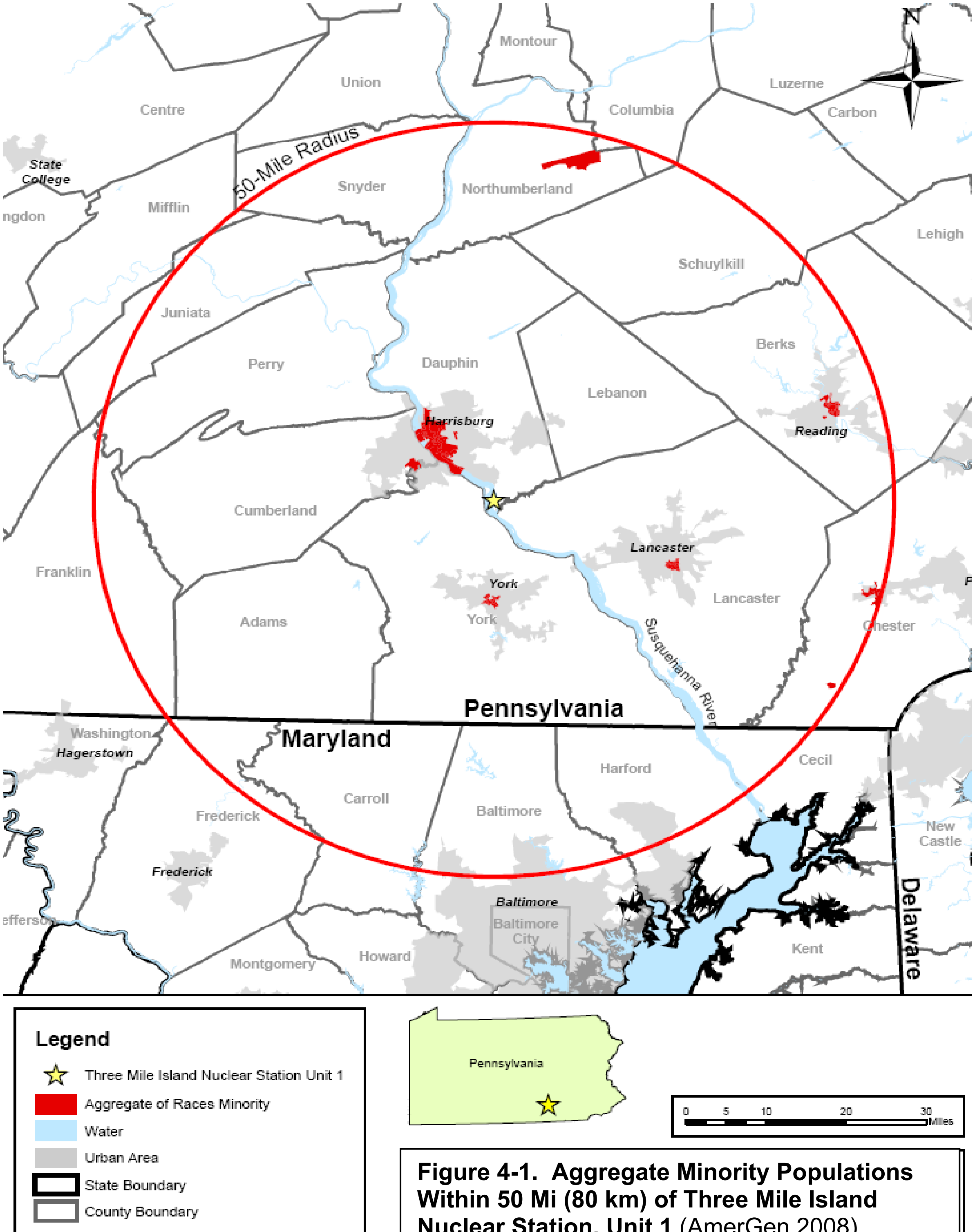

Figure 4-1. Aggregate Minority Populations Within 50 Mi (80 km) of Three Mile Island Nuclear Station, Unit 1 (AmerGen 2008)

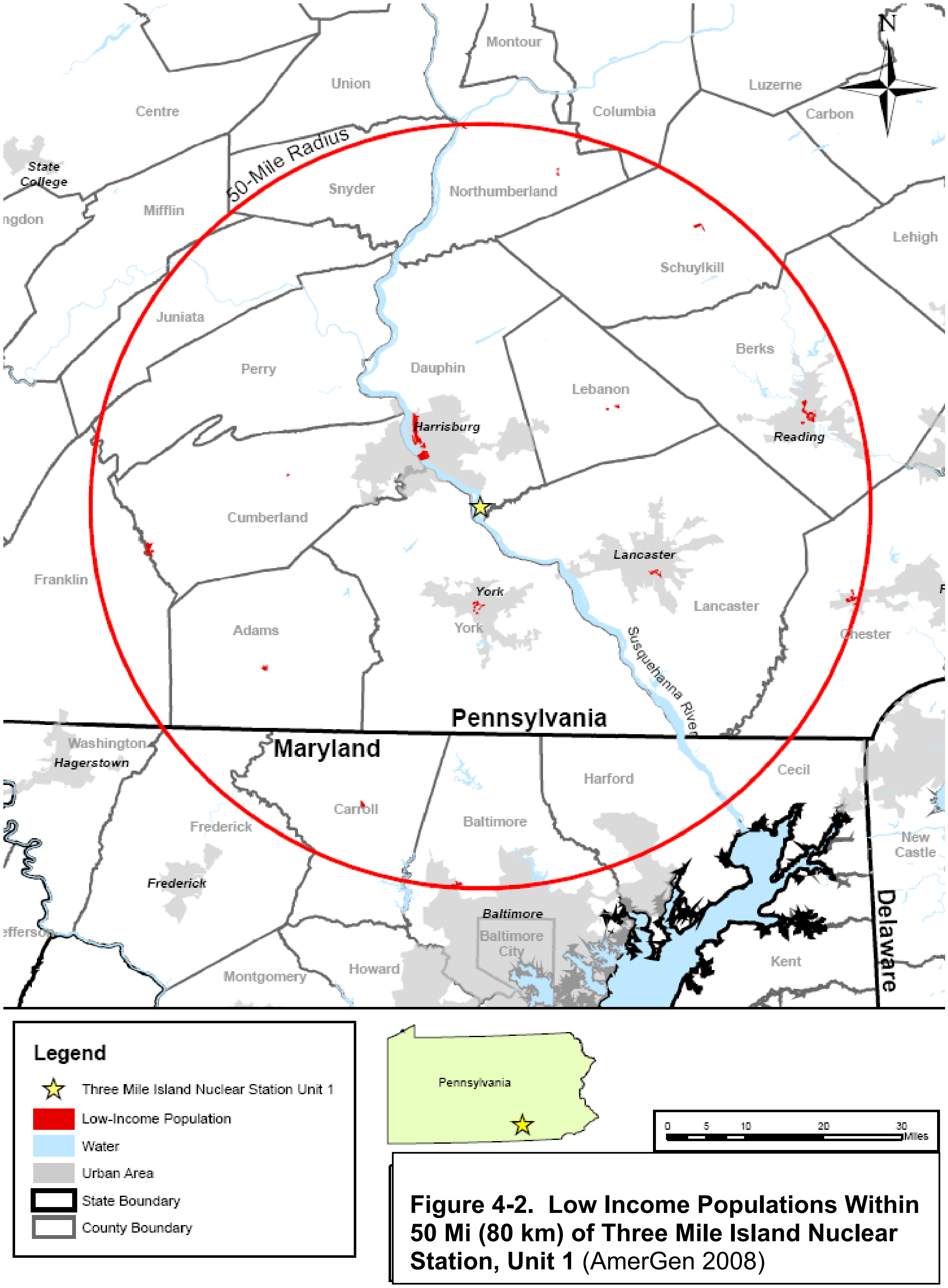

Figure 4-2. Low Income Populations Within 50 Mi (80 km) of Three Mile Island Nuclear Station, Unit 1 (AmerGen 2008)

disproportionately high and adverse impacts to minority and low-income populations from the continued operation of TMI-1 during the license renewal period.

As discussed in Section 4.9.2, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term. AmerGen estimates that steam generator replacement would require a one-time increase in the number of refueling outage workers for up to 70 days at TMI-1 (AmerGen 2008a). These additional workers would have little noticeable affect on minority and/or low-income populations in the region. These impacts are discussed in Chapter 3 of this draft supplemental EIS.

NRC also analyzed the risk of radiological exposure through the consumption patterns of special pathway receptors, including subsistence consumption of fish, native vegetation, surface waters, sediments, and local produce; absorption of contaminants in sediments through the skin; and inhalation of plant materials. The special pathway receptors analysis is important to the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area.

Subsistence Consumption of Fish and Wildlife

Section 4-4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this draft supplemental EIS, NRC considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts to American Indian, Hispanic, and other traditional lifestyle special pathway receptors. Special pathways that took into account the levels of contaminants in native vegetation, crops, soils and sediments, surface water, fish, and game animals on or near the TMI-1 site were considered.

Historic analyses of deer meat samples collected at TMI-1 from 1990 through 1997 found concentrations of cesium-137, tritium, and strontium-90. Cesium-137 was only detected in control samples (AmerGen 2008c). Since cesium-137 was not found in indicator samples, the presence of cesium-137 could be attributed to past fallout from nuclear weapons tests. Tritium was found in both indicator and control deer meat samples during this time period at concentrations similar to each other and similar to concentrations of tritium detected in other control food products such as milk, fruits, and vegetables (AmerGen 2008c). Since tritium occurs naturally in the environment and since the levels of concentrations were similar, the presence of tritium in both control and indicator samples therefore could not be directly attributed to TMI-1 operations. Strontium-90 was found in only one deer meat sample collected in 1992 and was consistent with the concentration found in one 1989 control sample (AmerGen 2008c). Therefore, the presence of strontium-90 in the deer meat sample could also be attributed to past fallout from nuclear weapons tests.

AmerGen has an ongoing comprehensive Radiological Environmental Monitoring Program (REMP) at TMI-1 to assess the impact of site operations on the environment. Samples are collected from the aquatic and terrestrial pathways in the vicinity of TMI-1 and TMI Unit 2. The aquatic pathways include fish, Susquehanna River surface water, ground water, and sediment. The terrestrial pathways include airborne particulates, milk, and food product garden (leaf) vegetation, and direct radiation. During 2007, 1,718 analyses were performed on 1,318 collected samples of environmental media as part of the required REMP and showed no significant or measurable radiological impact from TMI-1 operations (AmerGen 2008b).

During 2007, cesium-137, strontium-90, and tritium were the only potentially plant-related radionuclides detected in environmental samples. No radionuclides other than naturally occurring and tritium were detected in the Susquehanna River water samples collected in 2007. Tritium, whose presence is likely to be due to plant operations, has been detected in the past, was detected in 8 of 24 surface water samples taken downstream of the effluent outfall in concentrations well below regulatory limits. Tritium was also detected in 3 of 36 drinking water samples at slightly above the lower limit of detection. Cesium-137 was identified in sediment samples in 2007 at very low levels (just above the lower limit of detection), and were not distinguishable from background levels (AmerGen 2008b).

Strontium-90 was detected in 11 of 21 milk samples collected in 2007. The amount of activity detected was consistent with those detected in the pre-operational years. Strontium-90 was also detected in 24 of 26 food product samples in both the indicator and control samples (AmerGen 2008b). The source of the strontium-90 could be attributed to residual fallout from weapons testing.

The results of the 2007 REMP demonstrate that routine operation at TMI-1 had no significant or measurable radiological impact on the environment. No elevated radiation levels were detected in the offsite environment as a result of plant operations and the storage of radioactive waste. The results of the REMP continue to demonstrate that the operation of TMI-1 did not result in a significant measurable dose to a member of the general population or adversely impact the environment as a result of radiological effluents. The REMP continues to demonstrate that the dose to a member of the public from the operation of TMI-1 remains significantly below the federally required dose limits specified in 10 CFR Part 20 and 40 CFR Part 190.

The PADEP BRP maintains a comprehensive environmental radiation monitoring program in Pennsylvania, as required by the “Radiation Protection Act” (No. 1984-147). The purpose of the program is to evaluate long-term trends in environmental radiation levels; assess the environmental impact of particular sites, such as TMI-1; and provide this information to the public. The BRP currently maintains off-site environmental radiation monitoring programs around five nuclear power plants in Pennsylvania including TMI-1. Monitoring stations serve as indicators of any effects from plant operation and at control locations, which are beyond the measurable influence of the facility. These stations also provide verification of utility effluent monitoring programs during routine operations.

Each year, BRP collects dosimetry, air, water, milk, fish, produce, and sediment samples in the vicinity of TMI-1. Fish samples were collected in the vicinity of the TMI-1 discharge and produce samples of cabbage were collected from a truck garden located 0.4 mi east of TMI-1 in 2003 and 2004. No reactor-related radioisotopes were detected in the fish and produce samples. BRP also found no traces of cesium-137 in milk samples taken monthly at two local farms. Cesium-137 was detected in sediment samples collected upstream (control) and downstream (indicator) of the TMI-1 discharge. The presence of cesium-137 could be attributed to fallout from past weapons testing and the accident at Chernobyl in April 1986. BRP also found no reactor-related radioisotopes in fish and produce samples collected in 2001 and 2002 (PADEP BRP 2008).

Based on recent monitoring results, concentrations of radiological contaminants in native leafy vegetation, soils and sediments, surface water, and fish in areas surrounding TMI-1 have been quite low (at or near the threshold of detection) and seldom above background levels. Consequently, no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations in the region as a result of subsistence consumption of fish and wildlife.

However, with regard to nonradiological contaminants, it should be noted that for the reach of the Susquehanna River within the vicinity of the TMI-1 facility and the nearest major water bodies, including Swatara Creek, East Conewago Creek, West Conewago Creek, and Fishing Creek, Pennsylvania issued a health advisory to limit the consumption of smallmouth bass (*Micropterus dolomieu*) to no more than two meals per month due to mercury contamination (PFBC 2008c).

4.10 Evaluation of New and Potentially Significant Information

New and significant information is (1) information that identifies a significant environmental issue not covered in the GEIS and codified in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, or (2) information that was not considered in the analyses summarized in the GEIS and that leads to an impact finding that is different from the finding presented in the GEIS and codified in 10 CFR Part 51.

In preparing to submit its application to renew the TMI-1 operating license, AmerGen developed a process to ensure that information not addressed in or available during the GEIS evaluation regarding the environmental impacts of license renewal for TMI-1 would be properly reviewed before submitting the ER, and to ensure that such new and potentially significant information related to renewal of the operating license for TMI-1 would be identified, reviewed, and assessed during the period of NRC review. AmerGen reviewed the Category 1 issues that appear in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, to verify that the conclusions of the GEIS remained valid with respect to TMI-1. This review was performed by personnel from TMI-1 and its support organization who were familiar with NEPA issues and the scientific disciplines involved in the preparation of a license renewal ER.

The NRC staff also has a process for identifying new and significant information. That process is described in detail in NUREG-1555, Supplement 1, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants, Supplement 1: Operating License Renewal* (NRC 2000). The search for new information includes (1) review of an applicant's ER and the process for discovering and evaluating the significance of new information; (2) review of records of public comments; (3) review of environmental quality standards and regulations; (4) coordination with Federal, State, and local environmental protection and resource agencies; and (5) review of the technical literature. New information discovered by the NRC staff is evaluated for significance using the criteria set forth in the GEIS. For Category 1 issues where new and significant information is identified, reconsideration of the conclusions for those issues is limited in scope to the assessment of the relevant new and significant information; the scope of the assessment does not include other facets of the issue that are not affected by the new information.

The NRC staff has not identified any new and significant information on environmental issues listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, related to the operation of TMI-1 during the period of license extension. The NRC staff also determined that information provided during the public comment period did not identify any new issues that require site-specific assessment. The NRC staff reviewed the discussion of environmental impacts in the GEIS (NRC 1996) and conducted its own independent review (including the public scoping meetings held in May 2008) to identify new and significant information.

4.11 Cumulative Impacts

The NRC staff considered potential cumulative impacts in the environmental analysis of continued operation of TMI-1. For the purposes of this analysis, past actions are those related to the resources at the time of the power plant licensing and construction, present actions are those related to the resources at the time of current operation of the power plant, and future actions are considered to be those that are reasonably foreseeable through the end of plant operation including the period of extended operation. Therefore, the analysis considers potential impacts through the end of the current license terms as well as the 20-year renewal license term. The geographic area over which past, present, and future actions would occur is dependent on the type of action considered and is described below for each impact area.

The impacts of the proposed action, as described in Sections 4.1–4.9, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.

4.11.1 Cumulative Impacts on Water Resources

The SRBC regulates consumptive water use at TMI-1 and at all facilities drawing water from the Susquehanna River and the river basin. The SRBC is an independent agency that develops, effectuates, coordinates and adopts plans, policies, and programs related to water resources in the Susquehanna River basin (SRBC 2008). According to the SRBC, 89 percent of water use in the Lower Susquehanna River Basin (Lower Subbasin) is for power generation, 4.8 percent for industrial use, 4.2 percent for municipal use, 1.2 percent for agricultural use, and 0.8 percent for domestic use (SRBC 2007). TMI-1 has a permit with SRBC for consumptive use of river water up to 18 million gallons per day (mgd), on a 30-day average, for electric generation. TMI-1 also participates in the Cowanesque Reservoir water allocation project, which releases water to the Susquehanna River to augment flow during periods of drought (AmerGen 2008).

TMI-1 has five onsite ground water wells, and uses ground water for various industrial operations and for drinking water on site, as permitted by the SRBC. This water is primarily drawn from the Gettysburg shale aquifer located directly beneath the site (AmerGen 2008). The SRBC monitors and manages ground water use in the area including and surrounding Three Mile Island under the “Groundwater Management Plan for the Susquehanna River Basin,” which was initiated in 1993 (SRBC 2005). The SRBC estimates that the use of ground water in the Susquehanna River Basin is approximately 390 mgd. The main use in the basin is to supply drinking water wells, with the largest consumers being public water suppliers (115 mgd), followed by mining sites (90 mgd), domestic consumers (80 mgd), industrial consumers (48 mgd), agricultural consumers (42 mgd), and commercial consumers (12 mgd) (SRBC 2005).

According to the most recently issued draft ground water management plan (SRBC 2005), the quality of ground water in the Susquehanna River Basin is generally good, with the most common impacts being the geology of the area and land use. Degradation of ground water in the area is largely a result of abandoned coal mines (acid mine drainage) as well as agricultural and residential use of pesticides and contaminants. A particular problem addressed by the SRBC is the diversion of stormwater runoff into sinkholes, which essentially delivers the water directly to the aquifer. Section 4.11.2 of this report discusses ground water quality and its impacts on aquatic resources of the Susquehanna River in more depth. Other significant issues outlined by the SRBC management plan include increases in land development, overuse of ground water resources, transfer of discharge wastewater to a different watershed, unregulated use of ground water resources, drought impacts, and the need for flow compensation for consumptive water users in the basin (SRBC 2005).

The SRBC regulatory program, which includes the regulation of withdrawals, monitoring and enforcement duties, and the ability to designate protected areas, manages the basin's ground water resources. The regulatory program also allows for the development of ground water quality standards and conservation requirements. Additionally, the ground water management plan focuses on public outreach and education (SRBC 2005).

Recently there has been strong interest in the development of gas well drilling of the Marcellus shale, a gas reservoir stretching from Pennsylvania into Ohio and West Virginia which some claim contains enough gas to satisfy U.S. demand for 2 years (Buurma 2008; SRBC 2008). With the recent success of drilling the Barnett shale in Texas and new technological advances in horizontal drilling, several drilling companies have taken serious interest in the Appalachian area (SRBC 2008). The gas drilling process involves both horizontal drilling and the use of a technique known as hydraulic fracturing (or, "hydrofracking"). Hydrofracking is the high-pressure injection of a combination of sand, water, and chemicals into rock to fracture it and make it more permeable (Buurma 2008). The chemicals used in hydrofracking, however, are toxic and have the potential to contaminate drinking water and ground water systems. There is less concern over the transfer of these chemicals into ground water supplies simply because the wells are far deeper (4000 to sometimes 8000 ft deep) than the water-bearing aquifers (SRBC 2008). However, there is concern over the disposal of the toxic drilling water and where and how it will be discharged. Before any drilling can begin each company must apply to the SRBC for various water use permits. In August 2008, SRBC made the decision to require all natural gas drilling projects to apply for water withdrawal permits, regardless of the amount of water being withdrawn, as well as to raise the area's consumptive use mitigation fee (SRBC 2008).

To ensure that surface water and ground water resources of the Susquehanna River basin continue to meet the needs of the basin population, in addition to enforcing water use regulations, the SRBC coordinates with State and Federal agencies, conducts extensive water resources monitoring, project review, water withdrawal registration, drought coordination, flood management, low-flow management (i.e., water storage), reservoir feasibility studies, and ground water management (SRBC 2008). On the basis of this information, the independent review by the NRC staff concludes that the cumulative impact to water resources during the license renewal period would be SMALL.

4.11.2 Cumulative Impacts on Aquatic Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts on aquatic resources. For the purpose of this analysis, the geographic area considered for cumulative impacts on aquatic resources at TMI-1 is the Lower Subbasin, which is one of the six Susquehanna River major subbasins. The Lower Subbasin runs south from Sunbury in Northumberland County, PA, to Havre de Grace, MD. The lower Subbasin discharges into the Chesapeake Bay.

The Lower Subbasin, which drains approximately 5,809 square miles (mi^2) (15,045 square kilometers [km^2]) of land, is the most developed of the six Susquehanna River subbasins. The cities of Harrisburg, Lancaster, York, Lebanon, and Carlisle are contained within the Lower Subbasin. The subbasin is characterized by a mixture of land uses including residential areas, agricultural land, undeveloped land, forests, and recreational areas (SRBC 2008). The northern section of the Lower Subbasin consists primarily of forested areas interspersed with agriculture and residential areas, while the southern half of the subbasin is dominated by agriculture and urban areas, with some undeveloped areas, parks, and recreation areas (SRBC undated).

Almost a century of intensive anthracite coal mining within the Wyoming Valley seriously impaired the Susquehanna River's water quality and ecological resources. The river received highly acidic, iron-rich drainage from numerous mining sites that operated from the late 1800s through the early 1970s. These sites were mostly in the upper subbasins of the Susquehanna River; however, the Lower Subbasin was also impacted due to the natural flow of the river and the movement of pollutants downstream. Anthracite mining in Pennsylvania reached its peak around 1930 and ceased almost entirely in 1972, in part because of the evolving fossil fuel economy and tightening water quality regulations. However, the mines continued to leak iron-contaminated acidic runoff to streams that fed the river for many years following their abandonment. In addition to high levels of total iron and other dissolved heavy metals, mining effluents were also responsible for the high sulfate content, and low pH and dissolved oxygen levels in the river (CBF 2006).

Between 1972 and 1981, considerable improvement in the water quality of the Susquehanna River was noted. During this period, the volume of mining effluents being discharged to the river decreased. The reduction in mining caused a decrease in solids, iron, and sulfate concentrations throughout the Susquehanna River. These trends on improved water quality have continued, and will most likely continue as long as mining is kept at a minimum.

Agriculture and livestock production in the Lower Subbasin have contributed to declines in river water quality. Nutrient discharges including nitrates, nitrogen, phosphorus, and orthophosphates from runoff of pesticide and fertilized agricultural and livestock lands have been a primary source of decreased water quality (CBF 2005). Agricultural practices from the land along the Lower Subbasin have caused decreased river water quality in the Chesapeake Bay (CBF 2005).

Numerous wastewater treatment plants are located along the Lower Subbasin, discharges from which can contribute to decreases in river water quality. Treated water leaving wastewater plants can have increased levels of phosphates, orthophosphates, and chlorine (SRBC 2006). During high storm events, untreated overflow from treatment plants can add additional nutrient runoff to the Susquehanna River.

As mentioned above, the Lower Subbasin runs through more urban areas of Pennsylvania such as Harrisburg, Lancaster, and York. Urbanized areas contain more impervious surfaces than other land uses; this increases stormwater runoff to waterways and causes subsequent decreases in river water quality.

Anthropogenic sources of pollution will likely be an ongoing issue for the Susquehanna River. However, the SRBC, PADEP, and other environmental groups such as the Chesapeake Bay Foundation are working collaboratively in their efforts to conduct basin-wide monitoring and promote watershed protection and management. Furthermore, PADEP will continue to enforce water quality regulations through its NPDES permitting program. NPDES permits, issued by the PADEP Bureau of Water Supply and Wastewater Management, will continue to regulate municipal and industrial effluents to the Susquehanna River. The PADEP periodically reviews and renews NPDES permits; thus it is reasonable to predict that the improving trends in the Susquehanna River's water quality will likely continue throughout the license renewal period.

Construction of hydroelectric dams on the river in the Lower Subbasin has also created significant impacts on the aquatic ecosystem; and as power needs in Pennsylvania increase in the future, it is reasonable to predict potential uprates and improvements to current dams on the Susquehanna River. Dams can change aquatic ecosystems by altering flow, sediment transport, critical habitats, water temperature, and chemistry (CBF 2006). As discussed in Section 2.2.5 of this supplemental EIS, the American shad (*Alosa sapidissima*) is an anadromous fish species that was once of major sport and commercial importance within the Susquehanna River. Presently, American shad are rarely found in the upper reaches of the river because dams constructed in the last one hundred years have blocked the species' natural upstream migration. Between 1904 and 1932, four hydroelectric dams were constructed on the Susquehanna River. Fish passage facilities at these early dams were primitive and often prevented shad passage. The 1928 construction of the 95-ft-high (29-m-high) Conowingo Dam, located 10 mi (16 km) above the mouth of the Susquehanna River, effectively put an end to shad migration in the Susquehanna River, and at the time, authorities deemed the Conowingo Dam too high to include fish passage modifications in the dam's design. Fish ladders or lifts currently exist at all dams throughout the Lower Subbasin, however, in the years 2006–2008, shad populations have declined throughout all the dams in the subbasin (PFBC 2008a).

Shad restoration attempts began in the mid-20th century with feasibility studies conducted by the Pennsylvania Fish Commission (now the PFBC). From 1970–1980, the first Conowingo fish lift was built, and hatchery cultures of fry were stocked in the Susquehanna River and its tributaries. From 1985–1994, increasing numbers of fry were stocked, and over 125,000 adult shad were stocked above the Conowingo Dam. Fry were stocked in the North Branch Susquehanna River in Pennsylvania and New York, Chemung River in New York, West Branch Susquehanna River, Juniata River, Susquehanna River near Montgomery Ferry, Conodoguinet Creek, Conestoga River, Swatara Creek, and West Conewago Creek. During this period, the annual return of shad grew from 1,500 to 60,000.

During the years of 1988–1997, a permanent fish passage facility was built at Conowingo Dam, and through a series of settlements with utility companies that owned Susquehanna River dams, fish elevators were constructed at the Holtwood and Safe Harbor dams. In 1997, the shad return at Conowingo exceeded 100,000 fish. In 1999 and 2000, a fish ladder was completed at the Red Hill Dam, and smaller upriver dams along the Susquehanna River and major tributaries were reopened to allow natural shad migration through Binghamton, NY. In

2001, American shad passage at the Conowingo Dam exceeded 190,000 fish. In 2008, the number of American shad passing the Conowingo Dam had decreased to less than 20,000 fish, with only 21 American shad passing the Red Hill (York Haven) Dam fish ladder at TMI-1 (PFBC 2008a). An assessment of the coast-wide stock of American shad by the Atlantic States Marine Fisheries Commission noted that American shad stocks are at an all-time low and not recovering, with the primary causes for the decline attributed to “overfishing, pollution loss, and habitat loss due to dam construction” (ASMFS 2007). Design flaws in existing fish ladders at dams also limit fish passage at dams located on the Susquehanna River (Greenwire 2008). The stocking program continues to be conducted annually in efforts to rebuild the American shad population in the Susquehanna River (PFBC 2007b).

Other fish such as the smallmouth bass (*Micropterus dolomieu*) have also experienced a decline in their Susquehanna River populations. Damming of the river, bacterial infections, river pollution, and low dissolved oxygen levels are some of the known reasons for smallmouth bass decline (PFBC 2008b).

Twenty major electric power generating plants are located in the Susquehanna River Basin. Plants in the Lower Subbasin that withdraw cooling water from the Susquehanna River include Brunner Island, a three-unit, coal-fired, 1483-megawatt (MW) plant located 5 mi (8 km) south of Harrisburg (PPL 2008), and Peach Bottom Atomic Power Station, a two-unit, 2130-MW nuclear plant, located 18 mi (29 km) south of Lancaster (NRC 1996). PADEP and SRBC regulate these facilities with regard to their consumptive water use, NPDES-permitted discharges, and impact on aquatic resources in the Susquehanna River.

As discussed in Section 4.11.1 of this draft supplemental EIS, SRBC regulates consumptive water use at TMI-1 and at all facilities drawing water from the Susquehanna River. To ensure the water resources of the Susquehanna River Basin continue to meet the needs of the basin population, the SRBC coordinates with other State and Federal agencies and conducts extensive water resources monitoring, project review, water withdrawal registration, drought coordination, low-flow management (i.e., water storage), reservoir feasibility studies, and ground water management (SRBC 2007b).

The NRC staff concludes that the minimal aquatic impacts expected from the continued TMI-1 operations would not contribute to an overall decline in the condition of aquatic resources. However, the cumulative impacts on aquatic resources resulting from all past, present, and reasonably foreseeable future actions, including non-TMI-1 actions, will be SMALL to MODERATE.

4.11.3 Cumulative Impacts on Terrestrial Resources

This section addresses past, present, and future actions that could result in adverse cumulative impacts to terrestrial resources, including wildlife populations, upland habitats, wetlands, riparian zones, invasive species, protected species, and land use. For purposes of this analysis, the geographic area considered in the evaluation includes the TMI-1 site, the land owned by AmerGen along the eastern bank of the Susquehanna River, the wetlands on and in the vicinity of the TMI-1 site, and the in-scope transmission line ROWs identified in Section 2.1.5 of this report.

Before construction of the TMI-1 and TMI Unit 2 sites, terrestrial communities on Three Mile Island supported forest habitat, floodplain habitat, riparian areas, grasslands, and potential wetland habitat. Initial construction of the TMI-1 and TMI Unit 2 sites converted 200 ac (81 ha) of the island's 370 ac (150 ha) for plant facilities and industrial uses, which caused loss of terrestrial habitat (AmerGen 2008). A dike system was created during initial construction of the TMI-1 and TMI Unit 2 facilities, and a wetland habitat developed once the associated borrow pits began to fill with water (AmerGen 2008).

Construction of the transmission line ROWs maintained by FirstEnergy for the TMI-1 site resulted in subsequent changes to the plant species present within the ROWs. Because the length of in-scope transmission lines constructed for TMI-1 is relatively short (5.6 mi [9 km]), construction most likely did not affect wildlife in the vicinity of the lines. However, fragmentation resulting from the transmission line ROWs likely caused edge effects such as changes in light, wind, and temperature; an increased susceptibility to invasive species; and a possible reduction in habitat ranges for certain species. ROW maintenance has likely had past impacts and is likely to have present and future impacts on the terrestrial habitat, which may include the buildup of herbicide chemicals, prevention of natural succession stages, an increase in edge species, a decrease in interior species, and an increase in invasive species.

Neither AmerGen nor FirstEnergy manage invasive species on their land holdings; therefore, a potential exists for invasive species to be introduced on or in the vicinity of the TMI-1 site or its associated transmission line ROWs from present and future actions. Introduction of these species may contribute to the establishment of an invasive species population, which could compete with native populations for resources and degrade areas of terrestrial habitat.

As mentioned above, Brunner Island Power Plant is approximately 5 mi (8 km) south of TMI-1, and has three coal-fired units, totaling a 1,483-MW capacity (PPL 2008). Fossil plants release carbon dioxide, mercury, nitrogen oxides, and sulfur oxides, among other air emissions. Nitrogen oxides and sulfur oxides can combine with water to form acid rain, which can lead to erosion and changes in soil pH levels. Mercury can deposit on soils and surface water, and may then be taken up by plant or animal species, posing the risk of bioaccumulation. For these reasons, the Brunner Island Plant is likely to have current and future impacts to the terrestrial environment on the TMI-1 site and its surrounding area.

Two dams, the York Haven Hydroelectric Station, also known as Olympia Dam, and the Red Hill Dam, are both located less than 10 mi (16 km) from the TMI-1 project site. The Olympia Dam produces 19–20 megawatt electric (MWe) (AmerGen 2008). The Red Hill Dam does not produce electricity. Hydroelectric plants restrict the flow velocity of water downstream, which can lead to changes in downstream ecosystems. Because TMI-1 is located upstream of Olympia Dam, the plant is not likely to have cumulative impacts to the terrestrial environment on the TMI-1 site and its surrounding area.

Two wastewater treatment plants are located within 7 mi (11 km) of the TMI-1 site—the Borough of Middletown Wastewater Treatment Plant in Middletown, approximately 2 mi (3.2 km) north of the TMI-1 site, and the Fairview Sewerage Treatment Plant in New Cumberland, approximately 7 mi (11 km) north of the TMI-1 site. Both plants are on the Susquehanna River. Chemical discharges from these wastewater treatment plants that enter the Susquehanna River may have current and future impacts on the surrounding vegetation, wetlands, and wildlife.

Bioaccumulation of chemical discharges from these treatment plants also poses a threat to terrestrial and riparian habitats as well as to wildlife species.

Prior and continued residential, commercial, and industrial development of Dauphin, Lancaster, and York Counties may impact terrestrial habitat in the vicinity of TMI-1 and the associated transmission line ROWs. Increases in both commercial and residential development have occurred in these counties over the past 40 years. As this area continues to grow, additional runoff from roads and impervious surfaces, development adjacent to wetlands and riparian zones, and an increase in waste releases could have future impacts on the terrestrial habitat. Section 2.2.8.3 discusses offsite land use in the vicinity of TMI-1.

The NRC staff believes that the cumulative impacts during the term of license renewal on terrestrial habitat and associated species, when added to past, present, and reasonably foreseeable future actions, would be SMALL.

4.11.4 Cumulative Human Health Impacts

The NRC and EPA developed radiological dose limits for protection of the public and workers to address the cumulative impact of acute and long-term exposure to radiation and radioactive material. These dose limits are codified in 10 CFR Part 20 and 40 CFR Part 190. This analysis includes the area within a 50-mi (80-km) radius of the TMI-1 site. The REMP conducted by AmerGen in the vicinity of the TMI-1 site measures the cumulative impact of radiation and radioactive materials from all sources, including the shut-down and defueled TMI Unit 2; Peach Bottom Atomic Power Station, Units 2 and 3; and Peach Bottom Unit 1, which has been shut down since October 1974.

In addition to the Unit 1 operating reactor, Three Mile Island also contains the remains of the TMI Unit 2 facility that had an accident with a partial fuel meltdown in 1979. TMI Unit 2 is permanently shut down and defueled. The damaged fuel and core debris was shipped offsite to a DOE facility. The facility has been in a monitored storage mode since December 1993 and will remain in that condition until the operating license for TMI-1 expires, at which time both plants will be decommissioned.

Even though TMI Unit 2 is defueled and in a monitored storage mode, there are still some controlled radioactive effluent discharges resulting from maintenance and cleanup activities. These radioactive discharges are a very small fraction of the radioactivity released from TMI-1. The calculated radiation doses to members of the public from all radioactive material released from the TMI-1 site are well within NRC's radiation safety limits. In addition to the radioactive effluent information, the staff reviewed the TMI-1 annual radiological environmental monitoring report. This report summarizes the results of environmental monitoring conducted in the environs around the TMI-1 site to determine the environmental impact from the radioactive releases from the entire TMI-1 site. No unusual trends or significant radiation levels were detected in the environment from the two units located on Three Mile Island.

Peach Bottom Atomic Power Station has two active nuclear reactor units (Units 2 and 3). Each unit includes a light-water boiling reactor and a steam-driven turbine generator. The facility's core power output from the two units is 3,458 megawatt-thermal (MWt). In addition to the operating units, the site also contains the shut-down Peach Bottom Atomic Power Station Unit

1. Unit 1 was a prototype, high-temperature, gas-cooled reactor that had a net electrical output of 40 MWe (115 MWt) and operated from 1966–1974. Since then it has been maintained in a storage mode. As part of normal operations, Peach Bottom Atomic Power Station, Units 2 and 3, release radioactive effluents, contributing to the cumulative dose impacts to members of the public and the environment.

As discussed in Section 4.8.1 of this report, the staff reviewed the radiological environmental radiation monitoring results for the five-year period from 2003–2007 as part of the cumulative impacts assessment. Cumulative radiological impacts from all uranium fuel cycle facilities, including those discussed above, within a 50-mi (80-km) radius of the TMI-1 site, are limited by the dose limits codified in 10 CFR Part 20 and 40 CFR Part 190. In Section 4.8 of this report, the NRC staff concluded that the impacts of radiation exposure from the operation of TMI-1 during the renewal term to the public would be SMALL. The NRC and the Commonwealth of Pennsylvania will regulate any future actions in the vicinity of the TMI-1 site that could contribute to cumulative radiological impacts.

The continued operation of TMI-1 has a low risk of causing outbreaks from thermophilic microbiological organisms associated with thermal discharges. Available data assembled by the CDC for the years 1999 to 2004 (CDC 2001, 2002, 2002a, 2003, 2003a, 2004, 2005, 2006, 2007b) report no occurrence of waterborne disease outbreaks in the Commonwealth of Pennsylvania resulting from thermophilic microorganisms *Naegleria fowleri* and *Pseudomonas aeruginosa* from the operation of TMI-1. Outbreaks of legionellosis, samonellosis, or shigellosis that occurred in the Commonwealth of Pennsylvania were within the range of national trends in terms of cases per 100,000 population or total cases per year, and the outbreaks were associated with hotel pools and spas (CDC 2001, 2002, 2002a, 2003, 2003a, 2004, 2005, 2006, 2007b).

As part of its evaluation of cumulative impacts, the NRC staff also considered the effects of thermal discharges from other facilities on the Susquehanna River located within one mile upstream of TMI-1 that are also producing thermal effluents. Such facilities could promote the growth of thermophilic microbiological organisms. The NRC staff did not find any such facilities.

On the basis of these considerations, the NRC staff determined that the cumulative impacts to public health from thermophillic microbiological organisms resulting from operation of the TMI-1 thermal discharge to the aquatic environment or in the vicinity of the site would be SMALL.

The staff determined that the electric field-induced currents from the TMI-1 transmission lines are well below the NESC recommendations for preventing electric shock from induced currents. Therefore, the TMI-1 transmission lines do not detectably affect the overall potential for electric shock from induced currents within the analysis area. With respect to the chronic effects of electromagnetic fields, although the GEIS finding of “not applicable” is appropriate to TMI-1, the transmission lines associated with TMI-1 are not likely to detectably contribute to the regional exposure to extremely low frequency electromagnetic fields. Therefore, the staff has determined that the cumulative impacts of the continued operation of the TMI-1 transmission lines would be SMALL.

4.11.5 Cumulative Socioeconomic Impacts

As discussed in Section 4.9 of this draft supplemental EIS, continued operation of TMI-1 during the license renewal term would have no impact on socioeconomic conditions in the region beyond those already being experienced. Since AmerGen has indicated that no additional workers would be hired during the license renewal term, overall expenditures and employment levels at TMI-1 would be expected to remain relatively constant with no additional demand for permanent housing, public utilities, and public services. In addition, since employment levels and the value of TMI-1 would not change, there would be no population and tax revenue-related land use impacts. There would also be no disproportionately high and adverse health and environmental impacts on minority and low-income populations in the region. Based on this and other information presented in this draft supplemental EIS, there would be no cumulative socioeconomic impacts from the continued operation of TMI-1 during the license renewal term beyond those already being experienced.

However, AmerGen indicated in their environmental report that TMI-1 steam generators would be replaced prior to the license renewal term. AmerGen estimates that steam generator replacement would require a one-time increase in the number of refueling outage workers for up to 70 days at TMI-1 (AmerGen 2008). These additional workers would create a one-time short-term increase in the demand for temporary (rental) housing, increase use of public water and sewer services, and transportation impacts on access roads in the immediate vicinity of TMI-1. Given the short amount of time needed to replace the steam generators, the additional number of refueling outage workers and truck material deliveries needed to support this one-time replacement of the TMI-1 steam generators could have a temporary cumulative effect on socioeconomic conditions in the vicinity of TMI-1. However, there would be no long-term cumulative socioeconomic impacts from TMI-1 steam generator replacement in the region.

As discussed in Section 4.9.6, continued operation of TMI-1 during the license renewal term would have a SMALL impact on historic and archaeological resources. AmerGen has no plans to construct additional facilities at TMI-1 related to license renewal. Any land disturbing activities would be carried out under AmerGen's corporate procedures that ensure the protection of cultural resources (AmerGen 2008). AmerGen does not anticipate any changes or additions to transmission line structures. Additionally, AmerGen plans to revise its procedures to provide clear guidance regarding consideration of potential impacts on historic and archaeological resources. This revision includes a "stop work" provision when cultural resources are inadvertently discovered (AmerGen 2008). Since AmerGen has committed to issue revised procedures, no additional adverse impacts to historic and archaeological resources are expected during the license renewal term. However, as noted in Section 4.9.6, there is the potential for prehistoric and historic archaeological resources to be present at TMI-1. Should project plans change, then further mitigation and consultation would be initiated by AmerGen with the PHMC. Based on this and other information presented in the SEIS, the staff finds that there would be no cumulative historic and archaeological impacts from the continued operation of TMI-1 during the license renewal term beyond those that have already occurred.

AmerGen has indicated that it plans to replace TMI-1 steam generators prior to the license renewal term. Construction, decontamination, and laydown activities would be less than 10 ac (4 ha) and would be limited to previously disturbed areas (AmerGen 2008). AmerGen has consulted with the PHMC regarding this activity. The PHMC stated that the project would have no effect on historic and archaeological resources, however, should additional grounddisturbing activities occur, then further consultation with the PHMC would be required (AmerGen 2008).

4.11.6 Summary of Cumulative Impacts

We considered the potential impacts resulting from operation of TMI-1 during the period of extended operation and other past, present, and future actions in the vicinity of TMI-1. The preliminary determination is that the potential cumulative impacts resulting from TMI-1 operation during the period of extended operation would be SMALL to MODERATE.

Table 4-11. Summary of Cumulative Impacts on Resources Areas.

Resource Area	Impact	Discussion
Water Resources	SMALL	Impacts to water resources in the subbasin include increases in land development, overuse of ground water resources, unregulated use of ground water resources, drought impacts, and the need for flow compensation for consumptive water users. The SRBC regulates, monitors, and enforces withdrawals of ground water and surface water in the subbasin, and manages the subbasin's water resources. Continued operation of TMI-1 would have small cumulative impacts to water resources if compliance with SRBC regulations and participation in their water storage project is maintained.
Aquatic Resources	SMALL to MODERATE	Impacts to aquatic resources from continued operation of TMI-1 would have small cumulative impacts. Past impacts to Susquehanna River water quality have impacted aquatic resources; and continued impacts from agriculture, livestock production, and development will continue to impact aquatic resources. Regulation of point-source discharges by PADEP and of subbasin water use by the SRBC will continue to mitigate impacts. Continued operation and potential future uprates to dams on the Susquehanna River will also impact aquatic resources.
Terrestrial Resources	SMALL	ROW maintenance, emissions from the Bruner Island coal-fired power plant, invasive species, chemical discharges from nearby wastewater treatment plants, and development of Dauphin, Lancaster, and York Counties have all impacted terrestrial habitat and species in the vicinity of TMI-1, and would likely continue in the future.

Human Health	SMALL	The cumulative human health impacts of continued operation of TMI-1 from radiation exposure to the public, microbiological organisms from thermal discharge to the Susquehanna River, and electric-field-induced currents from the TMI-1 transmission lines would all be small.
Socioeconomics	N/A	There would be no cumulative impacts to socioeconomics during the license renewal period, and no long-term cumulative impacts from refurbishment. There would be no cumulative impacts to historic and archaeological resources during the license renewal period, including refurbishment, beyond those that have already occurred.

4.12 References

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10 CFR 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 61. *Code of Federal Regulations*, Title 10, *Energ*y, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

10 CFR Part 71. *Code of Federal Regulations*, Title 10, *Energy*, Part 71, "Packaging and Transportation of Radioactive Material."

36 CFR Part 60. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 60, Section 4, "Criteria for Evaluation."

36 CFR 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

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5.0 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

This chapter describes the environmental impacts from postulated accidents that might occur during the period of extended operation. The term "accident" refers to any unintentional event outside the normal plant operational envelope that results in a release or the potential for release of radioactive materials into the environment. Two classes of postulated accidents are evaluated in the GEIS and are listed in Table 5-1 below. These are design-basis accidents (DBAs) and severe accidents.

Table 5-1. Issues Related to Postulated Accidents. *Two issues related to postulated accidents are evaluated under NEPA in the license renewal review, design-basis accidents and severe accidents.*

Issues	GEIS Section	Category
Design-basis accidents	5.3.2; 5.5.1	1
Severe accidents	5.3.3; 5.3.3.2; 5.3.3.3; 5.3.3.4; 5.3.3.5; 5.4; 5.5.2	2

5.1 Design Basis Accidents

In order to receive NRC approval to operate a nuclear power facility, an applicant for an initial operating license must submit a safety analysis report (SAR) as part of its application. The SAR presents the design criteria and design information for the proposed reactor and comprehensive data on the proposed site. The SAR also discusses various hypothetical accident situations and the safety features that are provided to prevent and mitigate accidents. The NRC staff reviews the application to determine whether the plant design meets the Commission's regulations and requirements and includes, in part, the nuclear plant design and its anticipated response to an accident.

DBAs are those accidents that both the licensee and the NRC staff evaluate to ensure that the plant can withstand normal and abnormal transients, and a broad spectrum of postulated accidents, without undue hazard to the health and safety of the public. A number of these postulated accidents are not expected to occur during the life of the plant, but are evaluated to establish the design basis for the preventive and mitigative safety systems of the facility. The acceptance criteria for DBAs are described in 10 CFR 50 and 10 CFR 100.

The environmental impacts of DBAs are evaluated during the initial licensing process, and the ability of the plant to withstand these accidents is demonstrated to be acceptable before issuance of the operating license. The results of these evaluations are found in license documentation such as the applicant's final safety analysis report (FSAR), the safety evaluation report (SER), the final environmental statement (FES), and Section 5.1 of this draft supplemental environmental impact statement (EIS). A licensee is required to maintain the acceptable design and performance criteria throughout the life of the plant, including any extended-life operation. The consequences for these events are evaluated for the hypothetical maximum exposed individual; as such, changes in the plant environment will not affect these evaluations. Because of the requirements that continuous acceptability of the consequences and aging management programs be in effect for the period of extended operation, the environmental impacts as calculated for DBAs should not differ significantly from initial licensing assessments over the life of the plant, including the period of extended operation. Accordingly, the design of the plant relative to DBAs during the period of extended operation is considered to remain acceptable and the environmental impacts of those accidents were not examined further in the GEIS.

The Commission has determined that the environmental impacts of DBAs are of SMALL significance for all plants because the plants were designed to successfully withstand these accidents. Therefore, for the purposes of license renewal, design-basis accidents are designated as a Category 1 issue. The early resolution of the DBAs makes them a part of the current licensing basis of the plant; the current licensing basis of the plant is to be maintained by the licensee under its current license and, therefore, under the provisions of 10 CFR 54.30, is not subject to review under license renewal.

No new and significant information related to design-basis accidents was identified during the review of AmerGen's environmental report (ER) (AmerGen 2008a), site audit, scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS.

5.2 Severe Accidents

Severe nuclear accidents are those that are more severe than DBAs because they could result in substantial damage to the reactor core, whether or not there are serious offsite consequences. In the GEIS, the staff assessed the impacts of severe accidents during the license renewal period, using the results of existing analyses and site-specific information to conservatively predict the environmental impacts of severe accidents for each plant during the renewal period.

Severe accidents initiated by external phenomena such as tornadoes, floods, earthquakes, fires, and sabotage have not traditionally been discussed in quantitative terms in FESs and were not specifically considered for the Three Mile Island Nuclear Station, Unit 1 (TMI-1) site in the GEIS (NRC 1996). However, the GEIS did evaluate existing impact assessments performed by NRC and by the industry at 44 nuclear plants in the United States and concluded that the risk from beyond design basis earthquakes at existing nuclear power plants is SMALL. The GEIS for license renewal performed a discretionary analysis of terrorist acts in connection with license renewal, and concluded that the core damage and radiological release from such acts would be no worse than the damage and release expected from internally initiated events. In the GEIS, the Commission concludes that the risk from sabotage and beyond design-basis earthquakes at existing nuclear power plants is small and additionally, that the risks from other external events are adequately addressed by a generic consideration of internally initiated severe accidents (NRC 1996).

Based on information in the GEIS, the Commission found that

> The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to

mitigate severe accidents must be considered for all plants that have not considered such alternatives.

We identified no new and significant information related to postulated accidents during the review of AmerGen's environmental report (AmerGen 2008a), the site audit, the scoping process, or evaluation of other available information. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. However, in accordance with 10 CFR 51.53(c)(3)(ii)(L), we have reviewed severe accident mitigation alternatives (SAMAs) for TMI-1. The results of the review are discussed in Section 5.3.

5.3 Severe Accident Mitigation Alternatives

Section 51.53(c)(3)(ii)(L) requires that license renewal applicants consider alternatives to mitigate severe accidents if the staff has not previously evaluated SAMAs for the applicant's plant in an EIS or related supplement or in an environmental assessment. The purpose of this consideration is to ensure that plant changes (i.e., hardware, procedures, and training) with the potential for improving severe accident safety performance are identified and evaluated. SAMAs have not been previously considered for TMI-1; therefore, the remainder of Chapter 5 addresses those alternatives.

5.3.1 Introduction

This section presents a summary of the SAMA evaluation for TMI-1 conducted by AmerGen Energy Company, LLC (AmerGen) and the NRC staff's review of that evaluation. The NRC staff performed its review with contract assistance from Pacific Northwest National Laboratory. The NRC staff's review is available in full in Appendix F; the SAMA evaluation is available in full in AmerGen's ER.

The SAMA evaluation for TMI-1 was conducted with a four step approach. In the first step AmerGen quantified the level of risk associated with potential reactor accidents using the plant specific probabilistic risk assessment (PRA) and other risk models.

In the second step AmerGen examined the major risk contributors and identified possible ways (SAMAs) of reducing that risk. Common ways of reducing risk are changes to components, systems, procedures, and training. AmerGen identified 33 potential SAMAs for TMI-1. AmerGen performed an initial screening to determine if any SAMAs could be eliminated because they are not applicable to TMI-1 due to design differences, or have estimated implementation costs that would exceed the dollar value associated with completely eliminating all severe accident risk at TMI. No SAMAs were eliminated based on this screening, leaving all 33 for further evaluation.

In the third step AmerGen estimated the benefits and the costs associated with each of the SAMAs. Estimates were made of how much each SAMA could reduce risk. Those estimates were developed in terms of dollars in accordance with NRC guidance for performing regulatory analyses (NRC 1997). The cost of implementing the proposed SAMAs was also estimated.

Finally, in the fourth step, the costs and benefits of each of the remaining SAMAs were compared to determine whether the SAMA was cost beneficial, meaning the benefits of the

SAMA were greater than the cost (a positive cost benefit). AmerGen concluded in its ER that several of the SAMAs evaluated are potentially cost-beneficial (AmerGen 2008a). However, in response to NRC staff inquiries regarding estimated benefits for certain SAMAs and lower cost alternatives, several additional potentially cost-beneficial SAMAs were identified (AmerGen 2008b).

The potentially cost-beneficial SAMAs do not relate to adequately managing the effects of aging during the period of extended operation; therefore, they need not be implemented as part of license renewal pursuant to 10 CFR Part 54. AmerGen's SAMA analyses and the NRC's review are discussed in more detail below.

5.3.2 Estimate of Risk

AmerGen submitted an assessment of SAMAs for TMI-1 as part of the ER (AmerGen 2008a). This assessment was based on the most recent TMI-1 PRA available at that time, a plant specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer program, and insights from the TMI-1 Individual Plant Examination (IPE) (GPU 1993) and Individual Plant Examination of External Events (IPEEE) (GPU 1994).

The scope of the Level 1 PRA model includes both internal and external initiating events. The external events evaluated are external floods, seismic events, and internal fires. However, the external events models are not integrated with the internal events model, thereby necessitating a separate assessment of the risk (and risk reduction) for internal and external events. AmerGen placed particular emphasis on external flooding events since they dominate the calculated risk at TMI-1.

The baseline CDF for the purpose of the SAMA evaluation is approximately 2.37×10^{-5} per year for internal events (including internal flooding events), and 8.11×10^{-5} per year for external flooding events. AmerGen accounted for the potential risk reduction benefits associated with internal event- and external flooding-related SAMAs by separately quantifying the benefits using the internal event or external flooding model, respectively. For internal event-related SAMAs, AmerGen accounted for the potential risk reduction benefits associated with non-flooding external events (i.e., seismic and fire events) by doubling the estimated benefits for internal events. For seismic- and fire-related SAMAs, AmerGen separately estimated the risk reduction benefits using the seismic and fire risk models. The breakdown of CDF by initiating event for TMI-1 is provided in Tables 5-1 and 5-2 for internal events and external flooding events, respectively.

Table 5-2. TMI-1 Internal Events Core Damage Frequency

Initiating Event	CDF (Per Year)	% Contribution to CDF
Loss of Offsite Power	7.73×10^{-6}	32.6
Transients	5.80×10^{-6}	24.5
Small and Very Small LOCA	4.66×10^{-6}	19.7
Loss of Nuclear Service River Water	3.67×10^{-6}	15.5
Steam Generator Tube Rupture	9.93×10^{-7}	4.2
Internal Floods	4.50×10^{-7}	1.9
Large and Medium LOCA	2.06×10^{-7}	< 1
ISLOCA	1.80×10^{-7}	<1
Total CDF (internal events)	$\mathbf{2.37 \times 10^{-5}}$	**100**

Table 5-3 TMI-1 External Flooding Events Core Damage Frequency

External Flooding Event	CDF (Per Year)	% Contribution to CDF
>310 feet	6.37×10^{-5}	78.5
305 to 310 feet	1.71×10^{-5}	21.1
<305 feet	2.50×10^{-7}	< 1
Total	$\mathbf{8.11 \times 10^{-5}}$	**100**

As shown in these tables, internal event CDF is dominated by loss of offsite power events, transients, small loss of coolant accidents (LOCA), and loss of nuclear service water events. External flooding CDF is dominated by events with flood levels exceeding 305 feet mean sea level (msl).

AmerGen estimated the dose to the population within 50 miles (80 kilometers) of the TMI-1 site to be approximately 0.323 person-sievert (Sv) (32.3 person-rem) per year (AmerGen 2008a) for internal events and 1.76 person-Sv (176 person-rem) per year for external flooding events (AmerGen 2008b). The breakdown of the total population dose by containment release mode is summarized in Table 5-3. Steam generator tube rupture (SGTR) accidents, and basemat melt-through are the dominant contributors to population dose risk from internal events. For external flooding events, late containment failures and early containment failure (less than 12 hours following accident initiation) are the dominant contributors to population dose risk.

Table 5-4. Breakdown of Population Dose by Containment Release Mode

	Internal Events		External Flooding Events	
Containment Release Mode	**Population Dose (Person-Rem Per Year)**	**% Contribution**	**Population Dose (Person-Rem Per Year)**	**% Contribution**
Steam generator tube rupture	11.7	36	0.1	<0.1
Interfacing system LOCA	1.0	3	negligible	0
Containment isolation failure	1.1	3	29	16
Early containment failure	5.6	17	61	35
Late containment failure (large)	0.3	1	15	9
Late containment failure (small)	1.7	5	66	37
Basemat melt-through	6.9	22	4	2
No containment failure	4.0	13	1	1
Total	**32.3**	**100**	**176**	**100**

[1]One person-Rem = 0.01 person-Sv

The NRC staff has reviewed AmerGen's data and evaluation methods and concludes that the quality of the risk analyses is adequate to support an assessment of the risk reduction potential for candidate SAMAs. Accordingly, the staff based its assessment of offsite risk on the CDFs and offsite doses reported by AmerGen.

5.3.3 Potential Plant Improvements

Once the dominant contributors to plant risk were identified, AmerGen searched for ways to reduce that risk. In identifying and evaluating potential SAMAs, AmerGen considered insights from the plant-specific PRA, and SAMA analyses performed for other operating plants that have submitted license renewal applications. This search included reviewing insights from the plant-specific risk studies, and reviewing plant improvements considered in previous SAMA analyses. AmerGen identified 33 potential risk-reducing improvements (SAMAs) to plant components, systems, procedures and training. A detailed cost-benefit analysis was performed for each of the SAMAs.

The staff concludes that AmerGen used a systematic and comprehensive process for identifying potential plant improvements for TMI-1, and that the set of potential plant improvements identified by AmerGen is reasonably comprehensive and, therefore, acceptable.

5.3.4 Evaluation of Risk Reduction and Costs of Improvements

AmerGen evaluated the risk reduction potential of the candidate SAMAs. The SAMA evaluations were performed using realistic assumptions with some conservatism.

AmerGen estimated the costs of implementing the candidate SAMAs through the application of engineering judgment and the use of other licensee's estimates for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they account for inflation.

The staff reviewed AmerGen's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the staff based its estimates of averted risk for the various SAMAs on AmerGen's risk reduction estimates.

The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. The staff found the cost estimates to be reasonable, and generally consistent with estimates provided in support of other plants' analyses.

The staff concludes that the risk reduction and the cost estimates provided by AmerGen are sufficient and appropriate for use in the SAMA evaluation.

5.3.5 Cost-Benefit Comparison

The cost benefit analysis performed by AmerGen was based primarily on NUREG/BR 0184 (NRC 1997) and was executed consistent with this guidance. NUREG/BR-0058 has recently been revised to reflect the agency's revised policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed - one at 3 percent and one at 7 percent (NRC 2004). AmerGen performed the SAMA analysis using only a 3 percent discount rate (AmerGen 2008a) and based its decisions on potentially cost-beneficial SAMAs on these values. Use of only a 3 percent discount rate in the cost-benefit analysis is considered acceptable for the purposes of the SAMA evaluation since it would tend to result in identification of a greater number of potentially cost-beneficial SAMAs.

AmerGen identified nine potentially cost-beneficial SAMAs in the baseline analysis contained in the ER. The potentially cost-beneficial SAMAs are:

SAMA 8 – Automate reactor coolant pump trip on high motor bearing cooling temperature.

SAMA 11 – Enhance extreme external flooding mitigation equipment to address station blackout and loss of reactor coolant pump seal cooling scenarios.

SAMA 12 – Use the decay heat removal system as an alternate suction source for high pressure injection.

SAMA 16 – Automate high pressure injection on low pressurizer level.

SAMA 19 – Install battery backed hydrogen igniters or a passive hydrogen ignition system.

SAMA 21 – Install concrete shields to block direct pathways from the reactor pressure vessel to the containment wall and/or direct containment flooding early in external flooding scenarios.

SAMA 27 – Improve the 480V AC load center welds.

SAMA 32 – Pre-stage severe external flooding equipment.

SAMA 33 – Increase the flood protection height.

AmerGen performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment (AmerGen 2008a). If the benefits are increased by a factor of 2.75 to account for uncertainties, six additional SAMA candidates were determined to be potentially cost-beneficial:

SAMA 2 – Install damage-resistant high temperature reactor coolant pump seals with a portable 480V AC generator for extended emergency feedwater (EFW) operation.

SAMA 7 – Use fire service water as an alternate cooling source for the intermediate closed cooling water heat exchangers.

SAMA 15 – Automate swap to recirculation mode.

SAMA 23 – Develop alarm response procedures to direct operation of RR-V-5 on low reactor building emergency cooling flow.

SAMA 24 – Install damage-resistant high temperature reactor coolant pump seals with a diesel engine as an alternate drive for an EFW pump and a portable 480V AC generator for extended EFW operation.

SAMA 26 – Reroute cables so that they do not pass over ignition sources in fire zone CB-FA-2e or wrap them in fire proof material.

As a result of an additional sensitivity analysis and response to an NRC staff request, AmerGen identified two additional potentially cost-beneficial SAMAs (AmerGen 2008b):

SAMA 10 – Automate borated water storage tank refill.

SAMA 13 – Change instrument air system logic to automatically start IA-P-1A/B

The staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the SAMAs evaluated would be higher than the associated benefits.

5.3.6 Conclusions

The staff reviewed AmerGen's analysis and concluded that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by AmerGen are reasonable and sufficient for the license renewal submittal.

Based on its review of the SAMA analysis, the staff concurs with AmerGen's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of all or a subset of potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the staff considers that further evaluation of these SAMAs by AmerGen is warranted. However, none of the potentially cost-beneficial SAMAs relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of the license renewal pursuant to 10 CFR Part 54.

5.4 References

AmerGen (AmerGen Energy Company, LLC). 2008a. "Three Mile Island Nuclear Station, Applicant's Environmental Report, License Renewal Operating Stage." Kennett Square, Pennsylvania. ADAMS Accession Nos. ML080220255, ML080220257, ML080220261, and ML080220282.

AmerGen (AmerGen Energy Company, LLC). 2008b. Letter from Michael P. Gallagher, AmerGen Energy Company, LLC, to U.S. Nuclear Regulatory Commission Document Control Desk. Subject: "Response to NRC Request for Additional Information Related to Three Mile Island Nuclear Station 1 License Renewal Application (TAC No. MD7702)," dated July 17, 2008.

GPU (GPU Nuclear Corporation). 1993. Letter from T. G. Broughton, GPU, to U.S. NRC. Subject: Three Mile Island Nuclear Generation Station, Unit 1 (TMI-1), Operating License No. DPR-50, Docket No. 50-289, Response to Generic Letter 88-20, "Individual Plan Examinations for Severe Accident Vulnerabilities (IPE)". May 20, 1993.

GPU (GPU Nuclear Corporation). 1994. Letter from R. W. Keaten, GPU, to U.S. NRC. Subject: Three Mile Island Nuclear Generation Station, Unit 1 (TMI-1), Operating License No. DPR-50, Docket No. 50-289, Response to Generic Letter 88-20, Supplement 4, "Individual Plan Examination of External Events (IPEEE) for Severe Accident Vulnerabilities". December 29, 1994.

NRC (U.S. Nuclear Regulatory Commission). 1997. *Regulatory Analysis Technical Evaluation Handbook.* NUREG/BR 0184, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 2004. *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission.* NUREG/BR-0058, Rev. 4, Washington, D.C.

6.0 ENVIRONMENTAL IMPACTS OF THE URANIUM FUEL CYCLE AND SOLID WASTE MANAGEMENT

This chapter addresses issues related to the uranium fuel cycle and solid waste management during the period of extended operation. The uranium cycle includes uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level wastes and high-level wastes related to uranium fuel cycle activities. The generic environmental impact statement (GEIS) (NRC 1996, 1999) details the potential generic impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes, as listed in Table 6-1 below. The GEIS is based, in part, on the generic impacts provided in Table S-3, "Table of Uranium Fuel Cycle Environmental Data," in Title 10, Section 51.51(b), of the Code of Federal Regulations (10 CFR 51.51(b)), and in Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor," in 10 CFR 51.52(c). The GEIS also addresses the impacts from radon-222 and technetium-99.

The staff of the U.S. Nuclear Regulatory Commission (NRC) did not identify any new and significant information related to the uranium fuel cycle during the review of the AmerGen Energy Company, LLC environmental report (AmerGen 2008), the site audit, and the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS. For these Category 1 issues, the GEIS concludes that the impacts are SMALL, except for the collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.

Table 6-1. Issues Related to the Uranium Fuel Cycle and Solid Waste Management. *Nine generic issues are related to the fuel cycle and solid waste management. There are no site-specific issues.*

Issues	GEIS Section	Category
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste)	6.1, 6.2.1, 6.2.2.1, 6.2.2.3, 6.2.3, 6.2.4, 6.6	1
Offsite radiological impacts (collective effects)	6.1, 6.2.2.1, 6.2.3, 6.2.4, 6.6	1
Offsite radiological impacts (spent fuel and high-level waste disposal)	6.1, 6.2.2.1, 6.2.3, 6.2.4, 6.6	1
Nonradiological impacts of the uranium fuel cycle	6.1, 6.2.2.6, 6.2.2.7, 6.2.2.8, 6.2.2.9, 6.2.3, 6.2.4, 6.6	1
Low-level waste storage and disposal	6.1, 6.2.2.2, 6.4.2, 6.4.3, 6.4.3.1, 6.4.3.2, 6.4.3.3, 6.4.4,	1

Issues	GEIS Section	Category
	6.4.4.1, 6.4.4.2, 6.4.4.3, 6.4.4.4, 6.4.4.5, 6.4.4.5.1, 6.4.4.5.2, 6.4.4.5.3, 6.4.4.5.4, 6.4.4.6, 6.6	
Mixed waste storage and disposal	6.4.5.1, 6.4.5.2, 6.4.5.3, 6.4.5.4, 6.4.5.5, 6.4.5.6, 6.4.5.6.1, 6.4.5.6.2, 6.4.5.6.3, 6.4.5.6.4, 6.6	1
Onsite spent fuel	6.1, 6.4.6, 6.4.6.1, 6.4.6.2, 6.4.6.3, 6.4.6.4, 6.4.6.5, 6.4.6.6, 6.4.6.7, 6.6	1
Nonradiological waste	6.1, 6.5, 6.5.1, 6.5.2, 6.5.3, 6.6	1
Transportation	6.1, 6.3.1, 6.3.2.3, 6.3.3, 6.3.4, 6.6, Addendum 1	1

6.1 References

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants."

AmerGen (AmerGen Energy Company, LLC). 2008. "Three Mile Island Nuclear Station, Applicant's Environmental Report, License Renewal Operating Stage." Kennett Square, Pennsylvania. ADAMS Nos. ML080220255, ML080220257, ML080220261, and ML080220282.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* NUREG-1437, Volumes 1 and 2. Washington, D.C. ADAMS No. ML061770605.

NRC (U.S. Nuclear Regulatory Commission). 1999. G*eneric Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, Section 6.3, "Transportation," Table 9.1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1. Washington, D.C.

7.0 ENVIRONMENTAL IMPACTS OF DECOMMISSIONING

Decommissioning is defined as the safe removal of a nuclear facility from service and the reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. The U.S. Nuclear Regulatory Commission (NRC) issued a generic environmental impact statement (GEIS) for decommissioning (NRC 2002) that evaluated the environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license.

The NRC staff has not identified any new and significant information during the review of the AmerGen Energy Company, LLC environmental report (AmerGen 2008), the site audit, or the scoping process. Therefore, there are no impacts related to these issues beyond those discussed in the GEIS (NRC 1996, 1999). For the issues listed in table 7-1 below, the GEIS concluded that the impacts are SMALL.

Table 7-1. Issues Related Decommissioning. *Decommissioning would occur regardless of whether Three Mile Island Nuclear Station, Unit 1, is shut down at the end of its currect operating license or at the end of the period of extended operation. There are no site-specific issues related to decommissioning.*

Issues	GEIS Section	Category
Radiation doses	7.3.1; 7.4	1
Waste management	7.3.2; 7.4	1
Air quality	7.3.3; 7.4	1
Water quality	7.3.4; 7.4	1
Ecological resources	7.3.5; 7.4	1
Socioeconomic impacts	7.3.7; 7.4	1

7.1 References

AmerGen (AmerGen Energy Company, LLC). 2008. *Three Mile Island Nuclear Station, Applicant's Environmental Report, License Renewal Operating Stage.* Kennett Square, Pennsylvania. ADAMS Accession Nos. ML080220255, ML080220257, ML080220261, and ML080220282.

NRC (U.S. Nuclear Regulatory Commission). 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* NUREG-1437, Vols. 1 and 2. Washington, D.C. ADAMS No. ML061770605.

NRC (U.S. Nuclear Regulatory Commission). 1999. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3, Transportation, Table 9.1, Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants, Final Report." NUREG-1437, Volume 1, Addendum 1. Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission). 2002. *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*: Supplement 1, *Regarding the Decommissioning of Nuclear Power Reactors*. NUREG-0586, Supplement 1, Volumes 1 and 2. Washington, D.C.

8.0 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

The National Environmental Policy Act (NEPA) mandates that each environmental impact statement (EIS) consider alternatives to any proposed major Federal action. NRC regulations implementing NEPA for license renewal require that a supplemental EIS "consider and weigh the environmental effects of the proposed action [license renewal]; the environmental impacts of alternatives to the proposed action; and alternatives available for reducing or avoiding adverse environmental impacts," (10 CFR 51.71[d]). In this case, the proposed Federal action is issuing a renewed license for Three Mile Island Nuclear Station, Unit 1 (TMI-1), which will allow the plant to operate for 20 years beyond its current license expiration date. In this chapter, we examine the potential environmental impacts of alternatives to issuing a renewed operating license for TMI-1.

While NUREG-1437 "Generic Environmental Impact Statement for License Renewal of Nuclear Plants", (GEIS; NRC 1996, 1999), reached generic conclusions regarding many environmental issues associated with license renewal, it did not determine which alternatives are reasonable or reach conclusions about site-specific environmental impact levels. As such, NRC staff must evaluate environmental impacts of alternatives on a site-specific basis.

Alternatives to the proposed action of issuing a renewed TMI-1 operating license must meet the purpose and need for issuing a renewed license; they must

> "provide an option that allows for power generation capability beyond the term of a current nuclear power plant operating license to meet future system generating needs, as such needs may be determined by State, utility, and, where authorized, Federal (other than NRC) decisionmakers."

The NRC staff ultimately makes no decision as to which alternative (or the proposed action) to implement, since that decision falls to utility, State, or other Federal officials to decide. Comparing the environmental effects of these alternatives will assist the NRC in deciding whether the environmental impacts of license renewal are so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable (10 CFR 51.95[c][4]). If the NRC acts to issue a renewed license, all of the alternatives, including the proposed action, will be available to energy-planning decisionmakers. If the NRC decides not to renew the license (or takes no action at all), then energy-planning decisionmakers may no longer elect to continue operating TMI-1 and will have to resort to another alternative—which may or may not be one of the alternatives the NRC considers in this section—to meet their energy needs.

In evaluating alternatives to license renewal, we first select energy technologies or options currently in commercial operation, as well as some technologies not currently in commercial operation but likely to be commercially available by the time the current TMI-1 operating license expires.

Second, we screen the alternatives to remove those that cannot meet future system needs. Then, we screen the remaining options to remove those whose costs or benefits don't justify inclusion in the range of reasonable alternatives. Any alternatives remaining constitute alternatives to the proposed action that the NRC evaluates in-depth throughout this section. At the end of the section, we will briefly address each alternative that we removed during screening.

In-Depth Alternatives

- **Coal-fired Supercritical**
- **Natural-gas-fired Combined-cycle**
- **Conservation / Energy Efficiency**
- **Combination Alternative**
- **Purchased Power**

Other Alternatives Considered

- **Coal-fired IGCC**
- **Wind Power**
- **Solar Power (photovoltaic and concentrating)**
- **Wood Waste**
- **Conventional Hydroelectric Power**
- **Wave and Ocean Energy**
- **Geothermal Power**
- **Municipal Solid Waste**
- **Biofuels**
- **Oil-fired Power**
- **Fuel Cells**
- **Delayed Retirement**

The NRC staff initially considered 17 discrete potential alternatives to the proposed action, and narrowed the list to the four discrete alternatives and one combination alternative, which are considered in Sections 8.1 through 8.5.

Once we identify the in-depth alternatives, the staff refer to generic environmental impact evaluations in the GEIS. The GEIS provides overviews of some energy technologies available at the time of its publishing in 1996, though it does not reach any conclusions regarding which alternatives are most appropriate, nor does it precisely categorize impacts for each site. Since 1996, many energy technologies have evolved significantly in capability and cost, while regulatory structures have changed to either promote or impede development of particular alternatives.

Where applicable, our analyses draw on the GEIS and include updated information from sources like the Energy Information Administration (EIA), other organizations within the Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), industry sources and publications, and information submitted by the applicant (AmerGen Energy Company, LLC [AmerGen]) in the Environmental Report (ER).

For each in-depth analysis, we analyze environmental impacts across seven impact categories: (1) air quality, (2) ground water use and quality, (3) surface water use and quality, (4) ecology, (5) human health, (6) socioeconomics, and (7) waste management. As in earlier chapters of this draft supplemental EIS, we use the NRC's three-level standard of significance—SMALL, MODERATE, or LARGE—to indicate the intensity of environmental effects for each alternative that we evaluate in-depth. By placing the detailed alternative analyses in this order, the NRC staff do not mean to imply which alternative would have the least impact, or which alternative an energy-planning decisionmaker would be most likely to implement.

Sections 8.1–8.5 contain our analyses of environmental impacts of alternatives to license renewal. Alternatives include a supercritical coal-fired plant (Section 8.1), a combined-cycle natural gas-fired power plant (Section 8.2), a conservation alternative (Section 8.3), and a combination of alternatives (Section 8.4), which includes some natural gas-fired capacity, uprates at hydropower dams in Pennsylvania, and about half of the conservation capacity utilized in Section 8.3. The NRC also considers a purchased-power alternative in Section 8.5. A discussion of alternatives considered but dismissed is included in Section 8.6. Finally, in

> **Energy Outlook:** Each year the Energy Information Administration (EIA), part of the U.S. Department of Energy (DOE), issues its updated *Annual Energy Outlook (AEO)*. *AEO 2008* indicates that coal and natural gas are likely to fuel most new electrical capacity through 2030, with significant contributions from new renewable sources, and some growth in nuclear capacity (EIA 2008a), though all projections are subject to future developments in fuel price or electricity demand:
>
> *"Natural-gas-fired plants generally have lower capacity costs but higher fuel costs than coal-fired plants. As a result, coal-fired plants . . . account for 40 percent of total capacity additions from 2006 to 2030, compared with a 36-percent share for natural gas. Renewable and nuclear plants tend to have high investment costs and relatively low operating costs. EPACT2005 and State RPS programs are expected to stimulate generation from renewable and nuclear plants, which represent 18 percent and 6 percent of total additions, respectively. . . The quantity and mix of capacity additions can also be affected by different fuel price paths or growth rates for electricity demand."*

Section 8.7, the NRC considers the environmental effects that could occur if NRC takes no action and does not issue a renewed license for TMI-1.

8.1 Supercritical Coal-Fired Generation

In this section, we evaluate the environmental impacts of supercritical coal-fired generation at an offsite location. Given that the available space at the TMI-1 site is smaller than the amount of space we predict a new coal-fired alternative would require, we will not consider a coal-fired alternative at the TMI-1 site. A summary of the environmental impacts from the coal-fired alternative compared to continued operation of TMI-1 is contained in Table 8-1 on page 8-5.

Coal-fired generation accounts for a greater share of U.S. electrical power generation than any other fuel (EIA 2007). Furthermore, the EIA projects that coal-fired power plants will account for the greatest share of capacity additions through 2030—more than natural gas, nuclear, or renewable generation options. While coal-fired power plants are widely used and likely to remain widely used, we acknowledge that future coal capacity additions may be affected by perceived or actual efforts to limit greenhouse gas emissions. For now, we consider a coal-fired alternative to be a feasible, commercially-available option for providing electrical generating capacity beyond TMI-1's current license expiration.

Supercritical technologies are increasingly common in new coal-fired plants. Supercritical plants operate at higher temperatures and pressures than most existing coal-fired plants (beyond water's "critical point," where boiling no longer occurs and no clear phase change occurs between steam and liquid water). Operating at higher temperatures and pressures allows this coal-fired alternative to operate at a higher thermal efficiency than many existing coal-fired power plants. While supercritical facilities are more expensive to construct, they consume less fuel for a given output, reducing environmental impacts. Based on technology forecasts from EIA, we expect that a new, supercritical coal-fired plant beginning operation in 2014 would operate at a heat rate of 9,069 British thermal units per kilowatt-hour (Btu/kWh), or approximately 38 percent thermal efficiency (EIA 2008b).

In a supercritical coal-fired power plant, burning coal heats pressurized water. As the supercritical steam/water mixture moves through plant pipes to a turbine generator, the pressure drops and the mixture flashes to steam. The heated steam expands across the turbine stages, which then spin and turn the generator to produce electricity. After passing through the turbine, any remaining steam is condensed back to water in the plant's condenser.

In most modern U.S. facilities, condenser cooling water circulates through cooling towers or a cooling pond system (either of which are closed-cycle cooling systems). Older plants often withdraw cooling water directly from existing rivers or lakes and discharge heated water directly to the same body of water (called open-cycle cooling). For this analysis, the NRC assumed that a new supercritical coal-fired power plant would rely on closed-cycle cooling with cooling towers.

The plant likely would withdraw makeup water from nearby surface water sources and discharge blowdown (water containing concentrated dissolved solids and biocides) back to that same surface water. Cooling towers could be either natural draft (similar to the existing towers at TMI-1: tall towers powered only by the difference in density between heated, humid air, and surrounding cooler and usually drier air) or mechanical draft (shorter towers powered by mechanical fans).

In order to replace the 802 megawatt-electric (MWe) that TMI-1 currently supplies, the coal-fired alternative would need to produce roughly 850 megawatts (MW), using about 6 percent of power output for onsite power usage (AmerGen 2008). Onsite electricity usage powers scrubbers, cooling towers, coal-handling equipment, and other onsite electrical needs. A supercritical coal-fired power plant equivalent in capacity to TMI-1 would require slightly less cooling water than TMI-1 because the plant operates at a higher thermal efficiency.

Aside from cooling towers, other onsite structures would include the turbine building, boiler building, plant exhaust stack, coal pile, electrical switchyard, and a rail spur or coal dock. The GEIS (NRC 1996) estimated that a coal-fired alternative would require roughly 1.7 acres (ac) (1 hectare [ha]) per MWe capacity, or roughly 1,450 ac (587 ha). AmerGen indicated in their ER that the plant would require 129 ac (52 ha), a number more consistent with minimum utility needs as demonstrated by nearby power plants (including PPL Corporation's Brunner Island facility). We will adopt AmerGen's estimate for this analysis. Additional offsite land could be required for waste disposal, though much of the plant's ash and scrubber sludge could be reused in concrete and gypsum wallboard, respectively (ACAA 2007).

This 850 MWe power plant would consume 2.51 million tons (t) (2.28 million metric tons [MT]) of coal annually assuming an average heat content of 11,459 Btu/lb (EIA 2006). The EIA reported that most coal consumed in Pennsylvania originates in Pennsylvania. Coal would be mined either in underground mines or in surface mines, then mechanically processed and washed, before being transported—likely by rail— to the power plant site. Limestone for scrubbers would also arrive by rail. This coal-fired alternative would produce 404,000 t (366,000 MT) of ash and 263,000 t (238,000 MT) of scrubber sludge. Much of the coal ash and scrubber sludge could be reused, as noted above.

Environmental impacts from the coal-fired alternative will be greatest during construction. Site crews will clear the plant site of vegetation, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure, including a pipeline spur to serve the plant and electricity transmission infrastructure connecting the plant to existing transmission lines. Given available space onsite, the coal-fired alternative must be located elsewhere. Impacts resulting from a coal-fired unit offsite will vary depending on the nature of the site selected (e.g., a site that has never been developed will likely experience greater impacts than a site that was previously industrial; a site near other power plants or industrial facilities will likely experience smaller impacts than a site surrounded by farmland or relatively natural surroundings).

Table 8-1. Summary of Environmental Impacts of Supercritical Coal-Fired Generation Compared to Continued Operation of TMI-1.

	Supercritical Coal-Fired Generation		Continued TMI-1 Operation
	At TMI-1 site	At alternate site	
Air Quality	N/A	MODERATE	SMALL
Ground Water	N/A	SMALL	SMALL
Surface Water	N/A	SMALL	SMALL
Aquatic and Terrestrial Resources	N/A	SMALL to LARGE	SMALL
Human Health	N/A	SMALL to MODERATE	SMALL
Socioeconomics	N/A	SMALL to LARGE	SMALL
Waste Management	N/A	SMALL	N/A

8.1.1 Air Quality

Air quality impacts from coal-fired generation can be substantial because emissions contain significant quantities of sulfur oxides (SOx), nitrogen oxides (NOx), particulates, carbon monoxide (CO), and hazardous air pollutants such as mercury. However, many of these pollutants can be effectively controlled by various technologies.

TMI-1 is located within the Mid-Atlantic Air Quality Control Region, as designated by the EPA. The state is divided into six air regions and Dauphin County, where TMI-1 is located, belongs to the Southcentral Air Quality Region. Dauphin County is a nonattainment area for fine particulate matter ($PM_{2.5}$) and is part of the Harrisburg-Lebanon-Carlisle $PM_{2.5}$ nonattainment area (which includes Cumberland, Dauphin and Lebanon Counties). A new coal-fired generating plant developed at the TMI-1 site would need to comply with the new source performance standards for coal-fired plants set forth in 40 CFR 60 Subpart D(a), “Standards of Performance for Electric Utility Steam Generating Units for Which Construction is Commenced After September 18, 1978.” The standards establish limits for particulate matter and opacity (40 CFR 60.42D(a)), sulfur dioxide (SO_2) (40 CFR 60.43D(a)), and NOx (40 CFR 60.44D(a)). A coal-fired power plant constructed elsewhere in Pennsylvania would also need to comply with applicable provisions of the Clean Air Act (CAA) (42 U.S.C. 7401), based on the attainment status of the selected alternate site.

Section 169A of the CAA establishes a national goal of preventing future and remedying existing impairment of visibility in mandatory Class I Federal areas when impairment results from man-made air pollution. In 1999, EPA issued a new regional haze rule (64 FR 35714). The rule specifies that for each mandatory Class I Federal area located within a state, the State must establish goals that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals must provide an improvement in visibility for the most-impaired days over the period of the implementation plan and ensure no degradation in visibility for the least-impaired days over the same period (40 CFR 51.308(d)(1)). If a coal-fired plant were located close to a mandatory Class I area, additional air pollution control requirements would be imposed. There are no Mandatory Class I Federal areas in Pennsylvania, the closest is Brigantine Wilderness Area in New Jersey, roughly 125 miles east-southeast of TMI-1. At an alternate site, consideration may need to be given to the installation of additional air emission control systems if that site were in proximity to any Class I areas.

Pennsylvania regulates air emissions from power plants pursuant to terms of the Pennsylvania Air Pollution Control Act (APCA) (35 P.S. §§ 4001–4015). Regulations issued by the Pennsylvania Department of Environmental Protection (PADEP) adopt the EPA's CAA rules with modifications, to limit power plant emissions of SOx, NOx, particulate matter, and hazardous air pollutants (PADEP 2008). Depending where a new coal-fired facility is located within Pennsylvania, the facility will need to comply with the applicable Federal and State air regulations.

A supercritical coal-fired alternative would produce the following quantities of air pollutants:

<u>Sulfur Oxides</u>

A coal-fired alternative at the TMI-1 site would likely use wet, limestone-based scrubbers to remove SOx. EPA indicates that this technology can remove more than 95 percent of SOx from flue gases (EPA 2002). NRC projects total SOx emissions would be 4,991 t (4,528.20MT) per year. SOx emissions from a new coal-fired power plant would be subject to the requirements in 28 Title IV of the CAA. Title IV was enacted to reduce emissions of SO_2 and NOx, the two principal precursors of acid rain, by restricting emissions of these pollutants from power plants. Title IV caps aggregate annual power plant SO_2 emissions and imposes controls on SO_2 emissions through a system of marketable allowances. EPA issues one allowance for each ton of SO_2 that a unit is allowed to emit. New units do not receive allowances, but are required to have allowances to cover their SO_2 emissions. Owners of new units must therefore purchase allowances from owners of other power plants or reduce SO_2 emissions at other power plants they own. Allowances can be banked for use in future years. Thus, provided a new coal-fired power plant is able to purchase sufficient allowances to operate, it would not add to net regional SO_2 emissions, although it might do so locally.

<u>Nitrogen Oxides</u>

A coal-fired alternative at the TMI-1 site would most likely employ various available NOx-control technologies including low-NOx burners, over-fire air, and selective catalytic reduction. The EPA notes that when these emissions controls are used in concert, they can reduce NOx emissions by up to 95 percent (EPA 1998a). Assuming the use of such technologies, NOx emissions after scrubbing are estimated to be 628 t (570 MT) annually.

Section 407 of the CAA establishes technology-based emission limitations for NOx emissions. A new coal-fired power plant would be subject to the new source performance standards for such plants as indicated in 40 CFR 60.44a(d)(1). This regulation, issued on Sept 16, 1998 (63 FR 49442), limits gas discharges to 200 nanograms (ng) of NOx per joule (J) of gross energy output (equivalent to 1.6 lb/MWh), based on a 30-day rolling average. The NRC estimates that the total annual NOx emissions for a new coal-fired power plant with the modern emission controls identified in the previous paragraph would be approximately 12.4 percent of the new source performance standard mission rate. The EPA further controls the total amount of NOx that can be emitted on a State-level basis. Annual budget for NOx covered by allowances for 2009–2014 is 99,049 t (89,856 MT) (EPA 2005). A new coal-fired power plant would need to offset emissions through credit purchases or from a set-aside pool.

Particulates

A new coal-fired power plant would use fabric filters or electrostatic precipitators to remove particulates from flue gases. AmerGen indicates that fabric filters would remove 99.9 percent of particulate matter (AmerGen 2008). The EPA notes that filters or precipitators are each capable of removing in excess of 99 percent of particulate matter, and that SO_2 scrubbers further reduce particulate matter emissions (EPA 2002). As such, NRC staff believes AmerGen's removal factor is appropriate. Based on this, the new supercritical coal-fired plant would emit 161.27 t (146.3 MT) of total suspended particulates and approximately 37.09 t (33.65 MT) of PM_{10} annually. In addition, coal burning would also result in $PM_{2.5}$ emissions, and coal-handling equipment would introduce fugitive dust emissions when fuel is being transferred to on-site storage and then reclaimed from storage for use in the plant. During the construction of a coal-fired plant, on-site activities would also generate fugitive dust. Vehicles and motorized equipment would create exhaust emissions during the construction process. These impacts would be intermittent and short-lived, however, and to minimize dust generation construction crews would use applicable dust-control measures.

Carbon Monoxide

Based on EPA emission factors (EPA 1998), NRC staff estimates that the total CO emissions would be approximately 628 t (570 MT) per year.

Hazardous Air Pollutants

Following the D.C. Circuit Court's February 8, 2008, ruling that vacated its Clean Air Mercury Rule (CAMR), EPA is working to evaluate how it will regulate mercury emissions (EPA 2007). Before CAMR, EPA determined that coal- and oil-fired electric utility steam-generating units are significant emitters of hazardous air pollutants (HAPs) (EPA 2000a). EPA determined that coal plants emit arsenic, beryllium, cadmium, chromium, dioxins, hydrogen chloride, hydrogen fluoride, lead, manganese, and mercury (EPA 2000a). EPA concluded that mercury is the HAP of greatest concern and that (1) a link exists between coal combustion and mercury emissions, (2) electric utility steam-generating units are the largest domestic source of mercury emissions, and (3) certain segments of the U.S. population (e.g., the developing fetus and subsistence fish-eating populations) are believed to be at potential risk of adverse health effects resulting from mercury exposures caused by the consumption of contaminated fish (EPA 2000a). In light of the recent court decision, EPA will revisit mercury regulation, although it is possible that the agency will continue to regulate mercury as a HAP, thus requiring the use of best available control technology to prevent its release to the environment.

Carbon Dioxide

A coal-fired plant would also have unregulated carbon dioxide (CO_2) emissions during operations as well as during mining, processing, and transportation. Burning bituminous coal in the United States emits roughly 205.3 lb of CO_2 per million Btu (Hong and Slatick 1994). The supercritical coal-fired plant would emit approximately 5.914 million t (5.365 million MT) of CO_2 per year.

Summary of Air Quality

While the GEIS analysis mentions global warming from unregulated CO_2 emissions and acid rain from SOx and NOx emissions as potential impacts, it does not quantify emissions from coal-fired power plants. However, the GEIS analysis does imply that air impacts would be substantial (NRC 1996). The above analysis shows that emissions of air pollutants, including SOx, NOx, CO, and particulates, exceed those produced by the existing nuclear power plant, as well as those of the other alternatives considered in this section. Operational emissions of CO_2 are also much greater under the coal-fired alternative.[6] Adverse human health effects such as cancer and emphysema have also been associated with air emissions from coal combustion, and are discussed further in Section 8.1.5.

The NRC analysis for a coal-fired alternative at an alternative site indicates that impacts from the coal-fired alternative would have clearly noticeable effects, but given existing regulatory regimes, permit requirements, and emissions controls, the coal-fired alternative would not destabilize air quality. Thus, the appropriate characterization of air impacts from coal-fired generation would be MODERATE. Existing air quality at the alternate location would result in varying needs for pollution control equipment to meet applicable local requirements, or varying degrees of participation in emissions trading schemes.

8.1.2 Ground Water Use and Quality

An off-site location for a coal-fired plant was assumed because Three Mile Island is too small to accommodate the area needed for this alternative. If the alternative site is adjacent to the Susquehanna River and operates 10 percent more efficiently than the current nuclear plant, most of the approximately 13,000 gallon per minute (gpm) for maximum cooling water withdrawal would be taken from the river, with an average consumptive loss of about 16 million gallons per day (mgd). The need for ground water at the plant would be minor, with supply wells used for potable drinking water and various service water functions. No effect on ground water quality would be apparent.

Construction of a coal-fired plant at a new site could have a localized effect on ground water due to temporary dewatering and run-off control measures. Because of its temporary nature, the impact of construction would be SMALL.

8.1.3 Surface Water Use and Quality

Again, an offsite location for a coal-fired plant was assumed because Three Mile Island is too small to accommodate the area needed for this alternative. If the alternative site is adjacent to the Susquehanna River, most of the approximately 13,000 gpm needed for maximum withdrawal would be taken from the river with an average consumptive loss of about 16 mgd.

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6 Table S-3 in 10 CFR 51.51 indicates that electrical energy consumed during the uranium fuel cycle to supply a 1,000 MW(e) reactor is equivalent to the electricity produced by a 45 MW(e) coal-fired power plant.

This consumptive loss is less than 0.1 percent of the average annual flow of the Susquehanna River, and as such the NRC concludes the impact of surface water use at an alternative site would be SMALL. A new coal-fired plant would be required to obtain a National Pollutant Discharge and Elimination System (NPDES) permit from the PADEP for regulation of industrial waste water, storm water, and other discharges. If the plant is operated within the limits of the permit, the impact of discharges on surface water quality would be SMALL.

8.1.4 Terrestrial and Aquatic Ecology

Terrestrial Ecology

As indicated in previous sections, constructing the coal-fired alternative will require 129 ac (52 ha) of land. Coal-mining operation will also affect terrestrial ecology in offsite coal mining areas, although some of the land is likely already disturbed by mining operations. On-site and offsite land disturbances form the basis for impacts to terrestrial ecology.

Impacts to terrestrial ecology will be minor because the selected site has been previously disturbed. This could change if additional transmission line right-of-ways (ROWs), railways, or roads would need to be constructed through less disturbed areas. Additionally, these construction activities may have a cumulative effect of fragmenting or destroying habitats. Impacts to terrestrial ecology from on-site construction will remain minimal with occasional habitat fragmentation occurring on the southern areas of the island. Any on-site or offsite water disposal by landfilling will also affect terrestrial ecology at least through the time period when the disposal area is reclaimed. Deposition of acid rain or other emissions can also affect terrestrial ecology. Given the emission controls discussed in Section 8.1.1, air deposition impacts may be noticeable, but are not likely to be devastating. Impacts to terrestrial resources from a coal-fired alternative would be SMALL, and occur mostly during construction.

Aquatic Ecology

A new coal-burning power plant constructed at an alternate site would need a source of water for the plant’s cooling system (likely closed-cycled with cooling towers) as well as a discharge point for plant cooling tower blowdown. Aquatic impacts at an alternate site depend on location and ecology of the site, and the surface water body used for intake and discharge. These impacts are likely SMALL at a previously industrial site, owing to generally closer access to pipelines and transmission lines than at undeveloped sites. Impacts could range from SMALL to LARGE at previously undisturbed sites. Decreases in withdrawal from and discharge to the Susquehanna River may partially offset some aquatic impacts at an alternate site. Impacts will depend upon location and ecology of the site, and the surface water body used for intake and discharge.

8.1.5 Human Health

Human health risks of coal-fired power plants are described in general, in the GEIS Table 8-2 and Section 8.3.9. Cancer and emphysema are identified as potential health risks to occupational workers and members of the public (NRC 1996). The human health risks of coal-fired power plants, both to occupational workers and to members of the public, are greater than those of the current TMI-1 due to exposures to chemicals such as mercury; SOx; NOx;

radioactive elements such as uranium and thorium; and polycyclic aromatic hydrocarbon (PAH) compounds, including benzo(a)pyrene. However, the current Federal and State regulatory frameworks pertaining to air emission standards allow for the adequate protection of occupational workers and members of the public. Therefore, the NRC staff has adopted (where applicable) the Federal and State air quality regulatory limits as significance thresholds for determining the human health risks associated with the operation of a new coal-fired power plant.

Radiological Human Health Risks

Coal contains uranium, thorium, and other naturally occurring radioactive elements. The U.S. Geological Survey (USGS) indicates that Western and Illinois Basin coals contain uranium and thorium at roughly equal concentrations, mostly between 1 and 4 parts per million (ppm), but also indicates that some coals may contain concentrations as high as 20 ppm of both elements (USGS 1997). A typical 1,000 MWe coal-fired plant could release roughly 5.2 t (4.7 MT) of uranium and 12.8 t (11.6 MT) of thorium to the atmosphere (Gabbard 1993). The USGS and Gabbard indicate that almost all of the uranium, thorium, and most decay products remain in solid coal wastes, especially in the fine glass spheres that constitute much of coal's fly ash. Modern emission controls, such as those included for this coal-fired alternative, allow for recovery of greater than 99 percent of these solid wastes (EPA 1998), thus retaining most of coal's radioactive elements in solid form rather than releasing them to the atmosphere. Even after concentration in coal waste, the level of radioactive elements remains relatively low – typically 10 to 100 ppm – and consistent with levels found in naturally occurring granitic rocks, shale, and phosphate rocks (USGS 1997). Natural radioactive material in rocks and soil account for about 29 millirem (mrem) or 8 percent of the radiation dose a person typically receives in a year from all sources (natural and manmade). Currently, there is no scientific evidence that radiation dose exposures of 29 mrem above the natural background dose would cause adverse human health impacts. The Biological Effect of Ionizing Radiation (BEIR) committee has calculated the lifetime attributable risk (LAR) of incidence and mortality for all solid cancers and for leukemia to be four to five persons per 100,000 persons exposed to 100 milliseiverts (mSv) (10 rem), which is over 20 times that of the natural background radiation dose of 360 mrem (NAS 2005). Therefore, the radiological human health risks from a 1,000 MWe coal-fired plant to occupational workers and members of the public would be SMALL.

PAH Human Health Risks

The EPA has classified seven PAHs—benzo(a)pyrene, benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene—as probable human carcinogens (EPA 199a, EPA 199b, EPA 1999c). PAHs have been detected in ambient air from sources including coal tar production plants, coking plants, and coal-gasification sites. Epidemiologic studies have reported an increase in lung cancer risks in humans exposed to emission from coal tar production plants, coking plants, and coal-gasification sites. Each of these emissions mixtures contains a number of PAH compounds (ATSDR 1995, HHS 1993). The Occupational Safety and Health Administration (OSHA) has set a limit of 0.2 mg of PAHs per cubic meter (m^3) of air. Given that the plant must comply with OSHA regulatory limits, the health risks to occupational workers and members of the public from benzo[a]pyrene emission is expected be MODERATE.

Mercury Human Health Risks

As noted in Section 8.1.1, the EPA determined that coal-fired electric utility steam generating power plants were significant emitters of hazardous air pollutants and concluded that mercury is the hazardous air pollutant of greatest concern due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment (65 FR 32214). Noncancer risks of oral exposure to methyl-mercury have been observed to produce significant developmental effects in humans. Infants born to women who ingested high concentrations of methyl mercury exhibited central nervous system effects, such as mental retardation, ataxia, deafness, constriction of the visual field, blindness, and cerebral palsy. At lower methyl-mercury concentrations, developmental delays and abnormal reflexes were noted (ATSDR 1999, EPA 1997). No studies are available on the carcinogenic effects or cancer risks of methyl-mercury in humans, and only one available animal study reported renal tumors in mice; nevertheless, the EPA has classified methyl-mercury as a possible human carcinogen (EPA 1999d). The methyl-mercury dose resulting from emissions from a typical coal-fired power plant are uncertain. As noted in Section 8.1.1, EPA's CAMR regulation was vacated this year, and the near-term regulatory structure for mercury emission is uncertain. It is possible that EPA will return to regulating mercury as a HAP. The NRC staff expects that the EPA will implement new mercury regulations prior to the operational date of a coal-fired alternative. Because any new coal-fired plant will have to comply with EPA regulatory limits, the health risks to occupational workers and members of the public from mercury emissions is expected be MODERATE.

NOx and SO_2 Human Health Risks

NOx causes a wide variety of health risks and environmental impacts because of various compounds and derivatives in the family, including nitrogen dioxide, nitric acid, nitrous oxide, nitrates, and nitric oxide. NOx reacts with ammonia, moisture, and other compounds to form nitric acid and related particles. Human health risks include impacts to the respiratory system, damage to lung tissue, and premature death. Small particles penetrate deeply into sensitive parts of the lungs, and can cause or worsen respiratory diseases such as emphysema and bronchitis, and can aggravate existing heart disease (EPA 2008a). Environmental impacts include increased acidic deposition, and contributions to acid rain.

The combustion of fossil fuels (particularly coal) accounts for 50 percent of annual global SO_2 emissions. Human health risks of SO_2 include aggravation of asthma and chronic bronchitis, emphysema, impairment of pulmonary functions, respiratory irritation, and increased mortality. Environmental concentrations of 50-100 micrograms per cubic meter ($\mu g/m^3$) affect some plants species. SO_2 also contributes to the formation of acid rain in a similar manner as NOx (EPA 2008c).

As indicated in the Air Quality section, NOx and SO_2 emissions from coal-fired power plants are subject to the requirements in Title IV of the CAA. Because CAA regulations are based on human health or environmental criteria for setting permissible levels, it sets limits both to protect public health (including the health of "sensitive" populations such as asthmatics, children and the elderly) and to protect public welfare (including protection against decreased visibility, and damage to animals, crops, vegetation, and buildings). Given that the plant must comply with CAA regulatory limits, the environmental impact and health risks to occupational workers and members of the public from NOx and SO_2 is expected be MODERATE.

Summary

Regulatory agencies, including the EPA and State agencies, set air emission standards and requirements based on human health risks. These agencies also impose site-specific emission limits as needed to protect human health. Human health risks to occupational workers and to members of the public from a coal-fired power plant are expected be SMALL to MODERATE. Trading or offset mechanisms in nonattainment areas will act to prevent further degradation.

8.1.6 Socioeconomics

Land Use

The GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a new supercritical coal-fired power plant. Land-use impacts would vary depending on where the plant would be located and whether construction would take place on undeveloped land or within a previously disturbed (brownfield) area.

AmerGen indicated that approximately 129 ac (52 ha) would be necessary to support a coal-fired alternative capable of replacing TMI-1. The GEIS, however, estimates a need for up to 1,700 ac (688 ha) for a 1,000-MWe generating station (NRC 1996). This amount of land use would include other plant structures and associated infrastructure. By scaling the GEIS estimate, a 853-MWe plant could require up to approximately 1,450 ac (587 ha) of land for the plant site, transmission line ROWs, and a rail spur.

Based on land use for other power plants, the NRC staff believes the AmerGen estimate to be reasonable, although additional land may be used for buffer around plant structures or to support transmission lines and a rail spur. Even assuming additional land use for these purposes, total land required by the coal-fired alternative is unlikely to exceed 1,450 ac (587 ha) for all uses, excluding coal mining.

Many locations suitable for siting the coal-fired alternative (especially flat terrain areas along rivers similar to power plants currently located in this part of the United States) may have been disturbed by previous development. Brownfield sites, or sites that were previously used for industrial purposes, may be the most likely location for a new supercritical coal-fired power plant. Sites along rivers generally have easier access to transportation for coal fuel and major plant components, both by barge and train. Sites that have previously been used for industrial activities may also have existing rail spurs and dock or pier infrastructure and may be closer to transmission lines.

Coal mining introduces offsite land use impacts in addition to direct land use impacts from the construction and operation of new coal-fired power plants. Land disturbance would likely occur in Pennsylvania, Ohio, or West Virginia because a significant amount of coal used in Pennsylvania power plants originates in these three States, although significant amounts of coal also come from Kentucky and western States like Wyoming (EIA 2006).[7]

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[7] Western coal tends to have lower sulfur and somewhat lower heating content than eastern coal. Many power stations use western, subbituminous coal to reduce sulfur oxide emissions without having to install

According to analyses conducted for the GEIS, approximately 22,000 ac (8,903 ha) of land could be affected by coal mining and waste disposal in support of a 1,000-MWe coal plant during its operational life (NRC 1996). By scaling the GEIS estimate, an 853-MWe plant could require up to 18,800 ac (7,600 ha) of land to support a coal-fired power plant capable of replacing TMI-1; however, most of this land is located in existing coal-mining areas and has already been disturbed. The elimination of uranium fuel for TMI-1 could partially offset off site land use. In the GEIS, the NRC staff estimated that approximately 1,000 ac (405 ha) would not be needed for mining and processing uranium during the operating life of a 1,000-MWe nuclear power plant. For TMI-1, roughly 850 ac (344 ha) of uranium mining area would no longer be needed. However, an additional 159 ac (64 ha) of land would be needed for waste disposal during the 40 year plant life.[8] This is a smaller amount of land area than was estimated by AmerGen in the ER (AmerGen 2008), because of higher ash and gypsum recycling rates.

Land use impacts could range from MODERATE to LARGE, depending on where the power plant is located. The amount of land required under the coal-fired alternative could be reduced by constructing new transmission lines in existing ROWs.

Socioeconomics

Socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new coal-fired power could affect regional employment, income, and expenditures. Job creation is characterized by two types: (1) construction-related jobs, which are transient, short in duration, and less likely to have a long-term socioeconomic impact; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements of power plant construction and operation for the coal-fired alternative were determined in order to measure their possible effect on current socioeconomic conditions.

AmerGen projected a maximum construction workforce of 1,328 (AmerGen 2008). The GEIS projects a workforce of 1,200 to 2,500 for a 1,000-MWe plant (when extrapolated, a workforce of 1,000 to 2,100 for an 853-MWe plant). The NRC staff believes that the AmerGen estimate is reasonable and is within the range provided by the GEIS. Furthermore, the upper-end estimate of the GEIS is probably too large.

During the 5-year construction period, the communities surrounding the plant site would experience increased demand for rental housing and public services, although these effects would be moderated if the construction site is located near an urban area with many skilled workers. The relative economic effect of these workers on local economy and tax base would vary over time.

After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. As noted in the GEIS, the socioeconomic impacts at a rural construction site could be larger than at an urban site,

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scrubber equipment. A power plant equipped with scrubbers is more likely to use local, higher sulfur coals rather than incurring the cost of shipping low-sulfur coal from western states.

8 Only half of the land area needed for waste disposal is directly attributable to the alternative of renewing the TMI-1 operating license for 20 years.

because the workforce would have to move to be closer to the construction site. The impact of construction on socioeconomic conditions could range from SMALL to LARGE depending on whether the new power plant would be located at an urban or rural site. The socioeconomic impacts of power plant construction could be reduced if the power plant is located near an urban area with many skilled workers.

AmerGen estimated a power plant operations workforce of 92 (AmerGen 2008), while extrapolated GEIS estimates would call for up to 213 workers. The AmerGen estimate appears reasonable and is consistent with trends toward lowering labor costs by reducing the size of power plant operations workforces. Operations impacts will likely be SMALL to MODERATE, depending on whether the power plant is located near an urban or rural area.

Transportation

During five years of construction, up to 2,100 workers would be commuting to the construction site. This would increase the volume of traffic on roads leading to and coming from the construction site. Effects would vary depending on the number of site access roads. In addition to workers vehicles, trucks would deliver construction material and remove debris from the worksite. The number of additional vehicles on local roads could increase the overall effect. Trains or barges, or both, could be used to deliver large power plant components to the plant site.

Transportation impacts would be greatly reduced after construction of the power plant. The number of operations personnel commuting to and from the plant site would range from 92 to 213 workers. More significant, though, would be the frequent deliveries of coal and limestone to the plant site, most likely by rail, which would result in traffic delays at railroad crossings. Approximately 252 unit trains (trains with up to 100 cars carrying 100 t of coal per car for 10,000 t [9,070 MT] per train) per year would be necessary. Onsite coal storage would make it possible to receive several trains per day. Limestone would also be delivered by rail, which could cause additional traffic delays at railroad crossings (though considerably less rail traffic than that generated by coal deliveries). If coal and limestone were delivered by barge, rail transportation-related impacts to be would be reduced.

Overall, the coal-fired alternative would likely have SMALL to MODERATE transportation impacts in the vicinity of the power plant site, although the extent of impacts would depend on existing infrastructure capacity and demand, as well as whether coal and limestone would be delivered by rail or barge.

Aesthetics

Aesthetic resources are the natural and man-made features that give a particular landscape its character and aesthetic quality. The aesthetics impact analysis focuses on the degree of contrast between the power plant and the surrounding landscape and the visibility of the power plant.

The coal-fired alternative's power plant could be up to 200 ft (61 m) tall and may be visible off site in daylight hours. The exhaust stack could be up to 600 ft (183 m) high (at least 500 ft [152 m] for good engineering practice). Additional visual impacts would occur if a natural-draft cooling tower is constructed. Similar to the cooling towers at TMI-1, the natural-draft cooling tower may be several hundred feet high and sometimes topped with condensate plumes. Mechanical draft towers would also generate condensate plumes but will be lower than the plumes from the natural-draft tower. Other buildings on site may also affect aesthetics, as could construction of new transmission lines. Noise and light from plant operations, as well as lighting on plant structures, may be detectable off site.

If the coal-fired alternative is located along a river valley terrain, impacts may be moderated by higher elevation ridges along the valley rim, which could make it difficult to see and hear the plant outside of the river valley. Aesthetic impacts could be further mitigated if the plant were located in an industrial area adjacent to other industrial facilities and power plants. Overall, the aesthetic impacts associated with the coal-fired alternative would likely be SMALL to MODERATE, depending on the location of the site, topography, and proximity to other industrial facilities, as opposed to areas where visual resources are particularly valued.

Historic and Archaeological Resources

It is difficult to determine the effects on historic and archaeological resources when a specific location has not been selected. The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any proposed areas will need to be surveyed to identify and record historic and archeological resources, identify cultural resources, and develop possible mitigation measures to address any adverse effects from ground-disturbing activities. Studies will be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction will occur (e.g., roads, transmission corridors, rail lines, or other ROWs). In most cases, project proponents should avoid areas with the greatest sensitivity. Depending on the resource richness of the site ultimately chosen for the coal-fired alternative, impacts will range from SMALL to MODERATE.

Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new supercritical coal-fired power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. The minority and low-income populations are subsets of the general public residing around the site, and all are exposed to the same hazards generated from various operations at the site.

Minority and low-income populations could be affected by the construction and operation of a new supercritical coal-fired power plant. Some of these effects have been identified in resource areas discussed in this section. The extent of disproportionate effect is difficult to determine since it would depend on the location of the coal-fired power plant. For example, increased demand for rental housing during construction could disproportionately affect low-income populations. However, demand for rental housing could be mitigated if the alternate plant site is constructed near a metropolitan area. Also, increased coal consumption may affect employment opportunities and environmental conditions in low-income regions in Pennsylvania, Ohio, or West Virginia.

Impacts on minority and low-income populations from the construction and operation of a coal-fired alternative could range from SMALL to MODERATE and would depend on the location of the power plant site in proximity to minority and low-income populations.

8.1.7 Waste Management

Coal combustion generates several waste streams including ash (a dry solid) and sludge (a semi-solid by-product of emission control system operation). The NRC staff estimates that an 850-MWe power plant would generate 222,000 t (201,000 MT) of ash and approximately 55,200 t (50,000 MT) of scrubber waste per year, which would need to be disposed of onsite or in an offsite landfill (ACAA 2007). Based on industry-wide average recycling rates, of this waste, 182,000 t (165,000 MT) of the ash and 208,000 t (188,000 MT) of scrubber sludge could be recycled (ACAA 2007).

On-site disposal is likely to encompass approximately 159 ac (64 ha) over 40 years of operation. In addition to coal combustion wastes, a supercritical coal-fired alternative would also produce small amounts of domestic and hazardous wastes.

Waste impacts to ground water and surface water would extend beyond the operating life of the plant if leaching and runoff from the waste storage area makes its way into ground water or surface water. Disposal of the waste would noticeably affect land use and ground water quality if not properly managed, but with appropriate management and monitoring, impacts to ground water resources would be prevented. After closure of the landfill and revegetation, the disposal area would be available for other uses. Impacts of the waste generated by a coal-fired alternative are considered by the NRC to be SMALL to MODERATE.

8.2 Natural Gas Combined-Cycle Generation

In this section, we evaluate the environmental impacts of natural gas-fired combined-cycle generation at the TMI-1 site and at an alternate site. On page 8-18, Table 8-2 contains a summary of environmental impacts of natural gas combined-cycle generation in comparison to continued operation of TMI-1.

Natural gas fueled 20 percent of electric generation in the United States in 2006 (the most recent year for which data are available), accounting for the second greatest share of electrical power after coal (EIA 2007). Like coal-fired power plants, natural-gas-fired plants may be affected by perceived or actual action to limit greenhouse gas emissions, though they produce markedly fewer greenhouse gases per unit of electrical output than coal-fired plants. Natural gas-fired power plants are feasible, commercially available options for providing electrical generating capacity beyond TMI-1's current license expiration.

Combined-cycle power plants differ significantly from coal-fired and existing nuclear power plants. They derive the majority of their electrical output from a gas-turbine cycle, and then generate additional power—without burning any additional fuel—through a second, steam-turbine cycle. The first, gas turbine stage (similar to a large jet engine) burns natural gas which turns a driveshaft that powers an electric generator. The exhaust gas from the gas turbine is still hot enough, however, to boil water to steam. Ducts carry the hot exhaust to a heat recovery steam generator, which produces steam to drive a steam turbine and produce additional electrical power. The combined-cycle approach is significantly more efficient than any one cycle on its own; efficiencies can exceed 60 percent. Since the natural-gas-fired alternative derives much of its power from a gas turbine cycle, and because it wastes less heat than either the coal-fired alternative or the existing TMI-1, it requires significantly less cooling water and smaller cooling towers.

In order to replace the 802 MWe that TMI-1 currently supplies, the NRC selected a gas-fired alternative that uses two General Electric S107H combined-cycle generating units. While any number of commercially-available combined-cycle units could be installed in a variety of combinations to replace the power currently produced by TMI-1, the S107H is a highly-efficient model that will help to minimize environmental impacts. Other manufacturers, like Siemens, offer similar high efficiency models. This gas-fired alternative produces a net 400 MWe per unit. Two units produce a total of 800 MWe, or nearly the same output as TMI-1.

The combined-cycle alternative operates at a heat rate of 5,690 Btu/kWh, or nearly 60 percent thermal efficiency (GE 2007). Allowing for onsite power usage, including cooling towers and site lighting, the gross output of these units would be roughly 830 MWe. As noted above, this gas-fired alternative would require much less cooling water than TMI-1, because it operates at a higher thermal efficiency and requires much less water for steam cycle condenser cooling. Cooling towers for this alternative would likely be mechanical draft-type towers approximately 65 ft (20 m) in height.

In addition to cooling towers, other visible structures onsite include the turbines and heat recovery steam generators (which may be enclosed in a single building), two exhaust stacks, an electrical switchyard, and, possibly, equipment associated with a natural gas pipeline, like a compressor station. The GEIS (NRC 1996) estimated that a 1,000 MWe gas-fired alternative would require 110 ac (40 ha), meaning this 830-MWe plant would require 92 ac (37 ha). AmerGen indicated that the plant would require 32 ac (13 ha), a number more consistent with minimum utility needs as demonstrated by nearby power plants (including Dominion Resources' Fairless Energy Works). We will adopt AmerGen's estimate for the purposes of the following analysis.

This 830 MWe power plant would consume 34.2 billion cubic feet (ft^3) (970 million m^3) of natural gas annually assuming an average heat content of 1,033 Btu/ft^3 (EIA 2006). Natural gas would be extracted from the ground through wells, then treated to remove impurities (like hydrogen sulfide), and blended to meet pipeline gas standards, before being piped through the interstate pipeline system to the power plant site. This gas-fired alternative would produce relatively little waste, primarily in the form of spent catalysts used for emissions controls.

Environmental impacts from the gas-fired alternative will be greatest during construction. Site crews will clear vegetation from the site, prepare the site surface, and begin excavation before other crews begin actual construction on the plant and any associated infrastructure, including a pipeline spur to serve the plant and electricity transmission infrastructure connecting the plant to existing transmission lines.

Constructing the gas-fired alternative on AmerGen property located immediately south of remaining TMI Unit 2 plant structures would allow the gas-fired alternative to make use of TMI-1's existing transmission system, as well as take advantage of an already cleared and graded section of Three Mile Island. During the environmental site audit, TMI-1 staff indicated that some of this land is occasionally used for parking during outages and could be used during TMI-1 and TMI Unit 2 decommissioning. Additional offsite land, land farther south on Three Mile Island, or remaining land around the new gas-fired plant may be available for occasional use to offset this land requirement.

A gas-fired unit constructed offsite may cause additional construction-related impacts depending on the nature of the site selected (e.g., a site that has never been developed will likely experience greater impacts than a site that was previously industrial; a site near other power plants or industrial facilities will likely experience smaller impacts than a site surrounded by farmland or relatively natural surroundings).

Table 8-2. Summary of Environmental Impacts of Natural Gas Combined-Cycle Generation Compared to Continued Operation of TMI-1.

	Natural Gas Combined-Cycle		Continued TMI-1 Operation
	At TMI-1 site	At alternate site	
Air Quality	MODERATE	MODERATE	SMALL
Ground Water	SMALL	SMALL	SMALL
Surface Water	SMALL	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL TO LARGE	SMALL
Human Health	SMALL	SMALL	SMALL
Socioeconomics	SMALL TO MODERATE	SMALL TO MODERATE	SMALL
Waste Management	SMALL	SMALL	N/A

8.2.1 Air Quality

Dauphin County does not meet the National Ambient Air Quality Standards established by EPA under the CAA and is a nonattainment area for $PM_{2.5}$. A new gas-fired generating plant developed at the TMI-1 site would need to comply with the new source performance standards set forth in 40 CFR 60 Subpart D(a). The standards establish limits for particulate matter and opacity (40 CFR 60.42(a)), SO_2 (40 CFR 60.43(a)), and NOx (40 CFR 60.44(a)).

A gas-fired power plant constructed elsewhere in Pennsylvania would need to comply with applicable provisions of the CAA, based on the attainment status of the selected alternate site. If a natural gas-fired plant were located close to a mandatory Class I area, additional air pollution control requirements could be imposed. Pennsylvania does not have any designated Class I wilderness areas, the closest being Brigantine, NJ. For an alternate site, consideration may need to be given to installation of additional air emission control systems if the plant could potentially affect visibility in any of the Class I areas.

Pennsylvania regulates air emissions from power plants pursuant to terms of the APCA, as discussed in Section 8.1.1. Regulations enforced by the PADEP adopt the EPA's CAA rules, with modifications, to limit power plant emissions of SOx, NOx, particulate matter, and hazardous air pollutants, among other matters (PADEP 2008). Depending where a new gas-fired facility is located within the State, that facility will need to comply with the applicable Federal and State air regulations.

NOx is typically the pollutant of greatest concern for natural-gas-fired power plants. This gas-fired alternative relies on dry, low-NOx burners, as well as selective catalytic reduction (SCR) to reduce NOx emissions.

Pennsylvania and most other eastern states had been subject to requirements of 40 CFR 51.121(e), "Findings and requirements for submission of State implementation plan revisions relating to emissions of oxides of nitrogen," and the total amount of NOx emissions allowed for the Pennsylvania State implementation plan was 257,928 t (233,988 MT) for the 2007 ozone season, and would have been subject to ozone-controlling elements of the Clean Air Interstate Rule (CAIR) had CAIR not been vacated by the D.C. Circuit Court in July of this year. On September 24, 2008, EPA filed for a rehearing of the D.C. Circuit Court decisions. Until EPA, Congress, or the courts act, future NOx regulatory approaches remain uncertain.

The NRC staff projects the following emissions for a gas-fired alternative based on data published by the EIA, on EPA emissions factors, and on performance characteristics for this alternative and its emissions controls:

- Sulfur dioxide – 60 t/yr
- Nitrogen oxides – 192 t/yr
- Carbon monoxide- 40 t/yr
- PM_{10} – 33.5 t/yr

A natural gas-fired plant would also have unregulated CO_2 emissions and, in the case of this alternative to TMI-1, would emit approximately 1.99 million tons of CO_2 per year.

In December 2000, the EPA issued regulatory findings on emissions of hazardous air pollutants from electric utility steam-generating units (65 FR 32214). Natural gas-fired power plants were found by the EPA to emit arsenic, formaldehyde, and nickel. Unlike coal- and oil-fired plants, the EPA did not determine that emissions of hazardous air pollutants from natural gas-fired power plants should be regulated under Section 112 of the CAA.

Construction activities would also result in some air effects, including those from temporary fugitive dust, though construction crews would employ dust-control practices to limit this impact. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process, though these emissions are likely to be intermittent in nature and will occur over a limited period of time. As such, construction stage impacts would be SMALL.

The overall air-quality impacts of a new natural gas-fired combined cycle plant sited at TMI-1 or at an alternate site would be MODERATE.

8.2.2 Ground Water Use and Quality

The use of ground water for a natural gas combined cycle plant would likely be limited to supply wells for drinking water and possibly filtered service water for system cleaning purposes. The impact of ground water use would be SMALL. No effects on ground water quality would be apparent except during the construction phase when possible dewatering and run-off controls are used.

8.2.3 Surface Water Use and Quality

Consumptive use of surface water from the Susquehanna River would be much less for a gas-fired plant than the 18 mgd currently used on average by TMI-1. In addition, the discharge of waste water using this technology would be minimal. If this alternative is built on the current property, all intakes and discharges would be on the river and the impact on surface water resources would be SMALL.

8.2.4 Terrestrial and Aquatic Ecology

Terrestrial Ecology

As indicated in previous sections, constructing the natural gas alternative will require 32 ac (13 ha) of land. These land disturbances form the basis for impacts to terrestrial ecology. (Gas extraction and collection will also affect terrestrial ecology in offsite gas fields, although, as noted in Section 8.2.6, much of this land is likely already disturbed by gas extraction, and the incremental effects of this alternative on gas field terrestrial ecology are difficult to gauge.)

Impacts to terrestrial ecology will be minor because the selected site has been previously disturbed and is located on the southern end of the island. There is potential for disturbance of some areas with trees or manmade wetlands, and possible habitat fragmentation would occur. Construction of transmission line ROWs, a lengthy pipeline, or additional roads on undisturbed or less-disturbed areas could adversely impact terrestrial ecology by fragmenting or destroying habitats. However, a pipelined fuel source and a small workforce would help to minimize the need for additional transportation infrastructure.

In addition, construction on site may eliminate onsite habitats and alter the site for a long period of time. Some areas on site, such as any buffer areas, may remain undeveloped and could still harbor habitat for terrestrial species, though site lighting, noise, and activities may degrade the value of any remaining ecosystems. Deposition of air pollutants from this alternative may affect terrestrial ecology, but it is unlikely to be noticeable. Impacts to terrestrial resources from a natural gas combined-cycle alternative at both the TMI-1 site and an alternate site would like be SMALL.

Aquatic Ecology

Aquatic ecology actually benefits from the onsite, gas-fired alternative, as the combined-cycle plant rejects significantly less heat to the environment than the existing TMI-1, thus requiring less water. A gas-fired alternative would require less than half as much water as the existing plant due to its much higher thermal efficiency. As the onsite gas-fired alternative would continue to use the existing cooling system, impacts to aquatic ecology would also be minimal. Aquatic impacts at an alternate site depend on location and ecology of the site, and the surface water body used for intake and discharge. These impacts are likely smaller at urban or previously industrial sites, owing to generally closer access to pipelines and transmission lines than at undeveloped sites. Overall, the ecological impacts are considered SMALL at the TMI-1 site and could range from SMALL to LARGE at a different location, depending on the sensitivity of local aquatic communities.

8.2.5 Human Health

Like the coal-fired alternative discussed above, a gas-fired plant would emit criteria air pollutants, but generally in smaller quantities (except NOx, which requires additional controls to reduce emissions). Human health risks of a gas-fired alternative are generally low, although in Table 8-2 of the GEIS (NRC 1996), the NRC staff identified cancer and emphysema as potential health risks from a gas-fired alternative. However, the current Federal and State regulatory frameworks, pertaining to air emission standards, allow for the adequate protection of occupational workers and members of the public. Therefore, the NRC staff has adopted (where applicable) the Federal and State air quality regulatory limits as significant thresholds for determining the human health risks associated with the operation of a new gas-fired power plant.

NOx emissions contribute to ozone formation, which in turn contribute to human health risks. Emission controls on this gas-fired alternative maintain NOx emissions well below air quality standards established for the purposes of protecting human health, and emissions trading or offset requirements mean that overall NOx in the region would not increase. Health risks to workers may also result from handling spent catalysts that may contain heavy metals. Overall, human health risks to occupational workers and to members of the public from gas-fired power plant emissions sited at TMI-1 or at an alternate site would be similar to the risks described for coal-fired alternative and therefore, would likely be SMALL.

8.2.6 Socioeconomics

<u>Land Use</u>

A discussed in Section 8.1, the GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a natural gas-fired combined-cycle generation power plant at the TMI-1 site and at an alternate site. Land-use impacts would vary depending on where the plant would be located and whether construction would take place on undeveloped land or within a previously disturbed (brownfield) area.

AmerGen indicated that approximately 32 ac (13 ha) would be necessary to support a natural gas-fired alternative capable of replacing TMI-1. The GEIS, however, estimates 110 ac (45 ha) for a 1000-MWe generating station (NRC 1996). This amount of land use would include other plant structures and associated infrastructure. By scaling the GEIS estimate, an 853-MWe plant could require up to 92 ac (37 ha) of land. This amount of land will encompass the plant site at both TMI-1 and an alternate site, and transmission line ROWs at an alternate site. The NRC staff believes that the AmerGen estimate is reasonable. However, if additional land would be necessary for a buffer around plant structures or to support transmission lines at an alternate site and gas pipelines at both TMI-1 and at an alternate site, the NRC staff believes the GEIS estimate for land use provides a more useful approximation. Nevertheless, land use impacts from construction would be SMALL, and could be further reduced if the power plant is collocated with another generating station or on a previously industrial site like TMI-1. Impacts could be further mitigated at an alternate site by constructing new transmission lines in existing ROWs.

In addition to onsite land requirements, land will be required off site for natural gas wells and collection stations. The GEIS estimates that 3,600 ac (1,457 ha) would be required for wells, collection stations, and pipelines to bring the gas to a 1,000-MWe generating facility. If this land requirement were scaled directly with generating capacity, an alternative to TMI-1 could require up to 3,000 ac (1,200 ha) (though actual requirements will vary significantly). Most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas that could be used by the new power plant may come from outside of the United States and would be delivered as liquefied gas. Effects from gas extraction are generally smaller than those for coal mining, as most land around a gas extraction site remains undisturbed, except for roads and collection pipe network. Site reclamation after natural gas extraction would be less involved than land previously used for coal mining.

The elimination of uranium fuel for TMI-1 could partially offset off site land requirements. In the GEIS, the NRC staff estimated that approximately 1,000 ac (405 ha) would not be needed for mining and processing uranium during the operating life of a 1,000-MWe nuclear power plant. For TMI-1, roughly 850 ac (344 ha) of uranium mining area would no longer be needed. Overall land use impacts from a gas-fired power plant would be SMALL to MODERATE, depending on local land use and the availability of land near the proposed site.

<u>Socioeconomics</u>

As discussed in Section 8.1, socioeconomic impacts are defined as changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new natural gas-fired power could affect regional employment, income, and expenditures. Job creation is characterized by two types: (1) construction-related jobs, which are transient, short in duration, and less likely to have long-term socioeconomic impacts; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements of power plant construction and operations for the gas-fired alternative were determined in order to measure their possible effect on current socioeconomic conditions.

The socioeconomic impacts from constructing and operating a gas-fired plant would have little noticeable effect. Compared to the coal-fired alternative, the small size of the construction and operations workforce would have little or no socioeconomic impact.

AmerGen indicated that a 483-member workforce would be required to construct the gas-fired alternative (AmerGen 2008). After construction, local communities may be temporarily affected by the loss of construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. The impact of construction on socioeconomic conditions could range from SMALL to MODERATE depending on whether the new power plant would be located at TMI-1 or an alternate site. The socioeconomic impacts of power plant construction could be reduced if the power plant is located near an urban area with a large pool of skilled workers.

Following construction, a gas-fired alternative could provide up to 27 jobs, based on AmerGen estimates, or up to 125 jobs based on an extrapolated estimate fro the GEIS. Depending on location, the small number of workers would not have a noticeable effect on socioeconomic conditions in the region. Therefore, socioeconomic impacts associated with operation of a gas-fired power plant would be SMALL.

Transportation

Transportation impacts associated with construction and operation of a two unit power plant under the gas-fired alternative would consist of commuting workers and truck deliveries of construction materials to the TMI-1 worksite. Transportation effects would vary depending on the characteristics of site access roads. In addition to commuting workers, trucks would deliver construction materials to the worksite. These vehicles would increase the overall number of vehicles on local roads. Pipeline construction and modification to existing natural gas pipeline systems may also have a short-term impact.

Conversely, transportation impacts would almost disappear during plant operations. The estimated number of operating personnel would be approximately 27 workers, although the GEIS indicates that as many as 125 operations workers could be required. Since fuel is transported by pipeline, most transportation infrastructure will experience little increased use from plant operations.

Since fuel would be transported by pipeline, the transportation infrastructure would experience little to no increased use from plant operations. Overall, the gas-fired alternative would have a SMALL impact on transportation conditions in the region around TMI-1. Transportation impacts may vary at an alternate site and would depend on roadway capacity and average daily volume.

Aesthetics

As discussed in Section 8.1, aesthetic resources are the natural and man-made features that give a particular landscape its character and aesthetic quality. The aesthetics impact analysis focuses on the degree of contrast between the power plant and the surrounding landscape and the visibility of the power plant.

The two gas-fired units could be approximately 100 ft (30 meters [m]) tall, with two exhaust stacks at least 175 ft (53 m) tall or taller depending on the topography at an alternate site. Some structures may require aircraft warning lights. If the plant is located near the existing TMI-1, impacts may be moderated as higher elevations and vegetation along the river valley could make it difficult to see or hear the plant outside of the river valley. Power plant infrastructure would generally be smaller and less noticeable than TMI-1 containment and cooling tower. The mechanical draft cooling towers would be markedly shorter than the natural-draft towers located at TMI-1, but they would also generate condensate plumes and operational noise. Noise during power plant operations would be limited to industrial processes and communications.

In addition to seeing new power plant structures, the alternate plant site may require the construction of transmission lines and natural gas pipelines. The transmission lines would have a lasting visual effect on the landscape.

Noise from plant operations would be primarily limited to industrial processes and communications. Unlike the coal-fired alternative, pipelines would deliver natural gas fuel, thus eliminating the noises from fuel and waste handling and associated transportation equipment. Noise from the pipelines could be audible off site near compressors.

In general, aesthetic changes would be limited to the immediate vicinity of TMI-1 or an alternate site. Impacts would likely to be SMALL to MODERATE, depending on the amount of new transmission line required.

Historic and Archaeological Resources

The potential for historic and archaeological resources can vary greatly depending on the location of the proposed site. To consider a project's effects on historic and archaeological resources, any proposed areas will need to be surveyed to identify and record historic and archeological resources, identify cultural resources, and develop possible mitigation measures to address any adverse effects from ground disturbing activities. Studies will be needed for all areas of potential disturbance at the proposed plant site and along associated corridors where new construction will occur (e.g., roads, transmission corridors, rail lines, or other ROWs). In most cases, project proponents should avoid areas with the greatest sensitivity.

Depending on the resource richness of the site ultimately chosen for the gas-fired alternative, impacts will range from SMALL to MODERATE.

Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a new natural gas-fired combined-cycle generation power plant. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. The minority and low-income populations are subsets of the general public residing around the site, and all are exposed to the same hazards generated from various power plant operations.

Minority and low-income populations could be affected by the construction and operation of a new natural gas-fired power plant. Some of these effects have been identified in resource areas discussed in this section. For example, increased demand for rental housing during construction could disproportionately affect low-income populations. However, demand for rental housing could be mitigated if the alternate plant site is constructed near a metropolitan area. Impacts on minority and low-income populations from the construction and operation of a natural-gas-fired alternative could range from SMALL to MODERATE, due to the small number of workers needed to construct and operate the natural gas-fired power plant.

8.2.7 Waste Management

Minor quantities of waste are generated during burning of natural gas compared to other alternatives, however use of SCR to control NOx will generate spent SCR catalysts and small amounts of solid waste products.

It is concluded in the GEIS by the NRC staff that gas-fired technology waste generation would be minimal (NRC 1996) and the waste impacts would be SMALL for a natural gas-fired combined-cycle plant sited at TMI-1 or at alternate site.

8.3 Energy Conservation/Energy Efficiency

In this section, the NRC staff evaluates the environmental impacts of a demand-side energy conservation or energy efficiency alternative. On the following page Table 8-3 summarizes the environmental impacts of energy conservation/energy efficiency compared to continued operation of TMI-1.

Though often used interchangeably, energy conservation and energy efficiency are different concepts. Energy efficiency typically means deriving a similar level of services by using less energy, while energy conservation simply indicates a reduction in energy consumption. Both fall into a larger category known as demand-side management (DSM). DSM measures – unlike the energy supply alternatives discussed in previous sections – address energy end uses. DSM can include measures that shift energy consumption to different times of day to reduce peak loads, measures that interrupt certain large customers during periods of high demand or measures that interrupt certain appliances during high demand periods, and measures like replacing older, less efficient appliances, lighting, or control systems. DSM also includes measures that utilities use to boost sales, such as encouraging customers to switch from gas to electricity for water heating.

Unlike other alternatives to license renewal, the GEIS notes that conservation is not a discrete power generating source; it represents an option that states and utilities may use to reduce their need for power generation capability (NRC 1996). In addition, conservation represents a possible consequence of the no-action alternative. The GEIS "assumes that conservation technologies produce enough energy savings to permit the closing of a nuclear plant."

Prior to the implementation of Pennsylvania's Alternative Energy Portfolio Standard (AEPS), several Pennsylvania foundations sponsored a study by engineering firm Black and Veatch to document the potential effects renewable energy, conservation/efficiency, and unconventional power sources like waste coal (Pletka 2004). The study divided energy efficiency and conservation, and defined conservation as demand-side measures, and efficiency as supply-side measure like repowering or other power plant, transmission, or distribution improvements. Because Black and Veatch's defined energy efficiency as only supply-side options, and because Black and Veatch defined conservation as including all demand-side measures to reduce electricity consumption, we will only use Black and Veatch's conservation estimates in the following section.

Black and Veatch's analysis indicated 18,206 gigawatt-hours (GWh) of conservation could be achieved within 10-15 years of the study's 2004 publication date (Pletka 2004), or roughly three times the amount of electricity produced by TMI-1 in a given year. The total magnitude of these savings could be as large as 6872 MW, or more than eight times TMI-1's power output. Overall, Black and Veatch indicated that Pennsylvania had "good" conservation resources.

Since the study, PJM has instituted new measures to capture energy efficiency potential, and energy efficiency measures now count for inclusion in the AEPS. The NRC had difficulty determining how much of the potential identified in the 2004 report remains available in

Pennsylvania, though it appears unlikely that all or even most of this potential would already have been exploited. Beyond near-term potential, Black and Veatch's analysis identified an additional 70,000 GWh or 28,824 MW of conservation potential, some of which may be available at higher costs or on longer time horizons. Also, because TMI-1 sells power into the PJM interconnection, conservation in other nearby states may also help to offset power produced by TMI-1, even though sufficient capacity appears to exist in Pennsylvania alone. Therefore, the NRC staff chose to evaluate conservation as an alternative to license renewal.

A conservation alternative will produce different impacts than the other alternatives addressed. Unlike the discrete generation options, there is no major construction and few ongoing operational impacts. The most significant effects occur during installation or implementation or conservation measures, when old appliances may be disposed of, buildings may be retrofitted, or control devices may be installed. In some cases, increases in efficiency may come from better management of existing control systems. Many of these items may be recycled, though volumes of landfilled trash may still increase.

The GEIS generally indicates that impacts from a conservation alternative are small and that some postulated effects (like increases in mercury, polychlorinated biphenyls (PCBs), or chlorofluorocarbon (CFC) releases as fluorescent bulbs, old transformers or old refrigerators are replaced) may prove not to be significant as effective disposal methods can prevent health effects, and as more environmentally-benign alternatives have emerged (NRC 1996).

Table 8-3. Summary of Environmental Impacts of Energy Conservation/Energy Efficiency Compared to Continued Operation of TMI-1.

	Energy Conservation/Energy Efficiency	Continued TMI-1 Operation
Air Quality	SMALL	SMALL
Ground Water	SMALL	SMALL
Surface Water	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL
Human Health	SMALL	SMALL
Socioeconomics	SMALL	SMALL
Waste Management	SMALL	N/A

8.3.1 Air Quality

Implementation of the energy conservation alternative reduces direct fuel use and reduces environmental emissions resulting from plant fuel cycles, workers' commuting, and plant operation and maintenance. Improvements in efficiency may also reduce consumption of fuels used for space or water heating at the same time they reduce electrical consumption.

As noted above, no major construction would be required and few ongoing operational impacts would be experienced during implementation of the conservation alternative. The conservation alternative would likely cause only minor and short-duration air quality impacts—use of best management practices would minimize air quality impacts during installation of new appliances or systems. Implementation of energy conservation measures would improve efficiency of boilers and heating units and would help to reduce already low air emissions.

The overall impacts on air quality of the energy conservation and/or energy efficiency alternative would be SMALL.

8.3.2 Ground Water Use and Quality

The conservation alternative would not require any groundwater. It is possible that wastes produced during installation of improved equipment could have an effect on groundwater if leachate from landfills infiltrate groundwater, but this effect is not likely to be noticeably altered by a small increase in overall waste production, if any, associated with the conservation alternative. Overall impacts to groundwater are SMALL.

8.3.3 Surface Water Use and Quality

The impacts on surface water use and quality because of energy conservation efforts would be SMALL, but positive. The consumptive use of water from the Susquehanna River would certainly decrease as would the discharge of waste water streams.

8.3.4 Terrestrial and Aquatic Ecology

<u>Terrestrial Ecology</u>

Terrestrial ecology impacts would be SMALL. No additional land disturbances on or offsite would be required.

<u>Aquatic Ecology</u>

Impacts to aquatic resources would be SMALL, but positive, as withdrawals from and discharges to the Susquehanna River would cease, since the no-power generation alternative would take the place of TMI-1. If more energy is conserved than is produced by TMI-1, then positive impacts to aquatic resources could extend beyond the Susquehanna River to other water bodies. This net conservation of energy could result in less demand for power production at other plants and could lead to lower rates of water withdrawal and discharge at these power plants. The implementation of conservation measures, such as the increased use of mercury-containing compact fluorescent light bulbs and their impact to the environment after landfill disposal, would result in SMALL impacts to the aquatic environment. While increased mercury levels in landfills could leach into adjacent waterways, State and local landfill regulations could reduce or eliminate such pollution.

8.3.5 Human Health

Energy demand reduction measures are specific procedures or technologies that are undertaken to reduce energy demands. Human health risks of the energy conservation alternative are minimal, although in Table 8-2 of the GEIS (NRC 1996) the NRC staff identified radon as the major potential health risk from energy conservation alternative. Currently, there are no Federal or State regulatory frameworks pertaining to radon exposure standard, therefore, the NRC staff has chosen the EPA recommendation level of 4 picocuries per Liter (pCi/L) as a significant threshold for determining the human health risks associated with the energy conservation alternative.

Radon-222 is a naturally occurring radioactive noble gas that is formed from the decay of radium-226. Radiation exposure from radon-222 is indirect. Radon has a short half-life (4 days) and decays into other solid particulate radioactive nuclides that give off high energy alpha particles. These radioactive particles are inhaled and remain lodged in the lungs, causing continued exposure. People in affected localities can receive up to 10 mSv per year background radiation of radon-222. Radon-222 is thus the second leading cause of lung cancer after smoking, and accounts for 15,000 to 22,000 cancer deaths per year in the U.S. alone (Darby 1989). The general population is exposed to small amounts of polonium as a radon-daughter in indoor air; the isotopes polonium-214 and polonium-218 are thought to cause the majority of the estimated lung cancer deaths from radon (Darby 1989). A Bonneville Power Administration radon-222 exposure study found that radon-222 was a serious concern in new home construction if mitigation measures were not implemented. Cancer cases from radon-222 exposures were estimated to be 335 per 100,000 for baseline homes but as high as 767 cases per 100,000 for new homes with advanced infiltration control but no exhaust or mechanical ventilation (Pace 1991).

EPA recommends homes be fixed if the radon level is 4 pCi/L or more. Because there is no known safe level of exposure to radon, EPA also recommends that Americans consider fixing their homes for radon levels between 2 pCi/L and 4 pCi/L. The average radon concentration in the indoor air of America’s homes is about 1.3 pCi/L. The average concentration of radon in outdoor air is 0.4 pCi/L, about 1/10th of EPA’s 4 pCi/L action level (EPA 2008b). Given that a member of the public has taken appropriate mitigative actions—such as installing a more efficient ventilation system for radon removal, sealing cracks in basements, etc.—to achieve an indoor radon concentration below 2 pCi/L, the human health risks to members of the public from the energy conservation alternative would be within the range of the national average and would likely be SMALL.

8.3.6 Socioeconomics

Land Use

Since AmerGen would continue to use the existing transmission lines land use impacts of an energy efficiency alternative would be SMALL. Quickly replacing and disposing of old inefficient appliances could generate waste material and potentially increase the size of landfills. However, given the 10 to 15-year timeline for program development and implementation, the cost of replacements, and the average life of an appliance; the replacement process would probably be more gradual. Older appliances would simply be replaced by more efficient appliances as they fail (especially in the case of frequently replaced items, like lightbulbs). In addition, many items (like home appliances or industrial equipment) have substantial recycling value and would likely not be disposed of in landfills.

Socioeconomics

Socioeconomic effects of an energy efficiency program would be SMALL. As noted in the GEIS, the program would likely employ additional workers. Lower-income families could benefit from weatherization and insulation programs. This effect would be greater than the effect for the general population because low-income households experience home energy burdens more than four times larger than the average household (OMB 2007).

Transportation

Transportation impacts would be SMALL, because fewer employees would commute to TMI-1. Any transportation effects from the energy efficiency alternative would be widely distributed across the State, and would not be noticeable.

Aesthetics

Impacts from energy efficiency programs would be SMALL because TMI-1 would be decommissioned with no alternative power plant to replace it. The transmission lines would remain after plant decommissioning. Traffic to the plant would decrease, however, as would noise and emissions. Some noise impacts could occur in instances of energy efficiency upgrades to major building systems, though this impact would be intermittent and short-lived.

Historic and Archaeological Resources

Impacts from the energy conservation/energy efficiency alternative would be SMALL, since TMI-1 would be decommissioned with no alternative power plant to replace it. A separate environmental review would be conducted for decommissioning. That assessment will address the protection of historic and archaeological resources.

Environmental Justice

Weatherization programs could target low-income residents as a cost-effective energy efficiency option since low-income populations tend to spend a larger proportion of their incomes paying utility bills (according to the Office of Management and Budget, low income populations experience energy burdens more than four times as large as those of average households [OMB 2007]). Impacts to minority and low-income populations from energy efficiency programs would be SMALL, depending on program design and enrollment.

8.3.7 Waste Management

The most significant effects occur during installation or implementation or conservation measures, when old appliances may be disposed of, buildings may be retrofitted, or control devices may be installed. Implementation of the recycling programs would help to decrease volumes of the generated waste, though volumes of the trash sent to the landfills may still increase.

According to the GEIS, impacts from a conservation alternative are minimal, and some postulated effects (like increases in mercury, PCBs, or CFC releases as fluorescent bulbs, old transformers or old refrigerators are replaced) may prove to be insignificant as more environmentally-benign alternatives have emerged, and if proper disposal methods are employed (NRC 1996).

Overall, the waste impacts would be SMALL for the energy conservation and/or energy efficiency alternative.

8.4 Combination Alternative

In this section, we evaluate the environmental impacts of a combination of alternatives. This combination will include a portion of the energy efficiency/conservation potential identified in Section 8.3, a portion of the combined-cycle gas-fired capacity identified in Section 8.2, and a series of uprates to existing hydroelectric dams. This alternative requires little new construction (only for the single gas-fired unit installed at the TMI-1 site and minor renovation at uprated dams). We acknowledge that we could also include some amount of wind power in this alternative as a companion to the hydropower uprates, though the NRC elected not to do so since constructing wind power facilities would likely increase the environmental impact of the combination alternative without a commensurate decrease in operating impacts from other portions of the combination alternative. Table 8-4 on the following page contains a summary of the environmental impacts of the combination alternative compared to continued operation of TMI-1.

In this alternative, slightly more than half of TMI-1's output (approximately 420 MW) would be replaced by conservation. Power uprates at existing hydroelectric dams will account for roughly 100 MWe of capacity (as identified in INEEL 1997) and 280 MWe will come from one GE S107FB combined cycle power plant. The only major construction we anticipate will happen at the current TMI-1 site where the combined-cycle gas-fired power plant would be constructed. No major construction should be necessary for the conservation portion, and relatively minor construction would occur at existing dams for purposes of power uprates.

The appearance of the single-unit gas-fired facility would be similar to that of the two-unit gas-fired alternative considered in Section 8.2, except smaller. We estimate that the single-unit gas-fired facility would require approximately 35 percent of the space necessary for the two-unit gas-fired facility considered in Section 8.2, and that all construction effects—as well as operational aesthetic, fuel-cycle, air quality, socioeconomic, land use, environmental justice, and water consumption effects—will scale accordingly.[9] Since the gas-fired portion of this alternative uses roughly a third of the available land south of TMI Unit 2 on Three Mile Island, AmerGen may still be able to use most of the available space for outage personnel and eventual decommissioning activities of TMI-1.

[9] The S107FB unit considered here is slightly less efficient than the S207H units considered in Section 8.2 (heat rate of 5950 btu/kWh for the S107FB versus 5690 btu/kWh for the S207H; GE 2007). We've calculated air quality impacts in the following sections accordingly.

Table 8-4. Summary of Environmental Impacts of the Combination Alternative Compared to Continued Operation of TMI-1.

	Combination Alternative		Continued TMI-1 Operation
	At TMI-1 Site	At Alternate Site	
Air Quality	SMALL to MODERATE	MODERATE	SMALL
Ground Water	SMALL	SMALL	SMALL
Surface Water	SMALL	SMALL	SMALL
Aquatic and Terrestrial Resources	SMALL	SMALL	SMALL
Human Health	SMALL	SMALL	SMALL
Socioeconomics	SMALL to MODERATE	SMALL TO MODERATE	SMALL
Waste Management	SMALL	SMALL	N/A

8.4.1 Air Quality

As noted in Section 8.2.1, Dauphin County does not meet the National Ambient Air Quality Standards established by EPA under the CAA and is in a nonattainment area for $PM_{2.5}$. A new gas-fired generating plant developed at the TMI-1 site would need to comply with the new source performance standards set forth in 40 CFR 60 Subparts D(a). The standards establish limits for particulate matter and opacity, SO_2, and NOx.

Pennsylvania and most other eastern states had been subject to requirements of 40 CFR 51.121(e), “Findings and requirements for submission of State implementation plan revisions relating to emissions of oxides of nitrogen,” and the total amount of NOx emissions allowed for the Pennsylvania state implementation plan was 257,928 t (233,988 MT) for the 2007 ozone season, and would have been subject to ozone-controlling elements of the Clean Air Interstate Rule (CAIR) had CAIR not been vacated by the D.C. Circuit Court in July of this year. On September 24, 2008, EPA filed for a rehearing of the D.C. Circuit Court decision. Until EPA, Congress, or the courts act, future NOx regulatory approaches remain uncertain.

As noted in 8.2.1, NOx is typically the pollutant of greatest concern for natural-gas-fired power plants. Like the plant in 8.2.1, this gas-fired portion of this alternative relies on dry, low-NOx burners, as well as selective catalytic reduction (SCR) to reduce NOx emissions.

For the combination alternative only one gas-fired unit would be built. Emissions of SOx, NOx, mercury, and particulate matter would be approximately 37 percent of those detailed in Section 8.2.1. A natural gas-fired plant would also have unregulated CO_2 emissions; a single-unit gas-fired facility would emit approximately 728,000 t (660,000 MT) of CO_2 per year.

As noted in 8.2.1, EPA has determined that natural gas-fired power plants emit arsenic, formaldehyde, and nickel. Unlike coal and oil-fired plants, EPA did not determine that emissions of hazardous air pollutants from natural gas-fired power plants should be regulated under Section 112 of the CAA.

Construction activities for the gas-fired unit as well as retrofits at existing dams would also result in some air effects, including those from temporary fugitive dust, though construction crews would employ dust-control practices to limit this impact. Exhaust emissions would also come from vehicles and motorized equipment used during the construction process, though these emissions are likely to be intermittent in nature and would occur over a limited period of time. Construction stage impacts would, therefore, be SMALL.

The overall air-quality impacts of the combination alternative—based largely on the impacts from a new, single-unit, natural gas-fired combined cycle plant sited at TMI-1—would be SMALL to MODERATE.

8.4.2 Ground Water Use and Quality

If the onsite gas-fired plant continued to use groundwater for drinking water and service water, the total usage would likely be much less than TMI-1 uses, because many fewer workers are onsite, and because the gas-fired unit would have fewer auxiliary systems requiring service water. The current permitted withdrawal rate is 225,000 gpd, and pumping tests indicate this rate would not cause an effect on nearby supply wells. A reduction in this withdrawal rate means that impacts of the combination alternative would remain SMALL.

8.4.3 Surface Water Use and Quality

Using a combined alternative with conservation as a major component will reduce the amount of surface water consumed for cooling purposes. The maximum consumptive use would be reduced to a fraction of the 18 mgd used by the current nuclear plant. This represents less than 0.1 percent of the average annual flow rate in the river. The impact of this withdrawal would be SMALL.

8.4.4 Terrestrial and Aquatic Ecology

Terrestrial Ecology

Impacts to terrestrial ecology would be SMALL. ROW maintenance would continue, although no additional transmission lines would be necessary. The only construction activities that would occur for the combination alternative are the construction of a combined-cycle gas-fired power plant and any retrofit-related construction (largely internal) at existing dams. These activities would be confined to previously disturbed areas at the TMI-1 site, and would be relatively limited at dam sites. Some habitat fragmentation impacts on the southern part of the island may occur.

Aquatic Ecology

Aquatic ecology would actually benefit from the combination efficiency/conservation, hydroelectric power plant uprates, and gas-fired power plant alternative, as the combined-cycle plant would reject significantly less heat to the environment than the existing TMI-1, thus requiring less water. Impacts to aquatic resources would be SMALL, but positive, as withdrawals from and discharges to the Susquehanna River would be significantly less. Energy conservation and efficiency would likewise result in less withdrawals and discharges corresponding to a decreased demand for power generation as discussed in Section 8.3. Uprates to hydroelectric power plants to compensate for loss of power generation at TMI-1 could lead to slight increases in entrainment and impingement impacts at these hydroelectric plants, but these impacts would be regulated and likely SMALL.

8.4.5 Human Health

The human health risks of a combination of alternatives include those that have already been discussed in their respective sections (i.e. energy conservation and combined cycle gas-fired alternatives). The human health risks are uncertain, but considered to be SMALL given the combination of alternatives must comply with health-based Federal and State emission standards.

8.4.6 Socioeconomics

Land Use

As discussed in Section 8.1, the GEIS generically evaluates the impacts of nuclear power plant operations on land use both on and off each power plant site. The analysis of land use impacts focuses on the amount of land area that would be affected by the construction and operation of a single natural gas-fired unit power plant at the TMI-1 site and minor renovation of dams.

Approximately 11 ac (5 ha) would be necessary to support a single natural gas-fired unit combination alternative based on AmerGen estimates for a discrete gas-powered alternative. By scaling the GEIS estimate, a 280 MWe plant could require up to approximately 32 ac (13 ha) of land and would encompass available space at the TMI-1 site. The NRC staff believes that the AmerGen estimate is reasonable. However, if additional land were necessary for a buffer around plant structures and the construction of gas pipelines at TMI-1, the NRC staff believes the GEIS estimate provides a more useful approximation. Nevertheless, land use impacts from construction would be SMALL.

In addition to onsite land requirements, land will be required offsite for natural gas wells and collection stations. The GEIS estimates that 3,600 ac (1,457 ha) would be required for wells, collection stations, and pipelines to bring the gas to a 1000-MWe generating facility. If this land requirement were scaled directly with generating capacity, the combination alternative could require up to 1,025 ac (425 ha), though actual requirements will vary significantly. As previously discussed in Section 8.2, most of this land requirement would occur on land where gas extraction already occurs. In addition, some natural gas that could be used by the new power plant may come from outside of the U.S. and would be delivered as liquefied gas. Effects from gas extraction are generally smaller than those for coal mining, as most land around a gas extraction site remains undisturbed, except for roads and collection pipe network. Site reclamation after natural gas extraction would be less involved than reclamation of land previously used for coal mining.

As previously discussed, the elimination of uranium fuel for TMI-1 could partially offset offsite land requirements. In the GEIS, the NRC staff estimated that approximately 1,000 ac (405 ha) would no longer be needed for mining and processing uranium during the operating life of a 1000-MWe nuclear power plant. For TMI-1, roughly 850 ac (344 ha) of uranium mining area would no longer be needed. Overall land use impacts from a single natural-gas-fired power plant unit under the combination alternative would be SMALL.

Socioeconomics

As discussed in Section 8.1, socioeconomic impacts are defined in terms of changes to the demographic and economic characteristics and social conditions of a region. For example, the number of jobs created by the construction and operation of a new single natural gas-fired power plant unit could affect regional employment, income, and expenditures. Job creation is characterized by two types: (1) construction-related jobs, which are transient, short in duration, and less likely to have long-term socioeconomic impacts; and (2) operation-related jobs in support of power plant operations, which have the greater potential for permanent, long-term socioeconomic impacts. Workforce requirements for power plant construction and operations for the combination alternative were determined in order to measure their possible effect on current socioeconomic conditions.

The socioeconomic impacts from constructing and operating a single unit natural-gas-fired plant and minor renovation of dams would have little noticeable effect. Compared to the coal-fired alternative, the small size of the construction and operations workforce would have little or no socioeconomic impact.

AmerGen indicated that a peak construction workforce of 169 workers would be required to construct this alternative (AmerGen 2008). After construction, local communities may be temporarily affected by the loss of the construction jobs and associated loss in demand for business services, and the rental housing market could experience increased vacancies and decreased prices. The impact of construction on socioeconomic conditions would be SMALL.

Following construction, a single unit gas-fired combination alternative could provide up to nine jobs, based on AmerGen estimates, or up to 44 jobs based on an extrapolated estimate from the GEIS. Socioeconomic impacts associated with the operation of a single unit natural-gas-fired power plant would be SMALL.

Transportation

Transportation impacts associated with construction and operation of a single unit gas-fired power plant under the combination alternative would consist of commuting workers and truck deliveries of construction materials to the TMI-1 worksite. These vehicles would increase the overall number of vehicles on local roads. Pipeline construction and modification to existing natural gas pipeline systems may also have an additional, short-term impact.

Conversely, transportation impacts would almost disappear during plant operations. The estimated number of operating personnel would be approximately nine workers, although, the GEIS indicates that as many as 44 operations workers could be required. Since fuel would be transported by pipeline, the transportation infrastructure would experience little to no increased use from plant operations. Overall, the combination alternative would have a SMALL impact on transportation conditions in the region around TMI-1.

Aesthetics

As discussed in Section 8.1, aesthetic resources are the natural and man-made features that give a particular landscape its character and aesthetic quality. The aesthetics impact analysis focuses on the degree of contrast between the power plant and the surrounding landscape and the visibility of the power plant.

A single natural gas-fired unit located at TMI-1 could be approximately 100 ft (30 m) tall, with an exhaust stack of at least 175 ft (53 m) tall. The impact would be moderated as higher elevations and vegetation along the river valley could make it difficult to see or hear the power plant outside of the river valley. The alternative power plant infrastructure would generally be smaller and less noticeable than the current TMI-1 containment and cooling tower. The mechanical draft cooling towers would be markedly shorter than the natural-draft towers located at TMI-1, but they would also generate condensate plumes and operational noise. Noise during power plant operations would be limited to industrial processes and communications.

In addition to the power plant structures, construction of natural gas pipelines would have a short-term impact. Noise from the pipelines could be audible offsite near compressors.

In general, aesthetic changes would be limited to the immediate vicinity of TMI-1; therefore aesthetic impacts would be SMALL.

Historic and Archaeological Resources

As discussed in Section 8.2.6, depending on the resource richness of the site ultimately chosen for the gas-fired single unit as part of the combination alternative, impacts will range from SMALL to MODERATE.

Environmental Justice

The environmental justice impact analysis evaluates the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations that could result from the construction and operation of a single unit natural gas-fired power plant and uprates to existing hydroelectric dams. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal adverse impacts on human health. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant and exceeds the risk or exposure rate for the general population or for another appropriate comparison group. The minority and low-income populations are subsets of the general public residing around the site, all of whom are exposed to the same hazards generated from power plant operations.

Minority and low-income populations could be affected by the construction and operation of a new single unit natural gas-fired combined-cycle generation power plant at TMI-1. Some of these effects have been identified in resource areas discussed in this section. Effects on minority and low-income populations in the vicinity of TMI-1 would vary from construction to operations. Increased localized rental housing demand during construction in some locations could disproportionately affect low-income populations. The impacts on minority and low-income populations from the combination alternative would likely be SMALL.

8.4.7 Waste Management

As discussed in Sections 8.2.7 and 8.3.7, NRC staff concluded in the GEIS that gas-fired technology waste generation would be minimal (NRC 1996) and the waste impacts would be SMALL for a natural gas-fired combined-cycle plant sited at TMI-1 or at an alternate site; and impacts from a conservation alternative would be SMALL. Overall, the waste impacts from the combination alternative would be SMALL.

8.5 Purchased Power

AmerGen participates in the PJM Interconnection. This restructured energy supply system allows for the sale of energy across parts of 13 States and the District of Columbia (PJM 2008). Across the PJM, coal is the predominant fuel used for generation, accounting for 55.3 percent in 2007, followed by nuclear (33.9 percent), natural gas (7.7 percent), hydroelectric (1.7 percent), oil (0.5 percent), solid waste (0.7 percent), and wind (0.2 percent) (PJM 2008). Many of PJM's gas-fired units are actually able to burn fuel oil, as well, although gas utilization is much higher due to lower costs and emissions. Given the size and flexibility of PJM, the NRC staff considers it likely that purchased power could reasonably replace TMI-1.

Impacts would likely be similar to those of the above options located at alternate sites. If power purchases cause currently existing capacity to operate at higher capacity factors, however, rather than triggering new construction, then construction stage impacts would be eliminated. It is likely, then, that purchased power would come from older, less efficient plants than those considered in this chapter, from plants with once-through cooling, or from plants without modern emissions controls. Accordingly, impacts are difficult to quantify, although they are likely similar to those of other alternatives considered in Sections 8.2 through 8.4 in this draft supplemental EIS, as well as in the GEIS.

Given the location of TMI-1, it is unlikely that purchased power from outside the U.S. could replace TMI-1 capacity, regardless of whether either country has sufficient existing export capacity.

Since purchased power may come from a variety of generating resources, including coal, natural gas, nuclear, hydroelectric, and perhaps oil-fired installations (where impacts in previous NRC documents, including the supplemental EIS and the GEIS, were determined to be similar to or larger than those of natural-gas fired generation), NRC staff evaluation indicates that impacts from the purchased power alternative would be greater than the impacts of license renewal, and within the range of other alternatives considered in this chapter.

8.6 Alternatives Considered but Dismissed

In this section, the NRC staff presents the alternatives it initially considered for analysis as alternatives to license renewal of TMI-1, but later dismissed due to technical, resource availability, or commercial limitations that currently exist and that the NRC staff believes are likely to continue to exist when the existing TMI-1 license expires. Under each of the following technology headings, the NRC staff indicates why it dismissed each alternative from further consideration.

8.6.1 Coal-Fired Integrated Gasification Combined-Cycle

While utilities across the U.S. have considered or are considering plans for integrated gasification combined-cycle (IGCC) coal-fired power plants, few IGCC facilities have yet been constructed. All facilities constructed in the U.S. to date have been smaller than TMI-1.

The technology, however, is commercially available and essentially relies on a gasifier stage and a combined-cycle turbine stage. Existing combined-cycle gas turbines (like the ones considered in Section 8.2) could be used as part of an IGCC alternative.

EIA indicates that IGCC and other advanced coal plants may become increasingly common in coming years (EIA 2008a, 2008b), though uncertainties about construction time periods and commercial viability in the near future leads NRC staff to believe that IGCC is an unlikely alternative to TMI-1 license renewal. For plants whose licenses expire at later dates, IGCC (with or without carbon capture and storage) may prove to be a viable alternative, though NRC did not evaluate IGCC as an alternative to TMI-1 license renewal.

8.6.2 New Nuclear

In its ER, AmerGen indicated that it is unlikely that a nuclear alternative could be sited, constructed and operational by the time the TMI-1 operating license expires in 2014 (AmerGen 2008). Sources in the nuclear industry have recently indicated that reactor projects currently under development are likely eight or nine years from completion (Nucleonics Week 2008), or possibly online in the 2016-2017 timeframe. While several new reactor proposals currently under development or undergoing NRC review are within the footprint of PJM, they are unlikely to be available prior to the expiration of the TMI-1 operating license. Further, potential plant owners or operators wishing to submit a new proposal specifically to offset the capacity of TMI-1 would require additional time to develop an application. Given the relatively short time remaining on the current TMI-1 operating license, NRC staff has not evaluated new nuclear generation as an alternative to license renewal.

8.6.3 Wind Power

Windpower, by itself, is not suitable for large baseload capacity. As discussed in Section 8.3.1 of the GEIS, wind has a high degree of intermittency and low average annual capacity factors (up to 30 to 40 percent). Windpower, in conjunction with energy storage mechanisms or another readily dispatchable power source, like hydropower, could serve as a means of providing baseload power. Current energy storage technologies are too expensive for windpower to serve as a large baseload generator.

The Commonwealth of Pennsylvania is mostly a windpower Class 1 region, although some areas, particularly along ridgelines, may provide wind classes ranging from 4 to 6 (DOE 2003). Wind turbines are economical in windpower Classes 4 through 7, which have average windspeeds of 12.5 to 21.1 miles per hour (20 to 34 kilometers per hour) (DOE 2007).

Through the end of 2007, operators had installed 294 MWe in Pennsylvania (DOE 2008). While installed windpower capacity is relatively low, windpower installation in Pennsylvania has accelerated in recent years. As noted by the NRC staff in the draft SEIS for the Susquehanna Steam Electric Station, PJM has a maximum potential of 6,658 MWe of wind capacity with an achievable potential of 665 MWe to 1,995 MWe. Given that this capacity will function at a 30–40-percent capacity factor, it is unlikely that there will be sufficient windpower potential to replace TMI-1.

Therefore, the NRC staff does not consider windpower to be a stand-alone alternative to TMI-1 license renewal.

8.6.4 Solar Power

Solar technologies use the sun's energy to produce electricity. Currently, the TMI-1 site receives approximately 4 to 4.5 kWh per square meter per day (approximately 0.4 kWh of solar radiation per square foot per day), as does much of Pennsylvania (NREL 2008), for solar collectors oriented at an angle equal to the installation's latitude. Since flat-plate photovoltaics tend to be roughly 25 percent efficient, a solar-powered alternative will require at least 3,590 to 4,040 ac (1,450 to 1,640 ha) of collectors to provide an amount of electricity equivalent to that generated by TMI-1. Space between parcels and associated infrastructure increase this land requirement. This amount of land, while large, is consistent with the land required for coal and natural gas fuel cycles. In the GEIS, the NRC staff noted that, by its nature, solar power is intermittent (i.e., it does not work at night and cannot serve baseload when the sun is not shining), and the efficiency of collectors varies greatly with weather conditions. A solar-powered alternative will require energy storage or a backup power supply to provide electric power at night. Given the challenges in meeting baseload requirements, the NRC staff did not evaluate solar power as an alternative to license renewal of TMI-1.

8.6.5 Wood Waste

In 1999, DOE researchers estimated that Pennsylvania has biomass fuel resources consisting of urban, mill, agricultural, and forest residues, as well as speculative potential for energy crops. Excluding potential energy crops, DOE researchers projected that Pennsylvania had 5,090,000 tons (4,617,570 MT) of plant-based biomass available at $50 per ton delivered (Walsh et al. 2000; costs are in 1995 dollars). The Bioenergy Feedstock Development Program at Oak Ridge National Laboratory estimated that each air-dry pound of wood residue produces approximately 6,400 Btu of heat (ORNL 2007). Assuming a 33 percent conversion efficiency, using all biomass available in Pennsylvania at $50 per ton—the maximum price the researchers considered—would generate roughly 6.3 terawatt hours of electricity. This is roughly the same as the amount of electrical energy produced by TMI-1 operating at 85 percent capacity for one year.

Walsh et al. (2000), go on to note that these estimates of biomass capacity contain substantial uncertainty, and that potential availability does not mean biomass will actually be available at the prices indicated or that resources will be usably free of contamination. Some of these plant wastes already have reuse value, and would likely be more costly to deliver because of competition. Others, such as forest residues, may prove unsafe and unsustainable to harvest on a regular basis. As a result, the available resource potential is likely less than the estimated totals in Walsh et al., and the total resource is not likely to be sufficient to substitute for the capacity provided by TMI-1. As a result, the NRC staff has not considered a wood-fired alternative to TMI-1 license renewal.

8.6.6 Conventional Hydroelectric Power

According to researchers at Idaho National Energy and Environmental Laboratory, Pennsylvania has an estimated 2,217 MW of technically available, undeveloped hydroelectric resources at 104 sites throughout the State (INEEL 1997). This amount occurs primarily in small installations generating 10 MWe or less, though one site in Pennsylvania is capable of providing at least 100 MWe. These sites are scattered widely across the state, with a significant number in the Susquehanna River Basin region. The NRC staff notes that the total available hydropower potential is greater than the capacity considered for the other alternatives to license renewal of TMI-1, although INEEL indicates that many sites may not be available for development for a variety of reasons. Given the large numbers of individual installations needed to replace the TMI-1 capacity and the uncertainty surrounding available resource potential, the NRC staff did not evaluate hydropower as an alternative to license renewal. The NRC does, however, consider that the portion of this potential capacity that is available through uprates at existing hydroelectric facilities could play a role in a combination alternative in Section 8.4.

8.6.7 Wave and Ocean Energy

Wave and ocean energy has generated considerable interest in recent years. Ocean waves, currents, and tides are often predictable and reliable. Ocean currents flow consistently, while tides can be predicted months and years in advance with well-known behavior in most coastal areas. Most of these technologies are in relatively early stages of development, and while some results have been promising, they are not likely to be able to replace the capacity of TMI-1 by the time its license expires. The NRC staff has previously evaluated the potential for wave or ocean energy to provide an alternative to license renewal for the Oyster Creek Nuclear Generating Station (OCNGS) in New Jersey, also part of PJM and located on the coast. In 2007, the NRC staff concluded that wave and ocean energy could not provide a feasible alternative to license renewal at OCNGS, a smaller plant than TMI-1 (NRC 2007). While testing of new technologies to produce electricity from the ocean continues, the NRC has not yet seen technological advances significant enough to consider wave and ocean energy as an alternative to TMI-1 license renewal.

8.6.8 Geothermal Power

Geothermal energy has an average capacity factor of 90 percent and can be used for baseload power where available. However, geothermal electric generation is limited by the geographical availability of geothermal resources (NRC 1996). As illustrated by Figure 8.4 in the GEIS, no feasible eastern location for geothermal capacity exists to serve as an alternative to TMI-1. The NRC staff concluded that geothermal energy is not a reasonable alternative to license renewal at TMI-1.

8.6.9 Municipal Solid Waste

Municipal solid waste combustors incinerate waste to produce steam, hot water, or electricity. Combustors use three types of technologies—mass burn, modular, and refuse-derived fuel.

Mass burning is currently the method used most frequently in the United States and involves no (or little) sorting, shredding, or separation. Consequently, toxic or hazardous components present in the waste stream are combusted, and toxic constituents are exhausted to the air or become part of the resulting solid wastes. Currently, approximately 89 waste-to-energy plants operate in the United States. These plants generate approximately 2,700 MWe, or an average of approximately 30 MWe per plant (Integrated Waste Services Association 2007). More than 25 average-sized plants will be necessary to provide the same level of output as the other alternatives to TMI-1 license renewal.

Estimates in the GEIS suggest that the overall level of construction impact from a waste-fired plant will be approximately the same as that for a coal-fired power plant. Additionally, waste-fired plants have the same or greater operational impacts than coal-fired technologies (including impacts on the aquatic environment, air, and waste disposal). The initial capital costs for municipal solid-waste plants are greater than for comparable steam-turbine technology at coal-fired facilities or at wood-waste facilities because of the need for specialized waste separation and handling equipment (NRC 1996).

The decision to burn municipal waste to generate energy is usually driven by the need for an alternative to landfills rather than energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term as energy prices increase; however, it is possible that municipal waste combustion facilities may become attractive again.

Regulatory structures that once supported municipal solid waste incineration no longer exist. For example, the Tax Reform Act of 1986 made capital-intensive projects such as municipal waste combustion facilities more expensive relative to less capital-intensive waste disposal alternatives such as landfills. Also, the 1994 Supreme Court decision C&A Carbone, Inc. v. Town of Clarkstown, New York, struck down local flow control ordinances that required waste to be delivered to specific municipal waste combustion facilities rather than landfills that may have had lower fees. In addition, environmental regulations have increased the capital cost necessary to construct and maintain municipal waste combustion facilities.

Given the small average installed size of municipal solid waste plants and the unfavorable regulatory environment, the NRC staff does not consider municipal solid waste combustion to be a feasible alternative to TMI-1 license renewal.

8.6.10 Biofuels

In addition to wood and municipal solid-waste fuels, there are other concepts for biomass-fired electric generators, including direct burning of energy crops, conversion to liquid biofuels, and biomass gasification. In the GEIS, the NRC staff indicated that none of these technologies had progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant such as TMI-1. After reevaluating current technologies, the NRC staff believes other biomass-fired alternatives are still unable to reliably replace the TMI-1 capacity. For this reason, the NRC staff does not consider other biomass-derived fuels to be feasible alternatives to TMI-1 license renewal.

8.6.11 Oil-Fired Power

EIA projects that oil-fired plants will account for very little of the new generation capacity constructed in the United States during the 2007 to 2030 time period. Further, EIA does not project that oil-fired power will account for any significant additions to capacity (EIA 2008a).

The variable costs of oil-fired generation tend to be greater than those of the nuclear or coal-fired options, and oil-fired generation tends to have greater environmental impacts than natural-gas-fired generation. In addition, future increases in oil prices are expected to make oil-fired generation increasingly more expensive. The high cost of oil has prompted a steady decline in its use for electricity generation. Thus the NRC staff did not consider oil-fired generation as an alternative to TMI-1 license renewal.

8.6.12 Fuel Cells

Fuel cells oxidize fuels without combustion and its environmental side effects. Power is produced electrochemically by passing a hydrogen-rich fuel over an anode and air (or oxygen) over a cathode and separating the two by an electrolyte. The only byproducts (depending on fuel characteristics) are heat, water, and CO_2. Hydrogen fuel can come from a variety of hydrocarbon resources by subjecting them to steam under pressure. Natural gas is typically used as the source of hydrogen.

At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation. EIA projects that fuel cells may cost $5,374 per installed kW (total overnight costs) (EIA 2008b), or 3.5 times the construction cost of new coal-fired capacity and 7.5 times the cost of new, advanced gas-fired, combined-cycle capacity. In addition, fuel cell units are likely to be small in size (the EIA reference plant is 10 MWe). While it may be possible to use a distributed array of fuel cells to provide an alternative to TMI-1, it would be extremely costly to do so. Accordingly, the NRC staff does not consider fuel cells to be an alternative to TMI-1 license renewal.

8.6.13 Delayed Retirement

Neither AmerGen nor its parent company, Exelon, has any plans to retire generating capacity within PJM (AmerGen 2008). As a result, delayed retirement is not a feasible alternative to license renewal. Other generation capacity may be retired within PJM prior to the expiration of the TMI-1 license, but this capacity is likely to be older, less efficient, and without modern emissions controls.

8.7 No-Action Alternative

This section will examine the environmental effects that will occur if NRC takes no action. No action in this case means that the NRC does not issue a renewed operating license for TMI-1, and the license expires at the end of the current license term, in April 2014. If the NRC takes no action, the plant will shutdown at or before the end of the current license. After shutdown, plant operators will initiate decommissioning according to 10 CFR 50.82, “Termination of License.”

Table 8-5 below contains a summary of the environmental impacts of the no-action alternative compared to continued operation of TMI-1.

We note that no action is the only alternative that we consider in-depth that does not satisfy the purpose and need for this draft supplemental EIS, as it does not provide power generation capacity. Furthermore, it would not meet the needs currently met by TMI-1, or the alternatives evaluated in sections 8.1 through 8.4. Assuming that a need currently exists for the power generated by TMI-1, the no-action alternative would require the appropriate energy planning decisionmakers to rely on an alternative to replace the capacity of TMI-1 or reduce the need for power.

In this section, we address only those impacts that arise directly as a result of plant shutdown. The NRC already addressed— in several other documents— environmental impacts from decommissioning and related activities. These documents include the *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG 0586, Supplement 1 (NRC 2002); the license renewal GEIS (Chapter 7; NRC 1996); and Chapter 7 of this draft supplemental EIS. These analyses either directly address or bound the environmental impacts of decommissioning whenever AmerGen ceases operating TMI-1.

We note that, even with a renewed operating license, TMI-1 will eventually shut down, and the environmental effects we address in this section will occur at that time. Since these effects have not otherwise been addressed in this draft supplemental EIS, we will address the impacts in this section. We expect that— as with decommissioning effects— shutdown effects will be similar whether they occur at the end of the current license or at the end of a renewed license.

Table 8-5. Summary of Environmental Impacts of the No Action Alternative Compared to Continued Operation of TMI-1.

	No Action		Continued TMI-1 Operation
	At TMI-1 site	At alternate site	
Air Quality	SMALL	N/A	SMALL
Ground Water	SMALL	N/A	SMALL
Surface Water	SMALL	N/A	SMALL
Aquatic and Terrestrial Resources	SMALL	N/A	SMALL
Human Health	SMALL	N/A	SMALL
Socioeconomics	SMALL to MODERATE	N/A	SMALL
Waste Management	SMALL	N/A	N/A

8.7.1 Air Quality

When the plant stops operating, there will be a reduction in emissions from activities related to plant operation, such as use of diesel generators and employees' vehicles. In Chapter 4, the NRC staff determined that these emissions would have a SMALL impact on air quality during the renewal term. Therefore, if the emissions decrease, the impact to air quality would also decrease and would be SMALL.

8.7.2 Ground Water Use and Quality

The use of groundwater would diminish as plant personnel are removed from the site and operations cease. Some consumption of groundwater may continue as a small staff remains onsite to maintain facilities prior to decommissioning. Overall impacts would be smaller than during operations, but would remain SMALL.

8.7.3 Surface Water Use and Quality

The rate of consumptive use of surface water would decrease as the plant is shut down and the reactor cooling system continues to remove the heat of decay. Wastewater discharges would also be reduced considerably. Shutdown would reduce the already SMALL impact on surface water resources and quality.

8.7.4 Aquatic and Terrestrial Ecology

<u>Terrestrial Ecology</u>

Terrestrial ecology impacts would be SMALL. No additional land disturbances on or offsite would occur.

<u>Aquatic Ecology</u>

If the plant were to cease operating, impacts to aquatic ecology would decrease, as the plant would withdraw and discharge less water than it does during operations. Shutdown would reduce the already SMALL impacts to aquatic ecology.

8.7.5 Human Health

Human health risks would be smaller following plant shutdown. The plant, which is currently operating within regulatory limits, would emit less gaseous and liquid radioactive material to the environment. In addition, following shutdown, the variety of potential accidents at the plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Chapter 4 of this draft supplemental EIS, the NRC staff concluded that the impacts of continued plant operation on human health would be SMALL. In Chapter 5, the NRC staff concluded that the impacts of accidents during operation were SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and variety of accidents decrease following shutdown, the NRC staff concludes that the risks to human health following plant shutdown would be SMALL.

In addition, the no-action alternative would require TMI-1 to initiate decommissioning activities. Environmental impacts from the activities associated with the decommissioning of any reactor before or at the end of an initial or renewed license are evaluated in the *Generic Environmental Impact Statement for Decommissioning of Nuclear Facilities*: Supplement 1, *Regarding the Decommissioning of Nuclear Power Reactors*, NUREG-0586, Supplement 1 (NRC 2002). The NRC's evaluation of the environmental impacts of decommissioning presented in NUREG-0586, Supplement 1, identifies a range of impacts for each environmental issue including human health risks. Based on information in the GEIS (NRC 1996) along with the information in

Chapter 7 of this draft supplemental EIS, the Commission found that doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 person-rem caused by buildup of long-lived radionuclides during the license renewal term. Therefore, the human health risks to an occupational worker and to a member of the public, from the decommissioning of TMI-1, due to the no-action alternative, would be SMALL.

8.7.6 Socioeconomics

Land Use

Plant shutdown will not affect onsite land use. Plant structures and other facilities will likely remain in place until decommissioning. Most transmission lines at TMI-1 will remain in service after the plant stops operating. Maintenance of most existing transmission lines will continue as before. The NRC staff expects the impacts on land use from plant shutdown to be SMALL.

Socioeconomics

Plant shutdown will have a minimal impact on socioeconomic conditions in the region around TMI-1, primarily because of the plant's proximity to the Harrisburg-Carlisle metropolitan statistical area and its relatively small contribution to local services. Plant shutdown will eliminate up to 525–695 jobs and will reduce tax revenue in the region, though the TMI-1 contributions to local taxing jurisdictions are a small percentage of total revenue for each of the jurisdictions discussed in Chapter 4 of this draft SEIS. The loss of these contributions, which may not entirely cease until after decommissioning, will have a SMALL impact, although job losses could increase the impact level slightly. Overall, the staff expects the impacts of plant shutdown to be SMALL to MODERATE. See Appendix J to NUREG 0586, Supplement 1 (NRC 2002), for additional discussion of the potential socioeconomic impacts of plant decommissioning.

Transportation

Traffic volumes on the roads in the vicinity of TMI-1 will decline after plant shutdown. Most of the reduction in traffic volume will be associated with the loss of jobs. The shipment of material to and from the plant will be reduced before decommissioning. Transportation impacts will be SMALL as a result of plant shutdown. Transportation impacts will increase if a new reactor or alternative energy facility is constructed on the TMI-1 site or in the immediate vicinity. Such impacts will be SMALL to MODERATE, but of short duration.

Aesthetics

Plant structures and other facilities will likely remain in place until decommissioning, although plumes from the plant's cooling towers are likely to disappear entirely. Noise caused by plant operation will cease. The NRC staff concludes that the aesthetic impacts of plant closure will be SMALL.

Historic and Archaeological Resources

Impacts from the no-action alternative would be SMALL, since TMI-1 would be decommissioned with no alternative power plant to replace it. A separate environmental review would be conducted for decommissioning. That assessment will address the protection of historic and archaeological resources.

Environmental Justice

Plant shutdown is unlikely to disproportionately affect minority and low-income populations. Impacts to all other resource areas would be SMALL to MODERATE. The communities in the immediate vicinity of TMI-1 do not have large populations of minority or low-income residents. Minority and low-income populations are generally concentrated in the urban areas of Harrisburg, Lancaster, and York. Thus, impacts from plant shutdown are likely to be SMALL. See Appendix J of NUREG 0586, Supplement 1 (NRC 2002), for additional discussion of these impacts.

8.7.7 Waste Management

After implementation of the no-action alternative, generation of high-level waste would stop and generation of low-level and mixed waste would decrease. Impacts from implementation of the no-action alternative are expected to be SMALL.

8.8 Alternatives Summary

In this chapter, we considered the following alternatives to TMI-1 license renewal: supercritical coal-fired generation, natural gas combined-cycle generation, energy conservation and energy efficiency, and a combination alternative. We also considered no action by the NRC and the effects it would have. The impacts for all alternatives are summarized in Table 8-6 on the following page.

The environmental impacts of the proposed action (issuing a renewed TMI-1 operating license) would be SMALL for all impact categories, except for the Category 1 issues of collective offsite radiological impacts from the fuel cycle, high level waste (HLW), and spent fuel disposal. The NRC staff did not assign a single significant level to these impacts, but the Commission determined them to be Category 1 issues nonetheless.

The coal-fired alternative is the least environmentally favorable alternative due to impacts to air quality from nitrogen oxides, sulfur oxides, particulate matter, PAHs, carbon monoxide, carbon dioxide, and mercury (and the corresponding human health impacts); and construction impacts to aquatic, terrestrial, and potential historic and archaeological resources. The gas-fired alternative would have slightly lower air emissions, and impacts to aquatic, terrestrial, and historic and archaeological resources would vary depending upon location of the plant. Purchased power would likely have operational impacts that would include aspects of coal-fired, gas-fired, and existing nuclear generation.

The NRC notes that the energy conservation/energy efficiency alternative has SMALL impacts in all categories evaluated, and upon shut down of TMI-1, current operating impacts of TMI-1 would cease. Therefore, the energy conservation/energy efficiency alternative is the environmentally preferred alternative to license renewal. All other alternatives capable of meeting the needs currently served by TMI-1 entail potentially greater impacts than the proposed action of license renewal of TMI-1. The no-action alternative does not meet the purpose and need of this draft SEIS, however if it triggers the energy conservation/energy efficiency action to replace the capacity currently supplied by TMI-1, it could result in an overall SMALL impact, as well.

Table 8-6. Summary of Environmental Impacts of Selected Alternatives Compared to Continued Operation of TMI-1.

Alternative	Impact Area						
	Air Quality	Ground Water	Surface Water	Aquatic and Terrestrial Resources	Human Health	Socioeconomics	Waste Management
License Renewal	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	N/A
Supercritical coal-fired alternative at a new site	MODERATE	SMALL	SMALL	SMALL to LARGE	SMALL to MODERATE	SMALL to LARGE	SMALL
Gas-fired alternative at the TMI-1 site	MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
Gas-fired alternative at a new site	MODERATE	SMALL	SMALL	SMALL to LARGE	SMALL	SMALL to MODERATE	SMALL
Energy Conservation/ Energy Efficiency	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
Combination of Alternatives	SMALL to MODERATE	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL
No Action Alternative	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL to MODERATE	SMALL

8.9 References

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10 CFR 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

36 CFR 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of Historic Properties."

36 CFR Part 60. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 60, Section 4, "Criteria for Evaluation."

40 CFR 51. *Code of Federal Regulations*, Title 40, *Protection of Environment,* Part 51, "Requirements for Preparation, Adoption, and Submittal of Implementation Plans."

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9.0 CONCLUSION

This draft supplemental environmental impact statement (EIS) contains the preliminary environmental review of AmerGen Energy Company, LLC's (AmerGen's) application for a renewed operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1) as required by Part 51 of Title 10, of the *Code of Federal Regulations* (10 CFR Part 51), the NRC's regulations that implement the National Environmental Policy Act (NEPA). Chapter 9 presents the conclusions and recommendations from the site-specific environmental review of TMI-1 and summarizes site-specific environmental issues of license renewal that were identified during the review. The environmental impacts of license renewal are summarized in Section 9.1; a comparison of the environmental impacts of license renewal and energy alternatives is presented in Section 9.2; unavoidable impacts of license renewal and energy alternatives and resource commitments are discussed in Section 9.3; and conclusions and NRC staff recommendations are presented in Section 9.4.

9.1 Environmental Impacts of License Renewal

Our review of site-specific environmental issues in this draft supplemental EIS leads us to conclude that issuing a renewed license would have SMALL impacts for the 21 Category 2 issues applicable to license renewal and refurbishment at TMI-1, as well as environmental justice and chronic effects of electromagnetic fields.

Mitigation measures were considered for each Category 2 issue, as applicable. For ground water and surface water use issues, current measures to mitigate the environmental impacts of plant operation were found to be adequate. Potential mitigation measures for reducing impacts from thermophilic microbiological organisms resulting from TMI-1's thermal discharge include periodically monitoring for thermophilic microbiological organisms in the water and sediments near the discharge, and prohibiting recreational use near the discharge plume. The staff identified a variety of measures that could mitigate potential acute electromagnetic field impacts resulting from continued operation of the TMI-1 transmission lines, including limiting public access to transmission line structures, installing road signs at road crossings, and increasing transmission line clearances.

Mitigation measures that could reduce impacts to the terrestrial environment, as well as to the threatened and endangered species during refurbishment activities, include installing silt fences to minimize sediment transport, the use of best management practices, and restoring cleared land that remains after completion of construction. Mitigation measures to reduce potential air quality impacts resulting from refurbishment activities include implementation of a dust control plan to minimize emissions from construction activities, and the use of multiperson vans and workforce shift changes to reduce the number of vehicles on the road at any one given time.

No impacts to known historic and archaeological resources are expected from the continued operation of TMI-1 during the license renewal term. AmerGen could mitigate this impact by developing a cultural resources management plan in addition to AmerGen's review procedures. This management plan would serve to integrate cultural resource considerations with ongoing TMI-1 activities. Additionally, training of AmerGen staff in the Section 106 process would ensure that informed decisions are made when considering the effects of future projects on historic and archaeological resources. As previously discussed, lands not previously surveyed should be investigated by a professional archaeologist prior to any ground disturbance. In addition, the historical farmstead site (36Da235) should be recorded and evaluated for eligibility.

The NRC also considered cumulative impacts of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes them. The staff concluded that cumulative impacts of TMI-1 license renewal and refurbishment would be SMALL for potentially affected resources.

9.2 Comparison of Environmental Impacts of License Renewal and Alternatives

In the conclusion to Chapter 8, we determined that impacts from license renewal are generally less than the impacts of alternatives to license renewal, with the exception of energy conservation and energy efficiency. In comparing likely environmental impacts from supercritical coal-fired generation, natural gas combined-cycle generation, energy conservation and energy efficiency, and a combination alternative that included natural gas, conservation/efficiency, uprates to existing hydroelectric dams, and environmental impacts from license renewal, we found that the energy conservation and energy efficiency alternative would result in the lowest environmental impact. Based on our analysis, we found that the impacts of license renewal are reasonable in light of the impacts from alternatives to the license renewal of TMI-1.

9.3 Resource Commitments

9.3.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all feasible mitigation measures. Implementing any of the energy alternatives considered in this supplemental EIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to emission and release of various chemical and radiological constituents from power plant operations. Nonradiological emissions resulting from power plant operations are expected to comply with U.S. Environmental Protection Agency (EPA) emissions standards, though the alternative of operating a fossil-fueled power plant in some areas may worsen existing attainment issues. Chemical and radiological emissions would not exceed the National Emission Standards for Hazardous Air Pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to radiation and hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and would not exceed any standards or administrative control limits. In comparison, the alternatives entailing the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals to workers and the general public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste would also be unavoidable. In comparison, hazardous and nonhazardous wastes would also be generated at non-nuclear power generating facilities. Wastes generated during plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and State regulations. Due to the costs of handling these materials, power plant operators would be expected to conduct all activities and optimize all operations in a way that generates the smallest amount of waste practical.

9.3.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The operation of power generating facilities would result in short-term uses of the environment as described in Chapters 4, 5, 6, 7, and 8. “Short term” is the period of time during which continued power generating activities would take place.

Power plant operations would necessitate short-term use of the environment and commitments of resources, and would also commit certain resources (e.g., land and energy) indefinitely or permanently. Certain short-term resource commitments would be substantially greater under most energy alternatives, including license renewal, than under the No Action Alternative due to the continued generation of electrical power as well as continued use of generating sites and associated infrastructure. During operations, all energy alternatives would entail similar relationships between local short-term uses of the environment and the maintenance and enhancement of long term productivity.

Air emissions from power plant operations would introduce small amounts of radiological and nonradiological constituents to the region around the plant site. Over time, these emissions would result in increased concentrations and exposure, but are not expected to impact air quality or radiation exposure to the extent that public health and long-term productivity of the environment would be impaired.

Continued employment, expenditures, and tax revenues generated during power plant operations would directly benefit local, regional, and State economies over the short term. Local governments investing project-generated tax revenues into infrastructure and other required services could enhance economic productivity over the long term.

The management and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste would require an increase in energy and would consume space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Power plant facilities would be committed to electricity production over the short term. After decommissioning these facilities and restoring the area, the land could be available for other future productive uses.

Conclusion

9.3.3 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitments of resources that have been identified in this supplemental EIS. Irreversible resources refer to when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitment of resources for electrical power generation would include the commitment of land, water, energy, raw materials, and other natural and man-made resources required for power plant operations. In general, the commitment of capital, energy, labor, and material resources would also be irreversible.

The implementation of any of the energy alternatives considered in this supplemental EIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, and, in some cases, fossil fuels. These resources would be committed during the license renewal term and over the entire life cycle of the power plant and would essentially be unrecoverable.

Energy expended would be in the form of fuel for equipment, vehicles, and power plant operations and electricity for equipment and facility operations. Electricity and fuels would be purchased from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

The irreversible and irretrievable commitment of material resources includes materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. However, none of the resources used by these power generating facilities are in short supply, and, for the most part, are readily available.

Various materials and chemicals, including acids and caustics, would be required to support operations activities. These materials would be derived from commercial vendors, and their consumption is not expected to affect local, regional, or national supplies.

The treatment, storage, and disposal of spent nuclear fuel, low-level radioactive waste, hazardous waste, and nonhazardous waste would require the irretrievable commitment of energy and fuel and would result in the irreversible commitment of space in disposal facilities.

9.4 Recommendations

Based on (1) the analysis and findings in the GEIS, (2) information provided in the Environmental Report submitted by AmerGen, (3) consultation with Federal, State, and local agencies, (4) a review of pertinent documents and reports, and (5) consideration of public comments received during scoping, the preliminary recommendation of the NRC staff is that the Commission determine that the adverse environmental impacts of license renewal for TMI-1 are not so great that preserving the option of license renewal for energy planning decision makers would be unreasonable.

10.0 LIST OF PREPARERS

This supplemental EIS was prepared by members of the Office of Nuclear Reactor Regulation, with assistance from other NRC organizations and contract support from Pacific Northwest National Laboratory.

Table 10-1. List of Preparers. *Pacific Northwest National Laboratory provided contract support for the severe accident mitigation alternatives (SAMA) analysis, presented in Chapter 5 and Appendix F.*

Name	Affiliation	Function or Expertise
	Nuclear Regulatory Commission	
Briana Balsam	Nuclear Reactor Regulation	Ecology, Project Support
Dennis Beissel	Nuclear Reactor Regulation	Hydrology
Richard Bulavinetz	Nuclear Reactor Regulation	Aquatic Ecology
Andrew Carerra	Nuclear Reactor Regulation	Radiation Protection; Human Health
Jennifer Davis	Nuclear Reactor Regulation	Historic and Archaeological Resources
Nathan Goodman	Nuclear Reactor Regulation	Terrestrial Ecology
Stephen Klementowicz	Nuclear Reactor Regulation	Radiation Protection
Ekaterina Lenning	Nuclear Reactor Regulation	Air Quality
Dennis Logan	Nuclear Reactor Regulation	Ecology
Sarah Lopas	Nuclear Reactor Regulation	Project Manager, Nonradiological Waste
Robert Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Alternatives
Jeffrey Rikhoff	Nuclear Reactor Regulation	Socioeconomics; Land Use; Environmental Justice
Andrew Stuyvenburg	Nuclear Reactor Regulation	Alternatives
Allison Travers	Nuclear Reactor Regulation	Hydrology
	SAMA Contractor[(a)]	
Steve Short	Pacific Northwest National Laboratory	Severe Accidents Mitigation Alternatives
Bruce Schmitt	Pacific Northwest National Laboratory	Severe Accidents Mitigation Alternatives
Tye Blackburn	Pacific Northwest National Laboratory	Severe Accidents Mitigation Alternatives

(a) Pacific Northwest National Laboratory is operated by Batelle for the U.S. Department of Energy

11.0 INDEX

Appendix A

Comments Received on the Three Mile Island Nuclear Station, Unit 1, Environmental Review

A. Comments Received on the Three Mile Island Nuclear Station, Unit 1, Environmental Review

A.1 Comments Received During Scoping

The scoping process began on March 28, 2008 with the publication of the NRC's Notice of Intent to conduct scoping in the *Federal Register* (73 FR 16729). The scoping process included two public meetings held at The Elks Theatre and Londonderry Elementary School in Middletown, Pennsylvania on May 1, 2008. Approximately 90 people attended the meetings. After the NRC's prepared statements pertaining to the license renewal process, the meetings were open for public comments. Attendees provided oral statements that were recorded and transcribed by a certified court reporter. Transcripts of the entire meeting, as well as written statements submitted at the public meetings, were placed into the NRC are an attachment to the Scoping Summary Report dated August 8, 2008 (NRC 2008). In addition to the comments received during the public meetings, comments were received through the mail and email.

Each commenter was given a unique identifier so every comment could be traced back to its author. Table A-1 identifies the individuals who provided comments applicable to the environmental review and the Commenter ID associated with each person's set of comments. The individuals are listed in the order in which they spoke at the public meeting, and in alphabetical order for the comments received by letter or e-mail. To maintain consistency with the Scoping Summary Report, the unique identifier used in that report for each set of comments is retained in this appendix.

Specific comments were categorized and consolidated by topic. Comments with similar specific objectives were combined to capture the common essential issues raised by participants. Comments fall into one of the following general groups:

Specific comments that address environmental issues within the purview of the NRC environmental regulations related to license renewal. These comments address Category 1 (generic) or Category 2 (site-specific) issues or issues not addressed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants* (GEIS). They also address alternatives to license renewal and related Federal actions.

General comments (1) in support of or opposed to nuclear power or license renewal or (2) on the renewal process, the NRC's regulations, and the regulatory process. These comments may or may not be specifically related to the TMI-1 license renewal application.

Comments that do not identify new information for the NRC to analyze as part of its environmental review.

Comments that address issues that do not to fall within or are specifically excluded from the purview of NRC environmental regulations related to license renewal. These comments typically address issues such as the Three Mile Island Unit 2 and the 1979 accident, emergency response and preparedness, security and terrorism, energy costs, energy needs, current operational safety issues, and safety issues related to operation during the renewal period.

Table A-1. Commenters on the Scope of the Environmental Review. *Each comment is identified along with their afflliation and how their comment was submitted.*

Commenter ID	Commenter	Affiliation	Comment Source	ADAMS Accession Number
TMI-A	Scott Portzline	TMI Alert	Afternoon Scoping Meeting; Written Comments	ML081300739 ML081330183
TMI-E	Andrew Dehoff	Susquehanna River Basin Commission	Afternoon Scoping Meeting	ML081300739
TMI-F	Eric Epstein	TMI Alert	Afternoon Scoping Meeting; Written Comments	ML081300739 ML081330183
TMI-H	Mary Osborn Ouassiai	Concerned Mothers, TMI Alert	Afternoon Scoping Meeting; Written Comments; Letter	ML081300739 ML081330183 ML081690678
TMI-J	Michael Helfrich	Lower Susquehanna RIVERKEEPER	Afternoon Scoping Meeting	ML081300739
TMI-N	Rachel S. Diamond; David J. Allard	Pennsylvania Department of Environmental Protection	Letter	ML081500598
TMI-O	Michael G. Brownell	Susquehanna River Basin Commission	Letter	ML081580174

Comments received during scoping applicable to this environmental review are presented in this section along with the NRC response. The comments that are general or outside the scope of the environmental review for TMI-1 are not included here, but can be found in the Scoping Summary Report (NRC 2008).

Scoping comments are grouped in the following categories:

- Aquatic Ecology
- Water Quality and Use
- Terrestrial Resources
- Air Quality
- Nonradiological Solid Waste and Hazardous Materials
- Socioeconomics

- Human Health
- Uranium Fuel Cycle and Waste Management
- Postulated Accidents
- Alternatives

A.1.1 Aquatic Ecology

Comment: I had – we've had some concerns lately with the area that Three Mile Island is in as far as fish health. We've had some fish kills there recently, and we believe, not caused necessarily by TMI, but in the vicinity there is a decline in some fish and a decline in small mouth bass that we were observing.

Let's see. We also have concerns with thermal pollution in this area, and although the amount it seems that is going into the river is much less than some of the other contributors, we would be interested to know if there were thermal shock zones in the area similar to Brunner Island which has problems there where the hot water is meeting the cold water at different times of the year.

So although I've talked to one of the NRC biologists earlier, and they said that approximately one dead fish found per day in the intakes, I'm interested in what's going on in the effluent, and also the temperatures of that effluent, and the temperature differences between the river temperatures and the effluent. (TMI-J-1)

Comment: And also with the thermal impact as brought up, where we are pre-boiling the fish that you catch, the 102 degree temperatures, we are going to see even increased temperatures with the droughts that are occurring across the nation, and the thermal impact of nuclear power plants is going to be pronounced in decades. (TMI-A-1)

Comment: "Whether the kills are legal or not, a former southern Lancaster County worker at the Peach Bottom nuclear plant said he was "sickened" by the large numbers of sport fish he saw sucked out of the Susquehanna. "When the water comes in, fish would swim in through tunnels and swim into wire baskets," said the man who lives in southern Lancaster County and asked that his name not be used. "There were hundreds and hundreds of fish killed each day. Stripers and bass and walleye and gizzard shad and all kinds of fish. It took a forklift to carry them out. "Every species in the river comes in there when they turn those big intakes on." (Intelligencer Journal, January 15, 2005) TMI has a similar system for disposing of the fish and other organisms that make it through the intake maze. "If they get that far, they're not going back," said Pete Ressler, a spokesman for TMI owner Exelon Nuclear. "They are dumped into a container and disposed of." Will this system function in the same manner for an additional 20 years? (TMI-F-7)

Comment: The Environmental Report states that in the early study (IA, 1979) the delta T did not exceed 5 degrees F while in the later study (2006 and 2007), delta T is often greater than 10 degrees F, and at one point was over 30 degrees. The cause for the increase in temperature change should be identified, and the potential adverse impacts assessed. Dramatic changes in temperature can be as detrimental, and sometimes more so, for long-term community sustainability than high temperatures. Any thermal assessments should also include the volume of discharged water, as that parameter is important to the delta T. (TMI-O-1)

Comment: AmerGen concludes that heat shock issue does not apply to TMI-1 because the unit does not use once-through cooling. However, it is conceivable that heat shock could be an issue during extremely low flows or during unusual operations (such as unexpected flow interruption or loss of York Haven pond). Such potential should be investigated. Again, without accurate determination of discharge water quantity and temperature, AmerGen's conclusion is unfounded. (TMI-O-2)

Comment: *Irreversible and Irretrievable Resource Commitments.* There is no mention of the long-term implications to the resource of the facility's thermal discharge. (TMI-O-3)

Comment: *Short-Term Use Versus Long-Term Productivity of the Environment.* As with the previous issue, there is no recognition of the potential impact due to the facility's thermal discharge. (TMI-O-4)

Comment: The Environmental Report states the number of shad passed (total, high, and low), but does not compare those numbers to what was passed downstream at Safe Harbor. Although Safe Harbor is a significant distance downstream, the percentages should at least be mentioned as a comparison - and to put the overall restoration into context. As with previous two comments, the quantities of water withdrawn and discharged and their potential effects on shad movement should be assessed. (TMI-O-5)

Response: *The comments, in general, express concern regarding the impacts on aquatic organisms resulting from operation of the TMI-1 closed-cycle cooling system. To operate TMI-1, NRC regulations require AmerGen to comply with the Clean Water Act and its associated requirements imposed by the U.S. Environmental Protection Agency (USEPA), as part of their National Pollutant Discharge Elimination System (NPDES) permit. The NRC staff based its analysis of environmental impacts of the TMI-1 license renewal on the GEIS, which was issued in 1996, as amended in 1999. The effects of closed-cycle cooling system operation on aquatic biota are all Category 1 issues. In considering the effects of closed-cycle cooling systems on aquatic ecology in the GEIS, the staff evaluated the same issues that were evaluated for open-cycle systems, including impingement of fish and shellfish, entrainment of fish and shellfish early life stages, and thermal discharge effects. Based on reviews of literature and operation monitoring reports, consultations with utilities and regulatory agencies, and comments on the draft GEIS, these potential effects have not been shown to cause reductions in the aquatic populations near any existing nuclear power plants.*

No change in operation of the TMI-1 cooling system is expected during the license renewal term, so no change in effects of cooling towers on aquatic biota in the Susquehanna River is anticipated. However, as part of its review the NRC staff looked for any new and additional information that might call into question the conclusions reached in the GEIS for Category 1 issues – no new and significant information was identified, therefore, there are no impacts beyond those discussed in the GEIS.

Comment: It appears that all of the presented information and conclusions are based on data at least 18 years old. Reference is made to monitoring conducted from 1974-1982 and through 1990, but nothing more recent, and there is no mention of the quantity of water withdrawn and whether that has changed over time. The environmental assessment for relicensing should require the collection of new monitoring data and evaluation of that data and any changes it shows. (TMI-O-6)

Response: *The NRC staff recognizes that the amount and quality of data available for NEPA evaluations sometimes falls short of ideal, but believes that there is sufficient information available to perform an assessment of the impacts of license renewal at TMI-1. Furthermore, NRC cannot require the collection of additional aquatic ecology data to support preparation of the draft supplemental environmental impact statement (EIS). NRC staff used the best available information, drawing from a variety of sources including data collected by AmerGen, the Pennsylvania Fish and Boat Commission, the Susquehanna River Basin Commission, other governmental agencies, independent researchers, and others. If new and significant information becomes available in the future that demonstrates a significant impact to the aquatic environment as a result of continued station operation, the staff would expect the Pennsylvania Department of Environmental Protection (PADEP) to require modifications to station operation as necessary to protect aquatic resources through the NPDES permitting process.*

A.1.2 Water Quality and Use

Comment: I am Andrew Dehoff. I'm the director of planning and operations at the Susquehanna River Basin commission in Harrisburg. First off I'd like to thank NRC and AmerGen staff for including us in the informational briefings and the facility tours that took place earlier this week. It was very helpful.

SRBC is still at the stage of gathering information, and as such don't have comments, specific comments, ready to share today, but we will be submitting written comments by the deadline.

Preliminarily I can offer that SRBC's main concerns would be related to the water withdrawn from the river for plant operations, and the water used onsite, and also any changes to operations or equipment that would affect the water use on site. Some examples of other issues, we might be commenting on, would relate to the facility and its situation on the river. And by that I mean flood preparedness and drought preparedness, and the fact that there is a great deal more water use both upstream and downstream of TMI than there was when the plant began operating. Finally just a thank you to NRC for hosting this open house today, and giving us the opportunity to speak. (TMI-E)

Comment: How does the NRC plan to deal with the following water related issues and structural challenges caused by: Micro fouling versus macro foiling, micro biologically influenced corrosion, biofilm's disease causing bacteria such as Legionella and listeria, the difficulty in eliminating established biofilms, oxidizing versus nonoxidizing biocides, chlorine versus bleach, alkaline versus non-alkaline environments, possible decomposition into carcinogens, and the eastward migration of Asiatic clams, zebra mussels and the anticipated arrival quagga mussels? (TMI-F-8)

Comment: *Drinking Water.* In Section 2.91 of the Environmental Report (ER), Dauphin County is listed as having 14 public water systems. According to the Safe Drinking Water Act (SDWA) definition of a public water system, that number is incorrect. The SDWA definition of a public water supply is: *a system which provides water to the public for human consumption which has* *at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.* The definition goes on to define a community water system as: *a public water system which serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residences.* Dauphin County residents are currently served by 28 community public water supplies. The population listed for two of the largest community water supplies also appears to be incorrect; the population for United Water Pennsylvania and Pennsylvania American Water Company – Hershey should be verified with the water companies.

Table 2.9-1 of the ER lists the community public water supplies in Dauphin County that serve more than 10,000 persons. The data provided for United Water Pennsylvania should be verified because it is not correct. Also, Middletown Borough Water Authority should be included in this table. Middletown's population (including two consecutive water systems that receive all their water from Middletown) is 10,247 persons.

In Section 2.3, 4.15.1 and 4.15.2, the ER states that the plant does not use water from a public water system. The SDWA defines a nontransient noncommunity public water system as: *a public water system which is not a community water system that regularly serves at least 25 of the same persons over six months per year.* Based on this definition, the Three Mile Island facility is a public water system and provides potable water to the plant population. (TMI-N-1)

Comment: It was observed during the site tour that soil has eroded from around and behind the headwall at Outfall 001. Backfilling around and behind the headwall may be necessary to prevent damage to the discharge line. (TMI-N-2)

Comment: Although generally satisfied with the ground water explanation, the 'glacial' materials could not in fact have been deposited by glaciers as their limit of extent is some 20 miles north of TMI. Water in the Gettysburg shale is commonly considered to be semi-confined and not artesian. (TMI-O-7)

Comment: SRBC has approved Wells 1, 2, and 3 (aka A, B, C) for industrial water supply and is perplexed to learn that the OSF Well is also used to augment the supply of service water. If this is the case, the well would require review and approval by SRBC. (TMI-O-8)

Comment: *EPA-Regulated Facilities in Dauphin, Lancaster and York Counties.* Review of the impacts of extending TMI's license should include analysis of potential effects of TMI's water use and thermal discharge on the operations and/or waste assimilation capability of downstream withdrawals and discharges; likewise, the operation, withdrawals and discharges of upstream facilities should be analyzed for potential impacts to TMI's operations and thermal discharge assimilation. (TMI-O-9)

Comment: The potential for nearby power facilities to impact TMI's operations, and vice versa, should be evaluated. Of particular concern is operations during periods of severe low flow and extreme temperatures, including heat and river ice conditions. (TMI-O-10)

Comment: What is the auxiliary water? What are the provisions for backup supply? What is the source of auxiliary? Has it been sufficiently reviewed, and does it have the appropriate permits? (TMI-O-11)

Comment: AmerGen concludes that any impacts caused by TMI-1 make-up water withdrawal would be “SMALL” and would not warrant additional mitigation. What is the conclusion based on? How small is “SMALL”? The assumptions and conditions used in the analysis should be provided; they may not be valid if the same assumptions and conditions were used as in the original siting study 40 years ago. In particular, the amount of other consumptive water use on the river both upstream and downstream of TMI has changed dramatically, and will continue to grow. Natural hydrologic conditions may also have changed. Without a demonstration of accurate accounting for water withdrawal and discharge, it is impossible to assess potential impacts to downstream water users. (TMI-O-12)

Comment: The assessment should include the potential impact of all ground water wells on site. The conclusions presented in the Environmental Report are based on the well withdrawals already approved by SRBC; however, there is at least one additional unapproved well in production. The 1996 pump tests cited by AmerGen do not include any unapproved wells, and are thus insufficient to evaluate potential ground water use conflicts.

The use of additional unapproved wells has likely increased the quantity of ground water withdrawal on site. It appears that all ground water evaluations in the Environmental Report are based on the withdrawal quantity from approved wells only; all assessments involving ground water impacts or conflicts should be performed again using an accurate value for total ground water withdrawal.

Applicant should assess the potential ground water conflicts among wells in their own system, to ensure their long-term viability. (TMI-O-13)

Comment: What is the basis for the conclusion by AmerGen that the impacts of the river withdrawal to local ground water are small? The details of that analysis should be made available for review.

As the Environmental Report states, SRBC directs the release of storage on behalf of TMI during times of drought. However, the quantity released is equivalent only to the consumptive loss at the plant, and not the total withdrawal, which is considerably greater. Further, replacement releases are made only during very severe droughts, and not during moderate droughts and other short-term periods of unusually low flows. Thus, despite releases by SRBC, there remains the potential for ground water impacts due to the difference between total withdrawal and consumptive loss, and during periods of moderate and short-term severe droughts. These potential impacts should be assessed.

There is no documentation presented demonstrating that TMI-1’s surface water withdrawal is capturing only river water, and not also drawing ground water from the adjacent aquifer. (TMI-O-14)

Comment: In addition to the impacts listed, other unavoidable impacts include thermal discharge and localized impacts of the river withdrawal. There may be others. (TMI-O-15)

Comment: Not listed among the resource commitments is the water demand. The water lost through plant operations is removed from the Susquehanna River Basin forever, and it is a cumulative loss that will continue through the end of license period. The long-term commitment and ultimate loss of that water renders it unavailable for use by any other power plant, water supply intake, recreational interest, aquatic habitat, or inflow to Chesapeake Bay. It is also important to note that renewal of the license commits that water in such a way that it is also unavailable to uses upstream of TMI, in order to ensure its continued availability for use at the plant. It is unexpected to find that AmerGen would overlook a resource as critical and integral to plant operations, as well as to the natural, social and economic development of the entire region, in its Environmental Report. (TMI-O-16)

Response: *The comments, in general, pertain to the plant's consumptive use of surface water from the Susquehanna River, ground water resources in the vicinity of TMI-1, the plant's use of ground water, and the plants impact on surface and ground water quality. Surface and ground water use and water quality issues, including cumulative impacts, are Category 2 issues and are addressed in Sections 2.1.7, 2.2.3, 2.2.4, 4.3, and 4.4 of this draft supplemental EIS.*

Comment: *Water Quality.* During steam generator replacement, high pressure water will be used to cut openings in the Unit 1 containment building. The containment building walls are made of concrete and are approximately 3 feet thick. According to AmerGen personnel, a temporary package plant will be used to treat wastewater from cutting activities (i.e., to settle suspended concrete particles and adjust pH) before discharge to the Susquehanna River. A temporary discharge permit is required for this plant. As an alternative, wastewater from this operation can be collect and sent off-site for treatment. Under no circumstances should this wastewater stream be sent to the existing wastewater treatment plant. Also, AmerGen should notify the DEP once the package plant is installed so DEP personnel can inspect it and sample the discharge. (TMI-N-3)

Comment: *Water Resources.* If transportation of the new generators along Pennsylvania highways or bridges requires any transportation system upgrades or other work, that work may encroach upon wetlands or waterways. Federal and State wetlands and stream encroachment permits or authorizations may be required for such encroachments. A 401 certification may also be necessary. Contrary to the statement made in the EIS, TMI's National Pollutant Discharge Elimination System (NPDES) permit (i.e., discharge permit) does not carry with it a new 401 certification. (TMI-N-4)

Comment: An erosion and sedimentation plan, and possibly a construction stormwater NPDES permit, will be required for earth disturbance associated with the new building construction. (TMI-N-5)

Response: *The comments pertain to AmerGen's planned replacement of the TMI-1 once-through steam generators. Environmental impacts of refurbishment activities are evaluated in Chapter 3 of this draft supplemental EIS. Impacts of refurbishment on ground water and surface water use and quality were examined in the GEIS and are Category 1 impacts. During its review the NRC did not identify any new and additional information that would call into question the conclusions reached in the GEIS for Category 1 issues. Chapter 3 also addresses the impact of refurbishment activities on threatened and endangered species, including aquatic species that may be impacted by erosion into and sedimentation of the Susquehanna River.*

A.1.3 Terrestrial Resources

Comment: AmerGen should consider enhancement of the created open-water wetlands established on-site from the original plant excavations. Such enhancements would be used to offset any impacts to aquatic resources that may occur as the result of its intake or other project activities. (TMI-N-6)

Comment: What is the value and quality of the wetlands that have been formed from the borrow pits? Consideration should be given to undertaking some enhancement features - perhaps in conjunction with a local environmental group. (TMI-O-17)

Response: *The potential impacts of the continued operation of TMI-1 on terrestrial ecology is a is addressed in Sections 2.2.6 and 4.6. Impacts of continued operation on terrestrial ecology were examined in the GEIS and are Category 1 impacts. During its review, the NRC did not identify any new and additional information that would call into question the conclusions reached in the GEIS for Category 1 issues. Impacts of continued operation to protected terrestrial species is a Category 2 issue and is addressed in Sections 2.2.7 and 4.7 of this draft supplemental EIS.*

A.1.4 Air Quality

Comment: *Asbestos*. As the date of construction falls within the general timeframe when the use of asbestos-containing materials (ACM) was phased out, there is some possibility that ACM maybe be present on-site. In the event that the project includes disturbance of any ACM, it may be subject to the federal asbestos regulations found at 40 CFR Part 61, Subpart M, beginning at 40 CFR 61.140. (TMI-N-7)

Comment: *Fugitive Emissions.* Construction and earthmoving activities must comply with 25 Pa. Code Sections 123.1 and 123.2. These sections generally require that: 1) reasonable measures must be taken to minimize airborne dust nuisances from construction activities, 2) any dirt drag-out onto paved streets must be promptly removed, and 3) any airborne dust generated from construction activities may not visibly cross off-property. (TMI-N-8)

Response: *The comments pertain to impacts to air quality during AmerGen's planned replacement of the TMI-1 once-through steam generators. Impacts to air quality during refurbishment activities is a Category 2 issue and is evaluated in Section 3.2.3 of this draft supplemental EIS.*

A.1.5 Nonradiological Solid Waste and Hazardous Materials

Comment: AmerGen should consider deconstruction and salvage to reduce waste disposal to the extent possible. All construction and demolition waste that cannot be salvaged or recycled should be properly transported and disposed of at a DEP-permitted facility. Open burning of waste is not acceptable. (TMI-N-9)

Comment: Documentation should be provided demonstrating that the flood protection dike – or the location and storage of hazardous material – ensures there is protection from contamination during the flood of record. (TMI-O-18)

Response: *Nonradioactive waste management and pollution prevention is discussed in Section 2.1.3 of this draft supplemental EIS. The staff reviewed the plant's protocols for storing and managing hazardous materials on site, however, the Pennsylvania Department of Environmental Protection has ultimate authority in implementing regulations regarding the treatment, storage, and disposal of hazardous materials.*

A.1.6 Socioeconomics

Comment: How many people work at TMI-1? How many people worked at TMI-1 when AmerGen purchased the plant from GPU? How many people does the NRC project will be working at TMI-1 in 20 years? Can you factor economics, staffing levels, or the tax base into a relicensing decision? (TMI-F-10)

Response: *The comments are related to the socioeconomic impacts associated with the continued operation or closure of TMI-1. Socioeconomic impacts such as housing, transportation, employment, and land use are Category 2 issues and are addressed in Sections 2.2.8 and 4.9 of this draft EIS.*

A.1.7 Human Health

Comment: TMI is located on Susquehanna River so any leaking contaminants from waste storage facilities will flow towards and eventually into the Bay. There are no monitoring wells lining the shoreline. Tritium and other leaks – examples and NRC policy on self-monitoring - also exist at Three Mile Island. How has the NRC changed modified its relicensing process to evaluate tritium monitoring? (TMI-F-11)

Comment: It was reported last year that tritium was being found in the ground water. We would like to know the extent of that, where the plumes of this are; also whether we can expect this to be increasing. Don't know that much about it, so I'd like to learn a lot more. But obviously when we are dealing with radiation and things with potentially very long half-lives, bioaccumulate – or accumulation in the environment is definitely a concern. So even though we were all – supposedly our concerns were quelled last year that these levels were not very high, if this is an ongoing issue, we would definitely want to know more about that, and have some kind of comparison to a more virgin area, perhaps somewhere far from nuclear reactors, that we might be able to get a better comparison of that. (TMI-J-2)

Comment: In sections 2.2.3 and 5.1, the report mentions an Environmental Protection Agency (EPA) drinking water standard for tritium of 20,000 pCi/L, which is used as a reference value to add perspective to results obtained in the their ground water monitoring program. Based on the method EPA uses to calculate the maximum contaminant level (MCL) for beta particle and photo radioactivity (of which tritium is a constituent), the report should have referenced the fact that gross beta analysis is routinely conducted and tritium is the only constituent which is detected in the samples. The clarification would better explain what contaminants are analyzed for, which have been detected, and how they relate to EPA's drinking water standards. (TMI-N-10)

Comment: AmerGen references data presented in Section 2.3 on ground water resources at TMI, concluding that tritium in the on-site ground water is not a threat to nearby ground water sources because the Susquehanna River acts as a boundary between the island and the aquifers on the east and west shore. If that is the case, what amount of tritium is being delivered to and carried away by the Susquehanna River? What is the potential impact to the aquatic community of such delivery? Have the appropriate regulatory agencies been properly notified? (TMI-O-19)

Comment: I would be very interested in getting some biological studies of the macro-invertebrates in the area, including radiation testing. I would also like someone to look at the mussels. The mussels are very much ignored in the Susquehanna River, but throughout the United States, 70 percent of our mussel species are endangered or threatened. And the mussels are the longest living thing I believe in the river. Some mussels – we are not entirely sure how long some of them live, but some of them have been known to live 120 years. The ones that we know of in the Susquehanna live up to 40 years, and we think that testing the mussels would be a good gauge of telling radiological bioaccumulation. (TMI-J-3)

Comment: The greater number of adverse health effects from nukes occur predominantly downwind and go further than five miles, depend on atmospheric conditions and in the older plants (which now include all U.S. nukes) – case the classic mutations in flora and fauna exposed. Which includes much of the food we eat. Mutated tomatoes, yellow squash, zucchini, peaches, plums, corn, turnips and even a Heinz pickle have been grown, not only from TMI country a few other areas as well. Do you care? (TMI-H-1)

Comment: Are the existing monitoring wells adequate (appropriate locations and density) to capture any problems? Has the risk of radwaste on the island contaminating local aquifers or water supply wells been assessed? Is there any need to consider monitoring quality and quantity at some neighboring residences or businesses? (TMI-O-20)

Comment: Radioactive Liquid Waste Disposal System: There is no mention of restrictions to liquid radwaste discharge during periods of low flow. There should be an analysis of appropriate flow thresholds below which it is inadvisable to discharge radwaste. There is no discussion in the application of precautions against spills or other accidental introduction of radwaste to surface or ground water. (TMI-O-21)

Response: *NRC regulations require licensees to control and limit radioactive releases, including tritium, to the environment (the air and water) to very small amounts. As part of the NRC requirements for operating a nuclear power facility, licensees must keep releases of radioactive material into the environment during normal operations as low as is reasonably achievable (ALARA), as required by 10 CFR Part 50.36a, and comply with radiation dose limits for the public in 10 CFR Part 20. For liquid discharges, the ALARA standard is to keep the annual dose to a member of the public to no more than 3 mrem. In comparison, the annual dose to an average member of the public from background radiation is approximately 300 mrem.*

TMI-1 conducts a radiological environmental monitoring program (REMP) in which radiological impacts to the environment and the public around the TMI-1 site are monitored, documented, and compared to NRC standards. AmerGen summarizes the results of their REMP in an Annual Radiological Environmental Operating Report. The reports are publicly available on the NRC's public website. The purpose of TMI-1's REMP is to:

- *Evaluate the relationship between quantities of radioactive material released from the plant and resultant radiation doses to individuals from principle pathways of exposure;*
- *Provide data on measurable levels of radiation and radioactive materials in the site environs;*
- *To verify in-plant controls for the containment of radioactive materials;*
- *To determine buildup of long-lived radionuclides in the environment and changes in background radiation levels;*
- *To provide reassurance to the public that the program is capable of adequately assessing impacts and identifying noteworthy changes in the radiological status of the environment; and*
- *To fulfill the requirements of the TMI-1 Technical Specifications.*

The REMP samples environmental media in the environs around the site to analyze and measure the radioactivity levels that may be present. The media samples are representative of the radiation exposure pathways to the public from all plant radioactive effluents. The REMP measures direct radiation, the airborne, and the waterborne pathways for radioactivity in the vicinity of the TMI-1 site. Direct radiation pathways include radiation from buildings and plant structures and airborne material that may be released from the plant. In addition, the REMP also measures background radiation (i.e. cosmic sources, and naturally occurring radioactive material, including radon and global fallout). Thermoluminescent dosimeters (TLDs) are used to measure direct radiation. The airborne pathway includes measurements of air, precipitation, drinking water, and broad leaf vegetation samples. The waterborne pathway consists of measurements of surface water, drinking water, effluent water, storm water, ground water, and fish and sediment from the Susquehanna River.

For TMI-1, the waterborne pathway consists of Susquehanna River water, fish and invertebrates, aquatic vegetation, bottom sediment, and shoreline soil. The NRC requires that only commercially or recreationally important species in the vicinity of the discharge point be sampled and analyzed. Other species, like mussels, while present in the area, do not represent a significant dose pathway to humans and are not required to be discussed in the radiological environmental report.

The REMP provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposure to members of the public. It does not require that every type of environmental media or biota in the area be sampled and analyzed.

The results of the REMP are intended to supplement the results of the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive material and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways. The two programs work together as a *check against each other. The* 2007 Annual Radiological Environmental Monitoring Report for TMI-1 *can be viewed in the ADAMS Public Electronic Reading Room, at accession number ML081300255.*

In addition to the routine REMP, starting in 2006, AmerGen implemented a ground water monitoring program at TMI-1. This monitoring program was added by AmerGen to assure that potential liquid release pathways were being thoroughly evaluated. The program is used to characterize any onsite contamination, to quantify and determine its potential onsite and offsite radiological impact to the workers, public and surrounding environment, and to aid in identification and repair of any leaking systems, structures, or components.

As noted in one of the comments, in September 2005, TMI-1 had a localized tritium leakage inside a utility access manway in the owner-controlled area. The highest concentration of tritium detected in one water sample from inside the manway was 45,000 picoCuries per liter. The U.S. Environmental Protection Agency's drinking water standard is 20,000 picoCuries per liter; however this water is not used for drinking. The leak was found and fixed. Sampling conducted at nearby ground water wells did not have elevated levels of tritium. State and federal officials were informed of the issue and kept updated throughout the event. A detailed discussion of the inspection performed by the NRC for this event can be found in the ADAMS Public Electronic Reading Room, at accession number ML062070664.

The radiological effluent monitoring and environmental monitoring programs are part of the NRC's routine inspection program of every nuclear power plant to ensure compliance with regulatory requirements. For license renewal, the NRC staff reviewed these areas and discussions are presented in Sections 2.1.2 and 4.8 of this draft supplemental EIS.

Comment: AmerGen has implemented a long-term ground water monitoring effort at TMI-1 referred to as the Radiological Ground Water Protection Program (RGPP). Prior to AmerGen's submittal of the license application to the Nuclear Regulatory Commission (NRC), DEP had requested that the licensee provide a description of the TMI-1 RGPP. Although the inclusion of this program in the license renewal application is not required by the Nuclear Regulatory Commission (NRC), AmerGen responded favorably to DEP's request. The program description, as included in the Environmental Section of the license renewal application (Appendix E), indications that a primary purpose of the RGPP is to provide timely detection and response to any radiological releases to ground water. Based on the information provided in this document and DEP's independent review of the TMI-1 RGPP, it has concluded that AmerGen has taken appropriate measures to protect public health and safety and the environment, both during current and extended periods of TMI-1 operations. DEP will continue to monitor AmerGen's activities in this area. This effort includes frequent interactions with the TMI-1 Environmental Monitoring Program staff and sampling of selected on-site monitoring wells, as deemed necessary. (TMI-N-11)

Response: *Sections 4.8 and 4.9.7 of this draft supplemental EIS contain the NRC staff's evaluation of the applicant's environmental monitoring program.*

Comment: DEP participated in the NRC's environmental audit of TMI-1 license renewal application during the week of April 28, 2008. At the time of the audit, DEP requested additional information regarding the Solid Waste Staging Facility (SWSF) at TMI-1. This facility is a passive system for temporary stating of radioactive waste prior to shipment to a disposal facility. The information requested by DEP includes a description of the system design, a description of the facility leak collection and monitoring systems, and a document identifying on-site monitoring wells within the SWSF area. DEP has reviewed the information provided by AmerGen and has no concerns. However, DEP staff will continue to perform on-site surveillances at the TMI site to verify the condition of the SWSF and to periodically review the sample results from the adjacent monitoring wells. (TMI-N-13)

Response: *This comment is general in nature, regarding the TMI-1 Solid Waste Staging Facility and on-site monitoring wells. The comment provided no new and significant information, and was not evaluated further.*

Comment: Have the owners of TMI-1 reassessed the National Academy of Science's statements on the harmful effects of low dose radiation exposure? After learning this from Dr. Helen Caldicott and Dr. Carl Johnson 29 years ago – the truth about the lower levels of radiation exposure has finally been realized by National Academy of Science! (TMI-H-2)

Response: *The GEIS evaluated human health issues and determined them to be a Category 1 issue. The amount of radioactive material released from nuclear power facilities is well measured, well monitored, and known to be very small. The doses of radiation that are received by members of the public as a result of exposure to nuclear power facilities are so low that resulting cancers have not been observed and would not be expected. A number of studies of cancer incidence in the vicinity of nuclear power facilities have been conducted and there are no studies to date that are accepted by the scientific community that show a correlation between radiation dose from nuclear power facilities and cancer incidence in the general public. The comments were noted but provided no new and significant information and were not evaluated further.*

A.1.8 Uranium Fuel Cycle and Waste Management

Comment: Paducah, Kentucky, talking about the – one speaker just a few minutes ago mentioned that there is no greenhouse gases released. That is not accounting for the mining and the whole fuel cycle which you would probably have to take into effect when they do an analysis, but the NRC is not going to look at that when it comes to operating this specific plant.

Paducah, Kentucky, emitted – one enrichment facility was emitting 88 percent of all United States CFC ozone-eating gas, 88 percent of all those produced gases came from that plant. That's – that was pretty bad. Fortunately they fixed some of those leaks in the refrigeration system. (TMI-A-4)

Response: *The carbon footprint of nuclear energy (including its fuel cycle) and alternative energy sources is an air quality issue. Air quality issues were evaluated in the GEIS and determined to be Category 1 issues. Although these comments do not provide any new and significant information on air quality pertaining to the relicensing of TMI-1, the carbon footprint of nuclear power versus other alternate energy sources is addressed in Chapter 8 (alternatives) of this draft EIS.*

Comment: Barnwell S.C. announced that it will close to generators on June 20, 2008. The NRC staff concluded that there was no new and significant information and therefore there would be no impacts of low level waste storage and disposal associated with the renewal term. The GEIS stated that, "…The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small." TMI is located on Susquehanna River so any leaking contaminants from waste storage facilities will flow towards and eventually into the Bay. There are no monitoring wells lining the shoreline. We deserve to know what the LLRW storage plans are before the application is decided; so that the re-licensing decision does not prejudge any LLRW storage decision. Where will the LLRW going to be stored? For how long? And will the location be above the flood plain? (TMI-F-15)

Response: *The comment is related to the environmental impacts associated with Low Level Radioactive Waste Management (LLRW), which was evaluated in the GEIS and determined to be a Category 1 issue. The GEIS evaluated impacts associated with LLRW management for all plants, including TMI-1, and determined that the impact was small. During the plant-specific environmental review of TMI-1, the NRC staff reviewed the future actions planned to be taken at the TMI-1 site for the storage of LLRW (see Section 2.1.2.3) and did not identify any new and significant information that would call into the question the conclusions contained in the GEIS regarding LLRW.*

A.1.9 Postulated Accidents

Comment: A few points to address some other things that came up after I spoke. The atmospheric sciences, I saw that is part of the environmental concerns, seems to me recognition by the nuclear industry that the atmosphere is changing; that there is more energy; that global warming may be occurring. They are certainly advertising to that extent to have people view nuclear power more favorably.

And if that were true then we do need to study the fact that the weather has more energy, and tornadoes are more severe, floods are more severe. There is a trend growing. It's not hard to see that in the next 10 to 20 years there could be some serious problems with tornadoes at nuclear plants like what happened at Davis-Besse a few years ago where the control room operator said, when they went into a station blackout situation, that their hearts went into their throat until finally things started to settle down a little bit. But at first they had power problems where they couldn't even read their control panels.

So I'd like to see that issue also cross-ties in with the security issues, where the loss of off-site power and station blackout can be caused by terrorism. The same thing can happen with a tornado, and that we need redundancy systems for – to prevent station blackout. There has been some discussion of that with the security discussions, but with environmental impact assessment including atmospheric sciences, I think that falls there too. So we've got to look at the floods. Don't forget, we had a bad flood in 1972, excuse me, the Agnes Flood, which flooded Three Mile Island. (TMI-A-6)

Comment: "AmerGen prepared this sever accident mitigation alternatives analysis… with support from it's parent company, Exelon." In case of another accident at TMI, and since AmerGen received the support from its parent company, Exelon, will Exelon also be held liable for costs and damages to the offsite humans, fauna and flora? Based on the continuing adverse effects caused by TMI-1's brother plant, TMI-2, State, Federal, and local governments must demand accountability next time – as many failed their constituents while, while few helped. (TMI-H-5)

Comment: "Benefits, costs, and net value of implementing potential S.A.M.A.'s" – Your cost-risk benefits have never been humane – benefitting only corporate profits (as usual – the NRC's actions assist those they are to regulate instead of health and safety of those paying taxes to play their employees.) Remember Davis-Besse?

Cost-Risk benefits actually should only be for promoting and protecting the life and health of humans, flora and the planet. Corporate greed is the predominant cause of our earth in distress from global warming and also nuclear-atomic zapping! Bomb fallout and Chernobyl dust is still circling the planet and TMI mutations 29 years later are still growing – with another bumper crop this year! (TMI-H-6)

Comment: Ground Water use must be considered a significant issue due to the fact that nuclear plan uptake of water is only possible with what nature provides, and as the earthquakes in China (5/2008) caused flow of rivers to cease and become a lake instead – you must be prepared for the unexpected. Especially since TMI-1 and TMI-2 are on an earthquake fault line. Remember April 22, 1984, where the meter was set so high it didn't register the quake – but the control room operators did feel the 4.0 quake, centered in Lancaster County, under TMI and under my home as well. (TMI-H-16)

Comment: A reassessment of likely flood scenarios should be performed. The original assumptions related to the hydrology, flow patterns, and flood return intervals of the Susquehanna River are likely outdated, and certainly do not account for potential changes over the course of the extended license period due to climate change or other phenomena. (TMI-O-26)

Response: *The comments are related to the impacts of design basis accidents and severe accidents. The impacts of design basis accidents were evaluated in the GEIS and determined to be small for all plants; therefore, it is a Category 1 issue. The impact of severe accidents is a Category 2 issue and must have a site-specific evaluation. Additionally, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. The applicant provided a severe accident mitigation alternatives (SAMA) analysis as part of the license renewal application for TMI-1. The NRC staff's review of the SAMA analysis is discussed in Section 5.3 and Appendix F of this draft supplemental EIS for TMI-1.*

A.1.10 Alternatives

Comment: Number one is conservation. Also energy created on site, on homes – not by greedy corporate energy producers. The hydrogen fuel cell home created by college students had a cost to build – but once built the cost of energy to operate the home was a big, fat zero = $0. Antiquated machinery is currently still in use because the money goes to support and finance nukes. Ancient Greece used solar and so did Florida – until electricity came along.

The time to change was 29 years ago – you obviously did not learn the lessons – even after Chernobyl. Shut-down nuclear TMI-1, put windmills on your cooling towers, solar on your parking lots – hydro from your little dam – non-tritiated water for geothermal under your ground – waste and non-food biomass. And conservation! No more subsidies to you for your ultra-hazardous (atomic bomb making) method of energy production. But going solar is what I recommend for your future. So that our will have a future. (TMI-H-4)

Comment: The assessment of alternatives in Chapter 7 is limited entirely to alternatives for power production in lieu of continued operation of TMI. An evaluation should also be conducted of alternatives to specific current operating practices at TMI that would allow continued generation at the plant, but with lesser impacts to the air, soil, and water resources of the region. Technology has advanced a great deal in the 40 years that have passed since the design of TMI-1, and its adoption and use on-site should be investigated as a condition of license renewal. (TMI-O-23)

Response: *The comments are related to the environmental impacts of alternatives to license renewal for TMI-1. Environmental impacts associated with various reasonable alternatives, including a combination of energy sources, conservation, coal and natural gas, to renewal of the operating licenses for TMI-1 is evaluated in Chapter 8 of this draft supplemental EIS.*

A.2 References

73 FR 16729. U.S. Nuclear Regulatory Commission, Washington, D.C, "Three Mile Island Nuclear Station, Unit 1; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process." *Federal Register:* Vol. 73, No. 61, pp. 16729–16731. March 28, 2008.

NRC (U.S. Nuclear Regulatory Commission). 2008. "Environmental Impact Statement Scoping Process Summary Report, Three Mile Island Nuclear Station, Unit 1." ADAMS Accession No. ML081920230.

Appendix B

NEPA Issues for License Renewal of Nuclear Power Plants

B. NEPA Issues for License Renewal of Nuclear Power Plants

Table B-1. Summary of Issues and Findings. *This table is taken from Table B-1 in Appendix B, Subpart A, to 10 CFR Part 51. Data supporting this table are contained in NUREG-1437,* Generic Environmental Impact Statement for License Renewal of Nuclear Plants. *Throughout this report, "Generic" issues are also referred to as Category 1 issues, and "Site-specific" issues are also referred to as Category 2 issues.*

Issue	Type of Issue	Finding
	Surface Water Quality, Hydrology, and Use	
Impacts of refurbishment on surface water quality	Generic	SMALL. Impacts are expected to be negligible during refurbishment because best management practices are expected to be employed to control soil erosion and spills.
Impacts of refurbishment on surface water use	Generic	SMALL. Water use during refurbishment will not increase appreciably or will be reduced during plant outage.
Altered current patterns at intake and discharge structures	Generic	SMALL. Altered current patterns have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered salinity gradients	Generic	SMALL. Salinity gradients have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Altered thermal stratification of lakes	Generic	SMALL. Generally, lake stratification has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Temperature effects on sediment transport capacity	Generic	SMALL. These effects have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Scouring caused by discharged cooling water	Generic	SMALL. Scouring has not been found to be a problem at most operating nuclear power plants and has caused only localized effects at a few plants. It is not expected to be a problem during the license renewal term.

Issue	Type of Issue	Finding
Eutrophication	Generic	SMALL. Eutrophication has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Discharge of chlorine or other biocides	Generic	SMALL. Effects are not a concern among regulatory and resource agencies, and are not expected to be a problem during the license renewal term.
Discharge of sanitary wastes and minor chemical spills	Generic	SMALL. Effects are readily controlled through NPDES permit and periodic modifications, if needed, and are not expected to be a problem during the license renewal term.
Discharge of other metals in wastewater	Generic	SMALL. These discharges have not been found to be a problem at operating nuclear power plants with cooling-tower-based heat dissipation systems and have been satisfactorily mitigated at other plants. They are not expected to be a problem during the license renewal term.
Water use conflicts (plants with once-through cooling systems)	Generic	SMALL. These conflicts have not been found to be a problem at operating nuclear power plants with once-through heat dissipation systems.
Water use conflicts (plants with cooling ponds or cooling towers using make-up water from a small river with low flow)	Site-specific	SMALL OR MODERATE. The issue has been a concern at nuclear power plants with cooling ponds and at plants with cooling towers. Impacts on instream and riparian communities near these plants could be of moderate significance in some situations. See § 51.53(c)(3)(ii)(A).
	Aquatic Ecology	
Refurbishment	Generic	SMALL. During plant shutdown and refurbishment there will be negligible effects on aquatic biota because of a reduction of entrainment and impingement of organisms or a reduced release of chemicals.

Issue	Type of Issue	Finding
Accumulation of contaminants in sediments or biota	Generic	SMALL. Accumulation of contaminants has been a concern at a few nuclear power plants but has been satisfactorily mitigated by replacing copper alloy condenser tubes with those of another metal. It is not expected to be a problem during the license renewal term.
Entrainment of phytoplankton and zooplankton	Generic	SMALL. Entrainment of phytoplankton and zooplankton has not been found to be a problem at operating nuclear power plants and is not expected to be a problem during the license renewal term.
Cold shock	Generic	SMALL. Cold shock has been satisfactorily mitigated at operating nuclear plants with once-through cooling systems, has not endangered fish populations or been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds, and is not expected to be a problem during the license renewal term.
Thermal plume barrier to migrating fish	Generic	SMALL. Thermal plumes have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Distribution of aquatic organisms	Generic	SMALL. Thermal discharge may have localized effects but is not expected to affect the larger geographical distribution of aquatic organisms.
Premature emergence of aquatic insects	Generic	SMALL. Premature emergence has been found to be a localized effect at some operating nuclear power plants but has not been a problem and is not expected to be a problem during the license renewal term.
Gas supersaturation (gas bubble disease)	Generic	SMALL. Gas supersaturation was a concern at a small number of operating nuclear power plants with once-through cooling systems but has been satisfactorily mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.

Issue	Type of Issue	Finding
Low dissolved oxygen in the discharge	Generic	SMALL. Low dissolved oxygen has been a concern at one nuclear power plant with a once-through cooling system but has been effectively mitigated. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses	Generic	SMALL. These types of losses have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Stimulation of nuisance organisms (e.g., shipworms)	Generic	SMALL. Stimulation of nuisance organisms has been satisfactorily mitigated at the single nuclear power plant with a once-through cooling system where previously it was a problem. It has not been found to be a problem at operating nuclear power plants with cooling towers or cooling ponds and is not expected to be a problem during the license renewal term.
Aquatic Ecology (for plants with once-through and cooling pond heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of entrainment are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. Further, ongoing efforts in the vicinity of these plants to restore fish populations may increase the numbers of fish susceptible to intake effects during the license renewal period, such that entrainment studies conducted in support of the original license may no longer be valid. See § 51.53(c)(3)(ii)(B).
Impingement of fish and shellfish	Site-specific	SMALL, MODERATE, OR LARGE. The impacts of impingement are small at many plants but may be moderate or even large at a few plants with once-through and cooling-pond cooling systems. See § 51.53(c)(3)(ii)(B).

Issue	Type of Issue	Finding
Heat shock	Site-specific	SMALL, MODERATE, OR LARGE. Because of continuing concerns about heat shock and the possible need to modify thermal discharges in response to changing environmental conditions, the impacts may be of moderate or large significance at some plants. See § 51.53(c)(3)(ii)(B).
Aquatic Ecology (for plants with cooling-tower-based heat dissipation systems)		
Entrainment of fish and shellfish in early life stages	Generic	SMALL. Entrainment of fish has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Impingement of fish and shellfish	Generic	SMALL. The impingement has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Heat shock	Generic	SMALL. Heat shock has not been found to be a problem at operating nuclear power plants with this type of cooling system and is not expected to be a problem during the license renewal term.
Ground Water Use and Quality		
Impacts of refurbishment on ground water use and quality	Generic	SMALL. Extensive dewatering during the original construction on some sites will not be repeated during refurbishment on any sites. Any plant wastes produced during refurbishment will be handled in the same manner as in current operating practices and are not expected to be a problem during the license renewal term.
Ground water use conflicts (potable and service water; plants that use <100 gpm)	Generic	SMALL. Plants using less than 100 gpm are not expected to cause any ground water use conflicts.
Ground water use conflicts (potable and service water, and dewatering plants that use >100 gpm)	Site-specific	SMALL, MODERATE, OR LARGE. Plants that use more than 100 gpm may cause ground water use conflicts with nearby ground water users. See § 51.53(c)(3)(ii)(C).

Issue	Type of Issue	Finding
Ground water use conflicts (plants using cooling towers withdrawing make-up water from a small river)	Site-specific	SMALL, MODERATE, OR LARGE. Water use conflicts may result from surface water withdrawals from small water bodies during low flow conditions which may affect aquifer recharge, especially if other ground water or upstream surface water users come on line before the time of license renewal. See § 51.53(c)(3)(ii)(A).
Ground water use conflicts (Ranney wells)	Site-specific	SMALL, MODERATE, OR LARGE. Ranney wells can result in potential ground water depression beyond the site boundary. Impacts of large ground water withdrawal for cooling tower makeup at nuclear power plants using Ranney wells must be evaluated at the time of application for license renewal. See § 51.53(c)(3)(ii)(C).
Ground water quality degradation (Ranney wells)	Generic	SMALL. Ground water quality at river sites may be degraded by induced infiltration of poor-quality river water into an aquifer that supplies large quantities of reactor cooling water. However, the lower quality infiltrating water would not preclude the current uses of ground water and is not expected to be a problem during the license renewal term.
Ground water quality degradation (saltwater intrusion)	Generic	SMALL. Nuclear power plants do not contribute significantly to saltwater intrusion.
Ground water quality degradation (cooling ponds in salt marshes)	Generic	SMALL. Sites with closed-cycle cooling ponds may degrade ground water quality. Because water in salt marshes is brackish, this is not a concern for plants located in salt marshes.
Ground water quality degradation (cooling ponds at inland sites)	Site-specific	SMALL, MODERATE, OR LARGE. Sites with closed-cycle cooling ponds may degrade ground water quality. For plants located inland, the quality of the ground water in the vicinity of the ponds must be shown to be adequate to allow continuation of current uses. See § 51.53(c)(3)(ii)(D).

Terrestrial Ecology		
Refurbishment impacts	Site-specific	SMALL, MODERATE, OR LARGE. Refurbishment impacts are insignificant if no loss of important plant and animal habitat occurs. However, it cannot be known whether important plant and animal communities may be affected until the specific proposal is presented with the license renewal application. See § 51.53(c)(3)(ii)(E).
Cooling tower impacts on crops and ornamental vegetation	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling tower impacts on native plants	Generic	SMALL. Impacts from salt drift, icing, fogging, or increased humidity associated with cooling tower operation have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Bird collisions with cooling towers	Generic	SMALL. These collisions have not been found to be a problem at operating nuclear power plants and are not expected to be a problem during the license renewal term.
Cooling pond impacts on terrestrial resources	Generic	SMALL. Impacts of cooling ponds on terrestrial ecological resources are considered to be of small significance at all sites.
Power line right of way management (cutting and herbicide application)	Generic	SMALL. The impacts of right-of-way maintenance on wildlife are expected to be of small significance at all sites.
Bird collisions with power lines	Generic	SMALL. Impacts are expected to be of small significance at all sites.
Impacts of electromagnetic fields on flora and fauna	Generic	SMALL. No significant impacts of electromagnetic fields on terrestrial flora and fauna have been identified. Such effects are not expected to be a problem during the license renewal term.

Floodplains and wetland on power line right of way	Generic	SMALL. Periodic vegetation control is necessary in forested wetlands underneath power lines and can be achieved with minimal damage to the wetland. No significant impact is expected at any nuclear power plant during the license renewal term.
	Threatened and Endangered Species	
Threatened or endangered species	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are not expected to adversely affect threatened or endangered species. However, consultation with appropriate agencies would be needed at the time of license renewal to determine whether threatened or endangered species are present and whether they would be adversely affected. See § 51.53(c)(3)(ii)(E).
	Air Quality	
Air quality during refurbishment (non-attainment and maintenance areas)	Site-specific	SMALL, MODERATE, OR LARGE. Air quality impacts from plant refurbishment associated with license renewal are expected to be small. However, vehicle exhaust emissions could be cause for concern at locations in or near nonattainment or maintenance areas. The significance of the potential impact cannot be determined without considering the compliance status of each site and the numbers of workers expected to be employed during the outage. See § 51.53(c)(3)(ii)(F).
Air quality effects of transmission lines	Generic	SMALL. Production of ozone and oxides of nitrogen is insignificant and does not contribute measurably to ambient levels of these gases.
	Land Use	
Onsite land use	Generic	SMALL. Projected onsite land use changes required during refurbishment and the renewal period would be a small fraction of any nuclear power plant site and would involve land that is controlled by the applicant.
Power line right of way	Generic	SMALL. Ongoing use of power line right of ways would continue with no change in restrictions. The effects of these restrictions are of small significance.

		Human Health
Radiation exposures to the public during refurbishment	Generic	SMALL. During refurbishment, the gaseous effluents would result in doses that are similar to those from current operation. Applicable regulatory dose limits to the public are not expected to be exceeded.
Occupational radiation exposures during refurbishment	Generic	SMALL. Occupational doses from refurbishment are expected to be within the range of annual average collective doses experienced for pressurized-water reactors and boiling-water reactors. Occupational mortality risk from all causes including radiation is in the mid-range for industrial settings.
Microbiological organisms (occupational health)	Generic	SMALL. Occupational health impacts are expected to be controlled by continued application of accepted industrial hygiene practices to minimize worker exposures.
Microbiological organisms (public health)(plants using lakes or canals, or cooling towers or cooling ponds that discharge to a small river)	Site-specific	SMALL, MODERATE, OR LARGE. These organisms are not expected to be a problem at most operating plants except possibly at plants using cooling ponds, lakes, or canals that discharge to small rivers. Without site-specific data, it is not possible to predict the effects generically. See § 51.53(c)(3)(ii)(G).
Noise	Generic	SMALL. Noise has not been found to be a problem at operating plants and is not expected to be a problem at any plant during the license renewal term.
Electromagnetic fields – acute effects (electric shock)	Site-specific	SMALL, MODERATE, OR LARGE. Electrical shock resulting from direct access to energized conductors or from induced charges in metallic structures have not been found to be a problem at most operating plants and generally are not expected to be a problem during the license renewal term. However, site-specific review is required to determine the significance of the electric shock potential at the site. See § 51.53(c)(3)(ii)(H).

Electromagnetic fields – chronic effects	Uncategorized	UNCERTAIN. Biological and physical studies of 60-Hz electromagnetic fields have not found consistent evidence linking harmful effects with field exposures. However, research is continuing in this area and a consensus scientific view has not been reached.
Radiation exposures to public (license renewal term)	Generic	SMALL. Radiation doses to the public will continue at current levels associated with normal operations.
Occupational radiation exposures (license renewal term)	Generic	SMALL. Projected maximum occupational doses during the license renewal term are within the range of doses experienced during normal operations and normal maintenance outages, and would be well below regulatory limits.
	Socioeconomic Impacts	
Housing impacts	Site-specific	SMALL, MODERATE, OR LARGE. Housing impacts are expected to be of small significance at plants located in a medium or high population area and not in an area where growth control measures that limit housing development are in effect. Moderate or large housing impacts of the workforce associated with refurbishment may be associated with plants located in sparsely populated areas or in areas with growth control measures that limit housing development. See § 51.53(c)(3)(ii)(I).
Public services: public safety, social services, and tourism, and recreation	Generic	SMALL. Impacts to public safety, social services, and tourism and recreation are expected to be of small significance at all sites.
Public services: public utilities	Site-specific	SMALL OR MODERATE. An increased problem with water shortages at some sites may lead to impacts of moderate significance on public water supply availability. See § 51.53(c)(3)(ii)(I).
Public services: education (refurbishment)	Site-specific	SMALL, MODERATE, OR LARGE. Most sites would experience impacts of small significance but larger impacts are possible depending on site- and project-specific factors. See § 51.53(c)(3)(ii)(I).

Public services: education (license renewal term)	Generic	SMALL. Only impacts of small significance are expected
Offsite land use (refurbishment)	Site-specific	SMALL OR MODERATE. Impacts may be of moderate significance at plants in low population areas. See § 51.53(c)(3)(ii)(I).
Offsite land use (license renewal term)	Site-specific	SMALL, MODERATE, OR LARGE. Significant changes in land use may be associated with population and tax revenue changes resulting from license renewal. See § 51.53(c)(3)(ii)(I).
Public services: transportation	Site-specific	SMALL, MODERATE, OR LARGE. Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with the additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J).
Historic and archaeological resources	Site-specific	SMALL, MODERATE, OR LARGE. Generally, plant refurbishment and continued operation are expected to have no more than small adverse impacts on historic and archaeological resources. However, the National Historic Preservation Act requires the Federal agency to consult with the State Historic Preservation Officer to determine whether there are properties present that require protection. See § 51.53(c)(3)(ii)(K).
Aesthetic impacts (refurbishment)	Generic	SMALL. No significant impacts are expected during refurbishment.
Aesthetic impacts (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
Aesthetic impacts of transmission lines (license renewal term)	Generic	SMALL. No significant impacts are expected during the license renewal term.
	Postulated Accidents	
Design basis accidents	Generic	SMALL. The NRC staff has concluded that the environmental impacts of design basis accidents are of small significance for all plants.

Severe accidents	Site-specific	SMALL. The probability weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to ground water, and societal and economic impacts from severe accidents are small for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. See § 51.53(c)(3)(ii)(L).
	Uranium Fuel Cycle and Waste Management	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high level waste)	Generic	SMALL. Off-site impacts of the uranium fuel cycle have been considered by the Commission in Table S-3 of this part. Based on information in the GEIS, impacts on individuals from radioactive gaseous and liquid releases including radon-222 and technetium-99 are small.
Offsite radiological impacts (collective effects)	Generic	The 100 year environmental dose commitment to the U.S. population from the fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be about 14,800 person rem, or 12 cancer fatalities, for each additional 20-year power reactor operating term. Much of this, especially the contribution of radon releases from mines and tailing piles, consists of tiny doses summed over large populations. This same dose calculation can theoretically be extended to include many tiny doses over additional thousands of years as well as doses outside the U. S. The result of such a calculation would be thousands of cancer fatalities from the fuel cycle, but this result assumes that even tiny doses have some statistical adverse health effect which will not ever be mitigated (for example no cancer cure in the next thousand years), and that these doses projected over thousands of years are meaningful. However, these assumptions are questionable. In particular, science cannot rule out the possibility that there will be no cancer fatalities from these tiny doses. For perspective, the doses are very small fractions of regulatory limits, and even smaller fractions of natural background exposure to the same populations. Nevertheless, despite all the uncertainty, some

		judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the commission has not assigned a single level of significance for the collective effects of the fuel cycle, this issue is considered Category 1 [Generic].
Offsite radiological impacts (spent fuel and high level waste disposal)	Generic	For the high level waste and spent fuel disposal component of the fuel cycle, there are no current regulatory limits for offsite releases of radionuclides for the current candidate repository site. However, if we assume that limits are developed along the lines of the 1995 National Academy of Sciences (NAS) report, "Technical Bases for Yucca Mountain Standards," and that in accordance with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository can and likely will be developed at some site which will comply with such limits, peak doses to virtually all individuals will be 100 millirem per year or less. However, while the Commission has reasonable confidence that these assumptions will prove correct, there is considerable uncertainty since the limits are yet to be developed, no repository application has been completed or reviewed, and uncertainty is inherent in the models used to evaluate possible pathways to the human environment. The NAS report indicated that 100 millirem per year should be considered as a starting point for limits for individual doses, but notes that some measure of consensus exists among national and international bodies that the limits should be a fraction of the 100 millirem per year. The lifetime individual risk from 100 millirem annual dose limit is about 3×10^{-3}. Estimating cumulative doses to populations over thousands of years is more problematic. The likelihood and consequences of events that could seriously compromise the integrity of a deep geologic repository were evaluated by the

Department of Energy in the "Final Environmental Impact Statement: Management of Commercially Generated Radioactive Waste," October 1980. The evaluation estimated the 70-year whole-body dose commitment to the maximum individual and to the regional population resulting from several modes of breaching a reference repository in the year of closure, after 1,000 years, after 100,000 years and after 100,000,000 years. Subsequently, the NRC and other federal agencies have expended considerable effort to develop models for the design and for the licensing of a high level waste repository, especially for the candidate repository at Yucca Mountain. More meaningful estimates of doses to population may be possible in the future as more is understood about the performance of the proposed Yucca Mountain repository. Such estimates would involve very great uncertainty, especially with respect to cumulative population doses over thousands of years. The standard proposed by the NAS is a limit on maximum individual dose. The relationship of potential new regulatory requirements, based on the NAS report, and cumulative population impacts has not been determined, although the report articulates the view that protection of individuals will adequately protect the population for a repository at Yucca Mountain. However, EPA's generic repository standards in 40 CFR Part 191 generally provide an indication of the order of magnitude of cumulative risk to population that could result from the licensing of a Yucca Mountain repository, assuming the ultimate standards will be within the range of standards now under consideration. The standards in 40 CFR Part 191 protect the population by imposing amount of radioactive material released over 10,000 years. The cumulative release limits are based on EPA's population impact goal of 1,000 premature cancer deaths worldwide for a 100,000 metric ton (MTHM) repository.

Nevertheless, despite all the uncertainty, some judgment as to the regulatory NEPA implications of these matters should be made and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the

		Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent fuel and high level waste disposal, this issue is considered in Category 1 [Generic].
Nonradiological impacts of the uranium fuel cycle	Generic	SMALL. The nonradiological impacts of the uranium fuel cycle resulting from the renewal of an operating license for any plant are found to be small.
Low-level waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls that are in place and the low public doses being achieved at reactors ensure that the radiological impacts to the environment will remain small during the term of a renewed license. The maximum additional on-site land that may be required for low-level waste storage during the term of a renewed license and associated impacts will be small. Nonradiological impacts on air and water will be negligible. The radiological and nonradiological environmental impacts of long-term disposal of low-level waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient low-level waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.

Mixed waste storage and disposal	Generic	SMALL. The comprehensive regulatory controls and the facilities and procedures that are in place ensure proper handling and storage, as well as negligible doses and exposure to toxic materials for the public and the environment at all plants. License renewal will not increase the small, continuing risk to human health and the environment posed by mixed waste at all plants. The radiological and nonradiological environmental impacts of long-term disposal of mixed waste from any individual plant at licensed sites are small. In addition, the Commission concludes that there is reasonable assurance that sufficient mixed waste disposal capacity will be made available when needed for facilities to be decommissioned consistent with NRC decommissioning requirements.
On-site spent fuel	Generic	SMALL. The expected increase in the volume of spent fuel from an additional 20 years of operation can be safely accommodated on site with small environmental effects through dry or pool storage at all plants if a permanent repository or monitored retrievable storage is not available.
Nonradiological waste	Generic	SMALL. No changes to generating systems are anticipated for license renewal. Facilities and procedures are in place to ensure continued proper handling and disposal at all plants.
Transportation	Generic	SMALL. The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S–4 – Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in § 51.52.

Decommissioning		
Radiation doses	Generic	SMALL. Doses to the public will be well below applicable regulatory standards regardless of which decommissioning method is used. Occupational doses would increase no more than 1 man-rem caused by buildup of long-lived radionuclides during the license renewal term.
Waste management	Generic	SMALL. Decommissioning at the end of a 20-year license renewal period would generate no more solid wastes than at the end of the current license term. No increase in the quantities of Class C or greater than Class C wastes would be expected.
Air quality	Generic	SMALL. Air quality impacts of decommissioning are expected to be negligible either at the end of the current operating term or at the end of the license renewal term.
Water quality	Generic	SMALL. The potential for significant water quality impacts from erosion or spills is no greater whether decommissioning occurs after a 20-year license renewal period or after the original 40-year operation period, and measures are readily available to avoid such impacts.
Ecological resources	Generic	SMALL. Decommissioning after either the initial operating period or after a 20-year license renewal period is not expected to have any direct ecological impacts.
Socioeconomic impacts	Generic	SMALL. Decommissioning would have some short-term socioeconomic impacts. The impacts would not be increased by delaying decommissioning until the end of a 20-year relicense period, but they might be decreased by population and economic growth.
Environmental Justice		
Environmental Justice	Uncategorized	NONE. The need for and the content of an analysis of environmental justice will be addressed in plant-specific reviews.

Appendix C

Applicable Regulations, Laws, and Agreements

C. Applicable Regulations, Laws, and Agreements

The Atomic Energy Act authorizes States to establish programs to assume NRC regulatory authority for certain activities. For example, through the Agreement State Program, beginning on March 31, 2008, Pennsylvania assumed regulatory responsibility over certain byproduct, source, and small quantities of special nuclear material. The Pennsylvania Department of Environmental Protection (PADEP) is responsible for implementing State nuclear regulations, which are contained in Title 25 of the Pennsylvania (Pa) Code, *Environment*, Article V, *Radiological Health*, Chapters 215 through 240.

In addition to implementing some Federal programs, State legislatures develop their own laws. State statutes supplement as well as implement Federal laws for protection of air, water quality, and ground water. State legislation may address solid waste management programs, locally rare or endangered species, and historic and cultural resources.

The Clean Water Act (CWA) allows for primary enforcement and administration through State agencies, provided the State program is at least as stringent as the Federal program. The State program must conform to the CWA and to the delegation of authority for the Federal National Pollutant Discharge and Elimination System (NPDES) program from the EPA to the State. The primary mechanism to control water pollution is the requirement for direct dischargers to obtain an NPDES permit, or in the case of states where the authority has been delegated from the EPA, an SPDES permit, pursuant to the CWA. In Pennsylvania, the PADEP issues and enforces NPDES permits.

One important difference between Federal regulations and certain State regulations is the definition of waters regulated by the State. Certain state regulations may include underground waters, while the CWA only regulates surface waters.

C.1 State Environmental Requirements

Certain environmental requirements, including some discussed earlier, may have been delegated to State authorities for implementation, enforcement, or oversight. Table C-1 provides a list of representative State environmental requirements that may affect license renewal applications for nuclear power plants.

Table C-1. State Environmental Requirements. TMI-1 is subject to numerous State requirements regarding their environmental program. Those requirements are briefly described below. See Section 1.9 for TMI-1's compliance status with these requirements.

Law/Regulation	Requirements
Air Quality Protection	
Air Pollution Control Act, PA Public Law (P.L.) 2119 and 25 Pa Code Chapter 127	All emission sources at TMI-1 must obtain a Synthetic Minor Operating Permit prior to operation; the PADEP issues and enforces permits.

Table C-1. State Environmental Requirements. TMI-1 is subject to numerous State requirements regarding their environmental program. Those requirements are briefly described below. See Section 1.9 for TMI-1's compliance status with these requirements.

Law/Regulation	Requirements
Water Resources Protection	
Clean Water Act (CWA) (33 U.S.C. Section 1251 et seq.); Pennsylvania's Clear Streams Law, as amended (35 Pennsylvania Statute [P.S.] Section 691.1 et seq.)	The National Pollutant Discharge Elimination System (NPDES) permit is required for plant industrial, sanitary, and stormwater discharges to the Susquehanna River. The NPDES permit requires the compliance of each point source with authorized discharge levels, monitoring requirements, and other appropriate requirements. The PADEP is the responsible State agency for NPDES permitting.
CWA (33 U.S.C. Section 401)	The *Clean Water Act* Section 401 Water Quality Certification requires a Section 401 water quality certification and payment of applicable fees before the issuance of a Federal permit or license to conduct any activity that may result in any discharge to waters of the State. In Pennsylvania, State issuance of an NPDES permit constitutes 401 Certification.
Susquehanna River Basin Compact, P.L. 91-575, Article 3, Section 3.10; and Susquehanna River Basin Commission (SRBC) Regulation 803.61	Requires a permit to cover consumptive water use over 20,000 gallons per day (gpd) (over a 30-day average) of surface and ground water; the SRBC is the regulatory agency that issues and enforces consumptive water use permits.
Susquehanna River Basin Compact, P.L. 91-575, Article 3, Section 3.10; and SRBC Regulation 803.43	The Compact requires a permit to cover ground water withdrawals over 100,000 gpd or more (over a 30-day average) of surface water, ground water, or a combination of the two; the SRBC is the regulatory agency that issues and enforces ground water withdrawal permits.
P.L. 834, 204, 851, 1987, etc.	The U.S. Army Corps of Engineers issues maintenance dredging permits for maintenance dredging of the TMI-1 intake bay.
P.L. 555, as amended	Maintenance dredging of the TMI-1 intake bay in the Susquehanna River also requires a maintenance dredging permit issued by the PADEP.
Pennsylvania Safe Drinking Water Act (P.L. 206, No. 43)	The PADEP issues and enforces public water supply permits for operation TMI-1 plant site drinking water systems.

Table C-1. State Environmental Requirements. TMI-1 is subject to numerous State requirements regarding their environmental program. Those requirements are briefly described below. See Section 1.9 for TMI-1's compliance status with these requirements.

Law/Regulation	Requirements
Waste Management and Pollution Prevention	
Pennsylvania Storage Tank and Spill Prevention Act (35 P.S. 6021.1016021.2104); 25 PA Code Chapter (Ch.) 245	The PADEP issues storage tank registration and permit certificates, which establish annual registration requirements for underground storage tanks containing petroleum or other regulated substances.
Pennsylvania Fire Marshall; Pennsylvania Storage Tank and Spill Prevention Act (35 P.S. 6021.1016021.2104); 25 PA Code Ch. 245	The Act requires a flammable and combustible liquid storage tank approval to construct or operate an underground storage tank containing flammable or combustible liquids.
71 P.S. Sections 510520; Sections 5 and 402 of The Clean Streams Law (35 P.S. 691.5 and 691.402); Section 9 of the Pennsylvania Sewage Facilities Act (35 P.S. Section 750.9).	The PADEP issues sewage sludge disposal agreements, which are required for the disposal of sewage sludge. The PADEP also issues on-lot sewage disposal system permits, and permit modifications for approvals of additional flows to on-lot sewage treatment systems.

C.2 Operating Permits and Other Requirements

Several operating permit applications may be prepared and submitted, and regulator approval and permits would be received prior to license renewal approval by the NRC. Table C-2 lists representative Federal, State, and local permits.

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Table C-2. Federal, State, and Local Permits and Other Requirements. TMI-1 is subject to other requirements regarding various aspects of their environmental program. Those requirements are briefly described below.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Air Quality Protection			
Approval (operating permit) for construction or modification of an air pollutant source.	PADEP	*Clean Air Act*, Title V, Sections 501-507 (42 U.S.C. 7661-7661f); Pa Code Ch.127	AmerGen may need to modify its existing Synthetic Minor Operating Permit, or apply for a new permit for temporary emissions associated with refurbishment.
Water Resources Protection			
NPDES permit for construction site storm water and other project-specific discharges.	PADEP	CWA (33 U.S.C. 1251 et seq.); 40 CFR Part 122; 25 Pa Code Ch. 92	AmerGen may need to modify the existing TMI-1 NPDES permit, or otherwise obtain authorization for temporary discharges associated with refurbishment.
Requires review and approval of any project that will result in consumptive use of water from the Susquehanna River.	SRBC	Susquehanna River Basin Compact; P.L. 91-575, Article 3, Section 3.10; 18 CFR Part 806; 25 Pa Code Ch. 806	Modifications to the existing TMI-1 consumptive water use permit may be necessary to supply water for refurbishment activities.
Requires any person withdrawing or diverting in excess of an average of 10,000 gpd for any consecutive 30-day period, from ground or surface water sources to register the amount of the withdrawal.	SRBC	Susquehanna River Basin Compact; P.L. 91-575, Article 3, Section 3.10; 18 CFR Part 807; 25 Pa Code Ch. 807	Refurbishment activities at TMI-1 may require additional ground water or surface water withdrawal; the existing TMI-1 water withdrawal permit may require modification.

Table C-2. Federal, State, and Local Permits and Other Requirements. TMI-1 is subject to other requirements regarding various aspects of their environmental program. Those requirements are briefly described below.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
Requires a permit be obtained before construction, modification, removal, destruction, or abandonment of an obstruction in a floodplain.	PADEP	Flood Plain Management Act (32 P.S. 679.101-679.601); 25 Pa Code Ch. 106	AmerGen is reviewing flood plain elevations associated with refurbishment activities; if avoidance is not possible, AmerGen will apply for appropriate permits.
A Spill Prevention Control and Countermeasures (SPCC) Plan is required for any facility that could discharge diesel fuel in harmful quantities into navigable waters or onto adjoining shorelines.	PADEP	CWA (33 U.S.C. 1251 et seq.); 40 CFR Part 112; 25 Pa Code Ch. 245	A SPCC Plan is required at nuclear power plants storing large volumes of diesel fuel or other petroleum products. AmerGen may need to modify its existing SPCC Plan, or develop a new plan to cover activities associated with refurbishment.
New Underground Storage Tanks System Registration is required within 30 days of bringing a new underground storage tank system into service.	PADEP	RCRA, as amended, Subtitle I (42 U.S.C. 6991a-6991i); 40 CFR §280.22; Storage Tank and Spill Prevention (35 P.S. 6021.101-6021.2104); 25 Pa Code, Ch. 245	Required if new underground storage tank systems would be installed during refurbishment at a nuclear power plant.
Waste Management and Pollution Prevention			
Registration and Hazardous Waste Generator Identification Number are required before a facility that generates over 100 kg (220 lb) per calendar month of hazardous waste ships the hazardous waste off-site	PADEP	RCRA, as amended (42 U.S.C. 6901 et seq.), Subtitle C; 25 Pa Code Articles VII (Hazardous Waste Management) and IX (Residual Waste	Generators of hazardous waste must notify EPA that the wastes exist and require management in compliance with RCRA. AmerGen will characterize wastes generated by refurbishment to determine proper disposal procedures and permit requirements.

Table C-2. Federal, State, and Local Permits and Other Requirements. TMI-1 is subject to other requirements regarding various aspects of their environmental program. Those requirements are briefly described below.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
		Management)	
Emergency Planning and Response			
Submission of a list of Material Safety Data Sheets is required for hazardous chemicals (as defined in 29 CFR Part 1910) that are stored onsite in excess of their threshold quantities.	State and local emergency planning agencies	Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), Section 311 (42 U.S.C. 11021); 40 CFR §370.20	Nuclear power plant operators are required to submit a List of Material Safety Data Sheets to State and local emergency planning agencies.
Transportation of Radioactive Wastes and Conversion Products Packaging, Labeling, and Routing Requirements for Radioactive Materials is required for packages containing radioactive materials that will be shipped by truck or rail.	U.S. Department of Transportation	HMTA (49 U.S.C. 1501 et seq.); Atomic Energy Act (AEA), as amended (42 U.S.C. 2011 et seq.); 49 CFR Parts 172, 173, 174, 177, and 397	When shipments of radioactive materials are made, nuclear power plant operators would comply with U.S. Department of Transportation packaging, labeling, and routing requirements.
Biotic Resource Protection			
Threatened and Endangered Species Consultation is required between the responsible Federal agencies and affected States to ensure that the project is not likely to: (1) jeopardize the continued existence of any species listed at the Federal or State level as endangered or threatened; or (2) result in destruction of critical habitat of such species.	U.S. Fish and Wildlife Service (FWS) and State agencies	*Endangered Species Act* of 1973, as amended (16 U.S.C. 1531 et seq.)	NRC would consult with FWS and State agencies regarding the impact of license renewal on threatened or endangered species or their critical habitats.
Clean Water Act Section 404 (Dredge and Fill) Permit is required to place dredged or fill material into waters of the U.S., including areas designated as	U.S. Army Corps of Engineers	CWA (33 U.S.C. 1251 et seq.); 33 CFR Parts 323 and	Any dredging or placement of fill material into wetlands within the jurisdiction of the U.S. Army Corps of Engineers at a nuclear power

Table C-2. Federal, State, and Local Permits and Other Requirements. TMI-1 is subject to other requirements regarding various aspects of their environmental program. Those requirements are briefly described below.

License, Permit, or Other Required Approval	Responsible Agency	Authority	Relevance and Status
wetlands, unless such placement is exempt or authorized by a nationwide permit or a regional permit; a notice must be filed if a nationwide or regional permit applies.		330	plant would require a Section 404 permit. AmerGen is reviewing options for transportation of the new steam generators from Port Deposit, Maryland, to the TMI-1 site. If the selected route requires dredge or fill activities, AmerGen would have to apply for a section 404 permit.
Cultural Resources Protection			
Archaeological and Historical Resources Consultation is required before a Federal agency approves a project in an area where archaeological or historic resources might be located.	Pennsylvania Historic and Museum Commission	*National Historic Preservation Act* of 1966, as amended (16 U.S.C. 470 et seq.); *Archaeological and Historical Preservation Act* of 1974 (16 U.S.C. 469-469c-2); Antiquities Act of 1906 (16 U.S.C. 431 et seq.); *Archaeological Resources Protection Act* of 1979, as amended (16 U.S.C. 470aa-mm)	NRC would consult with the State and Tribal Historic Preservation Officers and representative Indian tribes regarding the impacts of license renewal and the results of archaeological and architectural surveys of nuclear power plant sites.

Appendix D

Consultation Correspondence

D. Consultation Correspondences

The Endangered Species Act of 1973, as amended, the Magnuson-Stevens Fisheries Management Act of 1996, as amended; and the National Historic Preservation Act of 1966 require that Federal agencies consult with applicable State and Federal agencies and groups prior to taking action that may affect threatened and endangered species, essential fish habitat, or historic and archaeological resources, respectively. This appendix contains consultation documentation.

Table D-1. Consultation Correspondences. *This is a list of the consultation documents sent between the NRC and other agencies we are required to consult with based on NEPA requirements.*

Author	Recipient	Date of Letter
U.S. Nuclear Regulatory Commission (L. Lund)	U.S. Fish and Wildlife Service (D. Densmore)	April 4, 2008
U.S. Nuclear Regulatory Commission (L. Lund)	Oneida Indian Nation (R. Halbritter)	April 9, 2008[(a)]
U.S. Nuclear Regulatory Commission (L. Lund)	Advisory Council on Historic Preservation (C. Vaughn)	April 15, 2008
U.S. Nuclear Regulatory Commission (L. Lund)	Pennsylvania Department of Conservation and Natural Resources (C. Firestone)	April 15, 2008
U.S Nuclear Regulatory Commission (L. Lund)	Pennsylvania Fish and Boat Commission (C. Urban)	April 15, 2008
U.S Nuclear Regulatory Commission (L. Lund)	Pennsylvania Game Commission (L. Leigey)	April 15, 2008
U.S. Nuclear Regulatory Commission (L. Lund)	Pennsylvania Historical and Museum Commission (J. Cutler)	April 15, 2008
Stockbridge-Munsee Tribal Historic Preservation Office (S. White)	U.S. Nuclear Regulatory Commission (L. Lund)	April 21, 2008

Author	Recipient	Date of Letter
U.S. Fish and Wildlife Service (D. Densmore)	U.S. Nuclear Regulatory Commission (L. Lund)	April 23, 2008
Pennsylvania Department of Conservation and Natural Resources (R. Bowen)	U.S. Nuclear Regulatory Commission (L. Lund)	May 2, 2008
Pennsylvania Game Commission (J. Leigey)	U.S. Nuclear Regulatory Commission (L. Lund)	May 14, 2008
Pennsylvania Fish and Boat Commission (C. Urban)	U.S. Nuclear Regulatory Commission (S. Lopas)	June 3, 2008

(a) Similar letters went to fourteen other Native American Tribes listed in Section 1.8.

D.1 Consultation Correspondence

The following pages contain copies of the letters listed in Table D-1. Figures contained in the first letter (pages D-6 and D-7) were included with each letter.

April 4, 2008

Mr. David Densmore
U.S. Fish & Wildlife Service
Pennsylvania Field Office
315 South Allen Street, Suite 322
State College, PA 16801-4850

SUBJECT: REQUEST FOR LIST OF PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Densmore:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by AmerGen Energy Company, LLC (AmerGen), for the renewal of the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1). TMI-1 is located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife. This letter is being submitted under the provisions of the Endangered Species Act of 1973, as amended, and the Fish and Wildlife Coordination Act of 1934, as amended.

AmerGen is requesting renewal of its operating license for TMI-1 for a period of 20 years beyond the expiration of the current license term of April 2014. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. For the purpose of license renewal, AmerGen plans to replace the TMI-1 steam generators, and estimates that the total area disturbed by construction, decontamination, and laydown activities would be less than 10 acres, all of which would be previously disturbed property within the bounds of the TMI-1 flood protection dike.

The TMI-1 site encompasses several properties that total approximately 440 acres, including: the physical plant location on 200 acres of the 370-acre Three Mile Island; St. John's Island and Evergreen Island (also referred to as "Sand Beach Island"), together totaling 31 acres; a 6.4-acre section of Shelley Island, which is part of the western half of the TMI-1 Exclusion Area; and a 32-acre strip of land east of Three Mile Island along the eastern shore of the Susquehanna River; please see the attached site boundary map. The TMI-1 site is surrounded by fencing and contains few areas of undeveloped or undisturbed land; undeveloped land on Three Mile Island lies south of TMI-1 facilities. The majority of this land lies under the ten-year flood level, and contains wetlands and fallow field areas surrounded by a woodland buffer. Riparian buffer areas are intact around the perimeter of the island, although forested riparian areas only occur on the southern part of the island.

D. Densmore - 2 -

TMI-1 utilizes two hyperbolic natural draft cooling towers for dissipating heat from the plant steam cycle. The circulating water and service water systems withdraw water from the Susquehanna River, and are supplemented by three groundwater wells. TMI-1 has a permit with the Susquehanna River Basin Commission for consumptive use of river water up to 18 million gallons per day, on a monthly average, for electric generation. River water enters the intake structure located on the western bank of the island, passes under a skimmer wall, through automated trash racks with 1-inch vertical bar spacing, through 3/8-inch-mesh traveling screens, through the river water pumps, and finally through 1/8-inch-mesh strainers before entering the heat exchangers. Approximately 3000 gallons per minute of cooling tower blowdown are discharged to the Susquehanna River through a 48-inch-diameter river discharge line.

Four 230-kilovolt (kV) transmission lines totaling 5.6 miles of corridor and approximately 142 acres connect TMI-1 to the regional transmission system; please see the attached TMI-1 transmission system map. Two of these lines connect the plant with the substation at Middletown Junction, east of the Susquehanna River; each of these lines extends 1.5 miles. A third line extends for 4.1 miles to the west side of the Susquehanna River, where it connects to a 230-kV line terminating into the substation near Jackson – this line crosses the river twice. The fourth line extends 0.7 miles east across the Susquehanna River to the TMI-1 500-kV substation.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on Federally listed, proposed, and candidate species and critical habitat that may be in the vicinity of TMI-1 and its associated transmission line corridors. In addition, please provide any information you consider appropriate under the provisions of the Fish and Wildlife Coordination Act.

The NRC staff plans to hold two public NEPA scoping meetings on May 1, 2008. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:00 p.m., as necessary. In addition, during the week of April 28, 2008, the NRC plans to conduct a site audit. You and your staff are invited to attend both the public meetings and the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2008.

D. Densmore - 3 -

If you have any questions concerning the NRC staff's review of this license renewal application, please contact Ms. Sarah Lopas, License Renewal Project Manager, at 301-415-1147 or sll2@nrc.gov.

Sincerely,

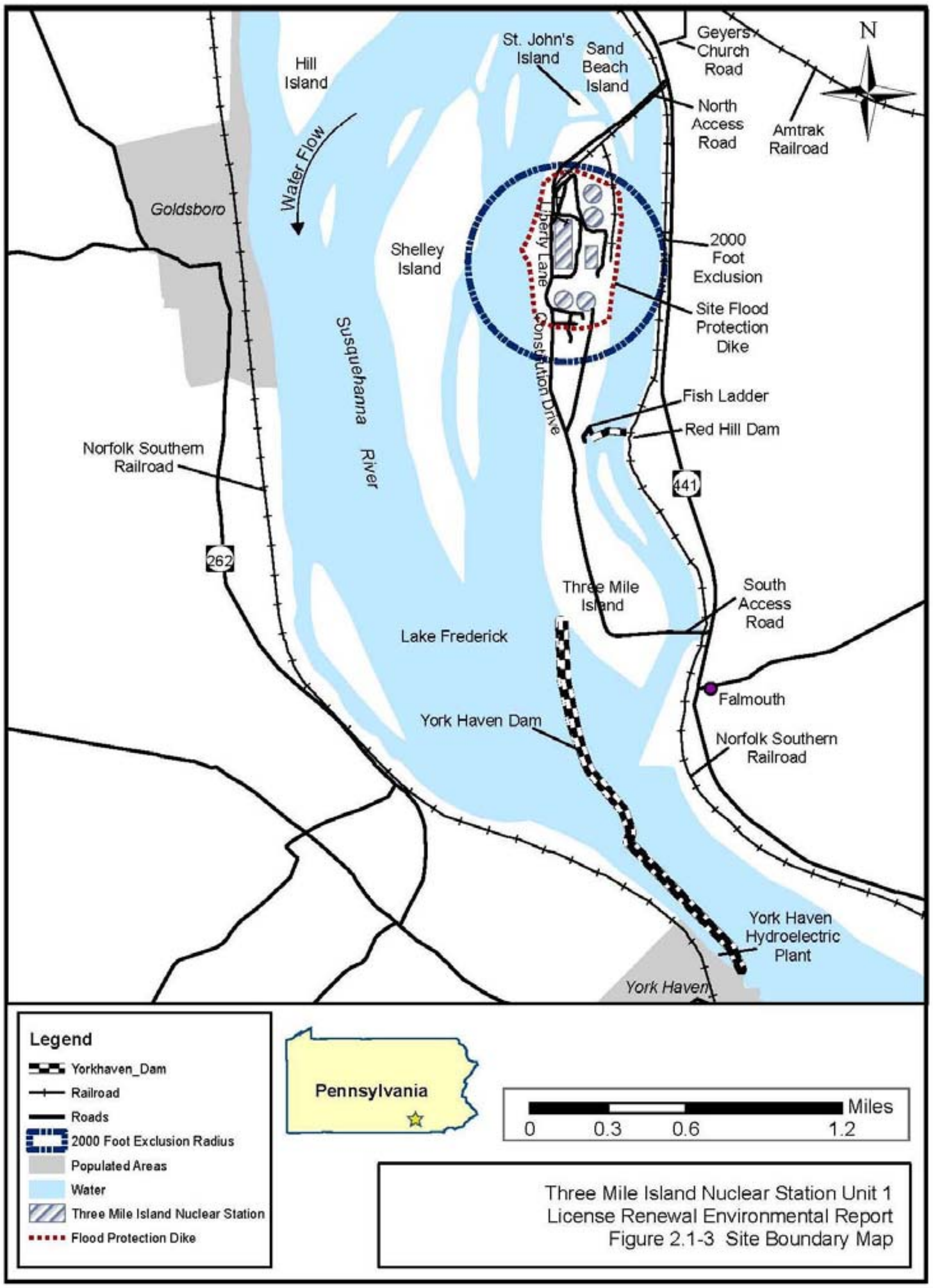
/RA/

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

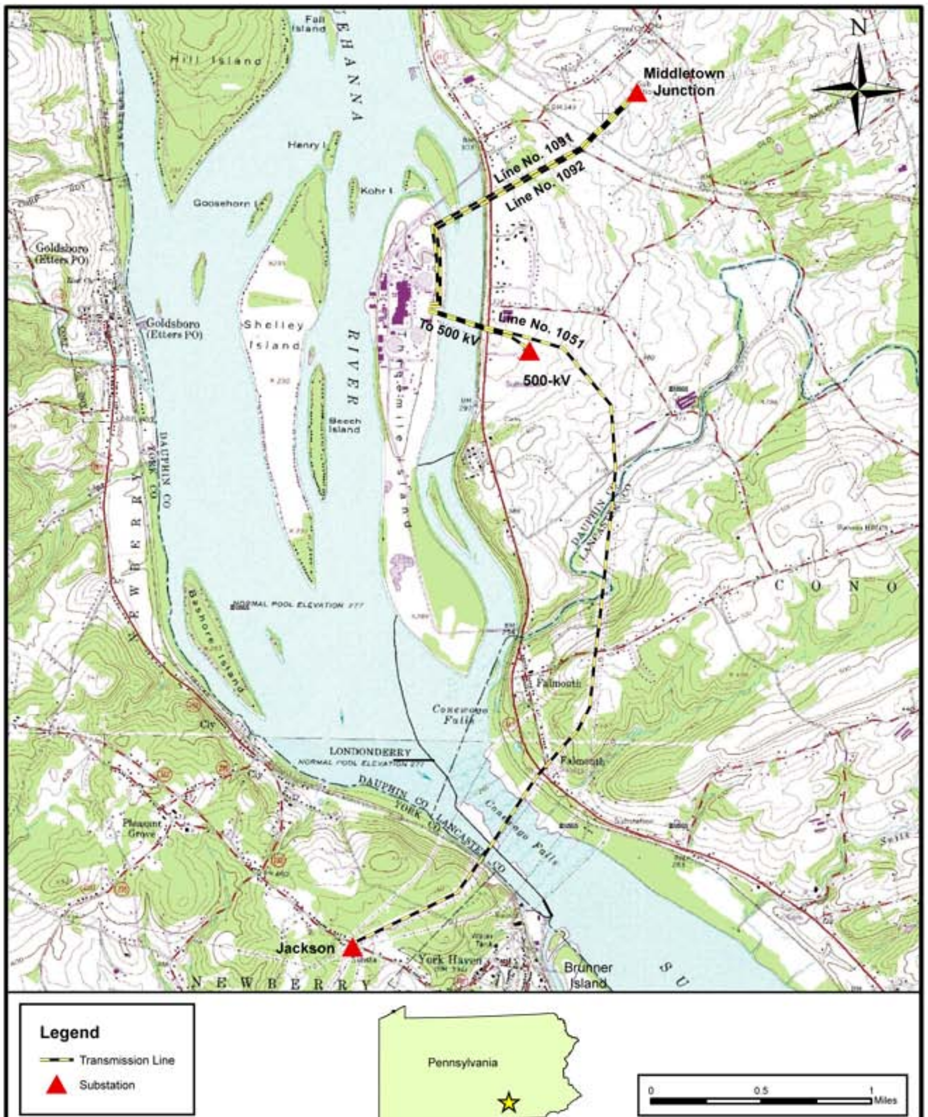
Docket No. 50-289

Enclosures:
1. Site Boundary Map
2. TMI-1 Transmission System Map

cc w/encls.: See next page



Hill Island
St. John's Island
Sand Beach Island
Geyers Church Road
North Access Road
Amtrak Railroad
N
Water Flow
Goldsboro
Shelley Island
Liberty Lane
2000 Foot Exclusion
Site Flood Protection Dike
Susquehanna River
Construction Drive
Fish Ladder
Red Hill Dam
Norfolk Southern Railroad
441
262
Three Mile Island
South Access Road
Lake Frederick
Falmouth
York Haven Dam
Norfolk Southern Railroad
York Haven Hydroelectric Plant
York Haven
Legend
Yorkhaven_Dam
Railroad
Roads
2000 Foot Exclusion Radius
Populated Areas
Water
Three Mile Island Nuclear Station
Flood Protection Dike
Pennsylvania
Miles
0 0.3 0.6 1.2
Three Mile Island Nuclear Station Unit 1
License Renewal Environmental Report
Figure 2.1-3 Site Boundary Map



Three Mile Island Nuclear Station Unit 1
License Renewal Environmental Report
Figure 3.1-2 TMI-1 Transmission System

April 09, 2008

The Honorable Raymond Halbritter
Nation Representative
Oneida Indian Nation
5218 Patrick Road
Verona, NY 13478

SUBJECT: REQUEST FOR SCOPING COMMENTS CONCERNING THE THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW

Dear Representative Halbritter:

The U.S. Nuclear Regulatory Commission (NRC or the staff) has recently received an application from AmerGen Energy Company, LLC (AmerGen), for the renewal of the operating license for the Three Mile Island Nuclear Station, Unit 1 (TMI-1), located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania. The NRC is in the initial stages of developing a Supplemental Environmental Impact Statement to the Generic Environmental Impact Statement (GEIS), which will document the impacts associated with the renewal of TMI-1. We would like your assistance in our review by providing input to the NRC's environmental review scoping process. The NRC's process includes an opportunity for public and inter-governmental participation in the environmental review. We want to ensure that you are aware of our efforts pursuant to Title 10 of the *Code of Federal Regulations* Part 51, Section 51.28(b). In addition, as outlined in 36 CFR 800.8(c), the NRC plans to coordinate compliance with Section 106 of the National Historic Preservation Act of 1966 through the requirements of the National Environmental Policy Act of 1969.

The NRC has also sent copies of this letter to the tribal contacts for the following Federally-recognized tribes: Absentee-Shawnee Tribe of Oklahoma; Cayuga Nation; Delaware Nation; Delaware Trust Board; Eastern Shawnee Tribe of Oklahoma; Oneida Indian Nation; Oneida Nation of Wisconsin; Onondaga Nation; Seneca Nation of Indians; Seneca-Cayuga Tribe of Oklahoma; St. Regis Mohawk Tribe; Shawnee Tribe; Stockbridge-Munsee Band of the Mohican Nation of Wisconsin; Tonawanda Seneca Nation; and Tuscarora Nation.

Under NRC regulations, the original operating license for a nuclear power plant is issued for up to 40 years. The license may be renewed for up to an additional 20 years if NRC requirements are met. The current operating license for TMI-1 will expire in April 2014. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. For the purpose of license renewal, AmerGen plans to replace the TMI-1 steam generators, and estimates that the total area disturbed by construction, decontamination, and laydown activities would be less than 10 acres, all of which would be previously disturbed property within the bounds of the TMI-1 flood protection dike. Provided for your information is the TMI-1 site boundary map (Enclosure 1) and transmission system map (Enclosure 2).

The GEIS considered the environmental impacts of renewing nuclear power plant operating licenses for a 20-year period on all currently operating sites. In the GEIS the NRC staff identified 92 environmental issues and developed generic conclusions related to environmental impacts for 69 of these issues that apply to all plants or to plants with specific design or site characteristics. For the remaining 23 issues, plant-specific analyses will be documented in a supplement to the GEIS. A supplemental environmental impact statement will be prepared for TMI-1 to document the staff's review of environmental impacts related to terrestrial ecology, aquatic ecology, hydrology, cultural resources, and socioeconomic issues (among others), and will contain a recommendation regarding the environmental acceptability of the license renewal action.

Please submit any comments that you may have to offer on the scope of the environmental review by May 30, 2008. Written comments should be submitted by mail to the Chief, Rules and Directives Branch, Division of Administrative Services, Mail Stop T-6D59, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Electronic comments may be submitted to the NRC by e-mail at ThreeMileIslandEIS@nrc.gov. At the conclusion of the scoping process, the NRC staff will prepare a summary of the significant issues identified and the conclusions reached, and mail a copy to you.

To accommodate interested members of the public, the NRC will hold two public scoping meetings for the TMI-1 license renewal supplement to the GEIS on May 1, 2008. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:00 p.m., as necessary. Additionally, the NRC staff will host informal discussions one hour before the start of each session.

The TMI-1 license renewal application and the GEIS are available on the internet at www.nrc.gov/reactors/operating/licensing/renewal/applications/three-mile-island.html. In addition, the following locations have agreed to make the license renewal application and the GEIS available for public inspection: Londonderry Township Municipal Building, 783 South Geyers Church Road, Middletown, PA 17057; Middletown Public Library, 20 North Catherine Street, Middletown, PA 17057; and Penn State Harrisburg Library, 351 Olmsted Drive, Middletown, PA 17057.

The staff expects to publish the draft supplemental environmental impact statement in December 2008. A copy of the document will be sent to you for your review and comment. The NRC will hold another set of public meetings in the site vicinity to solicit comments on the draft supplemental environmental impact statement. After consideration of public comments received, the NRC will prepare a final supplemental environmental impact statement, which is scheduled to be issued in July 2009.

-3-

If you need additional information regarding the license renewal review process, please contact Ms. Sarah Lopas, License Renewal Project Manager, at 301-415-1147 or at sll2@nrc.gov.

Sincerely,

\RA

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosures:
As Stated

April 15, 2008

Ms. Charlene Dwin Vaughn
Assistant Director
Advisory Council on Historic Preservation
Office of Federal Agency Programs
1100 Pennsylvania Ave, NW, Suite 803
Washington, DC 20004

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Vaughn:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application to renew the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1), located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County. TMI-1 is operated by AmerGen Energy Company, LLC (AmerGen). The application for renewal was submitted by AmerGen in a letter dated January 8, 2008, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54).

The NRC has established that, as part of the staff's review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8(c), the SEIS will include analyses of potential impacts to historic and cultural resources.

On May 1, 2008, the NRC will conduct two public NEPA scoping meetings. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:30 p.m., as necessary. You and your staff are invited to attend the public meetings. In addition, during the week of April 28, 2008, the NRC staff plans to conduct a site audit at TMI-1. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2008.

C. Vaughn -2-

If you have any questions or require additional information, please contact the License Renewal Project Manager, Ms. Sarah Lopas, at 301-415-1147 or by e-mail at sll2@nrc.gov.

Sincerely,

/RA/

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-289

cc: See next page

April 15, 2008

Ms. Chris Firestone
Native Plant Program Manager
Bureau of Forestry (Plant Program)
Forestry Advisory Services
Pennsylvania Department of Conservation
and Natural Resources
P.O. Box 8552
Harrisburg, PA 17105-1673

SUBJECT: REQUEST FOR LIST OF STATE-PROTECTED SPECIES AND IMPORTANT HABITATS WITHIN THE AREA UNDER EVALUATION FOR THE THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW

Dear Ms. Firestone:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by AmerGen Energy Company, LLC (AmerGen), for the renewal of the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1). TMI-1 is located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife.

AmerGen is requesting renewal of its operating license for TMI-1 for a period of 20 years beyond the expiration of the current license term of April 2014. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. For the purpose of license renewal, AmerGen plans to replace the TMI-1 steam generators, and estimates that the total area disturbed by construction, decontamination, and laydown activities would be less than 10 acres, all of which would be previously disturbed property within the bounds of the TMI-1 flood protection dike.

The TMI-1 site encompasses several properties that total approximately 440 acres, including: the physical plant location on 200 acres of the 370-acre Three Mile Island; St. John's Island and Evergreen Island (also referred to as "Sand Beach Island"), together totaling 31 acres; a 6.4-acre section of Shelley Island, which is part of the western half of the TMI-1 Exclusion Area; and a 32-acre strip of land east of Three Mile Island along the eastern shore of the Susquehanna River; please see the enclosed site boundary map. The TMI-1 site is surrounded by fencing and contains few areas of undeveloped or undisturbed land; undeveloped land on Three Mile Island lies south of TMI-1 facilities. The majority of this land lies under the ten-year flood level, and contains wetlands and fallow field areas surrounded by a woodland buffer. Riparian buffer areas are intact around the perimeter of the island, although forested riparian areas only occur on the southern part of the island.

C. Firestone - 2 -

Four 230-kilovolt (kV) transmission lines totaling 5.6 miles of corridor and approximately 142 acres connect TMI-1 to the regional transmission system; please see the enclosed TMI-1 transmission system map. Two of these lines connect the plant with the substation at Middletown Junction, east of the Susquehanna River; each of these lines extends 1.5 miles. A third line extends for 4.1 miles to the west side of the Susquehanna River, where it connects to a 230-kV line terminating into the substation near Jackson – this line crosses the river twice. The fourth line extends 0.7 miles east across the Susquehanna River to the TMI-1 500-kV substation.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on state-listed, proposed, and candidate species and critical habitat that may be in the vicinity of TMI-1 and its associated transmission line corridors.

The NRC staff plans to hold two public NEPA scoping meetings on May 1, 2008. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:00 p.m., as necessary. In addition, during the week of April 28, 2008, the NRC plans to conduct a site audit. You and your staff are invited to attend both the public meetings and the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2008.

If you have any questions concerning the NRC staff's review of this license renewal application, please contact Ms. Sarah Lopas, License Renewal Project Manager, at 301-415-1147 or by e-mail at sll2@nrc.gov.

Sincerely,

/RA/

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosures:
As stated

cc w/encls: See next page

April 15, 2008

Mr. Christopher Urban
Chief of Natural Diversity Section
Pennsylvania Fish and Boat Commission
450 Robinson Lane
Bellefonte, PA 16823-9620

SUBJECT: REQUEST FOR LIST OF STATE-PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Urban:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by AmerGen Energy Company, LLC (AmerGen), for the renewal of the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1). TMI-1 is located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife.

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TMI-1 utilizes two hyperbolic natural draft cooling towers for dissipating heat from the plant steam cycle. The circulating water and service water systems withdraw water from the Susquehanna River, and are supplemented by three groundwater wells. TMI-1 has a permit with the Susquehanna River Basin Commission for consumptive use of river water up to 18 million gallons per day, on a monthly average, for electric generation. River water enters the intake structure located on the western bank of the island, passes under a skimmer wall, through automated trash racks with 1-inch vertical bar spacing, through 3/8-inch-mesh traveling screens, through the river water pumps, and finally through 1/8-inch-mesh strainers before entering the heat exchangers. Approximately 3000 gallons per minute of cooling tower blowdown are discharged to the Susquehanna River through a 48-inch-diameter river discharge line.

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To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on state-listed, proposed, and candidate species and critical habitat that may be in the vicinity of TMI-1 and its associated transmission line corridors. Please see the enclosed Species Impact Review (SIR) request form.

The NRC staff plans to hold two public NEPA scoping meetings on May 1, 2008. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:00 p.m., as necessary. In addition, during the week of April 28, 2008, the NRC plans to conduct a site audit. You and your staff are invited to attend both the public meetings and the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2008.

FISH AND BOAT COMMISSION

NATURAL DIVERSITY SECTION

PFBC-DES-NDS-1 (5/2/03) **SPECIES IMPACT REVIEW (SIR) REQUEST FORM**

COMMONWEALTH

A. This form provides the site information necessary to perform a computer database search for species of special concern listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, the Pennsylvania Fish and Boat Code or the Wildlife Code.

B. Use only **one form** for each proposed project or location. Complete the information below and **mail** form to:

OF PENNSYLVANIA

Natural Diversity Section Division
of Environmental Services PA Fish
and Boat Commission 450
Robinson Lane Bellefonte, PA
16823 Fax: (814) 359-5175

C. This form, a cover letter including a project narrative, and accompanying maps should be sent to the above address for environmental reviews that only concern reptiles, amphibians, fishes and aquatic invertebrates. Reviews for other natural resources must be submitted to other appropriate agencies.

D. The absence of recorded information from our databases and files does not necessarily imply actual conditions on site. Future field investigations could alter this determination. The information contained in our files is routinely updated. A review is valid for one year.

E. Please send us only one (1) copy of your request – either by fax or by mail – not both. Mail is preferred to improve legibility of maps. Facsimile submission will not improve our response turn-around time.

F. Allow 30 days for completion of the review from the date of PFBC receipt. Large projects and workload may extend this review timeframe.

G. In any future correspondence with us following your receipt of the SIR response, please refer to the assigned SIR number at the top left of our cover letter.

H. FORMS THAT ARE NOT COMPLETED IN FULL WILL NOT BE REVIEWED.

PLEASE PRINT OR TYPE: If available, provide the potential conflict PNDI Search Number: **N/A**
PFBC response should be sent to Company/Agency: **U.S. Nuclear Regulatory Commission**
Form Preparer: **Sarah Lopas, License Renewal Project Manager**
Address: **U.S. Nuclear Regulatory Commission, 11555 Rockville Pike, Mail Stop O-11F1, Rockville, MD 20852**
Phone (8:00 AM to 4:00 PM): **301.415.1147**
Project Description: **Three Mile Island Nuclear Station, Unit 1, License Renewal (please see cover letter)**

Indicate if the project is: Transportation or Non-transportation **X** (check one)
Will the proposed project encroach directly or indirectly (e.g., runoff) upon wetlands or waterways? Circle one for each:
Wetlands: Yes No **UNKNOWN** Waterways: **YES** No Unknown
County: **Dauphin** Township/Municipality: **Londonderry**
Name of the United States Geological Survey (U.S.G.S.) 7.5 Minute Quadrangle Map where project is located: **Middletown**
Project size (in acres): **Approximately 276** Attach an 8.5" by 11" photocopy (**DO NOT REDUCE**) of the section of the U.S.G.S. Quadrangle Map which identifies the project location. On this map, indicate the location of the project center (if linear, depict both ends) and outline the approximate boundaries of the project area. Specify latitude/longitude of the project center.
Latitude: 40° /9.2' N.
Longitude: 72° /43.5' W

FOR PFBC USE ONLY

SIR#	Quad Name	Data Source	Search Result-Potential Species Conflict	Action

April 15, 2008

Mr. James Leigey
Wildlife Impact Review Coordinator
Pennsylvania Game Commission
2001 Elmerton Avenue
Harrisburg, PA 17110-9797

SUBJECT: REQUEST FOR LIST OF STATE-PROTECTED SPECIES WITHIN THE AREA UNDER EVALUATION FOR THE THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW

Dear Mr. Leigey:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application submitted by AmerGen Energy Company, LLC (AmerGen), for the renewal of the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1). TMI-1 is located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County. As part of the review of the license renewal application (LRA), the NRC is preparing a Supplemental Environmental Impact Statement (SEIS) under the provisions of Title 10 of the *Code of Federal Regulations* Part 51 (10 CFR Part 51), the NRC's regulation that implements the National Environmental Policy Act (NEPA) of 1969. The SEIS includes an analysis of pertinent environmental issues, including endangered or threatened species and impacts to fish and wildlife.

AmerGen is requesting renewal of its operating license for TMI-1 for a period of 20 years beyond the expiration of the current license term of April 2014. The proposed action would include the use and continued maintenance of existing plant facilities and transmission lines. For the purpose of license renewal, AmerGen plans to replace the TMI-1 steam generators, and estimates that the total area disturbed by construction, decontamination, and laydown activities would be less than 10 acres, all of which would be previously disturbed property within the bounds of the TMI-1 flood protection dike.

The TMI-1 site encompasses several properties that total approximately 440 acres, including: the physical plant location on 200 acres of the 370-acre Three Mile Island; St. John's Island and Evergreen Island (also referred to as "Sand Beach Island"), together totaling 31 acres; a 6.4-acre section of Shelley Island, which is part of the western half of the TMI-1 Exclusion Area; and a 32-acre strip of land east of Three Mile Island along the eastern shore of the Susquehanna River; please see the enclosed site boundary map. The TMI-1 site is surrounded by fencing and contains few areas of undeveloped or undisturbed land; undeveloped land on Three Mile Island lies south of TMI-1 facilities. The majority of this land lies under the ten-year flood level, and contains wetlands and fallow field areas surrounded by a woodland buffer. Riparian buffer areas are intact around the perimeter of the island, although forested riparian areas only occur on the southern part of the island.

J. Leigey - 2 -

Four 230-kilovolt (kV) transmission lines totaling 5.6 miles of corridor and approximately 142 acres connect TMI-1 to the regional transmission system; please see the enclosed TMI-1 transmission system map. Two of these lines connect the plant with the substation at Middletown Junction, east of the Susquehanna River; each of these lines extends 1.5 miles. A third line extends for 4.1 miles to the west side of the Susquehanna River, where it connects to a 230-kV line terminating into the substation near Jackson – this line crosses the river twice. The fourth line extends 0.7 miles east across the Susquehanna River to the TMI-1 500-kV substation.

To support the SEIS preparation process and to ensure compliance with Section 7 of the Endangered Species Act, the NRC requests information on state-listed, proposed, and candidate species and critical habitat that may be in the vicinity of TMI-1 and its associated transmission line corridors.

The NRC staff plans to hold two public NEPA scoping meetings on May 1, 2008. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:00 p.m., as necessary. In addition, during the week of April 28, 2008, the NRC plans to conduct a site audit. You and your staff are invited to attend both the public meetings and the site audit. Your office will receive a copy of the draft SEIS along with a request for comments. The anticipated publication date for the draft SEIS is December 2008.

If you have any questions concerning the NRC staff's review of this license renewal application, please contact Ms. Sarah Lopas, License Renewal Project Manager, at 301-415-1147 or by e-mail at sll2@nrc.gov.

Sincerely,

/RA/

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-289

Enclosures:
As stated

cc w/encls: See next page

April 15, 2008

Jean Cutler, Deputy State Historic Preservation Officer
Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, PA 17120-0093

SUBJECT: THREE MILE ISLAND NUCLEAR STATION, UNIT 1, LICENSE RENEWAL APPLICATION REVIEW (FILE NO. ER 07-1737-043-A)

Dear Ms. Cutler:

The U.S. Nuclear Regulatory Commission (NRC or the staff) is reviewing an application to renew the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1), located on Three Mile Island, which is situated in the Susquehanna River, in Londonderry Township of Dauphin County, Pennsylvania, about 2.5 miles north of the southern tip of Dauphin County. TMI-1 is operated by AmerGen Energy Company, LLC (AmerGen). The application for renewal was submitted by AmerGen in a letter dated January 8, 2008, pursuant to Title 10 of the *Code of Federal Regulations* Part 54 (10 CFR Part 54).

The NRC has established that, as part of the staff's review of any nuclear power plant license renewal action, a site-specific Supplemental Environmental Impact Statement (SEIS) to its "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, will be prepared under the provisions of 10 CFR Part 51, the NRC's regulation that implements the National Environmental Policy Act of 1969 (NEPA). In accordance with 36 CFR 800.8(c), the SEIS will include analyses of potential impacts to historic and cultural resources.

In the context of the National Historic Preservation Act of 1966, as amended, the NRC staff has determined that the area of potential effect (APE) for a license renewal action is the area at the power plant site and its immediate environs that may be impacted by post-license renewal land-disturbing operations or projected refurbishment activities associated with the proposed action. The APE may extend beyond the immediate environs in those instances where post-license renewal land-disturbing operations or projected refurbishment activities specifically related to license renewal may potentially have an effect on known or proposed historic sites. This determination is made irrespective of ownership or control of the lands of interest.

On May 1, 2008, the NRC will conduct two public NEPA scoping meetings. The first session will be held in the afternoon and an identical session will be held later that evening. The afternoon session will be held at the Elks Movie Theatre, 4 West Emaus Street, Middletown, PA 17057. The evening session will be held at Londonderry Elementary School, 260 Schoolhouse Road, Middletown, PA 17057. The first meeting will convene at 1:30 p.m. and will continue until 4:30 p.m., as necessary. The second meeting will convene at 7:00 p.m. and will continue until 10:00 p.m., as necessary. You and your staff are invited to attend. Your office will receive a

J. Cutler - 2 -

copy of the draft SEIS along with a request for comments. The staff expects to publish the draft SEIS in December 2008. If you have any questions or require additional information, please contact Ms. Sarah Lopas, License Renewal Project Manager, by phone at 301-415-1147 or by e-mail at sll2@nrc.gov.

Sincerely,

/RA/

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation

Docket No. 50-289

cc w/encls: See next page

Stockbridge-Munsee Tribal Historic Preservation Office

Sherry White - Tribal Historic Preservation Officer
W13447 Camp 14 Road
P.O. Box 70
Bowler, WI 54416

RULES AND DIRECTIVES USNRC

2008 APR 29 AM 8: 49

RECEIVED

April 21, 2008

Chief
Rules & Directives Branch
Division of Administrative Services
Mail Stop T-6D59
U.S. Regulatory Commission
Washington. DC 20555-0001

RE: Three Mile Island Nuclear Station, Unit 1
License Renewal Application Review

Dear Sir:

Thank you for contacting the Stockbridge-Munsee Tribe regarding the above referenced project. The Tribe is committed to protecting archaeological sites that are important to tribal heritage, culture and religion. Furthermore, the Tribe is particularly concerned with archaeological sites that may contain human burial remains and associated funerary objects.

As described in your correspondence, the proposed ground disturbing activity of this project is not in a region of archaeological interest to the Stockbridge-Munsee Tribe.

We appreciate your cooperation in notifying the Historic Preservation Office. Should you have any questions, feel free to contact me.

Sincerely,

Sherry White gj

Sherry White,
Tribal Historic Preservation Officer

STOCKBRIDGE-MUNSEE BAND OF THE MOHICANS

(715) 793-3970 *Email: sherry.white@mohican-nsn.gov*

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pennsylvania Field Office
315 South Allen Street, Suite 322
State College, Pennsylvania 16801-4850

April 23, 2008

Louise Lund, Branch Chief
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: Three Mile Island Nuclear Station, Unit 1, License Renewal Application Review
USFWS Project #2007-1764

Dear Ms. Lund:

This responds to your April 4, 2008, letter requesting information on threatened or endangered species or other natural resources of concern in the referenced project area. The following comments are provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species, and the Bald and Golden Eagle Protection Act (Eagle Act; 16 U.S.C. 668-668d).

Federally Listed Threatened or Endangered Species

Except for occasional transient species, no federally listed or proposed threatened or endangered species under our jurisdiction are known to occur within the project impact area. Therefore, based on currently available information, no biological assessment or further consultation under the Endangered Species Act is required with the Fish and Wildlife Service. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

Bald Eagle

In a letter to Michael Gallagher of AmerGen (copy enclosed), dated June 7, 2007, we advised that a bald eagle nest is located on the west side of the Susquehanna River to the northwest of the Three Mile Island facility. At the time, the bald eagle was federally listed as threatened. However, the Fish and Wildlife Service has since published a final rulemaking to remove the bald eagle from the federal *List of Endangered and Threatened Wildlife* on July 9, 2007 (*Federal Register*, Vol. 72, No. 130). This rule became effective on August 8, 2007. Although the bald eagle no longer receives protection under the Endangered Species Act, it continues to be protected under the Eagle Act and the Migratory Bird Treaty Act. Both acts protect bald eagles by prohibiting killing, selling or otherwise harming eagles, their nests or eggs. The Eagle Act also protects eagles from disturbance. Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

The Service has developed *National Bald Eagle Management Guidelines* to advise landowners, land managers and others who share public and private lands with bald eagles when and under what circumstances the protective provisions of the Eagle Act may apply to their activities. The *Guidelines* include general recommendations for land management practices that will benefit bald eagles; however, the document is intended primarily as a tool to provide those who seek information and recommendations regarding how to avoid disturbing bald eagles. Adherence to the *Guidelines* will benefit individuals, agencies, organizations and companies by helping them avoid violations of the law. The *Guidelines* can be found at http://www.fws.gov/migratorybirds/baldeagle.htm; any questions about the *Guidelines* or how they would apply to a particular project, can be directed to this office.

Transmission lines and their support structures within or close to the shores of the river would be ideal perching locations for foraging eagles. If the lines are not already equipped with features to prevent raptor electrocution and collisions, we recommend that any future upgrades be designed following the *Suggested Practices for Avian Protection on Power Lines: The State of the Art in 2006* (available from the Avian Power Line Interaction Committee at http://www.aplic.org).

Based on our review of the proposed project, it is our determination that this project will not disturb bald eagles. Because no take or disturbance is anticipated, none is authorized. If project plans change, please contact the Service to determine whether or not the project modifications will result in effects to bald eagles that may necessitate an Eagle Act permit or Endangered Species Act authorization.

Thank you for the opportunity to comment. Please direct any questions regarding this matter to Cindy Tibbott of my staff at 814-234-4090.

Sincerely,

David Densmore
Supervisor

Enclosures

2

Cc:
Michael Gallagher, AmerGen, 200 Exelon Way, KSA/2-E, Kennett Square, PA 19348

CTibbott:clt 4/15/08
P:\Drafts\Drafts 2008\2007-1764 Three Mile Island.doc

Pennsylvania Department of Conservation and Natural Resources

Bureau of Forestry

May 2, 2008

Louise Lund, Branch Chief, Reactor Projects 1
MS O-11F1
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

C.C. Sarah Lopas
MS O-11F1
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Pennsylvania Natural Diversity Inventory Review, PNDI Number	**19605 (old #19248)**
Three Mile Island Unit 1 License Renewal Species of Special Concern	
Dauphin & Lancaster Counties	

Dear Ms. Lund,

This responds to your request about a Pennsylvania Natural Diversity Inventory (PNDI) ER Tool "Potential Impact" or a species of special concern impact review. We screened this project for potential impacts to species and resources of special concern under the Department of Conservation and Natural Resources' responsibility, which includes plants, natural communities, terrestrial invertebrates and geologic features only.

PNDI records indicate that species and communities of special concern under DCNR's jurisdiction are known to occur in the vicinity of the above-mentioned project. **Please see the attached list for species found in the vicinity of this project. No impact is anticipated since earth disturbance is expected to be "within the bounds of the Three Mile Island Flood Protection dike," as stated in April 15, 2008 letter to DCNR. If plans change to include disturbance outside of the Flood Protection dike area (particularly if more disturbance is required for Transmission Line No. 1051), please coordinate with our office as a survey may be requested.**

This response represents the most up-to-date summary of the PNDI data files and is good for one (1) year from the date of this letter. An absence of recorded information does not necessarily imply actual conditions on-site. A field survey of any site may reveal previously unreported populations. Should project plans change or additional information on listed or proposed species become available, this determination may be reconsidered.

This finding applies to impacts to plants, natural communities, terrestrial invertebrates and geologic features only. To complete your review of state and federally-listed species of special concern, please be sure the U.S. Fish and Wildlife Service, the PA Game Commission and the Fish and Boat Commission has been contacted regarding this project either directly or by performing a search with the online PNDI ER Tool found at www.naturalheritage.state.pa.us.

Rebecca H. Bowen

Rebecca H. Bowen, Environmental Review Specialist
DCNR/BOF/PNDI, PO Box 8552, Harrisburg, PA 17105 ~ Ph: 717-772-0258 ~ F: 717-772-0271 ~ c-rbowen@state.pa.us

Stewardship Partnership Service

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Bureau of Forestry **May 2, 2008**

Pennsylvania Natural Diversity Inventory Review, PNDI Number 19605 (old #19248)
Three Mile Island Unit 1 License Renewal Species of Special Concern
Dauphin & Lancaster Counties

Plant Species of Special Concern

Scientific Name	Common Name	Current Status	Proposed Status	Habitat	Flowering time
Boltonia asteroides	Aster-like Boltonia	PE	PE	rocky shores and exposed rocky river beds	flowers July-Oct
Carex shortiana	Sedge	N	PR	calcareous wet meadows and swamps and rich woods	
Eleocharis compressa	Flat-stemmed Spike-rush	PE	PE	wet, sandy ground and river banks	
Ellisia nyctelea	Ellisia	PT	PT	damp, shady banks and rich alluvial woods	flowers in May

Additional Information:

Butterfly Species of Special Concern

Scientific Name	Common Name	Global Rank	State Rank	Habitat	Larval Host
Lycaena hyllus	Bronze Copper	Globally Secure	Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.	Low wet meadows / marshes, especially in river flood plains. Very large, floppy-flying copper.	Water dock (*Rumex orbiculatus*) and curled dock (*Rumex crispus*)

Geologic Features of Special Concern

Erosional Remnant made up of a series of large potholes in diabase in the bed of the Susquehanna from the Triassic Age is known to exist where the transmission lines cross the river towards York Haven.

Communities of Special Concern

There is also a Riverside Outcrop Community in the vicinity. This community is characterized by semi-permanently or seasonally flooded vegetation of the riverbed, banks and islands.

More information on this community may be found online in *Terrestrial & Palustrine Plant Communities of Pennsylvania* by Jean Fike, Pennsylvania Natural Diversity Inventory: http://www.dcnr.state.pa.us/wrcf/fikebook/21Chapter8.pdf (page 55).

No impact anticipated; this list is for your own information.

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA GAME COMMISSION
2001 ELMERTON AVENUE, HARRISBURG, PA 17110-9797

May 14, 2008

Ms. Louise Lund
U.S. Nuclear Regulatory Commission
Projects Branch 1
Division of License Renewal
Office of Nuclear Reactor Regulation
Washington, D.C. 20555-0001

In re: State-Protected Bird and Mammal Species Review
Three Mile Island Nuclear Station
License Renewal Application
Londonderry Township, Dauphin County, PA

Dear Ms. Lund:

This is in response to your request of April 15, 2008 regarding information on state-listed, proposed, and candidate species of birds or mammals, recognized by the Pennsylvania Game Commission (PGC), which may be in the vicinity of the Three Mile Island Nuclear Station (TMI).

Our office review has determined that Prothonotary Warblers (*Protonotaria citrea*), Bald Eagles (*Haliaeetus leucocephalus*), Yellow-crowned Night Herons (*Nycticorax violacea*), and Black-crowned Night Herons (*Nycticorax nycticorax*) have been documented nesting and foraging in proximity to the Three Mile Island Nuclear Station. Peregrine Falcons (*Falco peregrinus*) have been documented nesting on the Unit 1 Reactor Building, and Ospreys (*Pandion haliaetus*) have been documented nesting atop the weather station at the TMI.

The renewal of the TMI Operating License in not anticipated to cause any adverse impacts to special concern species of birds and mammals that may be in the vicinity of the transmission line corridors associated the electric generating station. No adverse impacts to ospreys and peregrine falcons are anticipated due to the license renewal since there has been ongoing coordination by the AmerGen Energy Company, LLC with the PGC regarding Best Management Practices for the endangered and threatened species nesting at TMI. This determination may be reconsidered if project plans change or extend beyond the present study area, or if additional information becomes available on state-listed species.

If you have any questions, please contact me at (717) 787-4250. Please be advised that this determination is only valid for one year from the date of this letter.

ADMINISTRATIVE BUREAUS:

PERSONNEL: 717-787-7836 ADMINISTRATION: 717-787-5670 AUTOMOTIVE AND PROCURMENT: 717-787-6594
LICENSE DIVISION: 717-787-2084 WILDLIFE MANAGEMENT: 717-787-5529 INFORMATION & EDUCATION: 717787-6286
WILDLIFE PROTECTION: 717-787-5740 WILDLIFE HABITAT MANAGEMENT: 717-787-6818 REAL ESTATE: 717-787-6568
AUTOMATEDTECHNOLOGY SYSTEMS: 717-787-4076

WWW.PGC.STATE.PA.US

Very truly yours,

James R. Leigey
Wildlife Impact Review Coordinator
Division of Environmental
Planning and Habitat Protection
Bureau of Wildlife Habitat Management

Cc: File

Pennsylvania Fish & Boat Commission
Division of Environmental Services
Natural Diversity Section
450 Robinson Lane
Bellefonte, PA 16823-9620
(814) 359-5237 Fax: (814) 359-5175

established 1866

June 3, 2008

IN REPLY REFER TO
SIR # 28464

SARAH LOPAS
UNITED STATES NUCLEAR REGULATORY COMMISSION
11555 ROCKVILLE PIKE
MAIL STOP 0-11F1
ROCKVILLE, MD 20852

RE: Species Impact Review (SIR) - Rare, Candidate, Threatened and Endangered Species
THREE MILE ISLAND NUCLEAR STATION
LONDONDERRY Township/Borough, DAUPHIN County, Pennsylvania

This responds to your inquiry about a Pennsylvania Natural Diversity Inventory (PNDI) Internet Database search "potential conflict" or a threatened and endangered species impact review. These projects are screened for potential conflicts with rare, candidate, threatened or endangered species under Pennsylvania Fish & Boat Commission jurisdiction (fish, reptiles, amphibians, aquatic invertebrates only) using the Pennsylvania Natural Diversity Inventory (PNDI) database and our own files. These species of special concern are listed under the Endangered Species Act of 1973, the Wild Resource Conservation Act, and the Pennsylvania Fish & Boat Code (Chapter 75), or the Wildlife Code. The absence of recorded information from our files does not necessarily imply actual conditions on site. Future field investigations could alter this determination. The information contained in our files is routinely updated. A Species Impact Review is valid for one year only.

_X_ ***NO ADVERSE IMPACTS EXPECTED FROM THE PROPOSED PROJECT***

___ Except for occasional transient species, rare, candidate, threatened or endangered species under our jurisdiction are not known to exist in the vicinity of the project area. Therefore, no biological assessment or further consultation regarding rare species is needed with the Commission. Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered.

_X_ An element occurrence of a rare, candidate, threatened, or endangered species under our jurisdiction is known from the vicinity of the proposed project. However, given the nature of the proposed project, the immediate location, or the current status of the nearby element occurrence(s), no adverse impacts are expected to the species of special concern.

If you have any questions regarding this review, please contact the biologist indicated below:

___	Jeff Schmid	814-359-5236	___	Tina Walther	814-359-5186
_X_	Nevin Welte	814-359-5234	___	Bob Morgan	814-359-5129

I am enclosing a copy of our "SIR Request Form", which is to be used for all future species impact review requests. Please make copies of the attached form and use with all future project reviews. Thank you in advance for your cooperation and attention to this important matter of species conservation and habitat protection.

SIGNATURE: Christopher A. Urban DATE: June 3, 2008
Christopher A. Urban
Chief, Natural Diversity Section

Our Mission: **www.fish.state.pa.us**

To protect, conserve and enhance the Commonwealth's aquatic resources and provide fishing and boating opportunities.

Appendix E

Chronology of Environmental Review

E. Chronology of Environmental Review Correspondence

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for Three Mile Island Nuclear Station, Unit 1. All documents, with the exception of those containing proprietary information are available electronically from the NRC's Public Electronic Reading Room found on the Internet at the following Web address: http://www.nrc.gov/reading-rm.html. From this site, the public can gain access to the NRC's Agencywide Document Access and Management System (ADAMS), which provides text and image files of NRC's public documents in ADAMS. The ADAMS accession number for each document is included below.

E.1 Environmental Review Correspondence

January 8, 2008	Letter from AmerGen forwarding the application for renewal of operating license for Three Mile Island, Unit 1, requesting an extension of operating license for an additional 20 years (ADAMS Accession No. ML080220219).
January 25, 2008	Letter to AmerGen, "Receipt and Availability of the License Renewal Application for the Three Mile Island Nuclear Station, Unit 1" (ADAMS Accession No. ML073310128).
January 28, 2008	NRC press release announcing the availability of the license renewal application for Three Mile Island, Unit 1, for public inspection (ADAMS Accession No. ML080280293).
January 31, 2008	*Federal Register* notice, "AmerGen Energy Company, LLC; Notice of Receipt and Availability of Application for Renewal of Three Mile Island Nuclear Station, Unit 1, Facility Operating License No. DPR-50 for an Additional 20-Year Period" (73 FR 5877).
February 14, 2008	Notice of public meeting to discuss the license renewal process for the Three Mile Island Nuclear Station, Unit 1, license renewal application Review (ADAMS Accession No. ML080380505).
February 26, 2008	NRC press release announcing the public meeting to discuss the review of the license renewal application for Three Mile Island Nuclear Power Plant (ADAMS Accession No. ML080570365).
March 10, 2008	Letter to AmerGen transmitting "Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Opportunity for a Hearing Regarding an Application from AmerGen Energy Company, LLC, for Renewal of the Operating License for Three Mile Island Nuclear Station, Unit 1" (ADAMS Accession No. ML080370352).

March 10, 2008	NRC press release announcing opportunity to request hearing on license renewal application for Three Mile Island Nuclear Plant (ADAMS Accession No. ML080700892).
March 14, 2008	*Federal Register* notice, “Notice of Acceptance for Docketing of the Application and Notice of Opportunity for Hearing; Regarding Renewal of Facility Operating License No. DPR-50 for an Additional 20-Year Period; AmerGen Energy Company, LLC Three Mile Island Nuclear Station, Unit 1” (73 FR 13923).
March 21, 2008	Letter to AmerGen, “Three Mile Island Nuclear Station, Unit 1 License Renewal Application Online Reference Portal” (ADAMS Accession No. ML080710465).
March 24, 2008	Letter to AmerGen forwarding *Federal Register* notice, “Three Mile Island Nuclear Station, Unit 1; Notice of Intent to Prepare and Environmental Impact Statement and Conduct Scoping,” in support of the review of the license renewal application (ADAMS Accession No. ML080780085).
March 26, 2008	Notice of public meeting to discuss the environmental scoping process for the Three Mile Island Nuclear Station, Unit 1, license renewal application review (ADAMS Accession No. ML080800502).
March 28, 2008	*Federal Register* notice, “Three Mile Island Nuclear Station, Unit 1; Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping Process” (73 FR 16729).
March 31, 2008	Letter from AmerGen, “Editorial Corrections to the Three Mile Nuclear Station Unit 1 License Renewal Application Environmental Report” (ADAMS Accession No. ML080930302).
March 31, 2008	Letter from AmerGen, “Three Mile Island Nuclear Station Unit 1 License Renewal Application Online Reference Portal” (ADAMS Accession No. ML080930301).
April 1, 2008	Letter to AmerGen, “Environmental Site Audit Regarding Three Mile Island Nuclear Station, Unit 1, License Renewal Application” (ADAMS Accession No. ML080840029).
April 3, 2008	Letter from AmerGen, “Three Mile Island Nuclear Station Unit 1 License Renewal Application Selected Environmental Report References” (ADAMS Accession No. ML081420193).
April 4, 2008	Letter to David Densmore, U.S. Fish and Wildlife Service, request for list of protected species for the Three Mile Island Nuclear Station,

	Unit 1, license renewal review (ADAMS Accession No. ML080840027).
April 9, 2008	Letter to The Honorable Raymond Halbritter, Nation Representative, Oneida Indian Nation, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Paul Spicer, Chief, Seneca-Cayuga Tribe of Oklahoma, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Barry Snyder, Sr., President, Seneca Nation of Indians, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Robert Chicks, Tribal Chairman, Stockbridge-Munsee Band of the Mohican Nation, Wisconsin, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Tony Gonyea, Faithkeeper, Onondaga Nation, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Gerald Dansforth, Chairwoman, Oneida Nation of Wisconsin, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Glenna Wallace, Chief, Eastern Shawnee Tribe of Oklahoma, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Kerry Holton, Tribal President, Delaware Nation, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).

April 9, 2008	Letter to The Honorable Clint Halftown, Heron Clan Representative, Cayuga Nation, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Scott Miller, Governor, Absentee-Shawnee Tribe of Oklahoma, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable James Ransom, Chief, St. Regis Mohawk Tribe, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Roger Hill, Chief, Tonawanda Seneca Nation, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Leo Henry, Chief, Tuscarora Nation, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 9, 2008	Letter to The Honorable Ron Sparkmann, Chairman, Shawnee Tribe, inviting participation in scoping process related to NRC's environmental review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML080980572).
April 15, 2008	Letter to Charlene Dwin Vaughn, Assistant Director, Advisory Council on Historic Preservation, regarding Three Mile Island Nuclear Station, Unit 1 license renewal review (ADAMS Accession No. ML080930296).
April 15, 2008	Letter to Rich Janati, Chief, Division of Nuclear Safety, Bureau of Radiation Protection, Pennsylvania Department of Environmental Protection, regarding Three Mile Island Nuclear Station, Unit 1, license renewal (ADAMS Accession No. ML080860022).

April 15, 2008	Letter to Rachel Diamond, Regional Director, Pennsylvania Department of Environmental Protection Southcentral Regional Office, regarding Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML080930617).
April 15, 2008	Letter to Michael G. Brownell, Chief, Water Resources Management, Susquehanna River Basin Commission, regarding Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML080930632).
April 15, 2008	Letter to Chris Firestone, Native Plant Program Manager, Pennsylvania Department of Conservation and Natural Resources, request for list of protected species and important habitats for the Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML080930247).
April 15, 2008	Letter to Christopher Urban, Chief of Natural Diversity Section, Pennsylvania Fish & Boat Commission, request for list of State-protected species for the Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML080930486).
April 15, 2008	Letter to James Leigey, Wildlife Impact Review Coordinator, Pennsylvania Game Commission, request for list of State-protected species for the Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML080930178).
April 15, 2008	Letter to Jean Cutler, Deputy State Historic Preservation Officer, Pennsylvania Historic and Museum Commission, regarding Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML080930380).
April 15, 2008	NRC press release announcing the Three Mile Island, Unit 1, license renewal environment scoping meeting (ADAMS Accession No. ML081060426).
April 21, 2008	Letter from Sherry White, Tribal Historic Preservation Officer, Stockbridge-Munsee Tribal Historic Preservation Office, regarding Three Mile Island Nuclear Station, Unit 1, license renewal review (ADAMS Accession No. ML081280309).
April 23, 2008	Letter from David Densmore, Supervisor, U.S. Fish and Wildlife Service, Pennsylvania Field Office, regarding Three Mile Island Nuclear Station, Unit 1, license renewal application review (ADAMS Accession No. ML081280307).

April 23, 2008	Letter from Rebecca H. Bowen, Environmental Review Specialist, Pennsylvania Department of Conservation and Natural Resources, regarding Three Mile Island, Unit 1, license renewal species of special concern (ADAMS No. Accession ML081300048).
May 2, 2008	Summary of public meetings related to the license renewal process for the Three Mile Island Nuclear Station, Unit 1, license renewal application (ADAMS Accession No. ML081000290).
May 14, 2008	Letter from James R. Leigey, Wildlife Impact Review Coordinator, Pennsylvania Game Commission, regarding State-protected bird and mammal species review for Three Mile Island Nuclear Station license renewal application, Londonderry Township, Dauphin County, Pennsylvania (ADAMS Accession No. ML081500671).
May 21, 2008	Letter to AmerGen, "Request for Additional Information Regarding Severe Accident Mitigation Alternatives for Three Mile Island Nuclear Station, Unit 1, License Renewal" (ADAMS Accession No. ML081330714).
May 22, 2008	Summary of public environmental scoping meetings related to the review of the Three Mile Island Nuclear Station, Unit 1, license renewal application (ADAMS Accession No. ML081360648).
June 3, 2008	Letter from Christopher A. Urban, Chief, Natural Diversity Section, Pennsylvania Fish & Boat Commission, regarding species impact review for Three Mile Island Nuclear Station, Londonderry Township/Borough, Dauphin County, Pennsylvania (ADAMS Accession No. ML081610104).
June 3, 2008	Commission order denying Mr. Marvin Lewis's Petition to Intervene (ADAMS Accession No. ML081550359).
June 10, 2008	Letter from AmerGen, "Three Mile Island Nuclear Station Unit 1 License Renewal Application Post-Audit Environmental Information" (ADAMS Accession No. ML082110260).
June 12, 2008	Summary of conference call with AmerGen to discuss the severe accident mitigation alternatives and requests for additional information for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML081560666).
July 17, 2008	Letter from AmerGen, "Response to NRC Request for Additional Information related to the Three Mile Island Nuclear Station Unit 1 License Renewal Application" (ADAMS Accession No. ML082040144).

August 4, 2008	Summary of site audit related to the review of the license renewal application for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML081420398).
August 5, 2008	Summary of telephone conference call held on July 17, 2008, between the NRC and AmerGen, concerning followup questions pertaining to the Three Mile Island Nuclear Station, Unit 1, license renewal environmental review and site audit (ADAMS Accession No. ML082120727).
August 5, 2008	Letter from AmerGen, "Three Mile Island Nuclear Station Unit 1 License Renewal Application Post-Audit Environmental Information" (ADAMS Accession No. ML082200589).
August 8, 2008	Letter to AmerGen regarding environmental scoping summary report associated with the staff's review of the application by AmerGen for renewal of the operating license for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML081920230).
September 8, 2008	Summary of conference call with AmerGen Energy Company, LLC, to discuss responses to severe accident mitigation alternatives request for additional information for Three Mile Island Nuclear Station, Unit 1 (ADAMS Accession No. ML082340226).

Appendix F
U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Three Mile Island Nuclear Station, Unit 1 In Support of License Renewal Application Review

F. U.S. Nuclear Regulatory Commission Staff Evaluation of Severe Accident Mitigation Alternatives (SAMAs) for Three Mile Island Nuclear Station, Unit 1 in Support of License Renewal Application Review

F.1 Introduction

AmerGen Energy Company, LLC (AmerGen) submitted an assessment of severe accident mitigation alternatives (SAMAs) for the Three Mile Island Nuclear Station, Unit 1 (TMI-1) as part of the environmental report (ER) (AmerGen 2008a). This assessment was based on the most recent TMI-1 probabilistic risk assessment (PRA) available at that time, a plant-specific offsite consequence analysis performed using the MELCOR Accident Consequence Code System 2 (MACCS2) computer code (NRC 1998a), and insights from the TMI-1 individual plant examination (IPE) (GPU 1993) and individual plant examination of external events (IPEEE) (GPU 1994). In identifying and evaluating potential SAMAs, AmerGen considered SAMA candidates that addressed the major contributors to core damage frequency (CDF) and population dose at TMI-1, as well as SAMA candidates for other operating plants which have submitted license renewal applications. AmerGen identified 33 potential SAMA candidates. AmerGen assessed the costs and benefits associated with each of the potential SAMAs, and concluded in the ER that several of the candidate SAMAs evaluated are potentially cost-beneficial.

Based on a review of the SAMA assessment, the U.S. Nuclear Regulatory Commission (NRC) issued a request for additional information (RAI) to AmerGen by letter dated May 21, 2008 (NRC 2008a). Key questions concerned: major plant and modeling changes incorporated within each evolution of the PRA model; justification for the multiplier used for external events; assumptions used to quantify the benefits for certain SAMAs; identification of an optimal subset of potentially cost-beneficial SAMAs; and further information on several specific candidate SAMAs and low cost alternatives. AmerGen submitted additional information by letters dated July 17, 2008 (AmerGen 2008b) and September 8, 2008 (NRC 2008b). In the responses, AmerGen provided: additional information regarding the PRA model development; additional justification for the treatment of external events; additional explanation and justification for the assumptions used to quantify SAMA benefits; a qualitative assessment identifying the potentially cost-beneficial SAMAs having the greatest risk reduction relative to the cost of implementation; and additional information regarding several specific SAMAs. AmerGen's responses addressed the NRC staff's concerns, and resulted in the identification of two additional potentially cost-beneficial SAMAs.

An assessment of SAMAs for TMI-1 is presented below.

F.2 Estimate of Risk for TMI-1

AmerGen's estimates of offsite risk at TMI-1 are summarized in Section F.2.1. The summary is followed by the NRC staff's review of AmerGen's risk estimates in Section F.2.2.

F.2.1 AmerGen's Risk Estimates

Two distinct analyses are combined to form the basis for the risk estimates used in the SAMA analysis: (1) the TMI-1 Level 1 and 2 PRA models, which are updated versions of the IPE (GPU 1993) and IPEEE (GPU 1994), and (2) a supplemental analysis of offsite consequences and economic impacts (essentially a Level 3 PRA) developed specifically for the SAMA analysis. The SAMA analysis is based on the most recent TMI-1 Level 1 and 2 PRA model available at the time of the ER, referred to as the 2004 Revision 2 Level 1 model (Exelon 2007a), and the Level 2 model of 2007 (Exelon 2007b). The scope of the Level 1 model includes both internal and external initiating events. The external events evaluated are external floods, seismic events, and internal fires. However, the external events models are not integrated with the internal events model, thereby necessitating a separate assessment of the risk (and risk reduction) for internal and external events. AmerGen placed particular emphasis on external flooding events since they dominate the calculated risk at TMI-1.

The baseline CDF for the purpose of the SAMA evaluation is approximately 2.37×10^{-5} per year for internal events (including internal flooding events), and 8.11×10^{-5} per year for external flooding events. AmerGen accounted for the potential risk reduction benefits associated with internal event-and external flooding-related SAMAs by separately quantifying the benefits using the internal event or external flooding model, respectively. For internal event-related SAMAs, AmerGen accounted for the potential risk reduction benefits associated with non-flooding external events (i.e., seismic and fire events) by doubling the estimated benefits for internal events. For seismic- and fire-related SAMAs, AmerGen separately estimated the risk reduction benefits using the seismic and fire risk models. This is discussed further in Sections F.2.2 and F.6.2.

The breakdown of CDF by initiating event is provided in Tables F-1a and F-1b for internal events and external flooding events, respectively. As shown in these tables, internal event CDF is dominated by loss of offsite power events, transients, small loss of coolant accidents (LOCA), and loss of nuclear service water events. External flooding CDF is dominated by events with flood levels exceeding 305 feet mean sea level (msl).

The Level 2 PRA model that forms the basis for the SAMA evaluation represents an updated version of the original IPE Level 2 model. The Level 1 core damage sequences are binned into Plant Damage State bins which provide the interface between the Level 1 and Level 2 models. The Level 2 model utilizes a single containment event tree (CET) containing both phenomenological and systemic events. CET nodes are evaluated using supporting fault trees and logic rules.

Table F-1.a TMI-1 Internal Events Core Damage Frequency		
Initiating Event	**CDF (Per Year)**	**% Contribution to CDF**
Loss of Offsite Power	7.73×10^{-6}	32.6
Transients	5.80×10^{-6}	24.5
Small and Very Small LOCA	4.66×10^{-6}	19.7
Loss of Nuclear River Water	3.67×10^{-6}	15.5
Steam Generator Tube Rupture	9.93×10^{-7}	4.2
Internal Floods	4.50×10^{-7}	1.9
Large and Medium LOCA	2.06×10^{-7}	< 1
ISLOCA	1.80×10^{-7}	<1
Total CDF (internal events)	$\mathbf{2.37 \times 10^{-5}}$	**100**

Table F-1.b TMI-1 External Flooding Events Core Damage Frequency		
External Flooding Event	**CDF (Per Year)**	**% Contribution to CDF**
>310 feet	6.37×10^{-5}	78.5
305 to 310 feet	1.71×10^{-5}	21.1
<305 feet	2.50×10^{-7}	< 1
Total	$\mathbf{8.11 \times 10^{-5}}$	**100**

The result of the internal events Level 2 model is a set of 39 release categories with their respective frequency and release characteristics. The release categories and their frequencies are presented in Table E.2-16 of the ER. The categories were defined based on the timing, duration, and magnitude of the release and whether the containment remains intact or is bypassed. The frequency of each release category was obtained by summing the frequency of the individual CET end states assigned to each release category. The 39 release categories were further collapsed into nine major source term groups having similar containment response. The nine major source term groups and their release characteristics are presented in Tables E.2-17 and E.2-18 of the ER. The release characteristics for these nine source term groups were developed from Modular Accident Analysis Program (MAAP) analyses performed specifically to support the SAMA analysis (AmerGen 2008b).

For external flooding events, a simplified version of the internal events CET was developed and used to map external flood sequences to representative release categories from the internal events analysis. The result of the analysis is a set of eight release categories with their respective frequencies. These release categories were subsequently collapsed into seven non-zero source term groups. The mapping of external flood sequences to source term group is presented in Tables E.2-21 and E.2-23 of the ER.

The offsite consequences and economic impact analyses use the MACCS2 code to determine the offsite risk impacts on the surrounding environment and public. Inputs for these analyses include plant-specific and site-specific input values for core radionuclide inventory, source term and release characteristics, site meteorological data, projected population distribution (within an 50-mile (mi) (80-kilometer [km]) radius for the year 2034, emergency response evacuation modeling, and economic data. The magnitude of the onsite impacts (in terms of clean-up and decontamination costs and occupational dose) is based on information provided in NUREG/BR-0184 (NRC 1997a).

AmerGen estimated the dose to the population within 50 mi (80 km) of the TMI-1 site to be approximately 0.323 person-sievert (Sv) (32.3 person-rem) per year (AmerGen 2008a) for internal events and 1.76 person-Sv (176 person-rem) per year for external flooding events (AmerGen 2008b). The breakdown of the total population dose by containment release mode is summarized in Table F-2. Steam generator tube rupture (SGTR) accidents, and basemat melt-through are the dominant contributors to population dose risk from internal events. For external flooding events, late containment failures and early containment failure (less than 12 hours following accident initiation) are the dominant contributors to population dose risk.

Table F-2. Breakdown of Population Dose by Containment Release Mode

	Internal Events		**External Flooding Events**	
Containment Release Mode	**Population Dose (Person-Rem Per Year)**	**% Contribution**	**Population Dose (Person-Rem Per Year)**	**% Contribution**
Steam generator tube rupture	11.7	36	0.1	<0.1
Interfacing system LOCA	1.0	3	negligible	0
Containment isolation failure	1.1	3	29	16
Early containment failure	5.6	17	61	35
Late containment failure (large)	0.3	1	15	9
Late containment failure (small)	1.7	5	66	37
Basemat melt-through	6.9	22	4	2
No containment failure	4.0	13	1	1
Total	**32.3**	**100**	**176**	**100**

(a) One person-rem = 0.01 person-Sv

F.2.2 Review of AmerGen's Risk Estimates

AmerGen's determination of offsite risk at TMI-1 is based on the following major elements of analysis:

- The Level 1 and 2 risk models that form the bases for the IPE submittal (GPU 1993) and the IPEEE submittal (GPU 1994),
- The major modifications to the IPE model that have been incorporated in the 2004 Revision 2 Level 1 model (Exelon 2007a), and the Level 2 model of 2007 (Exelon 2007b)
- Assignment of severe accident source terms to external flooding sequences, and
- The MACCS2 analyses performed to translate fission product source terms and release frequencies from the Level 2 PRA model into offsite consequence measures.

Each of these analyses was reviewed to determine the acceptability of AmerGen's risk estimates for the SAMA analysis, as summarized below.

The NRC staff's review of the TMI-1 IPE is described in an NRC report dated December 19, 1996 (NRC 1996). Based on a review of the IPE submittal and responses to RAIs, the NRC staff concluded that the IPE submittal met the intent of GL 88-20 (NRC 1988); that is, the licensee's IPE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities. Although no vulnerabilities were identified in the IPE, several improvements to the plant or procedures were identified. These improvements have been either implemented at the site or addressed in the SAMA evaluation process (AmerGen 2008a). These improvements are discussed in Section F.3.2.

There have been six revisions to the Level 1 model since the 1992 IPE submittal. AmerGen indicated that the 2004 Revision 2 Level 1 model reflects the TMI-1 configuration and design as of the model's completion date of June 2007, but that no plant changes have occurred since completion of the model that would impact the PRA. A comparison of internal events CDF between the 1992 IPE and the current PRA model indicates a decrease of approximately 43 percent (from 4.19×10^{-5} per year to 2.37×10^{-5} per year). A comparison of the contributors to the total CDF indicates that some have increased (e.g., loss of offsite power) while others have decreased (e.g., large and medium LOCA). A description of those changes that resulted in the greatest impact on the internal events CDF was provided in Section E.2.2 of the ER (AmerGen 2008a), and is summarized in Table F-3.

The CDF value from the 1992 IPE submittal (4.19×10^{-5} per year) is near the average of the CDF values reported in the IPEs for B&W plants. Figure 11.6 of NUREG-1560 shows that the IPE-based total internal events CDF for these plants ranges from approximately 1×10^{-5} to 7×10^{-5} per year, with an average CDF for the group of 3×10^{-5} per year (NRC 1997b). It is recognized that other plants have updated the values for CDF subsequent to the IPE submittals to reflect modeling and hardware changes. The current internal event CDF result for TMI-1 (2.37×10^{-5} per year, including internal flooding) is comparable to that for other plants of similar vintage and characteristics.

Table F-3. TMI-1 PRA Historical Summary

PRA Version	Summary of Changes from Prior Model	CDF (per year)
1992	IPE Submittal (excluding internal flooding)	4.19×10^{-5}
2000 Update	August 2000 update (including internal flooding CDF of 3.0×10^{-6}) - Changed model from reliability block diagrams to fault tree structure - Updated plant unavailability and failure rates	4.10×10^{-5}
L2RV2	November 2001 update (including internal flooding CDF of 2.56×10^{-6}) - Linked Level 2 model directly with Level 1 sequences	3.95×10^{-5}
ABSA	July 2003 update (including internal flooding CDF of 3.5×10^{-7}) - Resolved Level A and B Facts and Observations (F&Os) from peer certification - Updated initiating event, component failure, unavailability, and common cause databases - Revised human reliability analysis (HRA) using the EPRI HRA Calculator - Updated success criteria and operator action timing based on thermal-hydraulic (MAAP) analyses - Refined internal flooding screening analysis	3.38×10^{-5}
2004 Rev. 0	December 2004 update (including internal flooding CDF of 2.6×10^{-7}) - Converted model from RISKMAN linked event tree model to CAFTA single event fault tree model - Updated Main Feedwater and Main Steam system models related to steam generator isolation for SGTR and secondary line breaks - Updated 4KV/480V AC power system model to include individual fault trees for 480V buses and motor control centers - Updated common cause failure data to NUREG/CR-5497 (NRC 1998b) - Added logic to evaluate system availability following offsite power recovery - Incorporated joint human error probability (JHEP) basic events	3.07×10^{-5}
2004 Rev. 1	June 2005 update (including internal flooding CDF of 3.7×10^{-7}) - Corrected errors discovered subsequent to the conversion to CAFTA	3.36×10^{-5}
2004 Rev. 2	June 2007 update (including internal flooding CDF of 4.5×10^{-7}) - Added new basic events for common cause failure of several components - Added new maintenance unavailability events to include maintenance on various components - Added human error probabilities (HEPs) for controlling emergency feedwater, cooldown of the RCS, and steam generator isolation - Revised loss of offsite power (LOOP) initiating event frequency - Modified Very Small LOCAs event tree	2.37×10^{-5}

The NRC staff considered the peer reviews performed for the TMI-1 PRA, and the potential impact of the review findings on the SAMA evaluation. In the ER (AmerGen 2008a), AmerGen described the formal industry peer review of the 2000 Update Model conducted in August 2000. The final report on the peer review stated that “it was the general assessment of the peer review team that the TMI-1 PRA can be effectively used to support applications involving risk significant determinations supported by deterministic analysis, once the technical issues and recommendations for enhancements that are noted in the element summaries and Fact and Observation Sheets are addressed to an appropriate level of quality.” AmerGen stated in the ER that all “A” and “B” facts and observations (F&O) with the exception of one “B” level observation are closed, and that the unresolved “B” observation related to the need for independent technical and system engineer reviews of system notebooks and would have no significant impact on the SAMA evaluation. In response to an NRC staff RAI, AmerGen stated that no other peer reviews of the TMI-1 PRA have been conducted since the August 2000 peer review (AmerGen 2008b).

Given that the TMI-1 internal events PRA model has been peer reviewed and the peer review findings were either addressed or judged to have no adverse impact on the SAMA evaluation, and that AmerGen has satisfactorily addressed NRC staff questions regarding the PRA, the NRC staff concludes that the internal events Level 1 PRA model is of sufficient quality to support the SAMA evaluation.

As indicated above, the current TMI-1 PRA does not include an integral evaluation of external events. In the absence of such an analysis, AmerGen used the TMI-1 IPEEE, in conjunction with minor adjustments in seismic and fire risk results, to identify the highest risk accident sequences and the potential means of reducing the risk posed by those sequences, as discussed below.

The TMI-1 IPEEE was submitted in December 1994 (GPU 1994), in response to Supplement 4 of Generic Letter 88-20. This submittal included a seismic PRA, a fire-induced vulnerability evaluation, and risk analyses for external flooding, high winds, and other external events. While no fundamental weaknesses or vulnerabilities to severe accident risk in regard to external events were identified, several opportunities for risk reduction were identified and implemented when demonstrated to be cost effective as discussed below. In a letter dated July 9, 1999, the NRC staff concluded that the submittal met the intent of Supplement 4 to Generic Letter 88-20, and that the licensee’s IPEEE process is capable of identifying the most likely severe accidents and severe accident vulnerabilities (NRC 1999).

The IPEEE analysis of external flooding events followed the screening and evaluation approaches described in Supplement 4 of GL 88-20 (NRC 1991). The TMI-1 IPEEE showed that external floods are the most important contributors to external event CDF. The IPEEE external flooding analyses employed a simplified external flooding PRA and containment performance analysis. The evaluation used flood flow frequency data provided by the Corps of Engineers (COE), an assessment of the effectiveness of TMI-1 design measures to protect safety-related structures and components from the probable maximum flood (PMF), flood scenario evaluation, and manual risk quantification. The CDF for each flood scenario was obtained by multiplying the frequency of a flood reaching a given flood elevation by the conditional core damage probability associated with that flooding scenario. The potential impact on containment performance and isolation was evaluated following the core damage evaluation.

The external flooding CDF from the IPEEE was estimated to be 8.11 x 10^{-5} year (GPU 1994). The dominant external flooding initiating events and their contributions to the external flooding CDF are provided in Table E.2-21 of the ER (AmerGen 2008a), and summarized in Table F-1.b.

While no external flooding vulnerabilities were identified in the IPEEE, one plant improvement was identified. This improvement involved installing a flood-resistant means of providing 480V AC power and pumps to provide reactor coolant pump (RCP) seal cooling and makeup to the steam generators in station blackout conditions. AmerGen indicated that this external flooding improvement was subsequently implemented (AmerGen 2008a). Based on the information provided in the ER and in responses to RAIs (AmerGen 2008b), the NRC staff finds the treatment of external flooding events to be reasonable for the purposes of the SAMA analysis.

The TMI-1 IPEEE seismic analysis employed a seismic PRA with a simplified seismic containment performance analysis consistent with NUREG-1407. The seismic approach employed plant walkdowns by seismic review teams to identify components and structures that may impact risk, development of seismic fragility values for seismic components and structures, and CDF quantification using a modified version of the IPE risk model and integration of the plant logic model with the seismic hazard curve. The seismic CDF was quantified using two different sets of seismic hazard curves -- those developed by the Electric Power Research Institute (EPRI) (EPRI 1989) and those provided by Lawrence Livermore National Laboratory (LLNL) (NRC 1994). The applicant determined the seismic CDF to be 3.21 x 10^{-5} per year using the EPRI hazard curve and 8.43 x 10^{-5} per year using the LLNL hazard curve. Table F-4 summarizes the seismic CDF by initialing event category for both the EPRI and LLNL seismic hazard curves. The IPEEE did not identify any seismic vulnerabilities nor did it identify any seismic outliers beyond those already identified and resolved within the scope of the Unresolved Safety Issue (USI) A-46 program. However, in the process of performing the IPEEE analysis, several plant improvements were identified. These improvements involved modifications to: reinforce 1P, 1R, 1S, and 1T load center gusset welds, add main control room ceiling supports, add seismic restraint for penetration pressurization tank PP-T-1A, modify the supports for the diesel-driven fire pump fuel oil tanks and battery racks, modify the anchorage for the decay heat closed cooling water heat exchangers, and modify the anchorage for the emergency diesel generator (EDG) air receivers. The structural improvements to the main control room ceiling, the penetration pressurization tank, and the EDG air receiver anchorage were subsequently implemented. The structural improvements to the remaining three components are addressed by candidate SAMAs (SAMAs 27, 28, and 30). This is discussed further in Section F.3.2. The NRC review and closure of USI A-46 for TMI-1 is documented in a letter dated August 12, 1998 (NRC 1998c).

Table F-4. TMI-1 Seismic Events Core Damage Frequency			
		CDF (per year)	
Initiating Event	Earthquake Range	EPRI	LLNL
SEIS1	0.052g to 0.2g	5.78×10^{-6}	1.26×10^{-5}
SEIS2	0.2g to 0.3g	1.04×10^{-5}	2.61×10^{-5}
SEIS3	0.3g to 0.5g	1.22×10^{-5}	3.25×10^{-5}
SEIS4	0.5g to 1.01g	3.71×10^{-6}	1.31×10^{-5}
Total Seismic CDF		3.21×10^{-5}	8.43×10^{-5}

To provide additional insight as to the appropriate seismic CDF to use for the SAMA evaluation, the NRC staff developed an independent estimate of seismic CDF for TMI-1 using the approximation method described in a paper by Robert P. Kennedy, entitled “Overview of Methods for Seismic PRA and Margin Analysis Including Recent Innovations” and using updated 2008 seismic hazard curve data from the U.S. Geologic Survey (USGS). This approach uses a median capacity (C_{50}) of 0.29g, based on the TMI-1 IPEEE high confidence of low probability of failure (HCLPF) value for critical equipment. The NRC staff’s independent calculation estimates the seismic CDF for TMI-1 to be less than 3.3×10^{-5} per year. This is less than half of the IPEEE-reported screening value based on the LLNL seismic hazard curve (8.43×10^{-5} per year) and is essentially the same as the IPEEE-reported value based on the EPRI seismic hazard curve (3.21×10^{-5} per year). Based on the NRC staff’s independent estimate of the seismic CDF, and the fact that structural improvements implemented since the IPEEE have not been accounted for in the estimate of seismic CDF, the NRC staff concludes that the seismic CDF is likely less than 3.2×10^{-5} per year.

The IPEEE fire analyses employed a progressive screening analysis, with quantification based on the IPE PRA model. EPRI’s fire-induced vulnerability evaluation (FIVE) methodology was used with deviations. The evaluation was performed in nine steps: (1) identify critical areas of vulnerability, (2) identify components important to safety, (3) locate components important to safety, (4) review fire areas for growth and propagation, (5) evaluate component fragilities and failure modes, (6) review fire detection and suppression systems, (7) identify impacts on top events, (8) calculate screening CDF, and (9) perform detailed analysis of remaining fire areas using FIVE fire and damage modeling techniques. The total fire CDF from the IPEEE was estimated to be 2.4×10^{-5} year (GPU 1994). The dominant fire scenarios and their contributions to the fire CDF are listed in Table F-5. The IPEEE did not identify any fire vulnerabilities or improvements related to fire risk.

In the ER, AmerGen states that the use of the fire analysis results as a reflection of CDF may be inappropriate and that while the fire PRA is generally self-consistent within its calculational framework, the fire analysis does not compare well with the internal events PRA because of a number of conservative assumptions that have been included in the fire analysis process. The ER provides a list of fire analysis topics (involving technical inputs, data and modeling) that prevent the effective comparison of the CDF between the internal events PRA and the fire analysis. In response to an RAI requesting the applicability of the general topics to the TMI-1 fire analysis (NRC 2008a), AmerGen provided several TMI-1-specific examples of conservatisms in the fire analysis, including: potential reduction in fire ignition frequencies, conservative fire protection system assumptions (e.g., automatic fire suppression systems are not credited), conservative target fire damage assumptions (e.g., a fire in a given area was assumed to destroy all equipment in the area), and conservative failure probabilities for human recovery actions (e.g., manual fire suppression or detection is not credited) (AmerGen 2008b). Based on the arguments regarding the conservatisms in the fire analysis presented in the ER and RAI responses, AmerGen assumed a total fire CDF of 2.16×10^{-5} per year in the SAMA analysis, which is the sum of the fire CDF for the five fire areas having a fire CDF greater than 1×10^{-6} per year. While this assumption appears to be non-conservative, AmerGen noted in Section E.6.26 of the ER that the fire CDF for fire area CB-FB-2e reported in the IPEEE (5.81×10^{-6} per year) contained an error that overestimated the fire CDF and that the correct value is 3.09×10^{-6} per year. As shown in Table F-5, using the corrected fire CDF for fire area CB-FB-2e results in a revised total fire CDF of 2.13×10^{-5} per year, and offsets AmerGen not including the CDF from fire areas having a fire CDF less than 1×10^{-6} per year.

Based on the information provided by the applicant, the NRC staff finds the treatment of fire events to be reasonable for the purposes of the SAMA analysis.

Table F-5. TMI-1 Fire Areas and Their Contribution to Fire CDF

Fire Area	Fire Area Description	CDF (per year)	
		IPEEE	Corrected IPEEE
CB-FA-2d	East Inverter Room	4.94×10^{-6}	4.94×10^{-6}
CB-FA-2e	West Inverter Room	5.81×10^{-6}	3.09×10^{-6}[c]
CB-FA-3a	1D Switchgear Room	3.94×10^{-6}	3.94×10^{-6}
CB-FA-3b	1E Switchgear Room	4.96×10^{-6}	4.96×10^{-6}
CB-FA-4b	Control Room -- Console CR	1.96×10^{-6}	1.96×10^{-6}
CB-FA-4b	Control Room -- Panel CC	8.40×10^{-7}[a]	8.40×10^{-7}[a]
CB-FA-2	East Battery Room	7.35×10^{-7}[a]	7.35×10^{-7}[a]
	Other Scenarios	8.15×10^{-7}[b]	8.15×10^{-7}[b]
Total Fire CDF		2.4×10^{-5}	2.13×10^{-5}

(a) Values provided in response to RAIs (AmerGen 2008b).
(b) Value derived as the difference between the total fire CDF reported in the IPEEE and the fire CDFs reported for the seven fire areas.
(c) Corrected value from Section E.6.26 of the ER (AmerGen 2008a).

The IPEEE analysis of high winds and other non-flooding external events followed the screening and evaluation approaches described in Supplement 4 of GL 88-20 (NRC 1991) and did not identify any significant sequences or vulnerabilities (GPU 1994). (AmerGen modeled external flooding events separately, as discussed above.) Based on this result, AmerGen concluded that these other external hazards, which were estimated to have a combined CDF of 1.33×10^{-6} per year, would not impact the conclusions of the SAMA analysis. Accordingly, they did not consider specific SAMAs for these events. This is discussed further in Section F.3.2. AmerGen noted that the risks from deliberate aircraft impacts were explicitly excluded since this was being considered in other forums along with other sources of sabotage.

Using the CDF values reported in the ER, the non-flooding external events CDF would be approximately 4.5 times the internal events CDF (based on a seismic CDF of 8.43×10^{-5} per year, a fire CDF of 2.16×10^{-5} per year, a combined CDF from high winds and other non-flooding external events of 1.33×10^{-6} per year, and an internal events CDF of 2.37×10^{-5} per year). Accordingly, the total CDF from internal and non-flooding external events would be approximately 5.5 times the internal events CDF. However, in assessing the benefits for internal event-related SAMAs, AmerGen accounted for the potential risk reduction benefits associated with non-flooding external events (i.e., seismic and fire events) by doubling the estimated benefits for internal events. (This doubling was not applied to the seismic- and fire-related SAMAs, since those SAMAs are specific to external events.)

The NRC staff requested additional justification for increasing the internal events benefits by only a factor of two in view of the significant contribution to CDF from non-flooding external events (NRC 2008a). In the RAI response, AmerGen clarified that the seismic CDF reported in the ER (8.43×10^{-5} per year) is a screening value based on LLNL seismic hazard curves and was used only in evaluating the benefit of seismic-related SAMAs (discussed later). AmerGen indicated that, in order to not skew the external events CDF when comparing it to the internal events CDF, the seismic CDF based on the EPRI seismic hazard curves (3.21×10^{-5} per year) should be used in the multiplier development (AmerGen 2008b). In response to the same RAI, AmerGen provided several TMI-1-specific examples of conservatisms in the seismic analysis, including: use of generic, bounding component seismic fragility curves, conservative seismic response assumptions (e.g., recovery of seismically-induced failure of the offsite power system is not credited), conservative seismic damage assumptions (e.g., failure of the main control room ceiling is always assumed to damage train B of Class 1E AC power), and conservative component failure probabilities (e.g., if a component fails in a seismic event then all similar components are assumed to fail) (AmerGen 2008b). AmerGen also noted that plant modifications to address seismic risk have been implemented since the IPEEE (as described above) and are not reflected in the IPEEE results. AmerGen further noted that the IPEEE fire CDF was based on conditional core damage probability values from the IPE internal events model, and that a re-quantification of the fire CDF based on the current internal events PRA would result in about a 43 percent reduction in fire CDF (from 2.16×10^{-5} per year to 1.22×10^{-5} per year). Using the adjusted seismic and fire CDF values, the total CDF for non-flooding external events (4.56×10^{-5} per year based on a seismic CDF of 3.21×10^{-5} per year, a fire CDF of 1.22×10^{-5} per year, and high winds/other non-flooding external event CDF of 1.33×10^{-6} per year) is approximately twice the internal events CDF. The NRC staff concludes that AmerGen's use of a multiplier of two in evaluating internal event-related SAMAs is reasonable for the purposes of the SAMA evaluation. This is discussed further in Section F.6.2.

The NRC staff reviewed the general process used by AmerGen to translate the results of the Level 1 PRA into containment releases, as well as the results of the Level 2 analysis, as described in the ER and in response to NRC staff requests for additional information (AmerGen 2009a and 2008b).

The Level 2 PRA model that forms the basis for the SAMA evaluation is referred to as the CAFTA Level 2 model of 2007 (Exelon 2007b). The model represents an updated version of the original IPE Level 2 model previously reviewed by the NRC staff. The Level 2 model utilizes a single containment event tree (CET), containing both phenomenological and systemic events, that is directly linked with the CAFTA 2004 Revision 2 Level 1 model. CET nodes are evaluated using supporting fault trees and logic rules. The model is fully described in TMI-PRA-001 (Exelon 2007b).

AmerGen characterized the internal events releases for the spectrum of possible radionuclide release scenarios using a set of 39 release categories. The release categories and their frequencies are presented in Table E.2-16 of the ER. The categories were defined based on the timing, duration, and magnitude of the release and whether the containment remains intact or is bypassed. The frequency of each release category was obtained by summing the frequency of the individual CET end states assigned to each release category. The 39 release categories were further collapsed into nine major source term groups having similar containment response. The nine major source term groups and their release characteristics are presented in Tables E.2-17 and E.2-18 of the ER. The release characteristics for these nine source term groups were developed from Modular Accident Analysis Program (MAAP) analyses performed specifically to support the SAMA analysis (AmerGen 2008b).

The core damage sequences developed for the external flooding model include the three major groups shown in Table F-1b. Of these groups, the floods above 310 feet and those below 305 feet are each represented by a single core damage sequence. The floods between 305 and 310 feet are represented by six sequences that were quantified using a CET developed specifically for the IPEEE external flooding evaluation. The descriptions and frequencies of these flood sequences are summarized in Table E.2-21 of the ER. AmerGen characterized the external flooding events releases for the spectrum of possible radionuclide release scenarios using a set of eight release categories from the internal events analysis, which were subsequently collapsed into seven non-zero source term groups. The source term frequencies associated with each of the flooding sequences is provided in Table E.2-23 of the ER. In response to an RAI, AmerGen provided additional information on the logic used to derive the source term frequencies for each of the flooding sequences (AmerGen 2008b). In response to another RAI, AmerGen provided a corrected frequency of 1.68×10^{-8} per year for source term RC-1 (SGTR) in Table E.2-23 of the ER (AmerGen 2008b).

The NRC staff's review of the Level 2 IPE concluded that it addressed the most important severe accident phenomena normally associated with large, dry containments, and identified no significant problems or errors (NRC 1996). The Level 2 PRA model was included in the TMI-1 peer review mentioned previously. It should be noted, however, that the current Level 2 model is a revision to version that was peer reviewed. The changes to the Level 2 model are described in Section E.2.2.3 of the ER (AmerGen 2008). Based on the NRC staff's review of the Level 2 methodology for both internal events and external flooding events and the responses to the RAIs concerning the Level 2 model, the NRC staff concludes that the Level 2 PRA provides an acceptable basis for evaluating the benefits associated with various SAMAs.

As indicated in the ER, the reactor core radionuclide inventory used in the consequence analysis was based on a 2002 plant-specific ORIGEN 2.1 calculation and corresponds to a 24-month refueling cycle and the licensed thermal power of 2568 MWt. All releases were modeled as occurring at 51.6 meters (top of the reactor building). The thermal content of each of the releases is assumed to be 1.0E+07 watts based on values provided in Sample Problem A in the

MACCS2 user's manual (NRC 1998a) and NUREG/CR-4551 (NRC 1990a). AmerGen assessed the impact of alternatively assuming either a ground level release or an ambient (non-buoyant) plume. The results of these sensitivity cases showed that reducing the release height to ground level results in about a 5 percent decrease in population dose-risk, and reducing the thermal plume heat content to ambient conditions results in less than a 2 percent increase in population dose-risk.

The NRC staff reviewed the process used by AmerGen to extend the containment performance (Level 2) portion of the PRA to an assessment of offsite consequences (essentially a Level 3 PRA). This included consideration of the source terms used to characterize fission product releases for the applicable containment release categories and the major input assumptions used in the offsite consequence analyses. The MACCS2 code was utilized to estimate offsite consequences. Plant-specific input to the code includes the source terms for each release category and the reactor core radionuclide inventory (both discussed above), site-specific meteorological data, projected population distribution within a 50-mi (80-km) radius for the year 2034, emergency evacuation modeling, and economic data. This information is provided in Attachment E of the ER.

AmerGen used site-specific meteorological data for the 1998 calendar year as input to the MACCS2 code. The data were collected from the onsite meteorological tower. Data from 1998 through 2000 were also considered, but the 1998 data were chosen because they were the most complete and because results of a MACCS2 sensitivity analysis indicated that the 1998 data produced slightly more conservative results than the data sets for the other years. All of the missing data gaps were less than 2 hours and interpolation was used to fill the gaps. The NRC staff notes that previous SAMA analyses results have shown little sensitivity to year-to-year differences in meteorological data and concludes that the use of the 1998 meteorological data in the SAMA analysis is reasonable.

The population distribution the licensee used as input to the MACCS2 analysis was estimated for the year 2034, based on the U.S. Census Bureau population data for 2000, as provided by the SECPOP2000 program (NRC 2003), and the expected annual population growth rate. The baseline population was determined for each of sixteen directions and each of ten concentric rings (total of 160 sectors) out to a radius of 50 mi (80 km) surrounding the site. The transient population within 10 mi (16 km) of the site was included. U.S Census block-group level population data is allocated to each sector based on the area fraction of the census block-groups in that sector. The 1990 and 2000 census data were used to determine a ten year population growth factor for each of the 50-mi (80-km) radius rings. The population growth factor for each ring was applied uniformly to all sectors in the ring to calculate the year 2034 population distribution. Population sensitivity cases were performed in which the baseline 2034 population was increased by 30 percent, and then decreased to the year 2000 population data rather than the projected year 2034 population. The resulting population dose and offsite economic cost risk increased and decreased by approximately 30 percent, respectively. In response to an RAI regarding the sensitivity case using the year 2000 population, AmerGen clarified that the population change from year 2034 (to year 2000) was approximately 29 percent and that the change in offsite economic cost risk was consistent with the change in population (AmerGen 2008b). The NRC staff considers the methods and assumptions for estimating population reasonable and acceptable for purposes of the SAMA evaluation.

The emergency evacuation model was modeled as a single evacuation zone extending out 10 mi (16 km) from the plant. Based on information in the ER, it was assumed that 95 percent of the population would evacuate. This assumption is conservative relative to the NUREG-1150 study (NRC 1990b), which assumed evacuation of 99.5 percent of the population within the emergency planning zone (EPZ). The evacuation time used in the SAMA analysis was based on a projection for the year 2034. The evacuees were assumed to begin evacuating 90 minutes after a General Emergency has been declared and to evacuate at an average radial speed of 1.18 miles per hour (mph) (0.53 meters per second [m/s]). This speed is the time weighted value accounting for season, day of the week, time of day, weather conditions, and special events. A sensitivity analysis was performed in which the evacuation speed was decreased by a factor of two (to 0.26 m/s). The result was a 15 percent increase in the total population dose. The NRC staff concludes that the evacuation assumptions and analysis are reasonable and acceptable for the purposes of the SAMA evaluation.

Much of the site-specific economic data was provided from SECPOP2000 (NRC 2003) by specifying the data for each of the counties surrounding the plant to a distance of 50 miles. SECPOP2000 utilizes economic data from the 1997 Census of Agriculture (USDA 1998). Generic economic data that applies to the region as a whole was taken from the MACCS2 sample problem input and revised when better information was available. Revised values included daily living expenses for people who have been evacuated and relocated, and the value of farm and non-farm wealth. The economic data were inflation-adjusted to the year 2006 using the consumer price index.

AmerGen addressed the impact on the SAMA analysis of three recently reported problems with SECPOP2000. These problems involved: (1) an inconsistency in the format in which several economic parameters were output from the SECPOP2000 code and input to the MACCS2 code, (2) an error that resulted in use of agricultural/economic data for the wrong counties in the SECPOP2000 calculations, and (3) an error that resulted in the economic data for some counties being handled incorrectly. Correction of the first of these errors is reflected in the baseline risk estimates provided in the ER. Correction of the second two errors was evaluated in a sensitivity analysis contained in the ER. Correction of the second two errors resulted in a decrease in population dose of approximately one percent and an increase in offsite economic cost risk of approximately 15 percent. The revised population dose results are reported in Section E.7.6.4 of the ER, and have been used as the basis for the NRC staff evaluation.

The NRC staff concludes that the methodology used by AmerGen to estimate the offsite consequences for TMI-1 provides an acceptable basis from which to proceed with an assessment of risk reduction potential for candidate SAMAs. Accordingly, the NRC staff based its assessment of offsite risk on the CDF and revised offsite doses reported by AmerGen.

F.3 Potential Plant Improvements

The process for identifying potential plant improvements, an evaluation of that process, and the improvements evaluated in detail by AmerGen are discussed in this section.

F.3.1 Process for Identifying Potential Plant Improvements

AmerGen's process for identifying potential plant improvements (SAMAs) consisted of the following elements:

- Review of the most significant basic events from the current, plant-specific PRA,
- Review of potential plant improvements identified in the TMI-1 IPE and IPEEE,
- Review of Phase II SAMAs from license renewal applications for six other U.S. nuclear sites,
- Review of dominant contributors to external flooding, seismic and fire events in the current external event risk models, and
- Review of other industry documentation discussing potential plant improvements.

Based on this process, an initial set of 33 candidate SAMAs, referred to as Phase I SAMAs, was identified. In Phase I of the evaluation, AmerGen performed a qualitative screening of the initial list of SAMAs using the following criteria:

- The SAMA is not applicable at TMI-1 due to design differences, or
- The SAMA has estimated costs that would exceed the dollar value associated with completely eliminating all severe accident risk at TMI-1.

Based on this screening, no SAMAs were eliminated leaving all 33 for further evaluation. These SAMAs, referred to as Phase II SAMAs, are listed in Table F.5-3 of the ER (AmerGen 2008a). In Phase II, a detailed evaluation was performed for each of the 33 SAMA candidates, as discussed in Sections F.4 and F.6 below.

AmerGen accounted for the potential risk reduction benefits associated with internal event- and external flooding-related SAMAs by separately quantifying the benefits using the internal event or external flooding model, respectively. For internal event-related SAMAs, AmerGen accounted for the potential risk reduction benefits associated with non-flooding external events (i.e., seismic and fire events) by doubling the estimated benefits for internal events. For seismic- and fire-related SAMAs, AmerGen separately estimated the risk reduction benefits using the seismic and fire risk models.

F.3.2 Review of AmerGen’s Process

AmerGen’s efforts to identify potential SAMAs focused primarily on areas associated with internal initiating events, but also included explicit consideration of potential SAMAs for external flooding, seismic, and fire events. The initial list of SAMAs generally addressed the accident sequences considered to be important to CDF from functional, initiating event, and risk reduction worth (RRW) perspectives at TMI-1, and included selected SAMAs from prior SAMA analyses for other plants.

AmerGen provided a tabular listing of the PRA basic events sorted according to their RRW (AmerGen 2008a). SAMAs impacting these basic events would have the greatest potential for reducing risk. AmerGen used a RRW cutoff of 1.01, which corresponds to about a one percent change in CDF given 100-percent reliability of the SAMA. This equates to a benefit of approximately $52,000 (after the benefits have been multiplied to account for non-flood external events). External flooding contributions were not included in the benefit calculations establishing the RRW review threshold because the benefit of external flooding SAMAs are evaluated separately from the internal events model. AmerGen also provided and reviewed the large early release frequency (LERF)-based RRW events down to a RRW of 1.01. AmerGen correlated the basic events with highest risk importance in the Level 1 and 2 PRA with the SAMAs evaluated in Phase I or Phase II, and showed that, with a few exceptions, all of the significant basic events are addressed by one or more SAMAs (AmerGen 2008a). Of the basic events of high risk importance that are not addressed by SAMAs, each is closely tied to other basic events that had been addressed by one or more SAMAs.

The staff noted that basic event GADF-PALL6-CP2FS was identified in the Level 2 importance list review as being addressed by the same SAMAs as identified in the Level 1 importance list review for this same basic event but that this basic event was not listed in the Level 1 importance list (NRC 2008a). In response to the RAI, AmerGen clarified that this event contributes almost exclusively to station blackout (SBO) scenarios and is effectively addressed by SAMAs 2 and 11.

AmerGen considered the potential plant improvements identified in the IPE and IPEEE in the identification of plant-specific candidate SAMAs for internal and external events, as summarized below.

The TMI-1 IPE identified five major procedural improvements. These enhancements are: (1) revise procedures to direct operators to throttle low pressure injection (LPI) prior to swapping the pump suction source from the borated water storage tank (BWST) to the containment sump, (2) revise accident management guidelines for SGTR events to direct the operators to isolate the failed steam generator and cooldown the primary system using the intact steam generator, (3) revise accident management guidelines for SGTR events in which isolation of the ruptured steam generator is not possible to direct the operators to refill the BWST to keep pace with reactor coolant system (RCS) inventory loss, (4) revise accident management guidelines to direct the operators to verify closure of the MU-14 valves after the transition to recirculation mode from high pressure injection (HPI) mode, and (5) include six specific operator actions in the licensed operator requalification training program. AmerGen noted that the first four improvements have been implemented and the fifth improvement has been partially implemented; therefore these improvements were not considered further in the SAMA analysis. The six operator actions associated with the fifth improvement included: (1) switchover to reactor sump recirculation following a LOCA, (2) properly throttling HPI flow after ES actuation, (3) tripping RCPs before seal damage after loss of nuclear services closed cooling water (NSCCW), (4) taking actions to prevent boron concentration when in recirculation following a LOCA, (5) refilling the BWST given SGTR, and (6) holding open or reopening RCP seal injection valve MU-V-20 on loss of instrument air. The first four operator actions have been implemented, and therefore were not considered further in the SAMA analysis. While AmerGen has identified no specific training for the last two operator actions, failure to perform these actions is included in the TMI-1 PRA model. The importance list review conducted by AmerGen for the SAMA analysis identified failure of operator action (5) as an important contributor to CDF. SAMA 10 was identified to address this event. The RRW for failure of operator action (6) is less than the cutoff threshold of 1.01 for identifying potentially cost-beneficial SAMAs. Nevertheless, this and similar loss of instrument air events is addressed by SAMA 13.

The TMI-1 external flooding IPEEE identified one opportunity for improvement related to external flooding events. This enhancement was to install a flood-resistant means of providing 480V AC power and pumps to provide RCP seal cooling and makeup to the steam generators. AmerGen stated that this enhancement has been implemented and was credited in the IPEEE external floods CDF. Nevertheless, AmerGen further considered potential SAMAs for external floods and identified two opportunities for additional reduction of the external flooding risk, specifically, SAMA 32, pre-stage severe external flooding equipment, and SAMA 33, increase the flood protection height. The NRC staff questioned whether there was adequate time to install the TMI-1 flood gates in fast-developing floods, such as the flood surge produced by a hurricane, and requested justification for not identifying and evaluating potential SAMAs to reduce this response time (e.g., pre-staging of cranes needed to install the gates) (NRC 2008a). In response to the RAI, AmerGen clarified that TMI-1 staff have about 7.5 hours to install the six flood panels at the Intake Screen Pumphouse, which are the last flood gates to be installed if needed, but that TMI-1 staff only require at most about 3 hours to install these panels (AmerGen 2008b). AmerGen further clarified that TMI-1 staff have about 36 hours to install the many other flood gates, which is significantly more time than is needed to complete their installation (AmerGen 2008c). Based on these arguments, AmerGen determined that there were no additional potentially cost-beneficial SAMAs to mitigate external flooding events.

The TMI-1 seismic IPEEE identified six opportunities for improvements related to seismic events. The enhancements included: (1) add gusset weld reinforcements to load centers 1P, 1R, 1S, and 1T to improve seismic ruggedness, (2) install additional supports for the main control room (MCR) ceiling to prevent failure in seismic events, (3) install a restraint on penetration pressurization tank PP-T-1A to prevent seismic interaction with reactor building purge inlet isolation valve AH-V-1D, (4) modify the diesel fire pump battery and fuel oil tank supports to increase their seismic ruggedness, (5) modify the anchorage for the decay heat service heat exchangers (DC-C-2A/B) to improve their seismic ruggedness, and (6) modify the anchorage for the EDG air receivers to improve their seismic ruggedness. AmerGen stated that enhancements (2), (3), and (6) were subsequently implemented, and therefore were not considered further in the SAMA analysis. As noted in Section E.5.1.6.2.2 of the ER (AmerGen 2008a), SAMA 27, improve the 480V AC load center welds, SAMA 30, improve diesel fire pump fuel oil tank and battery rack supports, and SAMA 28, improve the decay heat service cooler (DC-C-2A/B) anchorages, were identified and retained for the Phase II evaluation to specifically address un-implemented enhancements (1), (4), and (5), respectively. AmerGen further reviewed the top contributors to seismic risk to identify additional areas for potential plant improvement and identified three opportunities for additional reduction of the seismic risk, specifically, SAMA 2, install damage resistant high temperature RCP seals with a portable 480V AC generator for extended emergency feedwater (EFW) operation (originally identified based on internal events risk), SAMA 29, replace EDG ground resistors, and SAMA 31, modify specific containment penetration motor operated valves (MOVs) to fail closed.

The TMI-1 fire IPEEE did not identify any opportunities for improvements related to fire events (AmerGen 2008a). Nevertheless, AmerGen further reviewed the top contributors to fire risk to identify areas for potential plant improvement and identified two opportunities for additional reduction of the fire risk, specifically, SAMA 2 (described above) and SAMA 26, reroute cables so that they do not pass over ignition sources in fire zone CB-FA-2e or wrap theses cables in fire proof material. In response to an RAI on the potential for SAMAs that could reduce the fire risk in other fire areas screened on low CDF, AmerGen evaluated the fire risk for two additional fire scenarios, CB-FA-2f (East Battery Room) and the CC panel from fire area CB-FA-4b, and identified no additional potentially cost-beneficial SAMAs to mitigate these fire scenarios (AmerGen 2008b).

The TMI-1 IPEEE did not identify opportunities for improvements related to high winds, accidental aircraft impact, and hazardous chemical release events (AmerGen 2008a). In Section E.5.1.6.5 of the ER, AmerGen states that the maximum benefit of completely eliminating the risk of these events is less than the $50,000 minimum cost for implementing a SAMA. The NRC staff questioned the methodology used by AmerGen to calculate the maximum benefit of these events and asked AmerGen to provide a revised assessment of potential SAMAs based on the methodology presented by the NRC staff (NRC 2008a). In response to the RAI (AmerGen 2008b), AmerGen stated that the only types of SAMA candidates that would be potentially cost-beneficial utilizing the higher benefit values calculated utilizing the NRC methodology would be procedure changes, of which none could be identified to mitigate these types of events (AmerGen 2008b). AmerGen therefore identified no additional potentially cost-beneficial SAMAs to mitigate high winds, accidental aircraft impact, and hazardous chemical release events.

As discussed above, AmerGen's SAMA evaluation included SAMAs addressing unimplemented enhancements identified in the IPE and IPEEE, and SAMAs addressing additional enhancements based on a review of the dominant contributors to internal, external flooding, seismic, and fire events. Based on this information, the NRC staff concludes that the set of SAMAs evaluated in the ER addresses the major contributors to internal and external event CDF, that the opportunity for SAMAs related to both internal and external events has been adequately explored, and that it is unlikely that there are additional potentially cost-beneficial SAMA candidates.

The NRC staff noted that none of the initial 33 SAMA candidates were screened from further consideration in the Phase I evaluation, and questioned whether AmerGen had conducted a pre-screening process to develop this initial list (NRC 2008a). In response to the RAI, AmerGen stated that no formal pre-screening process had been used in the development of the Phase I SAMA list and that the list of 33 SAMA candidates represents the complete results of the SAMA identification process described in the ER (AmerGen 2008b).

For a number of the SAMAs evaluated in the ER, the information provided did not sufficiently describe the proposed modification. Therefore, the NRC staff asked the applicant to provide more detailed descriptions of the modifications for several of the Phase II SAMA candidates (NRC 2008a). In response to the RAI, AmerGen provided the requested information (AmerGen 2008b).

The NRC staff notes that the set of SAMAs submitted is not all inclusive, since additional, possibly even less expensive, design alternatives can always be postulated. However, the NRC staff concludes that the benefits of any additional modifications are unlikely to exceed the benefits of the modifications evaluated and that the alternative improvements would not likely cost less than the least expensive alternatives evaluated, when the subsidiary costs associated with maintenance, procedures, and training are considered.

The NRC staff concludes that AmerGen used a systematic and comprehensive process for identifying potential plant improvements for TMI-1, and that the set of potential plant improvements identified by AmerGen is reasonably comprehensive and therefore acceptable. This search included reviewing insights from the plant-specific risk studies, and reviewing plant improvements considered in previous SAMA analyses. While explicit treatment of external events in the SAMA identification process was limited, it is recognized that the prior implementation of plant modifications for external flooding, seismic, and fire events and the absence of external event vulnerabilities reasonably justifies examining primarily the internal events risk results for this purpose.

F.4 Risk Reduction Potential of Plant Improvements

AmerGen evaluated the risk-reduction potential of the 33 SAMAs that were applicable to TMI-1. The SAMA evaluations were performed using realistic assumptions with some conservatism. On balance, such calculations overestimate the benefit and are conservative.

For most of the SAMAs, AmerGen used model re-quantification to determine the potential benefits. The CDF and population dose reductions for internal events were estimated using the TMI-1 Level 1 and 2 PRA model (Version 2004 Revision 2) and for external flooding events were estimated using the IPEEE external flooding PRA model with plant damage states correlated to release categories from the internal events analysis. The changes made to the models to quantify the impact of SAMAs are detailed in Section E.6 of Appendix E to the ER (AmerGen 2008a). Table F-6 lists the assumptions considered to estimate the risk reduction for each of the evaluated SAMAs, the estimated risk reduction in terms of percent reduction in CDF and population dose, and the estimated total benefit (present value) of the averted risk. The estimated benefits reported in Table F-6 reflect the combined benefit in both internal and external events and reflect corrections to previously identified SECPOP2000 errors, as described in Section E.7.6 of Appendix E to the ER (AmerGen 2008a). The determination of the benefits for the various SAMAs is further discussed in Section F.6.

The NRC staff questioned the assumptions used in evaluating the benefits or risk reduction estimates of certain SAMAs provided in the ER (NRC 2008a). For SAMA 1, enhance the SBO EDG with auto start and load capability, the NRC staff requested the bases for the assumption for SAMA 1 that making modifications to automate start of the SBO EDG only reduces the probability of failure to start the SBO EDG by a factor of 10. In response, AmerGen clarified that most of the benefit for this SAMA is from preventing all seal LOCA cases resulting from the inability to provide power for RCP seal cooling within 13 minutes. In order to show that the results of this SAMA evaluation are not sensitive to the human error probability used in the modeling process, AmerGen set the probability to zero and showed that the change in CDF was negligible (AmerGen 2008b). The NRC staff considers the assumptions, as clarified, to be reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff asked for clarification as to why SAMA 10, automate BWST refill, was assumed to prevent, rather than just delay core damage (NRC 2008a). In response to the RAI, AmerGen clarified that SAMA 10 would include the installation of a new, higher flow pump to ensure the BWST can be refilled at a rate greater than inventory is being lost through the steam generator tube rupture (AmerGen 2008b). The NRC staff considers the assumption, as clarified, to be reasonable and acceptable for purposes of the SAMA evaluation.

In a separate RAI on SAMA 10, the NRC staff asked AmerGen to provide an assessment of the impact on the net value of this SAMA if the benefit of mitigating ISLOCA events were considered in addition to the already estimated benefit of mitigating SGTR events (NRC 2008a). In response to the RAI, AmerGen re-evaluated this SAMA by assuming the SAMA also eliminates all ISLOCA events. This bounding assumption resulted in a CDF reduction of approximately 4.2 percent, compared to 3.4 percent reported in the ER, and a population dose-risk reduction of approximately 17 percent, compared to 14 percent reported in the ER (AmerGen 2008b). The NRC staff considers the assumption, as revised, to be reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff questioned the modeling assumption that seismic SAMA 27, improve the 480V AC load center welds (HCLPF of 0.12g), and seismic SAMA 28, improve the decay heat service cooler anchorages (HCLPF of 0.09g), would result in seismic failure probabilities similar to that for the BWST (HCLPF of 0.3g), given the design and functional dissimilarities between the respective components (NRC 2008a). In response to the RAI (AmerGen 2008b), AmerGen noted that SAMA 27 was shown to be cost-beneficial by a wide margin and that only extreme fragility data changes could impact this result, which is not likely. For SAMA 28, AmerGen compared the component failure probability data for decay heat service coolers, which is considered a good surrogate for heat exchangers, with the BWST failure probability data used in the IPEEE. Based on this comparison, AmerGen determined that they generally have similar failure probabilities for the initiating events evaluated in the IPEEE, and that use of the BWST values result in slightly larger averted cost-risk. The NRC staff considers the assumptions, as clarified, to be reasonable and acceptable for purposes of the SAMA evaluation.

For SAMAs that were specifically developed to address internal event issues, AmerGen increased the benefit that was derived from the internal events model by a factor 2 to account for the additional benefits that these SAMAs might have in external events other than external floods (primarily seismic and fire events). The benefits in external floods were separately quantified using the external flood risk model, where applicable (as noted in Table F-6), and combined with these benefits.

For SAMAs that specifically address seismic events (i.e., SAMAs 27 through 31), the reduction in seismic CDF and population dose was not directly calculated (in Table F-6 these are noted as NOT ESTIMATED). For these SAMAs, a bounding estimate of the impact of the SAMA was made based on general assumptions regarding: the approximate contribution to total risk from external events relative to that from internal events; the fraction of the external event risk attributable to seismic events; and the fraction of the seismic risk affected by the SAMA (based on information from the IPEEE). For example, AmerGen assumed that the contribution to risk from external events (excluding external flooding events) is approximately equal to that from internal events, and that seismic events contribute about 80 percent of this external events risk. The seismic re-analysis was then used to identify the fraction of the seismic risk that could be eliminated by the potential enhancements.

The NRC staff notes that AmerGen's assumption that the seismic CDF is equivalent to 80 percent of the internal events CDF effectively results in a seismic CDF of 1.9 x 10^{-5} per year. In response an RAI, AmerGen noted that the seismic CDF reported in the IPEEE (based on use of the EPRI hazard curves) is 3.21 x 10^{-5} per year. AmerGen also identified a number of conservative assumptions in the IPEEE seismic analysis, and identified several seismic-related plant modifications that have been implemented but not reflected in the IPEEE risk results (AmerGen 2008b). As discussed in Section F.2.2, based on an independent estimate of the seismic CDF, and the fact that structural improvements implemented since the IPEEE have not been accounted for in the estimate of seismic CDF, the NRC staff expects that the seismic CDF would be less than 3.2 x 10^{-5} per year. The NRC staff assessed the impact that use of the higher seismic CDF (3.2 x 10^{-5} per year) would have on the cost effectiveness of the evaluated seismic SAMAs and found that the conclusions regarding these SAMAs would not be impacted.

For the SAMA that specifically addresses fire events (i.e., SAMA 26), the reduction in fire CDF and population dose also was not directly calculated. For this SAMA, a bounding estimate of the impact of the SAMA was made using a methodology similar to that described for seismic SAMAs. For example, it is assumed that the contribution to risk from external events (excluding external flooding events) is approximately equal to that from internal events, and that internal fires contribute 85 percent of this external events risk. The fire re-analysis was then used to identify the fraction of the fire risk that could be eliminated by potential enhancements in the applicable fire area. AmerGen's assumption that the fire CDF is equivalent to 85 percent of the internal events CDF effectively results in a fire CDF of 2.0 x 10^{-5} per year. As discussed in Section F.2.2, using the corrected fire CDF for fire area CB-FB-2e results in a revised total fire CDF of 2.13 x 10^{-5} per year. Thus, the fire CDF used in assessing the benefits for the fire-related SAMA is consistent with the revised total fire CDF.

While noting that AmerGen's assumptions that seismic CDF is 80 percent and fire CDF is 85 percent of the total non-flooding external events CDF appear internally inconsistent, the NRC staff concludes that the resulting seismic and fire CDFs are in general agreement with the seismic and fire CDFs and accompanying qualitative justification presented in Section F.2.2, and that AmerGen's risk reduction estimates for the seismic-and fire-related SAMAs are acceptable for purposes of the SAMA evaluation.

The NRC staff has reviewed AmerGen's bases for calculating the risk reduction for the various plant improvements and concludes that the rationale and assumptions for estimating risk reduction are reasonable and generally conservative (i.e., the estimated risk reduction is higher than what would actually be realized). Accordingly, the NRC staff based its estimates of averted risk for the various SAMAs on AmerGen's risk reduction estimates.

Table F-6. SAMA Cost/Benefit Screen Analysis for TMI-1[(a)]

SAMA	Assumptions[(d)]	% Risk Reduction[(b)]		Total Benefit[(c)] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
1 – Enhance the SBO EDG with auto start and load capability	IE: Modify event tree to prevent all seal LOCA cases resulting from inability to provide RCP seal cooling within 13 minutes. Reduce the probability of failure to start the SBO EDG during loss of AC power events by a factor of 10, and set corresponding Joint Human Error Probabilities (JHEPs) to 0. EF: Reduce the risk for LOOP scenarios for floods below 305' msl by the same percent reduction as for internal events.	21 ~0	16 ~0	1.0M	2.9M	3.1M
2 – Install damage resistant high temperature RCP seals with a portable 480V AC generator for extended EFW operation	**IE: Reduce the probabilities of RCP seal LOCAs and loss of AC power to instrument air during SBO by a factor of 10. Reduce the probability of failure to operate EFW valve EF-V-30 due to loss of instrument air by a factor of 10, and set corresponding JHEPs to 0.** **EF: Eliminate all SBO events for floods between 305' and 310' msl when flood gates are correctly installed; eliminate all risk from floods below 305' msl.**	**53** **5**	**53** **6**	**4.6M**	**13M**	**7.3M**
3 – Use NSCCW as an alternate cooling source for the decay heat removal (DHR) heat exchangers (DH-C-1A/B)	IE: Modify fault tree to include cross-tie of the NSCCW system to the DHR heat exchangers. EF: Eliminate power-recovered SBO events for floods between 305' and 310' msl when flood gates are correctly installed; eliminate all risk from floods below 305' msl.	15 ~0	8 ~0	620K	1.7M	2.5M

SAMA	Assumptions(d)	% Risk Reduction(b)		Total Benefit(c) ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
4 – Provide alternate power to HPI pump minimum flow recirculation valves MU-V-36 and MU-V-37	The RRW for the basic event is below the cost-beneficial cutoff.	NOT ESTIMATED				
5 – Enhance valves MU-V-76A/B and MU-V-77A/B to allow for rapid alignment changes in accident conditions	IE: Reduce the probability of failure to align the "C" HPI pump to provide seal injection by a factor of 100. EF: Reduce the risk for floods below 305' msl by 6.3 percent.	6 0	3 0	240K	660K	3.2M
6 – Add cross-ties within the trains of cooling systems – DHR, DHCCW, DHRW	IE: Modify fault tree to include cross-ties between Trains A and B of the DHRW system, between Trains A and B of the DHCCW system, between Trains A and B of the LPI system, and between Trains A and B of the DHR system. EF: Eliminate power-recovered SBO events for floods between 305' and 310' msl when flood gates are correctly installed; eliminate all risk from floods below 305' msl.	13 ~0	5 ~0	410K	1.1M	2.8M
7 – Use fire service water as an alternate cooling source for the intermediate closed cooling water (ICCW) heat exchangers	**IE: Modify fault tree to include cross-tie of the fire service water system to the ICCW heat exchangers.** **EF: Eliminate all risk from floods below 305' msl.**	**13** **~0**	**6** **~0**	**470K**	**1.3M**	**1.0M**
8 – Automate reactor coolant pump trip on high motor bearing cooling temperature	**IE: Reduce the probability of failure to trip the RCPs upon loss of NSCCW by a factor of 10, and set corresponding JHEPs to 0.** **EF: Does not mitigate external flooding**	**13** **0**	**23** **0**	**1.3M**	**3.6M**	**150K**

SAMA	Assumptions[d]	% Risk Reduction[b]		Total Benefit[c] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
	scenarios.					
9 – Proceduralize local atmospheric dump valve (ADV) operation	The current model is conservative in that it does not credit existing procedures to perform local ADV operations. Crediting the existing procedures by assigning a human error probability of 0.1 for failure to locally operate ADVs on loss of air reduces RRW below the cost-beneficial cutoff.	NOT ESTIMATED				
10 – Automate BWST refill						
Baseline Case[e]	IE: Reduce the probability of failure to refill the BWST from 2.65E-02 to 1.0E-04, and set corresponding JHEPs to 0. Eliminate all ISLOCA events. EF: Does not mitigate external flooding scenarios.	4 0	17 0	1.3M[f]	3.5M[f]	3.8M
Sensitivity Case	**IE: Reduce the probability of failure to refill the BWST from 1.0 to 1.0E-04, and set corresponding JHEPs to 0. Eliminate all ISLOCA events.** **EF: Does not mitigate external flooding scenarios.**	**17[f]** **0**	**50[f]** **0**	**6.3M[f]**	**17M[f]**	**3.8M**
11 – Enhance extreme external flooding mitigation equipment to address SBO and loss of seal cooling scenarios	**IE: Reduce the probability of failure to operate the EDGs and TD EFW pumps to 0.** **EF: For all floods, reduce the probability of failure to implement the external flooding measures to 1.0E-04 and reduce**	**34** **93**	**25** **93**	**17M**	**47M**	**4.3M**

SAMA	Assumptions[d]	% Risk Reduction[b]		Total Benefit[c] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
	the probability of failure to provide flood-resistant AC power to 2.0E-02.					
12 – Use the DHR system as an alternate suction source for HPI	**IE: Modify fault tree to include alignment of existing DHR valves DH-V-7A/B having a probability of failure of 0.1.** **EF: Does not mitigate external flooding scenarios.**	**4** **0**	**3** **0**	**210K**	**580K**	**50K**
13 – Change IA system logic to automatically start IA-P-1A/B after a low voltage trip in conjunction with an engineered safeguards actuation signal (ESAS)						
Baseline Case	IE: Reduce the probability of failure to start the air compressors using emergency power to 1.0E-05, and set corresponding JHEPs to 0. EF: Does not mitigate external flooding scenarios.	3 0	4 0	330K	920K	950K
Sensitivity Case[g]	**IE: Reduce the probability of failure to start the air compressors using emergency power to 1.0E-05, and set corresponding JHEPs to 0. Set the probability of failure to refill the BWST from 2.65E-2 to 1 (in both baseline and sensitivity case).** **EF: Does not mitigate external flooding scenarios.**	**8** **0**	**19** **0**	**2.4M[f]**	**6.6M[f]**	**950K**

SAMA	Assumptions(d)	% Risk Reduction(b)		Total Benefit(c) ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
14 – Replace HPI pump cooling alignment valves with MOVs	IE: Modify fault trees for all three makeup pumps to include alignment of alternative cooling sources NSCCW and DHCCW from the MCR. EF: Eliminate all risk from floods below 305' msl.	17 ~0	8 ~0	630K	1.73M	3.15M
15 – Automatic swap to recirculation mode	**IE: Reduce the probabilities of failure to swap over from injection to recirculation mode within one minute and within ten minutes to 1.0E-05, and set corresponding JHEP to 0.** **EF: Eliminate all manual recirculation failures for floods between 305' and 310' msl when flood gates are correctly installed and for floods below 305' msl.**	**5** **0**	**3** **0**	**210K**	**576K**	**450K**
16 – Automate HPI injection on low pressurizer level	**IE: Reduce the probability of failure to initiate HPI to 1.0E-04, and set corresponding JHEPs to 0.** **EF: Reduce the risk for floods below 305' msl by the same percent reduction as the internal events CDF.**	**6** **0**	**26** **0**	**1.8M**	**4.8M**	**1.1M**
17 – Auto isolate steam generators on high steam line flow	IE: Reduce the probability of failure to isolate the steam generators by a factor of 10, and set corresponding JHEP to 0. EF: Does not mitigate external flooding scenarios.	1 0	1 0	55K	150K	950K
18 – Provide the capability to align	IE: Reduce the probability of failure to align	2	~0			

SAMA	Assumptions[d]	% Risk Reduction[b]		Total Benefit[c] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
the standby battery charger and the 1A/1B DC cross-tie from the MCR	the standby battery charger by a factor of 10. EF: Eliminate all manual battery charger alignment failures for floods between 305' and 310' msl when flood gates are correctly installed. Reduce the risk for floods below 305' msl by the same percent reduction as the internal events CDF.	 0	 ~0	32K	89K	100K
19 – Install battery backed hydrogen igniters or a passive hydrogen ignition system	**IE: Modify fault tree for early containment failures to represent addition of a hydrogen ignition system with an unavailability of 0.01 in all sequences, including LOOP and SBO scenarios.** **EF: For all floods with successful containment isolation, reduce early containment failure by the same percentage as for internal events, and reassign to late containment failure.**	**0** **0**	**11** **18**	**3.4M**	**9.4M**	**760K**
20 – Extend the high pressure boundary through DHR valve DH-V-3 for ISLOCA isolation	IE: Completely eliminate all ISLOCA events. EF: Does not mitigate external flooding scenarios.	1 0	3 0	190K	520K	3.0M
21 – Install concrete shields to block direct pathways from the reactor pressure vessel (RPV) to the containment wall, and/or initiate containment flooding early in external flooding scenarios	**IE: Reassign early containment failures due to liner melt-thru to either basemat failure (75 percent of events) or intact containment (25 percent of events).** **EF: Reassign early containment failures due to liner melt-thru to either basemat failure or intact containment depending on availability of containment spray in**	**0** **0**	**3** **7**	**1.3M**	**3.6M**	**1.2M**

SAMA	Assumptions[d]	% Risk Reduction[b]		Total Benefit[c] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
	specific flood sequence.					
22 – Install an independent EFW system	IE: Modify fault trees to include the independent EFW system. EF: Eliminate all risk from floods below 305' msl.	6 ~0	17 ~0	1.4M	3.8M	5.0M
23 – Develop alarm response procedures to direct operation of RR-V-5 on low reactor building emergency cooling (RBEC) flow	**IE: Reduce the probability of failure to open MOV RR-V-5 by a factor of 10.** **EF: Reduce the population dose risk and annual offsite economic cost risk for LOOP scenarios for floods below 305' msl by the same percent reduction as for internal events.**	**0** **0**	**1** **0**	**32K**	**89K**	**50K**
24 – Install damage resistant high temperature RCP seals, a diesel engine as an alternate drive for an EFW pump, and a portable 480V AC generator for extended EFW operations	**IE: Same as SAMA 2. In addition, completely eliminate failure of the TD EFW pump to operate.** **EF: Eliminate all SBO events for floods between 305' and 310' msl when flood gates are correctly installed; eliminate all risk from floods below 305' msl.**	**53** **5**	**55** **6**	**4.7M**	**13M**	**8.4M**
25 – Install an additional EDG	IE: Eliminate all failures of the SBO EDG. EF: Eliminate all risk for floods between 305' and 310' msl when flood gates are correctly installed and from all floods below 305' msl.	9 5	9 6	1.6M	4.3M	6.0M
26 – Reroute cables so that they do not pass over ignition sources in fire zone CB-FA-2E	**FE: Eliminate all cable damage due to fire in fire zone CB-FA-2E.**	**13**	**13**	**400K**	**1.1M**	**900K**

SAMA	Assumptions[d]	% Risk Reduction[b]		Total Benefit[c] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
(West Inverter Room) or wrap them in fire proof material	**EF: Does not mitigate external flooding scenarios.**	**0**	**0**			
27 – Improve the 480V AC load center welds	**SE: Reduce failure probabilities for 480V AC load centers 1P, 1R, 1S, and 1T to those corresponding to a HCLPF of 0.30g.** **EF: Does not mitigate external flooding scenarios.**	**NOT ESTIMATED** **0**	**NOT ESTIMATED** **0**	**1.4M**	**3.9M**	**580K**
28 – Improve the decay heat service cooler (DC-C-2A/B) anchorages	SE: Reduce failure probabilities for decay heat service coolers to those corresponding to a HCLPF of 0.30g. EF: Does not mitigate external flooding scenarios.	NOT ESTIMATED 0	NOT ESTIMATED 0	51K	140K	580K
29 – Replace EDG ground resistors	SE: Eliminate all failures of the EDG ground resistors. EF: Does not mitigate external flooding scenarios.	NOT ESTIMATED 0	NOT ESTIMATED 0	28K	76K	800K
30 – Improve diesel fire pump fuel oil tank and battery rack supports	SE: Eliminate all failures of the FSW system supports. EF: Does not mitigate external flooding scenarios.	NOT ESTIMATED 0	NOT ESTIMATED 0	28K	76K	150K
31 – Modify specific containment penetration MOVs to fail closed	The estimated cost is greater than the entire seismic MACR.	NOT ESTIMATED				4.1M
32 – Pre-stage severe external flooding equipment	**IE: Does not mitigate internal events scenarios.**	**0**	**0**	**14M**	**39M**	**1.7M**

SAMA	Assumptions[d]	% Risk Reduction[b]		Total Benefit[c] ($)		Cost ($)
		CDF	Population Dose	Baseline	Baseline With Uncertainty	
	EF: For floods > 310' msl, reduce the probability of failure to implement the external flooding measures to 1.0E-02 and reduce the probability of failure to provide flood-resistant AC power to 2.0E-02. For floods between 305' and 310' msl, reduce the probability of failure to implement the severe flooding measures to 0.14.	**84**	**84**			
33 – Increase the flood protection height	**IE: Does not mitigate internal events scenarios.** **EF: For floods > 310' msl, use same failure probability for installing flood doors as used for the 305' to 310' msl floods.**	**0** **61**	**0** **59**	**9.8M**	**27M**	**2.7M**

(a) SAMAs in bold are potentially cost-beneficial.
(b) First risk reduction value reflects results of changes made to the internal events PRA model and second risk reduction value reflects results of changes made to the external flooding PRA model (AmerGen 2008a).
(c) Estimated benefits reflect revised values provided after correction of SECPOP2000 errors, as reported in Section E.7.6.5 of the ER (AmerGen 2008a). Reported benefit values account for risk reduction in internal events, external floods, and other external events, including fire and seismic events.
(d) IE: internal events; EF: external flooding events; FE: fire events; SE: seismic events.
(e) Analysis and results for risk reduction estimates provided in response to NRC staff RAI 6.i (AmerGen 2008b).
(f) Values estimated by NRC staff using data available in the ER (AmerGen 2008a) and provided in response to RAIs (AmerGen 2008b).
(g) Analysis and results for risk reduction estimates provided in response to NRC staff RAI 6.f (AmerGen 2008b).

F.5 Cost Impacts of Candidate Plant Improvements

AmerGen estimated the costs of implementing the 33 candidate SAMAs through the application of engineering judgment and use of other licensees' estimates for similar improvements. The cost estimates conservatively did not include the cost of replacement power during extended outages required to implement the modifications, nor did they generally include contingency costs associated with unforeseen implementation obstacles (AmerGen 2008a, AmerGen 2008b). The cost estimates provided in the ER did not account for inflation, which is considered another conservatism.

The NRC staff reviewed the bases for the applicant's cost estimates (presented in Section E.6 of Attachment E to the ER). For certain improvements, the NRC staff also compared the cost estimates to estimates developed elsewhere for similar improvements, including estimates developed as part of other licensees' analyses of SAMAs for operating reactors and advanced light-water reactors. In response to an RAI requesting a more detailed description of the changes associated with SAMAs 1, 2, 3, 5, 6, 10, 11, 14, 15, 20, 21, 26, 27, 29, 29, 31, 32, and 33, AmerGen provided additional information detailing the analysis and plant modifications included in the cost estimate of each improvement (AmerGen 2008b). The staff reviewed the costs and found them to be reasonable, and generally consistent with estimates provided in support of other plants' analyses.

The NRC staff requested additional clarification on the estimated cost of $950,000 for implementation of SAMAs 13 and 17 and $1,100,000 for implementation of SAMA 16, which seem high for what appear to be just logic changes (NRC 2008a). In response to the RAI, AmerGen further described these modifications as involving the design, procurement, and installation of hardware, simulator modifications, and changes to procedures and training (AmerGen 2008b). Based on this additional information, the NRC staff considers these estimated costs to be reasonable and acceptable for purposes of the SAMA evaluation.

The NRC staff concludes that the cost estimates provided by AmerGen are sufficient and appropriate for use in the SAMA evaluation.

F.6 Cost-Benefit Comparison

AmerGen's cost-benefit analysis and the NRC staff's review are described in the following sections.

F.6.1 AmerGen's Evaluation

The methodology used by AmerGen was based primarily on NRC's guidance for performing cost-benefit analysis, i.e., NUREG/BR-0184, *Regulatory Analysis Technical Evaluation Handbook* (NRC 1997a). The guidance involves determining the net value for each SAMA according to the following formula:

Net Value = (APE + AOC + AOE + AOSC) - COE where, APE = present value of averted public exposure ($)

AOC = present value of averted offsite property damage costs ($)

AOE = present value of averted occupational exposure costs ($)

AOSC = present value of averted onsite costs ($)

COE = cost of enhancement ($).

If the net value of a SAMA is negative, the cost of implementing the SAMA is larger than the benefit associated with the SAMA and it is not considered cost-beneficial. AmerGen's derivation of each of the associated costs is summarized below.

NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC 2004a). AmerGen performed the SAMA analysis using only a 3 percent discount rate (AmerGen 2008a) and based its decisions on potentially cost-beneficial SAMAs on these values.

Averted Public Exposure (APE) Costs

The APE costs were calculated using the following formula:

APE = Annual reduction in public exposure (Δ person-rem per year)
x monetary equivalent of unit dose ($2000 per person-rem)
x present value conversion factor (15.04 based on a 20-year period with a 3-percent discount rate).

As stated in NUREG/BR-0184 (NRC 1997a), it is important to note that the monetary value of the public health risk after discounting does not represent the expected reduction in public health risk due to a single accident. Rather, it is the present value of a stream of potential losses extending over the remaining lifetime (in this case, the renewal period) of the facility. Thus, it reflects the expected annual loss due to a single accident, the possibility that such an accident could occur at any time over the renewal period, and the effect of discounting these potential future losses to present value. For the purposes of initial screening, which assumes elimination of all severe accidents due to internal and external flooding events, AmerGen calculated an APE of approximately $972,000 for internal events and $5,290,000 for external flooding events for the 20-year license renewal period (AmerGen 2008b).

Averted Offsite Property Damage Costs (AOC)

The AOCs were calculated using the following formula:

AOC = Annual CDF reduction
x offsite economic costs associated with a severe accident (on a per-event basis)
x present value conversion factor.

For the purposes of initial screening, which assumes all severe accidents due to internal and external flooding events are eliminated, AmerGen calculated an annual offsite economic risk of about $129,000 for internal events and $620,000 for external flooding events based on the Level 3 risk analysis. This results in a discounted value of approximately $1,940,000 for internal events and $9,320,000 for external flooding events for the 20-year license renewal period (AmerGen 2008b).

Averted Occupational Exposure (AOE) Costs

The AOE costs were calculated using the following formula:

AOE = Annual CDF reduction
x occupational exposure per core damage event
x monetary equivalent of unit dose
x present value conversion factor.

AmerGen derived the values for averted occupational exposure from information provided in Section 5.7.3 of the regulatory analysis handbook (NRC 1997a). Best estimate values provided for immediate occupational dose (3300 person-rem) and long-term occupational dose (20,000 person-rem over a 10-year cleanup period) were used. The present value of these doses was calculated using the equations provided in the handbook in conjunction with a monetary equivalent of unit dose of $2000 per person-rem, a real discount rate of 3 percent, and a time period of 20 years to represent the license renewal period. For the purposes of initial screening, which assumes all severe accidents due to internal and external flooding events are eliminated, AmerGen calculated an AOE of approximately $15,000 for internal events and $50,000 for external flooding events for the 20-year license renewal period (AmerGen 2008b).

Averted Onsite Costs

Averted onsite costs (AOSC) include averted cleanup and decontamination costs and averted power replacement costs. Repair and refurbishment costs are considered for recoverable accidents only and not for severe accidents. AmerGen derived the values for AOSC based on information provided in Section 5.7.6 of NUREG/BR-0184, the regulatory analysis handbook (NRC 1997a).

AmerGen divided this cost element into two parts – the onsite cleanup and decontamination cost, also commonly referred to as averted cleanup and decontamination costs, and the replacement power cost.

Averted cleanup and decontamination costs (ACC) were calculated using the following formula:

ACC = Annual CDF reduction
x present value of cleanup costs per core damage event
x present value conversion factor.

The total cost of cleanup and decontamination subsequent to a severe accident is estimated in the regulatory analysis handbook to be $\$1.5 \times 10^9$ (undiscounted). This value was converted to present costs over a 10-year cleanup period and integrated over the term of the proposed license extension. For the purposes of initial screening, which assumes all severe accidents due to internal and external flooding events are eliminated, AmerGen calculated an ACC of approximately $462,000 for internal events and $1,580,000 for external flooding events for the 20-year license renewal period (AmerGen 2008b).

Long-term replacement power costs (RPC) were calculated using the following formula:

RPC = Annual CDF reduction
x present value of replacement power for a single event
x factor to account for remaining service years for which replacement power is required
x reactor power scaling factor

AmerGen based its calculations on the value of 875 megawatt electric (MWe). Therefore, AmerGen applied a power scaling factor of 875/910 (the ratio of the actual power level to the "generic" plant power level in NUREG/BR-0184) to determine the replacement power costs. For the purposes of initial screening, which assumes all severe accidents due to internal and external flooding events are eliminated, AmerGen calculated an RPC of approximately $126,000 for internal events and $431,000 for external flooding events for the 20-year license renewal period (AmerGen 2008b). For the purposes of initial screening, which assumes all severe accidents due to internal and external flooding events are eliminated, AmerGen calculated the AOSC to be approximately $588,000 for internal events and $2,010,000 for external flooding events for the 20-year license renewal period.

Using the above equations, AmerGen estimated the total present dollar value equivalent associated with completely eliminating severe accidents from internal and external flooding events at TMI-1 to be about $3.5M and $16.7M, respectively, for a total of $20.2M. Use of a multiplier of 2 to the internal events benefits (to account for external events other than external flooding events) increases the value to $23.7M and represents the dollar value associated with completely eliminating all internal and external event severe accident risk at TMI-1, also referred to as the Modified Maximum Averted Cost Risk (MMACR).

<u>AmerGen's Results</u>

If the implementation costs for a candidate SAMA exceeded the calculated benefit, the SAMA was considered not to be cost-beneficial. In the baseline analysis contained in the ER (using a 3 percent discount rate), AmerGen identified nine potentially cost-beneficial SAMAs. The potentially cost-beneficial SAMAs are:

- SAMA 8 – Automate reactor coolant pump trip on high motor bearing cooling temperature.
- SAMA 11 – Enhance extreme external flooding mitigation equipment to address SBO and loss of RCP seal cooling scenarios.
- SAMA 12 – Use the decay heat removal (DHR) system as an alternate suction source for HPI.
- SAMA 16 – Automate HPI injection on low pressurizer level.
- SAMA 19 – Install battery backed hydrogen igniters or a passive hydrogen ignition system.
- SAMA 21 – Install concrete shields to block direct pathways from the reactor pressure vessel (RPV) to the containment wall and/or direct containment flooding early in external flooding scenarios.
- SAMA 27 – Improve the 480V AC load center welds.
- SAMA 32 – Pre-stage severe external flooding equipment.

- SAMA 33 – Increase the flood protection height.

AmerGen performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment (AmerGen 2008a). If the benefits are increased by a factor of 2.75 to account for uncertainties, six additional SAMA candidates were determined to be potentially cost-beneficial:

- SAMA 2 – Install damage-resistant high temperature RCP seals with a portable 480V AC generator for extended EFW operation.
- SAMA 7 – Use fire service water as an alternate cooling source for the intermediate closed cooling water (ICCW) heat exchangers.
- SAMA 15 – Automate swap to recirculation mode.
- SAMA 23 – Develop alarm response procedures to direct operation of RR-V-5 on low reactor building emergency cooling (RBEC) flow.
- SAMA 24 – Install damage resistant high temperature RCP seals with a diesel engine as an alternate drive for an EFW pump and a portable 480V AC generator for extended EFW operation.
- SAMA 26 – Reroute cables so that they do not pass over ignition sources in fire zone CB-FA-2e or wrap them in fire proof material.

These results, and the population dose and SAMA benefit estimates reported in the present document (e.g., in Tables F-2 and F-5), reflect corrections to previously identified SECPOP2000 errors (AmerGen 2008a, AmerGen 2008b).

AmerGen also performed a sensitivity analysis of SAMA 10, automate BWST refill, assuming the current manual BWST refill capability only delayed core damage, not prevented core damage as assumed in the baseline analysis (AmerGen 2008a). Based on this sensitivity analysis, SAMA 10 was determined to be potentially cost-beneficial.

In response to an RAI, AmerGen provided a sensitivity analysis of SAMAs 13 and 22 also assuming manual BWST refill capability only delayed, not prevented, core damage (AmerGen 2008b). The sensitivity analysis resulted in identification of SAMA 13 being potentially cost-beneficial.

The potentially cost-beneficial SAMAs, and AmerGen's plans for further evaluation of these SAMAs are discussed in more detail in Section F.6.2.

F.6.2 Review of AmerGen's Cost-Benefit Evaluation

The cost-benefit analysis performed by AmerGen was based primarily on NUREG/BR-0184 (NRC 1997a) and was executed consistent with this guidance.

NUREG/BR-0058 has recently been revised to reflect the agency's policy on discount rates. Revision 4 of NUREG/BR-0058 states that two sets of estimates should be developed, one at 3 percent and one at 7 percent (NRC 2004a). AmerGen performed the SAMA analysis using only a 3 percent discount rate (AmerGen 2008a) and based its decisions on potentially cost-beneficial SAMAs on these values. SAMA benefits produced using a 3 percent discount rate are greater than those produced using a 7 percent discount rate, and would tend to result in identification of a greater number of potentially cost-beneficial SAMAs. Since use of a 3 percent discount rate is conservative, the NRC staff concludes that use of only a 3 percent discount rate in the cost-benefit analysis is acceptable for the purposes of the SAMA evaluation.

SAMAs identified primarily on the basis of the internal events analysis could provide benefits in certain external events, in addition to their benefits in internal events. To account for the additional benefits in external events, AmerGen: (1) multiplied the internal event benefits by a factor of two for each SAMA, except those SAMAs that specifically address fire and seismic risk (SAMAs 26 through 31), and (2) separately estimated the benefits of reducing the risk of external floods for each SAMA using the external flooding risk model and an approach similar to that for internal events. Doubling the internal event estimate for SAMAs 26 through 31, or including a benefit for reducing external flooding risk would not be appropriate because these SAMAs are specific to fire and seismic risks and would not have a corresponding benefit on the risk from internal or external flooding events.

The NRC staff notes that using AmerGen's adjusted seismic and fire CDF values, the total CDF for non-flooding external events (4.56×10^{-5} per year) is approximately twice the internal events CDF. This would suggest that the internal events benefits be tripled rather than doubled to account for additional SAMA benefits in external events. However, there are several considerations that support the use of a lower external events multiplier, as summarized below.

- The external event CDF may be lower due to remaining conservatisms in the analysis. The seismic, fire, and high winds analyses were performed in support of the IPEEE, well before the current TMI-1 internal events PRA, and vary in their degree of completeness and conservatism. The general trend in PRA development since the IPEEE has been to remove conservative modeling practices as better techniques for assessing risk are developed. Recognizing the level of conservatism in the earlier analyses and the fact that seismic improvements implemented since the IPEEE are not accounted for in the seismic CDF, the NRC staff agrees with AmerGen's claim that the CDF for non-flooding external events would likely be lower than reported above.

- The significance of the external events multiplier is diminished by separate quantification of SAMA benefits in external floods and by consideration of additional SAMAs targeted specifically to seismic and fire events. AmerGen separately assessed the benefits that internal events-related SAMAs would provide in external flooding events (which are the largest risk contributors at TMI-1), and separately quantified the benefits of seismic- and fire-related SAMAs. The external events multiplier reflects only the additional benefits that internal events-related SAMAs provide in seismic and fire events. Use of an external events multiplier implicitly assumes that each SAMA would offer the same percentage reduction in external event CDF and population dose as it offers in internal events. However, internal events-related SAMAs would likely have smaller benefits in seismic and fire events than in internal events, and smaller benefits than external event-related SAMAs would have in external events. Thus, the use of a somewhat lower external events multiplier is reasonable.

- The benefits of additional SAMAs would be reduced by implementation of the currently identified cost-beneficial SAMAs. AmerGen evaluated the impact on the SAMA results if the estimated total benefits (internal and external events) were increased by a factor of 2.75, and included any additional potentially cost-beneficial SAMAs identified in this analysis within the set of SAMAs that they intend to examine further for implementation. AmerGen's SAMA analysis resulted in identification of 17 potentially cost-beneficial SAMAs in seven unique categories. Although use of a higher external events multiplier (in the baseline and uncertainty analyses) might result in identification of additional potentially cost-beneficial SAMAs, the currently identified SAMAs would have a greater net value, and implementation of the most cost-effective SAMAs from the set of 17 would likely reduce the benefits of any additional SAMAs to the degree that they are no longer cost beneficial.

In consideration of the above factors, the NRC staff concludes that AmerGen's use of a multiplier of two in evaluating internal event-related SAMAs is reasonable for the purposes of the SAMA evaluation.

The NRC staff notes that of the nine SAMAs determined to be cost-beneficial in the baseline analysis, two of these, SAMAs 19 and 21, improve containment performance but do not impact CDF, and that similar SAMAs have not been found to be cost-beneficial in previous SAMA evaluations for PWR plants. As with previously evaluated PWR plants, these SAMAs also would not be cost-beneficial if just considering the benefit associated with internal events risk reduction (and multiplier accounting for non-flooding external events); the significant additional benefit associated with reduction of external flooding risk makes these SAMAs cost-beneficial at TMI-1. The relatively high estimated benefits for these SAMAs are the result of early containment failure due to SBO events caused by external flooding. The NRC staff found the evaluation of these SAMAs to be reasonable.

AmerGen considered the impact that possible increases in benefits from analysis uncertainties would have on the results of the SAMA assessment. In the ER, Entergy presents the results of an uncertainty analysis of the internal events CDF which indicates that the 95th percentile value is a factor of 2.75 times the point estimate CDF. AmerGen considered whether any additional Phase I SAMAs might be retained for further analysis if the benefits (and MMACR) were increased by a factor of 2.75. However, since no SAMAs were screened from further analysis during the Phase I screening, the use of the 95th percentile CDF has no impact on the Phase I analysis.

AmerGen also considered the impact on the Phase II screening if the estimated benefits were increased by a factor of 2.75 (in addition to the multiplier of 2 for external events other than external floods). Six additional SAMAs became cost-beneficial in AmerGen's analysis (SAMAs 2, 7, 15, 23, 24, and 26, as described above). Although not cost-beneficial in the baseline analysis, AmerGen included these six SAMAs within the set of potentially cost-beneficial SAMAs that they intend to examine further for implementation.

AmerGen did not develop a cost-risk analysis for three Phase II SAMAs:

- SAMA 4 – Provide alternate power to HPI pump minimum flow recirculation valves MU-V-36 and MU-V-37,

- SAMA 9 – Proceduralize local ADV operation, and
- SAMA 31 – Modify specific containment penetration MOVs to fail closed.

In the ER, AmerGen noted that the only events that could cause the valves in SAMA 4 to be "stranded closed" are those in which power was available to close the valves when directed by an engineered safeguards actuation signal (ESAS) and then power was lost before the valves could be re-opened prior to failure of the HPI pumps, which corresponds to an available time of 45 minutes out of 24 hours. To address this issue, AmerGen modified the fault tree to include a new basic event representing the fraction of time available to re-open the valves. For SAMA 9, AmerGen noted that TMI-1 already has procedures to perform local ADV operations that are not credited in the PRA model. To address this issue, AmerGen assigned a human error probability of 0.1 for the basic event representing local ADV operation. For both SAMAs 4 and 9, AmerGen's analysis showed that both the CDF and LERF based RRW for the basic events is below the review cutoff of 1.01 for identifying and assessing SAMAs. For SAMA 31, AmerGen noted the estimated cost to replace existing isolation valves with "fail closed" AOVs was greater than the maximum averted cost risk for seismic events. The benefits of these SAMAs were therefore not evaluated. The NRC staff found this rationale to be reasonable.

AmerGen also provided the results of additional sensitivity analyses in the ER, including variations in MACCS2 input assumptions, assumptions regarding BWST refill capability and extreme flooding mitigation capability, and the impact of implementing SAMA 32 (pre-stage severe external flooding equipment) on the other potentially cost-beneficial SAMAs. The analyses of the variation in MACCS2 input assumptions and extreme flooding mitigation capability assumptions did not identify any additional potentially cost-beneficial SAMAs beyond those already identified through the uncertainty analysis.

The baseline SAMA analysis contained in the ER assumes that manual BWST refill is capable of preventing core damage for SGTR events at TMI-1. AmerGen indicated in the ER that the validity of this assumption has recently been called into question, and therefore included in the ER an additional evaluation of SAMA 10 assuming the current capability only delayed, not prevented, core damage (AmerGen 2008a). Based on these results, SAMA 10 was determined to be potentially cost-beneficial, but was not included among the set of potentially cost-beneficial SAMAs identified in the ER. In response to an NRC staff request for clarification regarding AmerGen's plans for enhancement of the BWST refill capability, the licensee indicated that the SAMA process, in conjunction with other plant analyses, has identified the limited BWST refill capability as a potential area for improvement at TMI-1, and that this issue has been captured in the TMI-1 Corrective Action Program. AmerGen further stated that while the SAMA analysis does not explicitly evaluate the costs and benefits associated with only enhancing the existing manual capability, this potential option will be considered further in conjunction with the automation of the BWST refill function, i.e., SAMA 10 (AmerGen 2008b).

The NRC staff asked the licensee to identify and re-assess any other SAMAs that may be impacted by the BWST manual refill capability assumption (NRC 2008a). In their response to the RAI, AmerGen stated that only those SAMAs that significantly impacted SGTR frequency would be impacted by this assumption, specifically SAMAs 2, 11, 13, 16, 22, and 24. Of these, SAMAs 2, 11, 16, and 24 were already identified as being potentially cost-beneficial and were not evaluated further. AmerGen re-assessed the benefits of SAMAs 13 and 22 assuming the current BWST refill capability only delayed, not prevented, core damage. Based on this re-assessment SAMA 13, change IA system logic to automatically start IA-P-1A/B after a low voltage trip in conjunction with an ESAS, would be potentially cost-beneficial (AmerGen 2008b).

The NRC staff notes that given the impact of BWST refill capability on the estimated benefits for many of these potentially cost-beneficial SAMAs, it would be prudent for AmerGen to either resolve the BWST issue prior to performing the more detailed evaluation of these SAMAs, or to conservatively assume that the current manual BWST refill capability is not effective when evaluating the potentially cost-beneficial SAMAs for implementation.

In summary, the NRC staff notes that the 15 potentially cost-beneficial SAMAs (SAMAs 2, 7, 8, 11, 12, 15, 16, 19, 21, 23, 24, 26, 27, 32, and 33) identified in either AmerGen's baseline analysis, or uncertainty analysis, are included within the set of SAMAs that AmerGen will consider further for implementation (AmerGen 2008a). In response to an RAI by the NRC staff (NRC 2008a), AmerGen stated that SAMAs 10 and 13 would also be included within the set of SAMAs to be considered for implementation (NRC 2008b).

In the ER, AmerGen evaluated the impact of implementing SAMA 32, pre-stage severe external flooding equipment, on the benefit estimate for the other potentially cost-beneficial SAMAs. Since SAMA 32 addresses external flooding risk only, implementing this SAMA has no effect on the internal events model and associated benefit results for the other cost-beneficial SAMAs, nor does it have any affect on non-external flooding external events and those SAMAs identified to specifically address seismic and fire risk. This sensitivity analysis was performed for the baseline case assumptions with uncertainty (the most conservative case) and resulted in one previously identified potentially cost-beneficial SAMA, SAMA 21, no longer being cost-beneficial.

In light of the many potentially cost-beneficial SAMAs identified in the ER, the NRC staff asked AmerGen to identify those SAMAs having higher priority for being considered for implementation based on risk reduction potential and implementation cost, and which SAMAs would no longer be cost-beneficial if these higher priority SAMAs were implemented (NRC 2008a). In response to the RAI (AmerGen 2008b), AmerGen performed a qualitative assessment to prioritize the cost-beneficial SAMAs into a “minimal SAMA set” addressing the most significant risk contributors. Those SAMAs determined to have the most cost-effective risk reduction potential for each of the major risk areas defined the “minimal SAMA set.” Other cost-beneficial SAMAs were assigned to the “minimal SAMA set” category best representing the risk contributors each is mitigating. AmerGen determined that SAMAs 32 and 2 would have the highest priority based on their potential for significant reduction in risk (and relatively low implementation cost in the case of SAMA 32). AmerGen further identified SAMAs 12, 15, 16, 26, and 27 as a second tier priority based on their mitigation of plant risk contributors not addressed by SAMAs 32 and 2. The remaining cost-beneficial SAMAs were grouped into one of these seven high priority groups. The impact of these remaining potentially cost-beneficial SAMAs is expected to be reduced significantly if the higher priority SAMAs are implemented. The NRC considers this approach for prioritizing SAMAs to be reasonable.

The NRC staff concludes that, with the exception of the potentially cost-beneficial SAMAs discussed above, the costs of the other SAMAs evaluated would be higher than the associated benefits.

F.7 Conclusions

AmerGen compiled a list of 33 SAMAs based on a review of the most significant basic events from the plant-specific PRA, insights from the plant-specific IPE and IPEEE, Phase II SAMAs from license renewal applications for other plants, and review of other NRC and industry documentation. An initial screening was performed to remove SAMA candidates that (1) were not applicable at TMI-1 due to design differences or (2) had estimated costs that would exceed the dollar value associated with completely eliminating all severe accident risk at TMI-1. Based on this screening, no SAMAs were eliminated leaving all 33 candidate SAMAs for evaluation.

For the remaining SAMA candidates, a more detailed evaluation was performed as shown in Table F-6. The cost-benefit analyses showed that nine of the SAMA candidates were potentially cost-beneficial in the baseline analysis (SAMAs 8, 11, 12, 16, 19, 21, 27, 32, and 33). AmerGen performed additional analyses to evaluate the impact of parameter choices and uncertainties on the results of the SAMA assessment. As a result, six additional SAMAs (SAMAs 2, 7, 15, 23, 24, and 26) were identified as potentially cost-beneficial. AmerGen further identified SAMA 10 as being potentially cost-beneficial based on the results of a sensitivity analysis. In addition, as a result of the NRC staff review, AmerGen concluded that SAMA 13 was also potentially cost-beneficial. AmerGen has indicated that all of these SAMAs (SAMAs 2, 7, 8, 10, 11, 12, 13, 15, 16, 19, 21, 23, 24, 26, 27, 32, and 33) will be considered further for implementation.

The NRC staff reviewed the AmerGen analysis and concludes that the methods used and the implementation of those methods were sound. The treatment of SAMA benefits and costs support the general conclusion that the SAMA evaluations performed by AmerGen are reasonable and sufficient for the license renewal submittal. Although the treatment of SAMAs for external events was somewhat limited, the likelihood of there being cost-beneficial enhancements in this area was minimized by improvements that have been realized as a result of the IPEEE process, separate analysis of external flooding events, and inclusion of a multiplier to account for external events.

The NRC staff concurs with AmerGen's identification of areas in which risk can be further reduced in a cost-beneficial manner through the implementation of the identified, potentially cost-beneficial SAMAs. Given the potential for cost-beneficial risk reduction, the NRC staff agrees that further evaluation of these SAMAs by AmerGen is warranted. However, these SAMAs do not relate to adequately managing the effects of aging during the period of extended operation. Therefore, they need not be implemented as part of license renewal pursuant to Title 10 of the *Code of Federal Regulations*, Part 54.

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11. ABSTRACT *(200 words or less)*

This supplemental environmental impact statement (EIS) has been prepared in response to an application submitted by AmerGen Energy Company, LLC (AmerGen) to the Nuclear Regulatory Commission (NRC) to renew the operating license for Three Mile Island Nuclear Station, Unit 1 (TMI-1), for an additional 20 years under 10 CFR Part 54. The supplemental EIS includes the NRC's analysis that considers and weighs the environmental impacts of the proposed action, the environmental impacts of alternatives to the proposed action, and mitigation measures available for reducing or avoiding adverse impacts. It also includes the NRC's recommendation regarding the proposed action.

The NRC's preliminary recommendation is that the Commission determine that the adverse environmental impacts of license renewal for TMI-1 are not so great that preserving the option of license renewal for energy-planning decisionmakers would be unreasonable. The recommendation is based on (1) the analysis and findings in the GEIS; (2) the Environmental Report and supplemental information submitted by AmerGen; (3) consultation with Federal, State, and local agencies; (4) the NRC's own independent review; and (5) the NRC's consideration of public comments received during the scoping process.

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